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## A Study of Drivers and Barriers

Doctoral Thesis

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Thesis for the degree of Philosophiae Doctor

Trondheim, April 2018

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A ella, sin la que no hubiera podido llegar hasta aquí…

*Acknowledgement*

The PhD thesis presented here is the result of a long journey, reaching far beyond the three years of work that the research itself has demanded. Many people have assisted me in this process at different stages and in different ways. The list includes colleagues, friends, family, and supervisors. As the list may be too long to name everyone at this point, I should mention Dag Kittang and Eli Støa, my supervisors, who have provided support and guidance whenever I needed it. I would like to express my sincerest gratitude to them but also to the long list of unnamed contributors. I would also like to thank the Department of Urban Design and Planning of the Norwegian University of Science and Technology for funding my three years of research and the Department for Science, Technology, and Innovation (COLCIENCIAS) of the Colombian government for providing me with an additional study grant.

## Summary

This article-based doctoral thesis addresses the following question: What are the main drivers and barriers of urban densification as planning strategy in the quest for more sustainable cities in Norway? The research uses a mixed-method approach to explore specific aspects of the densification process. One such aspect is the practicability of making denser the sprawling Norwegian cities, and the effects that such gains in density imply for transport, one of the most significant aspects of sustainability. Another aspect investigated is the issue of social acceptability using land prices as a proxy. The analysis, based on a hedonic pricing model for Trondheim, indicates a tendency towards higher prices of dwellings per square metre in denser locations, although some aspects of density seem to produce a contrary effect. The research also delivers a systemic overview of the actors and factors shaping urban development. This analysis applies a multilevel-perspective approach used in sustainability transition studies to study the main factors and actors behind urban densification in Trondheim. Resulting data indicate that despite a strong emphasis in planning towards sustainability, practices behind urban development have not changed much.

As an answer to the main question posed above, the main drivers and barriers of urban densification in Norway are as follows. *The environmental:* Global environmental concerns have driven the adoption of national and local policies towards greater efficiency in the use of natural resources and a decrease in pollution. Urban densification is regarded as an important means to achieve these targets. The most important environmental barrier is the pre-existence of a scattered urban layout, fragmented in the rugged Norwegian geography, which makes it difficult to increase urban density and make substantial gains from recent changes in policy. *The social:* Demographic changes have facilitated the application of densification policies but entrenched social values, such as freedom of choice, make it difficult to apply restrictive measures, such as urban containment or car-usage restrictions. *The economic:* Changes towards a knowledge-based economy imply multiple benefits from larger, more intense urban environments; but given the pre-existence of a large sprawled urban form, the sunk investments in infrastructure make it difficult to accelerate urban changes towards denser urban environments. *The institutional:* The discourse on sustainability has gained strength at almost all institutional levels. However, to a large extent legal frameworks and procedural traditions remain unchanged.

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# Preface

Before starting this PhD, a significant part of my education and professional experience was gained in Colombia, my home country. I also completed a master's degree in Urbanism in the Netherlands and worked there for a short period of time. Colombia, the Netherlands, and Norway are very different countries, and even though architects and planners in general undertake similar tasks in these three countries, they face different challenges depending on each context. Colombia is a country with big cities, large, unplanned, and marginalised settlements, and notable differences between affluent and poor areas. The Netherlands is one of the densest countries in Europe with a significant part of its territory lying below sea level, yet it has a sophisticated infrastructure to cope with such a challenge. Norway, on the other hand, is one of least dense countries in Europe, with smaller cities, a highly affluent society, and a world-renowned social welfare system. In all three countries architects must design meaningful and useful buildings, and urban planners must anticipate future social needs and challenges to produce regulations and guidelines to adapt the urban spaces. In this PhD research, I draw from my experience as an architect and urban planner to address the issues outlined by the PhD project.

The research presented here addresses the issues outlined by the PhD project 'City Reconstruction and Densification' launched by the Department of Urban Design and Planning at the Norwegian University of Science and Technology (NTNU) in 2012. The general frame of the project is the adaptation of the existing city to the demands of sustainable development with a particular focus on densification. Density has long been regarded as a key attribute in the implementation of sustainable city strategies, because it is assumed that denser urban environments require fewer resources, facilitate the flow of people, goods, and energy, and produce fewer greenhouse gases. The initial call for proposals did not specify the research context but – owing to the location of NTNU, and the particularities of the Norwegian urban landscape, which was completely new to me – I decided to challenge myself and put the focus of this research on Norway, and to explore what lessons about sustainability can be learned in a context apparently hostile to densification. The Norwegian context is characterised by a relatively low population density in the larger cities, and a scattered population distribution throughout the country; but at the same time the country has some of the fastest growing urban areas in Europe. Norwegians also enjoy one of the highest per capita incomes in the world, allowing them to easily bear the cost of low-density lifestyles. When I first started this research

project in 2013, this combination of factors gave me the impression that urban densification policies in Norway might be unfeasible.

Urban density, being one of the most prominent characteristics of urban form, is an attractive attribute for an architect such as myself to study. Trained as a designer, I have often been intrigued by the formal aspects of density and how they materialise in the built environment; but at times during my practice as an urban planner, I have felt the need to understand the forces behind urban densification as a process. Questions, such as how some cities become denser than others in similar contexts, or how in some places but not in others denser inner-city areas are much more desirable environments to live in, are not the typical questions asked by an architect or even an urban designer, but they are frequent in city planning. I have had the good fortune to work in both, design and planning, facing two different ways of understanding the built environment. In my practice as an architect and designer, I have focused more on the aesthetics and proportions between built and unbuilt space in the city. As a planner, however, I have been fascinated by the forces behind densification, such as social values, economic interests, technological drivers, and urban politics. These combinations between material and non-material aspects put urban planning on a disciplinary edge that has commonly been researched by geographers, sociologists, economists, or engineers. Nonetheless, architects claim for their profession a more central role in urban forming. However, without a thorough understanding of the agents of urban change such a central role seems difficult to reach.

Throughout the development of this research, I have had conflicting pressures. Especially in the beginning, it was not easy to decide if I should research the formal aspects of density or the processes behind densification. Architects are mostly trained as designers and not as researchers. Of course, good design demands good research, for example about the users and their needs, the materials and their properties, or about the formal aspects of the building as an architectural object. However, I was more interested in studying the city as a process rather than as an object, which requires approaches and tools different to the ones used for the exercise of designing or the study of urban form. The understanding and interpretation of the architectural object and the urban form as static elements (the existent) are substantially different from the study of these objects as processes and products of social changes. The study of change involves a great deal of the unknown, because it is intended to predict possible futures (as yet non-existent). This task demands the expertise of several disciplines: engineering, social sciences, and humanities all have a fundamental role to play.

The reader of this thesis may ask if these two perspectives, whether to study the city as an object or the city as a process, have affected my work in any way. The answer is yes. There was a time when I had to decide what type of research I should do, and for what purpose. Here, in developing this thesis, my purpose has been to learn how to research and how to write about research; in parallel to this, I have been driven by the issue of sustainability and the important role that the built environment plays in achieving sustainability goals. That is why I decided to engage in research which in my opinion is more connected to the tradition of the social sciences than to the tradition of architecture. The reason for this is that the social sciences offer an extensive body of knowledge, from which I believe architects should learn in order to contribute better to the transformation of the built environment, in which the expertise of several disciplines is needed. In this work, I chose to focus on urban densification because it is a complex and pertinent concept in both urban planning and architecture; and I chose the Norwegian context because it sparked my intellectual curiosity. The Norwegian government has a strong commitment to the sustainability agenda, which at the urban level relates to, among other things, densification policies. At the same time, Norway is an advanced post-industrial economy, where free-market policies have been widely applied in urban development. It also experiences a demographic transition characterised by population ageing, immigration, and population concentration in the larger cities. Many other countries experience similar challenges, making the Norwegian case an interesting exploratory case study from which relevant lessons can be drawn.

# Part One

# 1. Introduction

*Today's problems cannot be solved if we still think the way we thought when we created them.*

Albert Einstein

The sustainability agenda promoted by multilateral organisations such as the United Nations and the European Union has placed an important emphasis on cities (Nijkamp & Kourtit 2013). Cities are the epicentre of most human activities, not only because the world's population is increasingly becoming more urbanised, but also because most economic activities are located in urban areas. Over the last decades, the process of global warming with its foreseeable consequences, such as sea level rise, an increase in frequency and intensity of extreme weather events, the destruction of ecosystems, and the deterioration of agricultural land, has become one of the main concerns about humankind's future. Since the 1970s different actions have been put on public agendas to combat the phenomenon of an increasing greenhouse effect in the atmosphere due to an accumulation of gases, such as $CO_2$. Climate change, poverty and social inequality, and the depletion of natural resources have become the major challenges for the future. These concerns have contributed to strengthening the interest in the planning discipline as a way to foresee future scenarios and to anticipate possible solutions to cope with these challenges. The concept of sustainable development has proved to be a useful tool in coordinating global actions aimed at overcoming these challenges.

The achievement of sustainable development goals, such as the reduction of greenhouse gas emissions and a more efficient use of natural resources, is in many ways connected with the way in which cities are built and how they operate. A denser urban form, according to many experts, is one of the fundamental pillars of the sustainable city (Jenks & Burgess 2000; Dodman 2009, Gudipudi et al. 2016, United Nations 2017). Higher urban densities allow public transport to be operated at lower costs for users and providers, and with higher travel frequencies. The reduction of distances also facilitates the possibility of walking or cycling as principal means of transport. This contributes to limit car usage, seen by many as a main factor in the worsening of local pollution and the increase of greenhouse gasses affecting the global climate. Denser cities can also reduce the cost of building and maintaining urban infrastructure and services (Livingston et al. 2003). Based on the assumption that denser cities use resources more efficiently, it is hoped that by adapting them – by making them more compact – it is possible to address sustainability challenges such as climate change, increase liveability, and

unleash robust economic growth based on economies of scale. The compact city has become the paradigm of sustainable urban development and, in turn, urban densification has become one of the main planning strategies towards sustainability. But even though there are supposedly many benefits to higher urban densities, densification policies remain controversial.

## 1.1. Urban Densification and its Challenges

Denser cities may have many advantages but they also have problems. The most prominent appear to be social acceptability, and the practicability of reverting decades of sprawled urban development. In market societies, individual values and institutions are based on the ideas of freedom of choice and self-interest. Consequently, social preferences in terms of the qualities of the built environment, housing types, and transport options are particularly important (Breheny 1997, Høyer & Næss 2001; Garcia & Riera 2003; Sager 2011; Bramley et al. 2009; Xue et al. 2016). Even if people accept the need to live more compactly, large parts of existing cities are already built in a periurban sprawl. Homeowners in such areas cannot easily move to more central and denser locations just to live more sustainably. Sunk investments in infrastructure, represented in capital which cannot be recovered, are an important limitation.

Changes in the built environment are gradual and influenced by a multitude of factors entangled in environmental, societal, economic, and institutional dimensions. A multilateral global agenda developed around environmental concerns has been a main driver in the application of urban densification policies, but many other local factors influence – in different ways – how such an approach is implemented. Proximity and concentration of activities seem to have certain benefits, particularly in terms of efficiency, making easier and cheaper the provision of transport and other basic urban services (Bettencourt & West 2010; Fertner & Große 2016). Urban containment can alleviate environmental pressures on ecosystems by limiting human activities in adjacent agricultural lands and highly valued natural areas. However, higher urban concentration can also decrease the local environmental quality for city dwellers by decreasing the area per head of open and green spaces and increasing exposure to noise and pollution (de Roo 2000; Evans 2003; Jim 2004; Foord 2010). Such trade-offs are a source of social resistance, particularly among affluent segments of the population. Thus, local institutions steering urban development are manoeuvring complex webs of social concerns about the local environment, the interests of powerful social groups, and 'common good' ideals such as global environmental protection (Stenstadvold 1996; Fernando 2003; Nijkamp & Kourtit 2013).

## 1.2. Research Problem and the Main Question

The problem researched in this thesis is the process of urban densification as a planning strategy to achieve sustainable development goals. The successful implementation of such a planning strategy is embedded in environmental circumstances, social values and demographic changes, economic interests, and institutionalised legal frameworks and procedural traditions. Denser urban environments are considered a fundamental requirement to decrease energy consumption, especially in transport. There are several other potential benefits derived from the proximity of services and functions offered by compact city areas, mostly in terms of efficiency in the use of infrastructure and the preservation of natural and agricultural periurban areas. However, changes in the built environment, such as densification, are influenced by powerful drivers and barriers, making implementation difficult and potential benefits uncertain.

The purpose of this thesis is to understand better the processes of urban change in general and the numerous drivers and barriers influencing the application of a specific planning strategy: urban densification in this case. A better understanding of drivers and barriers of urban densification may help to improve institutional practices and regulatory frameworks to better steer a transition towards more sustainable cities. This work also seeks to contribute to the academic debate on the challenges of city planning in the frame of sustainability after nearly three decades of action at different levels in Norway.

The central question underpinning the research is:

- *What are the main drivers and barriers of urban densification as planning strategy in the quest for more sustainable cities in Norway?*

This main question is the result of a series of attempts to find a way to better integrate the different parts of the research that had been developed as research articles and conference papers. After several attempts, the concept of *drivers and barriers* appeared to offer the best umbrella for the integration of the different research pieces, which only shared a common theme: urban densification in Norway.

## 1.3. Further Research Questions

Settlement patterns of Norway are rather scattered along its long coast line, characterised by numerous fjords and islands. This configuration has been influenced by the need for better

access to key natural resources such as arable land and fishery. These environmental factors are not now as determinant as they were in the past, but they have influenced the Norwegian way of living and its institutional approach towards the use of space. On the one hand, the dominance of detached houses in the Norwegian urban landscape suggests a widespread preference for spaciousness, privacy, and scenic views. On the other hand, strict regulations to protect agricultural land and forests, as well as a rugged landscape have shaped a patchy urban form, sprawled over vast areas. Urban expansion processes in the larger cities were particularly accelerated in the 1970s and 1980s, enabled by the economic expansion after the development of the Norwegian oil industry and increased car ownership (Næss et al. 2015). Norwegian cities, at first glance, appear almost the antithesis of the idea of a compact city.

Norway performs well according to different indices of sustainable development, where the environment is only one among other dimensions. High performance in social welfare and equality, as well as good governance, contribute to these results (Van de Kerk & Manuel 2014; Hsu et al. 2016). The big task, however, seems to be to improve some key indicators in environmental performance where, in contrast to other dimensions, the measurements are low. For example, according to analyses by the World Bank (2013), even though its electricity is derived mostly from hydroelectric power, Norway has one of the largest carbon footprints in Europe. The low density of urban agglomerations surely contributes to this. Norwegians have one of the highest average distances for daily trips made by car in Europe (Brunvoll & Monsrud 2013). Such a context raises a first research question:

- *How feasible and effective is urban densification in achieving the objectives of the sustainable city in Norway?*

For over twenty years, the Norwegian government has promoted urban densification as a key planning policy to cope with challenges such as curbing $CO_2$ emissions from transport (Norwegian Ministry of the Environment 1995, 2002, 2007, 2008, 2012, 2013). Among the primary approaches are the prioritisation of public transport, cycling and walking; the promotion of mixed-use areas along main public transport corridors; and proximity and enhanced accessibility to public services within walkable distances. Given the fact that Norwegians enjoy high incomes that allow them to bear the costs of low-density urban environments and car-based transport, it is understandable that urban densification as a planning strategy is difficult to implement. It has been mentioned already that social values and intuitional arrangements in market-driven societies are strongly influenced by free-choice

(Høyer & Næss 2001; Xue et al. 2016). Consequently, preferences regarding housing types and living environments are determinant in the way cities are shaped. Social acceptability of denser urban areas in a market-driven economic context becomes another issue of relevance. If one takes housing prices as a proxy measure of social acceptability of urban density, a second research questions arises:

- *How is urban density valued in the Norwegian housing market*?

In a market-driven society, urban changes are gradual, and they are influenced by multiple factors and actors. The government, in its multiple levels, is just one of these actors. City planning policies, however important or well-intended, require agreements with multiple parties to be implemented. Sustainable urban development, materialised through denser urban environments, is a desirable policy goal for local authorities. But resources such as land and capital to invest in the materialisation of planning policies such as densification are mostly in private hands. For private stakeholders, short-term economic issues are the dominant influences in decision-making in many cases. Following from this, if a project under the guidelines of a given planning initiative is not considered economically viable, its implementation is very likely to be postponed indefinitely. Given the complex interaction of factors and actors behind urban changes, a third research question has been formulated in the following terms:

- *What factors and actors influence the transition towards denser cities in Norway?*

These three questions introduced above have guided the development of three research articles forming Part Two of this thesis.

## 1.4. Research Design and Schematic Overview

This thesis has been conceived as an exploratory investigation to contribute to a better understanding of a complex process: urban densification as a planning strategy in Norway. Being an exploratory study, the focus is on several aspects, studied in their particular contexts. Hence, it forms a cumulative case study combining evidence from several cases taken as empirical support (see Figure 1). The theoretical component has been developed around the study of key concepts such as sustainable development, the sustainable city, urban theory, planning theory, sustainability transitions, and social change. These concepts have served as a platform to ground the empirical component. A multidimensional and multilevel analysis underpinned by the concept of drivers and barriers grouped in four dimensions – environmental,

social, economic, and institutional – has provided an integrative assessment framework leading to the main question:

- *What are the main drivers and barriers of urban densification as planning strategy in the quest for more sustainable cities in Norway?*

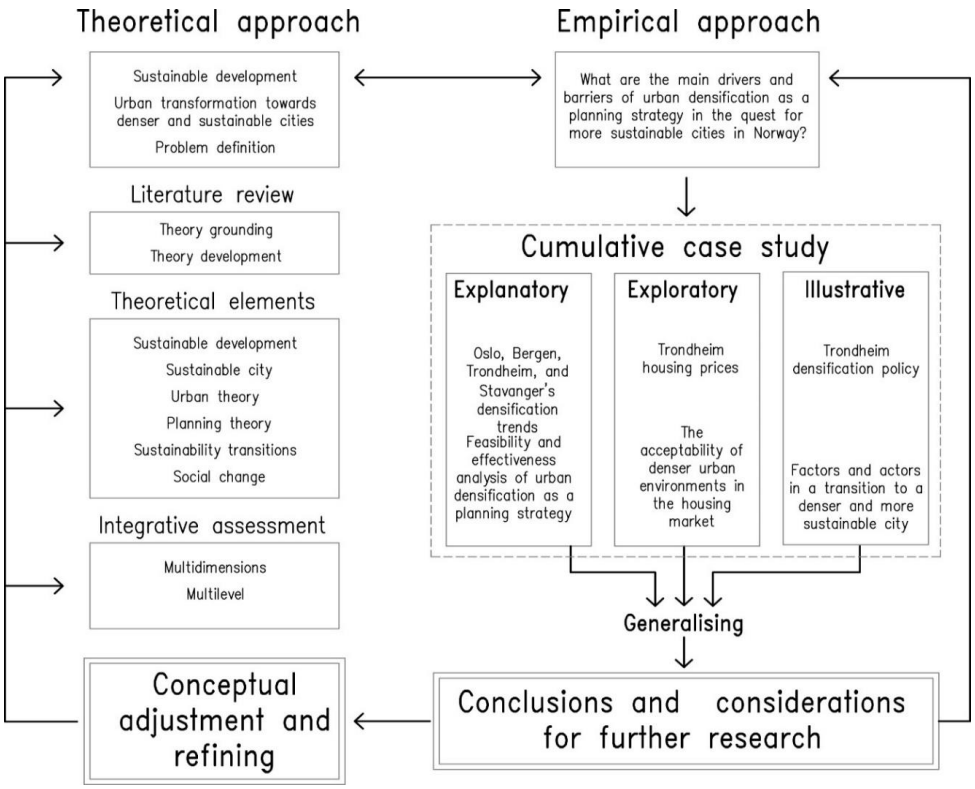


Figure 1. The research process

The structure of the theoretical and the empirical approaches synthesised in Figure 1 was defined throughout the research process. Such an intricate route has led to a long process of reflections on epistemological grounds, methodological approaches, and discussions of results (see *Section 3. Research Approach and Methodology*, p. 59). The central question presented here was designed at a later stage of the research as a platform of integration of the three case studies forming the empirical component

The research was originally developed in five separate research pieces: two conference papers and three research articles. The two conference papers – *Urban quality and the sustainable city in Norway: The challenge of density* and *The sustainable city in Norway: The quest for urban densification* – were merged into the text of *Section 2. Research Background.* The three research

articles (two of them published) correspond to: *Section 5. On the Feasibility and Effectiveness of Urban Densification in Norway*; *Section 6. The Value of Urban Density: An Exploratory Study of the Relationship between Urban Density and Housing Prices in Trondheim, Norway*; and *Section 7. A Transition to a Denser and More Sustainable City: Factors and Actors in Trondheim, Norway.* Formed by several pieces, the PhD research presented here has been a semi-structured process, in which only the issue of densification as a planning strategy was clear at a preliminary stage. As a final step of this research, the work has been organised and structured.

## 1.5.Structure of Thesis

The thesis is organised in two parts. Part One is formed by four sections. *Section 1. Introduction* presents the research problem, the research questions, and the research design. *Section 2. Research Background* introduces the antecedents of sustainable development, some of its main concepts, and their implications for cities. Densification as planning strategy is recognised as one of the most notorious instruments of the sustainable agenda with regards to the built environment. The section then introduces some of the most prominent drivers and barriers of urban densification in existing cities. And the final two sub-sections reflect upon the adaptation of sustainable development ideas in Norway. S*ection 3. Research Approach and Methodology* describes the research strategy, the theories and concepts, and the research methods used. *Section 4. Research Findings and Discussion of Results* examines the results in relation to the research questions and discusses the contribution of this work to the field of sustainable city studies.

Part Two presents the research articles. They seek to answer key questions about urban change towards denser and more sustainable cities in Norway. Each paper addresses a separate aspect of densification. *Section 5. On the Feasibility and Effectiveness of Urban Densification in Norway*, analyses figures such as density changes, dwelling types evolution, and shares of transport by mode in four Norwegian cities: Oslo, Bergen, Trondheim, and Stavanger. A combination of successful planning efforts and demographic trends seem to be the main reasons of the positive densification tendencies. But the effectiveness of this strategy with regard to curbing down car usage is less evident. *Section 6. The Value of Urban Density: An Exploratory Study of the Relationship between Urban Density and Housing Prices in Trondheim, Norway*, explores how housing prices, used as a proxy of social acceptability, are affected by urban density. The analysis suggest, despite some contradictory results, that densification in certain

conditions is well-accepted. And *Section 7. A Transition to a Denser and More Sustainable City: Factors and Actors in Trondheim, Norway* uses a multilevel perspective approach to analyse the interaction of drivers and barriers in the implementation of densification policies. Figures from Trondheim suggests that despite a shift of paradigm in planning towards sustainability legal frameworks and procedural traditions have not changed much.

# 2. Research Background[1]

This section discusses the issue of sustainable development and how sustainability has become a main aspect of the contemporary agenda in urban planning. The compact city model and densification as planning strategy have become dominant strategies in the search of more sustainable cities. Cities are embedded in specific geographic, social, and economic contexts, which require the adaptation of urban sustainability premises and the application of tailor-made planning strategies. The section discusses some of the most important drivers and barriers in the application of densification strategies found in contemporary cities. Norway as a country, despite having many things in common with other advanced economies, has particularities that have driven urban development in distinct ways. The section also introduces both general views on sustainability at the urban level and specific aspects of the Norwegian context, which influence urban policies and their outcomes. Planning for more sustainable cities has propelled the compact city as a paradigm of sustainable urban form and densification as a dominant planning strategy with particular implications for Norway.

## 2.1. What Is Sustainable Development?

The idea of sustainability has been developed to promote economic growth and social prosperity without harmful effects to the environment (Adams 2006). Sustainable development has become a dominant discourse since the early 1990s. The concept of sustainable development can be seen as an evolution of former concepts such as the late 19$^{th}$ and early 20$^{th}$ century idea of progress and the middle 20$^{th}$ century concept of development. While progress seems to emphasise the advance and diffusion of new technologies and modern institutions, and the control of nature (Fay 1947), it seems to have less concern about social issues such as poverty or equity, or the preservation of nature. Development, on the other hand, pays increased attention to the social dimension, but with less consideration of environmental aspects (see, for example, Goulet 1978, 1983). Population growth, increased inequality among the prosperous industrialised nations and the less developed ones, and depletion of natural resources create the

[1] Preliminary components of this section were presented at two conferences. The first was published in the conference proceedings of Sustainable Development and Planning VII as F. A. Hernández-Palacio. 2015. Urban quality and the sustainable city in Norway: The challenge of density. *WIT Transactions on Ecology and the Environment*, 193 (1), pp. 677–87. The second was presented at the symposium 'The Production of Knowledge in Architecture by PhD Research in the Nordic Countries' organised by the Nordic Association of Architectural Research, Stockholm, 19–20 May 2016. A paper with the title 'The sustainable city in Norway: The quest for urban densification' is to be published in the conference proceedings of this event, prepared by the *Nordic Journal of Architectural Research.*

framework for a shift of paradigm. The concept of sustainable development was developed through several white papers published by multilateral organisations. The most significant among them is *Our Common Future*, known as the Brundtland Report. According to this report, 'Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future' (Brundtland 1987).

*Our Common Future* and its view on the relation of humankind and nature cannot be regarded as a starting point nor as the ultimate evolution of thought. Even though it is likely the best known definition of sustainable development, it was neither the first attempt nor will it be the last. To start with, the relationship between humankind and nature has been a concern of societies of all times and places. Mebratu (1998) proposes as precursors of the concept of sustainable development different ideas categorised in three historical periods. In the first, which could be called a premodern period, he notes different religious and traditional views on the relationship of humankind and nature and a traditional wisdom calling to live in harmony with the environment and in society. A second period is influenced by the views of economics and the 'theory of limits' proposed by Robert Malthus who foresaw the limits to human prosperity in the scarcity of natural resources. Mebratu refers to the third period as the 'political economy and the "scale" of organization' where he gathers different critics on industrialisation and the expansion of capitalism and a system dominated by large-scale institutions seen as problematic for a truly human development. He sees this third period synthesised in Schumacher's *Small is Beautiful* (1973). These ideas, according to Mebratu, were precursors to the concern about a global environmental crisis, which surged in the 1970s in different multilateral scenarios, such as the UN Conference on the Human Environment in Stockholm (1972), and the report produced by the so-called Club of Rome on the state of the global environment (Meadows et al. 1972).

The concept of sustainable development, despite its overwhelming diffusion, has not been exempt of criticism, especially because of the difficulty in its implementation. For example, before the UN-sponsored World Summit on Sustainable Development in Johannesburg in July 2002, *The Economist* presented sustainable development as a 'dangerously slippery concept': a very alluring image that, in principle, hardly anyone can be against, but difficult to operationalise in practice (*The Economist* 2002). The challenge, according to *The Economist*, is in the balance between the 'development' and the 'sustainable' and the difficulties in reconciling both. To explain that contradiction *The Economist* quotes Robert Solow's analysis of sustainability from an economist's perspective. For Solow, sustainability is a question of

'distributional equity between the present and the future … a choice between current consumption and providing for the future' (1991: 1005). However, for Solow, the main paradox is not about the equity between present and future, since from an economist's perspective there are several alternatives to deal with it; rather the paradox is about equity in the present and the concern about today's poor. Economic growth has been the strategy to combat poverty; however, it has been achieved mainly at a great cost to the environment.

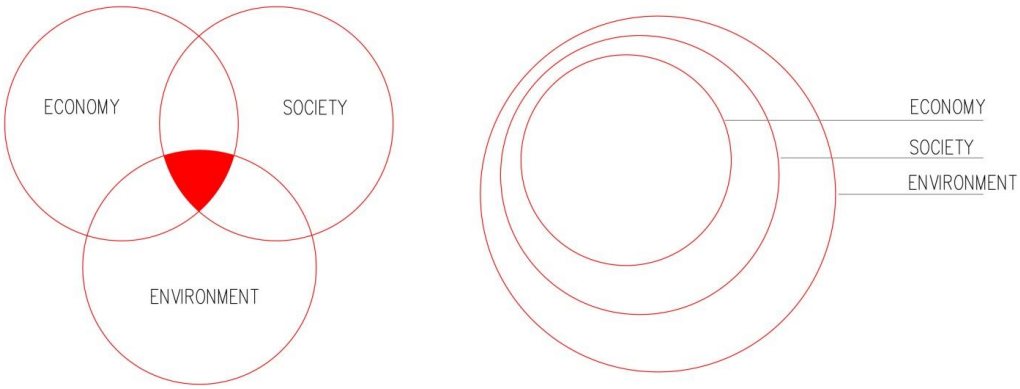


Figure 2. Two alternative representations of the sustainable development concept

*On the left, sustainability is represented as the articulation of three different dimensions by using a logical relations diagram (Brundtland 1987). On the right, sustainability is represented in a stacked circles diagram where the economy dimension is contained within the society dimension, and the society dimension is contained within the environment dimension (O'Riordan 1998).*

This aforementioned paradox has contributed to the rise of an interpretation of sustainable development based on three dimensions: the economy, the society, and the environment. Finding the right balance between social demands, protecting natural resources – all without sacrificing economic progress – is the issue in question (Strange & Bayley 2008). Explaining the new concept by the interaction between these three dimensions gained much popularity. However, the paradox seems to remain and different interpretations persist. For some, this is a necessarily holistic view (see Figure 2). For others, this fragmented vision seems to be one of the hindrances in the achievement of sustainability targets. Most arguments focus on where to prioritise actions in order to achieve sustainability targets. Giddings et al. (2002), for example, point out that decision-making related to sustainability issues tends to prioritise the economy, and to consider social aspects as separate from the environment. They argue for a conceptual change, which clearly portrays the economy as being dependent on the society and the society in turn being dependent on the environment. Vallance et al. (2011) argue for a greater emphasis on the social dimension of sustainability. According to them, a true change towards

sustainability is a social change, based on behavioural transformations, strengthening of social capital, and justice.

These controversies seem so far unsolvable and it is common to find that sustainability means different things in different contexts (Robinson 2004; Delyse & Michael 2015). While in developing countries strategies towards sustainability emphasise social aspects, in more developed nations the focus is on the environment. Sustainability strategies in nations where poverty is still a major issue are aimed at improving access to a healthy environment, basic sanitation, education, and energy. On the other hand, in developed nations, sustainability tackles environmental issues; and the prevailing idea seems to be the preservation of resources for future generations, guaranteeing a similar quality of life to the one the current generation enjoys. The strategies then tend to be focused on decreasing greenhouse gas emissions, on alleviating global warming, and on preserving biodiversity and natural resources. Advancing clean energy generation and its more efficient use, and improving resources and waste management in all human activities are among the most common aims in the greener approach to sustainability.

The economic issue of sustainability, almost three decades later, seems still stuck in Solow's (1991) dilemma: the choice between current consumption and providing for the future or, to put it in other terms, short-term profit versus long-term gain. This issue actually seems to be a persistent barrier in achieving sustainability targets in many different contexts. Many authors claim that even though the market seems to have fully embraced the sustainability discourse, it is still mostly a marketing strategy rather than a real change in practices and procedures (Greer & Bruno 1996; Lyon & Maxwell 2011). As a consequence, facing the strong scepticism towards free markets as providers of solutions conducive to more sustainable development, there has been a call for strengthening governance and regulatory frameworks (Fernando 2003). Governance, which has always been a central concept in the sustainable development argot, has been proposed as a fourth dimension. Appending the well-established three-dimensional definition of sustainable development, governance should aid in making the concept an integral platform that is suitable for addressing main global challenges (SDSN 2013).

Even though the idea of sustainable development might seem vague, it provides an open conceptual platform for global action in different contexts and areas. Sustainable development ideas have gained strength, in particular, in the environmental and economic debates. The current environmental crisis, characterised by a mix of elements such as climate change and decline in wild life, fisheries, and biodiversity in general, is different from environmental crises

of the past. Former crises had local implications, associated with poor waste management and air pollution affecting specific regions. The environmental crisis of today is considered a global problem, affecting even remote areas and isolated populations (Martens & Rotmans 2005). Such a view constitutes one of the fundamental aspects of the transnational strength of sustainable development initiatives, despite controversies in social and economic aspects. Economic globalisation has also contributed to the view that a global agenda to balance economic interest is needed. The rise of powerful transnational corporations aided by liberal market structures promoted by multilateral institutions has affected the economic life of societies worldwide. Sustainability has also become a platform for ideas of social justice and equity not only among today's and future generations but also among today's rich and poor social segments of the global society (Delyse & Michael 2015).

## 2.2. What Does Sustainable Development Mean for Cities?

The concept of sustainability, despite the controversies, has endured for almost three decades and has been adopted by numerous national and international organisations. The new Sustainable Development Agenda launched by the United Nations in 2015 set goals 'to end poverty, protect the planet, and ensure prosperity for all' (United Nations 2015). The Sustainable Development Agenda in its different versions has been conceived as a holistic vision with global applicability, accepted by all member states of the United Nations. It is formulated in terms of goals and targets that should be adapted to the different national circumstances and priorities, levels of development, and capacities of action. According to this agenda, it is envisioned that cities can significantly contribute to key goals, for example through the creation of spaces for social inclusion and equity, through minimising the negative impacts on the global climate system, and through the efficient use of resources.

Cities are complex systems and defining the urban qualities that foster sustainable societies can be an intricate task. Müller-Eie & Bjørnø (2014) define urban sustainability as a 'compound concept', formed by various conceptual layers, where other sub-concepts are related to aims, strategies, and actors. These authors divide the definition in a global and local component. In global terms, they define urban sustainability as 'the capacity of a city to meet formal, functional, social, economic and cultural standards that enable its population to live well and thrive without negatively impacting on global environmental, social and economic conditions' (p. 98). In the local component, urban sustainability is defined as 'the facilitation and coordination between formal and functional strategies, such as sustainable land use

(compactness, intensity, density), sustainable transportation and their integration, as well as cyclic resource management' (p. 98). The successful implementation of these strategies is enabled by the sustainable behaviour of the individual and the community, and by urban institutions providing sustainable choices. This is, however, a process where contradictions and tensions are common and where, following the Müller-Eie & Bjørnø's argument, 'social innovation' is fundamental.

A global agenda on urban development has been promoted and updated through the United Nations Conferences on Housing and Sustainable Urban Development, the last one held in Quito in 2016, where a new version was adopted. According to the 'New Urban Agenda', cities are the main scenario for sustainable development in its multiple dimensions, since they concentrate an increasing part of the population, infrastructure, and economic activities (United Nations 2017). This agenda recognises the relation between good urbanisation and development expressed in better livelihood opportunities and the enhancement of quality of life. Cities, if well-planned and well-managed, are also seen as potential sources of solutions to, instead of the origin of, the challenges faced today by the global society.

However, the implementation of strategies aimed at achieving these objectives can be immersed in contradictions. The emphasis on one aspect, on many occasions, can cause detriment in other aspects. When the field of action is the city, the dimensions of sustainable development have been frequently addressed in divergent ways. From the economic perspective, cities are regarded as spaces for socio-economic prosperity and innovation (Nijkamp & Kourtit 2013); competitiveness has been considered as a central concept in creating the urban qualities that can attract economic and human capital (Rogerson 1999). The societal perspective usually addresses the city as the space of social development and social process (Castells 1972; Lefebvre & Nicholson-Smith 1991; Harvey 2003), involving concepts such as equity (Troy 2012), social justice (Harvey 2010), well-being, and quality of life (Pacione 2003; Van Kamp et al. 2003). The environmental dimension of the city in the frame of sustainable development has been focused mainly on the question of the demands and the impacts of the city and society on ecosystems in terms of the ecological footprint (Wackernagel et al. 2006), or environmental quality and public health (Van Kamp et al. 2003; Frank & Engelke 2001). Balancing the different dimensions is the biggest challenge in the implementation of the sustainable development agenda at the urban level (Næss 1995; Nijkamp & Kourtit 2013).

Many of the strategies for advancing the sustainable development agenda seem to be best implemented through the adaptation and improvement of policies and institutions, but many others also require concrete action in the built environment. The right to an adequate standard of living requires not only regulatory and financial components, but has to be materialised in a stock of adequate and sufficient housing, reliable and efficient infrastructure that provides basic services, and a network of well-distributed public spaces that allow meaningful social interaction. Achieving more efficient, environmentally friendly, and accessible public transport systems requires both changes in social attitudes and improved regulatory frameworks, in addition to improvements in material aspects, such as the adaptation of infrastructure, the implementation of new technologies, and a certain degree of urban compactness. The protection and restoration of ecosystems, natural resources and biodiversity requires regulatory limits and changes in consumption and production patterns. This can be translated into restrictions of various kinds to human activities, such as quotas for extraction, and constraints on land use and urban expansion.

The idea of a sustainable urban form arises from the belief that the environment influences human behaviour and, consequently, there are some physical characteristics of cities that provide better conditions to achieve sustainability goals. The New Urban Agenda (United Nations 2017) recognises the importance of 'good urbanisation' as an essential basis to achieve the goals of sustainable development. However, the qualities of such 'good urbanisation' are kept in general terms. Some of the most significant qualities of the built environment addressed to increase sustainability are urban compactness, density, mixed-use areas, and polycentric urban systems. Adequate ranges of urban density are expected to increase the efficiency of infrastructure to provide access to drinking water and sanitation. Compact urban areas are considered especially important for the implementation of 'resource-efficient' transport systems based on public transport and non-motorised options such as walking and cycling (Frank & Pivo 1994; Cervero & Kockelman 1997; Jahanshahi & Jin 2016). Moreover, the combination of compact urban extensions with existing denser and multifunctional urban areas is expected to preserve productive agricultural land and protect important ecosystems.

The concept of 'good urbanisation' in the 'New Urban Agenda' (United Nations 2017) is covered in general terms, but implies physical characteristics of cities that are considered important in the achievement of sustainable development goals. For example, in the 'New Urban Agenda' it is recognised that 'urban form, infrastructure and building design are among the greatest drivers of cost and resource efficiencies' (p. 14). Thus 'appropriate compactness

and density, polycentrism and mixed uses' should be promoted through city planning and urban design instruments. To achieve cities with such characteristics, the agenda encourages spatial development strategies such as urban renewal and the prevention of urban sprawl and marginalisation (p. 15). The implementation of the agenda for sustainable urban development requires policies, legislation, and projects to be implemented by governmental bodies (national, regional, and local) and relevant stakeholders through partnership and cooperation.

## 2.3. How Did the Compact City Become the Paradigm of Sustainable Urban Development?

After near three decades of the existence of a sustainability agenda, aimed at preserving the environment and ensuring continuous social well-being, the city has become a significant focus for the application of many sustainability measures. Efficiency in the use of resources (energy, raw materials, and space) is one of the main strategies to achieve sustainable outcomes. Wasting less, polluting less, and producing fewer greenhouse gas emissions to curb global warming are some of the cornerstones of this agenda. Denser cities, as explained in Section 2.2, have been regarded as the archetype of efficiency because they use less space and may also significantly reduce energy consumption, which in turn may reduce greenhouse gas emissions (Newman & Kenworthy 1989; Næss et al. 1996; Næss 2012; Newman 2014). This efficiency could, if achieved, reduce greenhouse gas emissions to mitigate climate change, as well as reduce the use of material goods to protect forests and agricultural land. A combination of strategies, such as denser urban layouts, cleaner and more efficient technologies, and the promotion of renewable energy sources, constitutes the steps to achieve such targets (SDSN 2013: 20).

How did these ideas become so influential? The answer seems to lie in a synergy of multiple trends and ideas combining old and new concerns that have regained attention mostly since the 1960s. Among the most relevant are: a) the materialisation of sociotechnical changes in the built environment; b) the crisis of the modern urban planning paradigm; c) an emergent concern about a global environmental crisis; d) an energy crisis that originated in the oil embargo from the OPEC on the supporters of Israel in the Middle East conflict in 1973; e) the rise of evidence about global warming caused by pollution from human activity; and f) new social trends such as a 'new demographic transition' and the rise of the 'creative class'.

## Sociotechnical Shifts

The development of the modern city is strongly linked to the rise of industrialisation and the centralisation of production in large factories. The process of development under this model was characterised by a national protectionism for mass production and mass consumption from external competition (Jessop 1992). Such organisation of production is strongly linked to a regional pattern of complementary industrial activities influencing a specific urban model. According to Scott (1988), these industrial regions were characterised by an intricate network of connections, containing a large number of urban agglomerations of different sizes and intensities to house the work force required to operate the system. The popularisation of cars is perhaps the most influential phenomenon in shaping the use of space by allowing an expanded personalised mobility and an unprecedented expansion of urban functions in the countryside.

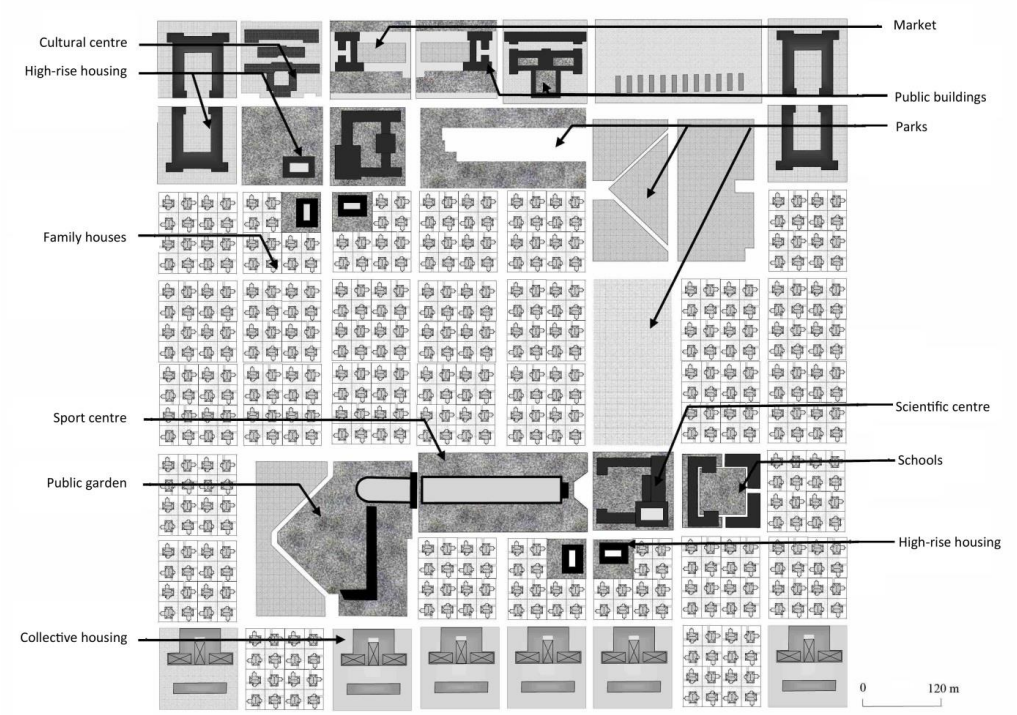


Figure 3. Broadacre City, general plan

*Source: City Club of Chicago 1916.*

Several visions of the city of the future were proposed by architects and engineers of the time. Some examples are Frank Lloyd Wright's Broadacre City, presented in the book *City Residential Land Development*, published by the City Club of Chicago in 1916 (see Figure 3) and Le Corbusier's La Ville Radieuse of 1935 (see Figure 4).[2] Broadacre City proposes a relatively low density of 2 acres per family. It consists of a mile-wide continuous fringe, extended along the new highway system, where former centralised urban functions are decentralised. Among the preconditions for the practicability of such a proposal is the development of a vast transportation network, the decentralisation of housing and industry, and a shift in land ownership regulations to allocate space to new development (Grabow 1977). Le Corbusier's proposal, on the other hand, favours much denser land use, aiming to accommodate the 3 million inhabitants of central Paris in the same surface area by using high-rise buildings with a footprint no greater than 15% of the total surface. His idea is based on a separation of functions to alleviate the chaos of the existing city, providing a large amount of green space, and better access to natural light.

[2] The first proposal for the Radiant City was made in the 1922 salon d'Automne in Paris; however, the book presenting a more comprehensive proposal was written between 1931 and 1934.

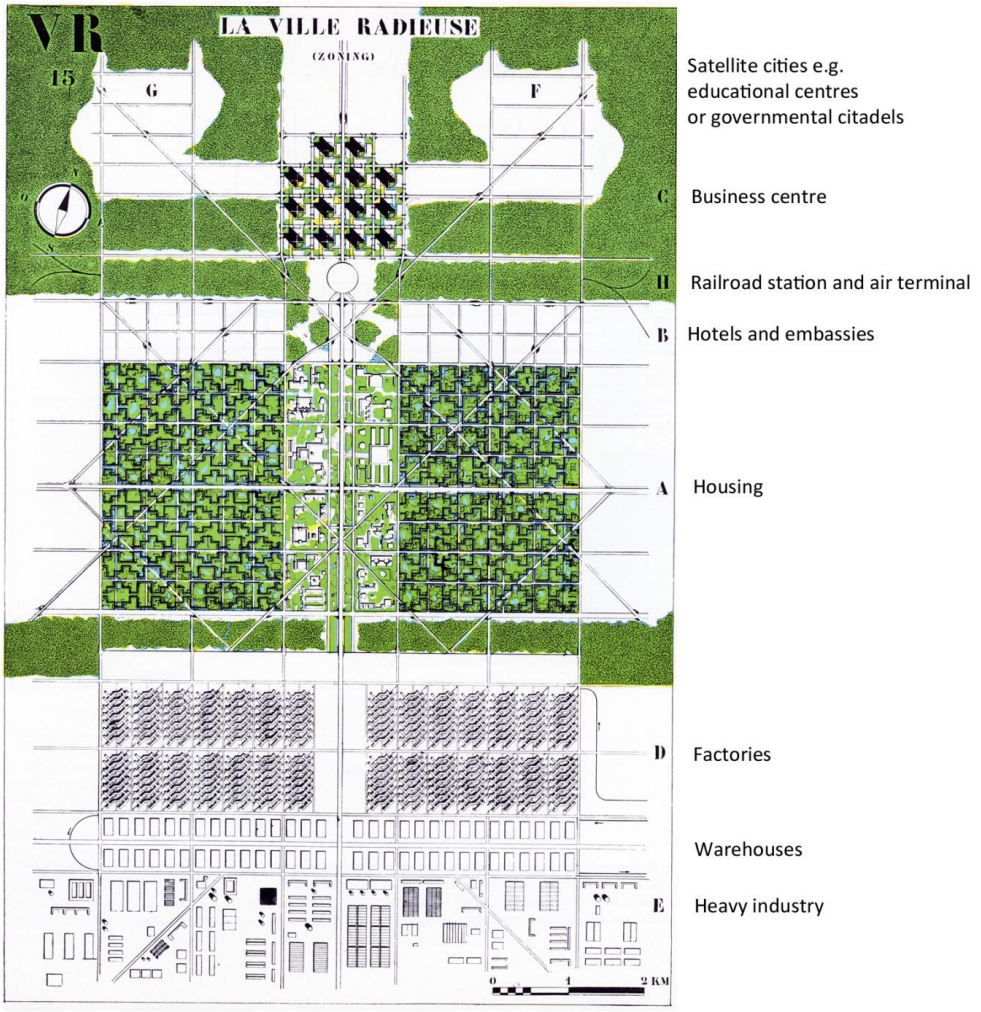


Figure 4. La Ville Radieuse, general plan
*Source: pinterest.com.*

In both proposals, the new transportation technologies were fundamental, and considered as ultimate expressions of freedom. Although the ideas of Le Corbusier and Wright were initially regarded as unachievable utopias, they became influential in the rise of master planning in the following decades (see, for example, Figures 5 and 6, two master plans for the city of Oslo from the 1950s and 1960s). These visions for the modern built environment, together with mainstream modernisation strategies, promoted economic and social development, especially after 1945 (Huntington 1971).


Figure 5. Lambertseter plan (1950) by Frode Rinnan

*Formed by different types of three- and four-storey apartment blocks, this plan aimed to accommodate 10,000 inhabitants. Source: Oslo City Archive.*

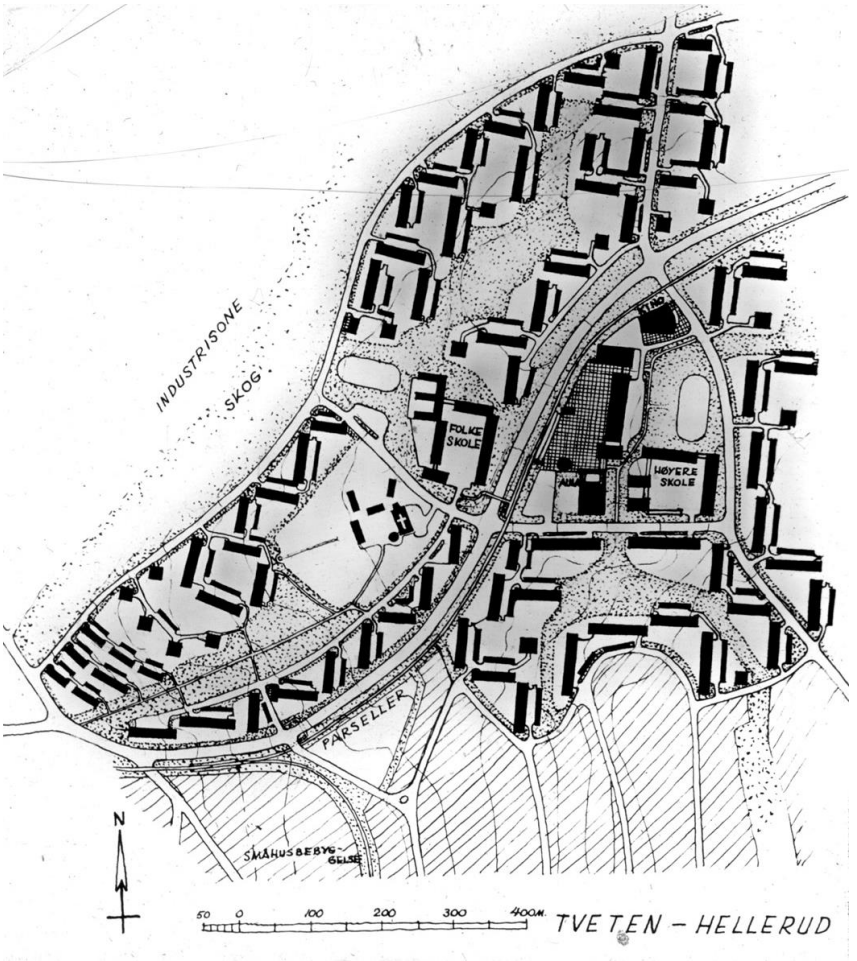


Figure 6. Master plan for Tveita in Oslo (1960)

*Source: Oslo City Archive.*

From the 1970s onwards, technological innovations and market conditions favoured a displacement of low-aggregated-value and labour-intense mass production to less developed countries with cheaper labour (for example, in the textile and clothing industries, in ship building, and in white goods). Advanced economies gradually shifted to a model of flexible specialisation retaining the production of knowledge-intensive items, research and design, marketing, financial services, and management activities (Hirst & Zeitlin 1991). These changes have had profound implications for the built environment requiring, among other things, the adjustment of infrastructure to new production strategies.

The migration of industrial activities created numerous brownfield sites in the now 'post-industrial cities' of the advanced economies. Many cities have, since the 1980s, suffered local crises due to the migration of former economic activities and the need for structural adjustments not only in infrastructure but also in readapting workforces to the new conditions of a flexible specialisation model, based on tertiary activities instead of traditional low-skill industrial activities (Harris 1997; Carmona et al. 2009). Cities are now expected to be the spearhead of a strategy of global economic competition to attract investment and new economic activities and expertise. In many places, this new scenario has produced a wave of urban renaissance and a return to urbanity as one of the fundamental qualities for competitiveness in a global economy (Carmona et al. 2009; Carmona 2009).

The new post-industrial economy, mostly based on knowledge production rather than the production of goods, requires human capital as its main asset. Researchers, scientists, engineers, artists, and designers provide the expertise for this new economy. This means, according to Florida (2003), the rise of a new social class: the 'creative class'. Its members produce new ways of doing things: new designs and new solutions to problems that can be replicated on a mass scale. Florida acknowledges that creative professionals contribute to knowledge-based business, such as financial services, technology development, law and management, and the healthcare professions. The new creative class, according to Florida, tends to concentrate in creative clusters that are no longer driven by access to natural resources or transport infrastructure, as was the case for industrial production; nor are the traditional facilities such as large shopping malls, stadiums, and freeways the attractors of the new creative class. Instead the new hubs for the creative class are vibrant city environments with a diverse population. Contrary to some previous beliefs pointing towards a deconcentration of activities due to the advance of omnipresent communication technologies, the creative class demands specific locations with access to diversity of social and cultural services, only possible in highly intense urban environments.

## The Crisis of the Modern Urban Planning Paradigm

The Vitruvian virtues *utilitas*, *firmitas*, and *venustas* (usefulness, solidity, and beauty) have been recognised as the key qualities in architecture and the city since Roman times and have been part of the western tradition since then. Hence, over time there has been more or less emphasis on one of those aspects, or new values have been added. The functional city of the modern movement in the first half of the 20$^{th}$ century, for example, placed a greater emphasis

on the utilitarian aspect of space, proposing a separation according to four essential functions: living, working, recreation, and circulation (Iamandi 1997). Architecture experienced a radical shift, particularly with a strong emphasis on high-rise dwelling typologies that should be produced in a standardised fashion. This would allow the affordable provision of housing, initially to the recently industrialised cities and later for the reconstruction of post-war Europe.

In the second half of the 20th century, modern planning principles, such as the drastic separation of urban functions, and the urban typologies proposed by modernist architects and planners were questioned, mainly on social grounds, but also on aesthetic ones. Thus the debate on the 'good city' gained a central position among theorists and practitioners of the disciplines related to social and built environment issues, particularly in the 1960s and 1970s. Among the most significant texts in this debate are *The Image of the City* (Lynch 1960), *The Death and Life of Great American Cities* (Jacobs 1961), *The City in History* (Mumford 1961), *A Pattern Language* (Alexander et al.1977), 'The reconstruction of the city' (Krier 1978), and *Good City Form* (Lynch 1981). Table 1 presents a synthesis of the qualities of the good city according to these authors.

Table 1. The good city in the 1960s and 1970s

| *Lynch (1960)* | *Jacobs (1961)* | *Mumford (1961)* | *Alexander (1977)* | *Krier (1978),* | *Lynch (1981)* |
|---|---|---|---|---|---|
| - Legibility<br>- Structure<br>- Identity<br>- Meaning | - Diversity<br>- Intensity<br>- Connectivity<br>- Density | - Significance<br>- Flexibility<br>- Density<br>- Integration | - Diversity<br>- Character<br>- Accessibility<br>- Density<br>- Meaning | - Conservation<br>- Multifunctionality<br>- Returning to the traditional types<br>- The public space as the city structuring | - Vitality<br>- Sense<br>- Fit<br>- Accessibility<br>- Control |

Lynch devotes attention to the visual quality of the built environment in his book *The Image of the City* (Lynch 1960). He highlights the scarcity of beautiful urban environments in existing American cities. One of the main qualities of the good city, according to Lynch, is 'legibility', or the clarity of the image that the city offers to its users. The city 'structure' is composed of five types of elements: path, landmark, edge, node, and district. The quality of the city is defined in terms of the image that it creates for the user, its 'identity', according to the combination and disposition of these elements. Such an image is gradually developed over time by society to the extent that a series of 'meanings' that go beyond the functional aspect are assigned to the different elements of the built space. These meanings, whether social, historical, functional, economic, or individual, according to Lynch, are the essence of a true place, remarkable and unmistakable.

Jane Jacobs's *The Death and Life of Great American Cities* (1961) is perhaps one of the most influential books of this period. Jacobs criticises, in particular, orthodox city planning, characterised by a top-down approach based on the expert's view. Such an approach, according to Jacobs, was executed not only by the modernist movement but also by previous movements such as the garden city movement. She criticises the separation of functions proposed by the modern planning approach, advocating instead mingling different functions, ones that support each other and produce lively cities. Jacobs highlights the negative impacts of large facilities on urban functioning. Large facilities, she argues, erode diversity and undermine the vitality of adjacent areas. Jacobs also sees cars as an eroding force of both public spaces and urban diversity. For her, cities are systems of organised complexities composed of a multitude of interconnected factors; therefore, a top-down planning approach has negative effects on preserving diversity. As an alternative, she advocates horizontal and more democratic structures in city planning. Jane Jacobs, a social activist, remains influential for both social scientists and architects involved in city planning alike.

According to Jacobs, the principles and aims that have shaped modern, orthodox city planning and rebuilding do not understand how cities operate in real life. For her (pp. 3–25), cities are systems of complex and fine diversity of environments and users that support each other mutually, both socially and economically. The dominant tradition in urban design and planning, according to Jacobs, has failed in attaining the diversity that sustains urban vitality. She outlines four primary conditions to urban vitality: 1) diversity of uses in urban districts to keep vitality throughout the day and promote intensive use of existing facilities and public spaces; 2) small blocks to allow connectivity and promote diverse alternatives for pedestrians in attaining a destination; 3) diversity of buildings in ages and styles to allow different uses and diverse users (the diversity of users understood as a mix of people from different social backgrounds, ages, and incomes is a key element of a vibrant urban environment); and 4) urban density as a condition to allow intensity and diversity.

In his seminal work, *The City in History* (1961), Mumford criticises the standardisation of existing cities and its consequent lack of significance. He highlights the virtues of the medieval town, particularly its diversity, intimacy, and rich spatial experience produced through a system that combines high density, intricate public space fabric, and controlled openness. However, he does not propose formulations for existing cities. Alexander et al. (1977) develop a compendium of patterns in the built environment in their book *A Pattern Language*: in it, 253 patterns, from the regional scale to the details of construction, are described. According to these

authors, the vitality of the built environment depends on how society as a whole sets and combines different patterns in towns and buildings. Without being an open criticism of the existing paradigm ruling the development of the built environment, this work has the aim of providing the fundamentals for an incremental change of ongoing theories and practices.

In 'The reconstruction of the city' (1978), Krier criticises the post-war reconstruction of European cities because of its monotony and its vagueness in defining the public space. He argues that the separation of functions, the dissolution of the urban fabric, and the introduction of large and mono-functional urban blocks have caused the physical and social destruction of cities. He proposes the re-creation of the basis for architecture and urban design as a return to tradition and to the historical city, particularly in the conception of the urban components: the block, the street, the square, and the *quartier*. Among the principles of the reconstruction of the city are: the conservation of the historical centres as models of collective life; the idea of the public space as organiser of the urban form; and the transformation of mono-functional housing areas into *quartiers* combining multiple urban functions.

Lynch further develops the principles around urban quality in *Good City Form* (1981). The attributes or dimensions which determine the good city are closely related to a 'good quality of life'. Hence, a good settlement according to Lynch (pp. 116–19) 'enhances the continuity of a culture and the survival of its people, increases a sense of connection in time and space, and permits or spurs individual growth development, within continuity, via openness and connection … a good settlement is also an open one: accessible, decentralised, diverse, adaptable, and tolerant to experiment …'. The good city is determined by five attributes: 1) vitality, understood as the capacity to support the vital functions and biological requirements of human beings; 2) sense, in terms of perception and meaning; 3) fit, in terms of capacity to support the social needs of the community and the capacity to adapt to future demands; 4) accessibility, as the capacity to provide access to enough diverse people, activities, resources, services, information, or places; and 5) control, as the ability to modify and adapt the degree of access, creation, modification, and reparation of elements. Additionally, two meta-criteria are proposed: 6) efficiency, in terms of cost of maintenance and operation of the settlement; and 7) justice, understood as the ability to provide benefits to inhabitants in an equitable way.

Among these critics of the modernistic planning approach, there is a consensus that there is a need for denser, low-rise urban areas with bigger urban coverage, an increased mix of functions to promote vitality in the public space, and a more complex and intricate urban fabric to favour

pedestrian movement and human interaction in the public realm. There is also a strong position against the monotony of the modernistic approach, stressing the necessity for creating a more meaningful architecture, closer to local traditions and values. According to these critics, the separation of functions, that is artificially separating housing and working areas, is particularly problematic; it creates the need for a disrupting mass-transport infrastructure.

## An Emergent Concern about the Global Environmental Crisis and Food Security

Throughout the 20th century significant advances in medical care, improved food distribution, and newly introduced social practices in non-industrialised nations created a demographic boom with no precedents in history. This phenomenon revived old concerns about the availability of resources to provide social prosperity for all, triggering a new wave of neo-Malthusian thinking. It was envisioned that the competition for scarce resources could lead to catastrophic scenarios of crisis (Leroy 1975). Ehrlich & Holdren (1971), for example, pose the following five theorems that link population growth and environmental crisis. 1) They see a direct relation between population growth and environmental degradation. 2) They further argue that controlling population growth alone is not the solution for the global environmental crisis, rather it is also necessary to limit consumption of non-renewable natural resources. 3) Moreover, increasing population density in certain areas or redistributing population are not solutions to the environmental crisis. In the current age of technological advancements that span the planet, the impacts of population size are not only local but global. 4) Environment as a concept should be constructed broadly, from a global perspective. Society and all its dimensions are then understood as part of the environment and not as separate from it. 5) Finally, technological solutions alone are unlikely to solve the crisis. Advances in agricultural technologies have provided some solutions but have also created new environmental impacts. Demographic growth control is fundamental.

How to control the demographic boom? Economic development, even though some social scientists believed that it would stimulate fertility, is often presented as a solution to overpopulation. For example, Heer (1966) maintained that the processes involved in economic development serve to reduce fertility. The author based his position on a study of 41 nations over the course of the 1950s. What the process of economic development entails is perhaps better understood in a broader sense as modernisation (Huntington 1971). According to Huntington, modernisation requires a complex and radical process of change in human thought and behaviour. Among its fundamental components are industrialisation, urbanisation,

secularisation, better education, expansion of democracy, and more solid political institutions. The modern society, in contrast to the traditional society, is based on greater control over the natural and social environment by the expansion of science and technology. Urbanisation, in contrast to Ehrlich & Holdren's third theorem, is seen as a potential solution, despite the many challenges that such a process entails. Moving population from rural to urban areas, in addition to enhancing the possibilities of better access to sanitation and education, would facilitate the modernisation of agriculture and avert catastrophic scenarios of famine. Moreover, a more urbanised society, as Heer (1966) had already noticed, has a lower fertility rate.

The optimism in the belief that technological and social advances could solve global problems such as depletion of natural resources was, however, faced with scepticism by many scholars. These concerns were pointed out by the Club of Rome (Meadows et al. 1972) and by the Conference on Human Environment in Stockholm (United Nations 1972). There was a growing consensus about the need for global measures to avert worsening scenarios, but also different views on the path to achieve solutions. It was stressed that some of the global problems could have technological solutions, but that many other problems were beyond the scope of technological advance and that it was necessary to set limits to growth by redefining the concept of human development and endless growth.

## The Energy Crisis

The oil crisis of the early 1970s became a braking point in urban planning. The urban sprawl of earlier decades started to be seen as a highly vulnerable urban form in a scenario of energy scarcity (Small 1980; Newman & Hogan 1981). Some years later, Newman & Kenworthy (1989) published an influential article on urban form and automobile dependency, comparing gross population density with fuel consumption in cites from Europe, North America, Asia, and Australia. Their work was heavily criticised with regards to methodology, feasibility, and ideology. The critics argued that fuel consumption is a complex phenomenon, connected to multiple factors, not only to urban form. Additionally, rearranging metropolitan systems and introducing public transport systems can only be made at an enormous cost and requires long-term planning. Such a strategy also needs a heavy top-down approach (see, for example, Gordon & Richardson 1989; Breheny 1995; and Mindali et al. 2004). Despite controversies, the work of Newman & Kenworthy became one of the most influential studies in the rise of the compact city model as a dominant strategy to combat climate change.

## Human-made Global Warming

Climate change has been recognised as a phenomenon for a long time. The idea of a greenhouse effect in the Earth's atmosphere seems to have its origin in the work of Fourier in the early 19th century (Fleming 1999). He and other scientists of that time observed the effects of gases in the atmosphere in keeping temperatures stable on the Earth's surface. The pioneer in an attempt to quantify the effect of $CO_2$ on global temperatures was the Swedish scientist Svante Arrhenius, who in the late 19th century estimated a gradual and beneficial increase of the Earth's temperature caused by the emissions from industrial activity (Uppenbrink 1996). He estimated that doubling the amount of $CO_2$ in the atmosphere would result in a rise in global temperature of 5 to 6 degrees Celsius. The time needed to double $CO_2$ emissions by human activities was estimated to be three centuries. However, he also explained historic ice ages in the changes of $CO_2$ levels produced by volcanic activity.

Further advances in meteorological devices and techniques improved short-term weather predictions, but difficulties remain in accurately predicating long-term climate changes. In the 1970s, for example, there was an intense debate about whether the Earth was getting warmer or cooler; and whether this phenomenon was natural or a result of human activity. Peterson et al. (2008) outline how popular views driven by the media predicted the return to an ice age, and how this worry contributed to an in-depth study of climate change that ultimately pointed in the opposite direction. By this time, it was recognised among the scientific community that variations in the Earth's orbit, aerosols, and the rapid increase in greenhouse gases were the main drivers of climate change. According to Peterson et al. (2008), a growing number of studies supporting the effect of greenhouse gases, such as $CO_2$, as a dominant contributor to global warming, began to change the political agenda towards climate change, and called for urgent action. Moriarty & Honnery (2008), quoting Heywood (2006), estimated that motorised transport accounts for a quarter of global greenhouse gas emissions, but it is expected to increase due to the rapid industrialisation of former agricultural economies in developing countries.

## New Demographic Trends

Some significant demographic changes have occurred in many developed nations and, more recently, in some developing nations. Among them are: slower population growth, a decrease in fertility rates, an increase in life expectancy, and an upsurge in net immigration. These changes are accompanied by an increased number of couple separations, increasing

cohabitation, and a growing number of single-occupant homes (Champion A. 2001). This phenomenon, called second demographic transition (Van de Kaa 1987), is considered a consequence of increased economic development, greater participation by women in the labour market, and a growing social shift in values towards secularisation and individualisation (Lesthaeghe 1983, 1995). Such social changes influence urban development in many different ways (Buzar et al. 2005).

One evident effect of demographic change can be observed in the housing market, where sizes and typologies of dwellings have shrunk to shelter individuals and smaller families. Some studies indicate a strengthening of housing in inner-city locations, instead of the previous pattern of sprawled urban development (Haase et al. 2008, 2010). Buzar et al. (2005) note that these new demographic trends are an important force in urban change. However, this has been marginalised from mainstream literature on city transformation. The influence of such demographic changes has been an important factor in the repopulation of the inner city in several urban regions (Barber 2007; Haase et al. 2008, 2010). This phenomenon, however, is most commonly addressed in academic literature as gentrification, or the exclusion of a less affluent population from privileged inner-city locations (Smith 2012).

## 2.4. A New (Old) Paradigm

Cities have traditionally been compact for essentially utilitarian reasons. The development of costly infrastructure, for example aqueducts or walls, has been attenuated by increased densities. Technological advances, however, particularly in transport with the development of railways systems and cars, made traditional infrastructure cheaper or redundant. In addition, large periurban areas gained notable accessibility by reducing transport time and costs. Subsequently, the most notable impact of these technological advances has been a drastic reduction in urban density (Burchell et al. 1998; Christiansen & Loftsgarden 2011; Rode et al. 2017). A return to a more compact urban environment would support the widely accepted idea that denser cities use resources more efficiently. As Section 2.3 has shown, the rise of the compact city as a paradigm of sustainability involves multiple aspects of diverse origins; some of them originated several decades ago, others are more recent. The six aspects presented in Section 2.3 are perhaps the most influential globally. However, several other aspects may emerge as relevant in specific contexts.

Densification became a dominant planning strategy to achieve more efficient cities. Efficiency is an attractive ideal not only in relation to the optimisation of resources for future generations, but also in the optimisation of resources now, to enable more equitable societies in which it is possible to better meet the needs of vulnerable populations. In addition to the overarching qualities of density and compactness, a wide set of attributes are recommended to achieve more sustainable cities. Characteristics such as mixed use, a balanced network of centralities of different hierarchies, and proximity between housing areas, working areas, and urban services are also considered key elements of a sustainable urban form. Authors such as Montgomery (1998) and Kenworthy (2006) have summarised a number of relevant factors to achieve the urban qualities necessary to foster a more sustainable society. Montgomery, for example, places emphasis on physical attributes under the concept of 'urbanity'. Kenworthy, on the other side, using the concept of 'eco-city', summarises a composite list of aspects, including physical (compact and mixed-use urban form with high-quality public and green spaces); technological (cleaner technologies in transport prioritising public transport, cycling, and walking); and political dimensions based on a 'strong, community-oriented sustainability framework for decision-making'.

Urbanity, in Montgomery's terms, is understood as the ability of an urban area to favour activity in streets and public spaces. This is only achievable if a city area has a sufficiently dense concentration of people, mixture of uses, and diversity of buildings. For Montgomery (pp. 96–7), urbanity requires the combination of three qualities: 'activity (land uses, pedestrian flow, behaviour patterns, noise & smell, vehicle flow); physical setting (townscape, built form, permeability, landscape, and furniture); and meaning (legibility, cultural associations, perceived functions, attractions, qualitative assessments)'. He revises the work on urban quality of several authors such as Gordon Cullen, Jane Jacobs, Christopher Alexander, and Kevin Lynch, and develops a list of 12 physical conditions for making a city (see Table 2). Montgomery sees urbanity as an essential quality to achieve the long-term objectives of environmental and economic sustainability in cities set out in 'The Green Paper on the Urban Environment' (Commission of the European Communities 1990), a pioneering document in the field.

According to Kenworthy (2006), for a city to be sustainable, it must decrease the usage of all types of resources and reduce its waste production. Simultaneously, it has to increase liveability, social prosperity, human well-being, accessibility, urban design quality, and reinforce the sense of community belonging. Transport and urban form are the two fundamental aspects to achieve

the ‘eco-city’. This involves formal characteristics such as compact urban form, mixed uses, permeability of the urban fabric to increase accessibility options, variety of environments to increase possibilities of choice, robustness in terms of flexibility to adapt the building stock to diverse uses and needs, and visual richness to support the enjoyment of places. The greatest concentrations of activity should happen around well integrated high-quality public transport systems. At the same time, road capacity increases should be minimal to limit car usage. Such principles, according to Kenworthy, should be promoted through a strong, broad and plural framework for decision making, favouring a reformist thinking of ‘debate and decide’ instead of the traditional ‘predict and provide’ approach.

Table 2. The good city within the frame of sustainability

| *Montgomery (1998)* | *Kenworthy (2006)* |
|---|---|
| Development intensity | Compact urban form |
| Mixed use | Rural–urban permeability |
| Fine grain (diversity) | Priority of a non-car-based mobility |
| Adaptability (flexibility to accommodate new uses) | Use of clean technologies |
| Human scale | Balanced accessibility |
| City blocks and permeability | High-quality public realm |
| Streets: contact, visibility and horizontal grain | Variety of urban environment |
| Public real (vitality) | Dynamic economy |
| Movement (transport management) | Inclusive planning |
| Green space and water space | Integral decision making |
| Landmarks, visual stimulation and attention to detail | |
| Architecture style and image | |

The qualities of the ‘good city’ defended by the critics of the modern urban planning paradigm of the 1960s and 1970s (see ‘The Crisis of the Modern Urban Planning Paradigm’ in Section 2.3) have been reaffirmed under the frame of urban sustainability. The compact city is a comprehensive and versatile concept that can be adapted to many circumstances. In the most developed countries, where housing and basic infrastructure are not major concerns, a particular emphasis has been placed on curbing $CO_2$ emissions from transport. By making cities denser, developing a polycentric structure, and enhancing origin-destination proximity, it is expected that non-motorised mobility and public transport can be increased. The compact city approach has also served to frame other aspects of urban development in less developed contexts. High densities favour the affordability of critical infrastructure, such as transport, water supply, sewage systems and electricity network, making it possible to improve the urban environment for millions of urbanites in the growing cities of the Global South (Jenks & Burgess 2000).

Urban change, however, is a slow process involving a multitude of factors. As a result of car-based transport systems, massive low-density city expansion has added immense areas to

existing cities. Reversing such developments, or making those areas more compact, seems the biggest challenge of the compact city model. New projects, especially in former well-located industrial areas, are becoming the spearheads of compact city development. These new developments propose a return to the traditional block, with a mix of uses and typologies, combining housing and other functions, as well as emblematic public buildings. Proposals for Nyhavna, a former port area, close to Trondheim city centre, are currently in the planning stage, and provide an emblematic case of this new approach in Norway (see Figure 7).


Figure 7. Proposal for Nyhavna area in Trondheim, prepared by NSW architects (2008)

## 2.5.Drivers and Barriers of Densification of Existing Cities

An important part of contemporary literature on urban planning has been devoted to the debate on the physical characteristics of the built environment that can best meet the requirements of more sustainable societies. The previous sections have described how the compact city model, characterised by a concentrated urban layout, high-density urban environments, and mixed-use areas, has become the paradigm for urban sustainability. Densification as planning strategy grew into one of the most common approaches to achieve more sustainable cities. However, urban change is a complex and gradual process, requiring long-term planning and involving a range of private and public actors.

Table 3. Drivers and barriers of densification of existing cities

| **Environmental drivers** | **Environmental barriers** |
|---|---|
| Preservation of periurban agricultural land | Loss of local open and green spaces for everyday use |
| The protection and restoration of ecosystems, natural resources and biodiversity | Potential loss of local environmental quality due to decreased access of natural lighting and ventilation |
| Potential reduction of car usage by decreasing distances within urban areas | Intensification of local environmental issues such noise and pollution |
| Potential reduction in the use of resources to build, maintain, and operate cities | Potential reduction of local environmental services provided by nearby green areas |
| **Societal drivers** | **Societal barriers** |
| Urban population growth | Declining population growth |
| Demographics shift towards smaller households | Potential decline in the quantity and quality of children and elderly friendly spaces |
| Preferences for intense urban lifestyles | Preferences for suburban lifestyles |
| Potential increases in social equity thanks to better access to jobs and services of less affluent urbanites | Increased perception of social tensions and conflicts |
| **Economic drivers** | **Economic barriers** |
| Efficiency in the use of infrastructure | Pre-existence of large sprawled peripheries and massive sunk investments in their infrastructure |
| Profitability of economies of scale | Complex and costly urban renewal and brownfields redevelopment processes |
| Costs reduction in daily transport | Scarcity of space to the location of large business dependent on parking facilities to operate |
| Enhanced potential for network formation and interaction which nurture creativity and innovation | Decrease in affordable housing |
| **Institutional drivers** | **Institutional barriers** |
| The existence of a dominant discourse on sustainability | Conflicting interests of public planning agencies and private urban developers |
| Possibilities to increase tax revenues from an intense property and business environment | Administrative fragmentation |
| Potential to provide local services more efficiently and at a decreased cost (public services, education, transport, health care) | Scarcity of resources (technical, economic, human) |
| | Legal frameworks and procedural traditions |

Characteristics of the urban form such as size, shape, density, land-use patterns, types and configuration of transport systems, and amount and distribution of green spaces are developed over long timespans. Moreover, they are influenced by environmental, societal, economic, and institutional factors (see Table 3). This section presents some of the most influential drivers and barriers in the implementation of densification policies. In this analysis drivers are understood as the factors favouring the advance of densification policies; barriers, on the other hand, are the issues and circumstances hindering their successful implementation.

### Environmental Drivers and Barriers

Global environmental motivations are perhaps the best-known reasons for the ongoing interest in urban densification. Exhaustion of natural resources and climate change are the most prevalent. The idea of a finite amount of natural resources to fulfil the needs of humankind is at the very core of the idea of sustainable development (see 'An Emergent Concern about the Global Environmental Crisis and Food Security' in Section 2.3). Containing urban expansion is expected to alleviate the pressures on agricultural land, forests, and other ecosystems (Brueckner 2000, 2001; Angel et al. 2005). Sprawling urban agglomerations and their growing need for petrol-fuelled transportation have been highlighted as one of the main factors in the increase of emissions of $CO_2$ and other gases causing climate change (Gudipudi et al. 2016). Denser cities are expected to lower the impact of factors causing climate change and the depletion of nature.

Local environmental considerations have also been important. Compact cities are expected to support environmentally-friendly transport, increased energy efficiency in buildings, and a more durable use of natural resources. Multiple benefits are expected from improvements in these three areas. For example, reducing car usage is expected to reduce air pollution, noise, and costly accidents (Nykvist & Whitmarsh 2008). Replacing car trips with walking and cycling may also bring health benefits to the individual (Stevenson et al. 2016). Proximity between buildings can facilitate the implementation of combined heat and power systems that contribute to a significant increase in energy efficiency and, consequently, to the reduction of $CO_2$ emissions (Steemers 2003). Other factors such as the preservation of agricultural land and the protection and restoration of areas with valuable ecosystems offer both global and local benefits (Jim 2004; Daniels & Lapping 2005). Basic goods such as food, water, and energy are fundamental for the prosperity of cities. The protection of strategic areas in the regions adjacent

to urban centres is not only vital for local environmental quality but in many cases for the very existence of cities.

However, there are several negative aspects connected to denser urban environments (De Roo 2000). Urban densification can bring loss of local green and open spaces within walking distances (Jim 2004). This is seen as a reduction of spatial quality, especially for children and the elderly population who are frequent users of such spaces. There are claims that the inhabitants of denser urban areas compensate for the lack of access to green spaces by travelling more by plane, questioning the real gains in energy efficiency of compact urban environments (see, for example, Holden & Norland 2005). Moreover, local green spaces provide valuable environmental services such as solar shading, temperature reductions, capture of particulate matter from the air, absorption of rainwater preventing flooding and filtering pollutants, and an increase in local biodiversity (Jackson 2003). The detriment of perceived spatial quality inside buildings is also considered an important barrier to densification. Some high-density building typologies with low open-space ratios affect spatial quality elements such as openness to natural light, air, and also near and distant views (Fisher-Gewirtzman & Wagner 2003). Moreover, massive and high-rise buildings cause disruption on the landscape, which can be seen as problematic. Furthermore, too much concentration can also increase exposure to noise, pollution, and potential diseases and epidemics (Evans 2003).

The environmental drivers for densification seem to be mostly based on views of the common good for the global society or for a large national or regional community. But a number of unavoidable trade-off issues appear when a more local perspective is considered, taking into account impacts on specific groups and limitations to individualistic aspirations. The relinquishment of benefits for the individual in favour of general well-being is a source of many barriers to urban densification. The challenge for the implementation of urban densification and other sustainable city policies is to find the balance between both.

### Societal Drivers and Barriers

Urban changes are entangled with societal changes (Whitehead 2001). Demographic and economic changes are powerful determinants of how cities grow (Seto et al. 2011). One of the most influential drivers of urban form is population growth (Kasanko et al. 2006). Although an evident fact, it tends to be neglected by some analyses. If a population is growing and restrictions to urban expansion exist, the only way to accommodate the excess of population is by densifying the built environment. Population growth is both a driver and an enabler of urban

densification. It is important to stress this because urban growth boundaries to separate urban land from rural land and protected natural areas do not increase urban density *per se*. Such an increase occurs only if, in addition to an effective restriction to urban expansion, there is population growth.

The so-called second demographic transition (Van de Kaa 1987; Lesthaeghe1995), characterised by contemporary trends towards decreasing family size, ageing population and immigration, is one of the most significant factors influencing reurbanisation processes in many European cities (Haase et al. 2008). Reurbanisation refers in general terms to the process of population gains in the inner-city areas (Champion T. 2001). Some studies have found that smaller households – single-parent families, empty-nest homes, and single-occupant households – rely heavily on being near urban services and tend to live in smaller housing units in denser urban environments (Haase 2015; Haase et al. 2008, 2010; Rérat 2011). This 'back to the city movement' is not only driven by the allure of vibrant city environments. The demographic trends mentioned above have population decline as their grey side. In shrinking urban regions, concentrating the remaining population is the most reasonable answer to make many urban services affordable (Haase et al. 2013; Lauf et al. 2016). Urban densification is motivated not only by the drive to make cities more suitable for public transport, cycling, and walking, but also by the need to make them viable in general.

After decades of suburbanisation and density decline in many cities in the most advanced economies, some authors see the 'back to the city movement' and the new urban renaissance as an opportunity to strength sustainability in a wider sense (Giddings et al. 2005; Rogers et al. 2005; Salvati & Carlucci 2016). Such emerging demographic circumstances are linked to specific habits, preferences, and lifestyles making inner-cities denser again. These ongoing demographic tendencies merge with cultural and economic trends such as globalisation and the rise of a knowledge-based post-industrial economy. Vibrant urban areas are particularly attractive environments to the new creative class leading the new global economy (Florida 2003). Some studies claim a range of positive impacts in social equity in denser urban environments thanks to better access to jobs and services for the less affluent city dwellers (Burton 2003; Dempsey et al. 2012). Urban density appears as a positive factor beyond environmental reasons.

Life in denser urban environments has trade-offs from a societal perceptive. The suburbanisation trends from earlies decades were partly driven by the search for family-friendly

environments (Champion T. 2001). The potential decline in the quantity and quality of child-friendly spaces in denser inner-city locations is still seen as problematic. Reurbanisation is mostly driven by households without children, while families with children still prefer detached houses in low-density environments (Berndgen-Kaiser et al. 2014). Perceptions associated with poor environmental quality and social tensions and conflicts still constitute significant barriers to denser urban environments (EEA 2009). Studies have also found that some urban design characteristics and construction-quality issues affect the perception of privacy (Fisher-Gewirtzman & Wagner 2003; Lindsay et al. 2010). This suggests that good design and construction could attenuate some of the problems but high-density environments are still perceived negatively from a residential perspective, despite positive impacts on public space quality and vitality (Mitrany 2005).

### Economic Drivers and Barriers

Economic reasons for densification are particularly influential drivers in the local sphere. Denser urban areas provide a better environment for local businesses and services, which can reach a wider public at a lower cost (Burchell, et al. 1998; Carruthers & Ulfarsson 2003; Klug et al. 2007). Thanks to an improved economy of scale it is easier to find a wider range of products and specialised services within a smaller geographical area. According to Cervero (2001), employment density has been associated with enhanced productivity by workers, suggesting the benefits of agglomeration economies and the advantages of proximity, not only among firms but between residences and firms. Close proximity enhanced by high density facilitates not only transport of materials and components among firms but also the exchange and spread of ideas and information. The enhanced potential for network formation and interaction has been highlighted as an important condition to promote creativity and innovation, some of the fundamental elements in the knowledge-based new post-industrial economy (Florida 2003; Knudsen et al. 2008). Moreover, sales of final products and services to local residents are also facilitated by proximity (Henderson 2000).

Denser cities facilitate a more efficient use of infrastructure for urban services such as transport, water supply, waste collection, energy, and heating (Bettencourt & West 2010; Fertner & Große 2016). Thanks to an increased proximity between users, the costs of operation, maintenance, and expansion of such infrastructure can be borne by a larger population (Livingston et al. 2003). Making cities more compact offers potential reduction of car usage by decreasing distances within origins and destinations. This has been seen as advantageous to several local

issues beyond the environmental dimension. Building and maintaining an extensive road network has proven costly for local authorities (Burchell, et al. 1998; Litman 2015). Likewise, buying and maintaining a car results in extra costs for owners and constitutes financial distress for households in deprived urban communities (Curl et al. 2017). Public transport, cycling, and walking are cheaper alternatives for everyday commuting (Gössling & Choi. 2015).

Many factors associated with urban density can potentially generate economic advantages and be seen as drivers of densification policies. Yet, there are also numerous negative economic factors that can act as barriers. Some are consequences inherent to high densities, but several others may arise in the application of urban densification policies in low-density contexts. The pre-existence of large, sprawled peripheries and massive sunk investments in their infrastructure is probably the most important barrier to achieving compact cities. Making these areas more compact entails significant depreciation in value of buildings and infrastructure and other social costs. Examples can be found in the demography-driven suburban decline in many cities and towns in post-industrial areas (Martinez-Fernandez et al. 2012; Berndgen-Kaiser et al. 2014). In many of these cities, a concentration of activities in old inner cities has been an answer to the economic and demographic decline. An overview of these cases illustrates the potential barriers and costs for policy-driven urban densification.

Other economic obstacles emerge in the context of cities with a healthy economy and a growing population. One proven barrier is found in the costs and complexities of urban-renewal operations of brownfields sites (Stead & Hoppenbrouwer 2004). Dealing with multiple ownership, the dismantling or refurbishing of large obsolete infrastructure, and the remediation of polluted soil entails costs and risks that many urban developers are not willing to assume (De Sousa 2000; Thornton & Nathanail 2005). Many developers prefer instead the safer alternative of a greenfield location, where many of the above-mentioned economic and legal risks can be avoided (Hutchison & Disberry 2015). Even when the institutional and market conditions are favourable and urban-renewal operations become successfully accomplished, the high cost of housing in these projects creates new issues. A decrease in affordable housing might be seen as a normal market issue resulting from urban-renewal operations; but when such processes involve the replacement of low-income residents by more affluent ones, it is a highly contested issue. This phenomenon is a much discussed subject in the urban planning literature under the heading of gentrification (Smith 1979, 2012; Hamnett 1991; Barber 2007; Lees & Ley 2008; Quastel et al. 2012). Gentrification entails social conflicts and tensions which might constitute barriers for implementation of densification policies.

Gentrification originates not only from the high costs of urban-renewal operations but in general from supply and demand conditions affecting prices (Smith 1979). Scarcity of space has several negative effects, not only for affordable housing but for the location and economic viability of business. Compact urban environments might be attractive for the knowledge-based economy but there are many other types of businesses necessary for a healthy urban economy. Many businesses require large areas, parking facilities, and good accessibility from highways and other heavy transport infrastructure incompatible with high-density mixed-use environments (Foord 2010). Restrictive parking policies also affect residential users that might choose instead to live outside the city where both housing and parking are more affordable (Stead & Hoppenbrouwer 2004). In predominantly market-driven cities land supply is a crucial factor in the final price of housing (Bramley 1993). Land scarcity, particularly when it is policy driven is difficult to maintain without political costs, constituting a main barrier to the application of urban-containment strategies. According to Glaeser et al. (2006), in the context of flexible regulation and low density, urban success is expressed in population growth; on the other hand, in contexts of tight regulation and high density, urban success takes the shape of low population growth and increased housing prices and income. This reveals potential challenges for making compact cities more inclusive and socially diverse.

### Institutional Drivers and Barriers

The existence of a dominant discourse on sustainability consolidated over nearly three decades is an important institutional driver of urban densification policies. Densification and urban-containment strategies, among many other polices to tackle urban environmental problems, have gradually become part of local regulation frameworks (Brand 2007). Beyond the environment, local governments have many other reasons to promote denser urban environments particularly with regard to efficiency and fiscal health. Despite this, many of the challenges and barriers to achieving denser urban environments arise precisely from legal frameworks and procedural traditions entangled in the existing urban regime (Stone 1993; Næss & Vogel 2012; Eames et al. 2013). For many scholars this is particularly valid in the context of market-oriented societies and under the current neoliberal paradigm where the market is seen as a fundamental provider of solutions to different social problems, including urban problems (Høyer & Næss 2001; Sager 2011; Xue et al. 2016).

The concept of the urban regime has been used to analyse ‘how local communities are governed and how ... they establish and pursue problem-solving priorities’ (Stone 2005). In the context

of market-driven societies the government is just one of the actors dealing with existing problems. Non-governmental actors are also fundamental in problem-solving. Urban regimes are formal and informal arrangements that enable the cooperation between public and private actors in providing solutions for social needs (Stone 1993; Mossberger & Stoker 2001), among them the production and use of space (Purcell 1997). Public actors include all the government entities and agencies which exercise power through policies, regulations, taxes, and subsidies, and through investments in key infrastructure. The private actors, on the other hand, control capital, land, and property necessary to transform and expand the city; they include urban developers, investors, homebuyers, and community groups. Policy outcomes result from the cooperative engagement through which city authorities and private bodies bring together the capacity to implement policies, particularly through the construction of building projects. In this view, urban form is materialised through a coalition between public and private actors.

The efficiency of different urban sectors and the benefits it can bring are powerful drivers for the promotion of denser cities by local governments. Municipal agencies provide services to local residents who gain from the efficiency resulting from the proximity between users, thus requiring less extensive infrastructure networks, easier to maintain and operate (Carruthers & Ulfarsson 2003). Connected to this efficiency, another important driver is the consolidation of a robust tax revenue created by an intense urban environment of economic activities and well-valued buildings. A sound fiscal basis means that the relationship between expenses and income is positively widened, providing better means to improve public investment in infrastructure (roads, sewage, water pipes, etc.) and services (schools, hospitals, waste collection, etc.). An opposite scenario produced by the exodus of taxpayers and shrinking tax revenues means that local authorities have declining budgets to invest in services and infrastructure with negative consequences for the quality of life of the remaining local population (Klug et al. 2007).

However, local governments are only one of the parties in the coalition of actors that determine the form and use of urban space. Among private actors, there are many needs and interests that the compact city may not adequately satisfy (see, for example, the barriers mentioned in previous sections). Consequently, there are also powerful reasons to push for low-density urban environments. And since cities are shaped and operated through coalitions between public and private actors, there are many barriers to densification entrenched within existing urban regimes (Lowndes 2001). Coalition forming is perhaps the most important (Stone 1993). A coalition is formed through negotiations where formal practices (established legal procedures) and informal networks operate. Coalitions are by nature fragile and unstable, changeable by pressures and

circumstances, and usually formed around specific issues (Stone 2005). In such a context, conflicting interests between public planning agencies and private urban developers might also emerge as a significant barrier.

There are also legal frameworks and procedural traditions that facilitate the development of sprawled cities. One well documented example is administrative fragmentation (While et al. 2004; Bulkeley & Betsill 2005). Since local administrations have to compete to attract potential taxpayers, relaxation of regulations and exemptions in land uses are in many cases used as competition instruments (Oates & Schwab 1988). Another example can be found in property taxation regimes, which according to some studies have an influence on urban form. Property tax systems are generally based on the value of a given property. Such value is estimated on the valuation of a whole, mostly relating to the capital embodied in structures and to a lesser extent the land. According to Brueckner & Kim (2003) land tends to be developed less intensively under property taxation system than under a pure land tax system. A tax system based on land or a split-rate tax should have a contrary effect, producing denser built environments. A study by Banzhaf & Lavery (2010) found empirical evidence of such an effect in Pennsylvania where a split-rate tax was adopted in the 1980s, and the number of housing units per unit land area has been gradually increasing. Moreover, a study in Italy found that an increase in property taxation in core cities increased urban expansion in response, while an increase in property taxation in the periphery had a contrary effect, making urban development more compact (Ermini & Santolini 2017).

Another institutional barrier to achieve denser urban environments can be found in infrastructure development policies and subsidies allocated to car usage through different mechanisms. Perhaps the most influential has been the development of road infrastructure which in most of cases has been developed under centralised policies, not taking into account local problems (Stenstadvold 1996; Graham & Marvin 2001; Boarnet 2013). Even though road infrastructure is a powerful driver of urban form and function, urban planners and local authorities frequently play only a marginal role in their implementation (Taylor 2000). Other forms of transport subsidies such as free parking, tax deductions for commuting costs, or fuel subsidies are applied in different contexts. Several studies suggest that by not making drivers pay the total cost of their journeys, commuting is encouraged and is therefore seen as a possible cause of urban sprawl (Hanson 1992; Brueckner 2005; Su & De Salvo 2008; Christiansen et al. 2017). Subsidies for public transport have been questioned on the same grounds (Avner et al. 2017).

## 2.6. The Quest for Urban Densification in Norway

Under the influence of sustainable development principles, in most developed countries one of the main targets of urban planning has been the decarbonisation of urban mobility. This implies increases in the use of public transport, cycling, and walking for everyday commutes. Such increases seem possible only if land uses are intensified, and distances between origins and destinations for commuters are decreased. There is empirical evidence supporting a direct relationship between an increased density and a significant reduction in $CO_2$ emissions, both from transport and buildings (Gudipudi et al. 2016; Steemers 2003). Therefore, urban density has been promoted as one of the main characteristics of the sustainable city, and densification has become a common planning strategy (Jabareen 2006; Kenworthy 2006; Karathodorou et al. 2010). However, turning sprawled urban patterns into denser ones is not a short-term goal. Cities are embedded in large processes of permanent adjustment, in which societal, technological, economic, and environmental factors blend and merge. A frequently identified challenge, also in the Norwegian literature on planning for sustainability, is that economic issues and an increasing reliance on the market approach lead to a prioritisation of popular preferences over environmental protection (Hanssen 2012; Hanssen & Hofstad 2015; Støa 2014)

Norway is a good example of such a complex transition. The country is ranked high in different sustainable development indices, such as the Environmental Performance Index (Hsu et al. 2016) and the Sustainable Society Index (Van de Kerk & Manuel 2014), in which a large emphasis is placed on social well-being and equity, good governance, and economic performance. However, Norwegians have the third highest per capita carbon footprint in Europe, only surpassed by Luxembourg and Estonia (World Bank 2013). Since the late 1980s, the government has been promoting sustainable urban development with a focus on densification and decarbonisation of transport. Progress, however, is not constant. The Norwegian Travel Survey 2013–14 presents mixed results with some positive advances and remaining challenges. For example, the accessibility to a public transportation network rated as very good[3] in the survey increased by only 4% since the previous survey in 2009, with better conditions concentrated in the largest cities. The accessibility index to a very good public transportation network is 83% in Oslo, 45% in Bergen, and 64% in Trondheim and Stavanger,

[3] Very good public transport coverage implies a distance to the bus stop or terminal of less than 1km and a minimum frequency of four departures per hour (Hjorthol et al. 2014)

according to Hjorthol et al. (2014: 14). Yet, at the same time, there was an increase in car ownership per household from 85% to 88%, and the average length of a trip rose from 12km to 14.5 km. The share of trips by environmentally-friendly modes (walking, cycling, and public transport) has remained rather stable around 36% since 1992 (p. 25). Further improvements are hampered by barriers embedded in society, such as the prestige connected to cars, and the existing urban layout marked by a sprawled form; as well as by economic distortions originating in indirect subsidies to cars (e.g. via tax deductions for commuting), which are further supported by high charges for public transport.

A common view is that urban densification started as a strategy promoted by multilateral organisations as part of the sustainability agenda, and then moved to national and local levels (see, for example, UN-Habitat 1996; EEA 2009; UN-Habitat 2013). However, the concepts and ideas underpinning such an agenda have been around for a long time, and have been tested in different places previously. They have been adopted subsequently by multilateral agreements. This also seems to be the case with urban densification strategies aimed at decarbonising society. As it has been argued in Section 2.3, a combination of circumstances created the ground for new approaches to development in general, and to urban planning as one of its important components. In Norway, after decades of urban sprawl, urban containment became a main concern in the 1980s (Næss et al. 2015). The ideas of the seminal report from the World Commission on Environment and Development, *Our Common Future*, led by the former prime minister of Norway Gro Harlem Brundtland, were quickly adopted into local initiatives on urban planning, making Norway one of the pioneers in sustainable city planning.

In the Norwegian context, the principles of the Brundtland Report were mainly interpreted as environmental goals, aimed at reducing the impacts of human activities on the environment (Hanssen et al. 2013). Urban development during and after the 1960s was characterised by an unprecedented expansion and a sharp decline in density (Næss 1993). Containment of urban expansion was already an important element in municipal planning, particularly because providing roads, sewerage systems, and other infrastructure to low-density large urban areas was seen as an increasing burden on local finances (Næss et al. 2015). The NAMIT project (*Natur og Miljøvennlig Tettstedsutvikling* 1988–92) was the first initiative to implement sustainable development principles in urban planning. Among its aims were the reduction of energy use, the protection of biodiversity and landscape, the reduction of waste, the provision of better access to green areas, and the enhancement of social welfare. NAMIT was a scenario-based project, testing different alternatives of development over a 30-year horizon for the

Norwegian communities of Borre, Sogndalsfjøra, and Eastern Trondheim/Malvik. One of the main conclusions of this project was that there were significant benefits to be gained by substituting urban sprawl with compact city development (Næss et al. 2015).

NAMIT concluded that appreciable ecological and economic benefits were gained from restricting urban development to areas already served by infrastructure, and from enhancing the efficiency at each construction site. Some of the restrictions implemented included limits on the construction of new detached houses and the implementation of tighter parking controls to discourage the use of private cars. By using surveys, the project explored social perceptions towards the implantation of these initiatives. The results reveal that the main barrier to the implementation of such a strategy was poor popular support and a weak political will backing up concrete actions (Næss 1993). Restrictions in favour of more compact urban settlements were seen as limitations to people's lifestyle aspirations and curtailments of individual free choice. Even though politicians had a more favourable position towards the proposed actions, they were concerned about the risk of losing popular support. From this exploration of the social perception of densification policies, it was soon accepted that social behaviour would be a fundamental aspect in a successful transition towards more environmentally friendly urban development. Despite these original circumstances, urban densification, in connection to sustainable development goals, became a central element in Norwegian planning policies in the years to come.

## The Consolidation of a Norwegian Compact City Policy

Norway has come a long way in the development of sustainable city policies. The compact city model and densification as a planning strategy have been the dominant approach. This section introduces some of the most relevant initiatives on urban development to illustrate how policies have kept continuity through time. Urban densification has been encouraged through white papers, revisions to legislation, and through national programmes applied to cities and towns.

The first urban containment measures to protect the environment were introduced in the 1992–3 national policy on land use (*Den Regionale Planleggingen og Arealpolitikken*) (Næss et al. 2015). Another early example is the Sustainable Cities Programme for Five Cities (*Nasjonalt Program for Utvikling av Fem Miljøbyer*) (Norwegian Ministry of the Environment 1995). This initiative was designed as a partnership among local and national institutions to study best practices of the implementation of the sustainable city agenda at the local level. The programme included the cities of Fredrikstad, Bergen, Kristiansand, Tromsø, and Old Oslo.

Table 4. A better environment in cities and towns, 2002

| |
|---|
| **Promotion of regional urban networks between central cities and smaller towns** |
| **Urban densification and environmentally friendly public transport** |
| Integrated land use and transport planning in long-term strategies |
| Strengthening of public transport |
| Improvement of public space networks for pedestrians and cyclists |
| Urban intensification around public transport nodes |
| Promotion of denser housing solutions |
| Adequate location of business and urban services according to public transport |
| Reduction of motorised transport |
| **Preservation and development of green and forest areas accessible to urban residents** |
| **Conservation of historic urban areas and buildings** |
| **Strengthening of traditional urban centres and neighbourhood centres** |
| Varied offer of commerce, cultural activities and services |
| Protection of historic values in buildings and urban quarters |
| Conservation of green areas in the inner city |
| Promotion of good environments for children and youth |
| Incentivisation for accessibility to and safety in public space and outdoor green areas |
| Reduction of noise in residential areas |
| Promotion of denser and alluring urban environments |

Following the trend, the Norwegian Ministry of the Environment (2002) produced the report 'A Better Environment in Cities and Towns' (*Bedre Miljø i Byer og Tettsteder*) (see Table 4). In this white paper, a denser urban development is regarded as an important strategy to minimise the pressure on agricultural lands, forest, and other valuable natural environments. Such development is not only considered as a local issue but as a regional strategy by the promotion of urban networks with complementary concentrations of cities and towns. The document also defends the virtues of the compact city as an enabler of the efficiency of public transport, facilitator of travel by foot or bicycles, and, in general, optimiser of travel needs. Active travel choices such as walking and cycling not only contribute to reduce pollution but may also improve people's health.

Despite the potential benefits of denser urban environments, the document also discusses potential conflicts and implementation challenges. Denser urban areas need to be attractive enough to offer diversity of environments for people of different ages and social backgrounds. Increasing density without consideration for quality could cause the concentration of the lower-income population in lower-quality areas. A key aspect of quality is the accessibility to a system of public spaces and green areas of high standards. Such systems should be well distributed to offer proximity and accessibility to all the residential areas of the city. Some other challenges of increasing density are seen in a potential exposure of a large number of people to pollution, noise in particular, but also air pollution.

The implementation of policies to achieve a high-quality denser urban environment is perhaps the biggest challenge identified in the document. Municipalities are seen as the main responsible party in steering the development of the local environment. But urban development is a complex task where many other actors with different interests participate. The cooperation among private actors and public institutions, as well as the participation of civil society is seen as a fundamental matter in the successful implementation of urban development policies.

Table 5. Cities of the future

| **The four priority areas of the programme 'Cities of the Future'** |
|---|
| *Land use and transport*<br>To reduce the use of cars in the city<br>To strength the traditional city centre and the local centralities<br>To increase the use of collective transport, cycling and walking<br>To decrease the distances to daily urban services (grocery shops, kindergarten, schools, green public spaces) |
| *Consumption and waste*<br>To improve waste treatment and recycling<br>To decrease the use of disposable packaging<br>To encourage sustainable and durable consumption |
| *Energy and buildings*<br>To reduce energy consumption<br>To produce energy from sustainable sources<br>To implement heating districts in residential and commercial areas |
| *Climate change adaptation*<br>To strengthen cities to deal with events associated with climate change (rain, landslides, higher sea level, and wind) |

In 2007, the Norwegian Ministry of the Environment published 'The Government's Environmental Policy and the State of the Environment in Norway', a white paper with a broader scope on environmental issues, also dealing with the issue of urban densification as an important approach to strengthen the basis for environmentally sound choices for individuals and society as a whole. The report emphasises the direct connection between land use and transport and their influence on greenhouse gas emissions. Among the commitments included in the document are the inclusion of new planning provisions, which were later included in the new Planning and Building Act of 2009; the development of a national policy for the architectonic and environmental quality; and permission to use revenues from road tolls towards public transport.

A laboratory for the implementation of many of the principles of the compact city was set up through the programme 'Cities of the Future' (Norwegian Ministry of the Environment 2008).

This initiative was conceived as a partnership between the central government, the local authorities and private actors involved in urban development. The programme included the 13 most urbanised municipalities of Norway: Oslo, Bærum, Drammen, Sarpsborg, Fredrikstad, Porsgrunn, Skien, Kristiansand, Sandnes, Stavanger, Bergen, Trondheim, and Tromsø. The project's aim is to offer measurable results and benefits in four key areas of sustainable development applied to cities: land use and transport, consumption and waste, energy and buildings, and climate change adaptation (see Table 5).

'Norway's Environmental Targets' (Norwegian Ministry of the Environment 2012) established 'a good urban environment' as one of the 11 priority areas on the national agenda. The document proposes a list of 'sound principles of sustainable urban development':

- *Public transport should form the backbone of the urban structure and govern development patterns.*
- *There should be a strong centre with a concentration of workplaces, housing and retail and office functions.*
- *Commercial and residential developments should be concentrated around public transport nodes.*
- *There should be local communities with dense and varied residential districts, green spaces, schools, day-care centres and retail and commercial activities.*
- *There should be a continuous green structure with green corridors that link urban districts and green spaces with the surrounding countryside.*
- *There should be a network of main cycle routes that make cycling an attractive transport option.*
- *The main road system should not pass through local communities, but should serve urban centres and public transport nodes.*

These principles, mostly aiming at transport and land uses, are further developed in the 'The Contemporary Sustainable City' (Norwegian Ministry of the Environment 2013). This new report is organised around six areas mostly focused on the qualities that a denser urban environment should offer to encourage liveability, efficient transport alternatives, and meaningful environments (see Table 6). A high-quality and well-valued urban environment, according to the document, is achieved through the mix of buildings of different times, the mix of uses, and the vitality of the streets through active functions on the ground floor, particularly in central areas. The report also recommends the reuse and adaptation of existing structures, to the role of public buildings acting as a landmarks, and to an extensive system of green spaces, accessible to all the inhabitants.

Table 6. The contemporary sustainable city, 2013

| |
|---|
| **City of proximity** |
| Proximity and accessibility to public transport, shops and local services, kindergarten and schools, meeting space and attractive green spaces within walkable distances |
| **High quality** |
| High standards of quality, safety, aesthetics, landscape and architecture. Architecture, land use, transport and public spaces should be interconnected concepts in the search of attractiveness to diverse users |
| **Coexistence of old and new** |
| Densification within the existing boundaries demands reuse of the exiting building stock. Those buildings may need adaptions for current demands. This retrofit should be performed with special care for historic and aesthetic values. Cultural heritage is an essential part of the good urban environment |
| **Inclusive cities** |
| City space should be adapted to favour the pedestrian and cyclist. Car use should be avoided, particularly for short trips. Pedestrian networks and bicycle paths should be designed according to each urban context. Densification and proximity to services is also a key aspect of green mobility |
| **The green choice** |
| City space should be adapted to favour pedestrian and cyclist. The use of car should be avoided particularly in short trips. Pedestrian networks and cycle paths should be designed according to each urban context. Densification and proximity to services are key aspects of green mobility |
| **Healthy, green cities for all** |
| Urban space should encourage public health and welfare. The space of the city should promote diverse social activities, sense of belonging and togetherness |

Norway was an early adopter of urban densification and the compact city approach in connection with the sustainability agenda in Europe, and many of the ideas developed in NAMIT have had impacts beyond the Norwegian borders (Næss et al. 2015). Urban changes such as densification are gradual and are affected by the accumulation of persistent initiatives over long time-spans. Despite almost three decades of planning towards denser and more sustainable cities many challenges remain. Although urban sprawl which was the clearest tendency in urban development until the 1980s has gradually been replaced by densification, particularly in the larger cities, in smaller urban areas sprawl seems to continue. Oslo is where the most significant changes have occurred, both in densification gains and in significant gains in environmentally friendly transport. Yet some other places have either maintained a similar density or even increased the urban land area they cover.

## 2.7. How Does the Compact City Paradigm Relate to Norwegian Cities?

With nearly 80% of the population in Norway living in urban areas (SSB 2013),[4] there is a wide range of urban environments with very different degrees of compactness. This is especially the

[4] In Norway, a hub of buildings shall be registered as an urban settlement if it is inhabited by at least 200 persons (60–70 dwellings). The distance between the buildings shall normally not exceed 50 metres. Deviations are allowed for areas that cannot/are not to be occupied, for example parks, sport facilities, industrial areas, or natural barriers such as rivers and arable

case in the larger urban agglomerations where transportation technologies allow living and working within an extensive area, spilling beyond municipal borders. These agglomerations constitute functional urban areas, which according to Eurostat (2013) are formed by a city and its commuting zone.[5] The urbanisation patterns in the functional urban areas are normally discontinuous, with dense centres, but a number of smaller compact nuclei and intermediate low-density areas in different forms. In Norway, six functional urban areas were identified by an OECD study of 2013 (see Figure 8); and even though densification has been increasing in Norwegian urban areas, it might still be difficult to call such urbanisation patterns compact.

Urban development trends have noticeable variations through time. As a consequence, contemporary urban form is an archipelago of urban environments with contrasting intensities and shapes. Norwegian cities were relatively compact until the 1950s. However, in the following decades, they underwent an unprecedented period of growth in the form of 'centralised sprawl'. This means, according to Holden (2004), the concentration of the national population in a few large sprawled agglomerations, where most of the new growth has taken the shape of an expanding periphery, characterised by a low-density urban form, frequently discontinuous, with large agricultural and forestry areas in between (see Figure 9 and 10). The reason for this fragmented urban expansion is, according to Næss et al. (2015), a combination of urban planning regulations addressed to protect periurban agricultural and landscape areas, a sharp increase of car ownership, and a growing demand for housing in the 1970s and 1980s. However, a reurbanisation trend has been gradually changing the urban landscape since the 1990s (Næss et al. 2011a). Different figures confirm an increasing tendency towards densification. Hanssen et al. (2015), quoting figures from Statistics Norway (SSB), have identified an average density gain of 3% in Norwegian urban areas in the period 2000–12. This tendency is stronger in larger cities. Næss et al. (2011), using figures from SSB for the period 2000–9, highlight an increase in density of 4.6% in the 10 largest Norwegian cities, and 11% in the case of Oslo alone.

land. Also included are agglomerations that naturally belong to the urban settlement up to a distance of 400 metres from the centre of the urban settlement. Urban settlements are geographical areas with dynamic boundaries. Thus the number of urban settlements and their boundaries will change over time, depending on construction activity and changes of resident population. The delimitation of the urban settlements is independent of the administrative boundaries (Dysterud et al. 1999; own translation).

[5] A commuting zone can be identified when 15% of employed persons living in one city work in another city; these cities are treated as a single entity. All contiguous municipalities with at least 15% of their employed residents working in a city are included.

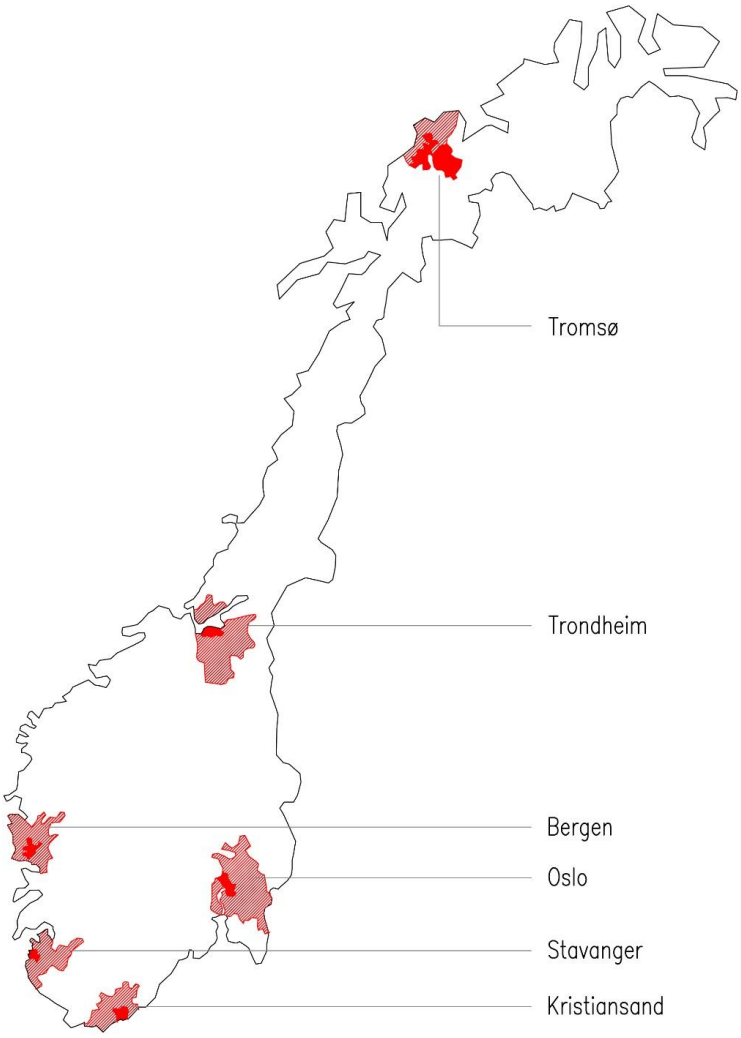


Figure 8. Norwegian functional urban areas

*Source: Eurostat Regional Yearbook 2013 (p. 220).*

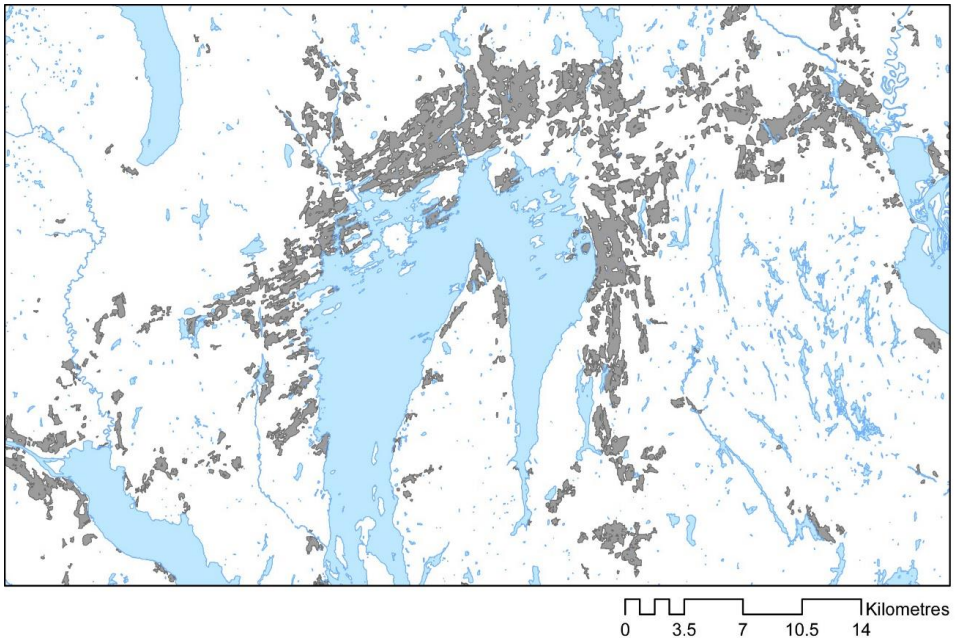


Figure 9. Urban area in the Oslo region

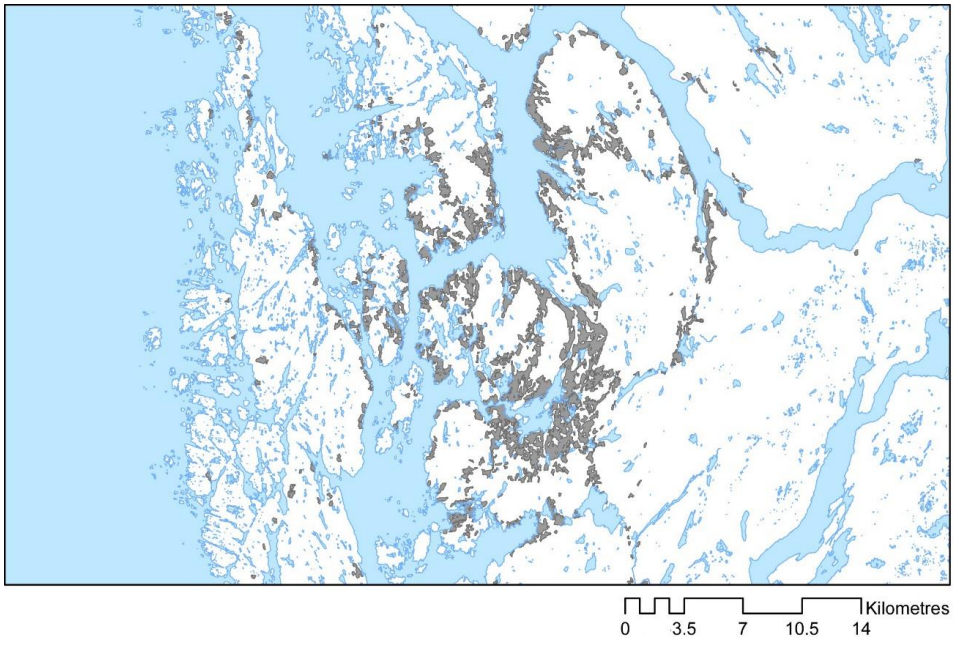


Figure 10. Urban area in the Bergen region

Recent gains in urban density, however, have not significantly changed the sprawled urban development of the previous decades based mainly on the proliferation of single-family houses.[6] Despite the increase in density, the urban agglomerations of Norway today have, on average, one of the lowest densities among the cities of the most developed nations. An OECD analysis of 2013 comparing 275 urban areas places the Norwegian urban agglomeration[7] as one of the least dense, with an average population density of 109 inhabitants per hectare; only Estonian (107) and Finnish (91) cities are less dense; Swedish (119), Canadian (124), and even US (288) cities are denser. The OECD definition of urban area is equivalent to the Eurostat definition of functional urban area addressed above. Lower densities, as it has been said elsewhere, have a direct impact on an increased car dependency for daily commuting. This seems to apply well to the Norwegian case. The average distance travelled in private cars per day in Norway in 2010 was 33.5km, the longest in Europe (Brunvoll & Monsrud 2013); this figure increased to 34.4km in 2015, despite modest gains in densification (SSB 2016).

Answering the question of how the compact city paradigm applies to Norwegian cities is difficult. On the one hand, there is a rather sprawled urban development characterised by a car-oriented, irregular urban fabric developed between the 1960s and the 1980s. The lower densities in these urban peripheries do not allow for a high frequency of public transport, and cars remain the main transport mode. Intensifying urban development in these vast residential peripheries seems a challenging process, involving highly fragmented land ownership and a potential lack of social acceptability. On the other hand, the tendency towards densification in the larger urban areas seems not to imply automatic and proportional gains in more environmentally friendly transportation (public transport, cycling, and walking). Indeed, a comparison of the figures between the national transport surveys of 2009 and 2013 indicates only small gains, or even some decreases, in the use of environmentally friendly transport. Environmentally friendly transport has presented an increase of 3% in the Oslo region, but a 1% decrease in the Oslo municipality, and a 1% decrease in the urban regions of Bergen, Trondheim, and Stavanger. However, further gains in densification might soon be reflected in travel behaviour; and public transport, as well as walking and cycling, should become the prevalent transport mode if increases in density are accompanied by additional policies.

[6] Figures from SSB 2013 indicate that nearly 53% of all Norwegian dwellings are detached houses. Additional details are founded in Section 5.4.

[7] Oslo, Bergen, Trondheim, Stavanger, Kristiansand, and Tromsø are the six cities included in the OECD analysis.

# 3. Research Approach and Methodology

The study of urban changes requires what Langley (2007) defines as 'process thinking'; this entails that the process has to be considered dynamically, in terms of permanent changes and temporal evolution. Phenomena such as urban changes cannot be isolated from their context, making their characteristics very distinct and difficult to *replicate*. The difficulty of replicability in social processes is cause for multiple challenges because the results of a given study cannot be publicly tested, as with many phenomena in the natural sciences. Therefore, in the study of social phenomena, the underlying assumptions, the modes of enquiry, and their validation are necessarily different from those used in the natural sciences. This section deals with these challenges and how they can be overcome in the study of urban densification.

The section is organised in six parts: *Section 3.1. Critical Realism as Epistemological Basis for a Mixed Methodology* elaborates on how the enquiry is conducted to find reliable answers to the research questions. *Section 3.2. A Priori Assumptions and Research Design* explains how previous personal experiences have influenced the way this research has been addressed. *Section 3.3. The Nature of the Problem* deals with some of the challenges of studying a process-based phenomenon embedded in social practices, such as urban densification. *Section 3.4. Toolkit for an Integrated Assessment* presents the main instruments and tools used in this research. *Section 3.5. Modes of Enquiry and Research Methods* describes the combination of quantitative and qualitative methods employed in the different research components. *Section 3.6. Cases, Validity, and Generalisability* outlines how case studies have been handled in this research, how they can be a valid means to generate knowledge, and what type of generalisations can be expected from them.

## 3.1. Critical Realism as Epistemological Basis for a Mixed Methodology

The basis for the justification of knowledge is directly linked to the interpretation of reality. This interpretation determines the focus of interest, the way of enquiring, the methods used in the development of the research, and the concepts and argumentation strategy in ultimate validation of the results (Popper 2005). The interpretation of reality has become a truly complex matter with controversial positions and enduring debates. One of the best known debates in epistemology addresses the fundamental question of *how we know things*. According to Walliman (2010), there are two basic ways of gaining knowledge: the empiricist tradition, which claims that knowledge is gained through sensory experience (inductive reasoning), and

the rationalist approach, which maintains that it is gained through reasoning, using deductions to infer particular instances in reference to a general principle (deductive reasoning). The advancement of the natural sciences is, however, following Walliman's argument, a combination of both approaches. This blend forms the hypothetico-deductive method, also called 'scientific method'.

One of the most relevant debates within the social sciences with regard to epistemological positions has been about the distinction between positivism and constructivism. The positivist approach advocates transferring the scientific method from natural sciences to the social sciences. The positivist view maintains that social phenomena, as natural phenomena, function according to natural laws, and can therefore be observed and described by the researcher in an objective fashion (Ray 2000). According to this view, the social sciences, similar to the natural sciences, can be advanced using the scientific method. Through the use of experiments, mathematical models, and quantifiable observations, it is possible to test hypotheses. Society can be ruled and improved by universal principles. On the other side of the spectrum are the constructivists or relativists (Mcallister 2000). They maintain that social reality is mainly shaped by ideas and, as ideas are changeable and diverse, so is society. The role of the researcher is to interpret such diversity, from which he or she cannot be subtracted. Objectivity is not possible; the observer makes observations according to values. Such reality can be better studied using qualitative descriptions, in order to establish possible meanings, relations, and interactions. The use of language is fundamental and cannot be neutral.

The choice of research methods is a fundamental aspect of an epistemological position, as can be seen in the debates outlined above. Research methods combine a wide range of instruments for collecting, analysing, and presenting data that can be grouped into two general categories: quantitative and qualitative methods (Walliman 2010). Many disciplines have a marked preference for one or the other of these categories, and tend to consider the interpretations of reality performed by their counterpart as insufficient, inaccurate, or narrow. This polarising view has contributed to a silo effect, hindering further advances of knowledge in many fields, such as in urban processes, characterised by many interlinked phenomena and complex interactions among them. A good illustration of such complexity can be seen in the debate on the causality of travel behaviour (Næss & Jensen 2002; Van Acker et al. 2007). Researching whether travel behaviour is determined by urban form or by socioeconomic aspects seems to require a position in-between the silos, combining elements of the constructivist and the positivist traditions.

A third line of argumentation, presenting an alternative view to the constructivist vs positivist debate, can be found in 'realism' or 'critical realism', as it has been called by Sayer (2000). The critical realist view maintains that the 'real' exists independent of the capacity of the human mind to interpret and understand it. The real is only known by using particular descriptions and explanations, within existing discourses, but this does not mean, following Sayer's argument, that this knowledge is better than any other. Knowledge is essentially transitive in nature. This means that it changes when new instruments to understand the world are developed. The best theories available today might eventually be replaced by better theories. Realism therefore, in Sayer's words, distinguishes between three categories: the real, the actual, and the empirical. The 'real' is everything that exists, whether a natural object or a cultural construct. The real exists beyond human experience or understanding. The real is the dimension of objects, their arrangements and relations, and powers; this includes not only that which is known but also that which is potential (the possibilities of change). The 'actual', following Sayers, refers to what happens if and when those powers are activated. The actual is the dimension of action: resulting from unleashing the potential and its effects. A study of drivers and barriers of urban densification belongs to this dimension. The 'empirical' is what is experienced; both the real and the actual can be experienced.

In the realist view, existing epistemologies such as empiricism, rationalism, positivism, and constructivism (see above) are not sufficient theories of what exits, but they can offer a set of instruments to be used (and combined) according to circumstances and requirements. The realists (following Sayer 2000: 11) 'seek to identify both necessity and possibility or potential in the world – what things must go together, and what could happen, given the nature of the objects'. Both the studied phenomenon and the knowledge gained from the study may have a very heterogeneous nature. To provide an example, many aspects of reality cannot be quantified. This is particularly true in the social sciences, where notions, such as political power, social development, or culture are best described by conceptual models; while for some other aspects, such as demographic or economic issues, the use of numbers and figures is more suitable. Realism, according to Olsen (2004), offers a good platform for the application of an integrated mixed-method approach as it follows a pluralistic epistemology.

In urban processes research, critical realism recognises the potential independent causes of both agents and structures and consequently offers an appropriate basis for studying the causal relations between the built environment and its socioeconomic context (the factors) and the actions of agents (the actors) influencing change (Næss 2015). This is especially valid in the

realisation of sustainable urban policies that require 'actions' to activate forces, both in the material world (where, for example, denser built environment can potentially result in shorter commutes), and in the realm of ideas and belief that shape how the society interacts with the material world (through, for example, taxes, legal frameworks, and procedural traditions).

Critical realism provides an alternative for combining existing instruments in a pragmatic fashion, not only to study the world as it is experienced, but recognising the probabilities of unknown powers and their potential effects. In Sayer's view, 'what has happened or been known to have happened does not exhaust what could happen or have happened' (2000: 12). The time dimension intrinsic to the realist view allows for the recognition of time constraints affecting the study of reality without predetermining future events. This epistemological platform makes it possible to understand, following Sayer's argument, 'how we could be or become many things which currently we are not'. For example, using an example that serves this thesis well, sprawled unsustainable cites could become denser and more sustainable. The methodological approach of combining instruments and discourses necessary to provide interpretations leading to an understanding of the real (including the potential) has been called triangulation (Olsen 2004).

## 3.2. A Priori Assumptions and Research Design

At the beginning of this research, I had very general ideas about densification, partially deduced from observing urban changes in Medellin, Colombia, my home city, and from previous experiences in city planning. There I had observed how urban sprawl was mostly driven by an affluent population, with the economic resources to afford the costs of a larger house in a countryside condominium, and car-based transport. I had also observed that despite limited public resources, local authorities invested in expensive infrastructure to address the demands of such minority groups; even going against the principles of well-conceived and democratically validated masterplans and regulations. Therefore, my research strategy did not start from the willingness to test a particular theory. Instead, I started from a set of empirical questions leading to the use of different analytical perspectives and instruments. My preliminary idea was to find out if densification or sprawl is taking place in Norwegian cities; how and by what factors the process is driven; and which actors and structures are behind urban changes in Norway.

A quite logical point of departure was to investigate the practicability of densification policies in Norway. Since Norway is an affluent society where many have the means to afford a suburban lifestyle, I have to admit that I was very sceptical of the success of a densification policy in this context. This personal assumption strongly influenced my first paper, set out in *Section 5. On the Feasibility and Effectiveness of Urban Densification in Norway*. By exploring static information on the four largest Norwegian cities, I found that densification was indeed occurring in these cities, even though at quite different rates. These densification gains, however, did not correlate with the anticipated decline in car usage.

From my previous experiences, I knew about the difficulties of steering urban development to thoroughly implement urban plans in market-driven societies. Therefore, I wanted to explore how such challenges were manifested in the Norwegian context. The other two papers are derived from this presupposition. I had seen how social acceptability was a crucial factor in achieving planning goals. The second paper, set out in *Section 6. The Value of Urban Density: An Exploratory Study of the Relationship between Urban Density and Housing Prices in Trondheim, Norway* had the purpose of studying how the housing market dealt with denser urban environments. I had also observed how urban development was steered by different forces, particularly in the case of the implementation of city plans developed by public agencies. The third paper, set out in *Section 7. A Transition to a Denser and More Sustainable City: Factors and Actors in Trondheim, Norway* had the purpose of studying how different factors and actors influenced urban change. In the end, I have to admit, I had three papers[8] but not a solid research design.

## 3.3. The Nature of the Problem

Planning the research and deciding its methodology, adopted over more than three years of research, was one of the major challenges. Although the subject of study, urban densification, was clear from the outset, the aspects that would be studied in such a complex phenomenon were the result of the process itself. This of course implies that there was not a ready-made methodological framework in the beginning. The methodological approaches used in the three research papers were identified and defined to match very different research problems. Consequently, the only possible option was to use an exploratory and open research approach, with continuous adjustment of the research questions. That is, the methodology described here

[8] A fourth paper was originally presented here, but following committee recommendations was merged with *Section 2. Research Background*.

is the result of a later reconstruction of the processes and not the application of a standard formula previously designed.

In the process of reconstructing this methodology, I discovered that such a problem was quite frequent among researchers investigating processes within the social sciences (Checkland & Holwell 1998; Downward et al. 2002; Yeung 2003; Miller & Tsang 2011). According to Yeung (2003) when a research problem encompasses the study of a phenomenon embedded in social practices, understanding the changing character of different actors, and exploring the influence of the context with its material and discursive elements in shaping possible new realities, the researcher can no longer rely solely on the tools provided by the empiricist research tradition. He proposes a process-based methodological framework using complementary mixed methodological approaches and triangulation. According to Yeung (2003: 442):

> *This process-based methodological framework is defined as the creative and coherent deployment of different methodological practices as different 'moments' of a research process that is sensitive to specific research questions and/or contexts. The framework is process-based because the configuration of different methodological practices is driven by the research process itself, rather than some preordained philosophical positions.*

This exercise involves the combination of multidisciplinary approaches, combining theoretical elements with empirical cases. At the start of such an investigation, the nature of findings is unpredictable; and the conclusions that emerge will undoubtedly be subject to revision. Research formats and standardised processes are also of little use. For example, the delimitation of the object of study (the city) is already a controversial area, since cities are both global systems and archipelagos of micro-realities. In this multidimensional context, the delimitation of any phenomenon is problematic. Understanding such complexity requires a pragmatic and flexible approach, allowing for a combination of methods. This combination can be tailored to understand the interrelations between abstract forces entangled in society and the specific aspects of the material realm of the city that shape urban form.

## 3.4. Toolkit for an Integrated Assessment

As already mentioned above, there was no one set methodological framework at the beginning of this PhD. The development of the framework has been a gradual process with many adjustments along the way. That is why what is explained here is a methodology reconstruction,

bringing together different procedures used in the development of the research. This task is accomplished by using a narrow-down sequence, going from general to particular aspects (see Figure 11). The research draws from the general body of knowledge on sustainable development, particularly on the sustainable city. It combines conceptual elements from sustainability transitions theory, city planning theory, and urban theory. The research papers build on concepts such as feasibility and effectiveness of urban densification, social acceptability and market value, and the city as a sociotechnical system. The research process has consisted mostly of collecting data from governmental sources and theoretical elements from available literature; then analysing them using a combination of techniques to produce different interpretations which were then presented in the form of scientific papers.

## Theoretical Elements, Conceptual Framework, and the Research Process

Sustainable development is an overarching concept connected to many aspects of contemporary societies. The idea of the sustainable city and the processes to achieve sustainability goals at the urban level are some of the main fields of study within contemporary urban planning. Sustainable development has become a concept deeply entrenched in planning discourses, and at the same time the study of urban changes such as densification can be connected to a wide range of disciplines ranging from social studies, economics, engineering, to political sciences and planning. To be able to navigate in such complexity, this thesis has taken theoretical elements from several of these fields. The most relevant are: urban theory, planning theory, social change, and sustainability transitions (see Figure 11).

From these theoretical elements, four conceptual frameworks are extracted and studied in separate research papers. One of them, urban density and the 'good city', was initially presented as a research paper but later merged with *Section 2. Research Background*. This second section deals with the antecedents of sustainable development. Here, urban density is studied in its relation to urban quality and the idea of the 'good city' within urban theory and later as a key element of the sustainable city concept and in the consolidation of a Norwegian compact city policy. The other three concepts, feasibility and effectiveness, social acceptability, and multilevel and multidimensional transition, are addressed in separate articles in Sections 5, 6, and 7.

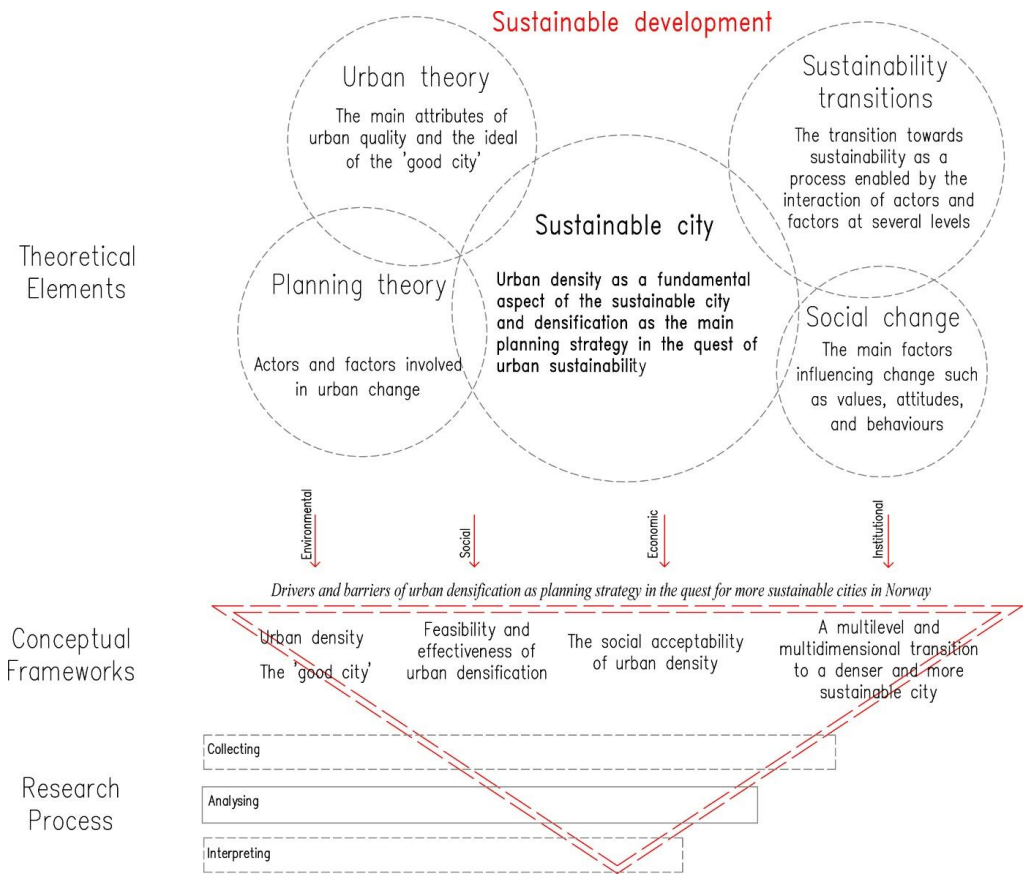


Figure 11. Theoretical elements, conceptual frameworks, and the research process

Section 5 aims to answers the question of *how feasible and effective urban densification is in achieving the objectives of the sustainable city in Norway.* The feasibility and effectiveness of urban densification serve as a conceptual framework in the study of recent efforts of densification in the largest Norwegian cities. Section 6 addresses the question of *how urban density is valued in the Norwegian housing market*. Housing prices are used as a proxy for social acceptability of urban density, aiming to understand to what extent social acceptability constitutes a major challenge in the implementation of sustainable city initiatives. Denser urban environments have been presented as undesirable and, given the power of individuals' free choice in market-oriented societies, densification has been questioned as a good planning strategy to sustainability at the local level. Section 7 answers the question of *what factors and actors influence the transition towards denser cities in Norway.* A multilevel and multidimensional approach was used to assess the transition to a denser and more sustainable

city in Norway, identifying some of the main actors and factors in urban change as well as some of the main challenges in the implementation of densification strategies.

The research process can be divided into three basic phases: collecting, analysing, and interpreting. These phases do not imply a fixed order in the real implementation of a research project, but a way of categorising a wide range of instruments to accomplish a research project. The *collection phase* consists of the exploration and primary valuation, in terms of quality and utility, of information necessary to accomplish the research task. Data can refer to very different types of material, such as texts, interviews, observations, photographs, maps, or numbers. Technological advances have substantially increased the availability and accessibility of many types of data. Nonetheless, gathering information is still one of the most time-consuming activities of any research project, often requiring specialised tools and/or skills. The *analysis phase* consists of a combination of methods to deal with information according to different research traditions and the type of data being analysed. This research combines qualitative and quantitative analyses of multiple case studies to provide answers to the research questions (see Figure 11 and Figure *12*). Finally, the *interpretation phase* has the purpose of presenting meaningful conclusions, useful for decision making and for further research in the field of study. These three steps require different techniques that are described in the following section.

Triangulation is applied by using the concept of 'drivers and barriers' of urban densification as planning strategy (see Figure 11). Some of the most relevant drivers and barriers of urban densification from a general perspective have been discussed in *Section 2.5. Drivers and Barriers of Densification of Existing Cities*. Here, the drivers and barriers are grouped in four categories: environmental, social, economic, and institutional. This analysis has been narrowed down to the Norwegian context, extracting elements from the different research articles in *Section 4.2. Answering the Main Question.* All articles use different data and methods to analyse different aspects of densification processes in Norway.

## 3.5. Modes of Enquiry and Research Methods

According to Walliman (2010), research is used to categorise, describe, explain, evaluate, compare, correlate, predict, and/or control diverse phenomena. The research problem, according to Walliman, is formulated in terms of research questions, hypothesis, and/or propositions. In this thesis, the research problem is mostly formulated using research questions; however, *Section 6. The Value of Urban Density* uses a hypothesis. Combining research

questions and hypotheses allows for a more flexible form of enquiry useful to research phenomena, such as urban densification, that entail complex social aspects. Research questions offer a flexible approach, simplifying the complexity of the problem and also splitting complex issues into more simple parts by using sub-questions. Questions and sub-questions offer the possibility of integrating a multitude of aspects such as political, economic, environmental, and social; the use of concepts used by other researchers is also facilitated; and, equally, the problem of scale (local, regional, national, and global) can be integrated in a more simple way. Enquiries using hypotheses, on the other hand, have the purpose of providing explanations of a phenomenon. These explanations, in the form of confirmation of a hypothesis, are intended to establish laws and principles that can predict the occurrence of a phenomenon if the circumstances are the same. Since every city is unique, and urban change is embedded in a changeable and complex context, enquiries based on hypotheses and deductions to predict possible futures seem of limited utility. However, it has been adopted as an efficient approach to study the issue of social acceptability by using housing prices as a proxy parameter, enquiring on the positive influence of urban density on housing prices.

This thesis is fundamentally an exploratory investigation seeking to contribute to further understanding of processes. As an exploratory evaluation it does not focus on a single case (a specific city), nor on a single aspect connected with the densification process; rather it explores different themes, analysing empirical evidence from multiple cases taken as illustrations, and contrasting the findings with theoretical perspectives (see Section 3.6). The form of enquiry in this research is guided by 'how' and 'what' questions. 'How' questions are posed to gain understanding of processes and phenomena, and 'what' questions are essentially aimed at defining the concept or concepts behind a phenomenon. This however does not exclude other types of enquiry, such as 'why' questions aimed at explaining motivations or reasons behind densification processes, and 'when' questions posed to enquire about the sequence of events that forms a process.

Research methods constitute a wide set of tools to classify, label, expound, assess, compare, associate /dissociate, forecast, and handle information on events and facts. This list of tasks is combined in many different ways, according to the nature of the research problem, and is accomplished using a wide set of methods. Research methods are commonly classified into two large groups: quantitative and qualitative. The use of one or the other is necessary in all types of research, despite some controversies in this regard. Even though some research traditions tend to favour one over the other, an increasing number of researchers in diverse disciplines

advocate a complementary approach, combining qualitative and quantitative instruments in the research process (Malterud 2001). This research combines both (see Figure 12). Qualitative methods such as descriptions, categorisations, comparisons, correlations, and multilevel analysis have been used in answering the questions: *'How feasible and effective is urban densification in achieving the objectives of the sustainable city in Norway?'* and *'What factors and actors influence the transition towards denser cities in Norway?'* On the other hand, a quantitative approach using regression analysis has been used to answer the question: '*How is urban density valued in the Norwegian housing market?*'

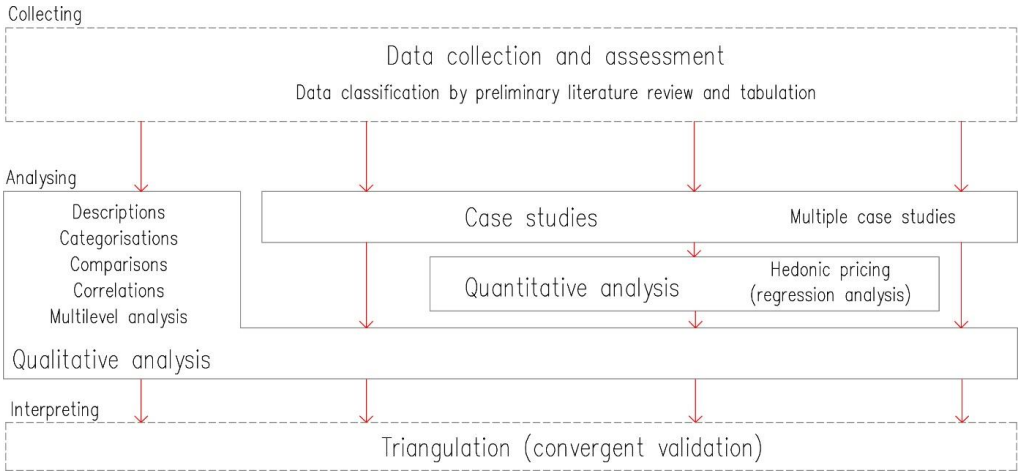


Figure 12. Research methods

## 3.6.Cases, Validity, and Generalisability

A case study, according to Yin (1994), is 'an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident'. According to Flyvbjerg (2006), the main purpose of a case study within the field of urban politic and planning is to produce concrete, context dependent knowledge. Hereafter, what can be expected from such a type of enquiry is the generation of context dependent causal explanations, avoiding the conception of causality 'in terms of universal empirical regularities' (Miller & Tsang 2011). Retaking the realist approach, the main concern of case studies within urban studies should be to provide understanding of potentialities by examining the real causal mechanism. For Groat & Wang (2002), case studies 'offer the potential to uncover the multiple, complex, and sometimes overlapping factors that eventually lead to particular outcomes'. They argue that 'case studies can, like experiments, be

explanatory'. But case studies seem to serve other purposes as well, and may be classified into many categories according to the type of enquiry they serve (see, for example, Morra & Friedlander 1999; McLeod 2013; Scapens 2004).

One noticeable characteristic of case study methodology, according to Johansson (2003), is the combination of different methods with the purpose of understanding the phenomena from different angles. This is triangulation by combination. Understanding a phenomenon such as urban densification in Norway requires examining many of the aspects shaping urban form, as well as their manifestation in several of the Norwegian cities. Such an exercise can be truly extensive and still not enough to elucidate all the complexity behind urban changes. Admittedly, I have had to focus my efforts in specific and restricted aspects using limited empirical material to provide examples of how some drivers and barriers operate in concrete context-dependent situations. The sum of these analyses is what is referred here as 'triangulation by combination'.

## The Cases

Case studies are widely used within the social sciences in areas as diverse as economics, sociology, political sciences, management, psychology, and planning. The purpose of choosing a case study approach for research is to provide an understanding of different events and conditions and their relations in the actual environment in a holistic way (Verschuren 2003). Such endeavour requires empirical data which only makes sense if it is consistently related to a specific context (Norway in this case). As such, this exercise can be levelled as a *cumulative* case study, enriched by a collections of findings from several cases (see Table 7). This cumulative exercise provides the empirical support to study different aspects of the implementation of urban densification policies in the frame of a global sustainability agenda.

In this research, three different analyses use the case study approach to explore the empirical aspects of the drivers and barriers of urban densification in Norway. The question *'What are the main drivers and barriers?'* (of densification) serves as the enquiry catalyst (see Figure 12 *The research process*). Following Morra & Friedlander (1999), the work itself can be categorised as a cumulative case study, bringing together results from sub-cases addressed separately in three research papers. The selection of cases has 'admittedly' been made on the basis of personal experiences and intuition, looking for good empirical examples of a given phenomenon. This process can be levelled as *information oriented selection*, where cases are selected on the basis of *expectations about their information content* (Flyvbjerg 2006: 230).

Table 7. The main types of case study

| Explanatory | Descriptive | Combined |
|---|---|---|
| *Programme implementation*<br>Investigates feasibility aspects of a given strategy in its real context, usually comparing several cases | *Illustrative*<br>Based on descriptive tools, has the purpose of providing an in-depth view of a phenomenon in its real context | *Cumulative*<br>Collects findings from multiple case studies (whether explanatory or descriptive) to provide understanding of a phenomenon or answer to one or several questions; data from multiple sources and multiple methods are normally used |
| *Programme effect*<br>Examines causality (the effects of a given strategy) by comparing multiple examples, using a multimethod assessment | *Exploratory*<br>Is also a descriptive case study, but its purpose is to prove new research instruments or theories, or to provide hypotheses to be tested in further research | |
| | *Critical instance*<br>Is a case study focused on a single example serving as an archetype for testing the implications of a given phenomenon, policy, problem, or strategy | |

Adapted from Morra & Friedlander 1999.

The first research paper (Section 5) has the purpose of answering the question of *how feasible and effective urban densification is in achieving the objectives of the sustainable city in Norway*. This is, following the definition of Morra & Friedlander (see Table 7), a typical *explanatory* case, where a strategy (densification) is assessed in its real context, comparing several cases (the advances in densification in the four largest Norwegian cities are assessed). Densification is assessed in terms of both programme implementation (feasibility) and programme effect (effectiveness). The cases for this paper, following Flyvbjerg (2006) information oriented selection criteria, can be classified as an 'extreme case' useful to illustrate on the advances in densification in the larger Norwegian cities. But it has the limitation of omitting the analysis of smaller urban areas of Norway, where a significant part of the urban population lives. Probably a selection with the criteria of 'maximum variation' could have provided a more thorough analysis, indicating that densification gains in larger cities might be producing population decline and 'dedensification' in peripheral regions of Norway.

The second research paper (Section 6) is an *exploratory* case study (see Table 7 ) used to answer the question of how urban density is valued in the Norwegian housing market. The research hypothesis is that density has a positive influence on property prices and is used to deal with the polemic issue of social acceptability of densification policies. I have labelled this case as exploratory because it uses a 'new research instrument' (a hedonic pricing model) to answer

the question of *how urban density is valued in the Norwegian housing market*. If case study is understood as a qualitative research exercise, the enquiry developed in this paper may not even be considered a case study, since it consists of a quantitative approach based on information of over twelve hundred transactions. However, the research was restricted to Trondheim and in that regard can be considered as a 'critical' case study following Flyvbjerg criteria for case selection.

The third paper (Section 7) is an *illustrative* case study (see Table 7) used to address the question of *what factors and actors influence the transition towards denser cities in Norway*. The study uses transition theory and a multilevel approach to examine how the existing planning regime deals with densification. This case could also be considered as a *critical* instance, analysing Trondheim as a sole case. Empirical information on Trondheim is taken as illustration of how urban regimes operate and how different factors and actors influence the transition toward denser cities in Norway.

## Validity and Generalisability

Case studies are quite common in research within architecture, urban studies, and planning. Groat & Wang (2002) describe Jane Jacobs's *The Death and Life of Great American Cities* (1961) as a classical example of a case study-based research, where the author uses New York City as a case to explore the complex socio-spatial underlying forces that contribute to the urban vitality. From the study of a single case, Jacobs made convincing arguments which have had enormous influence on both urban planning and architecture professions. The validity of case study-based research does not lie in its potential to generate predictive theory and universal principles. The type of knowledge produced by case study research is essentially context-dependent. Thus, the knowledge derived from case studies is validated by 'the force of example' without necessarily being considered an absolute generalisation (Flyvbjerg 2006). It does not exclude, according to Flyvbjerg, the possibility that some forms of generalisations can be derived from case studies, for example in the form of *'if it is (not) valid for this case, it is (not) valid for all (or many) cases'* under certain conditions.

Generalisations cannot be extracted from case studies, at least not in the same way as generalisations are extracted from experiments in the natural sciences (see, for example, the argument of Miller & Tsang 2011: 140–1, on the nature of social phenomena). In the natural sciences, regularity of events are expected when a phenomenon is isolated from external influences, but such a condition of isolation cannot be applied to most phenomena connected

to urban changes such as densification. However, some degree of generalisation is possible in the form of observations that very likely can occur in different contexts with similar circumstances. For example, it has been observed that in democratic market-driven societies, free choice is an important value that affects urban form in many ways. Hence, homebuyers can, in general terms, choose where to live, what type of house to buy, and what transport mode to use. Equally, instruments addressed to steer free choice, such as subsidies, taxes, and regulations, are expected to have similar results in different cities under free-market circumstances.

# 4. Research Findings and Discussion of Results

This thesis presents a cumulative case study on city planning in Norway framed by the sustainable development agenda. The objective of the research has been to assess the main drivers and barriers of urban densification as a planning strategy in the quest for more sustainable cities in Norway. The work has combined a theoretical and an empirical component. The theoretical part has dealt with sustainable development and its implications for planning, and has focused on urban densification as a dominant strategy in the planning domain. The empirical component, on the other hand, has studied some of the most crucial aspects of the implementation of densification policies, such as feasibility and effectiveness, social acceptability, and factors and actors contributing to a transition to a denser and more sustainable city. This section presents the main research conclusions and offers some recommendations for future research. *Section 4.1. Contrasting the Findings with Existing Research* offers an overview of the state of urban densification research in Norway and places this research among these studies. *Section 4.2. Answering the Main Question* provides a summary of the main drivers and barriers of urban densification in Norway, as identified by this PhD research. *Section 4.3. Ideas for Further Research on Densification as a Planning Strategy* presents some potential fields to expand knowledge in this area. The section also presents some reflections on what I would have liked to do differently and what aspects could have been expanded.

## 4.1. Contrasting the Findings with Existing Research

Over more than two decades, since the rise of the sustainable development agenda in Norwegian city planning, a substantial body of literature has been developed (see, for example, Hanssen et al. 2015 who present a comprehensive revision of sustainable city research in Norway). An important part of this research body has been dedicated to urban form and its connection to a more efficient use of resources. The literature on urban form and transport has been one of the main areas of research influencing this thesis. As mentioned before, decreasing car usage and promoting public transport, cycling, and walking became one of the main focuses of sustainable city planning in developed countries. In the Norwegian studies, there is a consensus that a more compact urban form is advantageous in meeting many of the goals of sustainable development, particularly in facilitating a more efficient use of resources and, in the case of transport, in decreasing the dependence on private cars (see, for illustration, Næss et al. 1996; Næss 2012; Holden 2004; Holden & Norland 2005). This belief among experts in urban planning has

become a powerful driver of densification in Norway, influencing how plans and regulations are designed by different government agencies.

The most significant divergence in the literature regarding the relationship between denser urban environments and a possible reduction of energy demands, specifically in transport, is based on epistemological grounds. For some authors, using statistical correlations and multivariate regression analysis, there is a strong causal relationship between urban structure and travel behaviour. For others, statistics and regression analysis cannot really confirm a causal relationship between urban form and transport patterns, since many other factors, difficult to quantify, influence how people use the urban space. For example, from the authors aforementioned, Holden, following a more positivistic approach, seems to support the view of a hard determinism of the built environment on social behaviour. This position appears in international studies that rely on quantitative methods (some examples are Jahanshahi & Jin 2016; Cervero & Kockelman 1997; Frank & Pivo 1994). Næss, on the other hand, taking a critical realism stand, recognises the influence of the built environment, but gives an important role to non-material aspects such as lifestyle. Agreeing with this standpoint are authors such as Dieleman et al. (1999), Van Acker et al. (2007), and Shammin et al. (2010), who acknowledge the potential for decreasing car usage as a proportion of urban transport by promoting higher urban densities, but also recognise the relevance of factors such as income and life style in travel behaviour. This thesis generally leans towards the second view as explained in *Section 3.1. Critical Realism as Epistemological Basis for a Mixed Methodology.* With regard to urban form and transport requirements, this thesis supports the view that whilst urban form influences travel behaviour, other factors also play a role. In *Section 5. On the Feasibility and Effectiveness of Urban Densification in Norway*, positive trends in densification in the four largest cities of Norway are identified; however, these trends do not automatically transfer to greener, less car-dependent transport, suggesting that many other factors, such as income and lifestyle, influence travel behaviour in everyday life.

Another aspect frequently addressed in Norwegian studies on the compact city is the question of the practicability of the compact city. Here, too, two different sides are usually discussed in the literature: social behaviour and governance issues. The first, social behaviour or attitudes towards environmental problems, is seen mainly as a barrier to achieving sustainability targets. Freedom of choice, also in the built environment (housing type and location, transport mode, space for leisure), is considered to be one of the main barriers to achieving more compact cities and a less fossil fuel-dependent urban transport system (see, for example, Næss 1993, 1995;

Næss et al. 2011a; Xue et al. 2016). Similar challenges have been recognised in international research on this issue (Breheny 1997; Garcia & Riera 2003; Bramley et al. 2009). In principle, according to my findings, the freedom of choice offered by the market is not an obstacle *per se* in achieving denser cities; indeed market forces have boosted densification in many cities around the world. In Norway, the housing choices provided by the market have been moving from suburban detached houses towards centrally located apartment blocks, driven by a combination of factors such as demographic changes and urban containment regulations (see Section 5).

The issue of social behaviour in regards to urban densification has been addressed in this thesis under the concept of social acceptability. Section 6 explores how housing prices, used as a proxy for social acceptability, are affected by urban density. Preliminary observations based on correlation analysis indicate that properties are more expensive in denser locations, with relatively high numbers of dwellings per hectare and proximity to certain urban services, suggesting that people are willing to pay more for housing in denser location. Even though the hedonic pricing model that was applied could not confirm the positive impact of density on pricing, as hoped for, it is still valid to say that the acceptability of denser urban environments seems not to be the main obstacle towards denser cities in Norway. More expensive dwellings in compact mixed-use inner cities do not imply that all social groups are willing to settle in such locations, but rather excludes this possibility. Even though this study did not include the social groups that reside in the identified urban environments, many studies suggest the popularity of inner-city environments among affluent social groups, such as single high-income professionals, pensioners, or couples without children (Buzar et al. 2005; Haase et al. 2008; Haase et al. 2010). Families and working-class groups tend to be located in peripheral areas, further away from inner-city working and leisure activities, being one of the many possible reasons why gains in densification do not transfer directly to less motorised commuting as observed in *Section 5. On the Feasibility and Effectiveness of Urban Densification in Norway*. This issue has been widely discussed under the perspective of gentrification, which addresses the problems of social tensions when decaying neighbourhoods are improved, and low-income residents are replaced by more affluent new residents (Smith 2012). Gentrification has not been researched in-depth in this thesis, but it is a phenomenon that has been mentioned as one of the driving forces towards denser cities.

Recurrent challenges towards denser and more sustainable cities stem from issues of governance. This fact has been widely acknowledged in the literature and is addressed in

*Sections 5.3. The Challenges of Urban Densification as a Planning Strategy in Norway* and *7.3. Trondheim's Pathway Towards Urban Densification*. Several Norwegian authors have recognised the difficulties of implementing densification and other urban sustainability policies (see, for example, Næss 1993; Stenstadvold 1996; Støa 2014; Hanssen & Hofstad 2015). Urban containment strategies and measures to decrease car usage tend to be unpopular. Even though they have often become policy targets, implementation is frequently hindered by a myriad of obstacles. A common case is the multi-segmented land use and transport regime; for example, land policies often target containment and densification in order to reduce car dependency, whereas the road network continues to be expanded and improved creating new incentives for car usage (see Næss et al. 2011a; Næss et al. 2011b; Næss & Vogel 2012). Another aspect of governance hindering densification policies relates to scale asymmetries; while most planning strategies and targets are designed at the municipal scale, transport tends to operate on a regional basis, with an important proportion of commuters living in one jurisdiction and working in other (Graham & Marvin 2001; Betsill & Bulkeley 2006). Trans-municipal planning instruments exist, but they are complex to operate.

Some other barriers connected to governance have been identified by exploring the concept of regime in the transition of cities towards sustainability (see *Section 7. A Transition to a Denser and More Sustainable City*). The Norwegian urban regime is a stable, sometimes rigid system operated through procedures of formulation, negotiation, and implementation involving public and private actors. Sustainability initiatives such as densification are implemented through urban projects, which in order to be executed depend on the successful coalition between public and private actors. This has been identified as a particularly relevant aspect in the Norwegian planning system, where detailed planning has been delegated to private actors (Hanssen 2012). Profit is one of the core interests of private actors; and although denser urban environments may in principle be attractive from an economic perspective, the redevelopment of derelict land in inner-city locations entails complex operations that are normally not considered in traditional planning instruments. Green fields in periurban locations, on the other hand, remain a safer choice for investors. Existing planning instruments such as zoning plans and building permissions do not address the intricacies connected to urban redevelopment operations and seem to be one major factor hindering further advances in densification. This, however, is an aspect that is not much explored in the Norwegian literature on planning; nor was it treated in depth in this research.

## 4.2. Answering the Main Question

*What are the main drivers and barriers of urban densification as a planning strategy in the quest for more sustainable cities in Norway?*

Changes in the urban form such as densification are gradual processes embedded in environmental, social, economic, and institutional factors. Such factors are difficult to disentangle. Norwegian settlement patterns were originally scattered across a complex geography formed by mountains, narrow valleys, and fjords. The scarcity of arable land in Norway has driven the formation of a network of small villages and towns to better use the limited resources. Land use legislation has acknowledged that fact by protecting arable land from urbanisation. The economic prosperity stimulated by the development of the national oil industry, as well as the new urban development paradigm linked to personal mobility, provided by cars, has led to an unprecedented urban expansion in recent decades. Such expansion took a leapfrog shape, creating a patchwork of urban enclaves, protected forests, and agricultural land, facilitated by an increased motorisation. The rise of new factors, such as new demographic trends, increasing concerns about environmental issues and climate change, and a new urban planning and development paradigm, has gradually influenced urban development towards a more compact form. Throughout this PhD research, the following drivers and barriers of urban densification strategies in Norway have been identified:

### Environmental Drivers and Barriers

Environmental motivations, such as reducing emissions of greenhouse gases to prevent global warming and protecting valuable natural areas and ecosystems, have been recognised as important drivers of urban densification policies in this thesis. Such factors have been addressed from a general perspective in *Section 2. Research Background*, and from a Norwegian perspective in the three research articles, Sections 5, 6, and 7. An additional research paper,[9] now merged with Section 2, discussed a shift of paradigm in urban planning and development towards a denser and more efficient urban form, leading to restrictions to urban expansion. This has been connected, on the one hand, to the preservation of periurban agricultural land and the protection and restoration of ecosystems, natural resources, and biodiversity (see *Section 7.3. Trondheim's Pathway Towards Urban Densification*, p. 154 and *Section 7.4. Analysis and Main*

[9] Hernández-Palacio, F. A. 2015. Urban quality and the sustainable city in Norway: The challenge of density. *WIT Transactions on Ecology and the Environment, 193* (1), pp. 677–87.

*Findings*, p. 164), and, on the other hand, to a potential reduction of car usage by decreasing distances within urban areas (see *Section 5.3. The Challenges of Urban Densification as a Planning Strategy in Norway*, p. 101 and *Section 7.2. Urban Densification from a Socio-technical Standpoint*, p. 150). Enhancing efficiency through densification has been seen as a way of reducing the use of resources to build, maintain, and operate infrastructure networks and services under municipal management.

The environmental barriers to densification in Norway are mostly marked by the rugged Norwegian landscape and the legal boundaries protecting valuable periurban agricultural land and forests. Such an environment has contributed to a patchy urban layout fragmented by geographical features and protected areas (see *Section 2.7. How Does the Compact City Paradigm Relate to Norwegian Cities?*, p. 54). This, from the onset, makes it difficult for any densification policies to deliver meaningful impacts, especially in term of reducing car dependency. Despite gains in densification, especially in the larger cities, travel distances and levels of car ownership are still increasing (some figures can be find in *Section 2.6. The Quest for Urban Densification in Norway*, p. 48 and *Section 5.4. Characteristics of the Norwegian Context / Facts on Mobility*, p. 114). Moreover, delivering good public transport is possible only in the larger urban agglomerations, where densities make the service economically feasible. Gains in densification seem to be restricted to the main cities, and they do not seem to be directly correlated with a decline in car usage. Significant numbers of the population still live and/or work in scattered low-density areas, depending on cars for their daily transport.

Nevertheless, the abundance of geographical features provides numerous opportunities for a valuable and diverse system of public spaces, which has turned into one of the most noticeable characteristics of Norwegian cities (see, for example, *Figure 9. Urban area in the Oslo region* and *Figure 10. Urban area in the Bergen region*, p. 57). This, so far, seems to be contributing to dissipate some well-known environmental barriers to urban densification, such as the loss of local open and green spaces for everyday use, and the reduction of local environmental services those spaces provide.

### Societal Drivers and Barriers

Demographic changes constitute some of the most powerful drivers of urban densification in the larger Norwegian cities. As in many other countries, the majority of the Norwegian population now lives in cities and the absolute number is growing steadily due to a combination of rural–urban migration, immigration from abroad, and natural population growth.

Simultaneously, significant changes are occurring in the composition of the population, characterised by an ageing population, and a growing number of single-occupant dwellers, a phenomenon known as the second demographic transition (Van de Kaa 1987, 2002). Such trends are evident in the rise of multi-dwelling buildings as the dominant typology in the schemes built recently, especially in Oslo, Bergen, and Trondheim (see *Section 5.4. Characteristics of the Norwegian Context*, p.107).

Moreover, the rise of the knowledge-based economy favours intense urban environments, as they allow for the creation of creative clusters and easy exchange of ideas and information. Physical proximity, despite the advance of virtual connectivity, seems to remain a fundamental element for members of a knowledge-based economy. The larger urban agglomerations in Norway, due to population growth and tighter controls on urban expansion, have also gained population density. In consequence, housing prices, especially in well located areas of the larger Norwegian cities, have been steadily growing for many years. This, together with urban expansion restrictions, has favoured the consolidation of more dense urban environments in central locations; which in turn makes new inner-city development projects attractive, worthwhile investments for private enterprises. Social acceptability of denser urban environments, perceived as a significant barrier to achieve more compact cities, does not seem to be the main obstacle to densification advances. The analysis presented in Section 6 displays a positive correlation between higher densities and higher prices per square metre.

The most relevant societal barriers to urban densification identified through this research have been a potential lack of social acceptability for some of the strategies connected to urban densification. Restrictions in general are unpopular in a market-driven society where free choice is regarded as an important value. This seems to apply to urban containment strategies and restrictive measures to car usage, which make politicians recoil from their implementation. For example, an important number of family-oriented new housing projects in new greenfield locations were found while collecting information for the analysis of housing prices in Trondheim (*Section 6. The Value of Urban Density: An Exploratory Study of the Relationship between Urban Density and Housing Prices in Trondheim, Norway*, pp. 127–48). Preferences for suburban lifestyles may still be dominant among some housing market segments, particularly families with children. Last but not least, social attitudes towards new developments and the not-in-my-back-yard (NIMBY) phenomenon seem to be hindering a number of projects. Densification in particular, which is often falsely associated with high-rise tower blocks and disruption of valuable scenic views, has faced resistance by the public (see

*Section 6. The Value of Urban Density: An Exploratory Study of the Relationship between Urban Density and Housing Prices in Trondheim, Norway / Introduction*, p. 127). These issues, however, can be handled with an adequate combination of good urban design, participatory planning, and educational campaigns.

### Economic Drivers and Barriers

Most of the economic drivers for densification introduced in *Section 2.5. Drivers and Barriers of Densification of Existing Cities* are very likely playing a significant role in the ongoing densification of the larger Norwegian cities. Larger urban agglomerations with their economies of scale offer better opportunities for development. For example, it is widely recognised that vibrant urban environments have a positive influence on the formation and expansion of innovation and creativity networks, fundamental in the new post-industrial economy. Hence, the migration from rural areas and towns to the larger Norwegian cities is very likely motivated by the search for better opportunities for development, particularly for young segments of the population.

Enhanced efficiency in the use of infrastructures and services under public agency management seems to be another important economic driver of urban densification in Norway. Indeed, restricting urban development to areas already served by infrastructure was an early motivation for the implementation of urban densification policies in Norway (see *Section 2.6. The Quest for Urban Densification in Norway*, p. 48 and sub-section *The Consolidation of a Norwegian Compact City Policy*, p. 50). Public services providers can get economic benefits from increased urban density, for example by reducing the costs for the provision of public transport and waste collection, and by a more efficient use of education and health-care facilities. Moreover, proximity also means a potential decrease in prices for transport for individuals. For example, Trondheim, which has the highest share of cycling in Norway, has achieved this because a large part of its populations is formed by students, and students tend to live closer to educational facilities, so they can commute by bicycle, which, together with walking, is the cheapest commuting option.

On the other hand, there are several economic barriers to denser cities. In Norway, the pre-existence of large, sprawled peripheries and the massive sunk investments in their infrastructure is perhaps the biggest barrier to attain real benefits expected from urban densification. For example, movements to curb car dependency and increase the use of environmentally friendly transport, one of the main targets behind urban densification policies in Norway, have been

heavily resisted despite gains in densification. The problem, at least partially, seems to be that new buildings within the existent urban area have been located where vacant lots existed, but not necessarily in areas well served by public transport. If a substantial increase in the share of public transport from densification is to be gained, it is necessary to proportionally increase the accessibility to a very good public transport network (that is, with stops within a distance of less than 1km and a frequency of at least four departures per hour, according to Norwegian standards). To achieve this, it would be necessary to increase population density around the transport corridors. This could be attained by replacing a substantial amount of low-density building typologies with denser ones, which in addition to being expensive is very unpopular. Instead, empirical evidence, at least in the case of Trondheim, indicates that in the coming years over 40% of new housing projects will take place in greenfield locations (see *Section 7.3. Trondheim's Pathway Towards Urban Densification*, p. 154–64).

Accommodating a substantial part of the expected population growth in the coming decades within existing urban land is not an impossible scenario, although it is a very unlikely one. Building on brownfield sites has proved to be complex and costly in Norway (see *Section 7.3. Trondheim's Pathway Towards Urban Densification*, pp. 154–64 and *Section 7.4. Analysis and Main Findings*, pp. 164–5). Instead, what seems to be happening is that the higher costs derived from the complexity of urban-renewal operations tend to be compensated by the production of smaller housing units, which can be sold at higher prices, while larger units suitable for families at more affordable prices tend to be located in the periphery (see *Section 6. The Value of Urban Density: An Exploratory Study of the Relationship between Urban Density and Housing Prices in Trondheim, Norway*, pp. 127–48). This trend seems to be reinforced by an apparent preference for suburban lifestyles among families with children. This, however, needs further research, extending the sample beyond Trondheim and combining different research techniques such as interviews with experts, both from public agencies and urban development agencies, questionnaire-based surveys to homebuyers, and statistical information on housing sales transactions.

## Institutional Drivers and Barriers

Perhaps the most powerful institutional driver of urban densification has been the persistent discourse on sustainability that has led to the continuity of urban containment policies for more than two decades (see *Section 2.6. The Quest for Urban Densification in Norway*, pp. 48–54 and *Section 7.3. Trondheim's Pathway Towards Urban Densification,* pp. 154–64). Hence,

tighter restrictions on urban expansion in agricultural land and forests have been widely implemented. Such restrictions, together with population growth, especially in larger cities, have favoured the development of many intra-urban plots and some brownfield locations. Norwegian cities have gradually been densified, following the sustainability targets put forth by the planning agencies. Beyond environmental aspects, municipalities can also accrue multiple benefits from denser urban environments such as possibilities to increase tax revenues from an intense property and business environment, and potential to provide local services more efficiently and at a decreased cost (public services, education, transport, health care). These aspects, however, have not been studied in detail in this thesis.

Institutional barriers, on the other hand, are many and influential. One, discussed at length in this thesis, is the complexity of the coalitions that steer urban development in market-driven societies (see *Section 7. A Transition to a Denser and More Sustainable City: Factors and Actors in Trondheim, Norway*, pp. 149–67). Many of the obstacles in the implementation of urban development policies such as urban densification originate in the divergence of interest between public planning agencies, which according to the law have to serve the common good, and business-oriented urban developers, which according to market logic have to make profit. Planning instruments such as restrictions to urban expansion are intended to make cities denser and more sustainable, but if urban development projects through which such policies are to be implemented are not profitable, private investors are not very likely to get involved.

Despite a change in the city planning discourse towards sustainability, most of the practices around urban development have remained stable for decades. Policies aimed at making cities more sustainable are using the same instruments and procedures that made them sprawled and fossil-fuel dependent. Whilst the housing market in Norway, especially in the cities, is thriving, urban renewal operations are still complex endeavours, combining the particularities of various actors, which can result in drawn-out battles over contractual fine print, which in turn can lead to the cancellation or stagnation of a project. Seemingly sound investments quickly turn sour when one of the many parties involved does not play ball. This is especially true in the redevelopment of multi-owned brownfield sites. Section 7, using Trondheim as a case study, has analysed how densification targets become entangled in a regime with multiple actors functioning within a market logic.

The institutional dimension is where most measures aimed at overcoming barriers towards more sustainable cities can be implemented. The dimension is complex and extensive. This research

could have been fully dedicated to its study and still be insufficient to disentangle all the complexities. In a market-driven urban regime the ways to circumvent policies such as urban densification are multiple. Some of the best known are administrative fragmentation among different public agencies and their domains, and among local, regional, and national administrative ranges. This research has analysed only some aspects and extensive research is required in this field.

### Shortcomings of the Research

In retrospect, there are many things in this research that could have been done differently, added, or changed. One or more of my research articles would have greatly benefited if I had had the chance to work with focus groups or carry out individual interviews with experts, that is, city planners or urban developers. With regard to the social acceptability of densification, a large-scale (500+ participants) semi-structured or structured survey would have been useful, allowing not only for the qualitative but also potentially for quantitative assessment of that data. However, due to time and resource constraints, quantitative proxy data were chosen; data that could have been improved. The qualitative criteria guiding the selection of the data used in *Section 6. The Value of Urban Density* made the analysis difficult from a statistical perspective, and any potential findings easier to criticise based on the potential bias of the sample. On a macro scale, I would like to have followed a densification project, such as the redevelopment of a brownfield site, from the initial planning stages to conclusion; which brings us to ideas for further research.

## 4.3. Ideas for Further Research on Densification as a Planning Strategy

Even though there is a growing body of literature on the compact city in Norway, there is still a lot that can be explored with regard to density and densification in the quest for more sustainable cities. The relationship between urban planning and development actors could be explored using transition management theory (see, for example, Loorbach et al. 2016), investigating, among other things, issues of governance and conflicts of interest. To evaluate the impact of densification on various modes of transport through time, a number of research tools could be combined, such as questionnaire surveys, spatial and quantitative analysis, expert interviews, and field experiments. An interesting tool in this field might be developed from the concept of travel budgets (Goodwin 1981; Stopher et al. 2016). To further explore the social acceptability and perception of densification by the public, survey research or action research

could be used. Further assessments of the impact of density on the property market could combine spatial, quantitative, and qualitative instruments. To gain a greater picture of densification efforts of, for example, Trondheim municipality, a research project could be designed that draws on all of the abovementioned and more, combining the best of many disciplines and accepting the fact that sustainability and, specifically, densification policies are multidisciplinary efforts that need to be assessed as such.

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# Part Two

# 5. On the Feasibility and Effectiveness of Urban Densification in Norway[10]

## 5.1. Introduction

Densification as a planning strategy has become the most common response to the challenge of attaining sustainable cities. Following this trend, the Norwegian programme 'Cities of the Future' has adopted the phrase *compact and good cities* as its slogan (Norwegian Ministry of Environment 2008). The Norwegian government has embraced urban densification as a key component in the pursuit of the sustainable city. However, there are two main issues that deserve attention in the discussion regarding urban density. The first issue is *feasibility*, or the viability of implementing urban densification as a strategy. The second issue is *effectiveness*, which is the capacity to achieve sustainable goals by implementing urban densification. During the discussion developed in this paper feasibility is understood as a precondition to effectiveness, but not a guarantee of this. However, both concepts are considered essential regarding the success of sustainable city strategies that have densification in focus.

Density is generally understood as the concentration of population, activities, building stock, and infrastructure within a spatial context. In this paper the data are usually expressed as the population per unit area (at the municipal, regional, or national level). Urban densification also refers to the concentration within urban boundaries as defined by the Norwegian legislation (see Section 5.4. Characteristics of the Norwegian context).The central objective of the paper is to explore the feasibility and effectiveness of urban densification as a planning strategy in Norway. The analysis is based on empirical data that were analysed in relation to densification, dwelling types, and transportation modes in four of Norway's largest cities (Oslo, Bergen, Trondheim, and Stavanger). The theoretical context of this analysis is the paradigm of the sustainable city, which has been guiding urban policies across the world for more than two decades. Norwegian urban policies are not an exception. However, there are context specificities that need to be understood in order to explore urban densification policies in Norway. One of Norway's most significant characteristics is the traditional low-density urban development in its cities and a seeming preference of Norwegian households for detached

[10] F. A. Hernández-Palacio 2014. On the feasibility and effectiveness of urban densification in Norway. *Nordic Journal of Architectural Research*, 2, pp. 83–112.

dwellings. The question that guides the development of the argument presented in this paper is 'How feasible and effective is urban densification in achieving the objectives of the sustainable city in Norway?'

*Feasibility* is broadly defined as the (realistic) potential to actually implement a desired action or to accomplish a desired effect of a specific action. In the context of this paper feasibility is referring to the potential of improving sustainability through the action of urban densification. The feasibility of densification is measured by the variation of population per unit area over time. The change in dwelling type over time is also analysed as a closely-related variable. Rising population concentration involves a gradual increase of housing types of higher density in the building stock. Housing types such as detached dwellings and houses with two dwellings are predominant in low-density urban areas, while terraced houses and multi-dwelling buildings are abundant in denser urban environments.

*Effectiveness* is in general defined as a measurable capacity of a system or a process to achieve established goals. In the context of this paper effectiveness refers mainly to the impact on environmental performance of the city as a result of urban densification. One of the most relevant impacts expected from densification policies is a development towards environmentally-friendly mobility. Concentrating people and activities are often proposed to contribute to shorter commuting, achieved by walking, cycling, or public transport. These transportation modes require less energy, less urban space for operation, and they produce less pollution. On the other hand, in sprawled urban areas, mobility is dominated by the car, with an increased demand for energy and space for infrastructure, and higher $CO_2$ emissions. Thus, transportation modes, car ownership, and car usage are considered important indicators in the assessment of effectiveness within the argument presented in this paper.

The paper is organised in five parts. *Section 5.1. Introduction* presents the aim of the paper, the central question, the main concepts involved, and the structure of the text. *Section 5.2. Sustainable Development and the Sustainable City* develops the theoretical frame of the paper exploring the concepts and interpretations in Norwegian policy, using as a case study the 'Cities of the Future' programme. *Section 5.3. The Challenges of Urban Densification as a Planning Strategy in Norway* serves as a bridge between the theoretical framework and the empirical case study: it explores the questions of feasibility and effectiveness of densification in Norway.

*Section 5.4. Characteristics of the Norwegian Context* presents some facts about Norway's urban environment with emphasis on two aspects: densification and mobility. These data constitute the empirical material for the analysis and discussion in the fourth and fifth parts of the paper. The study uses information from Oslo, Bergen, Stavanger, and Trondheim as relevant cases of the advances in the Norwegian context. Urban compaction and its influence in achieving the objectives of the sustainable city, particularly environmentally-friendly mobility, are discussed. *Section 5.5. Conclusions and Recommendations for Further Work* summarises the argument and findings.

## 5.2.Sustainable Development and the Sustainable City

The most widely used definition of sustainable development is the one introduced by the World Commission on Environment and Development which defines the concept in these terms: 'Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future' (Brundtland 1987). This concept involves the need for economic growth to increase social welfare while protecting the environment and natural resources. The Brundtland Report definition, despite covering so much, has become a classic. From it, various interpretations have evolved, and relate to three dimensions: economic, social, and environmental. The relation between these aspects has also been interpreted in various ways. For some, these are three independent pillars that support the concept of sustainable development. For others, the environmental dimension contains the social, and the social contains the economic (Giddings et al. 2002; Adams 2006).

Regardless of the wideness of this interpretation combining these three dimensions, the debate does not lead to universal procedures, standards or protocols. In general the ideas about sustainable development are more aims than definitions, and in that way generate an indefinite range of interpretations. Despite (or because of) the diversity of interpretations, the concept has spread worldwide. However, cities are concrete objects inseparable from specific environmental, social, and economic contexts. Cities can be considered as responses of societies to specific, temporal, and spatial contexts (Mumford 1961). Therefore, what applies in sustainability for a Norwegian city can be very different in the case of a Mediterranean or an African city. Strategies to accomplish sustainable cities may consequently differ substantially

from one context to another. Thus the concept is very frequently amalgamated with other ideas concerning development, e.g. competitiveness, quality of life, equality, resilience, or efficiency.

The concept of sustainable development is not easily translated into an urban form, making it difficult to sketch a concrete image of the sustainable city. The United Nations Sustainable Cities Programme defines the sustainable city as 'a city where achievements in social, economic, and physical development are made to last. A sustainable city has a lasting supply of the natural resources on which its development depends (using them only at a level of sustainable yield)' (UNCHS/UNEP 2000). From this definition it can be inferred that a sustainable city uses natural resources in an efficient way that can ensure durable human development. A sustainable city should probably also promote social equality in order to avoid risks originating in social conflicts. And, equally, it promotes economic growth in order to generate and maintain social welfare. But the definition does not present any relation to a specific form of appropriation of space. Instead, it suggests a connection to a scale larger than the city itself: a regional dimension or a niche that supplies the resources to support the city. Hence the effectiveness of a city in achieving sustainable development is not only related to internal functioning, but also to external impacts caused by activities inside urban areas (Nijkamp & Kourtit 2013).

The context of the city – the social, the economic, and the environmental situation – determines the emphasis in the strategies applied in the search for sustainable development. For some cities, the priorities may be focused on social aspects such as poverty alleviation, equality, and welfare. For some other cities, sustainable strategies are largely directed at adapting to economic changes, using comparative advantages and better economic performance in a durable way. In other cases, the precedence in the frame of sustainable urban development is to improve environmental quality or mitigate natural or technological risks. For some other cases, as in the Norwegian cities studied in this paper, the emphasis seems to be on environmental issues such as energy efficiency, rational use of space, and adaptation to climate change (Holden & Norland 2005). These targets are well described in different white papers from the Norwegian Ministry of Environment such as 'A Better Environment in Cities and Towns' (2002), 'The Government's Environmental Policy' (2007), 'Cities of the Future' (2008), 'Norway's Environmental Targets' (2012), and 'The Contemporary Sustainable City' (2013).

Despite the wide range of sustainable policy objectives, the debate on a sustainable urban form has been centred mainly on density. One of the focuses in the literature on urban form and sustainability has been on the feasibility and effectiveness of densification as a sustainable city booster (Breheny 1997; Williams 1999; Engebretsen 2005; Karathodorou et al. 2010; Berg et al. 2012).This discussion has been in the academic arena for several years and seems to be still open. Regarding feasibility the discussion has been centred on the difficulties, particularly from the social and political perspectives: to illustrate this point, see Breheny (1997), Bramley et al. (2009), and Dempsey et al. (2012). Effectiveness, on the other hand, presents two antagonistic positions. One stands for the inoperativeness or slim benefits of urban density regarding sustainability, see for example Breheny (1995) and Neuman (2005). The other, followed by a large number of planners and urban administrators around the world, is that denser cities are better to face the challenges of contemporary human needs, especially from the perspective of sustainable development; see, for example, Dieleman & Wegener (2004); Holden & Norland (2005); Ferguson & Woods (2010). These authors advocate higher urban densities mainly to reduce car dependency. From these antagonist positions some authors and institutions of urban planning have noticed a paradox. Densification seems to be a question of trade-off: there are advantages and disadvantages (Berg et al. 2012). It seems necessary to sacrifice some individuals' aspirations to achieve social aims such as sustainable development (Neuman 2005; EEA 2009)

## 5.3. The Challenges of Urban Densification as a Planning Strategy in Norway

The compact city has frequently been directly associated with the idea of the sustainable city, assuming that higher densities correlate with higher sustainable performance, especially in reduction of energy consumption in transportation. Mindali et al. (2004) stress that density *per se* is not the elixir of urban efficiency, this being one of the main arguments of the critics of the compact city. Dieleman et al. (1999) and Shammin et al. (2010), despite defending the potential of higher urban densities, argue that the relation between urban form and mobility is not a direct one, since factors such as income and life style are also relevant. Neuman (2005) claims that process is more critical than form in achieving a more sustainable city. There is empirical evidence in favour of this last argument. For example, the combination of highly dense urban areas with mobility based on cars can generate many problematic situations, such as high

demand for parking spaces and traffic gridlocks (Berg et al. 2012). In such a situation, effective use of time, energy efficiency, and environmental quality can be seriously affected.

High density also seems inefficient regarding environmental performance when high-density mono-functional residential areas are located on the periphery of cities. Mono-functional density increases daily intra-urban trips. Clustered density in the shape of low-scale compact residential enclaves might also be inefficient in terms of reducing energy consumption in mobility. Such locations are functionally dependent on the larger agglomeration in terms of jobs, specialised shopping, and leisure activities (Williams et al. 2000; Engebretsen 2005; Næss 2012). Hence, the spatial micro-pattern of land-use distribution and urban layout are, together with density, essential components of the sustainable urban form (Dempsey et al. 2010). In the Norwegian case, the 'Cities of the Future' programme follows the widespread model of urban compaction: containment of urban expansion, promotion and intensification of public transport and cycling; strengthening of commerce, leisure, and services in the central area; parking restrictions and limitation of car use; and densification around transport infrastructure (Table 8). This programme, operating from 2008 to 2014, is part of a national policy on urban densification being applied since the launch of the policy 'A Better Environment in Cities and Towns' (Norwegian Ministry of Environment 2002).

'Cities of the Future' is an initiative to achieve the goals established by this policy in the urban environment. Thirteen municipalities in Norway's larger urban settlements created a partnership with the central government and the private sector to achieve its objectives. The inhabitants of these urban areas make up more than a third of the national population. The priority area of land use and transport has as its central objective the efficient use of space. This aim is the most directly connected with urban form and urban densification. It implies a strong emphasis on the location of new dwellings inside existing urban borders; the use of environmentally-friendly modes of transport (public transport, cycling, and walking); and the decrease of distances from residences to urban services such as grocery shops, nurseries, schools, and green public spaces. It is expected that this planning strategy has a direct beneficial impact on the overall quality of the urban environment.

Table 8. The four priority areas of the programme 'Cities of the Future'

| |
|---|
| **Land use and transport** |
| To reduce the use of cars in the city |
| To strengthen the traditional city centre and district centres |
| To increase the use of public transport, cycling, and walking |
| To decrease the distance to daily urban services (grocery shops, kindergarten, schools, green public space) |
| **Consumption and waste** |
| To improve waste treatment and recycling |
| To decrease the use of disposable packaging |
| To encourage sustainable and durable consumption |
| **Energy and building** |
| To reduce energy consumption |
| To produce energy from sustainable sources |
| To implement heating districts in residential and commercial areas |
| **Climate change adaptation** |
| To strength the cities to deal with events associated with climate change (rain, landslides, higher sea level, and wind) |

Source: Norwegian Ministry of Environment 2008.

## On Feasibility

Feasibility is the capability to get things done, the practicability. Four possible feasibility factors for densification are suggested: population growth, limited access to new urban land, social acceptability, and governance (Table 9). For example, in the case of Norway, Oslo is more successful in densification than other Norwegian cities because its population is growing faster. If the population of a city is not growing or is declining, the city will not become denser, unless buildings in the periphery are demolished and people are relocated to the inner areas. Densification will occur when new land is incorporated into the existing urban land at a smaller proportion than the rate of population increase. The four cities studied for this paper experienced population growth during the last decade, but they also incorporated new urban land at different rates (Appendix: Table 11 and Table 12). A decrease in the incorporation of new urban land requires planning programmes resulting in the redevelopment of derelict urban land, the construction of denser housing typologies, and the availability of housing for lower income homes.

Table 9. Feasibility factors for densification

| Main factor | Associated factors |
|---|---|
| Population growth | Economic growth and opportunities for prosperity |
| Decrease of new urban land | Redevelopment of derelict urban land |
| | Denser housing typologies |
| | Housing availability for lower-income population |
| Social acceptability | Variety of urban environments |
| | Diversity of dwelling solutions |
| | Social meaning and collective pride |
| Governance | Political will |
| | Inter-municipal coordination |
| | Technical capacity (know-how) |

Social acceptability is a critical factor for feasibility. This is one of the most difficult issues regarding densification in developed countries where people have high incomes and freedom of choice is an important social value (Breheny 1997; Garcia & Riera 2003; Bramley et al. 2009). The negative perception about high urban density seems to be a major impediment in the practicability of the compact city and therefore an obstacle to attain sustainable city goals. It presents an antagonism between quality of life in the present versus the maintenance of the same quality in the future. At first glance it is necessary to sacrifice quality of life in order to achieve sustainable development.

Social changes such as the Second Demographic Transition (SDT) could drastically change the perception of quality of life and, as a consequence, the acceptability of densification (Van de Kaa 1987). According to this author, the SDT is an ongoing phenomenon in industrialised countries where fertility rates have fallen behind the population replacement level. The number of children born per woman is lower than 2, producing as a consequence a shrinking of the population during the coming decades. This drop in fertility rates will also bring considerable changes in the age of the population, with a resulting increase in elderly people. The housing accommodation and urban environment that used to be attractive to families with two or more children is perhaps different to the new qualities demanded by single people, one-child families, single mothers, and elderly people.

Norway is among the European countries experiencing diverse phenomena associated with the SDT since the 1970s, as illustrated by Van de Kaa (2002). Among these phenomena area fertility rate below replacement (taken to be 2.10); an increase in extramarital birth rates; growth

in the levels of cohabitation and rate of divorce; an augmentation of life expectancy; and an increase in immigration. This new demographic stage is rapidly changing household characteristics and consequently the type, size, and location of dwellings. Haase et al. (2008) maintain that householders in the SDT requires greater flexibility in the spatial characteristics and location of their home; changing house is more frequent; working and living in the same space is also common. This flexibility, according to these authors, is available in inner-city areas where there are a large number of buildings of different types and sizes, easily adaptable to spatial changes. This new type of household also demands greater proximity to urban facilities such as places of working, leisure, and education, which represent a new attitude regarding the urban environment.

The other key factor for feasibility is governance, understood as the 'capacity to get things done' (Kearns & Paddison 2000). This capacity for achieving aims involves factors such as political will, technical capacity (know-how), and inter-municipal cooperation (see Table 9). Contemporary cities are difficult to govern not only because decision-making in urban planning involves heterogeneous and divergent interests, but also because cities have become regional systems fragmented in various administrative jurisdictions, inherited in most cases from pre-modern times – for example municipalities, communes, counties, districts (Gilbert et al. 1996; Graham & Marvin 2001; Betsill & Bulkeley 2006). Many policies of urban issues, such as housing, mobility, land use, environmental questions, and public services among others, have traditionally been administrated by municipalities (*kommuner* in the Norwegian context), but they operate on a regional basis. This is particularly strong in densification and mobility issues. Densification rules can vary from one municipality to another and people have the freedom of choice among different municipalities within the same urban region. This implies daily commuting to access work and other urban services, producing impacts on sustainable urban performance as a whole.

## On Effectiveness

*Effectiveness* is the ability to achieve a desired effect. In the sustainable city, effectiveness or being efficient is understood as the capacity of the city to fulfil social demands with less use of energy and natural resources. Hence, a denser city seems certainly more efficient than a sprawling city at least in three aspects: the first is in consumption of space; the second in consumption of energy for transportation; and the third, concerning the economy, in the

provision of infrastructure (Breheny 1995; Burgess 2000; Ferguson & Woods 2010). Despite the wide-ranging debate about the relationship between urban form and sustainability, with arguments both in favour and against density as a key element, empirical evidence –illustrated in the Norwegian case according to Holden & Norland (2005) and Næss (2012) – has favoured the compact city as a more efficient urban form, particularly in relation to energy consumption, both in transportation and in housing.

Table 10. Effectiveness factors for densification

| **Main factor** | **Associated factors** |
|---|---|
| Proximity to urban services | Mix of uses (grocery shops, educational services, cafes, etc.) |
| | Availability of different kinds and sizes of recreational area |
| | Accessibility to public transport |
| | Local centres with availability of communal services |
| | Availability and diversity of public spaces, parks, and playgrounds |
| Green mobility | Sufficient and affordable public transport |
| | Availability and quality of pedestrian and cycle paths |
| | No car-friendly urban spaces |
| Transport-oriented development | The right use in the right location according to accessibility |
| Societal behaviour | Shift in social values |
| | Prevalence of common interests |

As has been discussed already, density per se is not a booster of efficiency. The effectiveness of increased density is dependent on factors such as proximity to urban services, environmentally-friendly mobility, transport-oriented development, and societal behaviour (

Table *10*). This simple list entails many complexities. Proximity to urban services, for example, requires attention to the neighbourhood or the micro-urban scale in terms of proximity between dwelling and daily services such as grocery shops, schools, and nurseries; availability of playgrounds and public spaces of diverse kinds and sizes; accessibility to public transport; proximity to local centres with communal services, shops, cafes, and collective facilities; and proximity to green public spaces and parks. These characteristics are, curiously, very close to the classic characteristics of the 'good city' described by Alexander et al. (1977), Lynch (1981), and Montgomery (1998). Density is a precondition for the viability of public transport and other urban services that require human agglomeration in order to be economically feasible (Newman & Kenworthy 1999). But the existence of these services is a key aspect in the effectiveness of compaction regarding sustainability. Environmentally-friendly mobility should also be promoted by measures such as the redesign of urban spaces in favour of pedestrians and cyclists

and other economic and legal instruments such as tolls, taxes, and subsidies. The effective performance of transportation requires special attention to the location of land uses and activity nodes, both in the neighbourhood and in the city region. This planning practice has been called transit-oriented development (Newman & Kenworthy 1996; Cervero 1998; Knowles 2012). It has already been argued by several authors that in a free-market society, where freedom of choice is an intrinsic value, social behaviour and lifestyle are key factors in achieving sustainable goals (Ostrom 1998; Banister 2008; Witt 2011). However, this freedom may be in conflict with sustainability in environmental terms. This is the case of social preferences for car usage, or for low density urban environments that are frequently regarded as part of the unsustainable issues in the built environment (Shammin et al. 2010; Haugen 2012). Therefore, the effectiveness of the sustainable city is above all a question of societal behaviour: a shift in social values and a priority of the common interest over the particular interest (Vallance et al. 2011).

## 5.4. Characteristics of the Norwegian Context

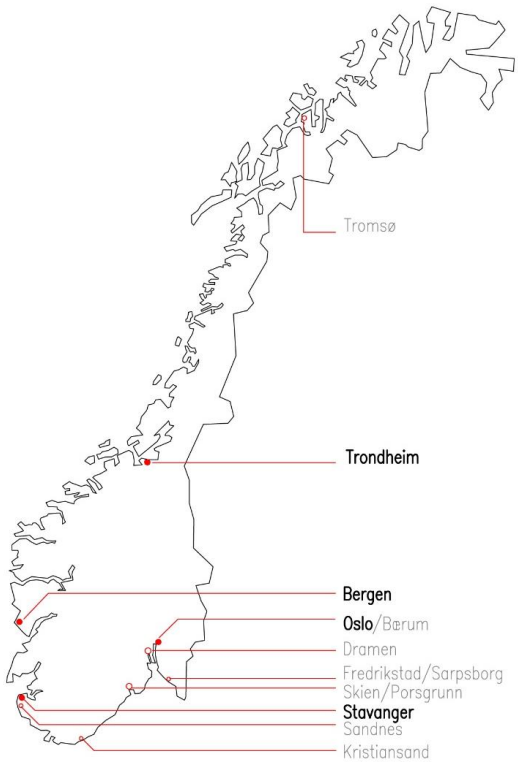


Figure 13. The case studies in the Norwegian context

Norway is a low-density country. According to Statistics Norway (Statistisk sentralbyrå SSB), national density is 16 inhabitants per km², while in Western Europe this density is 171 inhabitants per km². In the Norwegian context, an urban area is an agglomeration of more than 200 inhabitants, living in a settlement where the distance between buildings does not exceed 50 m, regardless of administrative boundaries. According to this definition, 79.5% of the national population lived in urban areas in 2011 (SSB 2012). The national average density in urban areas is also one of the lowest in Europe: 1,622 persons per km² according to SSB, while the denser cities in Europe, such as Bilbao, Istanbul, Milan, Palermo, and Belgrade, have more than 10,000 inhabitants per km² (JRC 2006). Norway is one of the wealthiest countries in the world with an average gross income per year above US $60,000. The combination of a high income and a sparse population results in a very particular context for the issue of urban densification as a planning strategy.

Norway has been considered one of the most successful countries in the application of sustainable policies. In diverse indexes on sustainable development, it is listed in the top position (Esty et al. 2005; Togtokh & Owen 2010; Kerk & Manuel 2012). Oslo was granted the European Sustainable City Award in 2003, and has been studied in various analyses of sustainable urban policies (Engebretsen 2005; Holden & Norland 2005; Næss et al. 2011a; Næss et al. 2011b). The other three cities studied here – Bergen, Trondheim, and Stavanger (Figure 13) – are less well-known in regards to sustainable urban policies; but, being the largest urban areas in Norway after Oslo, they are interesting cases in the analysis of the implications of national urban policies such as urban densification. In Norway central government has a strong influence regarding natural resources and land use policies. Hence, despite different characteristics, the Norwegian urban areas have been subject to the same densification agenda.

## Scope and Limitations of the Analysis

The previous section of this paper addressed the factors involved in the success of densification regarding the sustainable city. It has been said that feasibility depends on four factors: population growth, a decrease of new urban land, social acceptability, and governance. Effectiveness depends on other four factors: proximity to urban services, green mobility, transport-oriented development, and social behaviour (Table 9 and

Table 10). Analysis of these aspects involves complexities that are difficult to consider in depth in the format of a single paper. Hence, this paper considers only some figures related to some of these factors.

The question of feasibility is treated by using statistics on population growth and the incorporation of urban land. Acceptability is addressed indirectly by using information on dwelling type variations, assuming that the decline of the detached house market is a rough indicator for the preference of denser urban environments. Analysis of governance is limited to the heterogeneous achievements in densification in urban regions by comparing the results of core municipalities with the region as a whole. The question of effectiveness is addressed by the study of some aspects of environmentally-friendly mobility using indicators such as annual variation of number of cars per inhabitants, use of cars and public transport, and transportation modes. The period analysed is mainly the last decade. However, it has not been possible to compare exactly the same years for each variable studied because of limitations in information and data. Despite these restrictions, the information offers a clear picture of the evolution of the feasibility and effectiveness of urban densification in Norway.

## Facts about Urban Densification

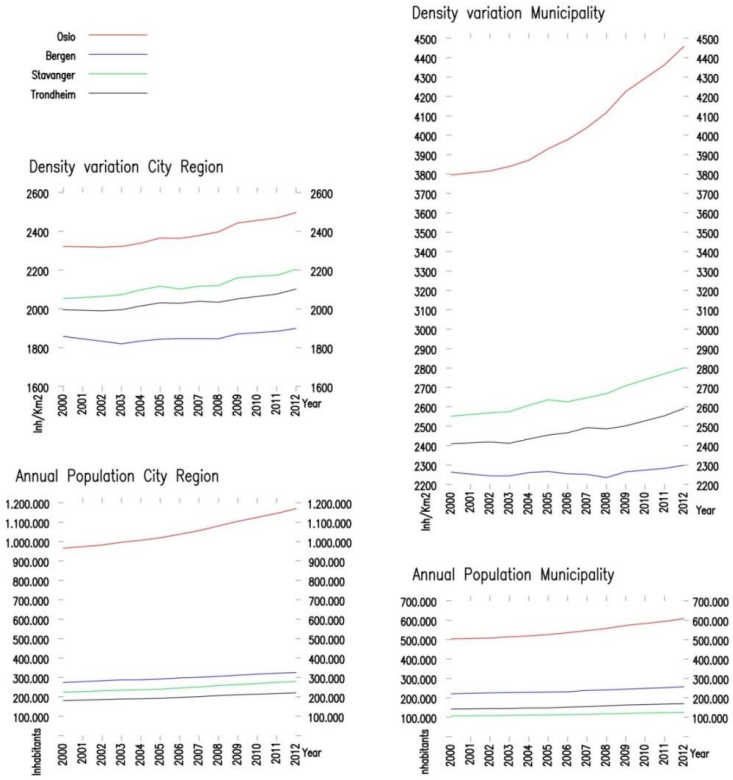


Figure 14. Density variations by municipality and city region

*Source: SSB 2013.*

## Density Variations

Urban density has been increasing steadily in the four case studies. However, this general trend hides differences when analysed at the scale of the core municipality or city region. For the period 2000–2012, core municipalities experienced a faster densification process than city regions as a whole, with the exception of Bergen (Figure 14). For Oslo this rate was twice as high in the core municipality. Stavanger and Trondheim came in second and third positions; and Bergen presented the slower rate being the only case where the core municipality experienced less dense development than the city region as a whole (Appendix: Table 11 and Table 12).

*Trends in dwellings types*

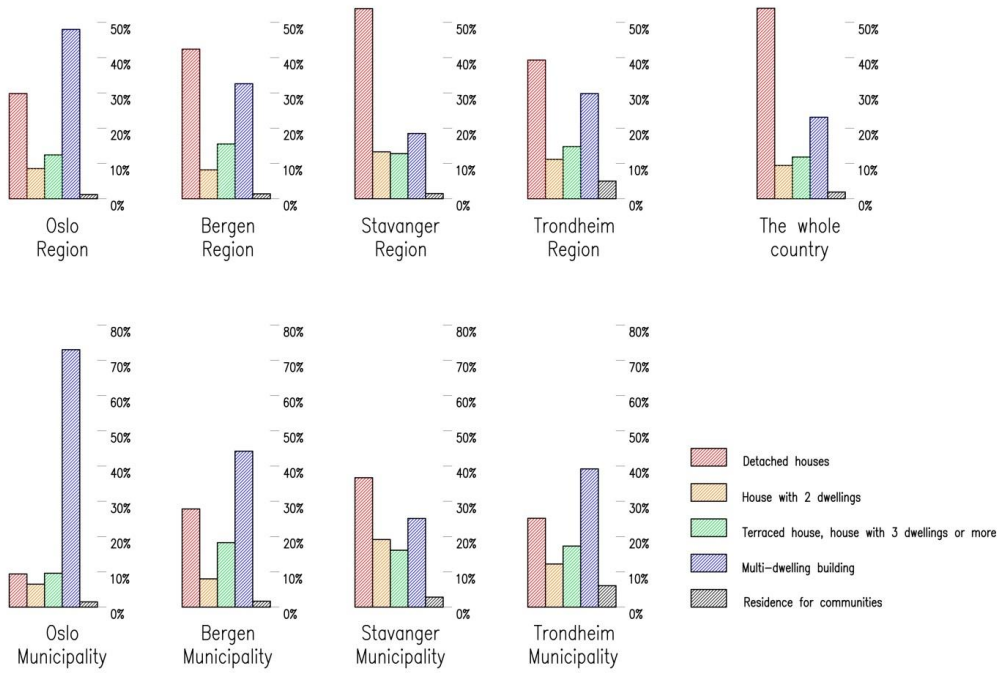


Figure 15. Dwelling types in the municipality and region, 2013

*Source: SSB 2013.*

The Norwegian landscape is dominated by detached houses. This building typology makes up 53.7% of homes according to information from SSB (2013). However, the picture changes within the four case studies analysed in this paper, and there are important differences within city regions and core municipalities. The Oslo region is the only case where multi-dwelling buildings provide the larger proportion of homes; the other city regions are still dominated by detached homes. In the core municipalities, on the other hand, the multi-dwelling typology is dominant. In the Oslo municipality multi-dwelling buildings are by far the most dominant – almost three quarters. Stavanger municipality remains the only case where detached houses are dominant, comprising more than one third, while multi-dwelling buildings comprise a quarter (Figure 15).

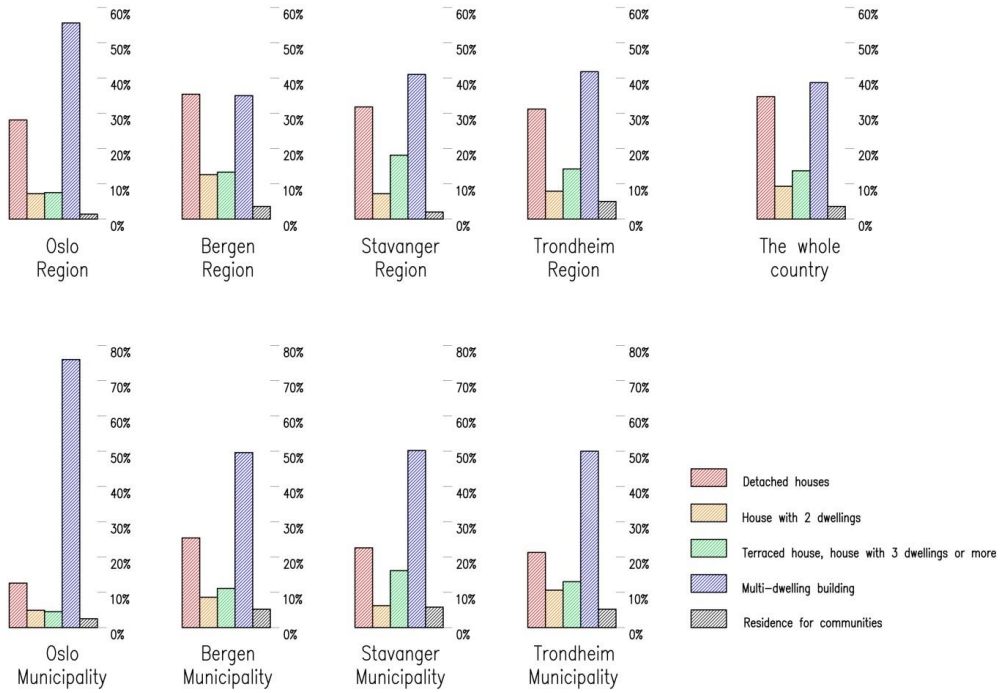


Figure 16. Variations in dwelling types, 2006–13

*Source: SSB 2013.*

Trends in housing typologies are changing the urban landscape in Norway (Figure 16). During the period 2006–13 more multi-dwelling buildings were constructed than detached homes in the country as a whole. This tendency is clear in all the regions of the case studies, with the exception of Bergen region, where detached houses have been growing slightly faster than multi-dwelling buildings. The increase in multi-dwelling buildings is significantly larger in the core municipalities of the case studies. In Oslo municipality three-quarters of the homes built during the period 2006–13 are in multi-dwelling buildings, while in the core municipalities of Bergen, Stavanger, and Trondheim, the share is about the half. The increase is sharper in Oslo, where the population is growing faster (Appendix: Table 13 and Table 14).

## Demographic Trends

In the coming years, it is expected that significant demographic trends will have greater impacts on urban lifestyle, the demand for urban services, and types of dwelling. There are three main

trends with direct impact on the larger cities of Norway. Two are exposed by Brunborg et al. (2012) in a study of the period 2012–2100. The first is the concentration of population in the main urban regions, particularly in the south of the country (Oslo, Bergen, Stavanger, and Kristiansand city regions) and with less intensity in Trondheim, located in central Norway (Figure 13). This will involve a decline in many municipalities, particularly in central and northern Norway. The second is the growth of the elderly population due to life expectancy increases, immigration of working-age population, and stagnation of fertility rates. According to an intermediate scenario developed by SSB and presented by Brunborg et al. (2012), it is expected that the percentage of the population over 70 years will double before 2040. The third trend is the increase in people living alone and the decrease of family size, a trend already observed during the last decades (Figure 17).

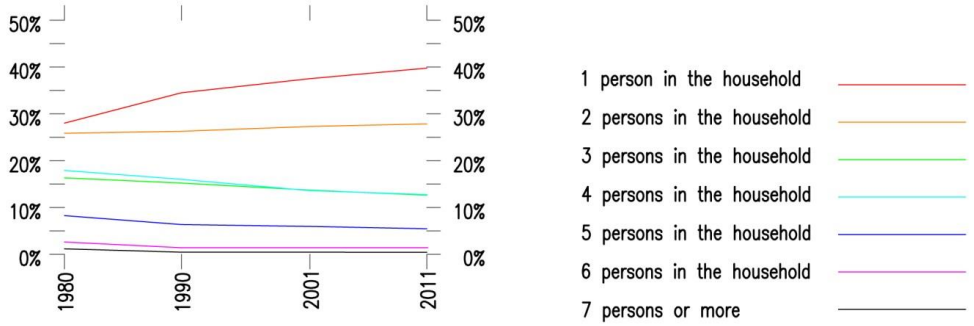


Figure 17. Persons by household, 1980–2011

*Source: SSB 2013.*

Immigration has been a significant factor in population growth in the country. According to data from Tønnessen et al. (2012), since 2005 net immigration has been higher than the birth surplus. According to these authors, this migration trend is expected to continue in the early years of the period analysed (2012–2100) but will decline later. Immigrants tend to be people of working age, predominantly men, who settle in the main urban regions where working opportunities are concentrated. This is a relevant aspect for urban dynamics such as urban densification and transport patterns. Limitation of information makes it difficult to establish further details, such as concentration, household conditions, or transport habits among the immigrant population. In general, statistics and reports on this topic present gross figures, on a national scale, and the analysis are not consistent over time (SSB 2014). One of the most

complete reports on this topic is that of Østby (2002). However, nowadays the cultural background of immigrants may differ widely from the 1990s and early 2000s compared to the current situation where the European economic crisis has a dominant impact.

## Facts on Mobility

Norway had the highest average car use in Europe in 2012, despite also having one of the highest fuel prices where taxes account for nearly 60% (Brunvoll & Monsrud 2013). Car ownership has been increasing steadily in the last decade, in the country as a whole and in all of the regions of the analysed case studies. The average figure for car ownership increased by 15% in the country during the period 2003–12 (Figure 18). However, car usage increased by only 2.7%, changing from 31.37 daily km per capita in 2003 to 32.26km in 2012. The share of public transport in daily mobility varied slightly during the period 2001–9, oscillating around 10.5% of daily trips (Appendix: Table 15).

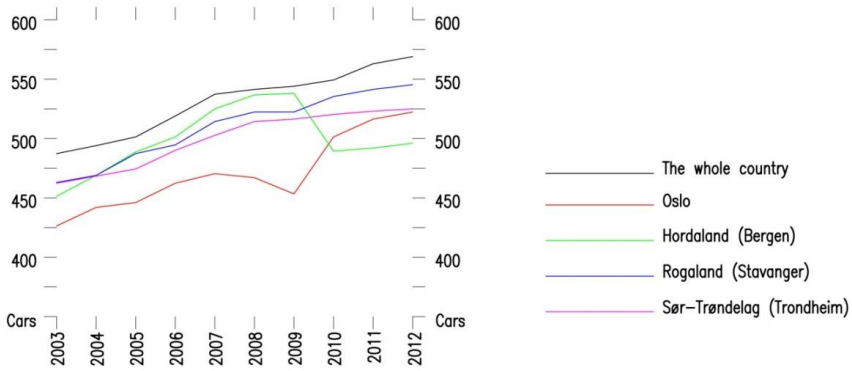


Figure 18. Number of cars per 1,000 people, 2003–12

*Source: SSB 2013.*

The change in the use of transportation modes in the four case studies displays mixed results during the period 2001–9 (Figure 19). Oslo made steady progress in reducing car usage in favour of walking, cycling, and public transport. By 2009 more than 60% of daily trips in the city were made by environmentally friendly modes. The advance of green mobility approached 10% during the period studied. Bergen achieved the second highest improvement with a 5% increase in use of environmental friendly modes. Trondheim advanced a modest 2% in the total

period but experienced a reduction between 2005 and 2009. Stavanger came in last with a negative figure of -2% during the period.

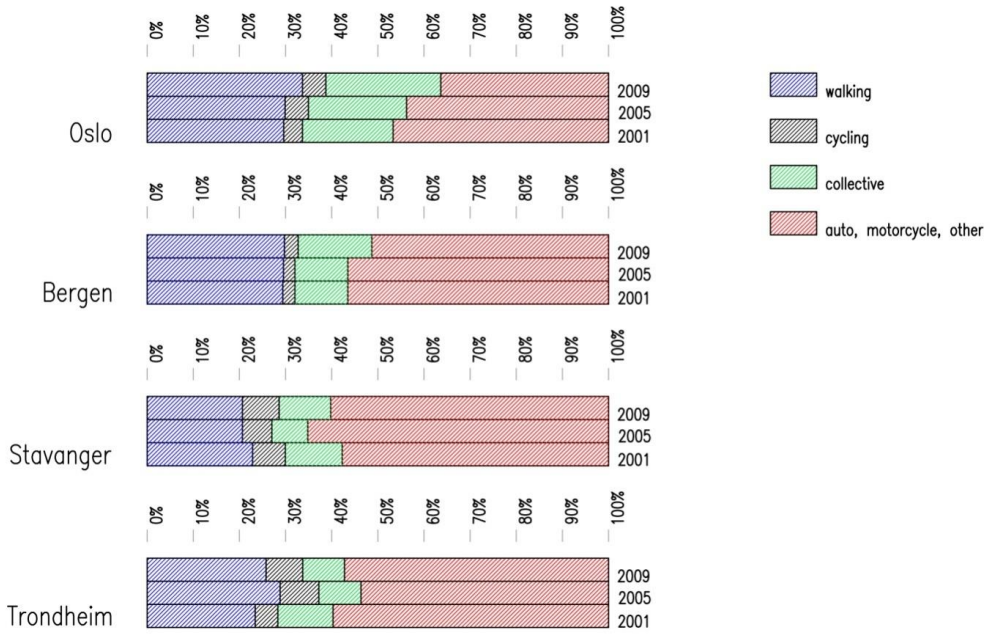


Figure 19. Urban transportation modes, 2001–9

*Source: adapted from Haagensen 2012.*

## Discussion on Data and Trends in Densification

In general, densification occurs when the population increases faster than the incorporation of new urban land. Thus, cities with the highest population growth have greater potential for increasing density. This simple logic explains why Oslo, both in the region and in the core municipality, is becoming denser faster than the other three case studies. Stavanger and Trondheim are also growing denser, both in the core municipalities and in the city region, although at a slower rate. Compared to the other three cities, Bergen displays the lowest increase in densification, both in the core municipality and in the region, yet with a positive variation. In general, core municipalities are increasing density faster than the city regions. Bergen municipality is the only case in which densification has been lower than in the region. This is explained by the fact that Bergen has incorporated the biggest proportion of new urban land, almost equal to the proportion of new inhabitants (Appendix: Table 11 and Table 12).

The type of home is also changing fast in the four larger urban areas in Norway. Multi-dwelling buildings already make up the largest proportion of homes in the core municipalities of Oslo, Bergen, and Trondheim. Stavanger remains the only case where detached houses provide the bigger proportion of homes. In the city region, however, detached houses maintain a larger participation, Oslo being the only exception, with a predominance of multi-dwelling buildings. The tendency, however, is for multi-dwelling buildings to increase everywhere. Multi-dwelling homes were by far the most commonly built type of home during recent years. This tendency is stronger in the core municipalities of the four case studies, but is also occurring in the urban region to a smaller extent. Such a phenomenon may be linked to a change in the housing market due to demographic trends, but also to availability of urban land and home prices (Figure 15 and Figure 16; Appendix: Table 13 and Table 14).

Family size has been declining during the last decades. However, SSB data do not register details for each municipality and city region (Figure 17). More people are living alone, particularly in Oslo, where 52% of the homes are one-person households. In Bergen and Trondheim the figure is around 45%. This number falls to less than 30% in the outer municipalities of Oslo, Bergen, Trondheim, and Stavanger. This indicates the preference of families with children for detached dwellings, more prevalent in the peripheral municipalities, while one-person households prefer the denser urban environments of the core municipalities (SSB 2013).

Densification is increasing in the four cities studied in this paper. This tendency is generally stronger in the core municipalities, and weaker in the peripheral ones. Family size has been declining, and there is a significant increase in one-person households. The type of home to accommodate smaller families seems to be the multi-dwelling building. This type of housing has had the highest share of new building during recent years. However, these positive trends in densification are not that clearly connected to trends in urban mobility. Car ownership has been increasing steadily in all four cities. (Bergen presents a sharp decline during 2009–10, possible more a statistical issue than a real trend.) The figures are presented on a regional scale, limiting a detailed analysis between core municipalities and other municipalities in the urban regions (Figure 18). A more detailed study developed by Haagensen (2012) with information built on a municipal scale, registers a sharper decline in private car usage in Oslo, a moderate decline in Bergen and Trondheim, and a slight increase in car usage in Stavanger.

The effectiveness of densification in attaining more environmentally-friendly mobility according to the variables studied is less clear. Car ownership has been analysed on the country and regional scale. In all the regions to which the four cities belong, there have been steady increases in vehicles per inhabitant, not dissimilar to the figures for the country as a whole. Vehicle ownership does not automatically mean increased car use, but this is far from being a proof of the advancement of environmentally-friendly mobility. The analysis of mobility modes in the core municipalities shows Oslo with the sharpest decline in car usage. Bergen and Trondheim have a slight decline, while Stavanger presents an increase in car usage. The positive tendency in Oslo, towards environmentally-friendly mobility has a correlation with an increase in density. But in the other cases there is not a direct correlation, since density has been increasing at a different speed from environmentally-friendly mobility (Figure 20).

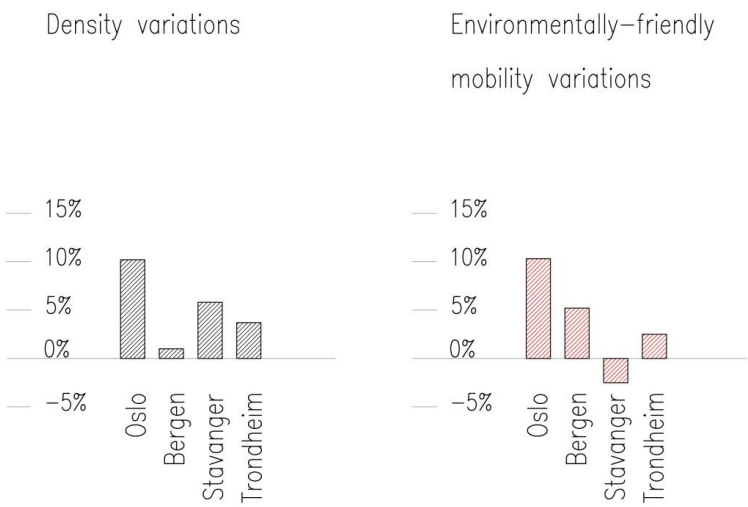


Figure 20. Correlation between variations in density and environmentally-friendly mobility

*Source: elaboration using data from SBB 2013 and Haagensen 2012. Figures for 2001–9.*

## 5.5. Conclusions and Recommendations for Further Work

The sustainable development agenda has deeply influenced the design of policies in most aspects of human activities. However, the sustainable city is still a very imprecise object, built on aims rather than facts. Although the compact city paradigm and densification as a planning strategy have been assumed as archetypes of urban sustainability in Norwegian cities, there are

many unanswered questions. Higher densities seem to have some advantages in terms of efficiency if compared to sprawling cities. Nevertheless the effectiveness of compaction depends on a combination of various factors and not merely density. Further research is required to study these factors. Some of them may be related to qualities of the local scale; the neighbourhood, the block, the street, the public space. Others may be determined by the regional scale in which synergies and co-ordination between municipalities rather than competition are necessary.

Analysis of literature and the empirical evidence have revealed that densification is not a definitive answer to the problem of sustainability. But it is a key aspect in the implementation of complementary strategies, such as environmentally-friendly mobility, and proximity to urban services for the population. The effectiveness of densification in attaining sustainable city goals depends on the combination of such planning strategies. To answer the research question proposed in this paper, densification as a planning strategy in Norway is feasible, but this feasibility does not imply a direct correlation with effectiveness. Densification requires additional planning initiatives and projects to produce effective improvements in urban sustainability.

*Acknowledgement*

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# Appendix

Table 11. Density, population, and urban land by municipality, 2000–12

**Density, inhabitants per km²**

| City | Year 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2000–12 % dif. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oslo | 3 795 | nd | 3 816 | 3 839 | 3 871 | 3 930 | 3 977 | 4 039 | 4 116 | 4 225 | nd | 4 363 | 4 458 | 14,88 % |
| Bergen | 2 263 | nd | 2 244 | 2 245 | 2 261 | 2 267 | 2 255 | 2 252 | 2 235 | 2 265 | nd | 2 283 | 2 299 | 1,56 % |
| Stavanger | 2 552 | nd | 2 569 | 2 575 | 2 608 | 2 636 | 2 626 | 2 647 | 2 668 | 2 709 | nd | 2 771 | 2 801 | 8,89 % |
| Trondheim | 2 410 | nd | 2 419 | 2 412 | 2 434 | 2 455 | 2 466 | 2 493 | 2 486 | 2 502 | nd | 2 554 | 2 592 | 7,04 % |

**Annual population**

| City | Year 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2000–12 % dif. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oslo | 504 348 | nd | 508 134 | 514 744 | 519 261 | 527 236 | 535 916 | 546 048 | 558 165 | 573 185 | nd | 594 479 | 608 013 | 17,05 % |
| Bergen | 221 108 | nd | 225 879 | 227 965 | 229 420 | 230 403 | 234 984 | 237 631 | 241 101 | 245 485 | nd | 253 232 | 256 532 | 13,81 % |
| Stavanger | 106 804 | nd | 108 271 | 109 728 | 111 059 | 112 243 | 113 517 | 115 491 | 117 666 | 119 673 | nd | 123 910 | 125 375 | 14,81 % |
| Trondheim | 142 277 | nd | 144 560 | 146 487 | 147 854 | 149 336 | 152 310 | 155 076 | 159 236 | 162 568 | nd | 167 557 | 170 242 | 16,43 % |

**Urban land growth, km²**

| City | Year 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2000–12 % dif. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oslo | 132,90 | nd | 133,17 | 134,08 | 134,13 | 134,16 | 134,77 | 135,19 | 135,60 | 135,65 | nd | 136,26 | 136,38 | 2,55 % |
| Bergen | 97,71 | nd | 100,64 | 101,55 | 101,49 | 101,63 | 104,22 | 105,50 | 107,88 | 108,39 | nd | 110,93 | 111,60 | 12,45 % |
| Stavanger | 41,85 | nd | 42,14 | 42,61 | 42,59 | 42,58 | 43,23 | 43,63 | 44,11 | 44,18 | nd | 44,71 | 44,76 | 6,50 % |
| Trondheim | 59,04 | nd | 59,76 | 60,73 | 60,74 | 60,84 | 61,77 | 62,21 | 64,06 | 64,98 | nd | 65,60 | 65,67 | 10,10 % |

Source: SSB 2013.

Table 12. Density, population, and urban land by city region, 2000–12

**Density, inhabitants per km²**

| City | Year 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2000–12 % dif. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oslo | 2 321 | nd | 2 318 | 2 321 | 2 339 | 2 365 | 2 363 | 2 378 | 2 397 | 2 443 | nd | 2 469 | 2 494 | 6,94 % |
| Bergen | 1 858 | nd | 1 833 | 1 820 | 1 834 | 1 844 | 1 844 | 1 847 | 1 846 | 1 871 | nd | 1 884 | 1 899 | 2,17 % |
| Stavanger | 2 053 | nd | 2 064 | 2 073 | 2 098 | 2 117 | 2 102 | 2 117 | 2 120 | 2 161 | nd | 2 174 | 2 204 | 6,82 % |
| Trondheim | 1 995 | nd | 1 990 | 1 995 | 2 015 | 2 031 | 2 029 | 2 039 | 2 034 | 2 052 | nd | 2 076 | 2 102 | 5,12 % |

**Annual population**

| City | Year 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2000–12 % dif. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oslo | 965 733 | nd | 983 070 | 997 387 | 1 006 914 | 1 019 825 | 1 037 994 | 1 056 580 | 1 081 243 | 1 104 966 | nd | 1 146 218 | 1 170 458 | 17,49 % |
| Bergen | 273 905 | nd | 283 516 | 287 658 | 290 213 | 292 057 | 297 596 | 301 366 | 306 358 | 311 643 | nd | 321 741 | 325 963 | 15,97 % |
| Stavanger | 224 341 | nd | 230 534 | 234 386 | 237 209 | 239 696 | 245 775 | 250 774 | 257 899 | 263 499 | nd | 275 372 | 280 497 | 20,02 % |
| Trondheim | 180 822 | nd | 185 842 | 188 626 | 190 673 | 192 692 | 196 764 | 200 906 | 206 619 | 210 502 | nd | 217 371 | 221 126 | 18,23 % |

**Urban land growth, km²**

| City | Year 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2000–12 % dif. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oslo | 416,08 | nd | 424,12 | 429,67 | 430,45 | 431,15 | 439,35 | 444,28 | 451,02 | 452,24 | nd | 464,16 | 469,27 | 11,33 % |
| Bergen | 147,40 | nd | 154,68 | 158,06 | 158,22 | 158,34 | 161,36 | 163,16 | 165,93 | 166,60 | nd | 170,82 | 171,61 | 14,11 % |
| Stavanger | 109,25 | nd | 111,67 | 113,05 | 113,04 | 113,24 | 116,94 | 118,45 | 121,66 | 121,95 | nd | 126,65 | 127,28 | 14,17 % |
| Trondheim | 90,65 | nd | 93,41 | 94,53 | 94,65 | 94,86 | 96,98 | 98,55 | 101,59 | 102,56 | nd | 104,69 | 105,18 | 13,81 % |

Source: SSB 2013.

Table 13. Dwelling type variations by municipality

| | | 2006 Dwellings* | 2007 Dwellings* | 2008 Dwellings* | 2009 Dwellings* | 2010 Dwellings* | 2011 Dwellings* | 2012 Dwellings* | 2013 Dwellings* | 2013 % | 2006–13 variation | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0301 Oslo municipality | Detached house | 26 182 | 26 271 | 25 553 | 25 662 | 25 783 | 25 997 | 29 818 | 29 795 | 9,40 % | 3 613 | 12,57 % |
| | House with 2 dwellings | 19 200 | 19 411 | 18 974 | 18 970 | 19 078 | 19 342 | 20 612 | 20 611 | 6,50 % | 1 411 | 4,91 % |
| | Terraced house, linked house and house with 3 dwellings or more | 29 212 | 29 457 | 29 153 | 29 465 | 29 759 | 30 081 | 30 206 | 30 506 | 9,62 % | 1 294 | 4,50 % |
| | Multi-dwelling building | 209 819 | 213 277 | 218 177 | 222 382 | 224 518 | 226 089 | 227 459 | 231 519 | 73,02 % | 21 700 | 75,51 % |
| | Residence for communities | 3 906 | 4 127 | 4 147 | 4 209 | 4 233 | 4 416 | 4 435 | 4 627 | 1,46 % | 721 | 2,51 % |
| | Total dwellings | | | | | | | | 317 058 | | 28 739 | |
| 1201 Bergen | Detached house | 33 205 | 33 356 | 33 985 | 34 017 | 34 216 | 34 436 | 36 370 | 36 393 | 27,83 % | 3 188 | 25,45 % |
| | House with 2 dwellings | 9 408 | 9 378 | 9 530 | 9 680 | 9 831 | 9 941 | 10 423 | 10 489 | 8,02 % | 1 081 | 8,63 % |
| | Terraced house, linked house and house with 3 dwellings or more | 22 502 | 22 652 | 22 859 | 23 138 | 23 158 | 23 421 | 23 763 | 23 888 | 18,27 % | 1 386 | 11,06 % |
| | Multi-dwelling building | 51 573 | 53 096 | 53 683 | 55 094 | 55 772 | 56 194 | 56 982 | 57 791 | 44,20 % | 6 218 | 49,64 % |
| | Residence for communities | 1 532 | 1 541 | 1 971 | 1 990 | 2 024 | 2 084 | 2 152 | 2 185 | 1,67 % | 653 | 5,21 % |
| | Total dwellings | | | | | | | | 130 746 | | 12 526 | |
| 1103 Stavanger | Detached house | 20 591 | 20 600 | 20 672 | 20 814 | 21 034 | 21 184 | 22 127 | 21 885 | 36,70 % | 1 294 | 22,60 % |
| | House with 2 dwellings | 11 074 | 11 071 | 11 084 | 11 142 | 11 179 | 11 237 | 11 599 | 11 433 | 19,17 % | 359 | 6,27 % |
| | Terraced house, linked house and house with 3 dwellings or more | 8 751 | 8 905 | 9 102 | 9 211 | 9 290 | 9 367 | 9 483 | 9 620 | 16,13 % | 869 | 15,18 % |
| | Multi-dwelling building | 12 124 | 12 530 | 13 430 | 13 994 | 14 533 | 14 730 | 14 580 | 14 995 | 25,15 % | 2 871 | 50,15 % |
| | Residence for communities | 1 363 | 1 369 | 1 370 | 1 404 | 1 389 | 1 529 | 1 699 | 1 695 | 2,84 % | 332 | 5,80 % |
| | Total dwellings | | | | | | | | 59 628 | | 5 725 | |
| 1601 Trondheim | Detached house | 21 202 | 21 312 | 21 363 | 21 464 | 21 518 | 21 622 | 23 155 | 23 216 | 25,21 % | 2 014 | 21,28 % |
| | House with 2 dwellings | 10 242 | 10 356 | 10 458 | 10 552 | 10 574 | 10 664 | 11 195 | 11 249 | 12,22 % | 1 007 | 10,64 % |
| | Terraced house, linked house and house with 3 dwellings or more | 14 703 | 14 783 | 14 905 | 15 181 | 15 287 | 15 288 | 15 604 | 15 929 | 17,30 % | 1 226 | 12,95 % |
| | Multi-dwelling building | 31 359 | 32 599 | 34 417 | 34 849 | 35 114 | 35 327 | 35 479 | 36 080 | 39,19 % | 4 721 | 49,88 % |
| | Residence for communities | 5 104 | 5 255 | 5 320 | 5 400 | 4 937 | 5 493 | 5 657 | 5 600 | 6,08 % | 496 | 5,24 % |
| | Total dwellings | | | | | | | | 92 074 | | 9 464 | |

*occupied and vacant

Source: SSB 2013.

Table 14. Dwelling type variations by city region

| | | 2006 Dwellings* | 2007 Dwellings* | 2008 Dwellings* | 2009 Dwellings* | 2010 Dwellings* | 2011 Dwellings* | 2012 Dwellings* | 2013 Dwellings* | 2013 % | 2006-2013 variation | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SP01 Oslo region | Detached house | 158 187 | 159 048 | 159 478 | 160 847 | 162 425 | 163 404 | 175 774 | 176 315 | 29,80 % | 18 128 | 28,12 % |
| | House with 2 dwellings | 45 978 | 46 574 | 46 582 | 46 946 | 47 350 | 47 975 | 50 357 | 50 598 | 8,55 % | 4 620 | 7,17 % |
| | Terraced house, linked house and house with 3 dwellings or more | 68 509 | 69 406 | 69 774 | 70 599 | 71 359 | 71 939 | 72 475 | 73 317 | 12,39 % | 4 808 | 7,46 % |
| | Multi-dwelling building | 248 261 | 254 148 | 262 165 | 268 616 | 271 927 | 274 990 | 277 666 | 284 296 | 48,05 % | 36 035 | 55,90 % |
| | Residence for communities | 6 236 | 6 076 | 6 150 | 6 304 | 6 460 | 6 690 | 6 742 | 7 113 | 1,20 % | 877 | 1,36 % |
| | Total dwellings | | | | | | | | 591 639 | | 64 468 | |
| SP02 Bergen | Detached house | 70 412 | 71 049 | 72 068 | 72 563 | 73 264 | 73 769 | 77 505 | 77 940 | 42,41 % | 7 528 | 35,42 % |
| | House with 2 dwellings | 12 312 | 12 452 | 12 917 | 13 390 | 13 669 | 13 950 | 14 707 | 14 997 | 8,16 % | 2 685 | 12,63 % |
| | Terraced house, linked house and house with 3 dwellings or more | 25 654 | 26 011 | 26 449 | 26 921 | 27 080 | 27 490 | 28 107 | 28 489 | 15,50 % | 2 835 | 13,34 % |
| | Multi-dwelling building | 52 406 | 54 079 | 54 958 | 56 553 | 57 310 | 57 861 | 58 819 | 59 848 | 32,56 % | 7 442 | 35,02 % |
| | Residence for communities | 1 762 | 1 812 | 2 275 | 2 300 | 2 340 | 2 410 | 2 481 | 2 525 | 1,37 % | 763 | 3,59 % |
| | Total dwellings | | | | | | | | 183 799 | | 21 253 | |
| SP03 Stavanger | Detached house | 67 671 | 67 993 | 68 521 | 69 128 | 69 789 | 70 260 | 73 816 | 73 833 | 53,94 % | 6 162 | 31,85 % |
| | House with 2 dwellings | 16 796 | 16 880 | 17 076 | 17 241 | 17 377 | 17 530 | 18 201 | 18 183 | 13,28 % | 1 387 | 7,17 % |
| | Terraced house, linked house and house with 3 dwellings or more | 14 033 | 14 403 | 14 979 | 15 366 | 15 690 | 16 083 | 16 702 | 17 529 | 12,81 % | 3 496 | 18,07 % |
| | Multi-dwelling building | 17 426 | 18 629 | 20 501 | 21 725 | 22 699 | 23 148 | 23 666 | 25 325 | 18,50 % | 7 899 | 40,83 % |
| | Residence for communities | 1 598 | 1 617 | 1 623 | 1 677 | 1 665 | 1 822 | 1 991 | 2 002 | 1,46 % | 404 | 2,09 % |
| | Total dwellings | | | | | | | | 136 872 | | 19 348 | |
| SP04 Trondheim | Detached house | 46 453 | 46 737 | 46 918 | 47 210 | 47 447 | 47 716 | 50 447 | 50 731 | 39,28 % | 4 278 | 31,20 % |
| | House with 2 dwellings | 13 320 | 13 408 | 13 556 | 13 633 | 13 636 | 13 726 | 14 323 | 14 397 | 11,15 % | 1 077 | 7,86 % |
| | Terraced house, linked house and house with 3 dwellings or more | 17 098 | 17 269 | 17 535 | 17 880 | 18 088 | 18 158 | 18 569 | 19 046 | 14,75 % | 1 948 | 14,21 % |
| | Multi-dwelling building | 32 792 | 34 199 | 36 221 | 36 897 | 37 209 | 37 454 | 37 737 | 38 519 | 29,82 % | 5 727 | 41,77 % |
| | Residence for communities | 5 780 | 5 953 | 6 057 | 6 140 | 5 661 | 6 271 | 6 449 | 6 461 | 5,00 % | 681 | 4,97 % |
| | Total dwellings | | | | | | | | 129 154 | | 13 711 | |

*occupied and vacant

Source: SSB 2013.

Table 15. Cars and public transport – daily distance per capita, 2003–12

| Year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total** all modes, passenger km (million) | 66 685 | 67 709 | 67 693 | 68 841 | 70 867 | 72 372 | 72 974 | 73 128 | 74 411 | 75 277 |
| Passenger km car (million) | 52 127 | 52 606 | 52 400 | 53 302 | 54 866 | 55 956 | 56 536 | 57 034 | 58 029 | 58 701 |
| Passenger km public transport (million) | nd | 6 469 | 7 254 | 7 259 | 7 220 | 7 506 | 7 481 | 7 807 | 7 711 | 7 800 |
| Total population | 4 552 252 | 4 577 457 | 4 606 363 | 4 640 219 | 4 681 134 | 4 737 171 | 4 799 252 | 4 858 199 | 4 920 305 | 4 985 870 |
| Daily km per capita all modes* | 40,13 | 40,53 | 40,26 | 40,65 | 41,48 | 41,86 | 41,66 | 41,24 | 41,43 | 41,36 |
| Daily km per capita car | 31,37 | 31,49 | 31,17 | 31,47 | 32,11 | 32,36 | 32,27 | 32,16 | 32,31 | 32,26 |
| Daily km per capita public transport | nd | 3,87 | 4,31 | 4,29 | 4,23 | 4,34 | 4,27 | 4,40 | 4,29 | 4,29 |
| Use of public transport | | 9,6 % | 10,7 % | 10,5 % | 10,2 % | 10,4 % | 10,3 % | 10,7 % | 10,4 % | 10,4 % |
| Use of private cars | | 77,7 % | 77,4 % | 77,4 % | 77,4 % | 77,3 % | 77,5 % | 78,0 % | 78,0 % | 78,0 % |

*all modes includes:
water transport including ferries
Norwegian State Railways, other railways, suburban railways, urban tramways
road transport, including scheduled bus services, taxis, private cars, motorcycles, mopeds
air transport

Source: SSB 2013.

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# 6. The Value of Urban Density: An Exploratory Study of the Relationship between Urban Density and Housing Prices in Trondheim, Norway[11]

## 6.1. Introduction

Urban density is widely accepted as a fundamental characteristic of sustainable urban form (Dempsey et al. 2012). This is built on the premise that more compact cities optimise the use of resources. Denser urban environments have the potential to reduce the use of land and optimise the flow of people, energy, and goods. They also increase the proximity between dwellings, work places, and public facilities, and consequently demand fewer resources and produce fewer greenhouse gases (Fatone et al. 2012). Over the last decades, sustainability targets have driven urban densification policies in Norwegian cities, with different degrees of success. During the period from 2000 to 2012, Oslo and Stavanger experienced relatively large increases in urban density, in contrast to Trondheim and Bergen where increases were modest (Hernandez-Palacio 2014). However, in the case of Trondheim, densification policies have been severely criticised by different actors in the public debate. The most common concerns relate to the decline of urban qualities highly valued by Norwegian society, such as the urban landscape, sun and shade, and the views (Hermann 2015; Sved 2015). Due to several factors, among them social acceptability, the continuation of a positive trend in the densification of sprawling Norwegian cities seems to be increasingly challenging.

The problem, however, does not seem to be urban density itself, but rather the perception thereof, which in turn also becomes a question of urban quality. Urban density is the result of multiple factors, which are materialised in numerous forms and produce very different environments (Berghauser Pont & Haupt 2009). Thus, a high concentration of people and activities can result in very different urban typologies, especially when taking into consideration geographical and cultural values (Urhahn & Bobic 1994). Indeed, the traditional Norwegian city centre, as found in the urban cores built before the 1950s, is notoriously denser than many of the areas developed after. Despite the higher-density environment, average property prices

[11] This section has been written in collaboration with Sabrina Scherzer, from the Department of Geography at the Norwegian University of Science and Technology, and Yngve Karl Frøyen, from the Department of Architecture and Planning at the Norwegian University of Science and Technology. A resulting journal article from this section is to be submitted for publication.

in inner-city locations seem to be higher than in the newer lower-density peripheral locations (see Table 16). This seems to indicate that there is perceived added value to central yet denser locations. To assess this preliminary observation, property sales data were collected for 23 distinct, yet representative areas of Trondheim and density measures were calculated. Based on initial correlation analysis of the average sales price per square metre and the density measures, the following working hypothesis was proposed. Urban density is a well-accepted and valued quality in Norwegian cities, which is reflected in willingness-to-pay in the housing market. Homebuyers are willing to pay more per square metre in well-integrated, denser urban areas than in low-density, disconnected locations. Among other things, they pay for the accessibility and proximity of urban services, but also for more intense urban environments such as the ones found in many traditional inner cities.[12]

This section is organised as follow: Section 6.2 presents Trondheim as the study area, describes the urban areas under investigation and gives some initial analysis. Sections 6.3 and 6.4 present the hedonic pricing model and give analysis and results of its application. Hedonic pricing assumes that the price of a good, such as a house or apartment, is a composite of many different attributes. That is why in this section the model not only includes density measures such as built coverage, dwellings per ha and population per ha, but also property characteristics, such as age of property and property type, and proximity measures, such as distance to the next bus stop or supermarket. The model was computed for the entire dataset as well as for the city centre and periphery subsets. Section 6.5 is a discussion of the results and recommendations for future research.

[12] Strictly speaking, the hypothesis to be tested in this study is: urban density has a significant effect on property prices. The null hypothesis accordingly is: urban density does NOT have an effect on property prices.

## 6.2. Trondheim: Study Area and Initial Analysis

The study area is the city of Trondheim, Norway. Trondheim, with a population of 178,833 in 2015, is the third largest city in the country, after Oslo and Bergen (SSB 2015). It is located on Trondheim Fjord in central Norway and has an average population density of 3027.5 inhabitants per km², which is considerably less than the average urban density in European cities estimated at 4,345 inhabitants per km² (Dodman 2009). Trondheim's urban area can be divided into two distinct urban environments: the inner city, comprising the pre-industrial core and its 19th and early 20th century developments, characterised by a denser urban fabric, formed mostly of compact blocks; and the less dense outer city, made up from different developments built during the second half of the 20th century and the beginning of the 21st century. A study of residential qualities in Oslo using hedonic pricing analysis defines these two basic urban environments: a denser inner city environment (*bymessige områder*) and a less compact collage of peripheral developments (*feltutbygginger*) (Sjaastad et al. 2007). This clear differentiation in urban form is also evident in many European cities. According to Benevolo (1993), the urban form of European cities is in general characterised by a dense network core spanning a fairly restricted area, which then grew through multiple additions over the course of the 20th century.

Historically, Trondheim remained a rather compact urban agglomeration, maintaining the dense pattern of the traditional European city, until the early 20th century (Trondheim byarkiv).[13] At this time, a new trend of expansion was set by wealthy families through the introduction of urban villas into the urban landscape. This new form of lower-density townscape was restricted to a small segment of the population. Compact housing schemes, such as terraced houses or courtyard blocks, provided housing solutions for the majority of urban dwellers. This traditional pattern of urban development was dominant until the mid-20th century, when new modernisation trends entered Norwegian cities with force; one of the main consequences was the abandonment of the compact housing scheme as the predominant urban typology. The modern city presents new urban typologies, such as slab blocks and towers. The former typologies, such as terraced houses and courtyard blocks, are still present in the newer parts of the city, but they have become more spacious, allowing for more green spaces and a less dense environment. The ideal of living in the 'green city' rather than in the crowded old city seemed

[13] These observations are based on historical maps from 1893, 1902, 1916, and 1940 available in the Trondheim byarkiv.

to dominate the housing market during the second half of the 20th century and still is influencing some new developments in the early 21st century.

## The Urban Areas

Initial data on property sales transactions were collected on a case-by-case basis from finn.no, a very popular online marketplace in Norway. Data were compiled for 1,255 sales transactions. The sample was drawn from 23 urban environments with diverse layouts and locations. The first 10 are in the older parts of the city, formed mostly before the mid-20th century, and are referred to in this section as Trondheim city centre (see Figure 21). The remaining 13 areas correspond to newer urban developments, and are referred to as Trondheim periphery (see Figure 22)

These areas were selected to cover the most representative types of urban environment in Trondheim. They range from high-density, high-rise buildings in Midtbyen (1) to low density development in Singsaker (7), Ilabekken (11), and Ranheim (22, 23). They cover areas with a high percentage of historic wooden houses in Bakklandet (5) and Møllenberg (6), and areas of urban renewal with an important component of refurbishment of old buildings in Nedre Elvehavn (3) and Persaunet (18). They also include areas in close proximity to large institutions in Gløshaugen (9) and Ila (10), to the fjord in Ila (10), Nedre Charlottenlund (21), and Ranheim (23), to large parks in Ilabekken (11), and to the river in Øya (2), Bakklandet (5), and Sjetnemarka (13). Post-war residential areas, such as Kolstad (14), form another part of the sample, as well as a representative selection of newer residential areas in the periphery, such as Selsbak (12), Tiller (15), Kattem (16), Moholt/Eberg (17), Nardo (19), and Angeltrøa (20).

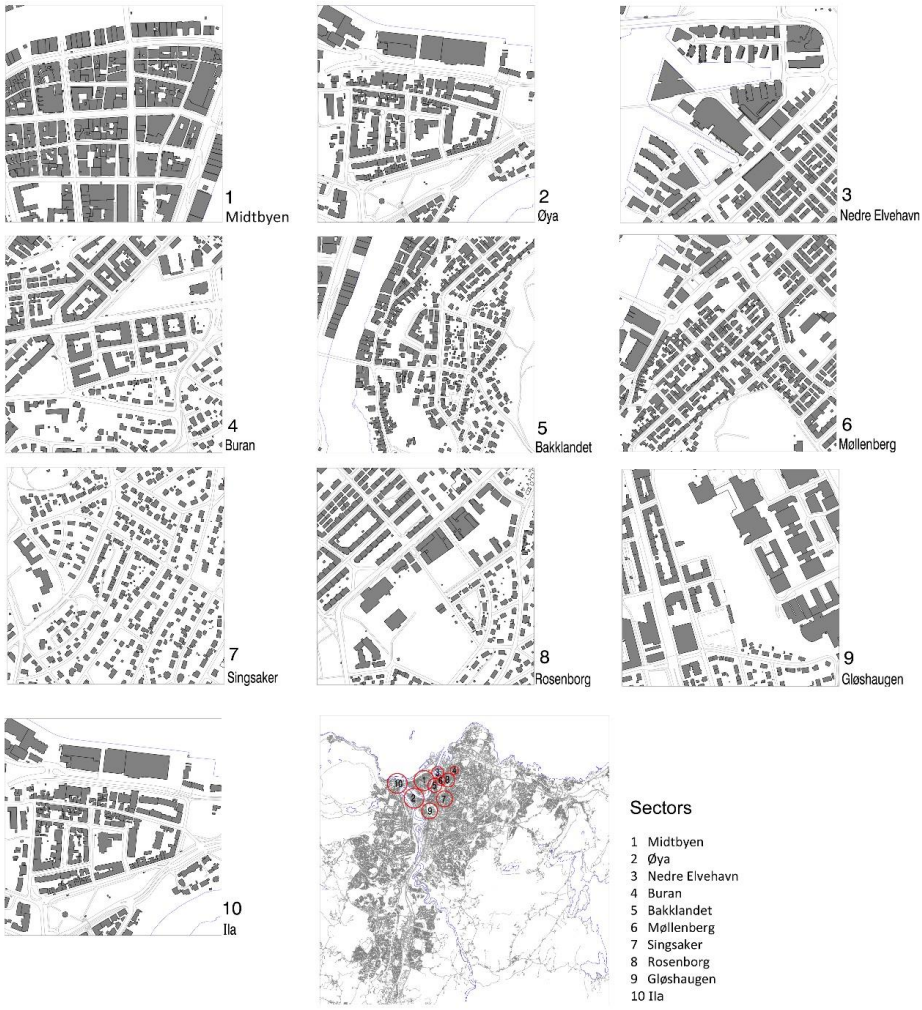


Figure 21. Analysed areas in Trondheim city centre


Figure 22. Analysed areas in Trondheim periphery

Table 16. Average square metre prices and densities

| Urban area | Average NOK price per $m^2$ | *Grunnkrets*-based densities* | | | Average hectare circle-based densities** | | |
|---|---|---|---|---|---|---|---|
| | | Built coverage density (% plot area) | Dwelling unit density (units / ha) | Population density (pers. / ha) | Built coverage density (% plot area) | Dwelling unit density (units / ha) | Population density (pers. /ha) |
| 1 Midtbyen | 49522.03 | 31.24319 | 27.3668 | 37.27576 | 33.556 | 76.11111 | 105.3611 |
| 2 Øya | 44144.26 | 14.99308 | 20.77107 | 25.46373 | 17.8133 | 102.0706 | 119.1294 |
| 3 N. Elvehavn | 56624.62 | 28.8629 | 64.06121 | 70.34461 | 22.7672 | 187.4928 | 208.3768 |
| 4 Buran | 43305.11 | 33.85348 | 134.5982 | 158.1368 | 22.831 | 143.5882 | 176.0294 |
| 5 Bakklandet | 52214.45 | 33.75853 | 75.38294 | 97.34675 | 33.7009 | 81.26415 | 112.5094 |
| 6 Møllenberg | 43461.24 | 33.57972 | 94.72068 | 115.9373 | 26.4257 | 107.3649 | 121.9865 |
| 7 Singsaker | 44375.01 | 16.50833 | 18.1603 | 36.47114 | 17.1389 | 53.51515 | 61.09091 |
| 8 Rosenborg | 32461.6 | 19.1092 | 43.79922 | 69.96051 | 14.1873 | 32.71429 | 62.28571 |
| 9 Gløshaugen | 42805.05 | 24.49498 | 75.25273 | 79.12404 | 17.6546 | 112.0227 | 106.75 |
| 10 Ila | 45810.98 | 22.30171 | 37.15877 | 52.67391 | 21.2688 | 103.9604 | 132.3366 |
| 11 Ilabekken | 33018.1 | 8.690827 | 10.42889 | 24.33408 | 11.7742 | 20.2 | 45 |
| 12 Selsbak | 36012.84 | 13.40433 | 15.11179 | 29.23108 | 9.3188 | 47.61039 | 80 |
| 13 Sjetnemarka | 26921.75 | 11.03952 | 8.359928 | 21.1524 | 15.4239 | 17.14286 | 43.82143 |
| 14 Kolstad | 28134.39 | 11.63399 | 22.94064 | 44.35794 | 11.7819 | 57.33333 | 118.8667 |
| 15 Tiller | 30741.61 | 18.89509 | 19.99317 | 50.79429 | 16.9758 | 34.40206 | 75.75258 |
| 16 Kattem | 25880.52 | 13.06405 | 18.25703 | 43.04455 | 12.2009 | 42.85714 | 103.1224 |
| 17 Moholt/Eb. | 38341.07 | 11.91568 | 20.32226 | 33.85865 | 13.5289 | 64.36 | 96.04 |
| 18 Persaunet | 43577.04 | 21.27847 | 40.69085 | 66.47749 | 12.9862 | 47.33333 | 80.9375 |
| 19 Nardo | 42775.44 | 16.84235 | 19.3603 | 32.80261 | 8.9541 | 32.69767 | 53.27907 |
| 20 Angeltrøa | 38896.6 | 16.45107 | 15.17837 | 42.96817 | 14.8621 | 40.46667 | 76.4 |
| 21 Ned. Charlot. | 40773.57 | 12.07866 | 13.71206 | 23.96629 | 16.8762 | 28 | 65.54546 |
| 22 Ranheim/Old | 33140.5 | 13.69619 | 13.39398 | 33.63238 | 15.7745 | 19.95652 | 46.08696 |
| 23 Ranheim | 37320.99 | 11.17222 | 15.19191 | 33.13085 | 13.6172 | 28.94444 | 36.05556 |

* *Grunnkrets* are a type of geographic unit used to provide statistical information in Norway. These basic statistical areas are subdivisions of municipalities intended to cover a homogeneous area. They vary in size and population density.

** Average hectare circles are 1 hectare circles around each sales point. Their purpose is to calculate more detailed density measures in the immediate vicinity of each sales point.

## 6.3. Hedonic Property Pricing

Hedonic property pricing is based on the assumption that property prices, housing unit prices in this case, are compound measures that reflect not only property characteristics, such as size or number of bedrooms, but also location, neighbourhood, as well as environmental characteristics (Freeman et al. 2014). Its most common functional form is linear or semi-linear regression analysis, whereby expenditures (price or rent) are regressed on housing and location characteristics (Malpezzi 2002). Hedonic property pricing models have been used to assess the impact of a great number of environmental factors and neighbourhood characteristics on housing prices, such as the impact of air quality (Carriazo et al. 2013; Amrusch 2005) or noise

pollution (Chang & Kim 2013; Dekkers & Van der Straaten 2009), proximity to amenities (Cheshire & Sheppard 1995), accessibility (Srour et al. 2002), proximity to green areas (Bengochea Morancho 2003; Jim & Chen 2006), the value of scenic views (Jim & Chen 2009), the value of urban wetlands (Tapsuwan et al. 2009), the value of urban tree cover (Sander et al. 2010; Vesely 2007), or the value of cultural heritage in urban areas (Lazrak et al. 2014). However, to the author's knowledge, no such model has previously been used to focus on the value of urban density.

In this analysis, a hedonic pricing approach is therefore used to estimate the marginal implicit prices of property, proximity, and density attributes. The marginal implicit price can be understood as the change in amount a person is willing to pay for an additional unit of an attribute (see Freeman et al. 2014). The model regresses the log-transformed property prices per square metre on a combination of housing characteristics, distances to amenities, and density measures. It is computed for the complete dataset as well as for subsets of Trondheim centre and Trondheim periphery. The model can be specified as follows:

$$ln\ P_i = \beta_0 + \beta_1 H_i + \beta_2 DIST_i + \beta_3 DENS_i + \varepsilon_i$$

$P_i$ is the price per square metre of property i. $H_i$ is a vector of housing characteristics of property i, such as age of property, housing type, and ground floor access. $DIST_i$ is a vector of distance measures from property i, such as distance to nearest supermarket or distance from fjord. $DENS_i$ is a vector of density measures for property i. $\varepsilon_i$ is the error term.

## The Data

The sales data initially collected included information on sales price, size of property, age of property, years since last refurbishment, type of property (house or apartment), which floor(s) the property occupies, and the type of building the property is or is located in (for a complete list of variables, see Table 17). The 1,255 properties included in the dataset range in price from NOK 800,000 to 14,900,000,[14] and include small (less than 20m²) and large properties (more than 450m²), as well as new ones (built in 2015) and very old ones (more than 100 years old). The oldest property in the dataset was built in 1721 (see Table 18).

Two basic types of residential unit are considered: apartments and houses, located in different building types, such as blocks, towers, or detached houses (explained below). The sample includes 23 areas, taken according to distinctive urban morphology patterns visually identified

[14] At current exchange rate about USD 93,000 to 1,700,000.

on the map of the city. The sales transactions were chosen to express the diversity of property types and property locations available in Trondheim. As the properties in the sample vary quite dramatically in size, it has been decided for this analysis to focus on the variation in price per square metre. Age of property (*AGE*) and years since last refurbishment (*YEARS_REFURB*) serve as proxies for the condition of the property. Both variables were computed by subtracting the year the property was built or refurbished from 2015. Type of property was dummy coded, taking the value 1 for houses and 0 for apartments (*HOUSE_APART*). The floor information was coded into two dummy variables: *GROUNDFLOOR* and *MULTISTOREY*. *GROUNDFLOOR* takes the value 1 if the property has ground-floor access, and *MULTISTOREY* takes the value 1 if the property spans across more than one floor.

As building types are fundamental in the differentiation of urban environments and density distributions, Trondheim's large variety of buildings was reduced to seven basic building types for the analysis (illustrated in Figure 23). Urban *villas* are single, freestanding dwellings surrounded by private gardens. They can have one, two, or three storeys, and basements. *Big house apartments* are apartment buildings in the settings of large detached houses, surrounded by gardens. In Trondheim, many former urban villas have been internally refurbished into apartment buildings. *Terraced houses* consist of similar residential units sharing side walls, usually forming blocks. They have separate entrances to the street and have gardens of different sizes, allowing natural lighting and cross-ventilation. In Trondheim, they have normally one, two, or three storeys. *Slab blocks* are multi-storey buildings with lengthened form, in which the apartments are commonly set around a long corridor, or around several staircases and/or lifts with independent entrances. *Courtyard apartment blocks* are constituted by blocks of two or more wings, which fold around an open space. L and S shape blocks, as well as atrium blocks around a patio are also part of this typology. *Tower blocks* are constituted by a multi-storey building with vertical proportions. They may have one or several dwellings per storey, organised around a central core constituted by staircases, lifts, and other technical components. *Hybrid buildings* correspond to a variety of buildings, mixing different uses and types. In some cases, they also correspond to the existing conditions of the context, such as the adaptation of former warehouses and other industrial buildings into new types and uses. For the purpose of the analysis, the dummy building type variables *BT_COURTYARD*, *BT_HYBRID*, *BT_SLABBLOCK*, *BT_TERRACE*, *BT_BIGHOUSE*, and *BT_TOWER* were coded against *BT_URBANVILLA*.

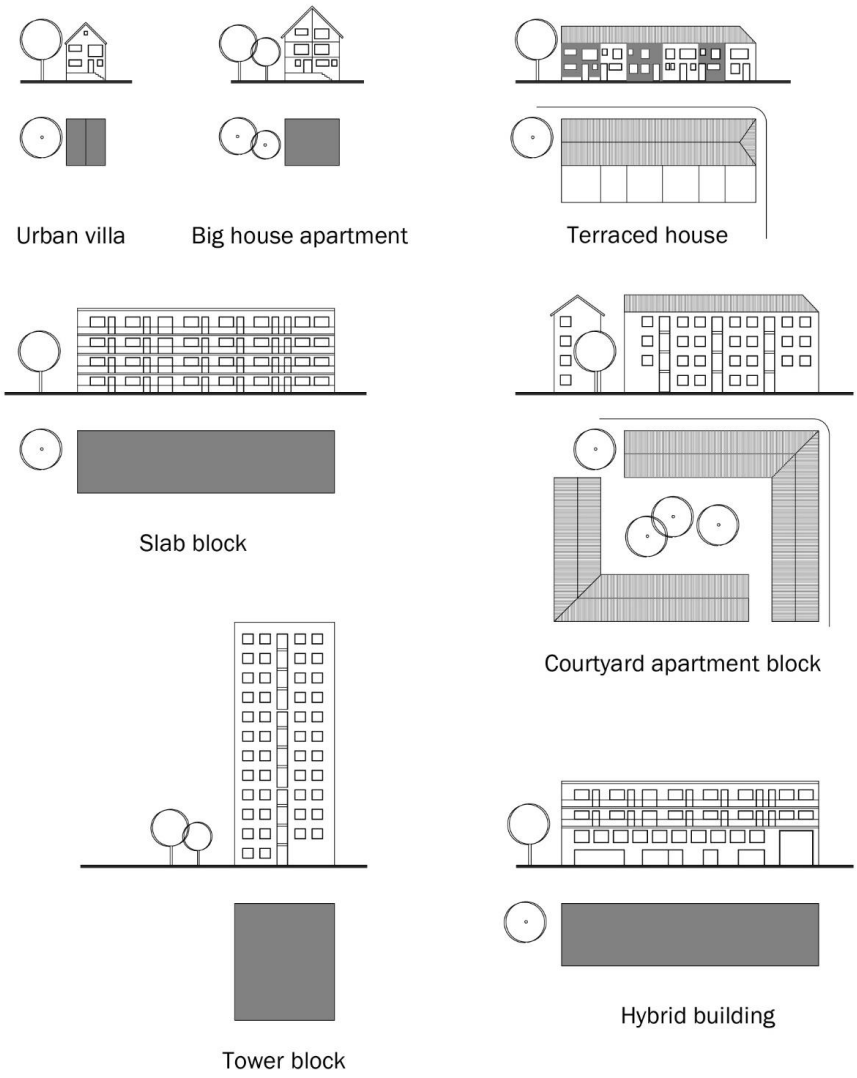


Figure 23. Building types

To compute geographical variables, such as distances to various amenities and density measures, the sales data were mapped in ArcGIS and additional data collected from Statistics Norway (the Norwegian Central Bureau of Statistics) and Norge Digitalt (a geographic information database). *ELEVATION* above sea level was computed for every sales address,

depicted as points in ArcGIS, using a digital elevation model (DEM) of Trondheim. Euclidean distances were computed from the sales points to the nearest bus stop (*DIST_BUSSTOP*), supermarket (*DIST_SUPERMARKET*), higher education facility (*DIST_HIGHEREDU*), kindergarten (*DIST_KINDERGARTEN*), school (*DIST_SCHOOL*), shopping centre (*DIST_SHOPPING*) as well as to the fjord (*DIST_FJORD*) and to the recreational areas surrounding the city (*DIST_NATURE*). Buses are an important mode of transportation in Trondheim. Approximately 10% of the population use them on a daily basis to commute (Hjorthol et al. 2014). Increasing the share of collective transport is a crucial aspect of the urban sustainability policies in Trondheim (Trondheim Kommune 2008). Supermarkets are the main source of food for the majority of people in Norway. Easy access to them is therefore considered a plus for homebuyers. Close proximity to kindergartens and schools, referring here to elementary schools, middle schools, and high schools, can be an important factor when a young family is hunting for a new home. Trondheim is a university city and higher education institutions, such as the Norwegian University of Science and Technology (NTNU) and the University College of Sør-Trøndelag (HIST), are some of the biggest employers. Being close to these institutions is therefore considered a desirable attribute for many homebuyers. As Norwegians have a high disposable income, shopping has become a favourite pastime for many. The shopping centres referred to are the biggest and most popular malls in the city. Norwegians also have a particular affinity for nature; not only do they enjoy the views that their country is famous for, they also spend a lot of time outdoors—hiking, skiing, fishing, and foraging. That is why the distances to Trondheim fjord as well as to the recreational green areas were also included in the list of variables.

As briefly mentioned above, for the density measure calculations, 1-hectare circles were drawn around each sales point. To calculate the percentage of built area or built coverage (*PERC_BUILT*), the sum of areas covered by buildings was divided by the total land area within the circle. Total land area excluded areas covered by water bodies, such as the main river Nidelva or the fjord. Number of people and dwellings were available on a building by building basis. Population per hectare (*POP_HA*) and dwellings per hectare (*DWELLINGS_HA*) were thus computed by adding all population and dwelling counts within a 1-hectare circle, respectively.

Table 17. Variable descriptions and expected relationship to dependent variable PRICE_M²

| Variable name | Description | Expected relationship to dependent variable |
|---|---|---|
| *Dependent variable* | | |
| PRICE_M² | Price per square metre in NOK | |
| *Property variables* | | |
| PRICE | Sales price of property in NOK | (incl. in dependent variable) |
| SIZE | Size of property in $m^2$ | (incl. in dependent variable) |
| AGE | Year property was built subtracted from 2015 | Negative |
| YEARS_REFURB | Year property was last refurbished subtracted from 2015 | Negative |
| HOUSE_APART | Dummy variable indicating general type of property (1 for house / 0 for apartment) | Negative |
| GROUNDFLOOR | Dummy variable indicating whether property has ground floor access (1 for YES / 0 for NO) | Positive |
| MULTISTOREY | Dummy variable indicating whether property has multiple storeys (1 for multi / 0 for single) | Negative |
| ELEVATION | Elevation of the lot on which the property sits in m | Positive |
| BT_COURTYARD | Dummy variable indicating whether property is a courtyard block (1 for YES / 0 for NO) | ? |
| BT_HYBRID | Dummy variable indicating whether property is a hybrid building (1 for YES / 0 for NO) | ? |
| BT_SLABBLOCK | Dummy variable indicating whether property is a slab block (1 for YES / 0 for NO) | ? |
| BT_TERRACE | Dummy variable indicating whether property is a terrace house (1 for YES / 0 for NO) | ? |
| BT_BIGHOUSE | Dummy variable indicating whether property is a big house (1 for YES / 0 for NO) | ? |
| BT_TOWER | Dummy variable indicating whether property is a tower block (1 for YES / 0 for NO) | Negative |
| BT_URBANVILLA | Dummy variable indicating whether property is a urban villa (1 for YES / 0 for NO) | ? |
| *Proximity variables* | | |
| DIST_BUSSTOP | Distance to nearest bus stop in m | Negative |
| DIST_SUPERMARKET | Distance to nearest supermarket in m | Negative |
| DIST_HIGHEREDU | Distance to nearest higher education facility in m | Negative |
| DIST_KINDERGARTEN | Distance to nearest kindergarten in m | Negative |
| DIST_SCHOOL | Distance to nearest school in m | Negative |
| DIST_SHOPPING | Distance to nearest shopping centre / mall in m | Negative |
| DIST_FJORD | Distance to Trondheim fjord in m | Negative |
| DIST_NATURE | Distance to recreational green areas / nature in m | Positive |
| *Density variables* | | |
| PERC_BUILT | Percentage land area that is built area within 1-hectare circle | ? |
| POP_HA | Number of people within 1-hectare circle | ? |
| DWELLINGS_HA | Number of dwellings within 1-hectare circle | ? |

Table 18. Summary statistics

| *Variable name* | *Mean* | *Standard. deviation* | *Minimum* | *Maximum* |
|---|---|---|---|---|
| LN_PRICE_M² | 10.59 | 0.30 | 9.73 | 11.28 |
| PRICE_M² | 41366.13 | 11771.49 | 16889.76 | 79513.60 |
| PRICE | 2980022.00 | 1352609.00 | 813983.00 | 14900000.00 |
| SIZE | 80.14 | 46.73 | 15.00 | 481.00 |
| AGE | 49.85 | 39.31 | 0.00 | 294.00 |
| YEARS_REFURB | 31.02 | 31.45 | 0.00 | 173.00 |
| ELEVATION | 59.08 | 57.56 | 0.90 | 168.60 |
| DIST_BUSSTOP | 162.87 | 98.05 | 8.39 | 578.57 |
| DIST_SUPERMARKET | 298.81 | 199.86 | 0.16 | 1102.05 |
| DIST_HIGHEREDU | 1951.83 | 2374.48 | 44.26 | 8605.30 |
| DIST_KINDERGARTEN | 230.68 | 142.56 | 0.03 | 742.54 |
| DIST_SCHOOL | 425.17 | 240.21 | 30.32 | 1353.48 |
| DIST_SHOPPING | 1208.80 | 898.38 | 53.20 | 3602.85 |
| DIST_FJORD | 2470.23 | 2711.56 | 27.71 | 8737.99 |
| DIST_NATURE | 300.92 | 220.48 | 0.00 | 958.38 |
| PERC_BUILT | 19.76 | 10.59 | 0.00 | 58.34 |
| POP_HA | 103.55 | 57.11 | 0.00 | 353.00 |
| DWELLINGS_HA | 74.07 | 55.73 | 4.00 | 333.00 |
| HOUSE_APART | 0.17 | 0.37 | 0.00 | 1.00 |
| GROUNDFLOOR | 0.43 | 0.49 | 0.00 | 1.00 |
| MULTISTOREY | 0.21 | 0.41 | 0.00 | 1.00 |
| BT_COURTYARD | 0.21 | 0.41 | 0.00 | 1.00 |
| BT_HYBRID | 0.09 | 0.28 | 0.00 | 1.00 |
| BT_SLABBLOCK | 0.33 | 0.47 | 0.00 | 1.00 |
| BT_TERRACE | 0.21 | 0.41 | 0.00 | 1.00 |
| BT_BIGHOUSE | 0.07 | 0.25 | 0.00 | 1.00 |
| BT_TOWER | 0.01 | 0.07 | 0.00 | 1.00 |
| BT_URBANVILLA | 0.09 | 0.29 | 0.00 | 1.00 |

## 6.4. Analysis and Results

Table 19 presents the results of the model outlined above for the complete dataset as well as for the two subsets, Trondheim centre and Trondheim periphery. Fourteen observations that had a population and/or built environment density of zero were excluded. A population and/or built environment density of zero should not be possible in a populated built-up area, but due to data inconsistencies arising from different ages of the underlying datasets, i.e. the population data being slightly older than the building data, and the building data being slightly older than the sales data, it nonetheless occurred.

After heteroscedasticity was confirmed, achieving significant results with both the Cameron & Trivedi's decomposition of IM-test and the Breusch–Pagan test, (heteroscedasticity) robust standard errors were used in the analysis. A common problem in hedonic pricing models is multicollinearity, which arises when independent variables are highly correlated. To address this issue, a correlation matrix for all independent variables was computed. Five variable pairs were identified as highly correlated (r>0.8***): *HOUSE_APART* and *MULTISTOREY*, *DIST_HIGHEREDU* and *ELEVATION*, *DIST_FJORD* and *ELEVATION*, *DIST_FJORD* and *DIST_HIGHEREDU*, *POP_HA* and *DWELLINGS_HA*. As there are very few multi-storey apartments in the dataset, but houses generally are multi-storey properties, the variables *HOUSE_APART* and *MULTISTOREY* practically describe the same thing and consequently the variable *MULTISTOREY* was dropped. Most higher education facilities are located in proximity of the fjord, which means that for most of the dataset as distance to the fjord increases so does distance to higher education; and as elevation increases with distance to fjord, these three variables point in the same direction. That is why, for the analysis, only *DIST_FJORD w*as included. Since the focus of this analysis is density, neither dwelling unit density nor population density was excluded, rather separate models were run, including one or the other. After further conceptual considerations and initial regression rounds, it became evident that the variable HOUSE_APART and the building type variables when coded against BT_URBANVILLA, which is the single-dwelling free-standing house in the dataset, effectively describe the same matter, the building type variables being the more detailed version. However, since adding the building type variables to the model, rather than HOUSE_APART, did not increase the variance explained by the model and the general conclusion remained the same, that is that apartments are overall more expensive than houses, the HOUSE_APART variable was chosen. Due to the clustered nature of the initial data collection, potential issues of spatially auto-correlated residuals were not explicitly addressed in this study.

Table 19. Regression results

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| VARIABLES | Global | Global | Periphery | Periphery | Centre | Centre |
| AGE | -0.00117*** | -0.00109*** | -0.00312*** | -0.00263*** | -0.000963*** | -0.000950*** |
| | (0.000180) | (0.000181) | (0.000554) | (0.000559) | (0.000195) | (0.000194) |
| YEARS_REFURB | -0.000911*** | -0.000921*** | -0.000909 | -0.000969 | -0.000736*** | -0.000734*** |
| | (0.000221) | (0.000221) | (0.000601) | (0.000592) | (0.000228) | (0.000227) |
| HOUSE_APART | -0.209*** | -0.193*** | -0.221*** | -0.168*** | -0.145*** | -0.140*** |
| | (0.0205) | (0.0206) | (0.0225) | (0.0230) | (0.0535) | (0.0540) |
| GROUNDFLOOR | -0.0180 | -0.0126 | 0.0591*** | 0.0693*** | -0.0199 | -0.0201 |
| | (0.0146) | (0.0146) | (0.0172) | (0.0170) | (0.0187) | (0.0187) |
| DIST_BUSSTOP | 5.57e-05 | 5.24e-05 | -0.000304*** | -0.000314*** | 0.000227** | 0.000216** |
| | (7.05e-05) | (7.04e-05) | (8.73e-05) | (8.58e-05) | (0.000105) | (0.000105) |
| DIST_SUPERMARKET | 9.36e-06 | 3.60e-05 | 1.31e-05 | 6.90e-05 | -1.22e-05 | 1.01e-05 |
| | (4.04e-05) | (4.11e-05) | (5.03e-05) | (5.08e-05) | (6.89e-05) | (6.95e-05) |
| DIST_KINDERGARTEN | -9.03e-05* | -9.66e-06 | -0.000167** | -0.000139* | -7.94e-06 | 2.99e-05 |
| | (4.79e-05) | (4.83e-05) | (7.98e-05) | (7.95e-05) | (6.94e-05) | (6.76e-05) |
| DIST_SCHOOLS | 1.59e-05 | 6.21e-07 | 0.000131*** | 0.000161*** | -8.88e-05* | -0.000108** |
| | (3.14e-05) | (3.20e-05) | (4.95e-05) | (4.78e-05) | (4.92e-05) | (4.89e-05) |
| DIST_SHOPPING | -4.38e-05*** | -3.74e-05*** | -2.85e-06 | 3.81e-06 | -0.000189*** | -0.000188*** |
| | (8.79e-06) | (8.97e-06) | (1.23e-05) | (1.20e-05) | (2.53e-05) | (2.51e-05) |
| DIST_FJORD | -5.08e-05*** | -5.13e-05*** | -4.54e-05*** | -4.15e-05*** | 7.21e-05*** | 7.03e-05*** |
| | (3.15e-06) | (3.18e-06) | (4.21e-06) | (4.24e-06) | (2.13e-05) | (2.10e-05) |
| DIST_NATURE | 0.000205*** | 0.000175*** | 0.000282*** | 0.000322*** | 0.000132** | 0.000105 |
| | (3.81e-05) | (3.98e-05) | (5.49e-05) | (5.37e-05) | (6.25e-05) | (6.42e-05) |
| PERC_BUILT | 0.00115 | 0.000491 | 0.00147 | 8.05e-05 | -0.00166* | -0.00178* |
| | (0.000780) | (0.000776) | (0.00184) | (0.00183) | (0.000963) | (0.000923) |
| POP_HA | -0.000455*** | | -0.000267 | | 3.97e-05 | |
| | (0.000116) | | (0.000238) | | (0.000155) | |
| DWELLINGS_HA | | 0.000143 | | 0.00143*** | | 0.000243* |
| | | (0.000118) | | (0.000364) | | (0.000141) |
| CONSTANT | 10.86*** | 10.79*** | 10.78*** | 10.60*** | 10.89*** | 10.88*** |
| | (0.0402) | (0.0397) | (0.0679) | (0.0722) | (0.0549) | (0.0543) |
| Observations | 1,241 | 1,241 | 609 | 609 | 632 | 632 |
| R-squared | 0.537 | 0.533 | 0.540 | 0.550 | 0.253 | 0.256 |
| Root MSE | 0.203 | 0.204 | 0.199 | 0.197 | 0.186 | 0.185 |
| Mean VIF | 1.60 | 1.64 | 1.64 | 1.66 | 1.85 | 1.85 |

Dependent variable = LN_PRICE_SQM
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The regression results of the model clearly show that there are substantial differences between the two subsets, Trondheim centre and Trondheim periphery. The $R^2$ –values, which measure the quality of fit of the models, are much bigger for the periphery (and the whole dataset) than for the city centre, indicating that the model as it is specified now explains more of the variation in property prices of the periphery dataset and the whole dataset than it does for the city centre dataset; which is a reasonable finding given the fact that there are likely many more factors contributing to property prices in the city centre than are included in this study. Taking a closer look at the coefficient estimates, one also finds considerable differences between what is and what is not significant in the different versions of the model. The only three parameters that are

significant for the global, centre, and periphery versions of the model are age of property (*AGE*), house or apartment (*HOUSE_APART*), and distance to fjord (*DIST_FJORD*).

The parameter estimates of AGE in the global versions of the model (columns 1 and 2 in Table 19) seem to indicate that an additional year would result in a decrease in price per square metre of between 0.109 and 0.117%, ceteris paribus.[15] At a mean property sales price per square metre of NOK 41,366, this results in a marginal implicit price of between NOK -45.09 and -48.40. In the city centre (columns 5 and 6), the decrease in price per square metre is smaller for every additional year added (between 0.095 and 0.096% or between NOK -39.30 and -39.84 evaluated at the mean property sales price per square metre), whereas in the periphery (columns 3 and 4) it is greater (between 0.263 and 0.312% or between NOK -108.79 and -129.06). This might be due to different valuations of building age in the periphery and the centre. In the city centre, many buildings are historic and/or under heritage protection, whereas in the periphery many developments are newer and age is not seen as a positive attribute, but rather as a potential cost factor. With respect to years since last refurbishment (*YEARS_REFURB*), the estimates were only significant for the global and the city centre versions of the model. The marginal implicit price of increasing the time since last refurbished by one year, evaluated at the mean property sales price, ranges from NOK -37.68 to -38.09 for the global model and from NOK -30.36 to -30.44 for the centre model. As with age of property, the price per square metre decreases with an increase in time passed.

Looking at the property type parameter estimates, house or apartment (*HOUSE_APART*), the estimates indicate that buying a house rather than an apartment reduces the price per square metre, in the case of the global versions by between 19.3 and 20.9%, in case of the periphery versions by between 16.8 and 22.1%, and in the case of the city centre versions by between 14.0 and 14.5%. Calculating the marginal implicit prices (for the mean sales price per square metre), this translates to NOK 5,791.24 and 5,998.07 for the city centre, NOK 6,949.49 and 9,141.89 for the periphery, and NOK 7,983.64 and 8,645.49 for the global versions. The dummy variable *GROUNDFLOOR* is significant only in the periphery, where ground-floor access seems to be a valued commodity, increasing the price per square metre by between 5.91 and 6.93%.

[15] For the remainder of this discussion ceteris paribus, i.e. all other variables held constant, is assumed.

With regard to the distance measures, proximity to a bus stop is a desirable attribute in the periphery, but not so in the city centre. In the periphery, the price per square metre decreases when the distance to the nearest bus stop increases. An additional 100 metres will reduce the price per square metre of a property sold at the mean sales price per square metre by between NOK 1,257.53 and 1,298.89. In contrast, an additional 100 metres distance in the city centre will increase the price per square metre of a similar property by between NOK 893.51 and 939.01. This could be due to the perception of a bus stop. In the centre, where many bus stops are frequented by multiple bus lines, a bus stop can be perceived as a noise pollutant and a nuisance; whereas in the periphery a bus stop is an important access point to the public transport network and represents an improvement in the general accessibility of the property.

Easy access to supermarkets has not been significant for any of the versions of the model. That is perhaps because supermarkets are scattered all over the city, and food seems to be readily available everywhere. Distances to shopping centres, on the other hand, have proven highly significant at a 0.01 level for the global and city centre version of the model. Evaluated at the mean sales price per square metre, an additional 100 metres in distance to the nearest shopping mall will reduce the price per square metre of the property by between NOK 154.71 and 181.18 globally and between NOK 777.68 and 781.82 in the city centre. Living close to a school seems to be an attractive quality in the city centre, but not so in the periphery. In the city centre, an additional 100 metres in distance to the nearest school can decrease the square metre price between NOK 367.33 and 446.75, whereas in the periphery the square metre price can increase between NOK 541.89 and 665.99. A kindergarten, on the other hand, is valued only in the periphery, where an additional 100 metres in distance reduces the square metre price between NOK 574.99 and 690.81.

In considering proximity to the fjord (*DIST_FJORD*), estimates for all three versions of the model are significant. For the periphery and globally, an increase in distance away from the fjord results in lower property prices per square metre. An additional 100 metres decreases the price per square metre in the periphery by between NOK 171.67 and 187.80 and globally by between NOK 210.14 and 212.21, evaluated at the mean sales price per square metre. For the city centre, however, property prices per square metre seem to increase with an increase in distance to the fjord. An additional 100 metres away from the fjord adds between NOK 290.80 and 298.25 to the property price per square metre. This distinction might be due to Trondheim's inner-city coastline characteristics. Much of Trondheim's waterfront is industrial rather than residential, which could explain why homebuyers in the centre prefer to avoid proximity to the

coast and the industrial areas. In the periphery, however, the fjord provides attractive views for many privileged dwellings.

With regards to proximity to green and recreational space (*DIST_NATURE*), parameter estimates for the global, periphery, and one of the city centre versions of the model are significant, indicating that an increase in distance away from the city boundaries and nature increases the price per square metre of a property. An additional 100 metres in distance to nature (and thus closer to the centre), again evaluated at the mean sales price per square metre, can add between NOK 723.91 and 848.00 globally, between NOK 1,166.52 and 1,331.99 in the periphery, and NOK 546.03 in the city centre. This is a plausible finding because properties close to green space (especially large ones) tend to be perceived as more isolated and far away from everything.

The parameter estimates of the density measures are not what one would have expected given the findings of the initial correlation analysis. Ideally, the estimates should have been significant throughout and all pointing in the same direction. However, they are not. Population density is only significant in the global model, where it indicates that adding 10 additional people within the 1-hectare circles would decrease the square metre price by NOK 188.22. Built coverage on the other hand is only marginally significant (at a 10% level) in the city centre, where according to the estimates a 10% increase in building mass would result in a square metre price reduction of between NOK 68.67 and 73.63. This could be due to the fact that above certain thresholds of building density spatial qualities such as natural lighting, ventilation, green spaces, and views are negatively affected. Where this threshold lies is dependent on the particular context, which is influenced by cultural and aesthetic values of the population. It seems that in Trondheim city centre where the larger values in build coverage exist, density is already perceived as high enough. The only variable that has a positive impact on square metre price in this model is dwelling unit density. The variable *DWELLINGS_HA* is significant in the periphery and the centre, where an additional 10 dwellings per hectare would add NOK 59.15 and 100.52 to the square metre price, respectively. These findings are somewhat hard to interpret. On the one hand, the model results seem to indicate that Trondheimers value spaciousness, i.e. space away from other people and from the next building. On the other hand, they also seem to value a certain degree of dwelling unit density. This, however, correlates with the fact that apartments, which are usually located close to other apartments, are generally more expensive per square metre than free-standing houses.

## 6.5. Discussion and Conclusion

A preliminary analysis comparing the average sales prices per square metre with population density and dwelling unit density measures indicates a pronounced positive correlation between higher densities and higher prices per square metre. From this initial observation, the working hypothesis was proposed that urban density is a well-accepted characteristic in highly valued urban centres of Norway and that therefore the housing market would reflect the Norwegians willingness-to-pay for higher density well-located urban environments. The hedonic pricing model, however, even though it did not contradict this hypothesis, displays a more nuanced picture in which higher dwelling density per hectare positively influenced land prices, but population density per hectare had a contrary effect. Multiple factors could have contributed to this finding.

The materialisation of density in the built environment involves a large variety of forms that influence urban and architectural qualities in different ways. How people value these qualities is a context-specific issue that influences the diversity of urban environments that exist, not only in different places but also through time. The variables of density and proximity used in this analysis are common measures, but they do not encompass all the spatial qualities affecting land prices. The variables included in the hedonic model, as well as the size of the sample, do not allow for the explanation of the apparent inconsistencies between the positive influence of an increased dwelling density on housing prices and the negative influence of people per hectare. One would assume that if in a given area an increase in dwelling density positively affects prices, the same would hold true for population density, but this is not the case here. However, dwelling and population density do not necessarily increase at the same rates. The concentration of single-occupant and dual-income no-kid homes in a given location increases the dwelling density but not the population density. This is especially true when compared to areas in the periphery that are characterised by larger dwelling units, which are more popular among families with children. This fact could explain this paradox. If this is the case, even though the hedonic analysis does not confirm the initial working hypothesis, neither has it offered solid evidence to prove it wrong.

The sampling method, based on the visual identification of 23 representative urban patterns, may account for the diversity of urban environments of Trondheim, but it does not allow for the estimation of the extent to which the sales transactions are likely to differ from the total housing transactions in the city; that is, the housing transactions clustered in the 23 characteristic urban areas

are not necessarily representative of the total housing transactions of the city. This represents a clear limitation for any generalisations drawn from this study and points towards the need of expanding the sample. Any future study of density and property prices in Trondheim should therefore either be based on a complete dataset of sales transactions over a certain period or on a random sample. What can be concluded from this study is that property prices and the measures of urban density correlate, indicating that properties are more expensive in denser locations. Yet it also shows that there is ample room to further study the relationship of urban density and housing prices. Is density indeed a quality reflected in property prices and thus socially accepted? Or is it a mere secondary object of consideration when buying a new property? Whilst the initial correlation analysis seemed to show that urban density is a valued quality in Trondheim's housing market, this study following the regression analysis cannot confirm this preliminary observation.

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# 7. A Transition to a Denser and More Sustainable City: Factors and Actors in Trondheim, Norway[16]

## 7.1. Introduction

Density has been regarded as an important quality of the urban form at different periods. Concentrating population and functions facilitates the provision of infrastructure and the proximity to diverse urban services (Steemers 2003). In most cases, economic purposes have been behind densification processes and urban containment strategies (Berg et al. 2012; Burton 2002; Roberts & Sykes 1999). However, since sustainability, with the objectives of protecting environmental resources and combating climate change, became a central issue, interest in denser urban areas has gained new strength. Denser city settings demand fewer environmental resources to function – not only less land, but also less energy for transportation and for the operation of buildings and infrastructure (Newman & Kenworthy 1996; Karathodorou et al. 2010; Newman 2014). Therefore, compact urban areas are considered a precondition for decreasing motorised travel, potentially reducing the use of fossil fuels and thus decreasing $CO_2$ emissions (Liddle 2013; Moriarty & Honnery 2008).

The Norwegian planning guidelines towards sustainability have embraced this idea. Urban densification has been one of the main targets in municipal policies on city development for at least two decades. However, despite the constancy in the targets, the advances have been uneven (Hernández-Palacio 2014). The application of such policies appears increasingly challenging and tests governance at the municipal level. The lack of feasibility in the implementation of densification policies is related to the functioning of the planning system and its relation with the regime behind urban development. Despite the new challenges, planning practices and instruments have remained much the same as decades before. It seems that planning as it currently operates in market-oriented societies has serious limitations in fostering increases in urban density (Gordon 2008). A transition towards a more sustainable city might therefore be hindered by the absence of change in procedures.

This paper presents an exploration of the actors and factors that influence the transition to denser cities in Norway by applying transition theory and the multilevel perspective to the case of

[16] F. Hernandez-Palacio 2016. A transition to a denser and more sustainable city: Factors and actors in Trondheim, Norway. *Environmental Innovation and Societal Transitions*, 22 (1), pp. 50–62.

Trondheim. The city of Trondheim had an estimated urban population of 170,242 inhabitants in 2012. In that year, its average urban density was 2,592 inhabitants per km² (SSB 2015a); this is quite low in comparison to the average population density in the built-up areas of Europe at approximately 4,345 inhabitants per km² (Dodman 2009). The analysis uses Trondheim densification policies as a case study. It combines quantitative and qualitative information from publicly available sources, such as documentation on municipal spatial policies and national white papers, but also draws from the academic literature. The central question guiding the argument is:

- What factors and actors influence the transition towards denser cities in Norway?

The remainder of the paper is organised as follows. Section 7.2 presents theoretical considerations for city change towards sustainability from a transition theory perspective. Urban densification is discussed from a socio-technical standpoint; the idea of transition from a multilevel perspective and the concept of socio-technical system are explored as tools to analyse city change. Section 7.3 presents the paper's case study: the city of Trondheim and its background facts and densification targets. Then the key factors and actors associated with city densification and urban development projects are outlined using a multilevel perspective approach. Section 7.4 provides analysis and key findings. Section 7.5 makes conclusions and sets out recommendations for future research.

## 7.2. Urban Densification from a Socio-technical Standpoint

Urban form has been highly influenced by transportation technologies. The existing socio-technical context, especially the fact that larger distances can be covered by car, in less time, at affordable prices, makes it particularly challenging to achieve densification targets in planning for the sustainable city (JRC 2006; Næss et al. 2011). Private car usage has been one of the main forces determining the sprawl of urban areas as well as social behaviour with regard to the use of urban space (Geels 2005). Urban sprawl and suburbanisation have mainly been driven by the mass use of cars and subsequent enhanced personal mobility (Brueckner 2000; JRC 2006; Oueslati et al. 2015). For example, land uses and land prices are strongly connected to transportation and accessibility (Cheshire & Sheppard 1995; Srour et al. 2002). Consequently, there are many economic interests around expanding and improving infrastructure for the car, and enabling new areas for urban extension, which in turn generate greater car dependency

(Dieleman & Wegener 2004; Kenworthy & Laube 1999). A car-based transport system is antagonistic to urban densification.

Transportation, being a major contributor to $CO_2$ emissions, has become a central issue in sustainability transition studies (Nykvist & Whitmarsh 2008; Geels et al. 2011; Geels 2012; Carvalho et al. 2012). There are two main transition pathways proposed in this debate. The first is an enhanced and cleaner technology for the automobile of the future; the second is a behavioural change towards less emphasis on personal mobility in favour of an intermodal, more collective-oriented system (Geels et al. 2011; Vergragt & Brown 2007). Sustainable city policies belong to the second strand. Urban densification, mixed land uses, and transit-oriented development are the main planning strategies in the shift towards sustainability (Dempsey et al. 2012; Carvalho et al. 2012; Valderrama Pineda & Vogel 2014). This spatial dimension in the transition towards sustainability in cities involves several other aspects, such as governance, energy, buildings, urban form, production, consumption, and everyday habits. Transition studies, however, have put a greater emphasis on the technical aspects of transition while the behavioural side has been analysed less (Whitmarsh 2012). This paper seeks to contribute to this second strand by exploring the factors and actors influencing the development of denser cities to enable cleaner transportation systems.

## Transition and the Multilevel Perspective

Transition is, according to the *Oxford English Dictionary* (3rd edn 2010), the 'process or a period of changing from one state or condition to another'. Transition towards sustainability is probably the most important target in current urban planning. A denser urban environment, less dependent on car usage, is one of the significant characteristics of the sustainable city. How such a process may take place is a fundamental question for designing and implementing different strategies to enable the transition. Transition studies have already analysed these processes in the case of technological transitions, identifying some particular patterns and mechanism of change. The shift from one technology to another has been described by Geels (2002) using a multilevel perspective approach. The multilevel perspective provides an integrated description of technical evolution, in terms of variation, selection, and retention; simultaneously, it describes a process of social reconfiguration around the new technologies, a shift in the socio-technical regime. Several examples of the multilevel perspective of transition have been described by Geels, including the transition from sailing ships to steamships (2002),

the replacement of horse-drawn carriages by cars (2005), and the change from cesspools to sewerage systems in the Netherlands (2006).

According to the multilevel perspective approach, transition is the result of the interaction of factors in three layers: (a) landscape, (b) regime, and (c) niches (Rip & Kemp 1998). The landscape is defined as the macro-scale. This is the general environment composed of material elements such as networks of cities and large infrastructure, and the availability of natural resources and other factors that foster the conditions for the existence of the system. According to Geels (2002), the landscape is an external context for interactions of actors. Within this level emerge factors such as economic globalisation trends, transnational political systems, and environmental challenges. The mezzo-scale is composed of the regime, mostly formed by social aspects that surround devices: users and producers, their beliefs, ideas, and institutions that mediate the relationship between society and objects. The niches constitute the micro-scale: a sort of protected space where experimentation and innovation are fostered. The niches are sometimes developed within regimes and, in other cases, they are partially or completely outside.

The process of change in the multilevel perspective is explained as a gradual phenomenon that evolves in several stages. Geels (2005) proposes four phases. In the first, radical innovations occur in niches, frequently outside the regime. These innovations arise as experimentations to find the best solutions. The process is fragile and does not constitute significant pressure to the existing regime. The second phase is characterised by the development of small niches that feed the process economically and technically. Increased forms of pressure trigger a process of change in the regime, although in many cases this is a slow process that can take decades. The change is complex because a given regime is embedded in society in many ways. Different strains in the system create 'windows of opportunity' through which innovation advances and creates competition with the dominant regime. Then follows a third stage in which significant developments of the new technology create competition with the established technology. The fourth phase is described as one of consolidation of a new regime. The new technology creates markets and starts the development of a complete system that gradually replaces the old technical regime.

**The City as a Socio-technical System**

The concept of the socio-technical system has been used in transition theory to understand the changes required to move towards sustainability in contemporary society (Berkhout et al. 2004;

Rip & Kemp 1998; Smith et al. 2005). Socio-technical systems are defined as complex networks where artefacts and tools are merged in social webs that include knowledge of production, use, and maintenance. This involves infrastructure networks and maintenance and supply chains rooted in everyday habits, cultural values, markets, and legal and political regimes. A good example of these systems is the car and the entire environment developed around this mode of transportation (Geels 2005). Within this framework, transition goes beyond the simple replacement of a particular device or tool by a new tool with better features. The entire system surrounding such devices has to change. Therefore, this transition implies changes in social functioning, which are in turn changes from one socio-technical system to another.

Cities, however, are in some aspects substantially different from socio-technical systems usually analysed in transitions studies. The most noticeable difference is that cities, in most cases, evolve from persistent spatial structures, developed over very long periods of time; and, with a few exceptions, they have adapted from pre-existing conditions. In contrast, most socio-technical systems – such as cars, mobile telephones, computers and their respective infrastructures – were developed in rather short timespans. Another obvious difference is that cities are highly complex, composed of a vast number of material elements and networks, embedded in environmental, social, and economic systems. There is no one city like another, whereas the infrastructure and devices around systems, such as the car, are composed of a much more limited number of elements, with evident similarities everywhere. Cities are also systems in permanent evolution, in which new elements are added and replaced constantly, though most of the older elements remain. These differences cast some questions on the role of transition theory when it comes to the city (Næss & Vogel 2012: 40). However, there are also several common elements that make this a plausible theory to apply to a possible urban shift. For example, cities as socio-technical systems studied from a transition theory perspective are embedded in complex networks of actors, operating in multiple layers. The material aspects of cities are in turn embedded in a complex regime, defined by non-material cultural values, everyday habits, market processes, and legal procedures; this implies that a change towards sustainability requires changes in all these aspects too.

Despite the differences between the city and other socio-technical systems, there are several transition studies related to the built environment: for example, transition to sustainability and spatial questions (Coenen et al. 2012; Raven et al. 2012); issues of production and consumption related to urban development (Tukker et al. 2008); the sustainability of everyday life (Shove & Walker 2010); and the issue of urban retrofit and sustainable transitions (Eames et al. 2013).

Transition studies also analyse city governance in moves towards sustainability (Bulkeley et al. 2011; Hodson & Marvin 2009, 2010; Næss & Vogel 2012; Nevens et al. 2013; Frantzeskaki et al. 2012, 2014). The advance towards enhanced sustainability in the city seems to rely on a combination of both technological and non-technological factors. In this regard, a more sustainable city requires more density in its spatial structures, but also cleaner technologies and greener social behaviours. The allure of transition theory is based in the comprehensive narrative that it offers to explain the complexities that change towards sustainability entails. This paper stands for the necessity of a framework combining the diversity of aspects identified in transition studies. Such an approach is required to analyse ongoing transition processes and to steer further advances in the quest for sustainability.

## 7.3. Trondheim's Pathway Towards Urban Densification


Figure 24. The case study in the Norwegian context

Trondheim (population in 2012: 170,906) is today the third largest city of Norway after Oslo (608,013) and Bergen (256,532) according to figures from Statistics Norway (SSB 2015a). The city is the capital of Sør-Trøndelag County. Trondheim has a long history as a commercial harbour and political and economic centre in central Norway (see Figure 24). Different plans have been stipulated to keep Trondheim's economic vitality. One of the most important is the

modernisation of the port through the creation of a new regional harbour in Orkanger, a municipality located in the Trondheim fjord, west of Trondheim (Trondheim Havn 2015). Another key strategy is the strengthening of Trondheim as a centre of education and innovation. Today the city has become increasingly specialised in education and research services with important institutions such as the Norwegian University of Science and Technology, St Olav University Hospital, and renowned research centres in natural sciences, social sciences, technology, and innovation. The university is currently in the process of merging with other higher education institutions to form the largest public university in the country. These two projects – port modernisation and university consolidation – are expected to attract new highly skilled people to the city and to free the former dockyard areas for new urban development. This is part of an ongoing national strategy to sustain a balanced population distribution in all territories through the promotion of economic growth in all parts of the country (Nakken 2012; Johansen 2004).

Densification was established as a central target in the 'Trondheim Municipal Plan of Land Use 1993–2005' (Trondheim Kommune 1995). Since then, the local planning policy has been committed to the principles of sustainability and has adopted different plans to reduce urban expansion, to increase the use of public transport, and to encourage cyclists and pedestrians. The policies have yielded modest improvements in densification and in environmentally friendly mobility. In the year 2000, Trondheim had a population of 142,277 and covered 59.04 km²: a density of 2,410 inhabitants per km². In 2012 the population was 170,242 in an urbanised area of 65.67km²: 2,592 inhabitants per km². During the period 2000–12 the population had increased by 27,965, and the urban land growth was 6.63km² (SSB 2015a). This outcome, despite being positive, indicates the challenging nature of reducing urban expansion. The potential for densification, in terms of population density, was equal to the population increase (19.7%) if no new land was added for urban use; however, the actual outcome was (7.6%). The Norwegian travel survey 2013–14 highlighted some advances in environmentally friendly mobility: walking and cycling have increased in the city, but cars and motorcycles are still used for more than half of all daily journeys (Hjorthol et al. 2014).

The city's plans for 2012–24 are consistent with the commitment to sustainability targets. One of the goals of Trondheim's municipal policy for transport is a reduction of $CO_2$ emissions by 20%, compared to the 2008 level, by 2018 (Trondheim Kommune 2008). It aims for more than 50% of total urban journeys to be made by environmentally friendly transportation, such as

walking, cycling, and public transport. The equivalent figure for 2008 is 42%. These targets are reinforced by defining concrete goals for the densification process, such as keeping 80% of new housing inside the existing urban boundaries, and developing an urban corridor along the main public transport line, containing 60% of labour-intensive industries (Trondheim Kommune 2012). However, planning alone is not sufficient to achieve sustainability targets (Stenstadvold 1996; Säynäjoki et al. 2014). There are several other factors and actors influencing the urban development. The following four sections[17] present a multilevel overview of such issues in connection with densification.

**A Multilevel Approach to Urban Densification**

The multilevel approach to describe transitions has been used mostly to explain technological changes. Cities, however, evolve from the existing material urban environment, following different transition paths. Commonly, changes in the material dimension of cities are gradual, and frequently mediated by slow changes in the regime. The following sections describe such possible change across the three stages proposed in a multilevel perspective, using densification policies as an explorative case.

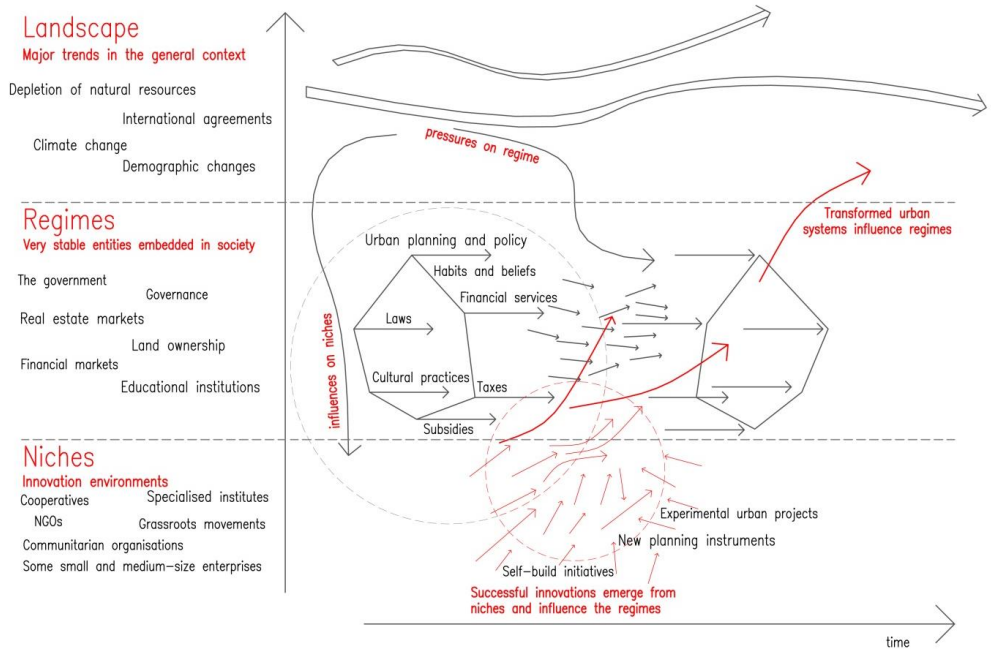


Figure 25. A possible multilevel transition towards sustainability in cities
*Source: adapted from Geels 2002 (p. 1263).*

[17] Adapted from the original journal article to match the numerals of the thesis structure

**The Landscape**

The landscape is defined by the external factors influencing urban transformation. The landscape or background where urban densification policies are embedded is determined by major global trends. Some of the most relevant are demographic changes (migrations, population growth, ageing population), depletion of natural resources, and climate change (see Figure 25). A sustainable development agenda has been created in response to these potential threats (Brundtland 1987; UNDSD 1992; SDSN 2013). Multilateral institutions and national governments have been involved actively in sustainability initiatives (Council of the European Union 2006; European Commission 2011). The city has become a key object in sustainable development as an increasing number of human activities happen within urban areas (UNCHS/UNEP 2000). Cities are expected to accommodate a large proportion of the population in compact urban settings to conserve arable land and natural resources in general. Climate change associated with $CO_2$ emissions has been tackled by targets for the reduction of fossil fuels consumption, both in the production of energy and in transportation. This multilateral environmental agenda is an important component of the landscape where planning policies for sustainable cities in Norway are embedded. Reduction of $CO_2$ and conservation of natural resources are targeted in several white papers produced by the Norwegian Ministry of Environment during recent years. Some examples of such policies are outlined in 'A Better Environment in Cities and Towns' (2002), 'Cities of the Future' (2008), 'Norway's Environmental Targets' (2012), and 'The Contemporary Sustainable City' (2013).

The Norwegian context has some particularities affecting urban sustainability strategies. From one standpoint, densification may be regarded as an ambitious target, due to the combination of three factors. First, Norwegian cities are among the least dense in Europe, with an average 1,904[18] inhabitant per km² (SSB 2015b), while several urban regions in Europe, such as Paris, London, and Brussels, have densities above 5,000 inhabitants per km² (Eurostat 2013). Second, Norway has maintained steady economic growth since the 1970s (SSB 2014), and the Norwegian population has one of the highest per capita incomes in the world. Third, the rise of a neo-liberal and pro-business ideology (Sager 2014) emphasises deregulation and encourages private investment within urban development. In synthesis, the Norwegian landscape is determined by a rather scattered population pattern, low-density urban areas, but a clear

[18] According to figures from Statistics Norway in 2013 the area occupied by urban settlements is 2,127.54 km² and the urban population in the country is 4,050,626.

commitment of the government with multilateral agendas to sustainable development. From another standpoint, demographic changes are a powerful force reshaping the urban form. The ongoing demographic trends in Norway are strongly marked by immigration, by the concentration of population in larger cities, and by the decline of family size and the growth of the elderly population (Van de Kaa 2002; KMD 2015). Such tendencies may be a positive agent in urban densification, since they lead to an increase of single-person homes and an increased reliance on proximity to urban services (Haase et al. 2008; Hernández-Palacio 2014).

**The Regime**

The regime is defined within transition studies as a system of social practices around material devices (Geels 2002; Geels & Schot 2007). This includes both the production and use of artefacts, and all the meanings and values around them. This is existing knowledge, creation of new knowledge, legislation, traditions, market and financial services, economic values, and values such as pride and prestige. There are a large number of institutions interlinked in the regime network: the state and all governmental bodies, financial institutions, markets, educational institutions, companies, and social organisations are some examples. Due to its very nature of many intricate links and diversity of actors, the regime requires stability and defined trajectories to function. Emphasis has been placed on the study of regime change towards sustainability within transition studies (see, for example, Berkhout et al. 2004; Geels & Kemp 2007; Smith et al. 2005; Verbong & Geels 2007).

The concept of regime applied to the city within planning theory – i.e. the urban regime – gives the impression of a less broad notion than the one defined in transition studies. Urban regime has an emphasis on the way the public and private sectors deal with the use and transformation of space (Mossberger & Stoker 2001). The public sector comprises the government in its local, regional, and national spheres. The private sector, on the other hand, involves a constellation of actors including land owners, private investors, and groups of different nature with interests in the city – mostly the use, expansion, and transformation of the building stock. The functioning of urban regimes involves formal and informal practices. Formal practices are regularised by institutional frameworks, laws, and procedures; on the other hand, informal practices are mediated by habits, beliefs, traditions, and social values (Mossberger & Stoker 2001; Irazábal 2009). The institutions and their regulatory framework constitute the *government*, which for spatial issues is called here he 'planning system'. But *governance* (the process of governing), which for spatial purposes is the control of the functioning and materialisation of the built

environment, needs support from the informal practices imposed by traditions and social values (Stoker 1998). The creation of the conditions for intervention in the built environment requires partnerships with non-government actors that control strategic resources to achieve the goals established by the government itself.

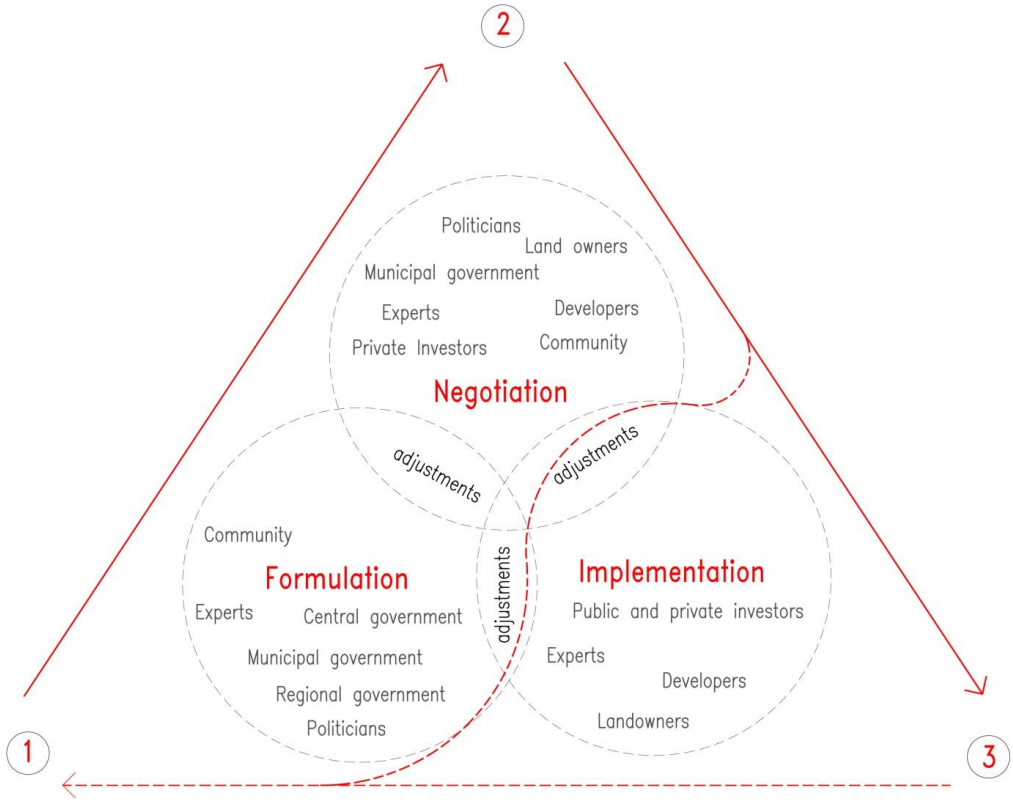


Figure 26. Actors and stages in urban development projects

A literature review on the implementation of urban projects led to the identification of three basic stages in this process: formulation, negotiation, and implementation (Nijkamp, Van Der Burch & Vindigni 2002; Muñoz Gielen & Tasan-Kok 2010; Van Der Veen & Korthals Altes 2011, 2012) (see Figure 26). The formulation initiative can come from public or private actors. Usually planning and regulatory policies and strategies originate in government, where politicians and experts are mandated to act in the public interest. Densification policies are a good example of such planning strategies. The community is expected to participate through different mechanisms of consultation and, in some cases, by presenting initiatives. The approval of initiatives is granted by elected officials accountable to the community. Urban development is effected through infrastructure, housing, and related facilities. Since the public sector does not control all resources necessary to implement the strategies, participation by private actors

becomes necessary. Private actors have economic interests and their initiatives are not always aligned with the targets established in the formulation of plans and regulations. Their participation therefore entails negotiation: implementation of schemes may be preceded by several cycles of formulation and negotiation. This is particularly common in large-scale urban projects, involving long-term implementation processes with several phases, where initial circumstances might change (Van Der Veen & Korthals Altes 2012).

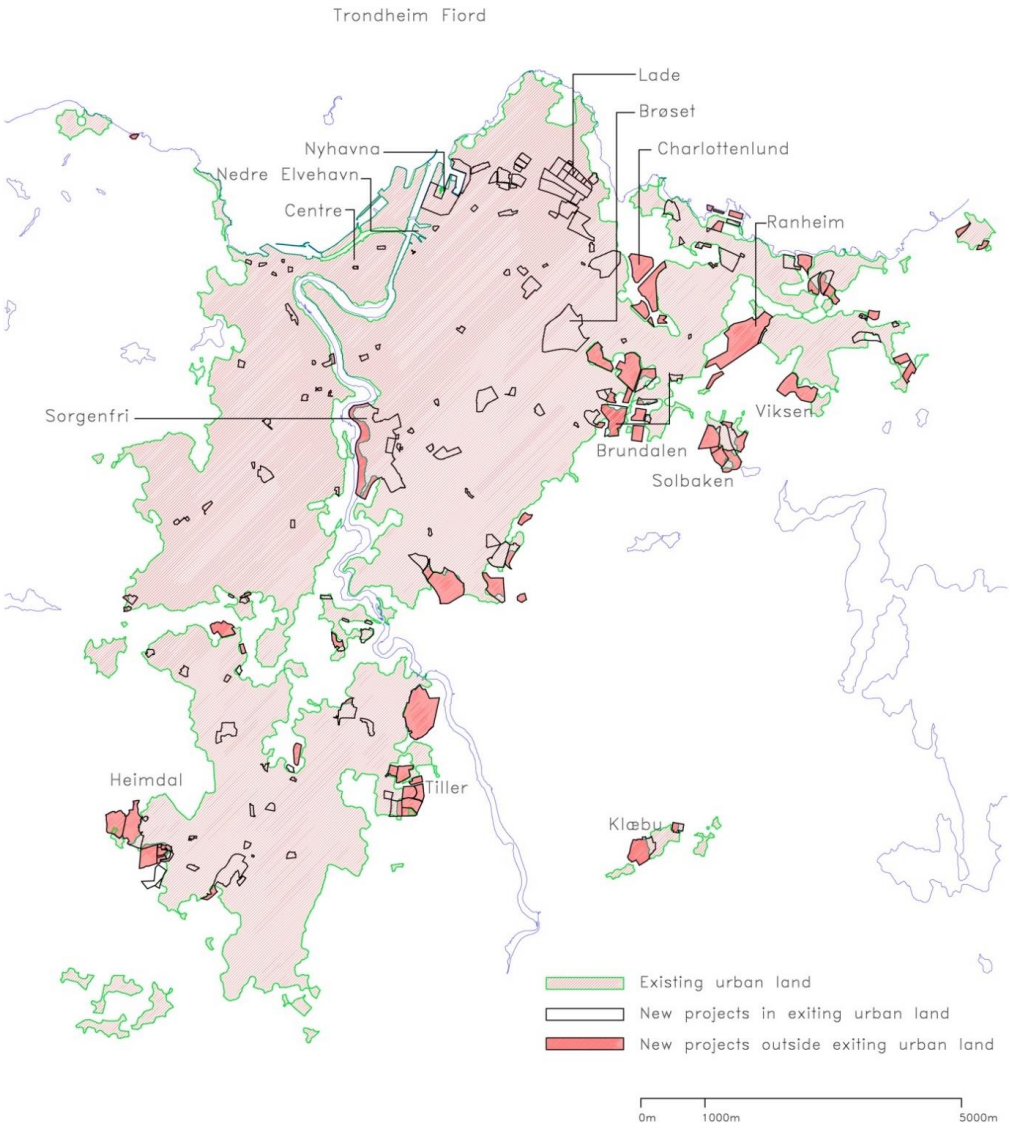


Figure 27. Ongoing and future urban development projects in Trondheim

An illustration of how the urban regime operates can be taken from the application of the densification targets established in the Trondheim 'Environmental Policy for Transport' (Trondheim Kommune 2008). As part of a wider plan for $CO_2$ reduction, a target of keeping 80% of new homes inside the existing urban boundary was set. The goals were established based on densification trends during previous years. Nevertheless, maintaining that pattern has proven increasingly difficult: analysis of information provided by the city of Trondheim on new housing construction projected for the coming years suggests a tendency far from the original target (see Figure 27 and Table 20).

Table 20. Housing projections in the city of Trondheim

| **Housing projections 2014–60** | |
|---|---|
| *Total future housing area (ha)* | 745 |
| urban land (ha) | 434.4 |
| greenfield sites (ha) | 310.6 |
| total housing potential | 36,569 |
| average density (houses per ha) | 49.1 |
| estimated houses on greenfield sites | 15,246.1 |
| percentage of houses on greenfield sites | 42% |
| | |
| **Housing projections 2014–24** | |
| *Total future housing area (ha)* | 703.7 |
| urban land (ha) | 408.4 |
| greenfield sites (ha) | 295.3 |
| total housing potential | 38,159 |
| average density (houses per ha) | 54.2 |
| estimated houses on greenfield sites | 16,013 |
| percentage of houses on greenfield sites | 42% |
| | |
| **Housing projections 2014–18** | |
| *Total future housing area (ha)* | 435.3 |
| urban land (ha) | 263.5 |
| greenfield sites (ha) | 171.8 |
| total housing potential | 22,839 |
| average density (houses per ha) | 52.5 |
| estimated houses on greenfield sites | 9,013.9 |
| percentage of houses on greenfield sites | 39% |

Table 20 uses two basic categories. The first is urban land equivalent to the area predominantly occupied by typical urban uses such as housing, industry, commerce, and other facilities. The

second is agricultural land, corresponding to areas occupied by crops and farms, potential arable land, forest, and the natural landscape.[19] According to these figures, the target of 80% of new housing within existing urban boundaries might become increasingly difficult. Instead, it is likely to be 61% for 2018 and 58% for 2024. Densification in sparsely populated areas is relatively easy because of the abundance of undeveloped plots. With advances, the available areas become scarcer. The remaining spaces are mostly brownfield sites, in unpopular locations, entailing complex and expensive operations, which are less attractive to developers. A good example of the latter scenario is the redevelopment of Nedre Elvehavn, the former Trondheim dockyards, which has proved to be a complex process, extending over nearly three decades (Sager 2014).

The city of Trondheim and its planning office seem to have a limited scope for action with regard to reaching the original target of 80% new development inside existing urban land. Urban and peri-urban land is mostly private; and investment in new homes is also controlled by private actors. It is only via regulations that the city can push to achieve the target. This area is where incremental innovations to produce regime changes are required. Different planning instruments can be designed and combined to foster the redevelopment of brownfield sites, the densification of building stock, and the provision of affordable housing. Examples include urban growth boundaries, other urban containment strategies (Dawkins & Nelson 2002; Millward 2006; Altes 2009), development rights, and land-value capture mechanisms (Suzuki et al. 2015). Transport policy instruments also play a key role in urban intensification: they are commonly used to increase commuting cost by car while subsidising public transport (Goodwin 1981; Hupkes 1982; Brueckner 2000; May 2012).

**The Niches**

Niches have been defined as protected spaces for radical innovations, insulated from 'normal' market selection in the regime (Geels 2002). The military has been given as an example of a niche environment, favouring the development of many radical innovations in its early stages (computers, geolocation systems, satellite networks). Innovations also occur in the regime but

[19] Information extracted from http://trondheimsregionen.no/kart/boligbase.html. The map in the source includes housing projects with more than 10 units and provides data on the location and name of each project, the housing potential, the plot area, cultivated area, potentially cultivated area, building process duration (earlier year of occupation by new inhabitants and year of conclusion). The figures were revised according to information provided via email by Svein Åge Relling on 12 December 2014 and 23 February 2015.

in a more incremental way according to Geels. The concept of niche is more difficult to grasp in relation to the city. There is an implicit question of scale, which seems not completely defined within transition theory. Hodson & Marvin (2010: 480) pose the question, 'Where do cities sit within the landscape – regime – niche hierarchy?' Indeed, can they be encompassed by both regime and niche? The answer may be related to the scale of the analysis, making it possible to place the city in all three levels of the hierarchy, according to the interaction of innovative activities within a wider social context – local, national, or transnational.

In addition to the question of scale is the question of how radical innovations in the case of city transformation can be. Niche-based transition happens when norms and practices developed in the niche get broadly implanted in the regime. Eventually a new regime is developed from such innovations. Berkhout et al. (2004) argue that this is only one of the transition mechanisms, but there are several other forms of change. Niche-based radical transformations may be less common in the case of cities where transformation appears more incremental. The location of the niche in regards to the system (the regime) also influences the use of the concept. According to Loorbach (2007: 22), 'the niches can be part of the regime, exist outside the regime or even (partly) outside the system'. This flexibility in the location and especially the experimental nature of niches makes the concept useful for analysing and developing transition strategies related to the city. The notion of niche is being used in different city-related issues such as governance and social experimentation (Evans & Karvonen 2014; Potter et al. 2015; Bulkeley & Castán Broto 2013). Niche-based transformations have also been applied in the analysis of energy use in residential buildings (Berry et al. 2013; Quitzau et al. 2012) and in urban transport (Nykvist & Whitmarsh 2008; Potter et al. 2015).

Probably the most discussed 'niche experimentation project' in Trondheim during the last years has been Brøset. The idea of a carbon-neutral neighbourhood was launched in 2007 (Støa et al. 2014). Principles of the sustainable city, such as a compact urban layout, environmentally-friendly waste management, building and infrastructure adaptations to climate change, and a 70% reduction of $CO_2$ emissions per inhabitant have informed the design. The area of intervention comprises 34 hectares located 4km from the city centre. When completed, around 1,800 new housing units will be provided, with a density of approximately 53 dwellings per ha. There will be space for shops and small businesses. Transport will mainly be provided by public transport, cycling, and walking. Cars will be restricted both by the design of public spaces and by a significant reduction in parking places, from 1.3 currently applied for residential areas, to

0.65. The Brøset process has developed a number of innovative approaches to planning, urban design, citizen participation, sustainable transport, integrated energy design, and waste infrastructure. This project is probably the most ambitious niche development for a transition towards sustainability in Trondheim. However, a missing agreement with the landowners is hindering the start of construction.

## 7.4. Analysis and Main Findings

Urban change is embedded in a complex system of factors and actors operating in several layers or scales. Analysing urban transitions using a multilevel perspective could prove a useful instrument in understanding the intricacies and interlinkages of such complex systems. The case of Trondheim's densification policies has been presented here at three different levels. At the macro-scale, or the *landscape*, there are three main factors: the first is a supra-national agenda around the decrease of $CO_2$ emissions originating from transport; the second is a national agenda for the protection of arable land and forests; the third is related to demographic changes such as immigration, concentration of population in larger cities and population ageing. The mezzo-scale, or the *regime*, in this case the Norwegian urban regime, has been described as a stable system, which seems to operate through procedures of formulation, negotiation, and implementation, involving public and private actors. Accordingly, the feasibility of the densification agenda depends on a coalition between two main types of actors: the first is the government and its different levels (see Figure 26); the second is a more heterogeneous set of non-governmental actors controlling strategic resources for urban development, such as land, financial resources, and even ideas and perceptions. The micro-level, or the *niche*, is less common in the context of urban development, but is described here as specific initiatives or experiments performed to achieve changes in the established regime. Brøset, a project for a carbon-neutral neighbourhood in Trondheim, is used as an illustration. However, the main lesson from this local experience is the existence of a persistent disconnection between urban sustainability targets and the conventional instruments of planning. Despite several years of negotiation, the project has not been implemented because of disagreements with landowners (Støa et al. 2014: 351–2).

Demographic changes together with environmental policies are, according to this analysis, the strongest contributors to an increase in density in Trondheim. However, the process is hindered by barriers arising from the very functioning of the regime. Urban densification may at first

glance provide an attractive potential for profit to landowners, urban developers, and investors: more units could be sold in a given development, using proportionally fewer resources. However, areas for development within the city, in the case of Trondheim, seem to be increasingly scarce. The few remaining spaces are mostly brownfield sites from former port and industrial activities, already identified in municipal plans. Additional potential for increasing densification might also be found in some low-quality housing areas in need of an ambitious agenda of refurbishment. However, the cost factors attached to site (re)development within the city (land prices, impacts on an already inhabited vicinity, multiple ownership, polluted soil, refurbishment and improvement of infrastructure) make developments in either case complex and expensive.

The governmental agenda in regards to densification has been tackled mainly by regulatory measures, such as zoning plans and building permissions. These instruments are intended to limit the sprawl of urban development into the surrounding countryside, but they do not address the complexities attached to urban refurbishment and brownfield developments. Even Brøset, an emblematic project in the sustainable city agenda, has been delayed because of issues related to land ownership and development rights. This mismatch between instruments and factors may explain the difficulties in achieving targets for densification. According to the figures presented in Table 20 around 42% of new housing development in the coming years may occur on greenfield sites. This is twice as high as the initial target that aimed to limited greenfield developments to 20%, suggesting a lack of feasibility of the densification agenda. Consequently, the private actors in the urban development process find ways of relaxing regulatory restrictions. This is a well-established pattern in traditional urban regimes, where the search for profit is the main driver for non-governmental actors, while the government agenda is driven by the needs of the general population, or in this case by sustainability. Such a situation suggests a need to explore new planning instruments to decrease the mismatch between economic profit and sustainability agendas.

## 7.5. Conclusions and Recommendations for Further Research

The case of Trondheim might be interpreted as an example of an early stage transition, where factors such as demographic changes and environmental issues are influencing local policies. These constitute pressures from the landscape on a traditional market-oriented urban regime. Despite the pressures, there is a regime obduracy that could be gradually overcome by designing

and introducing new planning instruments that connect spatial issues with economic aspects. Unsuccessful niche experiments such as Brøset could be regarded by many as an indication of a non-transition. This is, however, a single case, which may be reactivated in the near future. Densification and urban expansion are occurring simultaneously, even though densification is happening at a much slower pace compared to the planned targets. Instead of considering this as a non-transition, the current situation of urban growth by densification and expansion might be seen as two competing trends, which, with adequate adjustments, can be steered in favour of a denser and more sustainable urban environment.

Multilevel narrative instruments, such as multilevel perspective approach, enable an easier understanding of a complex web of actors and factors. The multilevel perspective analysis of the case of Trondheim suggests further action at two levels: at the regime level, new planning instruments towards a gradual regime evolution are required; at the niche level, new and diverse niche experiments should be implemented. Both types of actions require scholarly attention during the design, execution, and post-implementation phases. A research agenda in the field of sustainable city policies should consider social acceptability issues, for example what level of density is acceptable to residents, or which urban qualities are demanded in Norwegian cities. Economic instruments (e.g. taxes and subsidies) to accelerate the transition towards a denser and more sustainable city also require special consideration. Moreover, land development and transport demand greater attention. The transition towards a denser and more sustainable city in Trondheim has just started.

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