



UTRECHT-REGION UNDER PRESSURE

Development of a mobile strategy to keep the Utrecht region accessible, vital and livable

PART III: master thesis graduation project

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Development of a mobile strategy to keep the Utrecht region accessible, vital and livable

Master thesis

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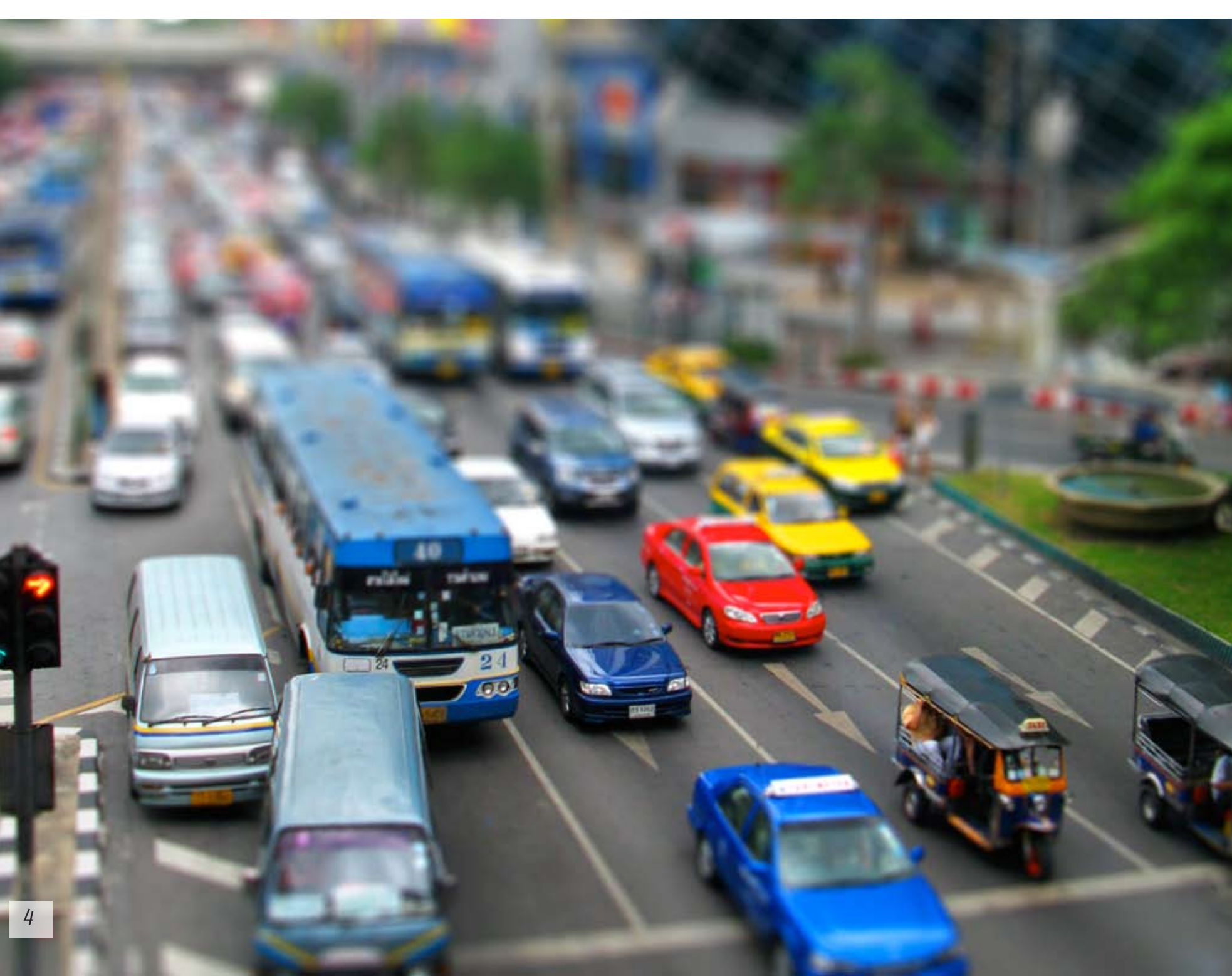
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Preface

Within the graduation track of the Technical University Delft, Faculty of Architecture, department of Urbanism, this final master thesis is written. This thesis is representing the work of two students: Johanan van Dijk and Remko Stinissen. Next to this product, the thesis plan, (PART I) describes the methodology and problem of this project extensively. The atlas of the Utrecht-region (PART II) describes the practical research and design done so far. Furthermore, two review papers are written for the theoretical anchoring of the graduation project.

The authors want to thank the first mentor of this project, Roberto Rocco for his guidance and positive energy during the past graduation year. Furthermore, we want to thank Verena Balz and Dominic Stead for their helpful comments and support during the process. Finally, we want to thank the Bestuur Regio Utrecht (BRU) and especially Peter Smit. The internship at the BRU made it possible to use valuable information and facilities, and provided a professional feedback and reflection on our work.

Utrecht, 15 January 2010

Summary

Contemporary city-regions are facing major challenges concerning the relation between mobility and urbanity. A concrete example of this is the phenomenon of urban sprawl, which evolved in the US and also in Western Europe. The car is a very popular mode of transportation. However, the automobile has some serious spatial consequences. It had a major role in the spatial planning practice of our environment the last decades. In fact, the automobile can be named as an unsustainable mode of transportation and its popularity has some major spatial consequences. The planning challenge for the future is therefore to tune the issues of infrastructure, accessibility and spatial developments for the development of sustainable city-regions. However, the development of a sustainable city-region is asking for a package of measures. Spatial planning and strategy is one of the parts that can contribute to the development of sustainable city-regions. A city-region whereby this relation between mobility and urbanity is very specific and urgent is the Utrecht-region. This region functions as an important connector between the Randstad and the hinterland. The region is *under pressure* for several reasons. First, there are significant housing shortages in the region. Moreover, these housing shortages are increasing in the future, despite the fact that a lot of new dwellings are being built. Next to this, there are problems in the region concerning its accessibility. Capacity problems in the regional public transport system and congestion problems on the road network are the daily examples.

The challenge hereby is to search for a suitable spatial strategy to deal with the relation between mobility and urbanity. For the Utrecht-region, a strategy has to be found to deal with the housing shortages and the accessibility of the region at the same time.

The specific goal for the Utrecht-region is to boost the region's comparative advantages, to maintain its spatial qualities and strengthen the position of the region in the Randstad.

A spatial concept that integrates spatial development and public transport is the concept of transit-oriented development (TOD). The goals of TOD appear on the regional and the local scale. In this research and design the focus is on the regional goals of TOD. Interactions and movements of people in space mostly occur on this specific scale level. Station areas can be named as nodes of human interactions and are therefore of great importance in spatial planning. In that way station areas are important objects of research. In this project the research of station areas is done with the node-place model of Bertolini. The node-place model addresses the ambivalent character of station areas: a (regional) node in the public transport system and a (local) place in the city. With the application of this model for the Utrecht-region, the potentials and opportunities of all the existing, planned and possible new stations are analyzed. In this way, the node-place model is supporting the design decisions made in the regional design proposal for the Utrecht-region. Every station area is proposed to develop in a certain direction, for the development of the Utrecht-region in a transit oriented way. Both, potentials of station areas and regional design goals were principal in the development of the design and strategy.

Simultaneously with the research and design of the station areas, the public transport system of the Randstad is restructured. New layers of public transport are introduced: the e.g. interregional system and an agglomerative system.

For a horizontal and vertical integration of public transport it is necessary to switch between different levels of scale. The integration between spatial developments and the (agglomerative) public transport system was hereby an important goal.

If the regional design for the Utrecht-region is compared with the current municipal plans some remarkable differences appear. Planned development locations by the different municipalities are often not located near high-quality public transport like, light rail or traditional heavy rail stations. An example is the major extension area of Rijnenburg, located in an area with a very poor access to public transit. In the proposed regional design for the Utrecht-region, spatial developments are mostly concentrated within a 600 meters catchment radius of a traditional station area. The allocation of spatial developments near the station areas will lead to a major reduction of the housing shortages in the Utrecht-region. The development of the different station areas in a certain typology has led to a less dominant position of Utrecht Centraal. It is no longer a matter of Utrecht Centraal, and all the other of the stations without major differences. The concentration of spatial developments around transit as proposed in this research and design will probably lead to a decrease of the demand for mobility of people. The concept of transit-oriented development will lead to less car dependency and a bundling of movements in the Utrecht-region. The application of this

concept for the Utrecht-region requires a major effort of the different stakeholders. The BRU could have a facilitating and steering role in this development process. The integration of the different aspects of planning, e.g. regional development, public transport and nature is thereby essential.

1 introduction

2 research

3 design

4 conclusion

Preface	5
Summary	6
Introduction	15
1.1 Motivation	15
1.1.1 Planning challenge: mobility and urbanity	15
1.1.2 Sustainability	16
1.1.3 The Utrecht-region	19
1.2 Problem statement	21
1.2.1 The Utrecht-region, two main challenges	21
1.2.2 Governance and urgency	23
1.3 Research questions	23
1.3.1 Main research question	23
1.3.2 Sub research questions	23
1.4 Scale and scope	27
1.5 Responsibilities	27
1.6 Four chapters	27
Research	31
2.1 Theoretical research	31
2.1.1 Interactive planning	31
2.1.2 Transit meets developments	40
2.1.3 The node-place model of Bertolini	51
2.2 Practice-based research	59
2.2.1 Why potentials of station areas?	59
2.2.2 Potentials of existing stations	61
2.2.3 Potentials of planned stations	91
2.2.4 Potentials of possible stations	99
2.2.5 Conclusion situation 2010	111
2.2.6 Demographic GIS analysis	113
2.2.7 Origin-destination analysis Utrecht-region	115
2.3 Conclusions from analysis	121
2.3.1 Conclusions infrastructure and accessibility	121
2.3.2 Conclusions spatial developments	125

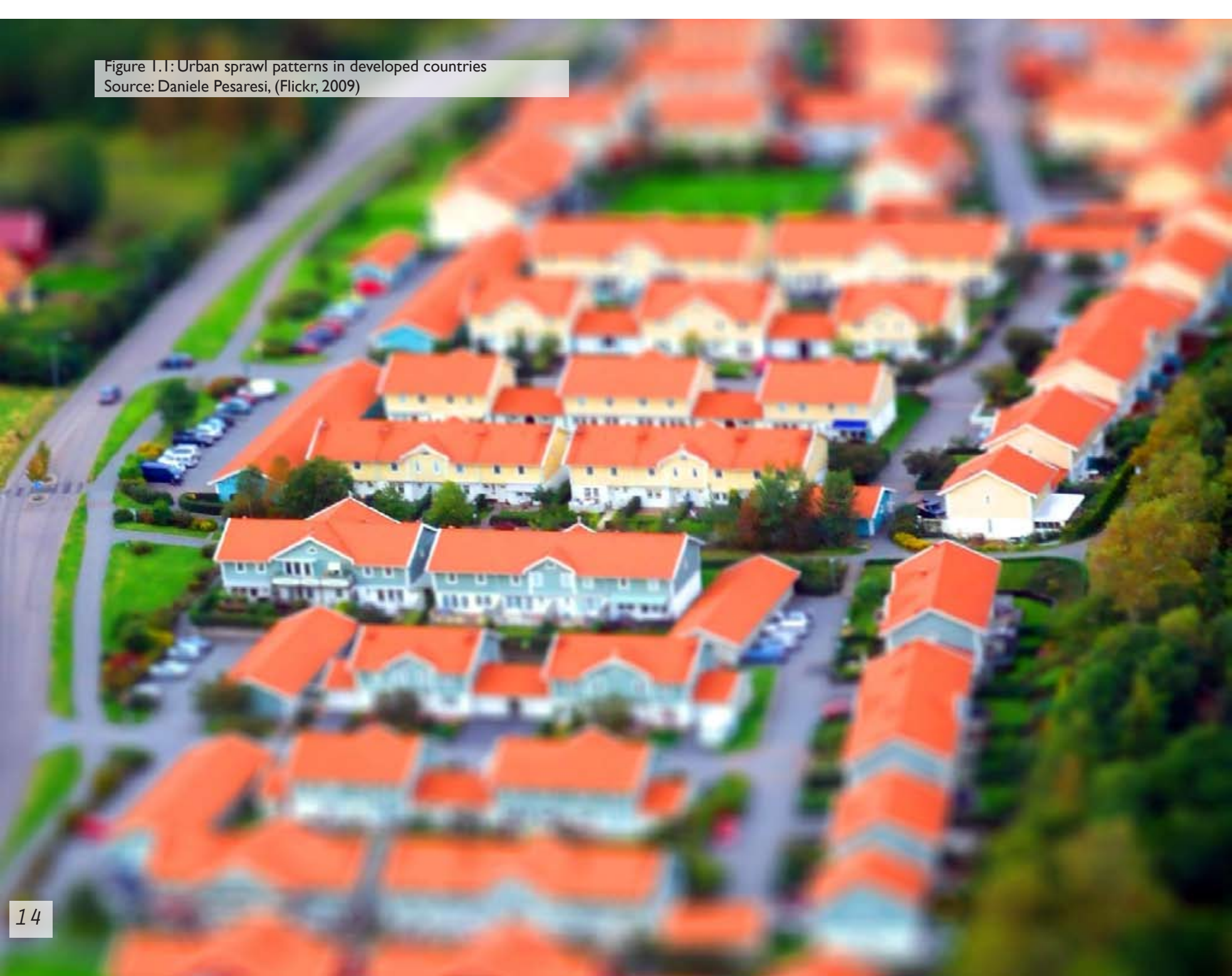
Design	131
3.1 Design proposal: public transport system	131
3.1.1 Connecting and unfolding networks	131
3.1.2 Layers public transport system	133
3.1.3 Why light rail?	137
3.1.5 One technique two modalities	140
3.1.6 Justification design agglomerative lines	140
3.1.7 Proposed lines	143
3.1.8 Proposed stations	147
3.2 Design proposal: spatial developments	151
3.2.1 Introduction	151
3.2.2 Categorization of station areas	151
3.2.3 TOD: local and regional goals	153
3.2.4 Strategy: from extension to densification	153
3.2.5 Rules for spatial developments	153
3.2.6 Design: Categorization of station areas	155
3.2.7 Challenges	163
3.3 Phasing	163
3.3.1 2010	163
3.3.2 2020	163
3.3.3 2030	165
Conclusion	167
4.1 Testing the design	171
4.2 Municipal plans versus regional design	175
4.3 Figures	177
4.4 Recommendations BRU	179
4.5 Evaluation	181
4.5.1 Reflection on content	181
4.5.2 Reflection on process	181
4.6 Further research and design	183
Urban planning language	183
Literature	185
Appendices	190



I introduction

- I.1 Motivation
- I.2 Problem statement
- I.3 Research questions
- I.4 Scale and scope
- I.5 Responsibilities
- I.6 Four chapters

Figure 1.1: Urban sprawl patterns in developed countries
Source: Daniele Pesaresi, (Flickr, 2009)



1. Introduction

1.1 Motivation

This chapter will describe the motivation, problem and the research questions of this graduation project. It will start with the motivation of this project whereby the 'why question' for this research will be answered. The main challenge or generic problem of the contemporary (Western-Europe) city-region will be described. Furthermore, the specific problem of the Utrecht-region will be explained in chapter 1.2. Chapter 1.3 describes the main- and sub research questions. In chapter 1.5 the responsibilities of the two authors are enlightened.

1.1.1 Planning challenge: mobility and urbanity

An important topic of this research is the relation between mobility and urbanity. The global trend in mobility is that the distance an average Western person travels everyday is still increasing. This increase of mobility rises nearly in proportion with income (A. Schafer and Victor, 2000). The reason for this is that people have fixed budgets for travel time, but they shift to a faster mode of transportation, for instance the automobile, if their budget allows this. Individuals devote a fixed budget of their income to travelling (Schafer and Victor, 2000). This increase of mobility has some negative environmental effects (Figure 1.2). The absolute and the relative share of emission of CO₂ attributed to transportation has increased enormously the last decades (Banister, 2005). The travel markets and the use of the transportation networks are being influenced by the increased mobility. A lot of west-European cities are confronted with problems concerning the impact of this growing mobility.

The auto mobilisation of the last decades is one of the reasons for a big share of transportation in the total emission of greenhouse gasses (Figure 1.3). The growth of mobility, and the popularity of using the car as a mode of transportation has some serious spatial consequences. This increased auto mobilisation led to urban sprawl patterns, with the suburbs in the USA as an extreme example (Figure 1.4). In the contemporary planning debate there are concerns about the sustainability of these trends and the development of urban sprawl patterns (Cervero, 1998). This example addresses the relation between mobility and urbanity.

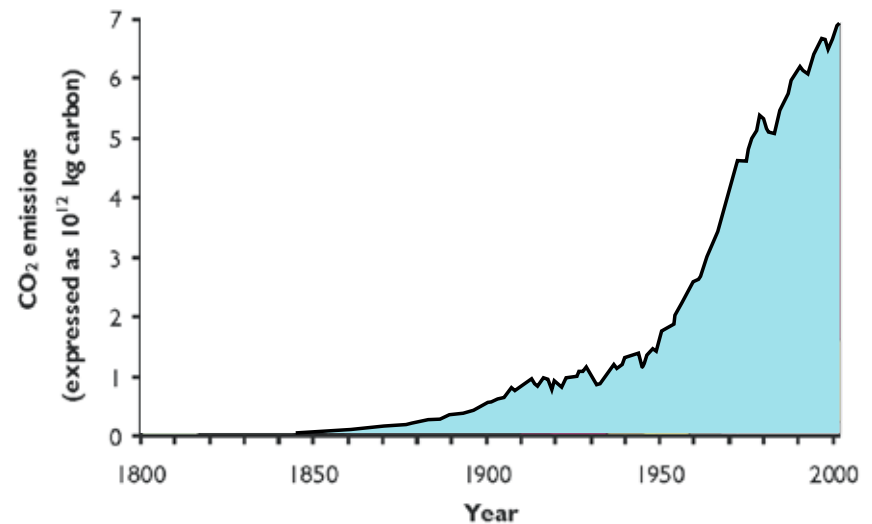


Figure 1.2: Global CO₂ emissions
Source: (Banister, 2005)

1.1.2 Sustainability

In this thesis is referred to the definition of Brundtland of sustainability. He states that a sustainable condition is a situation when there is stability for social and physical systems. This can be achieved by meeting the needs of contemporary people without compromising the possibilities for future generations to meet their needs (World Commission on Environment and Development, 1987).

In the light of the Brundtlandt report the automobile can be named as an unsustainable mode of transportation. Individual transportation in the form of the automobile can be seen as a great space and time consumer (Banister, 2005) (Figure 1.5). Even if the technology is further developed, with for instance clean eco cars, this does not contribute to a comprehensive solving of this problem.

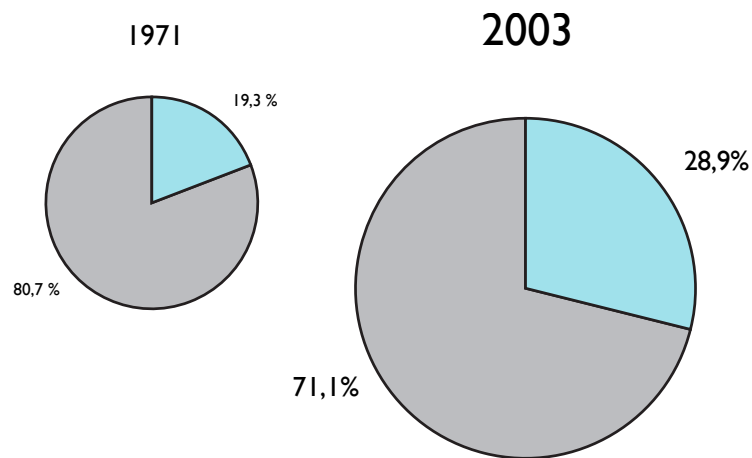


Figure 1.3: Share of transport CO₂ emissions
Source: (Banister, 2005)



Figure 1.4: Urban sprawl patterns in the USA
Source: (Flickr, 2009)

This individual transport mode will still use too much energy in use and production (Banister, 2005). In addition, the road capacity is not able to answer to the growing number of vehicles. This will lead to more congestion (Banister, 2005, Immers and Egeter, 2002). The extension of extra links of the road network in west-European economies will have marginal effect on accessibility (Banister, 2005, Immers and Egeter, 2002). Summarized, the car does not use only a lot of energy; it also consumes a lot of space. The more cars, the more asphalt is needed (Banister, 2005).

Addressing the problem of unsustainable transport, a large set of measures is necessary. The approach in this project should be seen as a small part of a much broader package of solutions for countering unsustainable transport. In general several strategies can be defined to counter unsustainable transport (Nijkamp, 1993, Banister et al., 1997, Nijkamp and Rienstra, 2000). The approach proposed in this project should be supplemented with for example the following strategies:

Strategies for demand control

Within this strategy an attempt is made to affect transport behaviour. A relevant example of this strategy is de the development of a road pricing system.

Strategies for supply control

Within this strategy a broad set of measures could be thought. For example by improving the quantity and quality of certain transport systems. For example, the introduction of new types of transport, an expansion of physical infrastructure and the improvement of the public transport (one of the measures that are proposed in this project).

Strategies of technological developments

New technological developments could compensate a part of the negative effects of transport. For example new car technologies: new types of engines running on alternative fuels, road guiding systems and traffic management.



Figure 1.5: Automobile as space and time consumer
Source: (Swim At Your Own Risk, 2009)

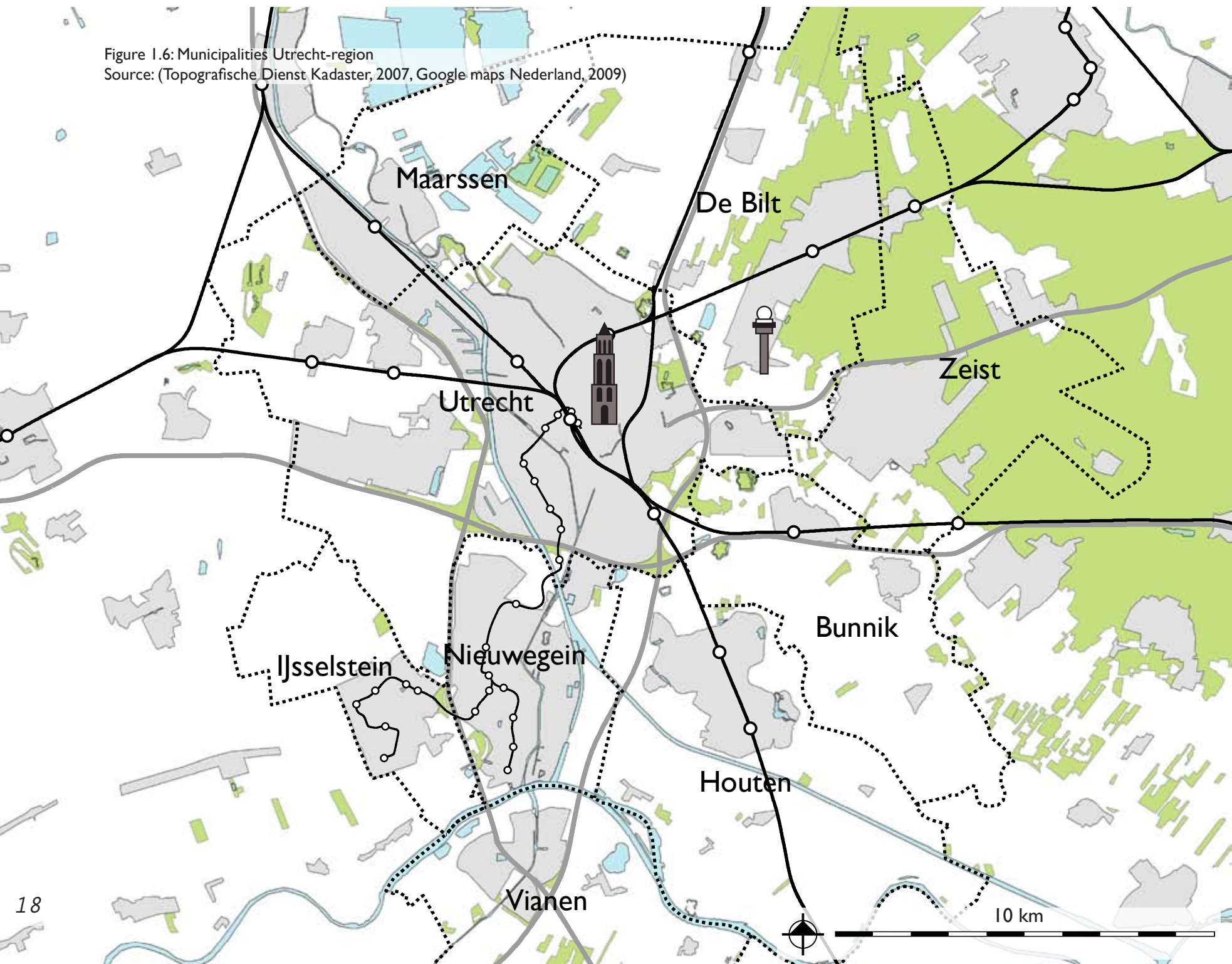
Planning strategies

With the use of physical planning the activity patterns of people can be affected. Examples are land-use regulations, and using the principles of transit-oriented development in planning like in this graduation project (Nijkamp, 1993).

Urban and regional planning can contribute in shaping preconditions for more sustainable cities. According Bannister (2005), public transportation is the key in developing more sustainable cities. Dealing with the relation between mobility and urbanity is hereby one of the main challenges of contemporary spatial planning. The interactions between spatial developments, accessibility and infrastructure, moreover the tuning between these issues is a challenge which exists in many European cities (Hall, 2002b) (Figure 1.7).

The general challenge for this project is to deal with the relation between mobility and urbanity in the contemporary West-European city-region.

Figure 1.6: Municipalities Utrecht-region
Source: (Topografische Dienst Kadaster, 2007, Google maps Nederland, 2009)



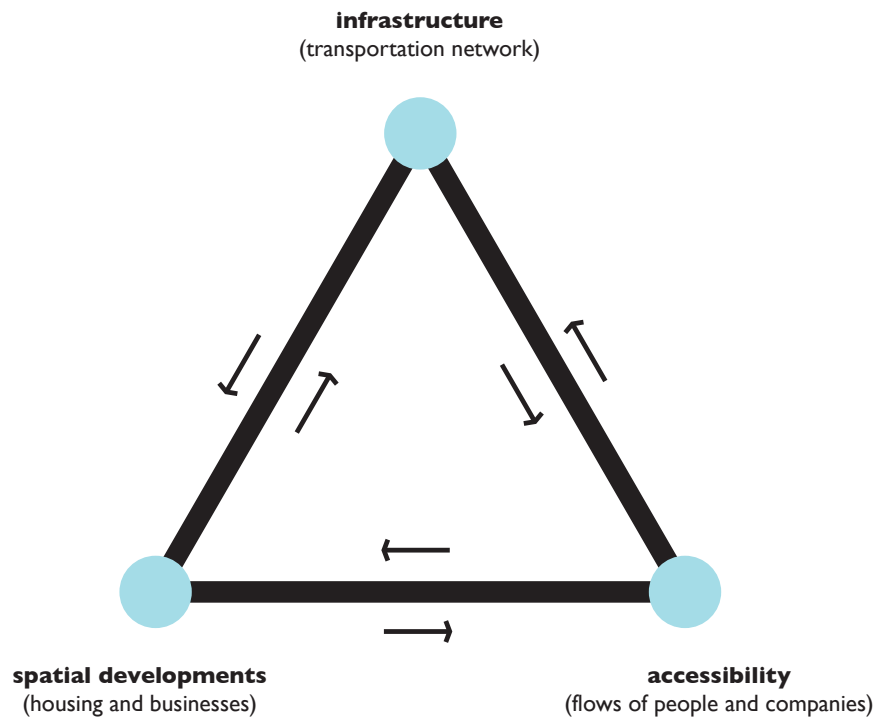


Figure 1.7: Challenges of the project
Source: (Hall, 2002)

1.1.3 The Utrecht-region

Problems concerning the relation between mobility and urbanity also appear in the Netherlands. Within the Netherlands these problems are most urgent and visible in the most urbanized western part of the country, the Randstad. The Utrecht-region is an important part of the Randstad, and functions as a connector from the Randstad towards the rest of the Netherlands. The tension between mobility and urbanity for the Utrecht-region specific is keeping the city vital and accessible, and healthy and liveable at the same time.

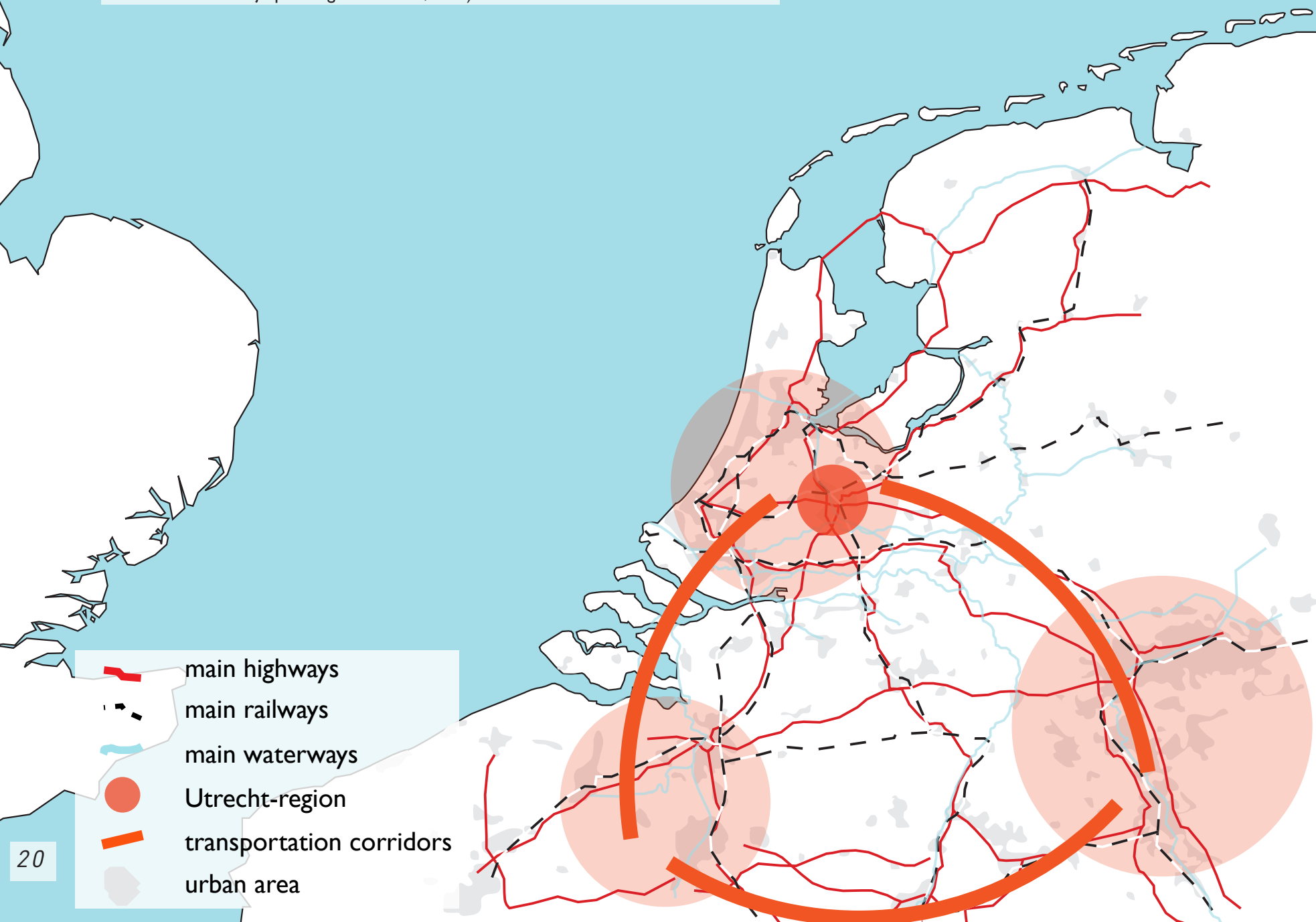
Utrecht has a central location within the Netherlands. Its geographic location has some consequences. There is e.g. much more traffic passing the city in comparison to arriving when it is compared with Amsterdam or The Hague.

Next to this, the Utrecht-region has a specific service sector and knowledge based economy. Such an economy requires a lot of daily interactions. These daily interactions demand mobility, which will increase if the economic growth increases.

The overall goal of developing a sustainable Utrecht-region is very much related with the discussion of emissions, the use of space and more sustainable solutions for transportation. Practical problems of the Utrecht-region related to this general challenge are elaborated in three main topics, further explained in PART II, the Atlas. Figure 1.6 shows the municipalities concerning the Utrecht-region.

Figure 1.8: Utrecht in northwest Europe

Sources: (Volters-Noordhoff, 2007, Ministerie van Volkshuisvesting Ruimtelijke Ordening en Milieubeheer and Rijksplanologische Dienst, 2001)



1.2 Problem statement

1.2.1 The Utrecht-region, two main challenges

The Utrecht-region has an important function in the Randstad. Although Utrecht is the smallest city of the largest four; it has an important role in this urban system (Meijers, 2007b). The region is centrally located in the Netherlands and functions as a connector from the Randstad towards the north, south and east of the Netherlands and further to the hinterland of Europe (Figure 1.8). The city of Utrecht has a very rich history and is one of the oldest cities of the Netherlands. The city started as a fortress for the Roman Empire named Trajectum in the year 47 AD. This fortress was located at the current Dom Square. Since the establishment of the fortress, the city of Utrecht developed as an important place in cultural, religious, economical and governmental aspect (Renes, 2005).

The contemporary Utrecht-region is associated in economic profile with wholesale trade and education, and is named as the national crossroad of traffic, transport and knowledge (Meijers, 2007b, Ministerie van Verkeer en Waterstaat, 2007). Utrecht Centraal is the most important hub in the public transport system on the local, regional and national scale. National highways (A28, A27) and international highways (A2, A12) cross the Utrecht-region (Figure 1.9).

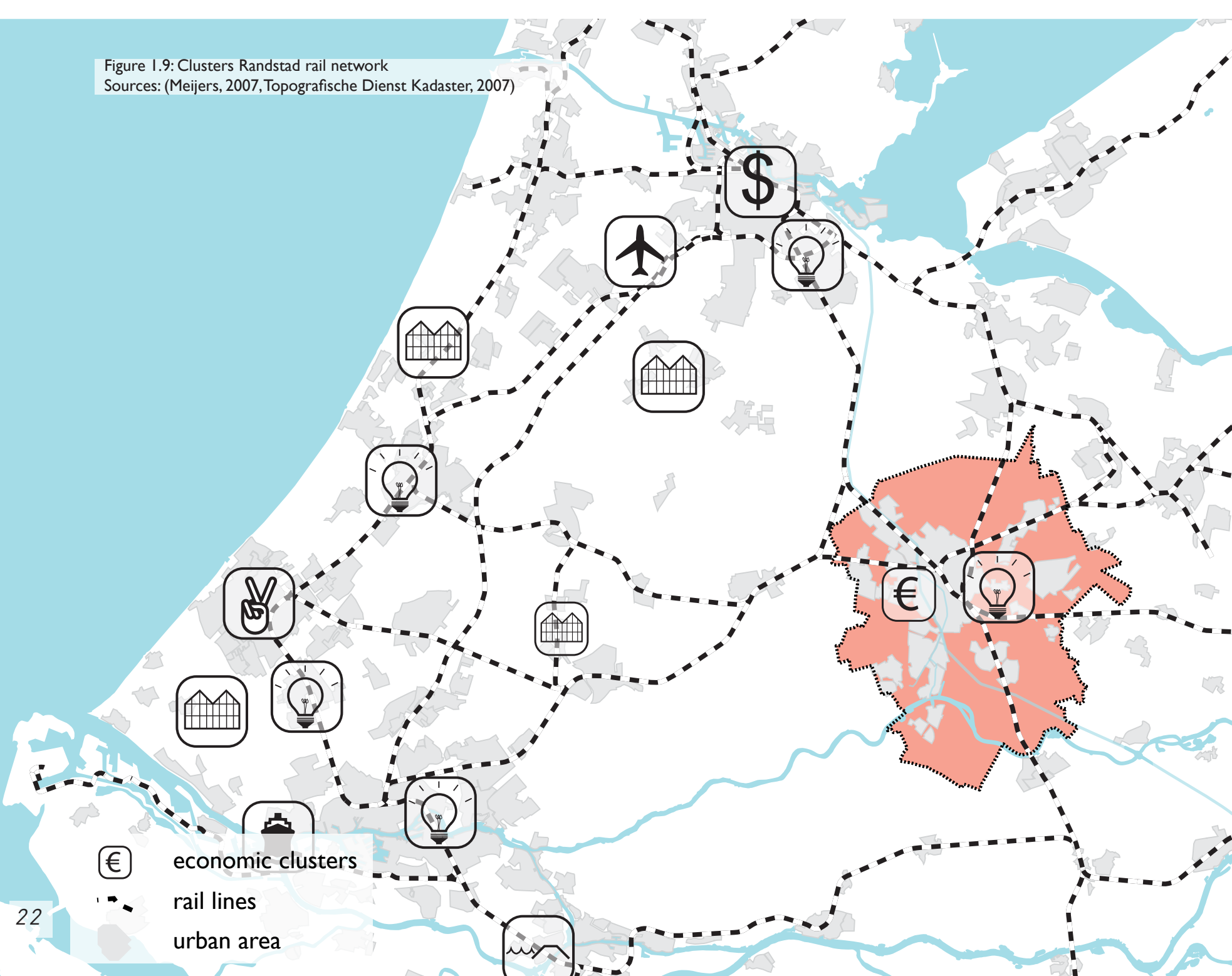
The biggest university of the Netherlands is located in Utrecht. An amount of 60.000 students study in the Utrecht-region on universities of empirical and fundamental sciences and applied sciences (Dutch: Hogescholen). The Universiteit Utrecht is ranked as the top University of the Netherlands (Shanghai Jiao Tong University, 2009). Furthermore, the Utrecht-region is a

very popular region for people to live, partly because of its central location and attractive living environments (Bestuur Regio Utrecht, 2005).

However, the Utrecht-region is facing major challenges to keep its position as an important region in the Randstad. Accessibility is important for the economic vitality of the region, but traffic problems are threatening the region (Bestuur Regio Utrecht, 2005). Congestion of highways, and the low quality and capacity of public transport systems are the daily examples of these problems (Witmond and Lahaye, 2006).

Furthermore, the Utrecht-region is facing an enormous challenge in realizing new housing. Until the year 2030, an amount of 79.500 new dwellings are planned within the Utrecht-region. Next to this amount, a shortage of 30.000 dwellings will remain in the year 2030 (Bestuur Regio Utrecht, 2008c) (Figure 2.98). However, the possibilities of expansion of the region are limited because of different so called “nationale landschappen” (protected landscapes), such as the “Groene Hart”, and the “Nieuwe Hollandse Waterlinie”. It seems that a big part of the new housing should be realized by densification of the existing urbanization. Densification of an already congested infrastructure represents a major planning challenge.

Figure 1.9: Clusters Randstad rail network
Sources: (Meijers, 2007, Topografische Dienst Kadaster, 2007)



1.2.2 Governance and urgency

A very important factor is governance, or rather the complex situation of different governmental bodies and conflicting interests (Huisman, 2008). There is no evidence that the current policy for the region will solve these problems.

An example of this is the new dwelling location in the southwest of Utrecht: Rijnenburg. The Province and the municipality of Utrecht were in conflict about the planned amount of dwellings for this area. This conflict has slowed the development process of this extension in the south west of Utrecht. Despite interventions in the Utrecht-region are needed, the different interests and the political conflicts contribute to a slow development process of the Utrecht-region. Hence, problems of the Utrecht-region concerning mobility and urbanity will increase further in the future. The exploration of a possible future for the Utrecht-region is thereby not only relevant from an academic point of view; it also has societal relevance.

1.3 Research questions

Facing the challenges of the Utrecht-region

In this chapter the main research question and sub-research questions are stated. The main research question will give focus to the development of a comprehensive strategy to face the challenges mentioned in the problem statement. The sub research questions are divided into theoretical and practical questions. This product, the Master thesis is answering these research questions. Every sub-research question will answer a part of the main research question.

1.3.1 Main research question

In what way can transit-oriented development (TOD) manage a complex city-region in developed countries? How can this spatial strategy respond to the need for housing and ensure the accessibility of a city-region?

Case and specific goal for the Utrecht-region:

The goal is to boost the region's comparative advantages, its spatial qualities and strengthen its position in the Randstad.

1.3.2 Sub research questions

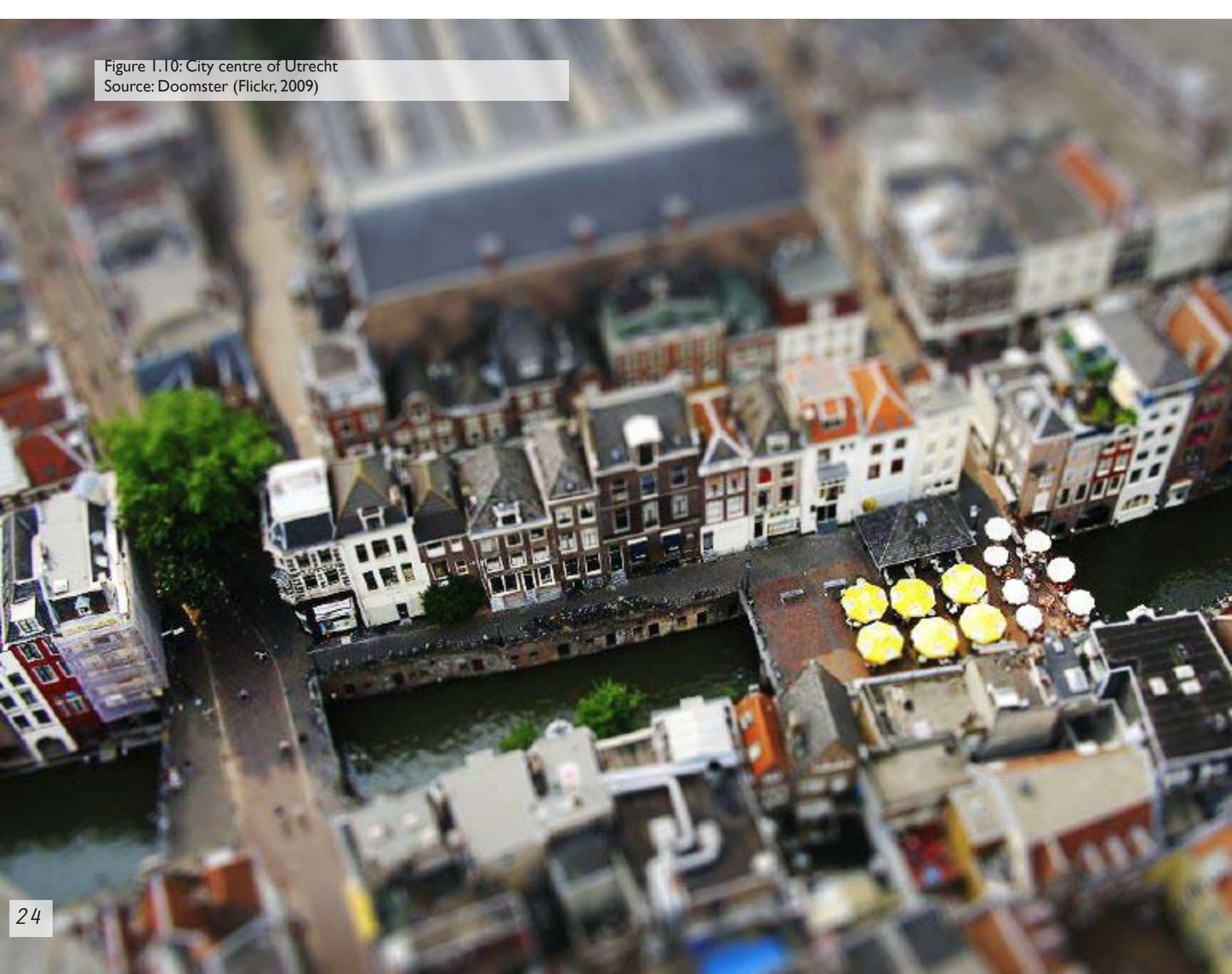
Theoretical research questions

- In what way is it possible to respond better to the rapidly changing social-economic interactions in society, and what scale of spatial planning fits to these complex interactions?

Sub research questions:

- What are the classic theoretical models to clarify urban systems?
- What does the concept Daily Urban System (DUS) mean?
- What is the definition and meaning of the concept of Action Space?
- How can the definition of a certain perspective be used in spatial planning?
- How do contemporary governmental institutes use these planning concepts?
- Are the concepts of DUS and Action Space operable planning concepts to respond better on interactions in society?

Figure 1.10: City centre of Utrecht
Source: Doomster (Flickr, 2009)



-
- Is the concept of TOD a comprehensive planning tool for countering the problems of the unsustainable Dutch city-region?

Sub research questions:

- What is the classical example of a regional design that combined transportation with spatial development?
- How did the concept of TOD develop in history?
- What is the definition of TOD?
- Which scale levels are crucial in TOD?
- What are the examples of TOD in Europe and the Netherlands?
- What are the criteria for measuring the success of TOD?
- What does TOD mean from the perspective of the households and the individuals?
- In what way is it possible to use the node-place model of Bertolini for the analysis of station areas?
 - What variables play a role in the node-place model?
 - Which situations can be identified of stations in the node-place model?
 - What are the geographical rules for the application of the model?

Practical research questions (process)

- What is the current situation of the Utrecht-region concerning transportation networks?
- What is the current situation of the Utrecht-region concerning flows of people and companies?
- What is the current situation of the Utrecht-region concerning spatial configuration of housing and

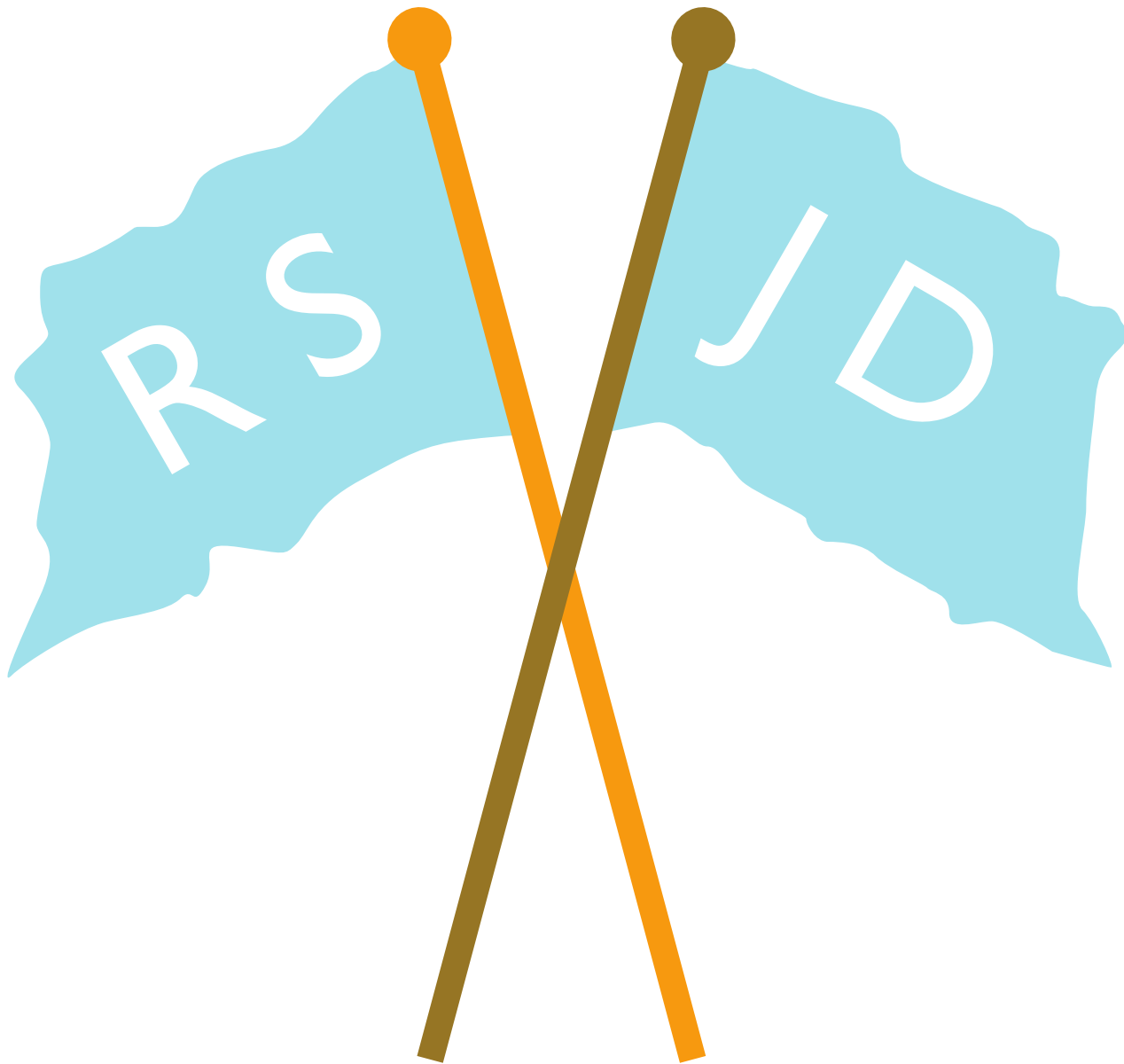
businesses?

- What are important anchor points in the Utrecht-region in terms of workplaces and dwelling areas and how is the region developing in terms of workers and inhabitants?
- What are the most important flows in the region, how are these movements developing and by which modes (car or public transport) are these trips undertaken?
- What is the current situation of existing, planned and possible stations in the Utrecht-region?

Practical research questions (solutions)

- In what way is it possible to densify the Utrecht-region, by taking advantage of the already existing infrastructures, without compromising mobility and quality of life?
- What are the possibilities for the restructuring of the public transport system in the Netherlands?
- In what way could new layers of public transport systems be introduced in the Randstad?
- What is a suitable layer and modality of public transport on scale of the city-region of Utrecht?
- How should the proposed new layer of public transport be realized in time?
- In what way could spatial developments take place in a transit oriented way?
- What are the possibilities of developing stations into important places of activity?
- What challenges can be identified for the spatial development of station areas?
- How should these spatial developments be realized in time?

Figure 1.11: Responsibilities in a team



- What is the expected situation according to the node-place model of existing, planned and possible stations after the executed interventions?
- What is the difference between the current municipal plans in comparison with the proposed regional design?
- What are recommendations for the BRU in developing the region in a transit oriented way, by developing housing and public transport in integrated way?

1.4 Scale and scope

Switching between scale levels and thinking about cause and consequence on a certain scale and its implications for other scales is a major task for the urban planner. In fact, this skill distinguishes the urban planners from other specialists and professions.

In this research and design, the most important scale is the city-regional scale, with a radius of 30 kilometres. However, with the design and restructuring of the public transport system, the scale of the Netherlands and especially the Randstad was important. Horizontal and vertical integration of this public transport design made it necessary to switch between different scale levels. The scope of the regional design will be from 2010 until the year 2030.

1.5 Responsibilities

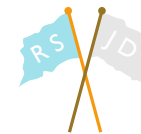
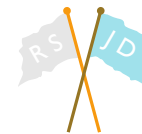
In general the graduation track is executed in a team. For an extensive description of the reasons why the project is executed together, we refer to PART I, the thesis plan. Working efficiently in a project-team requires clear communication and a division of the different tasks. In an

early stage of the graduation project the different tasks are divided. An example of this is the development of the review papers. In both papers there is a main author (mentioned first) and a co-author.

Within this final thesis, there is also a division in the work. The division of the work in the thesis plan is indicated with little flags with the initials of Remko Stinissen (RS) or the initials of Johanan van Dijk (JD). These flags are illustrated at the beginning of the designated chapters (Figure: 1.12).

1.6 Four chapters

The content of this master thesis is divided into four main chapters. These are: introduction, research, design and conclusion. In the introduction the motivation, problem, case and research question are described. In the second chapter the theoretical and practice-based research will be elaborated. The chapter design will enlighten the regional design proposal for the Utrecht-region that is divided into the design of the public transport system and the design proposal for the spatial developments. In the conclusion the regional design proposal will be tested, and the content and process of the graduation project will be evaluated.



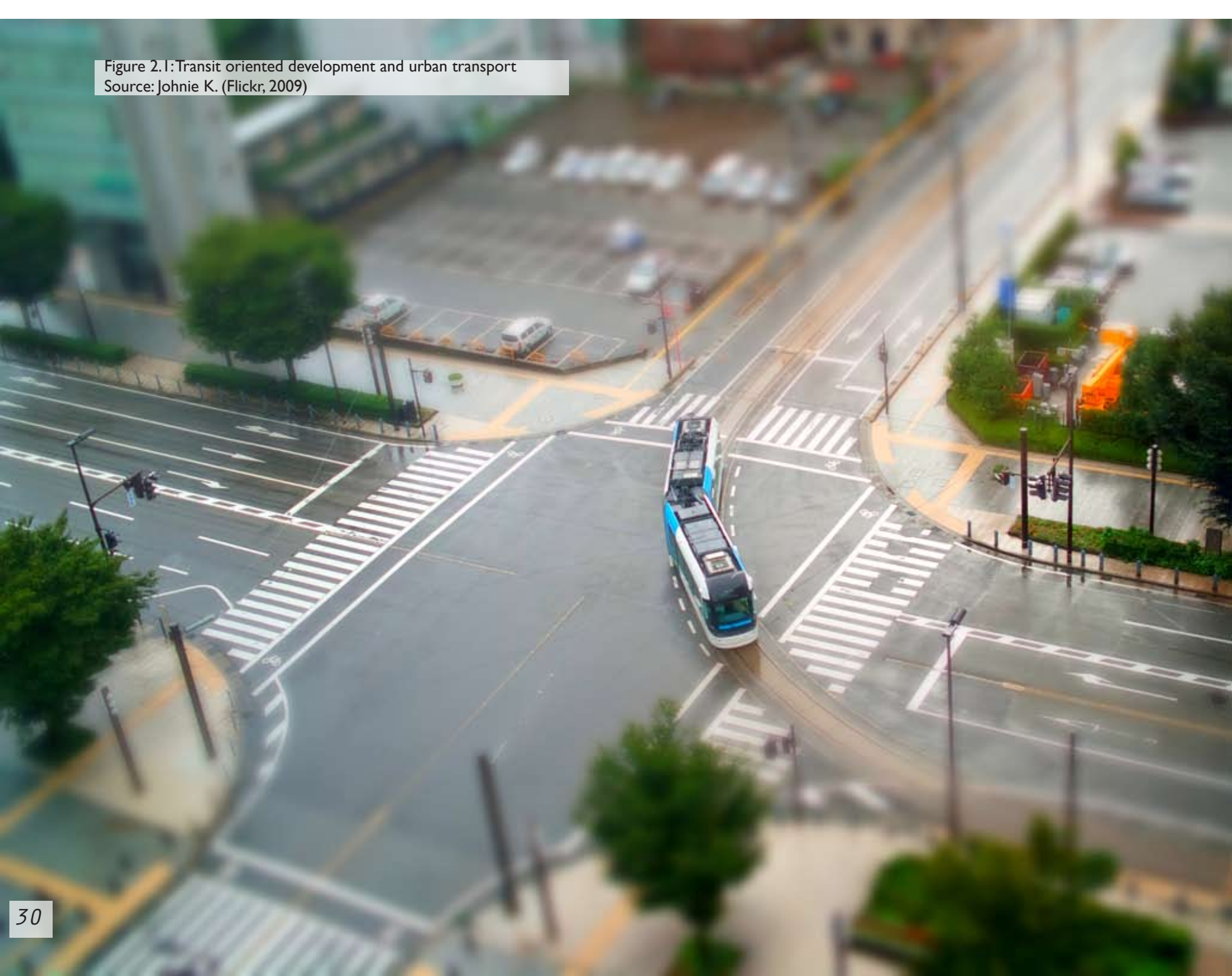
2 research

2.1 Theoretical research

2.2 Practice-based research

2.3 Conclusions from analysis

Figure 2.1: Transit oriented development and urban transport
Source: Johnie K. (Flickr, 2009)



2. Research

2.1 Theoretical research

The research part of this thesis consists of theoretical research and practice-based research. This chapter will describe the theoretical research of this project. It will start with a chapter that describes the increase of the complexity of daily interactions of people in society and tries to seek for a comprehensive planning concept to respond to this change.

Furthermore, the planning concept of transit-oriented development (TOD) will be elaborated. Thereby, the application of TOD for countering the problems of the unsustainable city-region will be described.



2.1.1 Interactive planning

Introduction

Society has changed rapidly in the last century. This change is mainly caused by the increase of all kinds of commercial, intellectual and social interactions. The interactions of households and businesses are developing in much more complex structures, which is reflected in the paper of Dijst (1999). The increase of the complexity of interactions in space is visible in the change of thinking about the spatial configurations of cities (Meijers, 2007b). In planning theory, this change can also be identified in the shift in paradigms about urban growth patterns, from the central place theory towards the network theory. Contemporary urban planning is dealing with the complex task of translating social-economic processes of society into space. The Netherlands has a rich and advanced planning tradition, however, contemporary planning lacks an in-depth understanding on the complex

social-economic interactions in complex urban systems. Examples of planning concepts using a specific perspective by identifying interactions are Daily Urban System (DUS) and the theory of Action Space. The research question of this chapter will therefore be:

How can contemporary spatial planning respond to the rapidly changing social-economic interactions in society in a more effective way, and what scale of analysis better conveys these complex interactions?

In order to answer this question, the following authors are being reviewed. Tordoir's definition of DUS will be used. He gives a comprehensive definition of DUS. Dijst is an important author, because he explains Action Space theory and the possibility for using this concept in spatial planning. Meijers is reviewed because he describes the change in paradigms on the understanding of the functioning of urban systems.

This chapter will search for a concept to identify interactions from the households' perspective on the scale of the city-region.

The first part of this chapter presents the change in paradigms about the understanding of urban systems, from the central place theory to the network theory. Then, several concepts for defining the complex interactions in society will be described, the concept of DUS and the theory of Action Space. After this, the significance of the use of a specific perspective in spatial planning will be stressed. Furthermore, the lack of use of a specific perspective in contemporary spatial planning will be elaborated. In the concluding the use concept of Action Space, will be described as a tool to expose complex interactions in society.

From central place theory to network theory

Cities change over time. A city with one clear identifiable node or centre is in many cases a part of the past. Cities in developed countries are often developing as expanded urbanized areas with multiple nodes, like office locations along highways, shopping malls and concentrations of leisure activities (Jacobs, 2000). This process has changed the shape and functional relations of urbanized areas. A lot of these areas are developing from single nodal structures into multinodal urban forms (Schwanen et al., 2001, Schwanen et al., 2003). In this way, the city is developing as a complex system the last decades. Therefore, the notion of *urban system* will be used in this chapter to indicate the complex nature of cities in Western developed societies nowadays. We can consider these urban systems as more than just urbanized parts of a landscape. They are focal points of different activities spread over the territory, but nevertheless maintaining close relationships through sophisticated infrastructures of movement and communication. An urban system can be seen as an

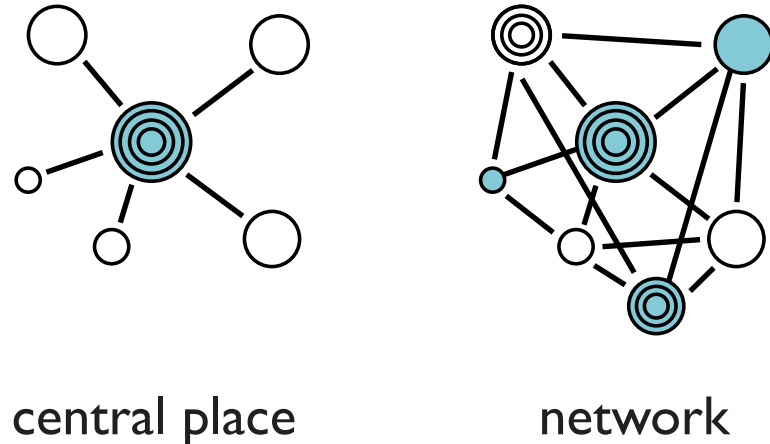


Figure 2.2: From central place to network
Source: (Stinissen & van Dijk)

economic and societal system with many relations and interactions (Tordoir, 2005).

The change in the structure and function of urban systems is also acknowledged in the research of urban systems through time. The vision on the functioning of urban systems has changed in the last decades. Before the mid-1980's urban systems were researched in terms of hierarchy. This hierarchical thinking about the city comes from the central place theory of Christaller (1933) and Lösch (1944) (Batten, 1995, Cortie, 1992, Meijers, 2007b). The theory is based on one-sided hierarchical relationships between different central places (cities). This means that places lower in hierarchy are dependant on the places higher in hierarchy. Cities higher in the hierarchy are providing specialized urban functions for the smaller cities. Hence, the central place theory is based on vertical relationships between cities (Figure 2.2). This theory neglects the horizontal relationships between cities equal in size. It states that if these places provide

the same activities, it is not possible that there are relationships between these cities (Meijers, 2007b, Cortie, 1992, Batten, 1995). In the central place theory the rank-size rule is essential. This means that when the marketing function or position of several places is known, the hierarchy can be deduced. In this way Christaller reverted to the classical economical model in which a perfect competition is present in a geographical context. Eventually, this structure is not easy to find in reality (Batten, 1995, Meijers, 2007a). The central place theory of Christaller and Lösch could not explain the complex patterns that occurred in spatial reality (Meijers, 2007a, Meijers, 2007b). In practice the strong hierarchical or pure vertical vision on spatial organisation does not exist. On the contrary: functions of a higher hierarchy were found in places lower in hierarchy. Furthermore, strong relations were found between places with a comparable size. These new insights led in the early 1990s to a new theory of spatial organisation of urban systems. From the early 1990s, the 'network model' became the new paradigm for explaining the complex functional organization of space. This theory is, in many ways, the opposite of the central place theory (Meijers, 2007a, Meijers, 2007b) (Figure 2.3). The concept of the dispersed city in one of the first models mentioned in the explanation of the network city. This dispersed city concept is defined as a group of cities similar in size, which are separated by open land but functioning as a single urban system (Meijers, 2007a). The network model emphasizes nodality, size neutrality and tendency towards two-way flows with linked settlements. The theory of the network model is based on horizontal relationships between cities (Batten, 1995). The different

nodes of this urban system and the relations between the nodes form a unique exchange environment (Batten, 1995). Hierarchy in the network model is no longer the most central aspect for explaining the functioning of an urban system. Complementarity between the different nodes is an important feature in the network model (Meijers, 2007a). This complementarity is established when different urban facilities are spread over different cities making it necessary for inhabitants of one to make use of opportunities located in another city. For instance, in a networked urban system, not all cities need to have a major hospital. This provides that accessibility to a major hospital is warranted from all the other nodes in the system. The main differences between the two theories are shown in Figure 2.3. The introduction of a new theory of urban systems does not mean that the network theory is replacing the central place theory. In literature there is confirmation about the existence of the two models next to each other. The network model dislocates the central place model, and it also updates it into a different socio-economic reality than the one existing when the central place theory was conceived. The theories follow the type of economy that was current at the time of their formulation. In the industrial economies the central place model is more valid, and in the service-sector dominated economies the network model is more applicable (Meijers, 2007a, Meijers, 2007b). The Netherlands, especially the north wing of the Randstad, including the Utrecht-region, has a service sector based economy (Ministerie van Verkeer en Waterstaat, 2007). For that reason the focus will be on explaining and describing complex urban systems by the network model.

aspects:	central place model:	network model:
place	centrality	nodality
tendency	primacy	complementarity
flows	one-way	two-way
spatial scales	fixed	variable
functions	raising and linked to scale	variable sets on same scale
territorial distribution of people	even	uneven
size	dependency	neutrality
competition over space	perfect	imperfect & price discrimination

Figure 2.3: The central place model versus the network model
Source: (Batten, 1995)

In contemporary planning theory the previous notion of 'dispersed city' is replaced by polycentric or poly-nuclear urban region (Meijers, 2007a). The concept of Polycentric Urban Region (PUR) is one of the many approaches using the network model (Meijers, 2007a, Parr, 2004). As Parente (2009) argues, there are many interpretations about the notion polycentricity. The definition of policentricity is for example totally different from Europe to Latin America (Parente 2009). In this chapter we focus on one definition of a single European author, because the project location is the (European) Utrecht-region. Meijers (2007) defined a PUR as a collection of historically distinct and administratively and political independent cities located in proximity of each other. The cities are well connected and there is lacking a dominating city in political, economical, cultural and in other aspects (Meijers, 2007b). This concept is used to a great extent in

European urban planning (Musterd and van Zelm, 2001). Often named as classical examples of PUR's are the Randstad Holland, Rhine-Ruhr area and the Kansai region in Japan (Batten, 1995). The central position of a city in the PUR model is not anymore determined by the location in relation with its surroundings. This is determined by the position in the network of connections and transaction (Laan, 1996). Two elements are considered to be essential to define an urban system as a polycentric unit. These are: a spatial structure with multiple centres and the existence of an intricate network-type relation between the multiple centres. These intricate relations are frequent interactions that are occurring between the different centres in the region (Meijers, 2007b, Musterd and van Zelm, 2001).

Definition of daily urban system and Action Space

For the measurement of these intricate relations or interactions in the PUR, several concepts can be used. The classical example is the concept of a DUS. In origin this American concept was used as a synonym for the local labour market (Laan, 1996). Due to the increased (auto) mobilization the supply side of the labour market (workers), was living outside the urban core while the labour demand (workplaces) stayed in the urban core. In this original definition the supply and demand side of the labour market (places) and especially the commuting patterns (flows) determine the existence of a DUS. Other examples of concepts to define and measure interactions are the Functional Urban Region (FUR), and the Standard Metropolitan Statistical Area (SMSA) (Laan, 1996).

Daily urban system

In this chapter the focus is on the daily interactions of households in space. A theory that is useful for describing these daily interactions is DUS. The definition of a DUS in general is: a functional entity of an urban system with an influence area. This definition is extendedly discussed by policy makers and scientists (Ruimtelijk Planbureau, 2006). The conviction that the city and the hinterland function as one entity exists since a long time (Ruimtelijk Planbureau, 2006). The discussion in literature of the spatial scale of daily urban systems has changed over time as a result of the up scaling of the activities of people and companies. This up scaling led in a change in theory about the functioning of the urban system as described in paragraph 2. In the past a daily urban system was seen as a single conurbation with a hinterland. Some scholars and policy makers suggest that the daily urban system exists at a higher level of scale for instance in a PUR (Ruimtelijk Planbureau, 2006). However, for example in the case of the Randstad there is no convincing empirical evidence for the existence of a cohesive polycentric urban region (Meijers, 2007b, Musterd and van Zelm, 2001). The discussion about the existence of a daily urban system on a certain level of scale is of course of great importance. However, if the perspective of the daily interactions is taken into account, the concept of DUS becomes less abstract. In the definition of DUS from Tordoir (2005) the perspective becomes much more significant. Tordoir (2005) interprets the DUS concept as the set of all daily interactions in society: commuter flows, the daily shopping, and also flows of services and goods between companies. This view differs from the classical view of DUS, which was only focussed on the perspective

of the labour market and commuter flows. Besides this, Tordoir acknowledges the various people, groups and companies and their interactions and recognizes more than one perspective. In the definition of Tordoir (2005) citizens and companies are selecting their location based on all their daily interactions (Tordoir, 2005). This definition is very similar to the theory of Action Space.

The theory of Action Space

A more precise and comprehensive concept for the research on daily activity of people is the concept of Action Space. This concept focuses on the use of space in time, the activity patterns (Dijst, 1999). The perspective that is used in the concept of Action Space is the individual or a group. The Action Space can be divided in potential, actual and perceived Action Space. The potential Action Space is an area with a set of activity places which a person or group can visit within a given time period. (Dijst, 1999). The set of activities that a person or group actually has visited given a certain time period is called the actual Action Space. The perceived Action Space are all the activity places that are known by an individual or a group of persons (Dijst, 1999). The relation between these Action Spaces is shown in Figure 2.4. The actual Action Space is entirely covered with the potential and perceived Action Space and is the space that a group or person has actually visited.

The theory of Action Space and DUS is initiating a certain perspective of the individual: people in their daily activities. In this chapter the concept of Action Space will be used for the discussion about daily interactions of people in space and the perspectives that are used in spatial planning.

Perspectives

Contemporary governmental planning does not explicitly address a specific perspective in spatial planning. However, defining the perspective is essential for effective and sustainable urban planning. The essential question is: which perspective is decisive in spatial planning, is it the perspective of the individual commuter, the traveller, the household, or the company (Lambooy, 1998)? If the perspective is selected, the interactions of a specific user or user group can be defined, for instance by using the concept of Action Space.

For the application of a certain perspective, governmental planning institutes should use adequate instruments. The theory of for instance Action Space of individuals as a specific perspective is not used in contemporary spatial planning. When the perspective is defined the question can be raised what kind of sub-environments could or should be developed for example for households within the city-region (Musterd and van Zelm, 2001). A household has a different Action Space than a private company and is using the region in a different way and at another level of scale. The theory of Action Space has already a specific point of view: the perspective of the individual or group of persons.

The majority of the activity pattern of an individual in a proposed polycentric urban region still occurs on local scale level. The lives of people are very much spatially bound. In that way it is questionable if different polycentric urban regions could be considered as one daily urban system (Musterd and van Zelm, 2001). In many cases it is premature to speak of a functional unit of polycentric urban regions like the Flemish Diamond, the Rhine-Ruhr area and the Randstad. The assumption

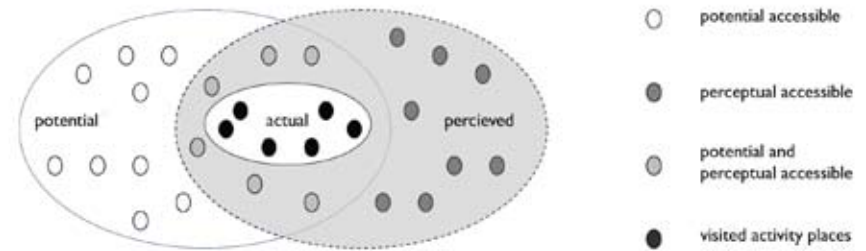


Figure 2.4: Relation between potential, actual and perceived Action Spaces
Source: (Dijst, 1999)

of a polycentric urban region being a coherent system is often the ambition of the planner and the policy makers (Musterd and van Zelm, 2001). Instead of discussing of the existence of a PUR on a certain scale, it is perhaps more useful to think of specific perspectives and the actual interactions that are occurring in space. However, in governmental spatial planning the perspective of the individual and its interactions are hardly recognized (Dijst, 1999).

Planning concepts and the use of rhetoric in planning

The notion DUS refers to (daily) activities of citizens and companies. In this chapter the notion is seen as a set of interactions. These multiple interactions have implications for space. The national governance assumes that spatial planning and policy can influence spatial developments. From this point of view it is useful to develop spatial planning concepts, visions and perspectives (Zonneveld et al., 2005). This position has led to numerous concepts in the field of urban and regional planning in the Netherlands. Policymakers and planners use these concepts to create support for their spatial plan of the city or region (Musterd and van Zelm, 2001). Examples of these planning concepts are the urban field, the

Deltametropool or the Randstad Holland (Zonneveld et al., 2005).

There are a few problems with this use of planning concepts by planners and policy-makers. First, these planning concepts are used as if they are representing reality. Musterd & van Zelm (2000) are questioning for instance if the concept of DUS is applicable for the Randstad. They state that the actual Action Space of people is much smaller than the spatial scale, of for example the Randstad (Musterd and van Zelm, 2001). The conviction of the occurrence of a DUS is often mentioned in scientific literature and governmental planning documents. The concept is used on several levels of scale. However, these convictions are mostly based on claims and assumptions without any empirical evidence (Frieling, 1994, Meijers, 2007b).

Second, with the use of planning concepts in the Netherlands there is an abundant use of rhetorical style-figures. The conceptualisation of the complex processes in spatial planning should simplify the patterns and structures in today's planning practice. However, the use of these rhetorical style figures and concepts is not contributing to a clear guiding of spatial issues in the Netherlands (Zonneveld et al., 2005). There is still too much confusion about the concepts for spatial planning of the city or region.

Finally, the interactions of people in society are becoming much more complex. This complexity is derived from a richer diversity of activity and more mobility patterns in space. The spatial planning concepts of the government are taking these dynamic trends in society not enough into account. If these trends are not taken into account, the spatial planning becomes less effective in solving spatial problems (Dijst, 1999).

Case: Utrecht-region in the Randstad

An example in the discussion about the existence of a DUS represented in a spatial constellation is the case of the Randstad. It is questionable if the Randstad is functioning as a daily urban system from different perspectives. For identifying the Randstad as a DUS the trips taken by people can be used as an indicator. In the case of the Randstad in the Netherlands the majority of the trips remain within the boundaries of the core cities, in many cases they do not exceed the limits of the core city, let alone the agglomeration of one of the four biggest cities in the Netherlands (Musterd and van Zelm, 2001). This shows that there is no strong and empirical evidence for the existing of a network city on the scale of the Randstad (Lambooy, 1998). Therefore, it is questionable if the Randstad functions as a DUS from the perspective of people and companies (Ruimtelijk Planbureau, 2006) (Figure 2.5).

If we consider the Randstad from the perspective of businesses the interactions often exceed the borders of the four big cities. However, the Randstad does not have a specific position in these relations: the relations are often focussed on other parts of the country or on foreign countries (Ruimtelijk Planbureau, 2006). Moreover, from the perspective of shopping people, interactions within the Randstad are mainly existing within the four biggest cities. The Randstad does not play a specific role in this scale and level of network operation (Ruimtelijk Planbureau, 2006). In this way the Randstad functions for a very few perspectives as a cohesive Action Space for people.

Zooming in at the spatial scale of the Utrecht-region from the perspective of the household, a certain complementarity with criss-cross relations can be identified. This agglomeration consists of the central city Utrecht and the eight municipalities around the city. All these municipalities have their own identity and together they form a DUS with many criss-cross relations in the Utrecht-region. These criss-cross relations mainly consist of commuter flows. (Laan, 1996, Birch, 2009) This fact shows the importance of planning on the scale of the city-region. From the perspective of households it is useful to think about the spatial configuration for the Utrecht-region. The various interactions primarily take place on the scale of the agglomeration of Utrecht (Dijst, 1999).

Conclusion

The conceptualisation of space can be more effective and less abstract if spatial planning concepts are directly related to respectively a perspective and a specific location. The conceptualisation of space on the regional

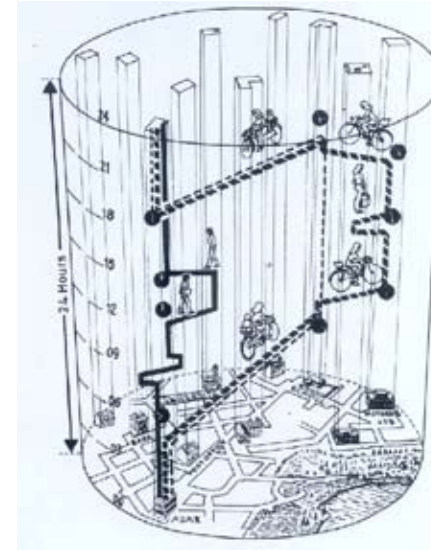


Figure 2.5: Illustration of Action Spaces
Source: (Dijst, 1999)

level becomes more important in that case (Zonneveld et al., 2005). The concept of Action Space can be used to define the scale and perspective for effective spatial planning (Dijst, 1999). The field of spatial planning could benefit more from theories such as DUS and Action Space. If the planner has a deep insight of the behaviour of people and their activity patterns, planning instruments can respond to these behaviours. Spatial planning can answer to and also influence the activity patterns of individuals in space on the local and regional scale. Setting a specific perspective is essential to explore in which spatial configuration the interactions are occurring.

Planning institutes have to become conscious about the perspectives than can be defined using a new approach on the understanding of how people move and interact in space. The rhetoric used in planning practice in terms of planning concepts does not simplify the complex task of spatial planning. Often, the concepts are not linked to a specific location or scale. These planning concepts can be seen as a selective interpretation of the spatial reality without a strong underpinning and argumentation. (Zonneveld et al., 2005) For all these concepts, including the existence of the concept of PUR on the scale of the Randstad, empirical evidence is lacking. In the case of the Randstad, it can be concluded that the most interactions still occur on the city-regional scale level. This indicates the relevance of planning for the city-regional scale, in our case the Utrecht-region. In that case the Randstad is not functioning as a cohesive DUS from the perspective of the households. Helpful for planning on the city-regional scale could be the concept of Action Space. With the application of the concept of Action Space the behaviour of an individual can be analyzed and used for spatial planning (Dijst, 1999). Further research about how this concept can be applied in the spatial planning process is necessary. Thereby an essential question is in what stage of the planning process the concept of Action Space should have a more dominant role, and in what stage a more general indication of people's interactions is sufficient. This is an issue that needs further research.



Figure 2.6: Zorbonaut, a metaphor for Action Space
Source: (Flickr, 2009)



2.1.2 Transit meets developments

Introduction

The global emission of CO₂, which is the main global warming gas, has increased by 60 percent between 1971 and 2001 to nearly 24 billion tonnes. The share of transport in this emission has increased from 19.3 percent in 1971 to 28.9 percent in 2001 (Banister, 2005). Hence, the absolute and the relative share of emission attributed to transportation is increasing (Banister, 2005).

One of the reasons for this big share of transportation on the emission is the auto mobilisation of transport the last decades. This increased auto mobilisation has a spatial consequence, namely urban sprawl patterns. These low density and car-based communities have appeared in the USA and also in Western Europe. In contemporary planning debate there are concerns about the sustainability of these trends (Cervero, 1998). In this thesis we refer to the definition of Brundtland of sustainability. He states that a sustainable condition is a situation when there is stability for social and physical systems. This can be achieved by meeting the needs of contemporary people without compromising the possibilities for future generations to meet their needs (World Commission on Environment and Development, 1987).

In the light of the Brundtlandt report the automobile can be named as an unsustainable mode of transportation.

Even if the technology is further developed, with for instance clean eco cars, this does not contribute to solving the entire problem. This individual transport mode will still use too much energy in use and production.

Furthermore, the car can be named as a space consumer (Bach et al., 2002). The current road capacity is not able to answer to the growing number of vehicles. This will

lead to more congestion (Banister, 2005). The extension of extra links of the road network in economies like the Netherlands will have marginal effect on accessibility. The car does not use only a lot of energy, it also consumes a lot of space, the more cars the more asphalt is needed (Banister, 2005).

Current trends in terms of lifestyle, and society production and consumption show that the demand for mobility will not decrease in the future. Mobility and the demand for transportation are strongly related to wealth. The mobility of people is an essential need that will occur today and increasingly in the future. The increase of mobility rises nearly in proportion with income (Schafer and Victor, 2000). These trends indicate the urgency and the need for searching for more sustainable ways for transportation.

One of the planning tools for countering these negative environmental effects is the implementation of TOD. This planning concept has its origin in the USA and is amongst others introduced for countering the urban sprawl (Belzer and Autler, 2002). There are many books written about this relatively new planning concept. However, how could this planning tool be implemented in the Netherlands on the city-regional scale? The main research question of this chapter is:

Is the concept of TOD a comprehensive planning tool for countering the problems of the unsustainable Dutch city-region?

For answering these questions three authors will be addressed. Bannister is describing the unsustainability of transportation. He argues that sustainable urban development is necessary; moreover, he states that it is feasible. The key for reaching sustainable cities is in his vision included in transportation. Next to this, the urban planner Calthorpe is a key author in this chapter. Calthorpe can be seen as the inventor of TOD. He describes the different goals of TOD, and divides these goals into regional and local aims. Another key author for this chapter is Cervero. He has a big share in the academic debate of TOD. He focuses on the relation between transit and metropolitan development, and also on the relation between transit and urban form. The previous chapter searched for a concept to identify interactions from the households' perspective on the scale of the city-region. This chapter is exploring TOD as a planning tool, which could be applicable for the Utrecht-region.

In the first part of this chapter, the history and the development of TOD will be elaborated. Secondly, the definition of TOD of Calthorpe will be described. Hereafter, the regional and local goals of TOD will be named, and these will be followed by a description of the principles of TOD. Then the first European example of the integration of transit and development will be given. The chapter continues with a description of the present in the Netherlands in using transit and development together for spatial development of the city. After this the spatial and functional criteria for measuring the success of TOD will shortly be described. Finally, the concept of TOD will be addressed from the perspective of the households.

History of TOD

We can consider the contemporary TOD in a broader historic perspective. In the nineteenth century Ebenezer Howard was one of the first planners who thought about the relation between urbanization and transport. Poor and unhealthy circumstances in the fast expanding cities made physical regulation necessary (Birch, 2009). Howard created one of the first classical examples of a regional design for solving the problems of the industrial cities (Figure 2.7) (Cammen, 2003). The main idea of "The garden city model" was to combine the advantages of the city and the rural areas. New satellite villages were proposed outside the existing city. These new towns were connected to the existing city with new railways and metro lines (Cammen, 2003). Howard presented his ideas as the solution for the fast growing unhealthy city of London (Castex et al., 2003).

A few decades later, with the introduction of the automobile, it was not longer necessary to travel only by public transport. The switch from the use of the car instead of public transit led to a decrease of investments in public transportation systems (Belzer and Autler, 2002). The car became much more popular and the dominant mode of transportation in the western world. After the Second World War many rail systems were abandoned. The public transport was still in operation, however, it was losing its importance as a mode of transportation. Moreover, the process of the increasing importance of the automobile enforced the decentralisation of the city and its functions and caused urban sprawl. This urban sprawl consists of car based monofunctional districts, low densities and poor access to public transport modes. These developments made public transport unviable and redundant (Belzer and Autler, 2002). These developments of decentralization and the dominance of the automobile as a mode of transportation could be considered as non-sustainable planning. The urban sprawl leads to inefficient land use patterns and the dominance of the car leads to a high use of fossil fuels, moreover to air and sound pollution (Banister, 2005).

In the 1970s the first attempts for reducing the congestion and urban sprawl, the precursor of today's TOD were made. Concrete projects of these attempts are the Bay Area Rapid Transit (BART) system in the San Francisco Bay area, and the Metropolitan Atlanta Rapid Transit Authority (MARTA) in Atlanta (Dittmar and Ohland, 2004). These transit systems were mainly built to reduce the congestion. The public sector funded these systems and there was no connection between the transit investments and the development patterns. The BART and

MARTA projects were fully serving the automobile; big parking lots were created near the transit stations. These parking lots created problems in the cities because the integration with the neighbourhoods was lacking (Dittmar and Ohland, 2004). In a later stage, the goal of combining transportation and development was broadened. Planners, policy makers and transit agencies were thinking increasingly of combining transportation with the urban development around nodes and stations (Dittmar and Ohland, 2004).

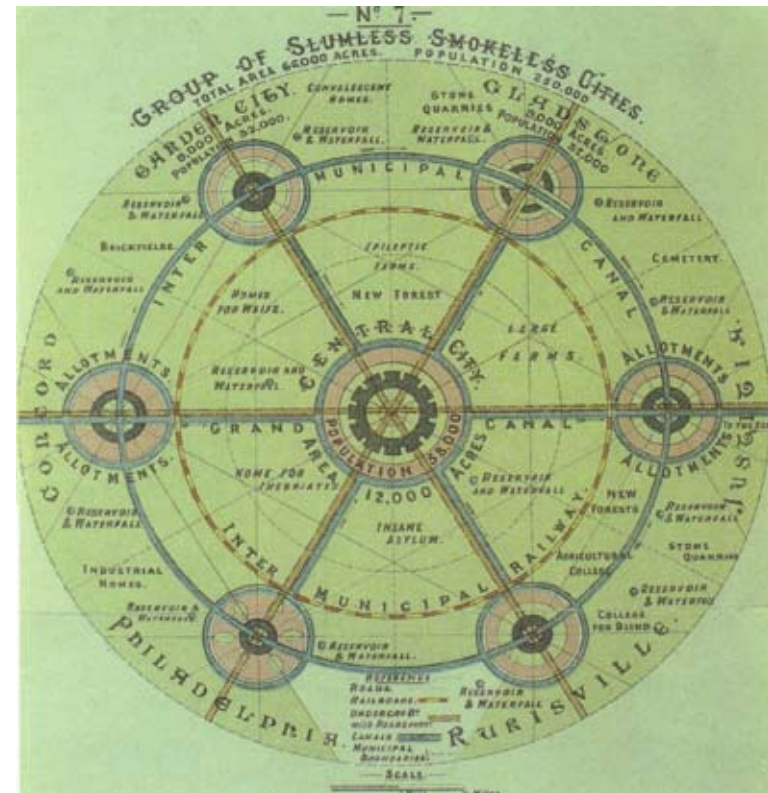


Figure 2.7: The garden city model of Ebenezer Howard
Source: (Cammen, 2003)

From growth management to TOD

Parallel to the use of transit systems for development, and as a reaction to the urban sprawl in the United States, the growth management came into being. Growth management was based on the use of planning policies for guiding the location, timing and form of growth (Neuman, 2000). It uses legislative rules and particular planning approaches to deal with land use issues i.e. urban sprawl (Haeuber, 1999).

In the first stage growth management did not use design as a tool for development (Neuman, 2000). It was a basic instrument for land-use planning, and pointed out where it was allowed to build. A continuation of growth management is the smart growth initiative. The smart growth management is a more cooperative and integral approach compared with the first stage of growth management. Smart growth management emphasized what type of development is allowed or encouraged on a certain area (Haeuber, 1999). By designing visions and perspectives smart growth introduced regional design and planning in the United States. Within these visions or perspectives TOD is introduced as a more concrete or visible instrument within the smart growth concept (Cervero et al., 2004, Renne et al., 2002).

Definition of TOD

As mentioned before, the concept and definition of TOD has its source in the American planning tradition. Calthorpe (1993) introduced TOD in the 1990s as:

“A mixed-use community within an average 2,000 foot walking distance of a transit stop and core commercial area. TODs mix residential, retail, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot, or car.” (Calthorpe, 1993)

Next to this first definition of Calthorpe, Renne & Wells (2002) defined the concept of TOD on the basis of two main components (Renne et al., 2002). First, the financial aspect. This component addresses the investments done in the existing commuter stops. This is coupled to revitalizing the urban areas around the stations that are economically in decay.

The second component of TOD is related to another type of public transport, namely light rail. Light rail is a modern way of rail transportation with mostly a high frequency and a high amount of stops. In comparison with the commuter rail, TOD with this type of transportation allows linear spatial developments. As we demonstrated above there is not a single definition of what TOD is.

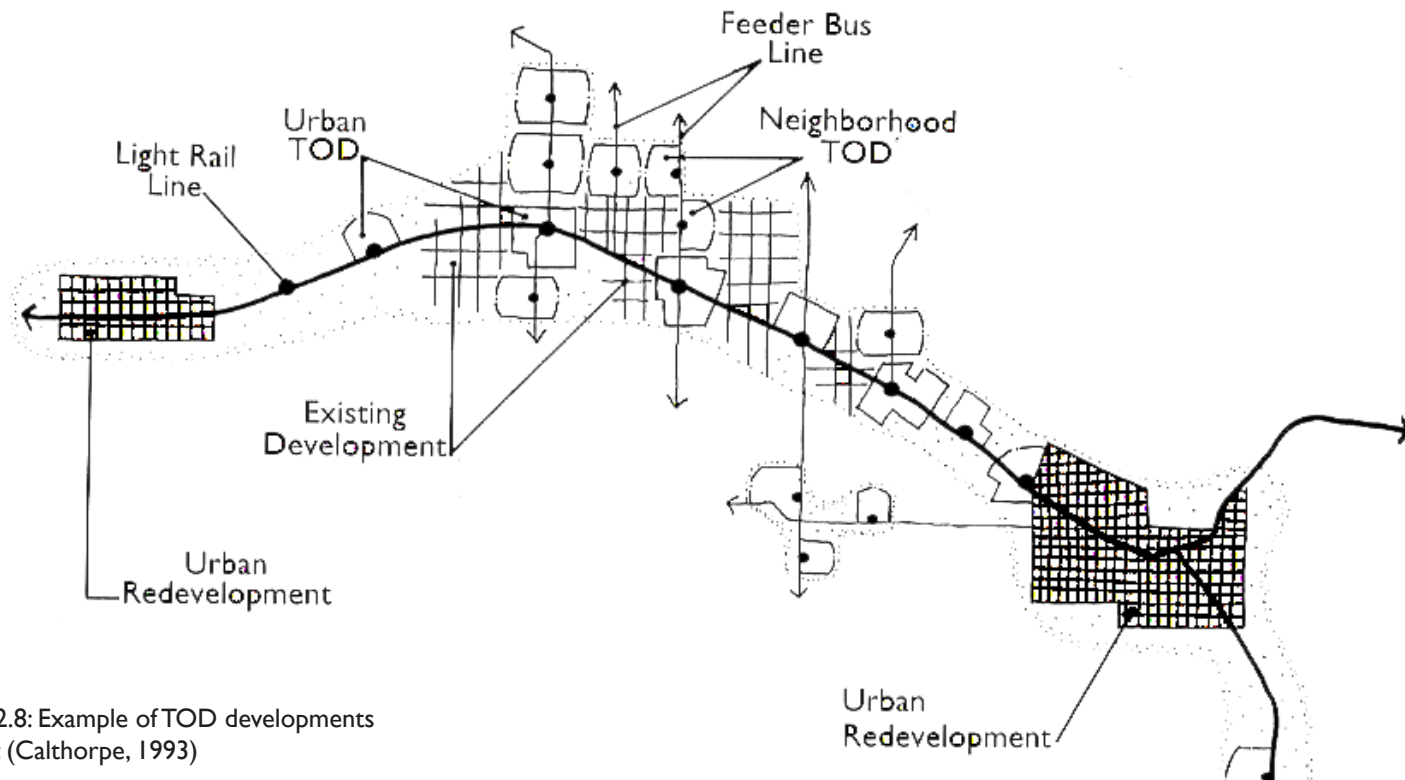


Figure 2.8: Example of TOD developments
Source: (Calthorpe, 1993)

Goals on two scales

The TOD concept has several underlying goals. In general, Calthorpe (1993) mentions two levels of scale, which are relevant in defining the goals of TOD. He mentions the more regional or metropolitan scale and the local or neighbourhood scale. The most important regional goal of TOD is to integrate the transit system on a regional basis. This goal has to contribute by defining an edge for the metropolitan area. Calthorpe (1993) states that the regional goal of TOD is to steer urban developments of the metropolis. The new developments will not only take place along highways, as in the last decades, but also along public transport lines. Another regional goal of TOD is to stimulate the redevelopment task within the urbanized area of the metropolis (Calthorpe, 1993).

The regional goal of TOD will be combined with the local goal. The local goal exists of the development or redevelopment of smaller communities and neighbourhoods into walkable environments. This will lead to alternatives for the car-based neighbourhoods into pedestrian friendly environments (Calthorpe, 1993). In this way TOD is trying to prevent the ongoing urban sprawl by connecting and creating new nodes of activities, working together on the regional and local scale. TOD can in this view be seen as a planning paradigm for creating an alternate for auto use, a strategy towards sustainable and affordable cities (Cervero et al., 2004, Calthorpe, 1993). TOD can be a crucial part of the solution for a lot of social and environmental problems (Dittmar and Ohland, 2004).

The strategy of TOD does not only counter the use of the car and giving alternatives, next to this it is also a solution for the development of affordable and pedestrian friendly communities. In short Calthorpe (1993) summarizes the local and regional principles of TOD into the following points:

- *Organize growth on a regional level to be compact and transit supportive;*
- *Place commercial, housing, jobs, parks, and civic uses within walking distance of transit stops;*
- *Create pedestrian friendly street networks which directly connect local destinations;*
- *Provide a mix of housing types, densities and costs;*
- *Preserve sensitive habitat, riparian zones, and high quality open space;*
- *Make public spaces the focus of building orientation and neighbourhood activity;*
- *Encourage infill and redevelopment along transit corridors within existing neighbourhoods.” (Calthorpe, 1993).*

TOD in Europe, the Stockholm case

A precursor of TOD can be found in Europe, in particular in Scandinavia. In Stockholm and Copenhagen development of a concept for the future metropolis was based on public transport systems. In these cities, corridors of rail infrastructure were planned to steer urban growth along these infrastructural lines (Cervero, 2006). Stockholm is named as the best example of efficiency and sustainable growth of a city. The development of the strategic plan for the Stockholm region has led to a far lower car dependency in this city. These developments around transit had to achieve larger

societal objectives, as the preserving of open space, the accommodation of reasonably priced dwellings (Cervero, 1998). With the development of the transportation lines and the clustering of the extension of the city, open spaces in the landscape could be preserved. The transport lines consist of several nodes, which are connected with the historical core of the city. In these nodes mixed use developments can be found. In that way the transportation network can serve a two-way flow of people in the city (Cervero, 1998). The example of Stockholm is a strategy focussed on the city-regional scale. Therefore, the case of Stockholm can be seen as an example of TOD with specific goals on the regional scale. These regional goals were assisted by the local planning of the transport nodes (Cervero, 1998). In Stockholm the planners and developers achieved a job-housing balance with the integration of transit and new developments (Cervero, 2006).

TOD in the Netherlands

Such an example of the development of a sustainable city is not easy to find in the Dutch situation. The tuning of public transportation networks and urban patterns is lacking the last decades (Bruinsma et al., 2008). In the Netherlands the growth centre policy and the VINEX policy were developed to steer spatial developments. These policies failed in creating synergy between urban development and infrastructure networks, especially with the public transportation networks. (Bruinsma et al., 2008).

As stated in the previous chapter a great part of the urbanised areas in the Netherlands changed from monocentric cities into network cities (Batten, 1995, Meijers, 2007b, Schwanen et al., 2001). This changing structure of urban systems is according to Priemus (2007) a promising perspective. He is questioning how the synergy between urban pattern and infrastructure networks can be enhanced taking these new urban structures into account. Priemus (2007) proposes to redesign the transit system on the regional level by creating or improving the transfer points (nodes) and by interconnecting the various transport modalities. He states that urban nodes have to be considered as interfaces between transportation networks and urban functions. This statement is referring to TOD. Recent examples of efforts to implement TOD in the Netherlands are the Rijn-Gouwe lijn and the Stedenbaan project (Figure 2.9) (Atelier Zuidvleugel, 2006).



Figure 2.9: Map of the Stedenbaan project
Source: (Atelier Zuidvleugel, 2006)

As mentioned, the idea of TOD is from its origin an American planning concept. With the development of TOD in the Netherlands this has to be taken into account. For example: In the American concept of TOD the bicycle does not seem to play a dominant role. This is unimaginable in the Dutch transportation tradition; the bicycle is a very important mode of transportation. This has major consequences for the implementation of this American concept in the Netherlands.

Criteria for measuring success

For judging the success of a TOD project several criteria can be used. These criteria can roughly be classified into spatial and functional criteria. Belzer & Autler (2002) state that definitions of TOD are often focussed on the built form or spatial quality of the project. An example of a

definition of TOD bases on the physical dimension is the definition of Bernick and Cervero (1996). They argue that 'the three D's' are important in TOD: density, diversity and design. These aspects of TOD refer to the physical form of the development. Belzer & Autler (2002) agree that within TOD the quality of the built object and space is necessary. However, they state that a good quality and physical form of the built environment is not enough for a successful and beneficial TOD (Belzer and Autler, 2002). They stress the importance of the functional criteria of TOD. Belzer & Autler (2002) argue that the success of a TOD should be measured by its function and outcomes. Six performance criteria are mentioned for measuring the success of TOD projects. These are: location efficiency, value recapture, liveability, financial return, choice and efficient regional land-use patterns. To measure these performance criteria, a specific perspective can be considered. The perspective of the households will be addressed to elaborate on these functional criteria of TOD.

TOD bottom up, perspective of households

The TOD concept has influence on the various actors within an urban system. One of these actors is the future user of the built environment. In this chapter the perspective of households and the possible implications that the TOD concept has for this user group will be elaborated. The implementation of TOD has major consequences in level of choice and freedom from the households' perspective (Dittmar and Ohland, 2004). When design principles on local and regional level are taken into account, the following advantages could be achieved:

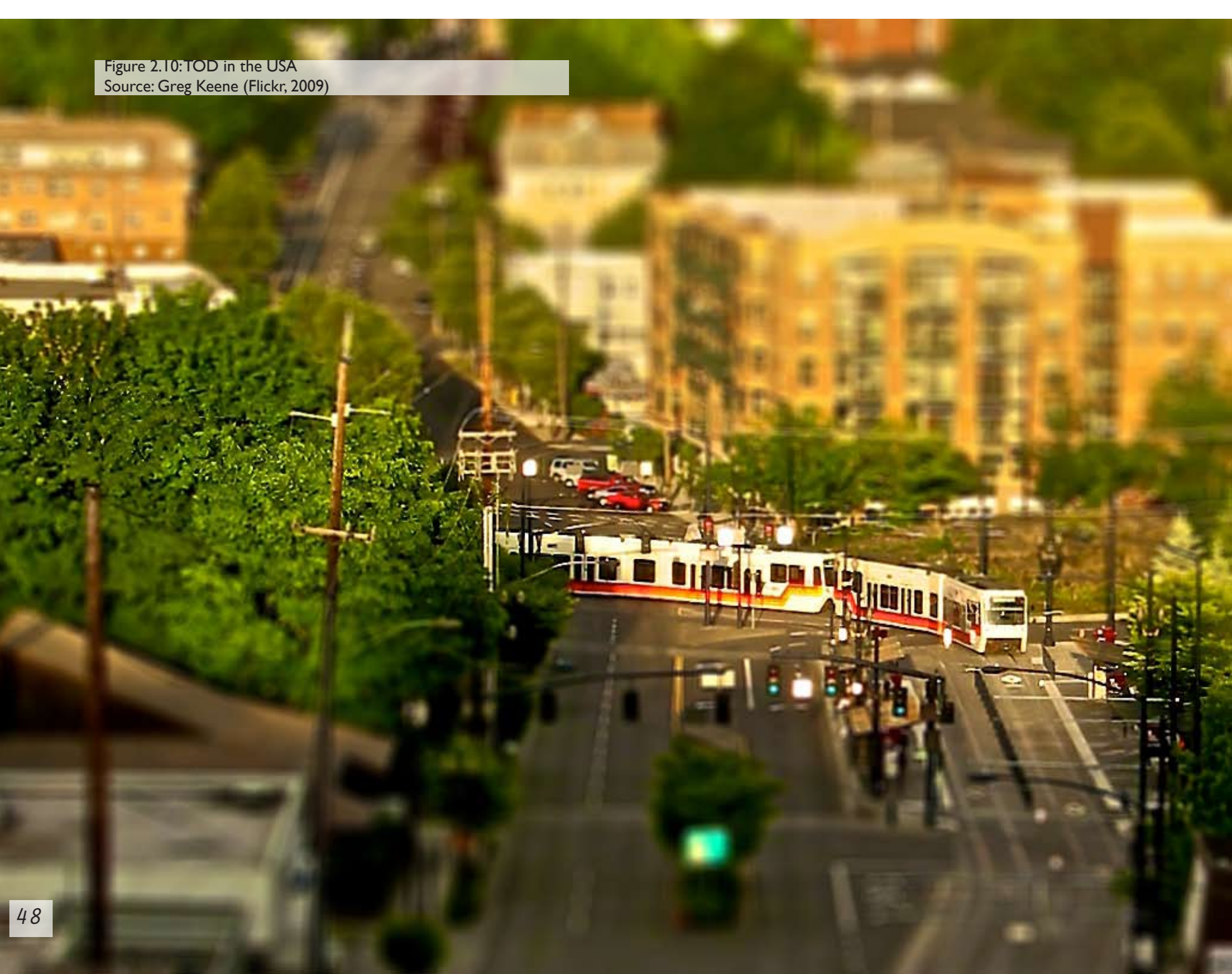
First, with the implementation of TOD families can choose to be less car dependant and can save money without compromising their demand for mobility. Furthermore, the TOD neighbourhood is facilitating a mixed-use environment where many activities can be undertaken within walking distance. This will make communities more convenient. Several activities can be done in a single trip and closely to the living area.

Moreover, if communities are build in a way that households are close to shops, jobs and services, the lifestyle can be more affordable (Calthorpe, 1993). In that way TOD can influence the interactions of a household. The Action Space of people in the concept of TOD will change. With implementing the TOD strategy, less time will be spend on travelling and more activities can take place in a shorter distance.

In addition, a TOD neighbourhood, build on the principle of choice, can provide the inhabitants with a wide variation for instance of housing typologies (Dittmar and Ohland, 2004). Within the TOD development households can select dwellings that fit their needs. If the families' progress trough live stages, for instance when the children are leaving the parental house, they can select another house within the community. The changed household does not have to leave the community (Dittmar and Ohland, 2004).

Finally, if jobs are integrated in the TOD neighbourhood, people can live close to their work. This can help to decrease the flows of people in the cities. Thereby this will contribute in solving the problems of unsustainable transport.

Figure 2.10: TOD in the USA
Source: Greg Keene (Flickr, 2009)



Conclusion

The car is an energy and space consumer. Road building is no longer an option or solution for the congested cities (Banister, 2005). The key to a sustainable and liveable city can be found in demand management, a strong policy to promote public transport and the concentration of developments (Banister, 2005). TOD is a concrete planning paradigm to implement these goals in today's planning practice. Examples all over the world show that the integration of development or redevelopment with public transport has significant sustainability benefits (Cervero, 2006).

TOD finds its origin in the USA, as a solution for countering the unsustainable urban sprawl patterns. In Europe the first attempts to combine spatial developments around transit systems can be found for example in Stockholm. Spatial policy in the Netherlands the last decades lacks this synergy between urban patterns and public transport infrastructure. The Dutch planning tradition lacks a comprehensive integration of public transport with new developments.

The development of new transit line has often only the primary goal to improve accessibility of the city or region. In this case this way of planning cannot be seen as integrated and comprehensive planning method.

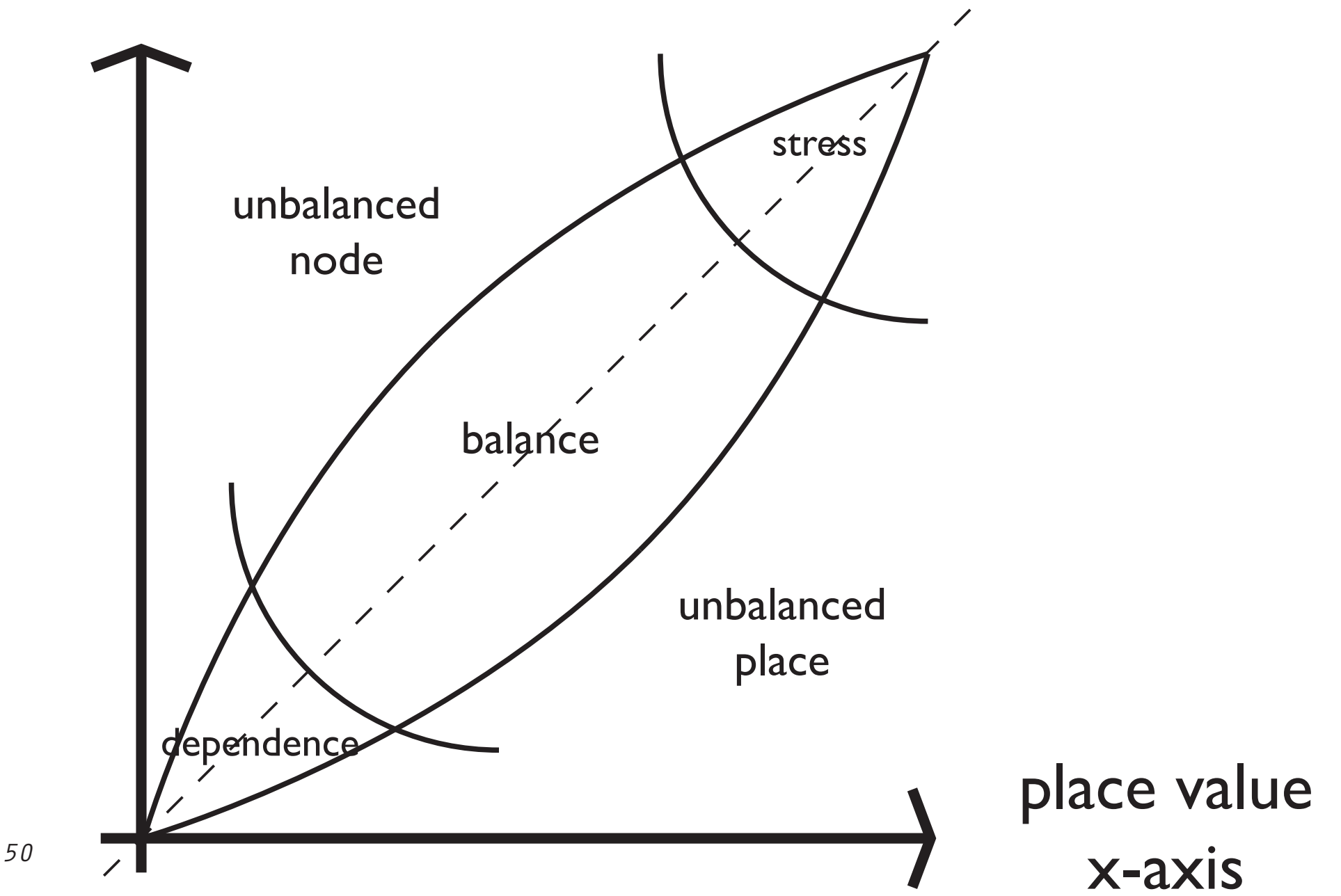
The objective is to narrow and mainly focussed on the technical part, on the sector of traffic engineering.

Despite this, first attempts are been made to create synergy between transit and development, for example with the development of the Stedenbaan project in the South wing of the Randstad. This project can be seen as one of the first attempts to implement the TOD strategy in the Netherlands. The implementation of TOD as a

strategy can influence the interactions that exist in the region. If all the principles of TOD will be implemented, both the physical and the functional, and the goals on regional scale as on the local scale will be strived after, this is a worthwhile strategy to implement in the Dutch planning tradition. Despite the problem of urban sprawl is less extreme in the Netherlands as in the USA, there are valid reasons for implementing the TOD strategy in the Netherlands in some city-regions, for instance in the Utrecht-region. The cities in the Netherlands are also facing problems concerning accessibility, sustainability and the search for new living environments. TOD can in this case be seen as a radical strategy to deal with the serious sustainability problems of the cities. In the TOD strategy the sustainability and accessibility problems of the city will be transformed into opportunities for the future of the city. For the success of TOD it is important to be aware of the complementarity of the regional and the local goals. The chapter hereafter will describe why this is important with the development of station areas.

node value
y-axis

Figure: 2.11: Scheme node-place model
Source: (Bertolini, 1999)





2.1.3 The node-place model of Bertolini

Introduction

The node-place model of Bertolini (1999) is the basis for the analysis and research of the potentials of existing, planned and possible new stations in the Utrecht-region. This model is selected for this research because it focuses on the interactions of e.g. a public transport node. According to Bertolini (1999), the goal of every public transport node is making interactions possible. The degree of possible interactions is determined by two components: the node value and the place value (Bertolini, 1999). Therefore, the station area has an ambivalent character. On the one hand it functions as a node in the (regional) public transport system. On the other hand the station area is an important place in the (local) city or urbanized area (Bertolini, 1999).

Node value (y-axis) and place value (x-axis)

The node value of a station represents its accessibility (Bertolini, 1999). If the station is very well accessible, this will result in a high node value. Subsequently, the node value indicates the *potential* for physical human interaction. The place value represents the diversity and intensity of activities that can be performed near the (public transport) node. It describes the degree of an *actual* realization of the potential interactions in e.g. a station area (Bertolini, 1999). The graph of this node-place model of Bertolini is shown in Figure 2.11.

The reason for using this concept for the analysis of station areas is that this model shows the potentials of station areas. The goal is to search for a balance between node- and place value. In that way the potentials of a station area are used optimally. There is a mechanism

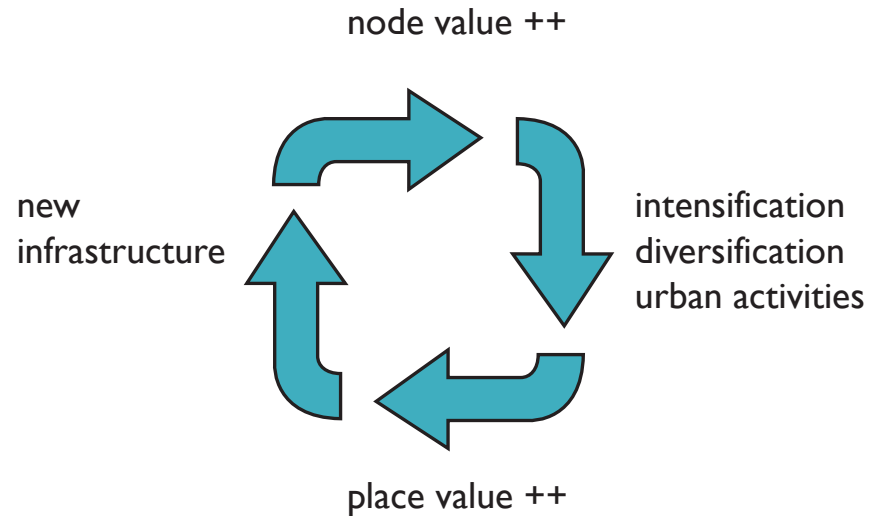
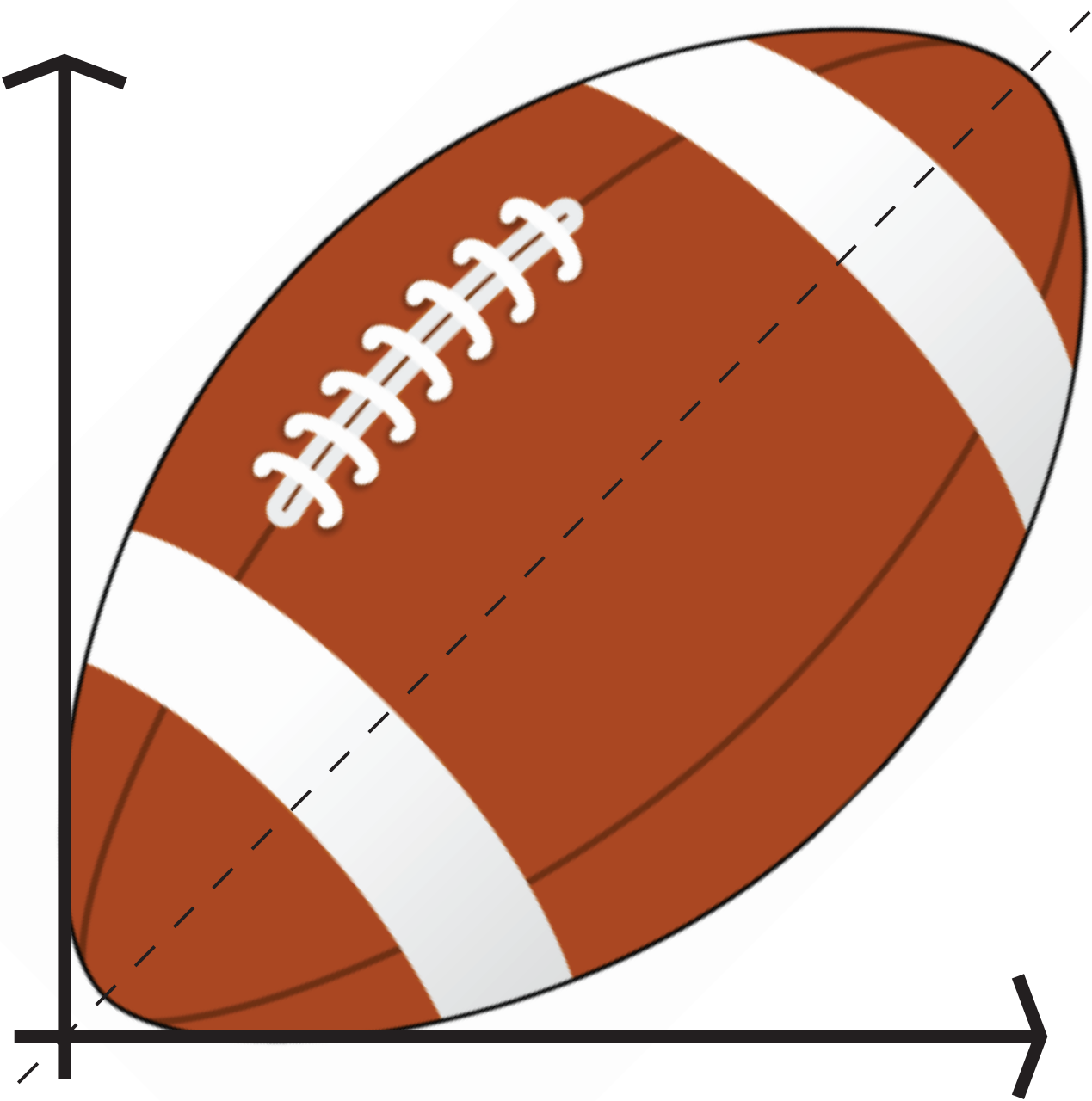


Figure 2.12: Mechanism node-place model
Source: (Bertolini, 1999)

behind this thought. Improving the provision of public transport of e.g. a station will lead to the creation of favourable conditions for intensification and diversification of the land use around this station (Bruinsma et al., 2008). The space value of this station area can be improved by adding urban activities. This process of intensification and diversification will lead to a growth in demand for connections. Hence, the creation of new conditions for development of new infrastructure at this node is possible. This cyclic process is shown in Figure 2.12.

node value
y-axis

Figure 2.13: Rugby ball node-place model
Source: (Bertolini, 1999)



place value
x-axis

Situations

In the node-place model of Bertolini, five situations can be distinguished. These five situations can be divided into the ideal-typical and the unbalanced situations. There are three ideal-typical situations and two unbalanced situations (Bruinsma et al., 2008).

First, the description of the ideal-typical situations.

Stations with a very high node- and place value are (public transit) nodes which are *under stress* (Bertolini, 1999).

The intensity and diversity of the transportation flows is maximal, these nodes have a very high node value.

Furthermore, the intensity and diversity of activities surrounding the node is also high, resulting in a high place value. The situation is called 'under stress' because all these different and intense activities and flows result in a great chance of conflicts (Bertolini, 1999). There is a limited amount of space and there are multiple extensive claims on this space.

The opposite of this stressed situation is the situation of *dependency*. When e.g. a station area is dependent this means that there are very few transportation services and the node value of this station is very low. Furthermore, the amount of urban activities around the station is resulting in a low place value. These nodes or stations are not feasible at all. Therefore, the question can be put forward whether these nodes or stations should exist (Serlie and Zweedijk, 1998).

Another ideal-typical situation is the accessible or *balanced* situation. Hereby the place and node value are equal (Serlie and Zweedijk, 1998). The balanced situation can be found around the middle line of the diagram (Figure 2.11). The existing potentials of the station area are in balanced with the actual present urban activities.

Next to these ideal-typical situations, two unbalanced situations can be distinguished. At the top left of the diagram the unbalanced or unsustainable nodes can be identified. At these stations the node value or supply of public transport is high. The urban activities around the node are low and not (yet) developed (Bruinsma et al., 2008).

The opposite of this situation are the unsustainable places. In this case the urban activities are quite intense and diverse, however, the node value or supply of transportation is relatively low. An example of an unsustainable place is an old historic district with a lot of urban activities but with a poor accessibility. The unbalanced situations can be found outside the lines of the "rugby ball". Within the curves of the "rugby ball" the more balanced stations can be found (Figure 2.13).

Operationalization of the node-place model

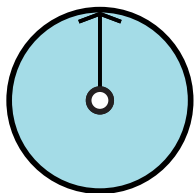
For measuring the node value of the stations in the Utrecht-region, two criteria are assessed. First, the position of each station in the public transport system is analyzed. An example of a variable is whether the station has an intercity stop. Second, the position of the station in the road network is researched. An example of measuring this is the amount of exits within the catchment area of each station.

The place value is also determined by two variables, namely the workers and residents density and the degree of functional mix. The degree of functional mix is determined by the ratio between workers and residents.

Figure 2.14: Geographical rules

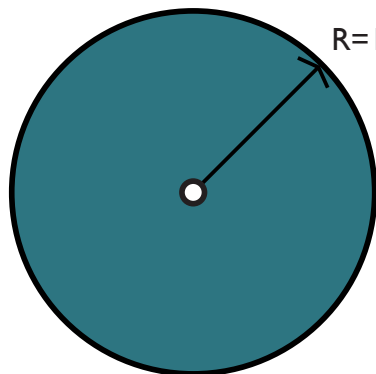
1

R=600



5 min

R=1200

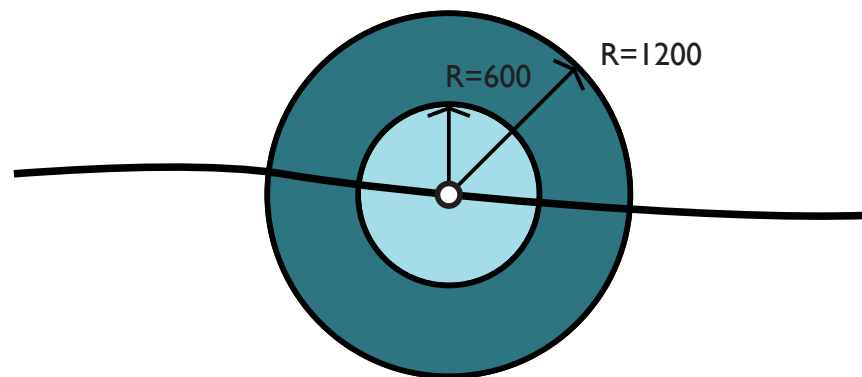


5 min

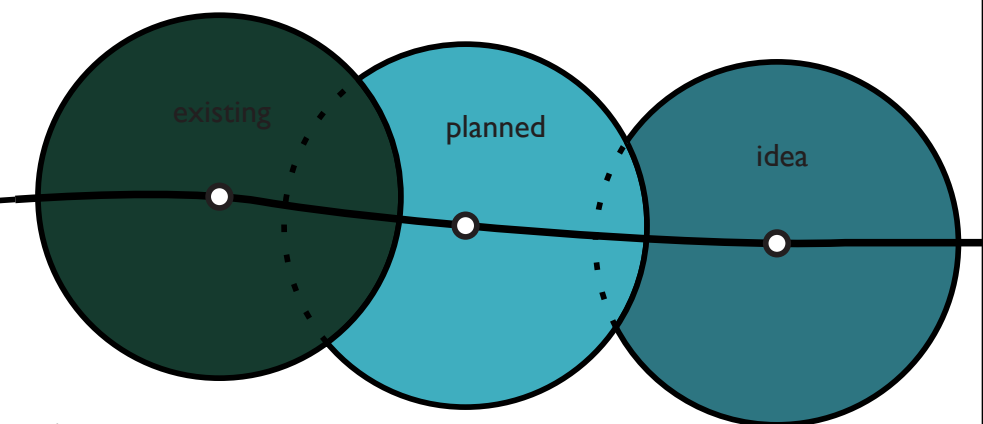


15 min

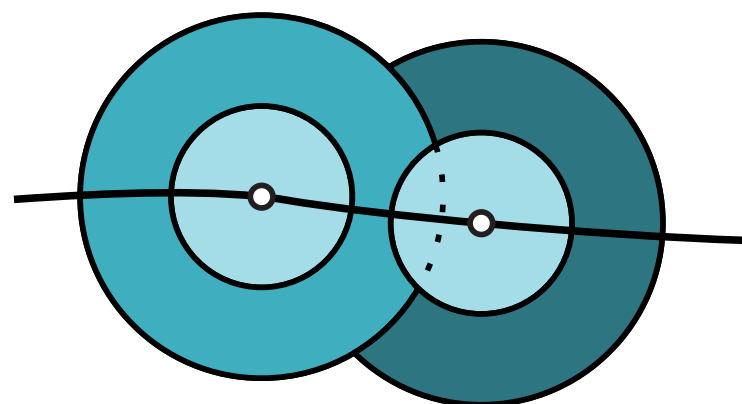
2



3



4



Geographical rules

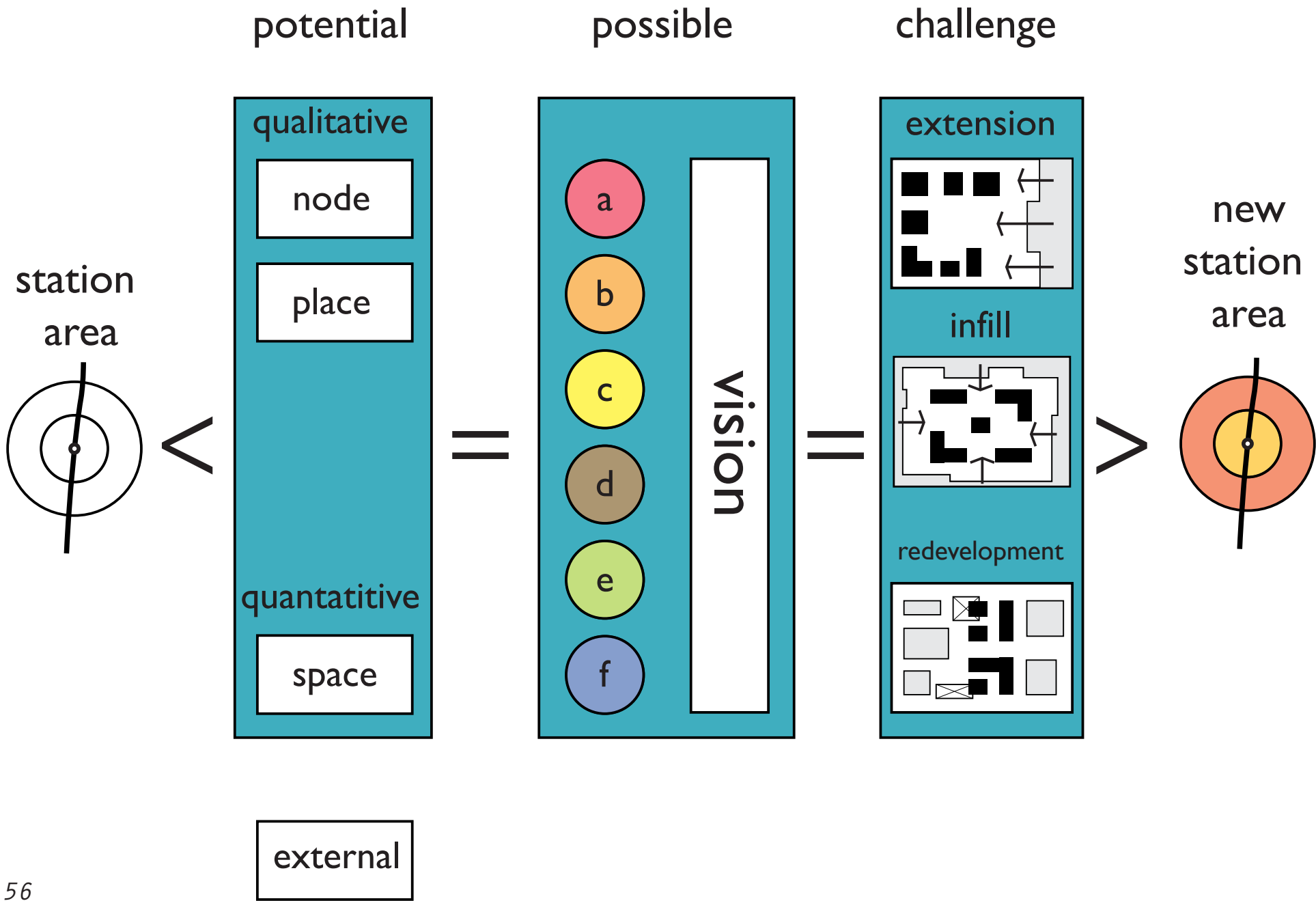
For the consistency and accuracy of this research, a set of geographical rules for the different catchment areas of the stations is defined. The different rules are graphically represented in Figure 2.14.

1. Every station area has two catchment areas. The first catchment area has a radius of 600 meter and the second is set with a radius of 1200 meters. In the definition of TOD a walking distance of 2.000 foot (=600 meter) is taken (Calthorpe, 1993). In the Netherlands the bicycle plays an important role in transportation. Therefore, a second catchment area of a radius of 1200 meter is also used. This distance can be covered within 15 minutes walking, or 5 minutes by bicycle (Atelier Zuidvleugel, 2006).
2. Catchment areas do not overlap; the 600-meter catchment area is always dominant over the 1200-meter catchment area.
3. The catchment areas of 1200 meters of existing stations are dominant over the catchment areas of planned stations.
4. Catchment areas of existing and planned station areas are dominant over the possible new station areas (Figure 2.14).

Scheme

Every existing, planned and possible new station of the Utrecht-region is researched to unravel its potentials. There are quantitative and qualitative variables used to describe the potentials of every station area (Figure 2.16). Qualitative variables are the node- and place value of the stations. A quantitative variable is e.g. the availability of open space that is suitable for the development of housing.

Figure 2.15: Process station areas, potentials, possibilities and challenges



Qualitative: Node-place values

For the identification of the qualitative variables the node-place model of Bertolini is used. The mutual influences of spatial configuration and mobility are combined in this model (Chapter 2.1.3). In this research the theory of Bertolini is combined with the concept of transit-oriented development (TOD). The node-place-theory of Bertolini has common ground with the principles of TOD. In fact, the success and the opportunities of a TOD are dependant on e.g. the position of this TOD in the public transport network. With other words, the node-place model of Bertolini is describing the position of every station in the regional context and its opportunities to develop in a transit oriented way.

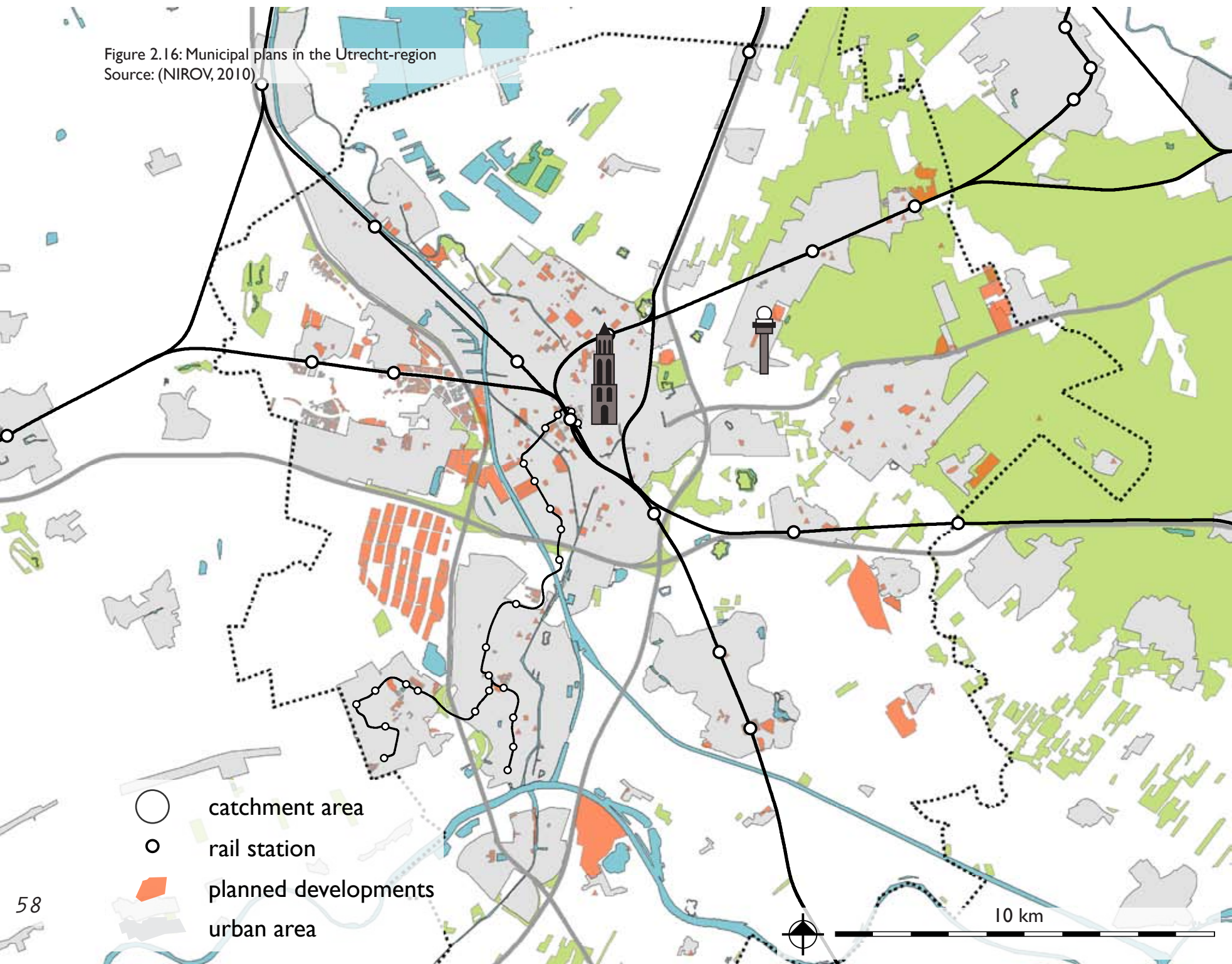
Quantitative: Available space, municipal plans & restrictions

Next to the qualitative variables, there are quantitative values of a station area. The availability of open space is one of the variables for measuring the potentials of a station area in a quantitative way. Example: if there is a station with a high node value and there is a lot of open space in the vicinity of the station that is not a protected landscape, this station has a great potential for development. The development of the municipal plans is strongly related to this variable. A station can have a great potential due to a very high node value, however the landscape surrounding the station area could be protected. This will diminish the potentials of this station area. In this project the municipal plans and restrictions are partly taken into account.

External: landscape and restrictions.

The qualitative and quantitative variables of station areas are not mentioning the scenic qualities and restrictions on the local scale level. Local municipalities eventually decide whether a station area could be developed. Within this research these external factors are partially taken into account. The local municipal plans are considered in this regional design proposal by means of the “Nieuwe Kaart van Nederland”. This map shows all the planned interventions and functional changes proposed by the municipalities in the Netherlands (NIROV, 2010b) (Figure 2.16).

Figure 2.16: Municipal plans in the Utrecht-region
Source: (NIROV, 2010)



2.2 Practice-based research

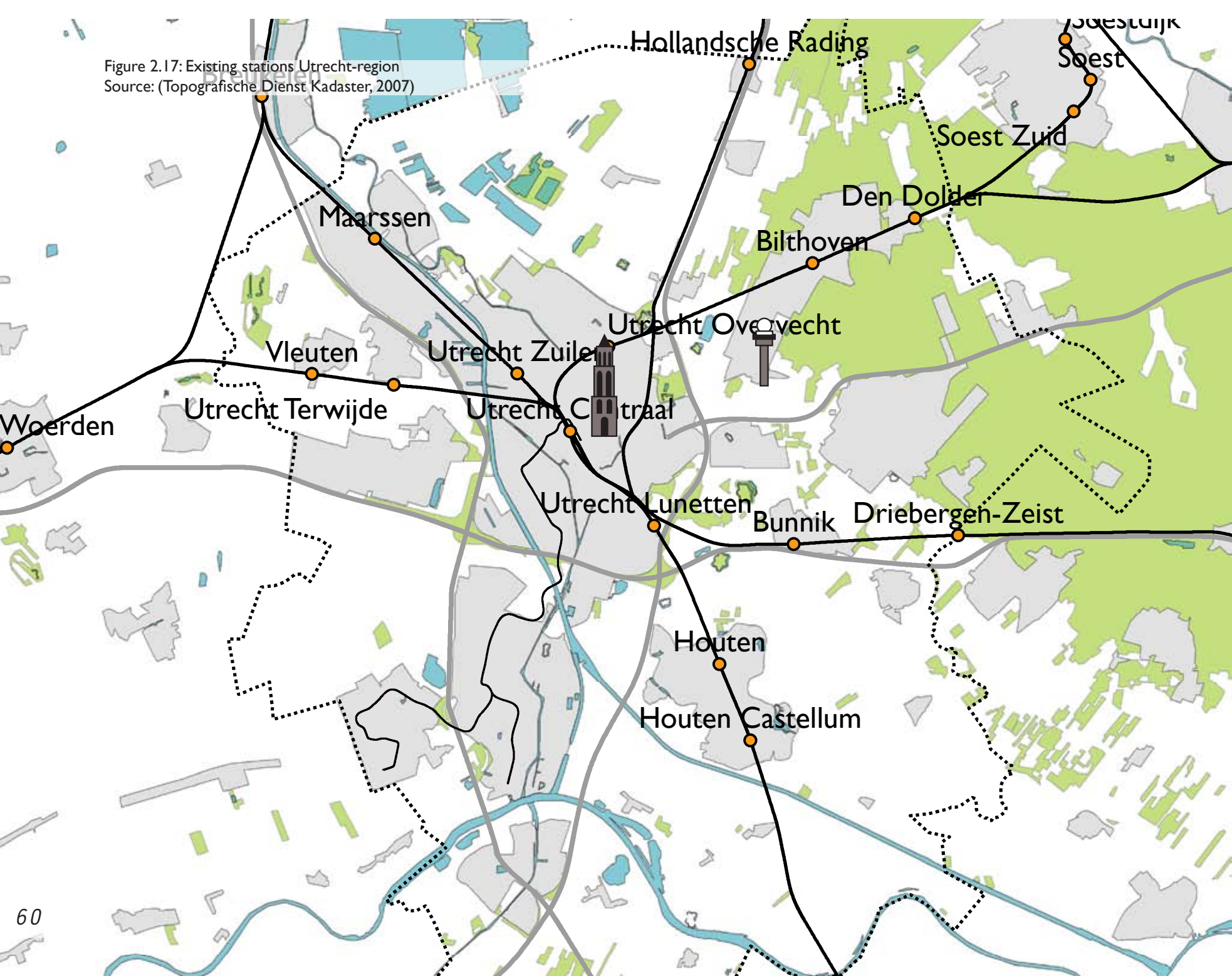
In this chapter, the practice-based research will be described. First, the potentials of all the existing, planned and possible station areas in the Utrecht-region are identified. This is executed by the analysis of the quantitative variables, namely the node- and place value of every station. Next to this, the demographic analysis and the origin- destination analysis are illustrated. In the last part of this chapter conclusions are written from all the analytical work that is executed. These conclusions will be further translated into requirements for the regional design of the Utrecht-region.

2.2.1 Why potentials of station areas?

Railway stations are becoming of great importance in contemporary European cities (Kusumo, 2007). They are highly accessible by multiple modes of transportation at different levels of scale. A lot of urban activities and interactions take place at station areas. Hence, the station can be seen as a node of socio-economic interactions (Jacobs, 2000). According Kusumo (2007), station areas are developing as new centres in the city.

Therefore, station areas are important subjects in contemporary urban and regional planning. For the development of a regional design and strategy for the Utrecht-region, station areas play a crucial role. For this research the node-place model is used. This model describes the actual realization and the potential of human interaction in a certain public transport node. All existing, planned and possible new station areas in the Utrecht-region are researched and identified.

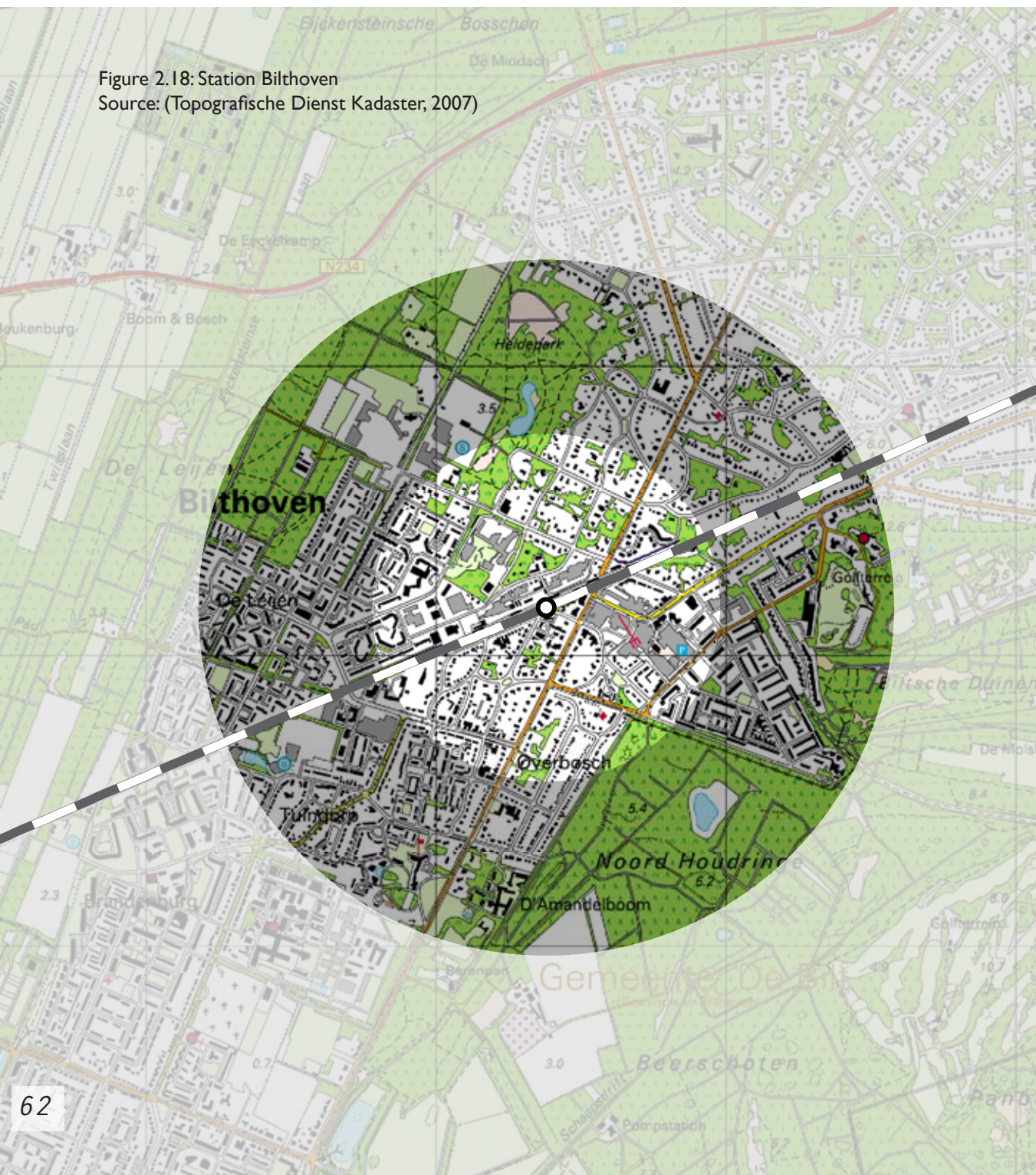
Figure 2.17: Existing stations Utrecht-region
Source: (Topografische Dienst Kadaster, 2007)



2.2.2 Potentials of existing stations

The existing stations in the Utrecht-region are researched on their potentials. There are large differences in opportunities of the existing station areas. Some of the existing station areas are already in (re) development. A good example is Centraal Station Utrecht. This station area will be in development until the year 2030. This is the reason that within this station area no new developments will be proposed in chapter 3. This also counts for stations within new development sites. Utrecht Terwijde and Houten Castellum are examples of station areas that are still in development (Figure 2.17).

Figure 2.18: Station Bilthoven
Source: (Topografische Dienst Kadaster, 2007)



Bilthoven

Node value

Position road network



Position transit network

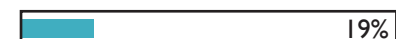


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



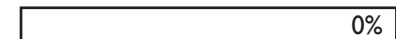
Open space



Nature



Water



Other





Figure 2.19: Impression station area Bilthoven
Source: (Flickr, 2009)

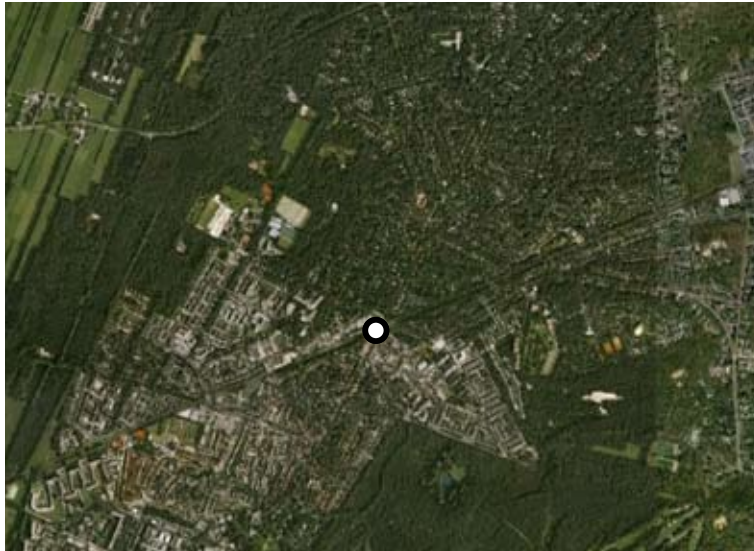


Figure 2.20: Aerial picture of station Bilthoven
Source: (Google maps Nederland, 2009)

Bilthoven

The station of Bilthoven is a typical station of a small village in the vicinity of the central city of Utrecht. Both, node value and place value are not high compared to the other stations in the Utrecht-region. For this reason the station of Bilthoven is near to the *dependent* stations. From a physical-spatial point of view possibilities for the development of Bilthoven are also limited due to existing urbanization and qualities of the landscape. Mostly the entire surface in the vicinity of the station is used for residential purposes.

Figure 2.21: Station Bunnik
Source: (Topografische Dienst Kadaster, 2007)



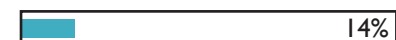
Bunnik

Node value

Position road network



Position transit network



Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other

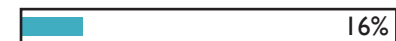




Figure 2.22: Impression station area Bunnik
Source: (Flickr, 2009)



Figure 2.23: Aerial picture of station Bunnik
Source: (Google maps Nederland, 2009)

Bunnik

The station of Bunnik has a relatively high place value. The reasons for this are the high density of workers and residents and the high mix between these functions. The node value of the station is low. The cause of this low node value is the position of Bunnik in the public transport network. Only a regional train stops at Bunnik and it has only two bus connections. The potential of this station is its high place value. Adding more supply for public transportation could strengthen this station. When this is done, the place value of the station can be further enhanced. The extensively used business location in between the rail tracks and the highway A12 is a potential area for redevelopment. Next to this, space is available at the south side of the A12 for further development within the catchment area of this station.

[illegible]

Node value

29%

Category	Percentage
Other	14%

Workers/inhabitants density

7%

29%

Agriculture

	0%
--	----

9%

	10%
--	-----

62%

0%

18%



Figure 2.25: Impression station area Den Dolder
Source: (Flickr, 2009)

Den Dolder

Den Dolder is a station that is near to the situation of *dependency*. Both, place and node value are relatively low. The place value of Den Dolder is slightly higher than its node value. From physical-spatial point of view there is space available for further developments. In the catchment area of this station there are some extensively used business locations and this areas have potentials for redevelopment. Furthermore, there are some areas that are extensively used for residential purposes and also have potentials for redevelopment. Next to this, a part of the old military airbase Soesterberg is located in the catchment area of the station.

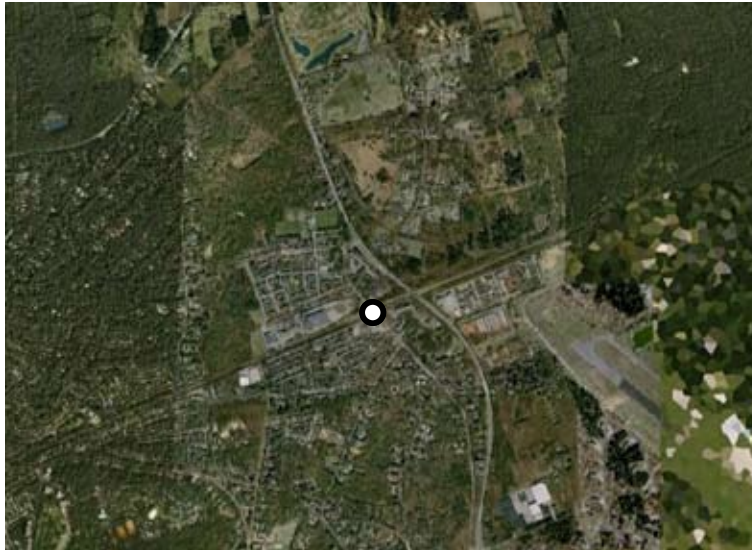


Figure 2.26: Aerial picture of station Den Dolder
Source: (Google maps Nederland, 2009)

Figure 2.27: Station Driebergen-Zeist
Source: (Topografische Dienst Kadaster, 2007)



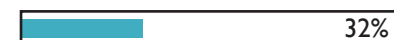
Driebergen-Zeist

Node value

Position road network

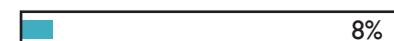


Position transit network

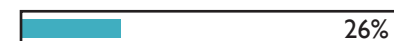


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other





Figure: 2.28 Impression station area Driebergen-Zeist
Source: (Flickr, 2009)



Figure 2.29: Aerial picture of station Driebergen-Zeist
Source: (Google maps Nederland, 2009)

Driebergen-Zeist

Driebergen-Zeist is a station with a relatively high node value. This value is high because Driebergen-Zeist has a strong position in the public transport network, among others because it has an intercity stop. The position in the road network is also very strong because there are multiple highway exits within the vicinity of the station. Despite the fact that the node value of Driebergen Zeist is high, the place value of the station is quite low. The catchment area of the station contains a lot of open space. There are just a few urban activities in the vicinity of the station. There are possibilities for developments in the catchment area of this station.

Figure 2.30: Station Hollandsche Rading
Source: (Topografische Dienst Kadaster, 2007)



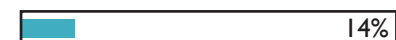
Hollandsche Rading

Node value

Position road network

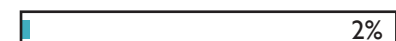


Position transit network

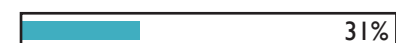


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



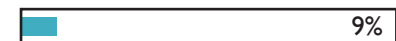
Nature



Water



Other

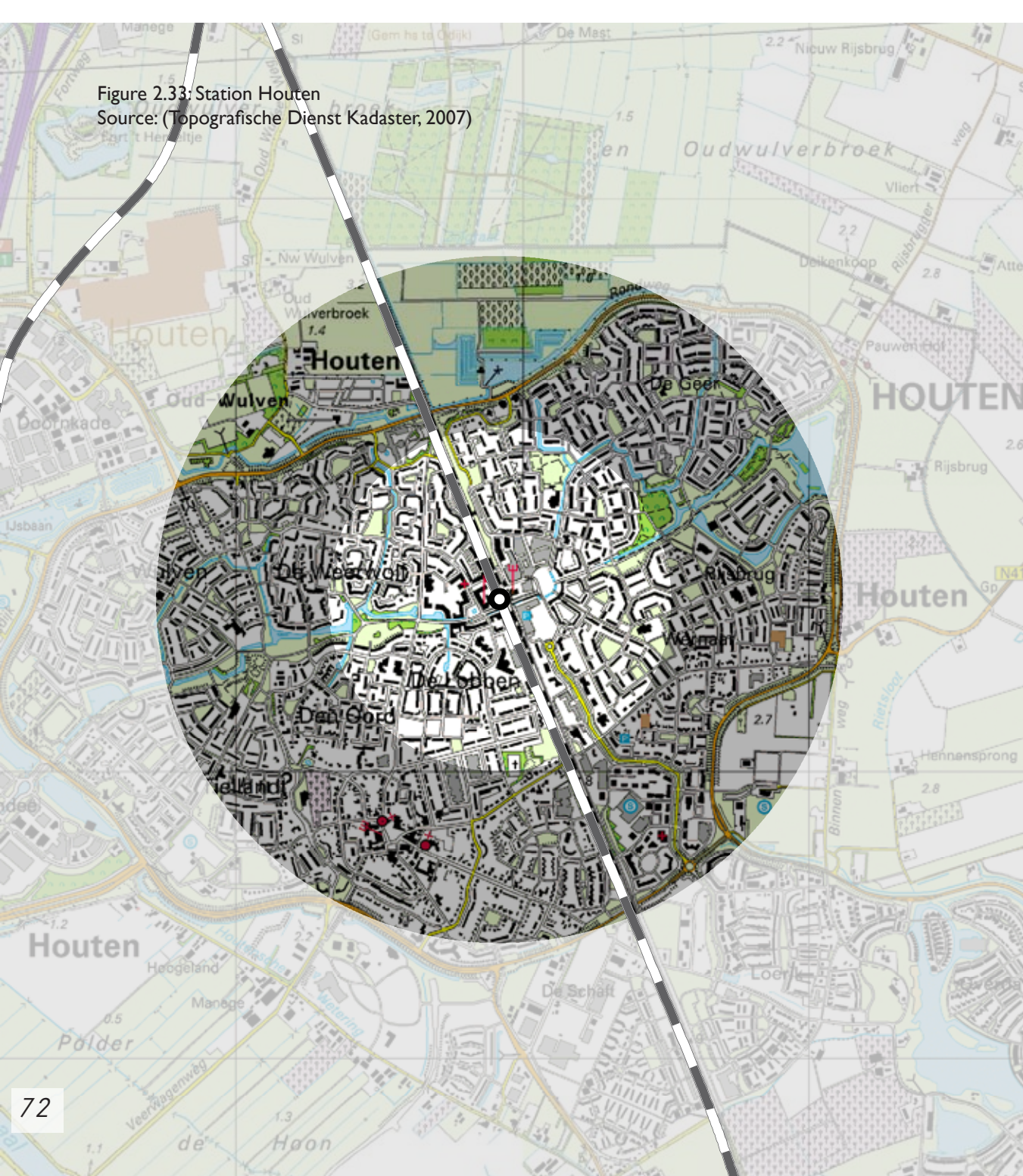




Hollandse Rading

The station of Hollandse Rading is a good example of a station near *dependency* (Bertolini, 1999). Place- and node value are low. For example: the train station is only connected by one bus line. The cause of the low place value is the small amount of workers and inhabitants within the catchment area of the station. Next to this, the little urban areas in the vicinity of the station are very extensive and have low densities. It is questionable whether the station Hollandse Rading should be maintained. Reasons for this are the limited amount of passengers using this station, and the limited possibilities for spatial developments.





Houten

Node value

Position road network



Position transit network

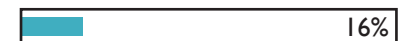


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other

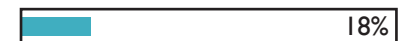




Figure 2.34: Impression station area Houten
Source: (Flickr, 2009)



Figure 2.35: Aerial picture of station Houten
Source: (Google maps Nederland, 2009)

Houten

The place value of this station is relatively high. This high place value is caused by the amount of inhabitants and workers within the catchment area of the station. This amount is relatively high. The node value of Houten is in the present situation quite low. However, the realisation of two extra rail tracks (one in each direction) will probably increase the node value of this station (Projectbureau Randstadspoor, 2008). From a physical-spatial point of view possibilities for more urban activities are limited. Planned interventions in the catchment area of Houten will most likely gain improvements of the place value. In the vicinity of the station of Houten new developments are taking place in combination with the construction of new tracks. Within the catchment area of the station most parts are already urbanized.

Figure 2.36: Station Houten Castellum
Source: (Topografische Dienst Kadaster, 2007)



Houten Castellum

Node value

Position road network

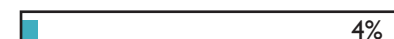


Position transit network

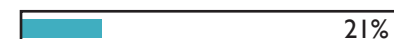


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



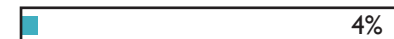
Open space



Nature



Water



Other

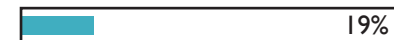




Figure 2.37: Impression station area Houten Castellum
Source: (Flickr, 2009)

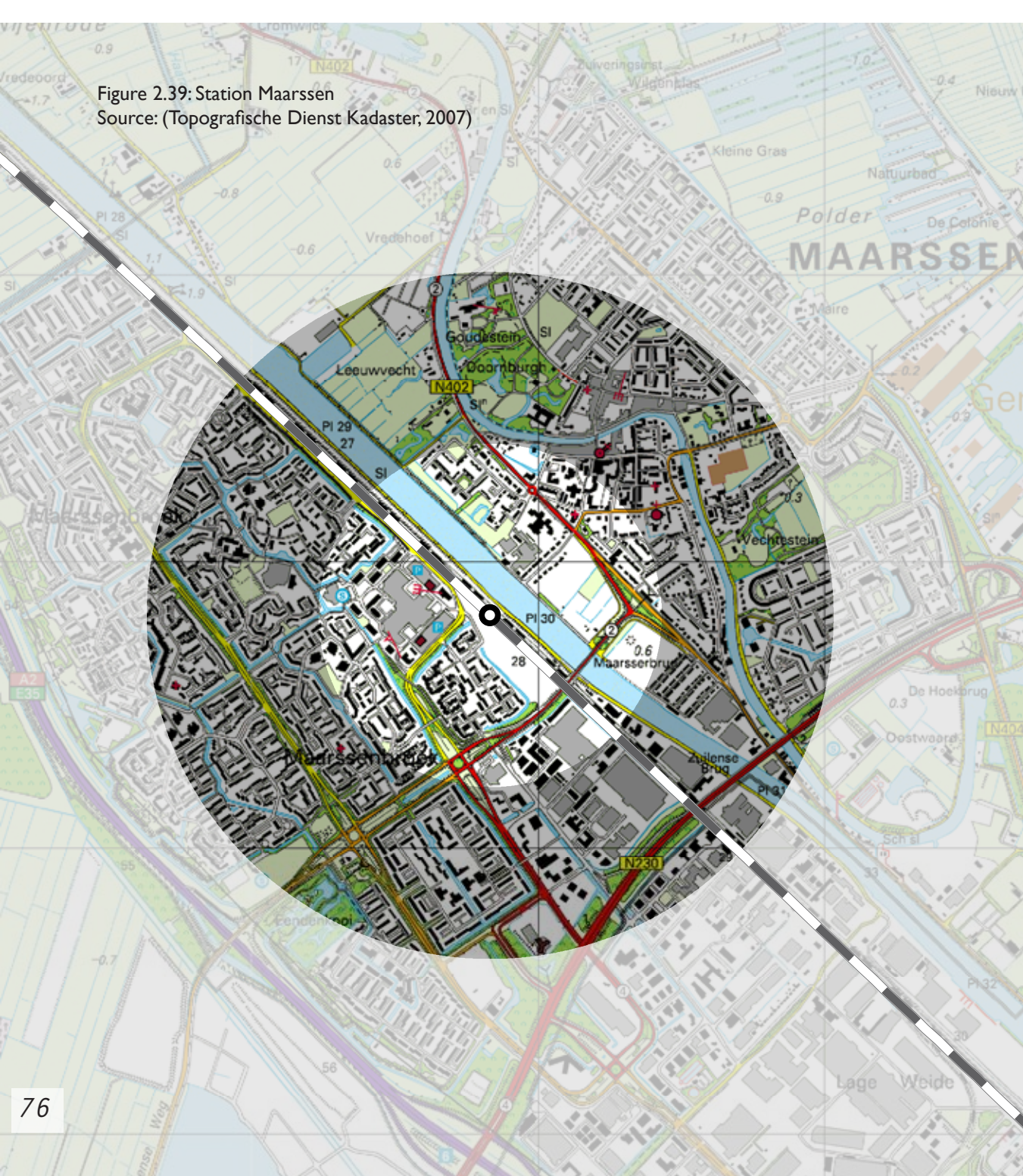
Houten Castellum

Node- and place value are equal at the station of Houten Castellum. This means that there is a balanced situation at this node. However, node and place value at this station are very low. The reason for this is that Houten Castellum is a station that is still under construction. Urban activities are planned near the station to increase the place value. Furthermore, the realization of two extra tracks will increase the node value of this station.



Figure 2.38: Aerial picture of station Houten Castellum
Source: (Google maps Nederland, 2009)

Figure 2.39: Station Maarssen
Source: (Topografische Dienst Kadaster, 2007)



Maarssen

Node value

Position road network

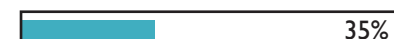


Position transit network

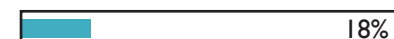


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other





Figure 2.40: Impression station area Maarsse
Source: (Flickr, 2009)

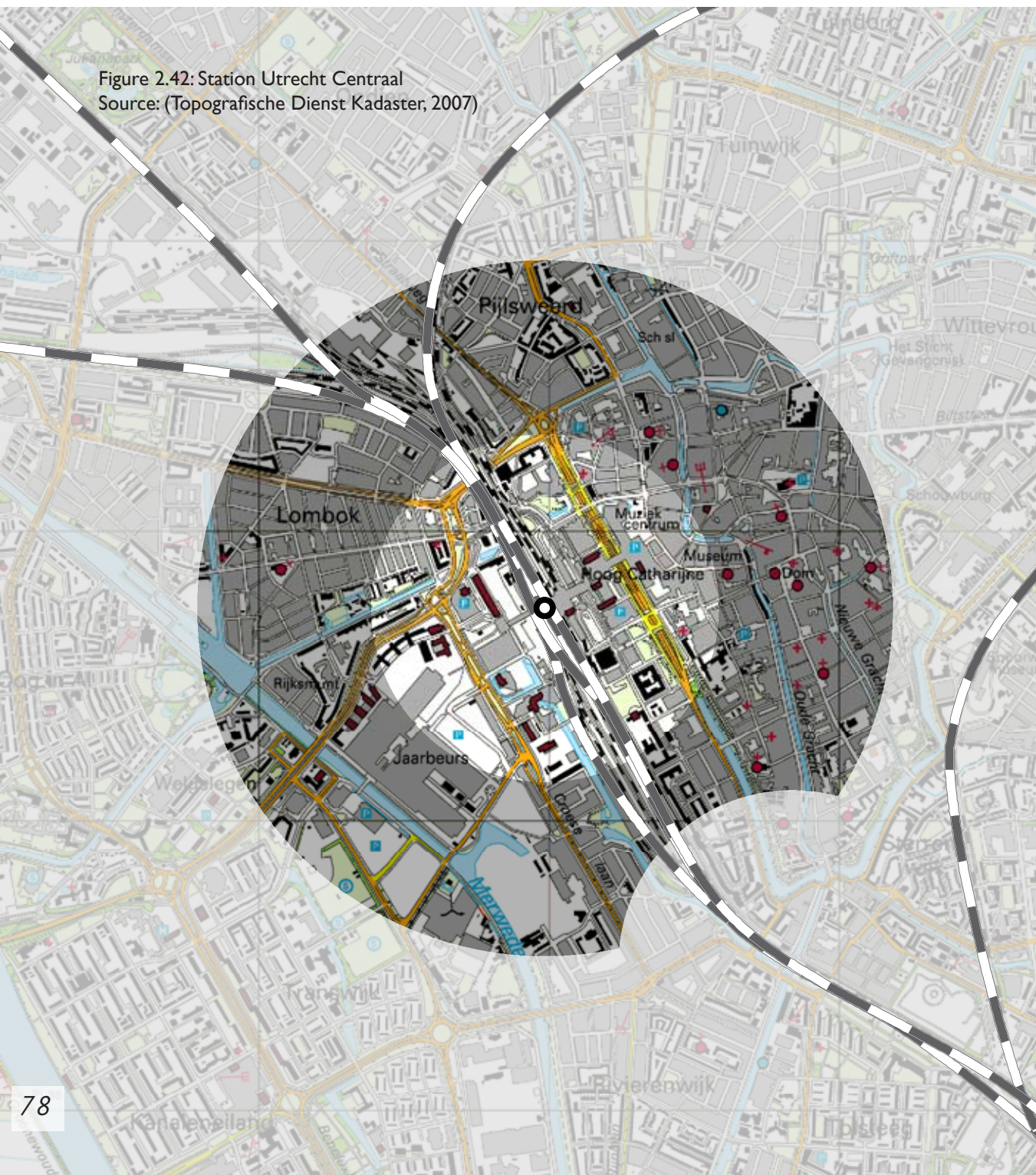
Maarsse

Maarsse is a station with a relatively high place value compared with its node value. One of the reasons for this high place value is the high density of workers and inhabitants within the catchment area of the station. A retail centre is located near the station that contributes to a high place value. Increasing the supply of transportation could further develop this station. From a physical-spatial point of view, space for development is very limited near the station area. Furthermore, the presence of a physical barrier the Amsterdam-Rijnkanaal is limiting the actual catchment influence of the station.



Figure 2.41: Aerial picture of station Maarsse
Source: (Google maps Nederland, 2009)

Figure 2.42: Station Utrecht Centraal
Source: (Topografische Dienst Kadaster, 2007)



Utrecht Centraal

Node value

Position road network



Position transit network

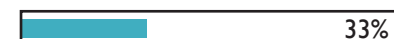


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



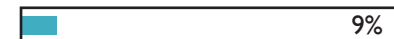
Open space



Nature



Water



Other

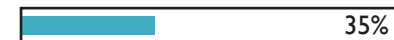




Figure 2.43: Impression station area Utrecht Centraal
Source: (Flickr, 2009)



Figure 2.44: Aerial picture of station Utrecht Centraal
Source: (Google maps Nederland, 2009)

Utrecht Centraal

Utrecht Centraal is a good example of a station *under stress* (Bertolini, 1999). It has the highest node and place value of all the stations in this research. For this reason the ratio of the node- and place value of Utrecht Centraal is set to 1. All other stations in the Utrecht-region are compared to Utrecht Centraal in Figure 2.86. The urban system of the Utrecht-region is dominated by one single location: Utrecht Centraal station (Bruinsma et al., 2008). Utrecht Centraal is a location with great concentration of flows and activities. The station area functions as a centre of cultural and economic activity in the region and has the highest densities of housing and workplaces. This also means that there is a great chance of conflicts between multiple claims on a limited amount of space. Currently the station area Utrecht Centraal station is in procedure for a big reconstruction.

Figure 2.45: Station Utrecht Lunetten
Source: (Topografische Dienst Kadaster, 2007)



Utrecht Lunetten

Node value

Position road network

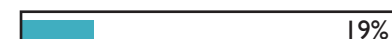


Position transit network

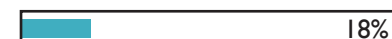


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



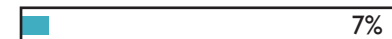
Open space



Nature



Water



Other

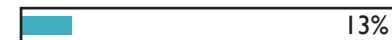




Figure 2.46: Impression station area Utrecht Lunetten
Source: (Flickr, 2009)

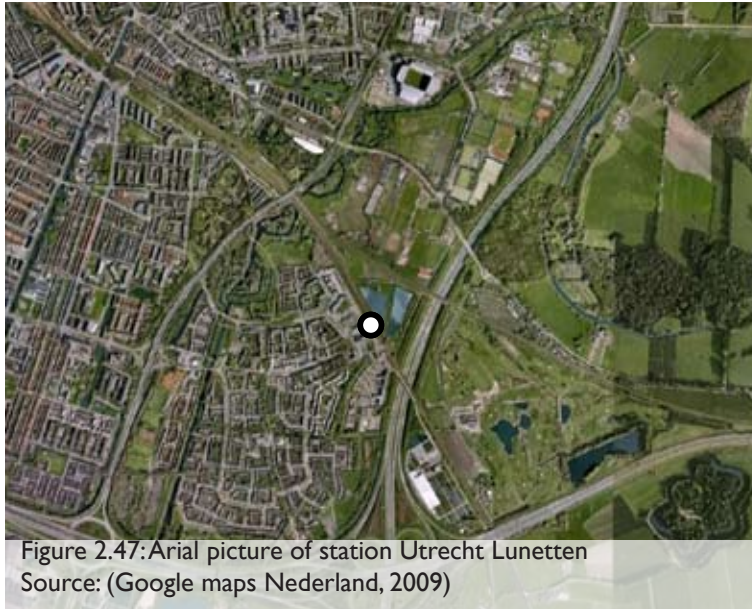


Figure 2.47: Aerial picture of station Utrecht Lunetten
Source: (Google maps Nederland, 2009)

Utrecht Lunetten

Utrecht Lunetten has quite a high node value. This is caused by its good position in the road network. The position in the public transport network is quite low and could be improved. The total place value of Utrecht Lunetten is low. This station will be moved towards the northwest and changed in the station Utrecht Lunetten Beatrixpark. This will increase the node value of this station further, because in the new situation the station area is connected to another traditional rail line. There is enough open space in the vicinity of this station to increase the place value of this station.

[illegible]

Node value

55%

Category	Percentage
30%	30%

Workers/inhabitants density

48%

22%

Agriculture

0%

35%

19%

Response	Percentage
U.S. should take more action to address climate change	6%

7%

33%



Figure 2.49: Impression station area Utrecht Overvecht
Source: (Flickr, 2009)

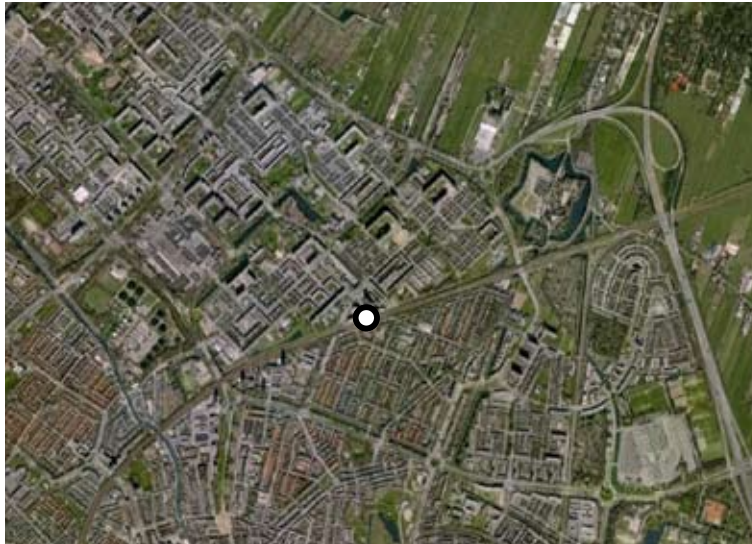
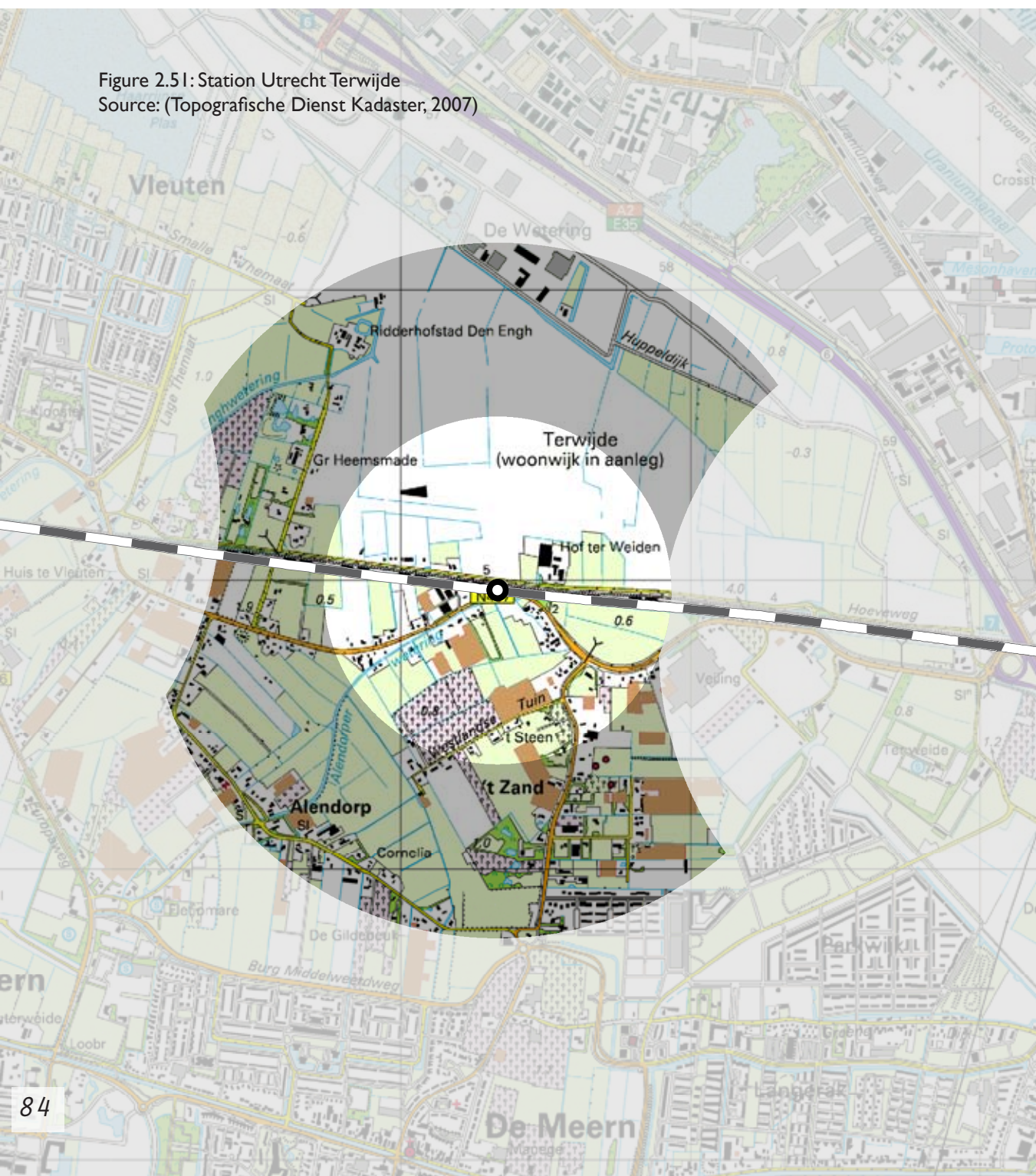


Figure 2.50: Aerial picture of station Utrecht Overvecht
Source: (Google maps Nederland, 2009)

Utrecht Overvecht

Both node and place value are quite high of the station Utrecht Overvecht. Utrecht Overvecht is currently a station with one intercity connection. This explains its node value. The position of the station in the road network is also quite strong. The place value is high because there are a lot of workplaces near the station area. Also the amount of residents in the vicinity of the station is very high. From a spatial point of view the possibilities for extension and infill in the close vicinity of the station are limited. However, in the area surrounding at the north side of the rail tracks there are possibilities for redevelopment and intensification.

Figure 2.51: Station Utrecht Terwijde
Source: (Topografische Dienst Kadaster, 2007)



Utrecht Terwijde

Node value

Position road network



Position transit network

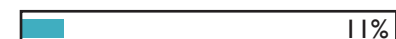


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other

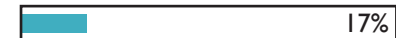




Figure 2.52: Impression station area Utrecht Terwijde
Source: (Flickr, 2009)

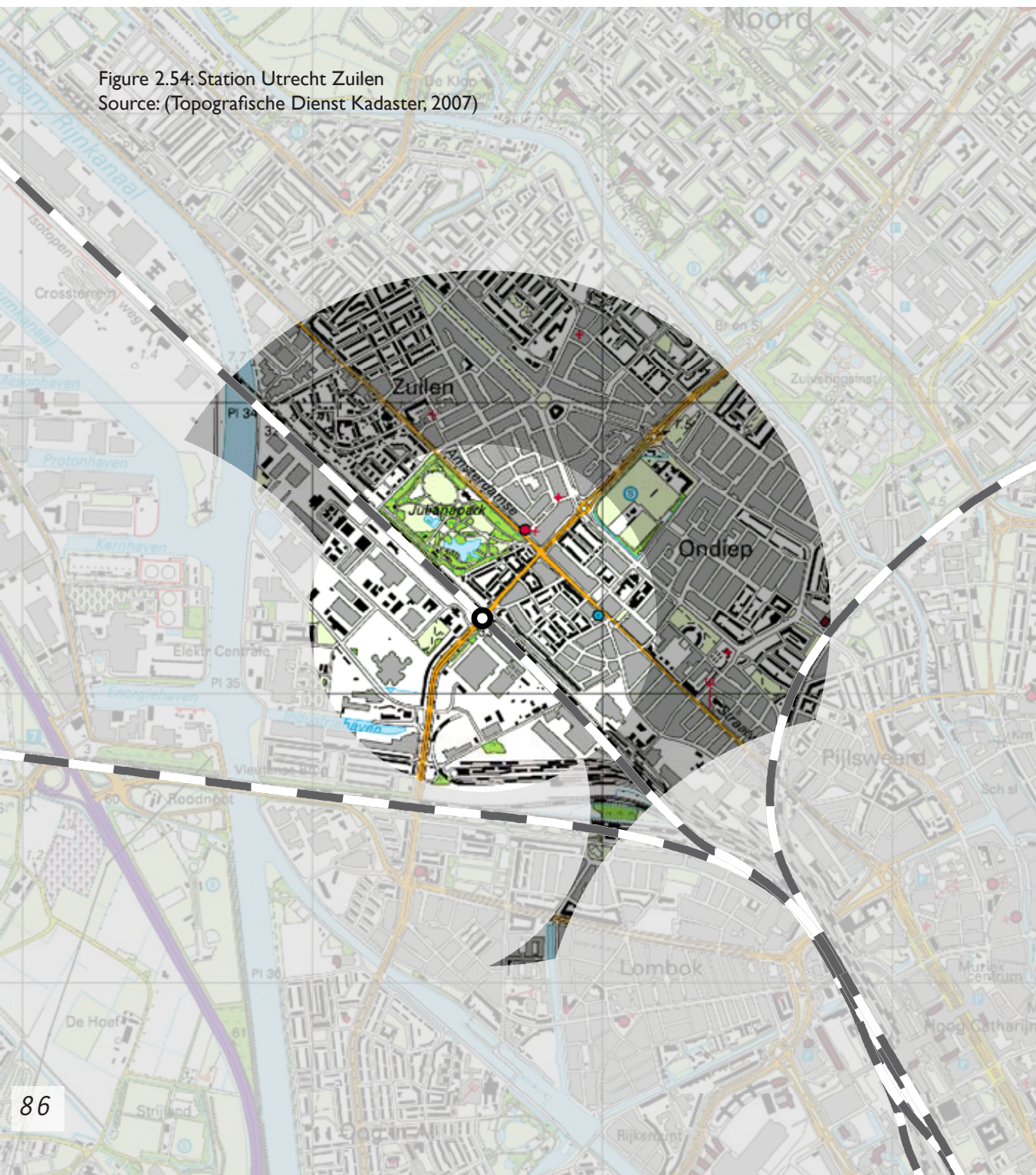


Figure 2.53: Aerial picture of station Utrecht Terwijde
Source: (Google maps Nederland, 2009)

Utrecht Terwijde

The existing station Utrecht Terwijde is in the present situation a moderate station in node- and place value. The node value is moderate due to the small amount of possibilities in the public transport - and road network. The cause of the moderate place value is the small amount of workers and residents and the poor functional mix in the catchment area of this station. The planned new developments in VINEX location Leidsche Rijn will influence the place value in a positive way. This also applies for the node value, due to improvements in the public transport system (extension of bus system) and the road system.

Figure 2.54: Station Utrecht Zuilen
Source: (Topografische Dienst Kadaster, 2007)



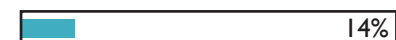
Utrecht Zuilen

Node value

Position road network



Position transit network



Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other

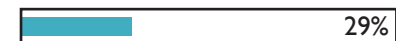




Figure 2.55: Impression station area Utrecht Zuilen
Source: (Flickr, 2009)

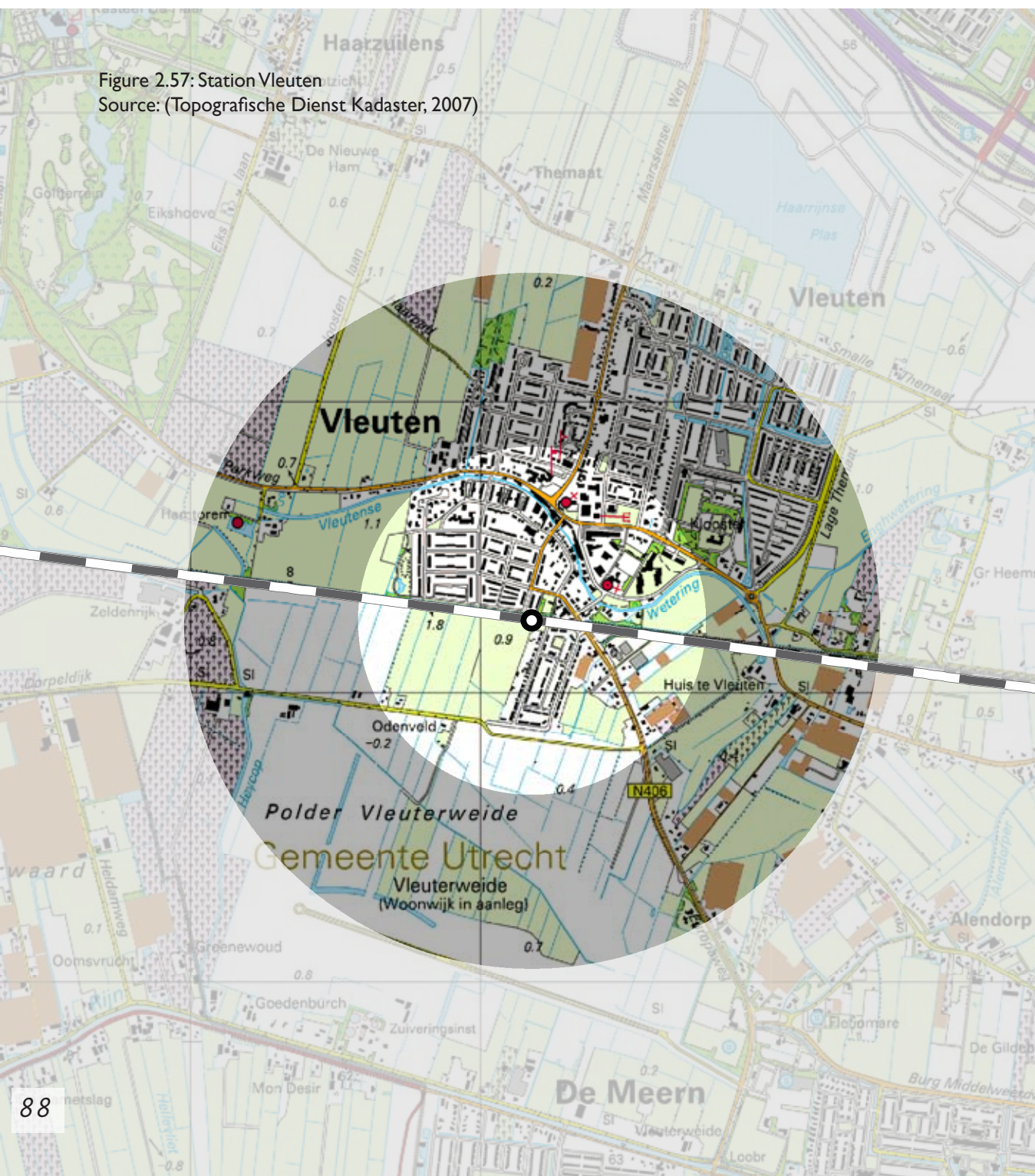
Utrecht Zuilen

Utrecht Zuilen has quite a high node- and place value. The node value is relatively high due to the good connection of the station with the road network. The position within the public transport network is moderate. The large amount of residents and a moderate score of the functional mix is the cause of a relatively high place value. There are possibilities for developments in the catchment area of Utrecht Zuilen. The redevelopment of the “Cartesiusdriehoek” and business location Daalsedijk will result in more support for this station.



Figure 2.56: Aerial picture of station Utrecht Zuilen
Source: (Google maps Nederland, 2009)

Figure 2.57: Station Vleuten
Source: (Topografische Dienst Kadaster, 2007)



Vleuten

Node value

Position road network

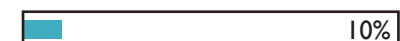


Position transit network

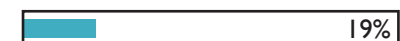


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other

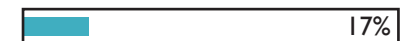




Figure 2.58: Impression station area Vleuten
Source: (Flickr, 2009)

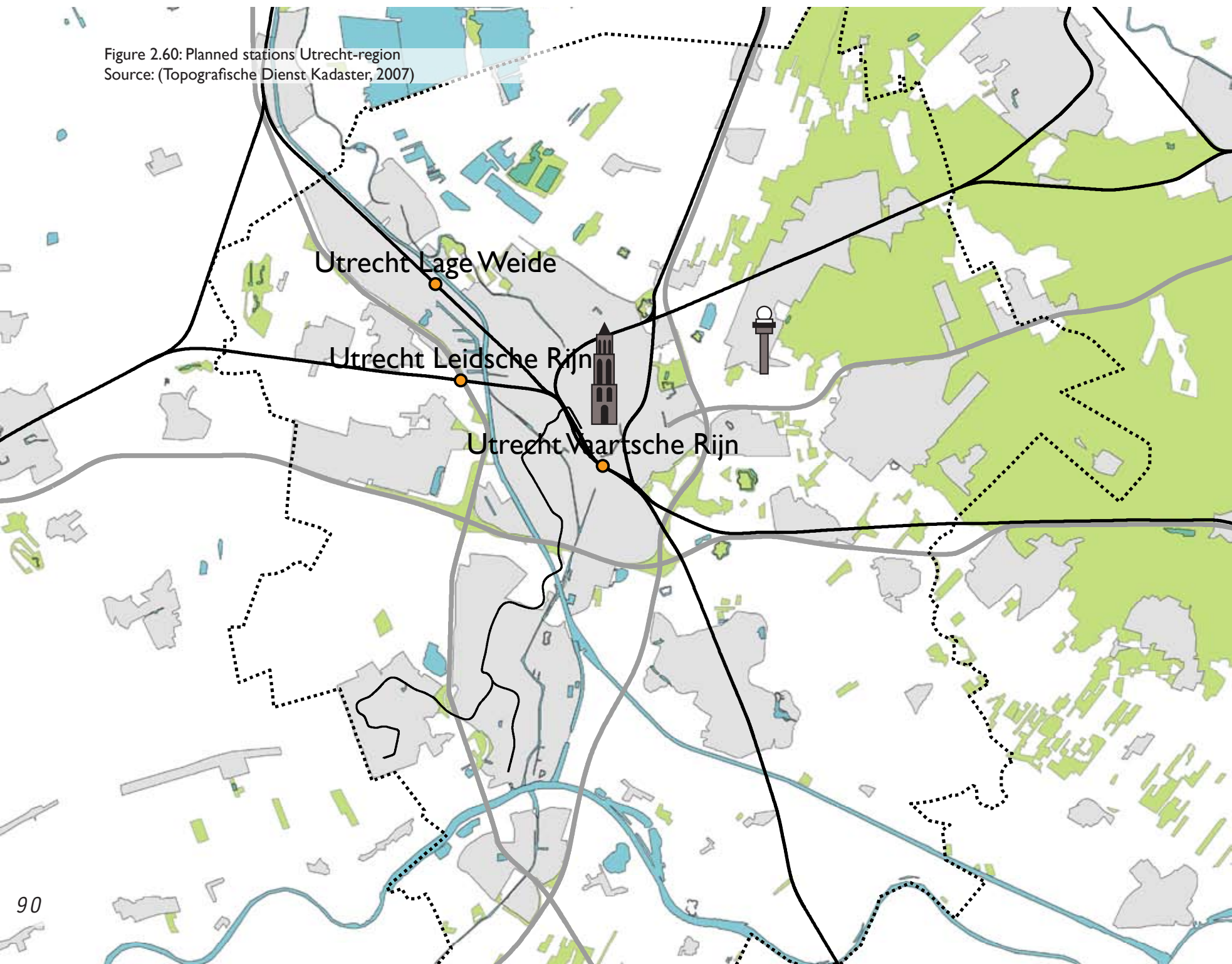
Vleuten

The existing station Vleuten is in the present situation a moderate station in node- and place value. The node value is moderate due to the small amount of possibilities in the public transport network and road network. The cause of the moderate place value is the small amount of workers and residents and the poor functional mix in the catchment area of this station. The planned new developments in VINEX location Leidsche Rijn will probably influence the place value in a positive way. This also applies for the node value, due to improvements in the public transport system and the road system.



Figure 2.59: Aerial picture of station Vleuten
Source: (Google maps Nederland, 2009)

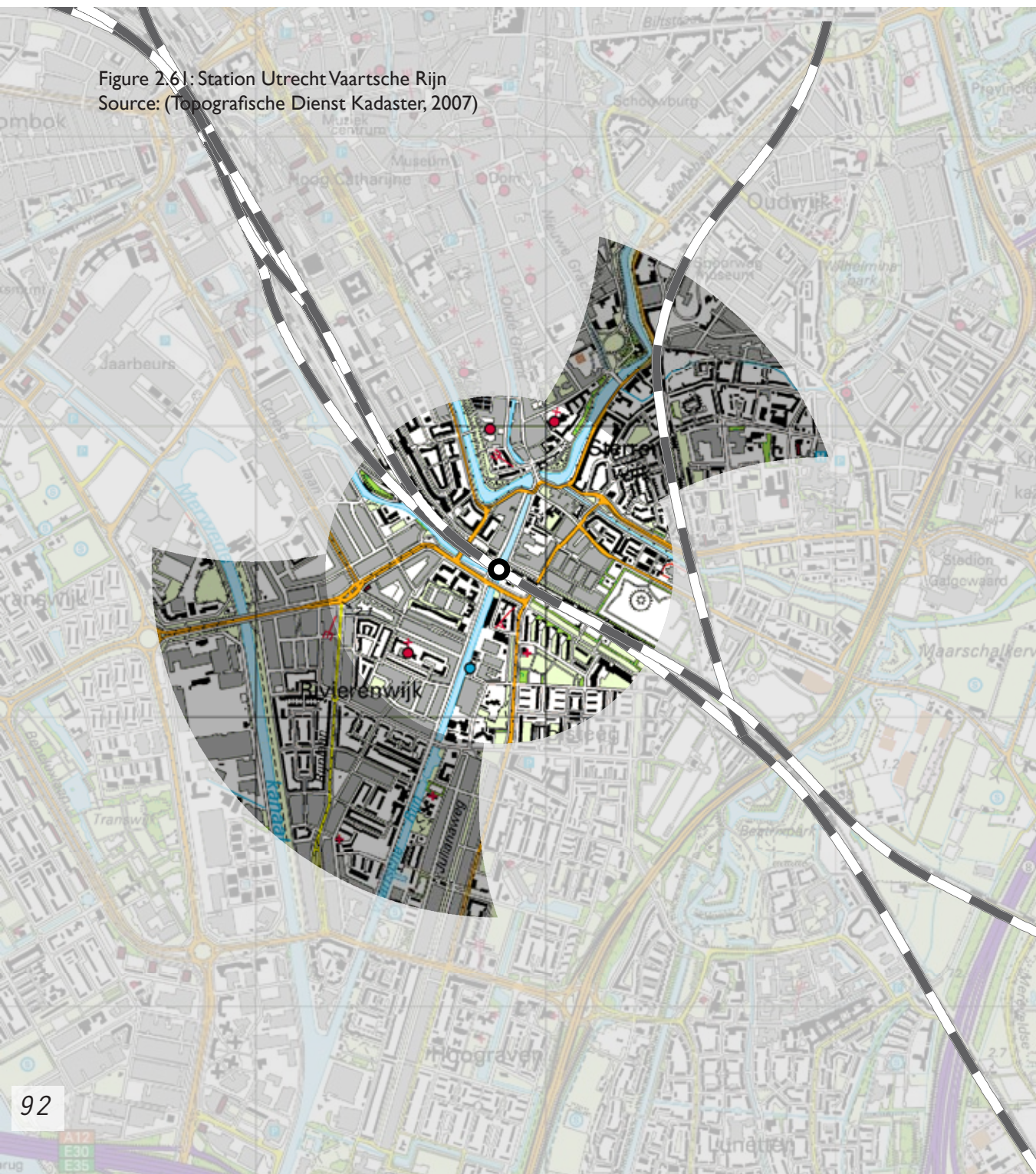
Figure 2.60: Planned stations Utrecht-region
Source: (Topografische Dienst Kadaster, 2007)



2.2.3 Potentials of planned stations

In the Utrecht-region there are a few stations that are already planned for development (Figure 2.60). In this research and design these planned stations are taken into account. This will result in a more realistic and valuable research and design for the BRU. The planned stations are Utrecht Vaartsche Rijn, Utrecht Leidsche Rijn Centrum and Utrecht Lage Weide. Utrecht Vaartsche Rijn and Utrecht Lage Weide are the stations which area already proposed without any additional spatial developments. Actually, there are opportunities in these station areas for developments. These opportunities are determined in this chapter and are taking into consideration in the design.

Figure 2.61: Station Utrecht Vaartsche Rijn
Source: (Topografische Dienst Kadaster, 2007)



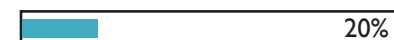
Utrecht Vaartsche Rijn

Node value

Position road network



Position transit network



Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



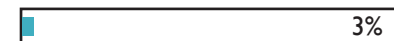
Built



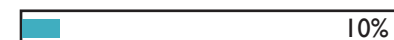
Open space



Nature



Water



Other

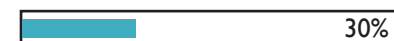




Figure 2.62: Impression station area Utrecht Vaartsche Rijn
Source: (Flickr, 2009)

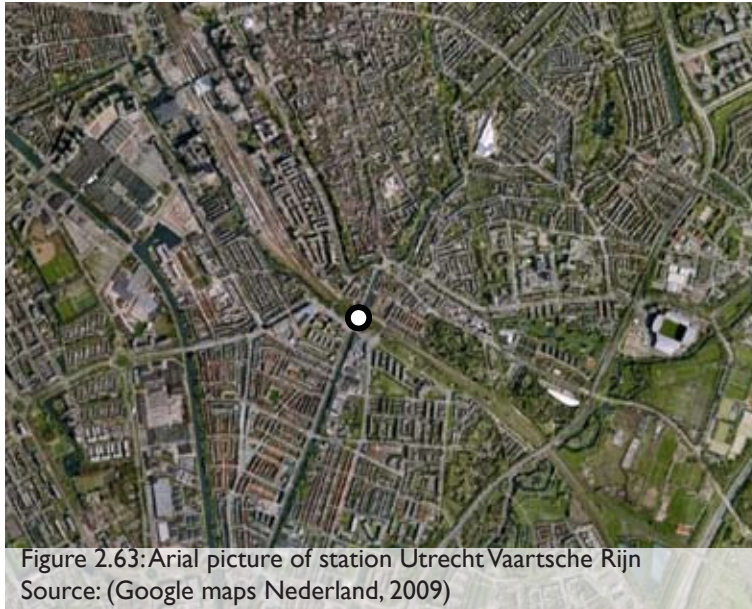
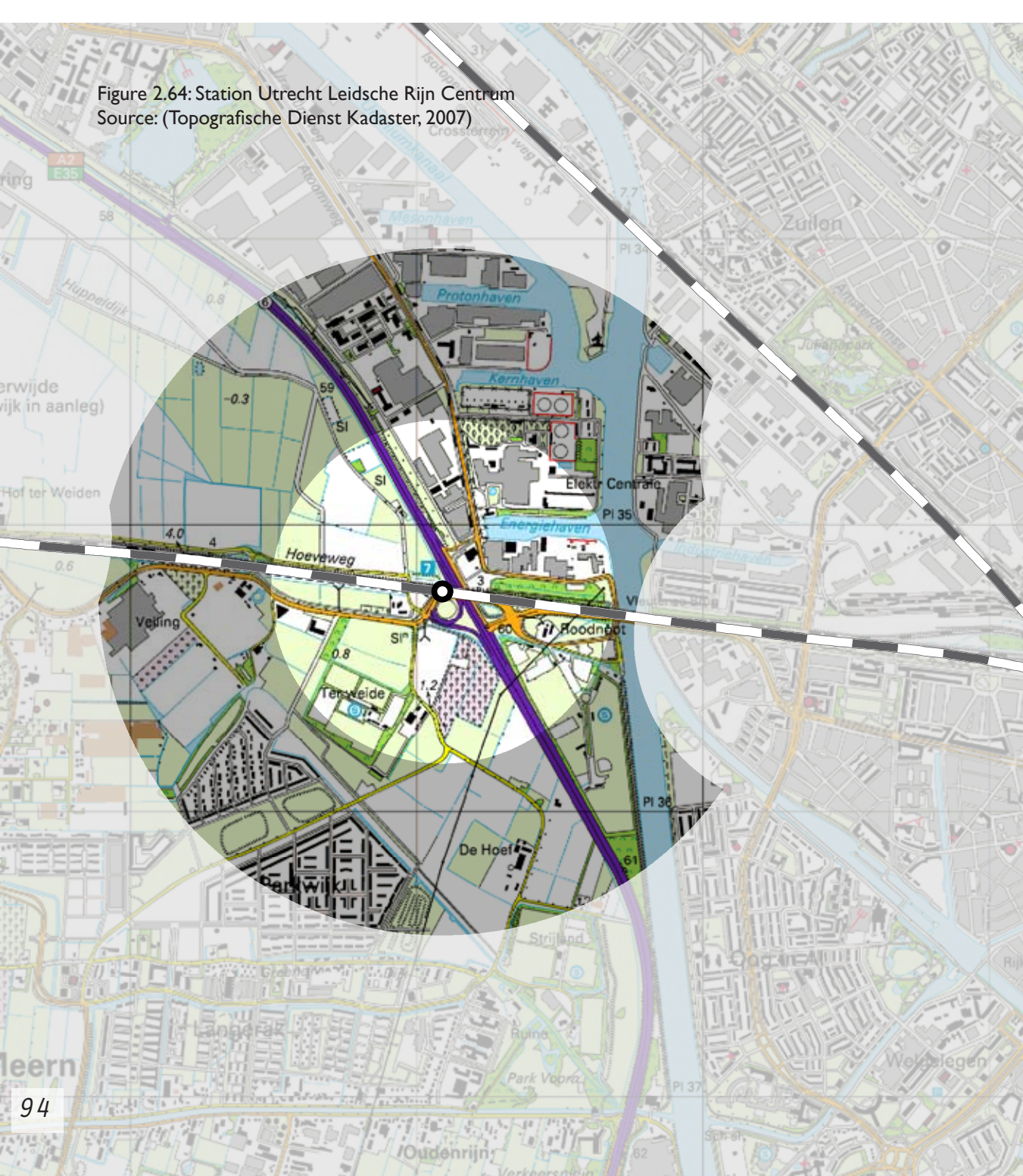


Figure 2.63: Aerial picture of station Utrecht Vaartsche Rijn
Source: (Google maps Nederland, 2009)

Utrecht Vaartsche Rijn

In the current situation, the planned station Vaartsche Rijn in the southeast direction from Utrecht Centraal will have quite a high node- and place value. The node value is high due to the large amount of regional roads in the vicinity of the planned station. The cause of the high place value is the large amount of residents and workers. Furthermore, the moderate score of the functional mix in the catchment area of this station leads to a high place value. A weakness of this station is the relatively small surface of the catchment area. The presence of Utrecht Centraal and Utrecht Lunetten (Beatrixpark) are dominating the planned station Utrecht Vaartsche Rijn. These (existing) stations are dominant over Vaartsche Rijn are causing the small catchment area of this station. The planned new light rail connection the “HOV om zuid will have a stop at this station. This will improve the network value. Space for development is limited and redevelopments are already in progress.

Figure 2.64: Station Utrecht Leidsche Rijn Centrum
Source: (Topografische Dienst Kadaster, 2007)



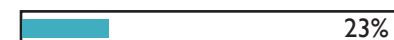
Utrecht Leidsche Rijn Centrum

Node value

Position road network



Position transit network



Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other

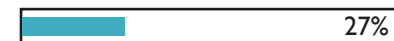




Figure 2.65: Impression station area Utrecht Leidsche Rijn Centrum
Source: (Flickr, 2009)

Utrecht Leidsche Rijn Centrum

In the current situation, the planned station Leidsche Rijn Centrum will have a high node- and moderate place value. The node value is relatively high due to the expected good position in the public transport system. The cause of the moderate place value is the small amount of residents and workers at this moment. The planned developments in this area will positively influence the place value of this station. In that way it will develop as an important station area in the Utrecht-region.



Figure 2.66: Aerial picture of station Utrecht Leidsche Rijn Centrum
Source: (Google maps Nederland, 2009)

Figure 2.67: Station Utrecht Lage Weide
Source: (Topografische Dienst Kadaster, 2007)



Utrecht Lage Weide

Node value

Position road network

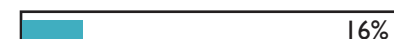


Position transit network

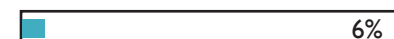


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other





Figure 2.68: Impression station area Utrecht Lage Weide
Source: (Flickr, 2009)

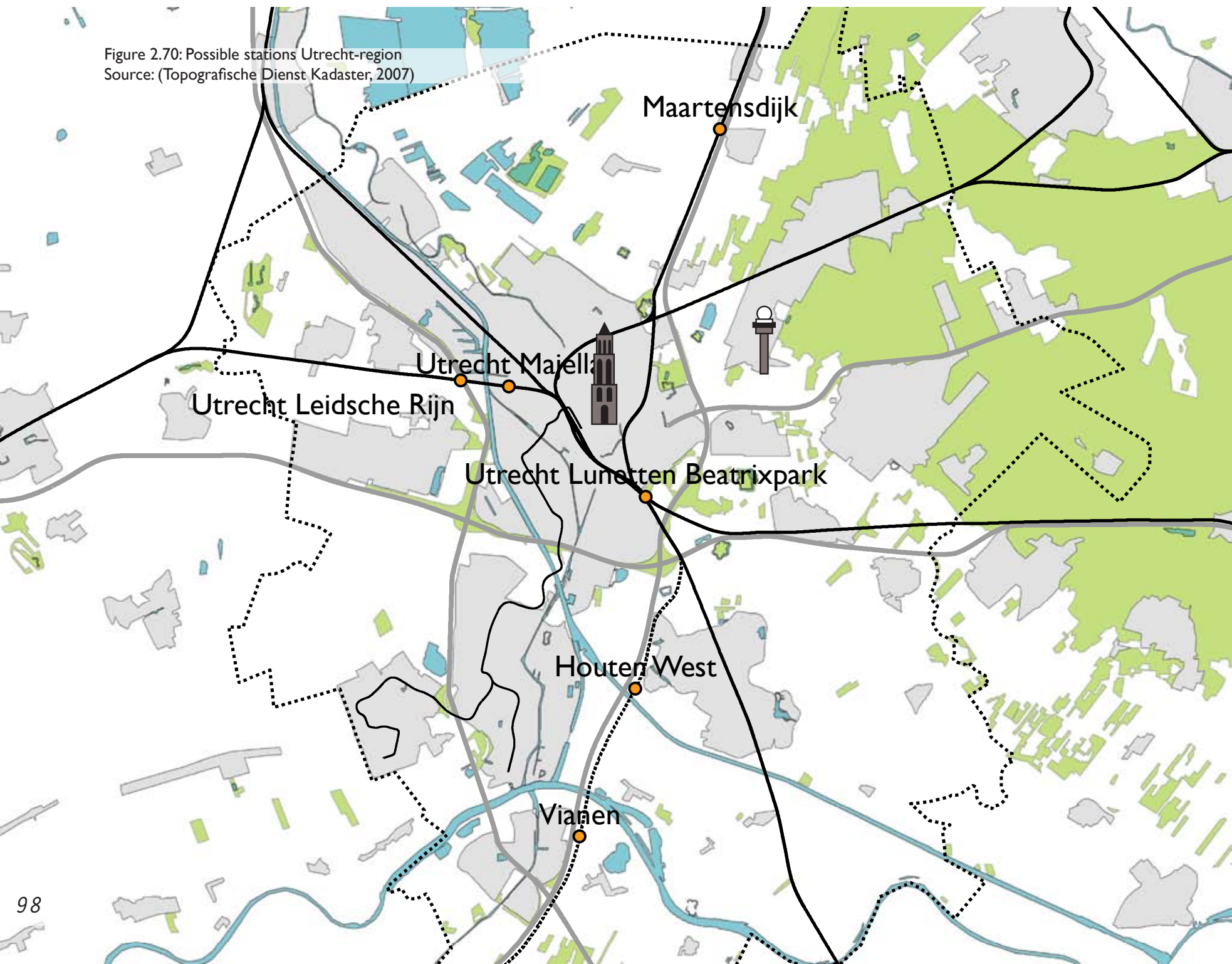


Figure 2.69: Aerial picture of station Utrecht Lage Weide
Source: (Google maps Nederland, 2009)

Utrecht Lage Weide

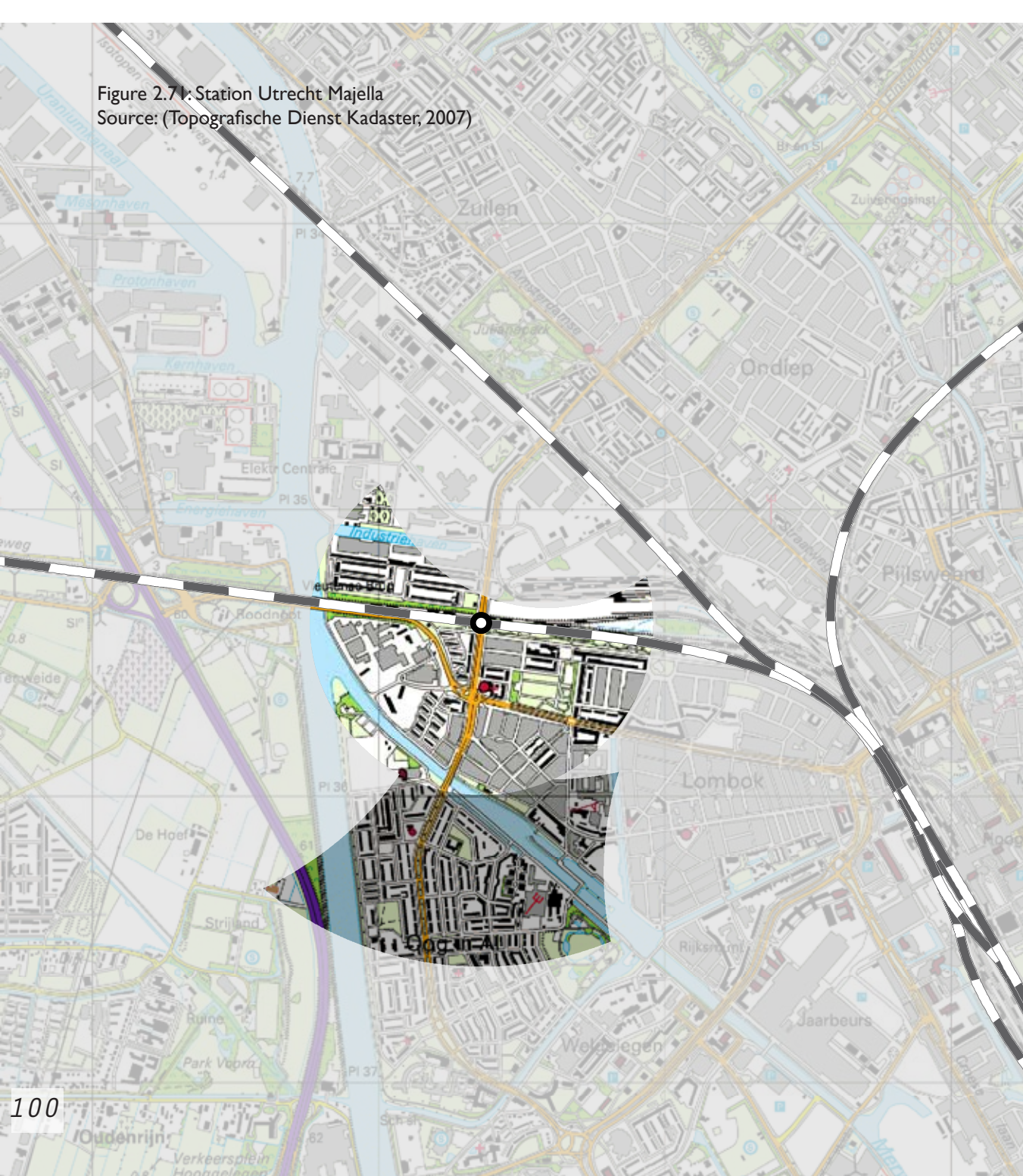
Utrecht Lage Weide results in a moderate node value and a moderate place value. The cause of this moderate node value is the small amount of possibilities in the public transport network and the weak position in the road network. The low place value in the present situation is a consequence of the very small absolute amount of residents. There is also a very moderate functional mix around this station. When this station is realised, new urban activities and functions are necessary. In the current situation business location Lage Weide is an extensive and monofunctional area.

Figure 2.70: Possible stations Utrecht-region
Source: (Topografische Dienst Kadaster, 2007)



2.2.4 Potentials of possible stations

The following stations are new stations, which are proposed in the regional design and strategy of this project (Figure 2.70). These stations are addressed in this chapter to explain the potentials of each station. More options for the introduction of new station areas are considered, the explanation of the decisions that are made for the proposed station areas are described in chapter 3.



Utrecht Majella

Node value

Position road network



Position transit network



Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other





Figure 2.72: Impression station area Utrecht Majella
Source: (Flickr, 2009)

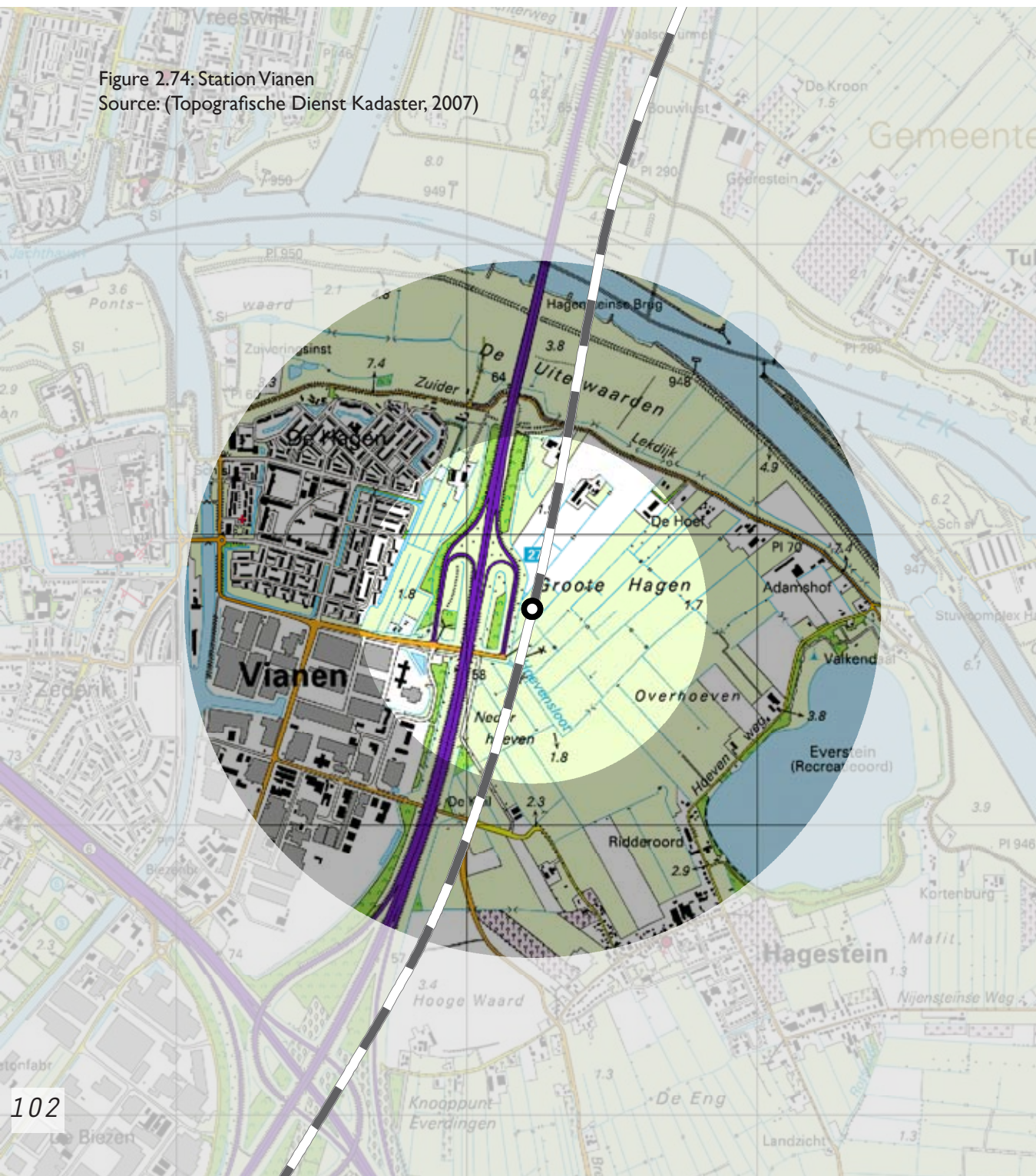


Figure 2.73: Aerial picture of station Utrecht Majella
Source: (Google maps Nederland, 2009)

Utrecht Majella

Currently, Utrecht Majella will have a high node and place value. The node value is high due to the large amount of regional roads in the vicinity of the planned station. The cause of the high place value is the large amount of residents and workers and the quite good score of the functional mix in the catchment area of this station. A weakness of this station is the relatively small surface of the catchment area. The presence of Utrecht Centraal, Utrecht Zuilen and in the future Utrecht Leidsche Rijn Centrum are dominating Utrecht Majella. For this reason there is a doubt about the viability of this station in the public transport network and support. New developments could improve the viability of Utrecht Majella. The displacement of for instance the “Douwe Egberts factory” and the redevelopment of the “Cartesiusdriehoek” will result in more support for this station. It will also increase the place value of the station.

Figure 2.74: Station Vianen
Source: (Topografische Dienst Kadaster, 2007)



Vianen

Node value

Position road network

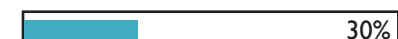


Position transit network

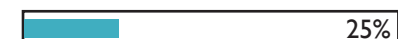


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



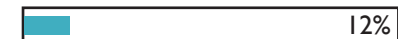
Open space



Nature



Water



Other





Figure 2.75: Impression station area Vianen
Source: (Flickr, 2009)



Figure 2.76: Aerial picture of station Vianen
Source: (Google maps Nederland, 2009)

Vianen

In the current situation, the proposed station Vianen located at the possible new railway between Breda and Utrecht will have a moderate node- and place value. The cause of the moderate node value is the relatively small amount of possibilities in the public transport network. The position of the station in the road network is quite good, due to the amount of highway exits and regional roads. The low place value in the present situation is a consequence of the very small absolute amount of workers and residents. There is a quite good functional mix. When the rail line and this station would be realised new spatial developments could take place. Then the place value will be improve and the station can be viable.



Houten West

Node value

Position road network



Position transit network



Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other

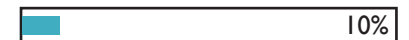




Figure 2.78: Impression station area Houten West
Source: (Flickr, 2009)

Houten West

The possible station Houten West located at the possible new railway between Breda and Utrecht will have a quite high node- and place value. The node value is relatively high due to the amount of highway exits and regional roads in the vicinity of the possible new station. The low place value in the present situation is a consequence of the very small absolute amount of workers and residents. There is a quite good functional mix. When the rail line and this station would be realised new spatial developments could take place.



Figure 2.79: Aerial picture of station Houten West
Source: (Google maps Nederland, 2009)

Figure 2.80: Station Utrecht Lunetten Beatrixpark
Source: (Topografische Dienst Kadaster, 2007)



Utrecht Lunetten Beatrixpark

Node value

Position road network

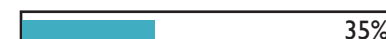


Position transit network

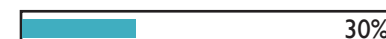


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



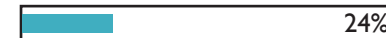
Nature



Water



Other

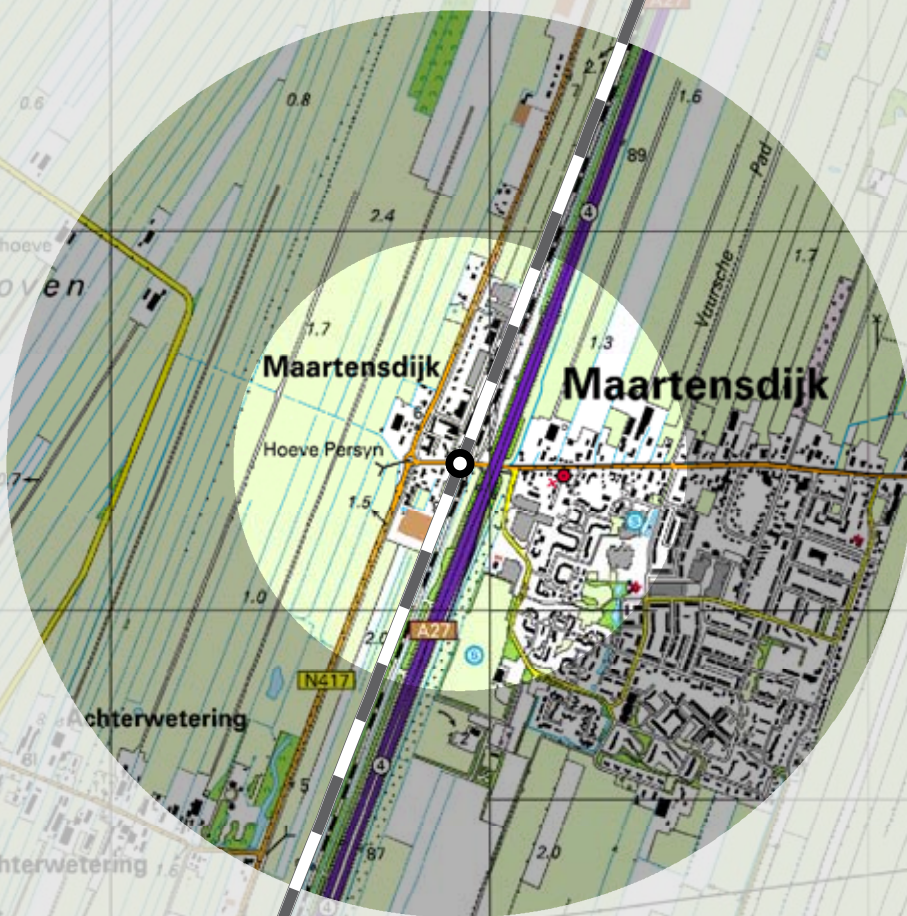




Utrecht Lunetten Beatrixpark

A possible new station as a replacement of the existing station Utrecht Lunetten would in the present situation have a quite high node and place value. The cause of the quite high node value is the good position in the public transport network. This station will add an extra rail direction (Ede-Wageningen) in comparison with the existing station Utrecht Lunetten. The cause of the quite high place value is the large amount of residents and workers and the high score of the functional mix in the catchment area of this station. When this station is realized, new spatial developments could take place at the north side of the station in the triangle of the rail tracks and the highway and in the Maarschalkerweerd. The planned new light rail connection the “HOV om Zuid” can have a stop at this station. This will improve the network or node value of this station.

Figure 2.83: Station Maartensdijk
Source: (Topografische Dienst Kadaster, 2007)



Maartensdijk

Node value

Position road network



Position transit network

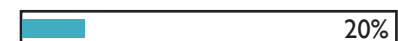


Place value

Workers/inhabitants density



Degree of functional mix



Space value

Agriculture



Built



Open space



Nature



Water



Other





Figure 2.84: Impression station area Maartensdijk
Source: (Flickr, 2009)

Maartensdijk

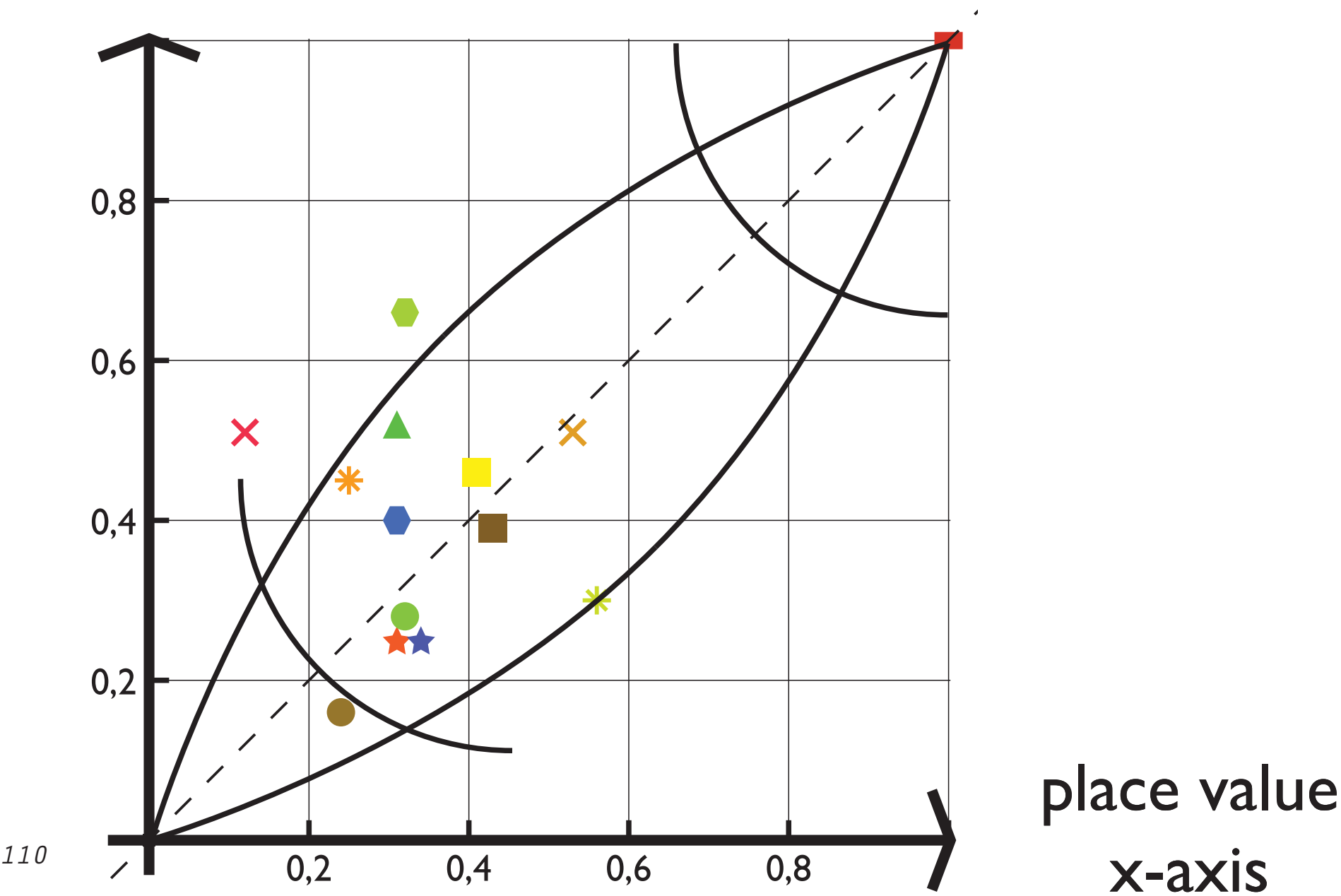
In the current situation the possible new station Maartensdijk between Utrecht and Hilversum will have a very poor node and place value. The cause of the poor node value is the small amount of possibilities in the public transport network and the weak position in the road network. Next to this, the place value is also very poor due to the small amount of workers and residents in the catchment area of the station. The viability of the station is questionable without spatial developments in the catchment area of this station. However, the station has possibilities for developments.




Figure 2.85: Aerial picture of station Maartensdijk
Source: (Google maps Nederland, 2009)

node value
y-axis

Figure 2.86: Utrecht-region situation 2010, node-place model



place value
x-axis

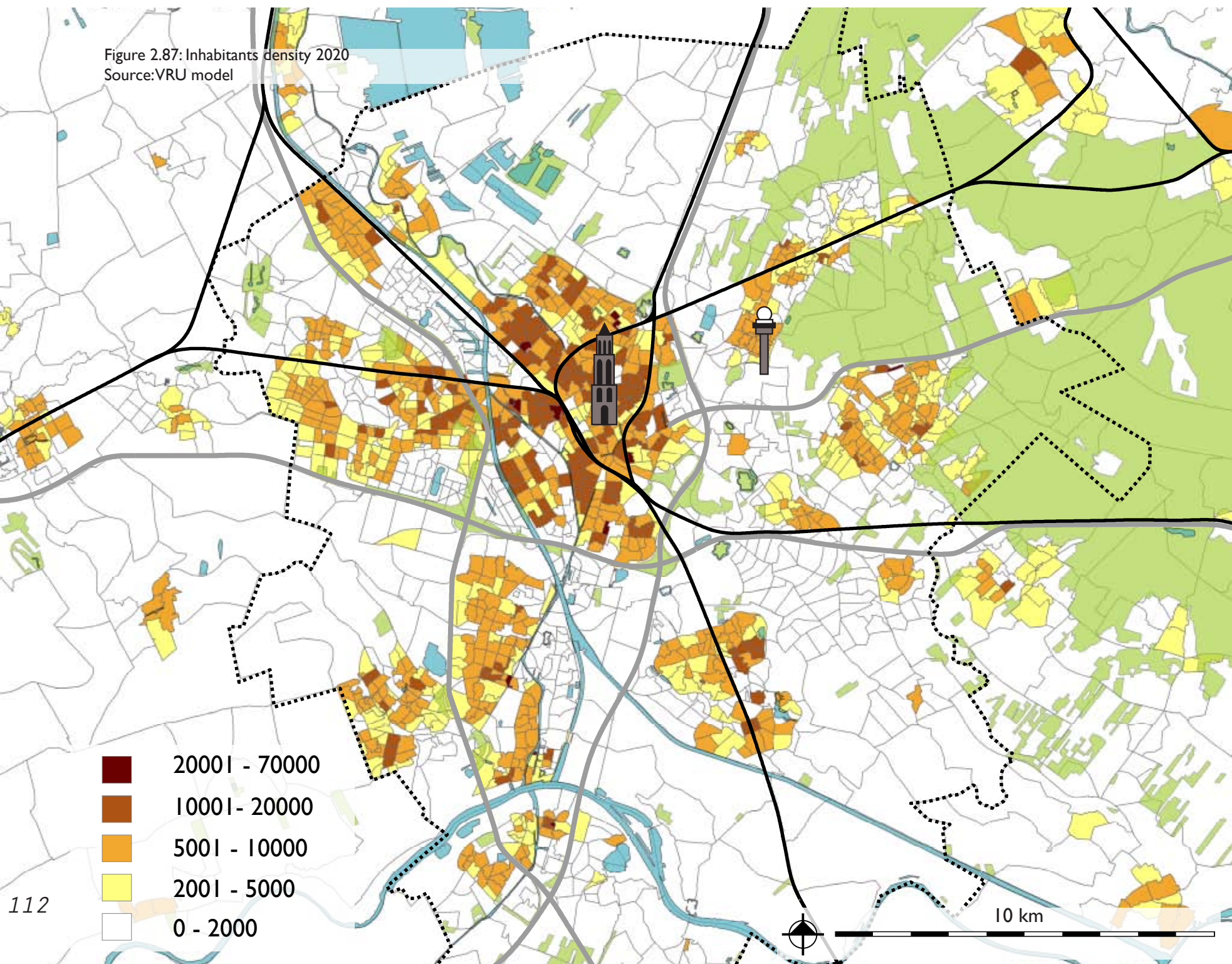
-
-  Bilthoven
 -  Bunnik
 -  Den Dolder
 -  Driebergen-Zeist
 -  Hollandsche Rading
 -  Houten
 -  Houten Castellum
 -  Maarrssen
 -  Utrecht Centraal
 -  Utrecht Lunetten
 -  Utrecht Overvecht
 -  Utrecht Terwijde
 -  Utrecht Zuilen
 -  Vleuten
 -  Utrecht Vaartsche Rijn
 -  Utrecht Leidsche Rijn Centrum
 -  Utrecht Majella
 -  Utrecht Lage Weide
 -  Vianen
 -  Houten West
 -  Utrecht Lunetten Beatrixpark
 -  Maartensdijk

2.2.5 Conclusion situation 2010

The total node- and the place value of all the station areas are visualized in this graph (Figure 2.86). Two main conclusions can be drawn from this node-place model. First, the public transport system of the Utrecht-region in the current situation is strongly monocentricly organized (Bruinsma et al., 2008). The node-place values of the station area of Utrecht Centraal are disproportionate larger than the node-place values of the other stations. Utrecht Centraal plays a dominant role in this system and can be seen as a focal point of urban activities. The structure of the public transport system is strongly radial in the Utrecht-region. When the public transport system is compared to the public transport system of e.g. Amsterdam, a few things differ. Amsterdam has a combination of a radial and tangential network. In this way Amsterdam is developed more as a polycentric city-region (Bruinsma et al., 2008).

The second conclusion, related to this first observation, tells something about the supply of station areas in the Utrecht-region. There is no category of station areas that are in terms of node- and place value between Utrecht Centraal and all the other station areas. In the present situation there is not a lot of variety of station areas in the Utrecht-region. This means that there is no supply of places that are highly accessible by public transport. Therefore, developments of the last decades are concentrated in areas with poor access to public (rail) transportation. Examples are dwelling area Leidsche Rijn, business location Papendorp and science centre de Uithof.

Figure 2.87: Inhabitants density 2020
Source:VRU model





2.2.6 Demographic GIS analysis

In this chapter an extensive analysis is enlightened. The workers and inhabitants of the Utrecht-region are visualized in several maps. From this analysis important conclusions are drawn which are used for the design decisions of the public transport network.

Inhabitants 2002 and 2020

In the situation of 2002 there are some recognizable places of living in the Utrecht-region (Figure 2.87). The neighbourhoods around the city centre of Utrecht have the highest densities of inhabitants. Next to this, the centres of the several towns in the vicinity of the central city of Utrecht have higher densities. However, the centre of gravity of inhabitants density is located in the central city of Utrecht.

The prognosis of inhabitants in 2020 shows some new places of living of e.g. Leidsche Rijn and Houten-Zuid. These new living areas will be completed around 2020. In comparison with 2002 the regions' density is increasing (Figure 2.88).

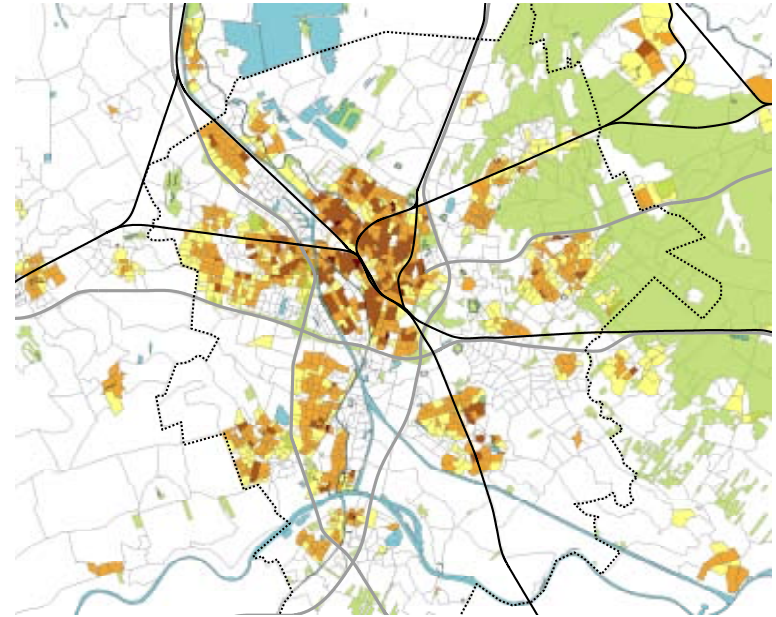
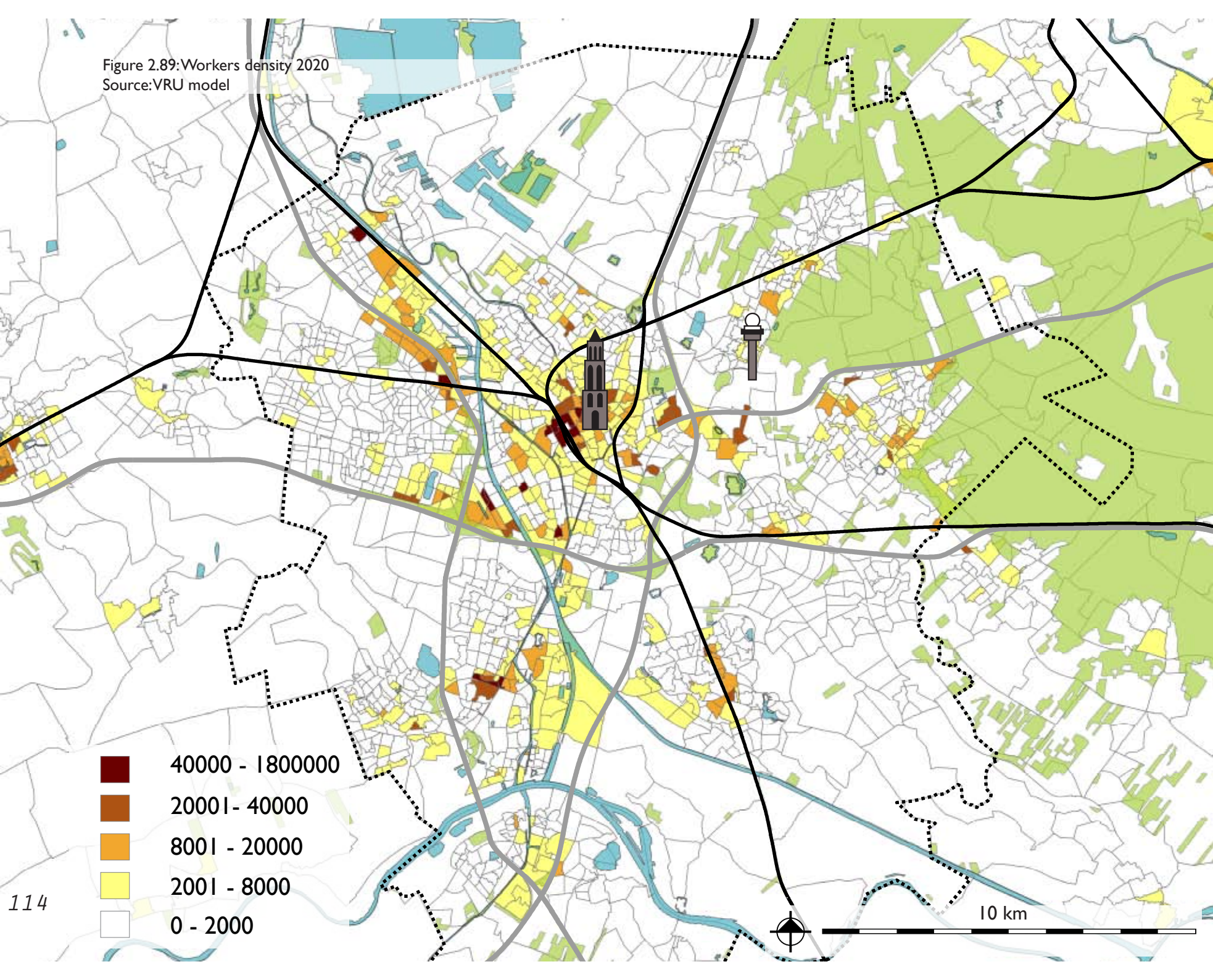


Figure 2.88: Inhabitants density 2002
Source:VRU model

Figure 2.89: Workers density 2020
Source:VRU model



Workers 2002 and 2020

In the situation of 2002 there are some strong anchors of workplaces in the Utrecht-region (Figure 2.90). The city centre of Utrecht, Lage Weide, de Uithof, Plettenburg in Nieuwegein and Zeist are showing the highest densities of workers. Furthermore, the several Town centres and smaller business locations have higher densities of workers.

In 2020 some major changes occur at the east side of Leidsche Rijn, a new business and office location will be realized in that area (Figure 2.89). Furthermore, office location Papendorp is realized and ensures high densities of workers in this area. In general, the region is denser in comparison with 2002.

Conclusion

In comparison to other city-regions in the Netherlands, the Utrecht-region is expected to grow further. In terms of inhabitants and workplaces this strong growth will continue minimal until 2040 (Bestuur Regio Utrecht, 2009). This is a major advantage of this region. However, this obligates planners, designers and policy makers to think about the facilitation of these people and their movements. In general, the new development locations of the Utrecht-region show new places of living and working. Furthermore, the already existing neighbourhoods, towns and villages and the city of Utrecht show an increase of the density of workers and inhabitants. The spatial mismatch between workers and inhabitants as mentioned before (chapter 1) is also visible in this analysis. This analysis shows that the functional mix on the city-region scale is limited, because concentrations of work and living are not well mixed.

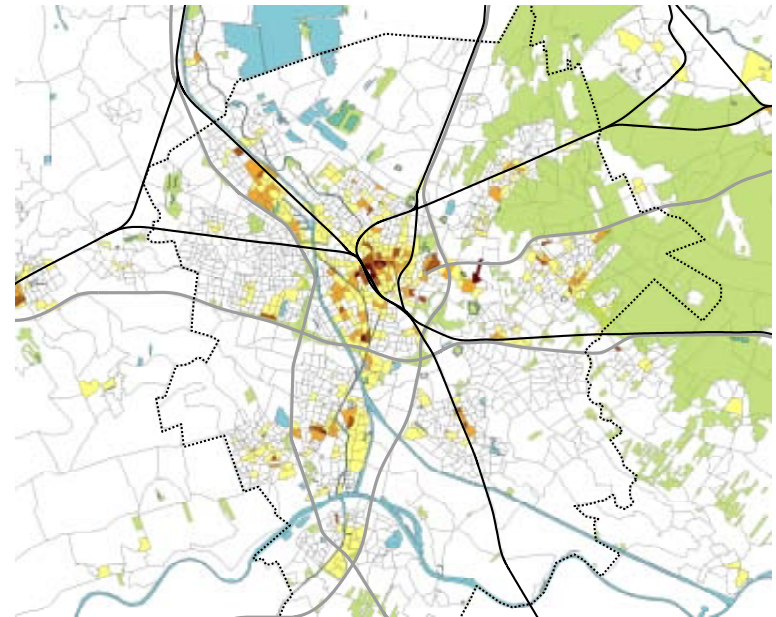
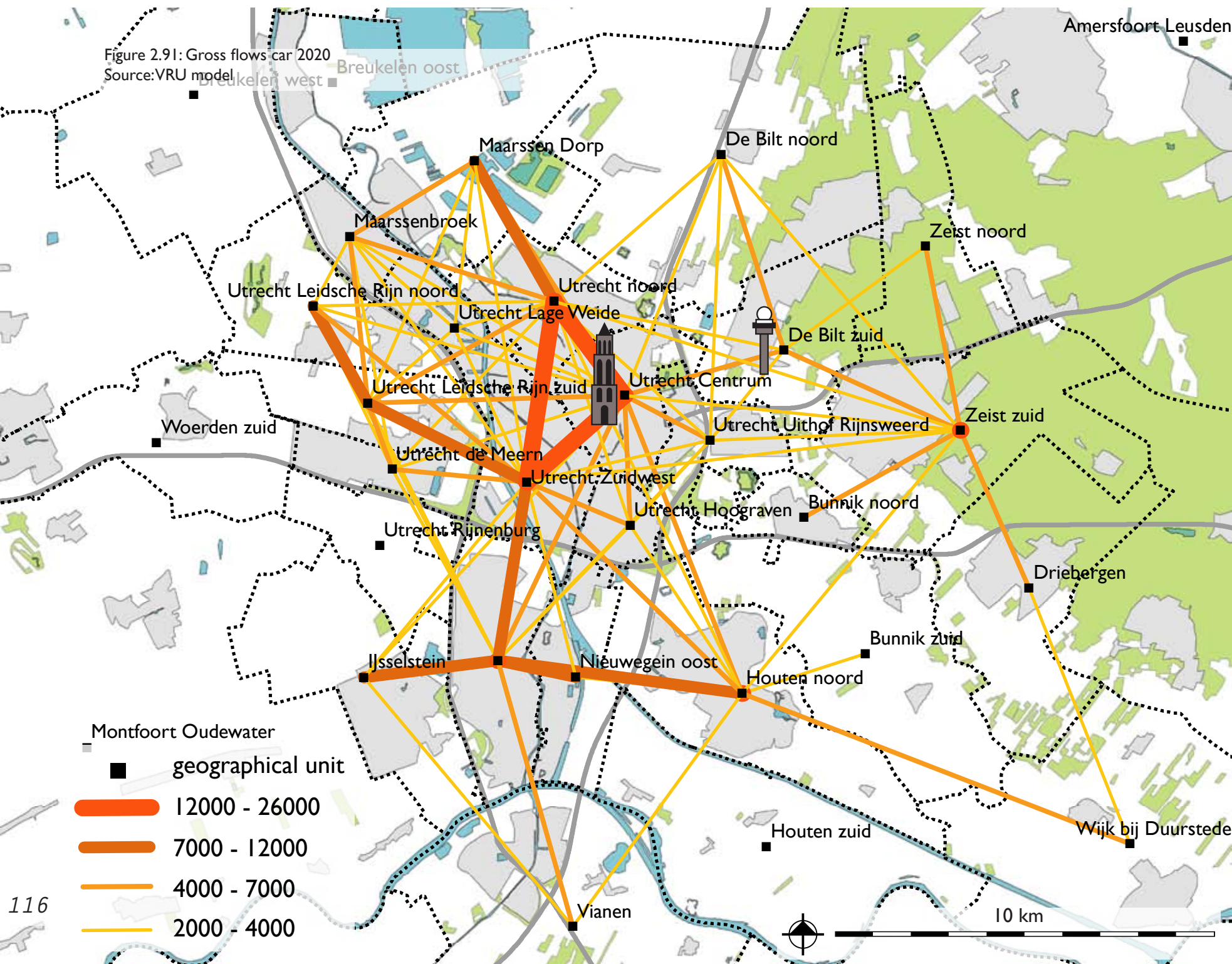


Figure 2.90: Workers density 2002
Source: VRU model

Figure 2.91: Gross flows car 2020

Source:VRU model





2.2.7 Origin-destination analysis Utrecht-region

Introduction to the methodology

In the previous analysis, some important anchors of living and working are identified. Hereafter, the flows between these different places are analyzed. An origin-destination analysis is executed to acquire more knowledge about the daily trips of people within the Utrecht-region. The focus of this research is the households' perspective, and therefore it is useful to gain information about their daily movement patterns. The origin-destination analysis has a specific level of detail: this information is only available at the level of scale of a collection of neighbourhoods. In comparison to e.g. the demographic analysis of inhabitants and workers the geographical entity of research is larger. The origin-destination analysis is executed for car trips and trips undertaken with public transport. The most up to date information for this analysis is from the year 2002. Furthermore, the analysis contains a prognosis of movements in the Utrecht-region for the year 2020.

The information that is required for the origin-destination analysis comes from the traffic model of the city-region of Utrecht (verkeersmodel regio Utrecht, VRU). This information is translated into a map. For keeping the map readable and interpretable all the trips from 2000 and more, undertaken by car are shown. The maps for the public transport movements are showing all the trips undertaken from 250 trips and more. The figures that can be found in the legend are the gross amount of trips between origin and destination. This means that all the trips undertaken between e.g. neighbourhood A to neighbourhood B, and vice versa are calculated.

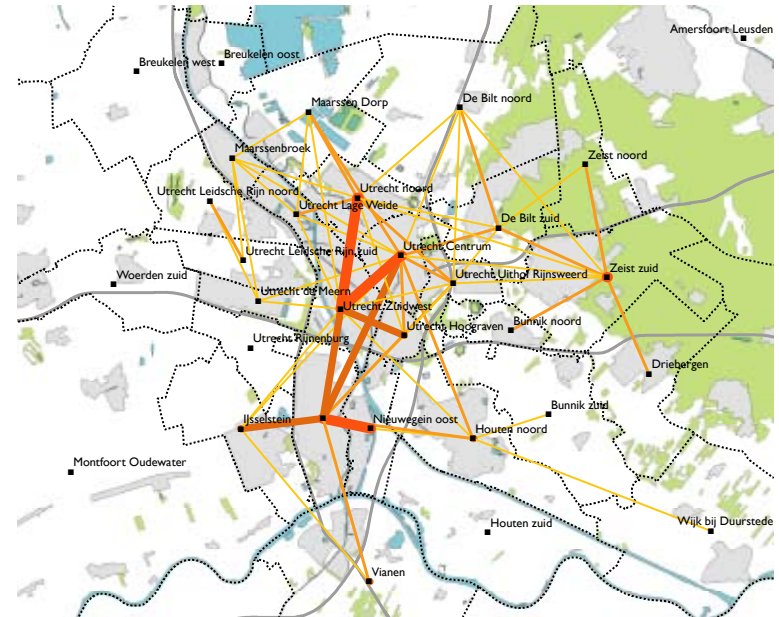


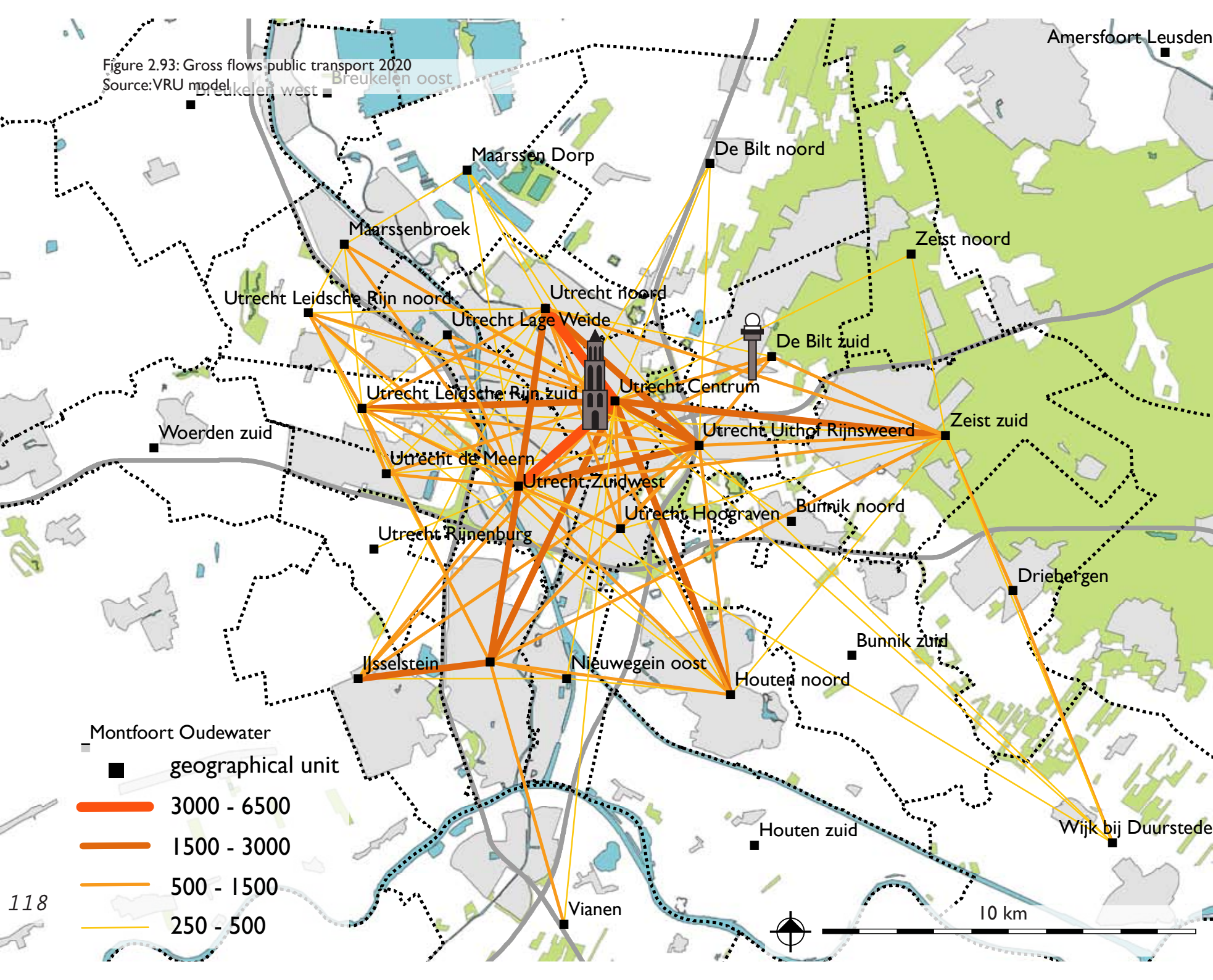
Figure 2.92: Gross flows car 2002

Source:VRU model

Research results car (reference date: 2002)

A lot of the daily movements by car in the Utrecht-region are within or related to the central city of Utrecht. The city centre of Utrecht has very strong car 'corridors' with the southwest of Utrecht, and in the direction of Nieuwegein and IJsselstein, despite the existing fast tram in this direction. From Utrecht in the direction of Zeist and De Bilt there are also a lot of car-based trips in the current situation. Zeist itself has a lot of car connections with its surrounding municipalities like Bunnik, Driebergen and De Bilt (Figure 2.92).

Figure 2.93: Gross flows public transport 2020
Source:VRU model



In the prognosis of 2020, car movements will increase further. Within the VRU traffic model, dwelling area Leidsche Rijn is projected to be at the final stage of development. This is visible in the analysis. Car movements to and from Leidsche Rijn have increased significantly in 2020. Leidsche Rijn is therefore developing as a new generator of car movements in the Utrecht-region. Another important trend is the increase of the importance of tangential connections between the different surrounding towns. An example of this is the connection between Houten and Nieuwegein. A big increase of car movements between these towns is forecasted for 2020. Furthermore, the movements between Maarssen and Utrecht and Lage Weide and Utrecht will increase significantly in 2020 (Figure 2.91).

Research results public transport (reference date: 2002)

Most of the daily movements of people by public transport are related to the city centre of Utrecht, more specific to Utrecht Centraal. This analysis supports the inventory of the several station areas (Chapter 2.2) of the Utrecht-region. In that research is observed that Utrecht Centraal station has a very dominant position in the agglomerative public transport system (Bestuur Regio Utrecht, 2009). The most important movement corridors are in the situation of 2002 between the city centre of Utrecht and Lage Weide, and between the city centre of Utrecht and Utrecht Zuidwest. Furthermore, a big corridor of public transport movements exists between Utrecht city centre and de Uithof/Rijnsweerd and Zeist (Figure 2.94).

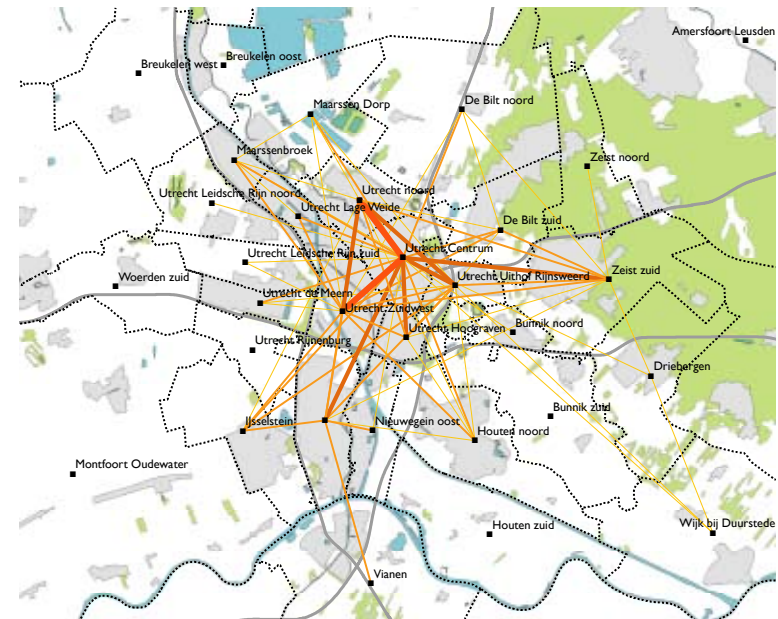


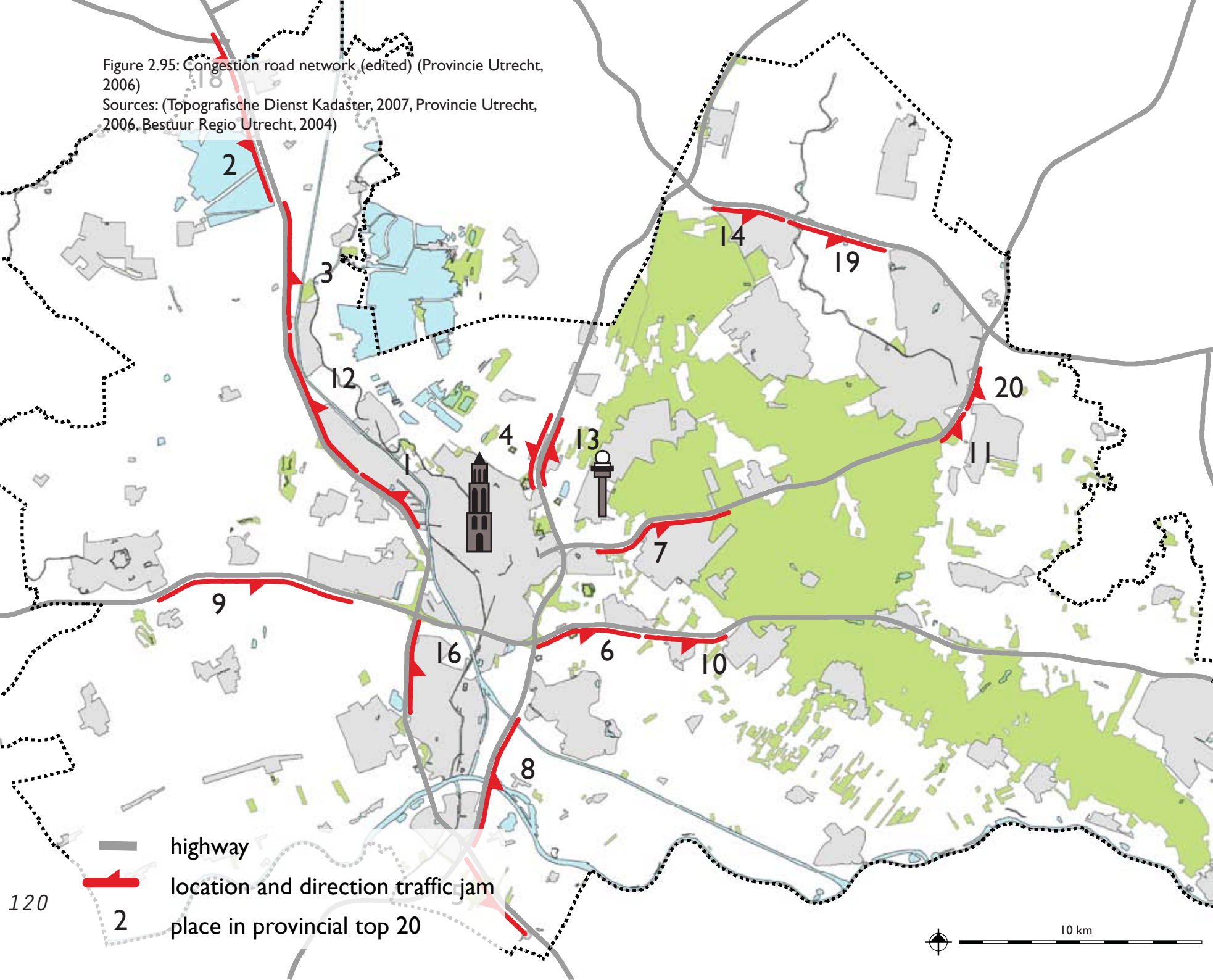
Figure 2.94: Gross flows public transport 2002

Source:VRU model

In the prognosis of the year 2020 the tangential movements in the public transport system are increasing. The movements between Nieuwegein and Zeist, Houten, and Leidsche Rijn are increasing significantly. Leidsche Rijn is almost completed and the effect on public transport movements is visible (Figure 2.93). There is an increase of movements between this new place of living and working with the city centre of Utrecht, Utrecht Lage Weide and Nieuwegein. Also the village Zeist shows an increase of movements on multiple directions, mostly to the central city of Utrecht.

Figure 2.95: Congestion road network, (edited) (Provincie Utrecht, 2006)

Sources: (Topografische Dienst Kadaster, 2007, Provincie Utrecht, 2006, Bestuur Regio Utrecht, 2004)



Conclusions

In general, movements in the city-region of Utrecht will increase in the future. Both, movements by public transport and especially trips undertaken by car are increasing in the future. More people are expected to live and work in the Utrecht-region and this growth causes a growth of movements (Bestuur Regio Utrecht, 2009). The major dwelling area Leidsche Rijn is causing a strong growth of movements by car but also by public transportation. Movements in the Utrecht-region are in the current situation often focused on the city centre of Utrecht and Utrecht Centraal.

However, there is a trend recognizable whereby movements are becoming more tangential. The major expected increase of car movements in 2020 between Houten and Nieuwegein is an example of this. The trips undertaken by public transport also show an increase of tangential movements in the region. The development of tangential public transport lines could facilitate these movements in the future.



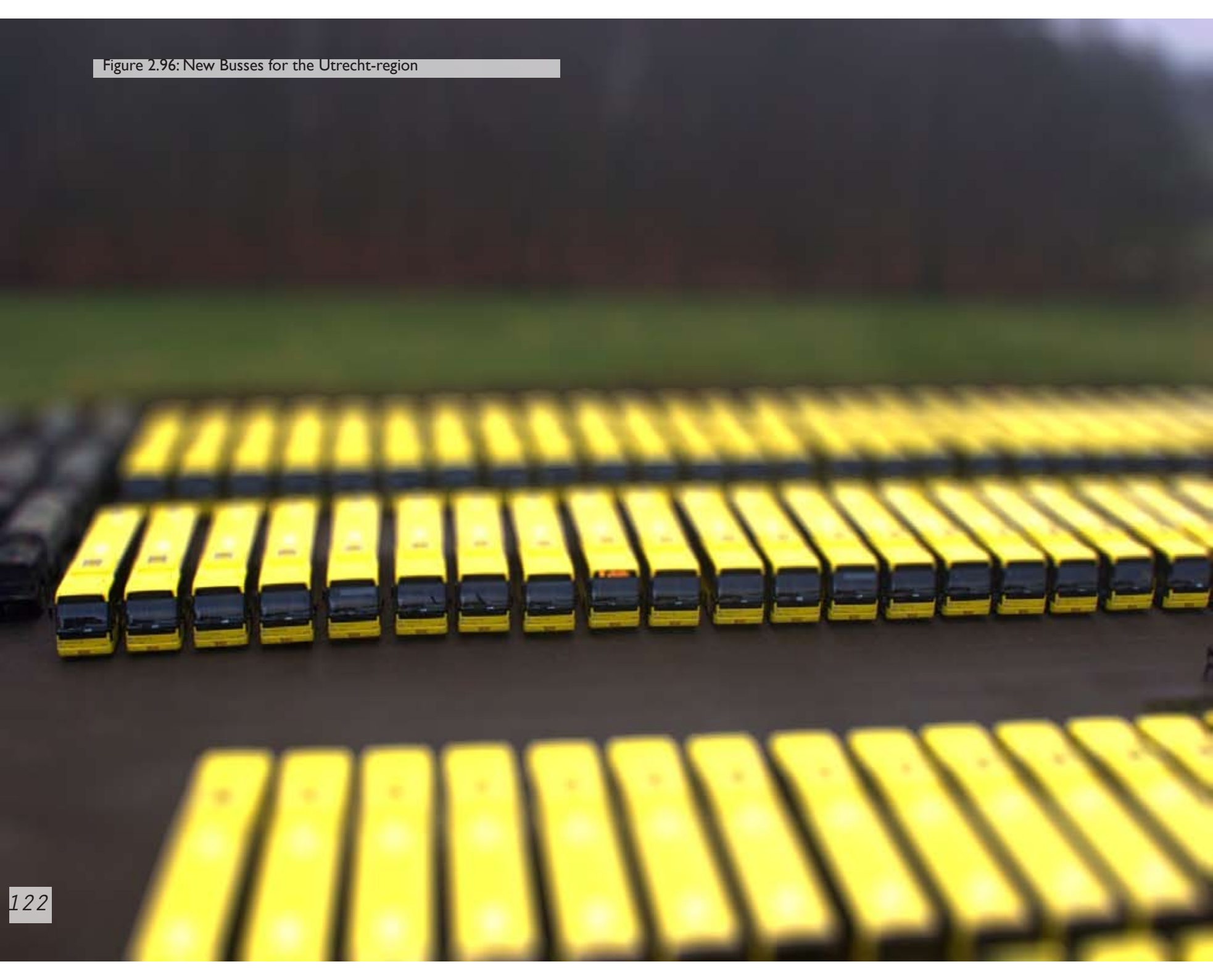
2.3 Conclusions from analysis

The arguments for developing in a certain direction are distilled from the conclusions of the analytical work. A part of the analytical work is presented in a booklet: “PART II: atlas”, which is completed in an earlier stage of the process. Next to this, new analytical work is executed and is embedded in this master thesis. All the conclusions will be further translated into requirements for a vision for the Utrecht-region. The requirements are mentioned after the conclusions. The requirements will be used to steer the decisions for the regional design in 2030. The conclusions are divided in the topics housing & spatial developments and infrastructure & accessibility.

2.3.1 Conclusions infrastructure and accessibility

- The Utrecht-region is well connected to the international train network, however, it lacks high-speed infrastructure that is suitable for high-speed trains (Deutsche Bahn, 2009, Nederlandse Spoorwegen, 2009, International Union of Railways, 2009).
 - A new high-speed connection towards the east is desirable.
- There is a very extensive intercity system in the Netherlands, however, this intercity system is functioning on interregional scale instead of functioning on national level (Nederlandse Spoorwegen, 2009, Van den Heuvel and Promotor Van Witsen, 1997).
 - The hierarchy in the public transport system of the Netherlands and in the Randstad should be restructured. New layers of public transportation e.g. (inter) national, interregional and agglomerative layers should be introduced or layers should be revitalized in the structure of the public transit system (Gent et al., 1998, Priemus et al., 1999, Schoemaker, 2002).
 - The scale of the intercity system should be increased. In that way the intercity system could function on a national level.
 - The scale level of a interregional system in the structure of the of public transport system is not present in the Netherlands. Adding such a system is desired in the Randstad and in the Utrecht-region (Van den Heuvel and Promotor Van Witsen,

Figure 2.96: New Busses for the Utrecht-region



1997).

- The scale level of an agglomerative system is present in the Netherlands and in the Utrecht-region. However, the regional public transport system is disfunctioning. The agglomerative public transport system of the Utrecht-region is lacking speed, interconnectivity and recognisability (Witmond and Lahaye, 2006).
- The structure of the agglomerative public transport system is mainly provided by bus transportation. This system is strongly radial, with Utrecht-Centraal as the focal point. The bus network of the Utrecht-region is widespread, however, some districts are poorly connected.

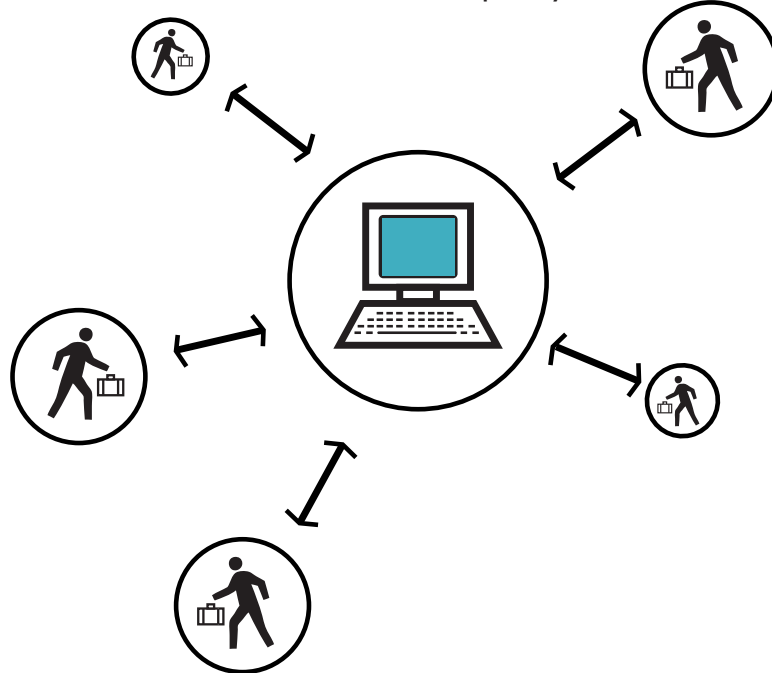


Figure 2.97: Spatial mismatch in the Utrecht-region
Source: (Laan L. van der, 1996)

Next to this, some bus corridors are at the limits of their capacity possibilities. Essential parts of the Utrecht-region are poorly connected by means of rail transportation e.g. Uithof, Zeist and Leidsche Rijn (Witmond and Lahaye, 2006, Gemeentelijk Vervoerbedrijf Utrecht, 2009, Connexxion, 2009).

- More tangential public transport lines should be introduced in developing a coherent public transport system with multiple nodes. These new centralities will accommodate not only the flows to Utrecht Centraal station but will also provide connections between the sub centres (Bestuur Regio Utrecht, 2008b).
 - The public transport system of the Utrecht-region should be a worthy competitor of the transportation by car, especially for commuter flows within the city-region.
 - Extend the capacity, comfort, speed, frequency and reliability of the agglomerative public transport system.
- New initiatives in the traditional rail network are RSS and the new rail line in direction of Breda. These new initiatives are providing new possibilities for urban developments and extending the use of the public transport in the Utrecht-region (Projectbureau Randstadspoor, 2008,

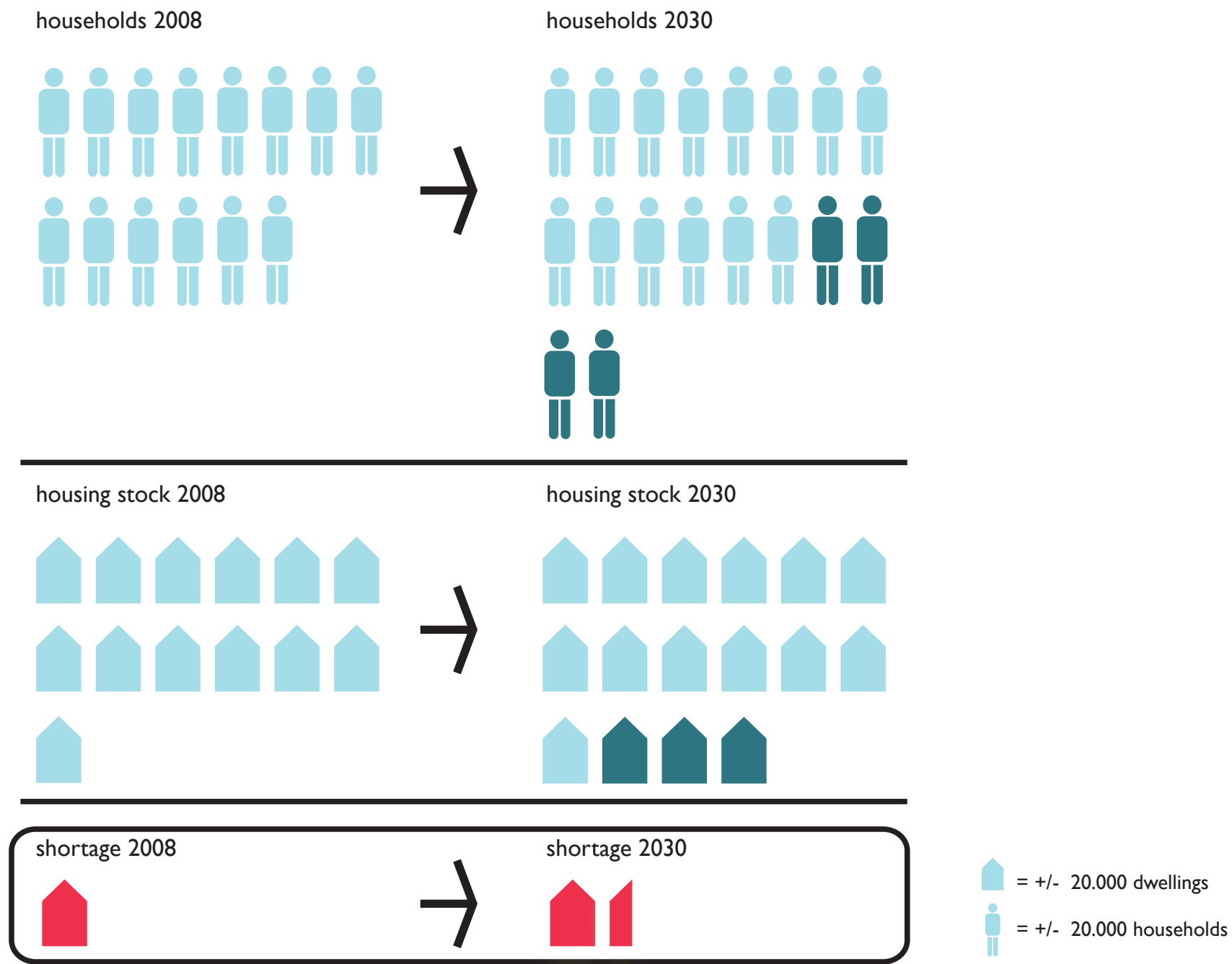


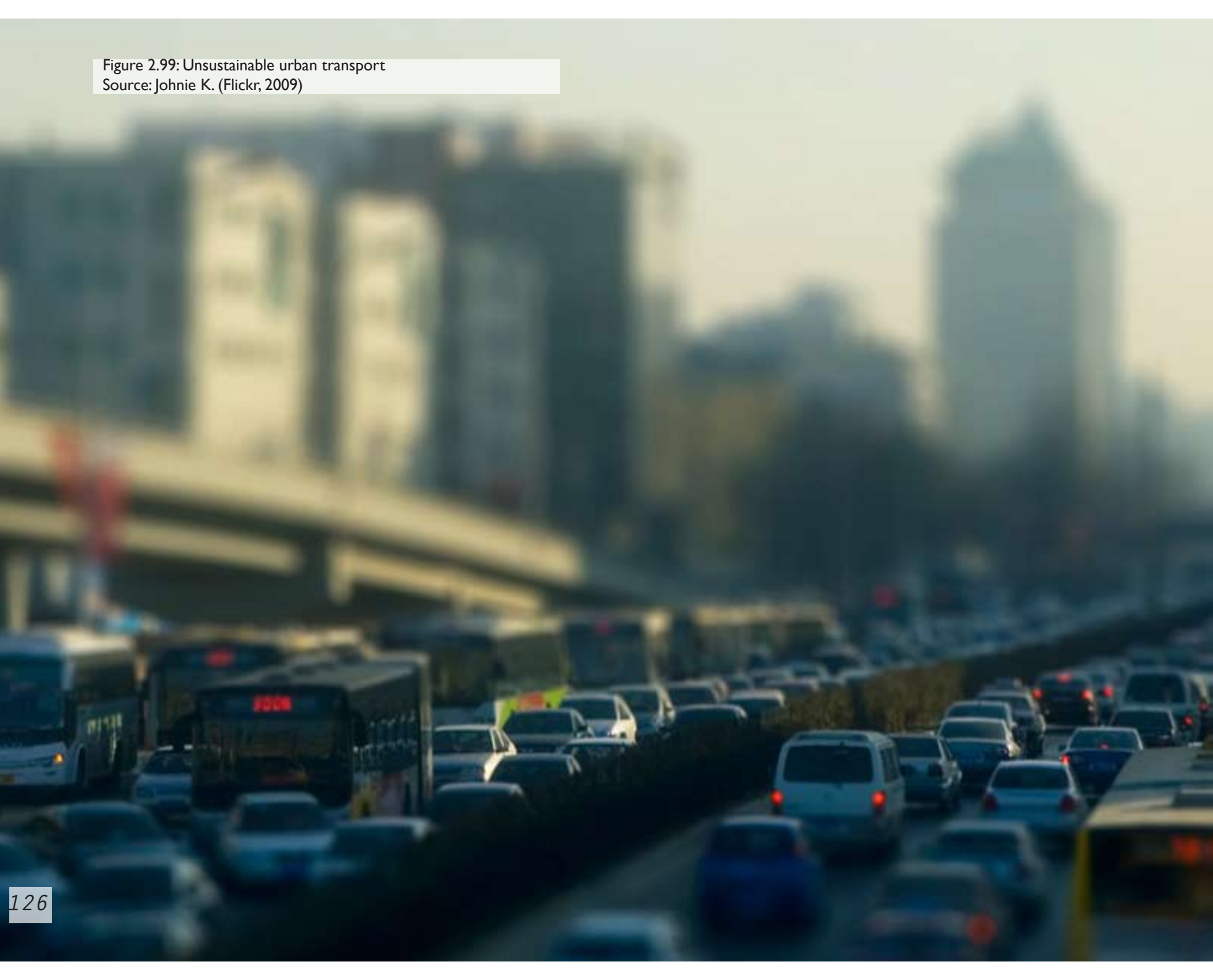
Figure 2.98: Housing shortages
Sources: (Bestuur Regio Utrecht, 2008)

-
- Goudappel Coffeng and BAM, 2008).
 - New spatial developments should take place in the catchment areas of the planned stations of the Randstadspoor.
 - At the proposed line between Utrecht and Breda new stations should be designed and should be consistent with the overall design of the Utrecht-region.
 - The P+R system of the Utrecht-region is not functioning optimal. Present P+R locations produce extra pressure on the busiest parts of the road network (Mee P. van der, 2001).
 - Provide more multimodal possibilities. The road system should be more interconnected with the public transport system to promote multimodal travelling.
 - New P+R locations should be developed in combination with new public transport nodes.
 - The transportation networks are generating a large quantity of sound pollution. The air quality is of great concern in the Utrecht-region. The poor air quality is mainly caused by (individual) transportation.
 - The entire road network of the Utrecht-region is congested; current and planned interventions will not be sufficient for solving these accessibility problems. Furthermore, these accessibility problems have significant unsustainable effects (Figure 2.95).
 - Reduce the negative environmental aspects of transportation like the sound pollution and the bad air quality. By using more clean and less space consuming modes of transportation, like the public transportation, the liveability of the Utrecht-region should be improved.
 - In the Utrecht-region is a spatial mismatch between workers and workplaces. This means that a lot of inhabitants of the central city find their work in one of the surrounding cores. The other way around: inhabitants of the surrounding villages find their jobs in the central city (Figure 2.97). A consequence of this is that mobility rises (Laan L. van der, 1996).

2.3.2 Conclusions spatial developments

- Several protected landscapes surrounding the Utrecht-region are restricting the possibilities for urban extensions of the Utrecht-region (Ministerie van Volkshuisvesting Ruimtelijke Ordening en Milieubeheer and Rijksplanologische Dienst, 2001).
 - Because of the restricted possibilities for urban extensions, new living environments should be developed within the existing urbanized areas.
 - Possible new stations and rail lines should be used to search for areas where new spatial developments are possible.
 - Developments should be in the vicinity (catchment area) of transit stops.

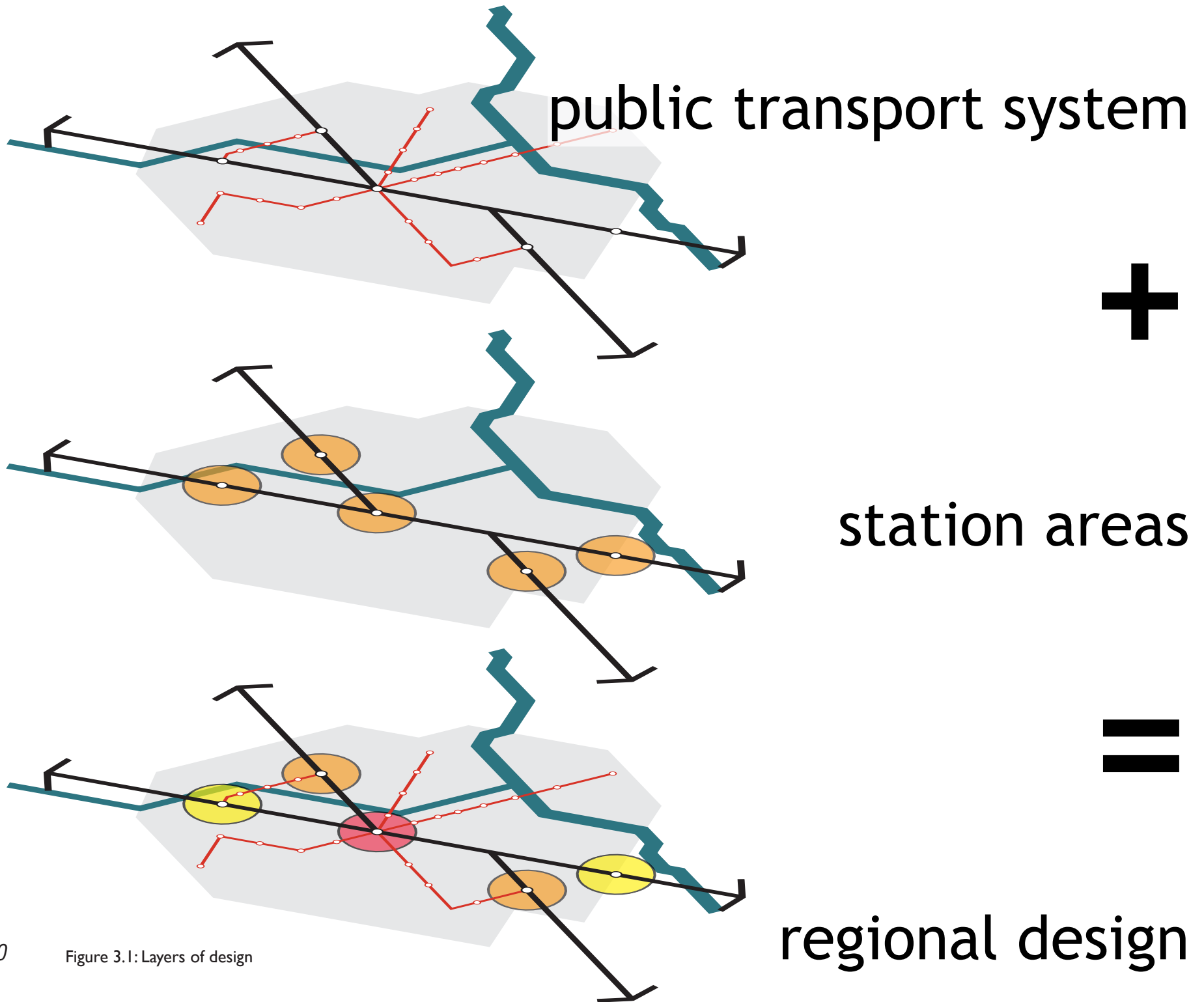
Figure 2.99: Unsustainable urban transport
Source: Johnie K. (Flickr, 2009)



-
- Current and planned interventions are not sufficient to reduce the shortages of dwellings in the Utrecht-region. Until 2030 a number of 109.500 dwellings should be build to reduce the housing shortages to 0%.With the current planned interventions will result in a shortage of 32.000 dwellings in 2030 (Bestuur Regio Utrecht, 2008c). Next to this, there is an amount of 29.000 dwellings that is planned without a physical place. This is resulting in a total shortage of 59.000 dwellings (Figure 2.98).
 - Developing within the catchment area of a transit stop should reduce the housing shortage.
 - Modifications in present municipal plans are possible.
 - The retail profile of the Utrecht-region is strongly hierarchical.The centre of Utrecht has the most dominant position in this network (Gemeente Utrecht, 2000, Gemeente Amersfoort, 2002).
 - New developments in the public transport system should take the retail locations into account.
 - The economy of the Utrecht-region is changing more and more into a service sector based economy.The amount of office locations has grown enormous the last decades and are roughly dispersed near the transportation networks (Lukey and Groenemeijer, 2007, Bestuur Regio Utrecht, 2008a).
 - New spatial developments including facilitating space for service sector based companies should be solved within the catchment area of a transit stop.
 - The Utrecht-region distinguishes itself as a region with a service and business economy on the national scale (Meijers, 2007b). Furthermore, the Utrecht-region has a strong education and knowledge production sector.
 - Make use the economic profile that is existing, focus on services and businesses and the education and knowledge sector. Furthermore, the interconnection (synergy) between these sectors should be addressed more.

3 design

- 3.1 Design proposal: public transport system
- 3.2 Design proposal: spatial developments
- 3.3 Phasing



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3. Design

Regional design and strategy Utrecht-region

In this chapter the design proposal for the Utrecht-region is explained. The elaboration of the regional design contains two layers distilled from the two challenges: the public transport system and the spatial developments. In the first chapter the public transport system will be described. Then the proposal for the spatial developments will be elaborated. In last part of this chapter the two layers and their developments will be phased in time (Figure 3.10).



3.1 Design proposal: public transport system

In this paragraph proposals of adjustments and extensions in the public transport system are elaborated. Next to this, the principles that form the basis for these adjustments are mentioned. In the first part the difference between *connecting* and *unfolding* systems will be explained. Second, the necessity of rethinking the layering and hierarchy of the public transport system is explained and applied. Several layers in the public transport system are considered and adjustments will be proposed. Furthermore, a justification and feasibility check for the introduction of a new city-regional public transport system is described. At the end of the paragraph, proposed transit lines and traditional train stations are described.

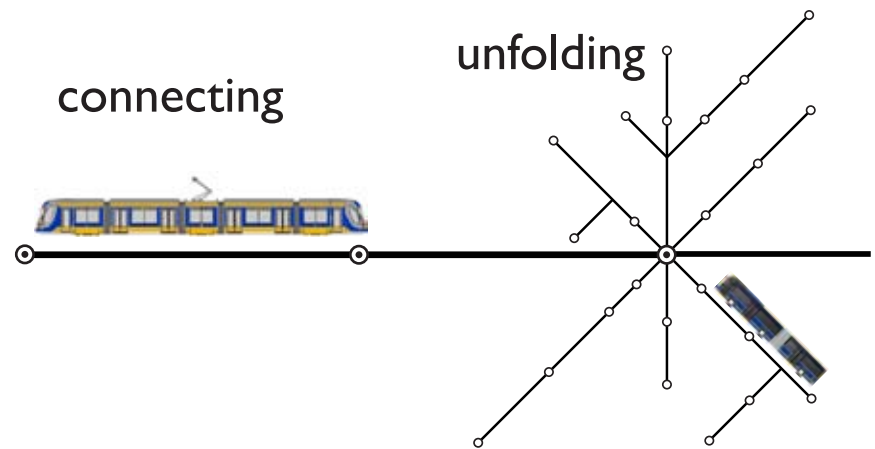


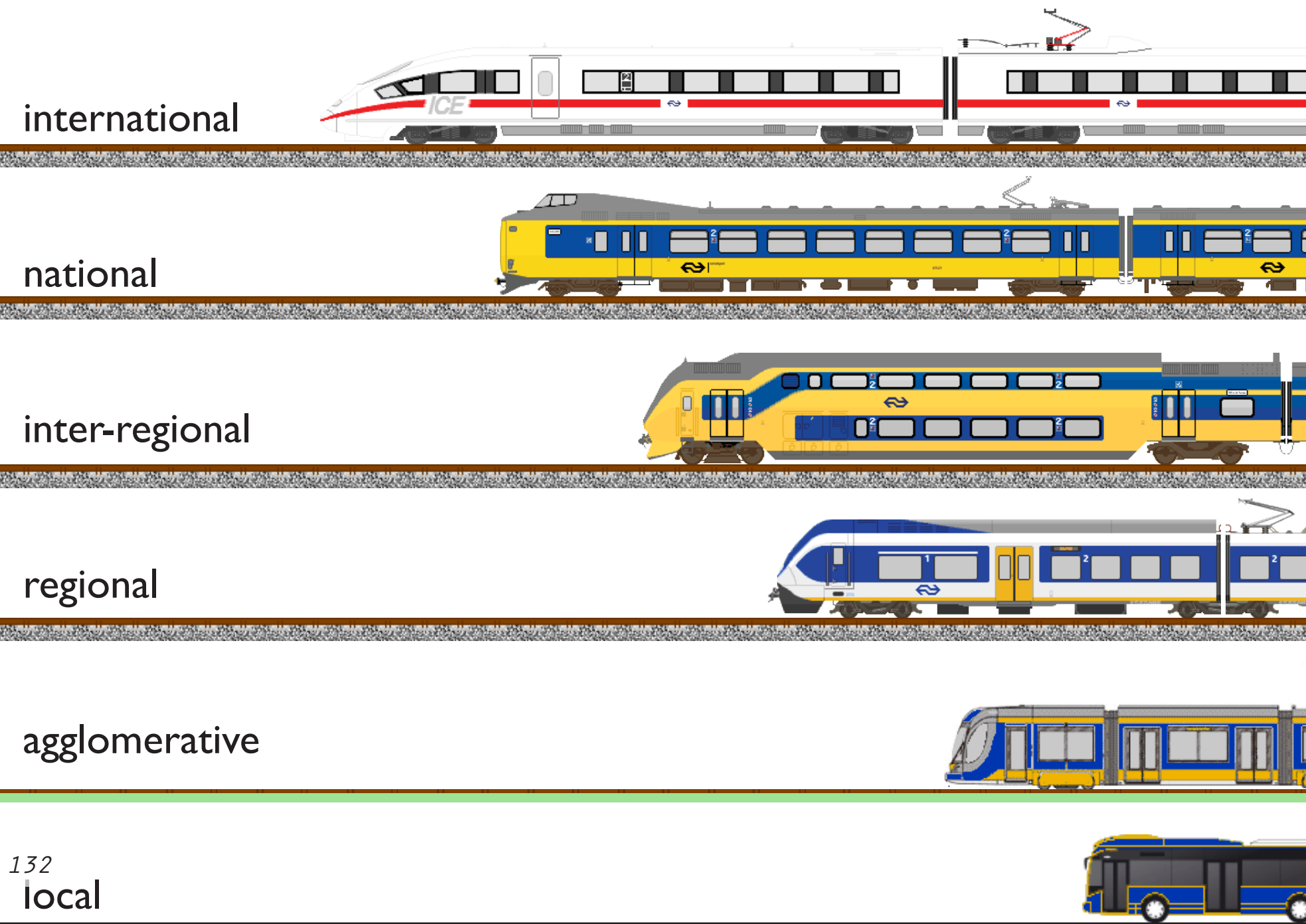
Figure 3.2: Scheme connecting and unfolding networks

3.1.1 Connecting and unfolding networks

According to some authors the public transport system has to be built up by two types of networks: *connecting* and *unfolding* networks (Priemus et al., 1999). According to Egeter (1993), thinking about *connecting* and *unfolding* networks is very meaningful when the public transport system is considered on agglomerative scale. This is the case in the Utrecht city-region, with the central city of Utrecht and the surrounding cores and VINEX (dwelling) areas (Egeter, 1993).

Connecting networks are characterized by high frequencies, a smaller amount of lines, higher speed and greater stop distances. Especially these networks have to compete with the use of the car as a mode of transportation. The techniques that are used for these networks are e.g. traditional trains, light rail systems and express busses (Van den Heuvel and Promotor Van Witsen, 1997).

Figure 3.3: Public transport system: hierarchy and modalities



name	distance	average speed	stop distance
international	> 300 km	150 km/h	100 km
national	100 - 300 km	100 km/h	30 km
inter-regional	40 - 100 km	70 km/h	10 km
regional	25 - 40 km	50 km/h	3 km
agglomerative	5 - 25 km	30 km/h	1 km
local	< 5	20 km/h	300 m

Figure 3.4: Scale levels of public transport systems
Source: (Van Den Heuvel and Schoemaker, 1989)

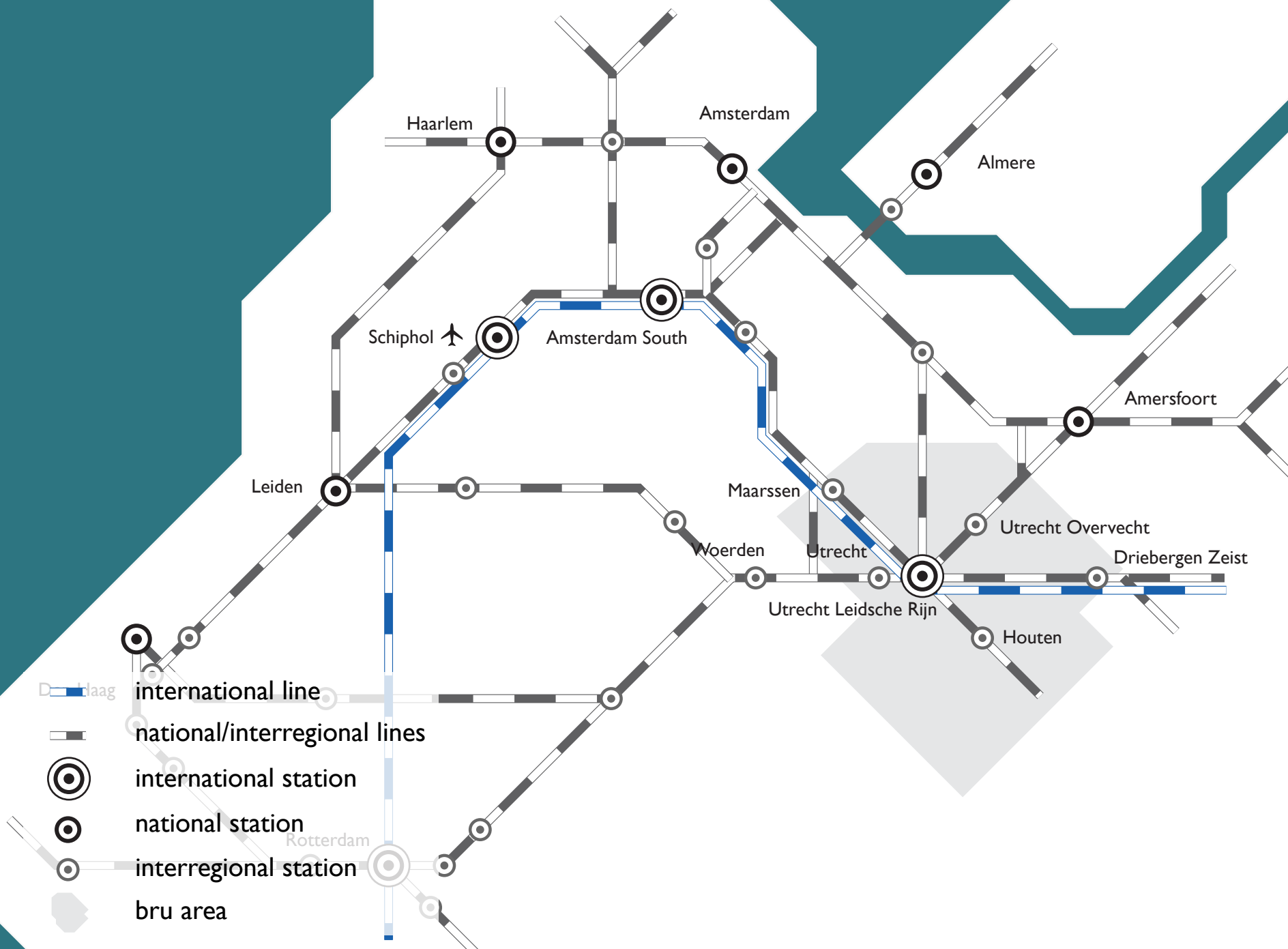
Unfolding networks are characterized by low frequencies, a bigger amount of lines, lower speed, and smaller stop distances. The techniques that are used for these networks are for e.g. traditional busses and streetcars (Van den Heuvel and Promotor Van Witsen, 1997). In an ideal public transport system the *unfolding* networks are acting as feeders for the *connecting* networks (Figure 3.2). In most Dutch city-regions these networks are not functioning in this ideal-typical situation. This is also the case in the Utrecht-region. The two systems are not well integrated and are not clearly classified in one system (Priemus et al., 1999). Problems are for example that city busses and regional busses are connected in low frequencies. Another example, the fast-tram between Utrecht and Nieuwegein is functioning as an *unfolding* system (low speed and smaller stop distances) while it should function as a *connecting* system (high speed, and greater stop distances). This situation is a product of the fragmentation of stakeholders (public transport companies, governmental bodies) and a lack of vision on the public transport in the Netherlands.

However, the distinction and cohesion of these systems is essential for the quality of public transport in the Utrecht-region. This is one of the reasons that new layers of public transport are proposed in this project based on the principles of *unfolding* and *connecting* networks.

3.1.2 Layers public transport system

For the introduction and restructuring of layers in the public transport system it is necessary to reconsider public transport system on the highest scale levels. As stated in the analysis, the hierarchy in the public transport system of the Netherlands and especially in the Randstad should be restructured and improved. This is necessary because the system on city-regional scale is strongly related to higher scale levels. In other words the success of the public transport system on city-regional scale is largely dependent on the functioning on higher scale levels. One of the most important reasons to adjust the public transport system is to create a better alternative for the car. Redefining the several layers of the public transport system can do this.

Figure 3.5: Proposed public transport system in the Randstad



Furthermore, the interconnection between the different modes of (public) transport is needed. New layers of public transportation on e.g. (inter) national, interregional and agglomerative scale should be added and categorized together with existing modalities in a clear hierarchy (Figure 3.3).

This introduction and reconsidering of the system should automatically improve the horizontal and vertical interconnectivity between the different modes and layers of the public transport (Gent et al., 1998, Priemus et al., 1999, Schoemaker, 2002) (Figure 3.4).

International scale

In the current situation, the Utrecht-region is connected to the international train network; however, the infrastructure for international high-speed trains is not available. For the Netherlands, the Randstad and the Utrecht-region it is desirable to connect to the European high-speed train network with accompanying infrastructure. The reason for this is, from the perspective of competitiveness of the Netherlands and the Randstad, it is essential to connect with neighbouring countries via such a network (Van Den Heuvel and Schoemaker, 1989, Baggen and Vleugel, 2008). In the proposal of the public transport system, Utrecht Centraal will remain as the only stop for the international trains in the region.

National scale

The scale and functioning of the intercity system in the Netherlands should be increased. By increasing the scale of this system it will truly function on the national level (Figure 3.3). With the reduction of stops the intercity system could have a higher average speed.

This reconstruction is possible due to the introduction of an interregional system in the Randstad (Schoemaker, 2002). This will lead to an intercity system with trains that only stop at places with a support more than 100.000 inhabitants. Places with a support of inhabitants between 30.000 and 100.000 will be served by the interregional system (Figure 3.5).

Interregional scale

In the current situation an interregional public transport system does not exist in the Netherlands. Adding such a system is desirable in the Randstad (Van den Heuvel and Promotor Van Witsen, 1997). Places which are too small for a national connection (intercity) and which deserve more than just a regional connection (stop train or sprinter) will be connected with the interregional system in the Randstad. This system will serve medium sized cities as Hilversum, Gouda, Delft, and in the Utrecht-region: Woerden, Houten, Maarsse, Driebergen-Zeist and Overvecht. According to some authors the Randstad is a suitable entity to introduce such a system amongst others because there is enough support for this layer of public transport. This is the reason why this system is proposed in this project (Figure 3.5).

Agglomerative scale

A major issue in the Netherlands is the integration of transit on the city-regional scale. In most Dutch city-regions, public transportation lacks a clear layering (Priemus et al., 1999). Modalities are connected in low frequencies and are functioning as connectors and unfolders at the same time. In other countries layering and hierarchy of systems is better embedded than in

Proposed public transport system in the Utrecht-region

Maartensdijk

Den Dolder

Bilthoven

Utrecht Overvecht

Utrecht Zuilen

Utrecht

Utrecht Vaartsche Rijn

Utrecht Lunetten

Bunnik

Driebergen Zeis

Houten West

Houten

Houten Castellum

Vianen

Culemborg

Maarssen

Lage Weide

Utrecht Leidsche Rijn Centrum

Vleuten

Utrecht Terwijde

Utrecht Majella

International line

National/interregional lines

Agglomerative lines

International station

National station

Interregional station

Regional station

Urban area

the Netherlands. This problem is also visible on the city-regional scale in the Utrecht-region. The public transport system of the Utrecht-region lacks a clear hierarchy and division between connecting and unfolding systems.

There is an increase of the action spaces of people as stated in the theoretical framework (chapter 2.1). This up scaling of daily activity patterns of the households from the city towards the city-region should lead to an up scaling of spatial developments in the city-region and a reconstruction of the public transport system on that scale.

The existence of some black holes in the public transport system and the up scaling of the daily activity patterns of households makes it necessary to introduce a new modality on agglomerative scale. As previously mentioned, the scale of the daily activity patterns is increasing. In that way, a logical consequence should be that city- and regional transit will be integrated (Figure 3.6).

This is one of the reasons that a new agglomerative system public transport system is proposed in this regional design. This system will connect the central city of Utrecht with the suburban cores. The suburban cores in their turn will also be connected with economical anchors (Van den Heuvel and Promotor Van Witsen, 1997). A suitable modality that could provide this public transport is a agglomerative light rail system.

3.1.3 Why light rail?

In this paragraph the justification for the introduction of a agglomerative public transport system is explained. It will start with the general comment about the demand for mobility. Next to this, the effects in terms of capacity and reliability, sustainability, safety and its role in the integration of the city and the region will be discussed.

Growth and public transportation

In general, the demand for transportation is increasing according to several authors (Schafer and Victor, 2000, Priemus et al., 1999). In the Utrecht-region this growing demand of mobility is also visible in the prognosis of the VRU model (chapter 2). Furthermore, the amount of inhabitants and workers in the region will keep on growing in the future, minimal until 2040. Hence, the daily movements of people in the Utrecht-region will also keep on growing. In relation with the current policy this will lead to a growing demand for public transportation. With the introduction of an attractive public transport modality, people are tempted to use public transit instead of individual (car) transport.

Capacity & reliability

A lot of the current HOV (= high quality public transport) bus connections are showing a lack of capacity and reliability. This problem is occurring already in the present situation and will increase on the long term. Some connections are already applying the longest busses with the highest possible frequencies. These problems appear on the corridors in the direction of science centre “De Uithof” and in the future towards business centre “Papendorp” and dwelling area “Leidsche Rijn”. Furthermore, other important bus connections are not able to respond on the growing demand for mobility in the region.

Some important bus corridors in the Utrecht-region already have enough support for developing into a different modality, e.g. light rail. The high transportation value of these connections makes the introduction of rail transit feasible.

Utrecht Centraal cannot deal with the growth of the public transport movements if these movements will be provided by bus connections. Up to 500 busses are driving from and towards Utrecht Centraal every hour. These busses and movements need space, therefore the pressure on the limited space of Utrecht Centraal increases (Bestuur Regio Utrecht, 2009). A light rail system could provide a higher capacity and quality of the public transport system of the Utrecht-region on the agglomerative scale.

Sustainability

The introduction of a light rail system will reduce emissions in the Utrecht-region, in comparison with the use of current city busses. Furthermore, the development of a coherent and integrated rail system on the agglomerative scale can help to provide alternatives for individual car transportation. Combined with a Park & Ride system, the congestion on the road network can be reduced, especially within the urbanized areas. This will lead to an improvement of the air- and sound quality. The poor air quality of the Utrecht-region is a major issue due to the loads of car and bus traffic in the region (Bach et al., 2002, Bestuur Regio Utrecht, 2009).

Synergy

The further development of a rail system on the agglomerative scale can provide opportunities for spatial developments. A coherent and well functioning public transport system on several levels of scale is an attractive location factor for people and companies. The development of a light rail system, could function as a sustainable backbone for further development of offices,

companies, dwellings, facilities and recreation (Bestuur Regio Utrecht, 2009). Furthermore, the development of a light rail system can be an instrument to create synergy between high quality public transportation, real estate development and urban vitality (Priemus et al., 1999).

Urbanity

A light rail system has a positive influence on its environment. If a light rail system is selected, this system could lead to a higher quality of public space and environment. Examples of other European cities like Montpellier and Strasbourg show that value can be added by light rail in terms of image of public transport, image of the city and its urbanity.

Safety

A light rail system in general is safer than a bus system because the light rail system has its own infrastructure. Therefore, the light rail and its infrastructure are more noticeable. This will probably lead to less traffic accidents, which is of course a desirable development.

Integration

The development of a light rail system will not solve all mobility problems (Priemus et al., 1999). Other transportation modalities like the local bus system will also maintain important functions. Essential is the integration between the different modes of public transportation in the city-region, both, horizontally and vertically.

However, a light rail system could add value in the city-regional context to integrate the city and the region (Priemus et al., 1999). A light rail system can make this



Figure 3.7: Feasibility introduction light rail system

integration physical possible. As stated in the analysis, there is a spatial mismatch between workers and workplaces in the Utrecht-region. The development of a coherent agglomerative public transport system combined with spatial developments can help to facilitate the movements undertaken in this exchange commuting system.

3.1.4 Feasibility light rail

As mentioned, there are a lot of advantages of a light rail system in the Utrecht-region. However, the development of this system has a price tag. This paragraph will explain why the development of this light rail system could still be feasible (Figure 3.7).

Rank-size rule

In general, in a region with more than 400.000 inhabitants it is feasible to introduce a light rail system. This “rank-size rule” stresses the relation of the size of a city-region with an appropriate public transport modality (Bach et al., 2002). The city-region of Utrecht has currently 618.000 inhabitants. In 2030 this amount will grow to an amount of 721.000 inhabitants. Hence, in terms of inhabitants there is enough support for a light rail system in the Utrecht-region.

Reciprocity and investment strategy

New quality impulses, due to the introduction of a new type of public transport combined with urban renewal, can contribute to the vitality and economic activity of a city-region. The interaction between public transport and spatial developments from the principle of transit-oriented development could provide significant positive effects (Calthorpe, 1993, Cervero, 1998). The new spatial developments in a station area or around a transit stop of a light rail line, could attract more visitors (Priemus et al., 1999). In that way these new developments are creating support for the public transport system, next to the already existing support. In short, the introduction of a new public transport system on agglomerative scale is an attractor for new spatial developments. Vice versa: new spatial developments could be the driver for the introduction of new public transport (Priemus et al., 1999). Thus, there is a mutual relation between supply of public transport and spatial developments. Therefore, new investments in the public transport system should be a part of a more integral investment policy for the Utrecht-region. For instance, the constructions of new lines have to be combined with spatial developments (urban design) as stated earlier. The urban development of e.g. a new important avenue should be realized in

collaboration with the introduction of a new transit line. High costs and poor results can be avoided when these two quantities are not developed separately, but in an integrated way (Priemus et al., 1999).

Increase turnover functions

In practice, the introduction of a new public transport modality can increase the turnover of e.g. retail or leisure activities close to a transit stop. This could double the income from rent and hereby the asset value will increase. Furthermore, this will result in an increase of the income of the property taxes for the municipalities (in Dutch OZB) (Bach et al., 2002).

3.1.5 One technique two modalities

The agglomerative transportation system consists of two modalities: a streetcar and a light rail. These systems are using the same technique: infrastructure and train units are similar. However, the line length, stop distance and thereby the average speed of the two systems differ. In this project the difference in functioning is determined by the length of the line and geographical situation. Public transport lines with a radius until 4.5 kilometres are functioning as streetcar and lines with a radius above 4.5 kilometres are functioning as agglomerative light rail. The light rail is functioning on greater distances than the streetcar (Ministerie van Verkeer en Waterstaat Directoraat-Generaal Personenvervoer, 1997).

The streetcar is functioning mainly within the urbanized area of the city of Utrecht. This modality provides the local *unfolding* of places with the highest densities of workers and inhabitants and is in essence replacing city buses. The city-regional light rail is connecting the central

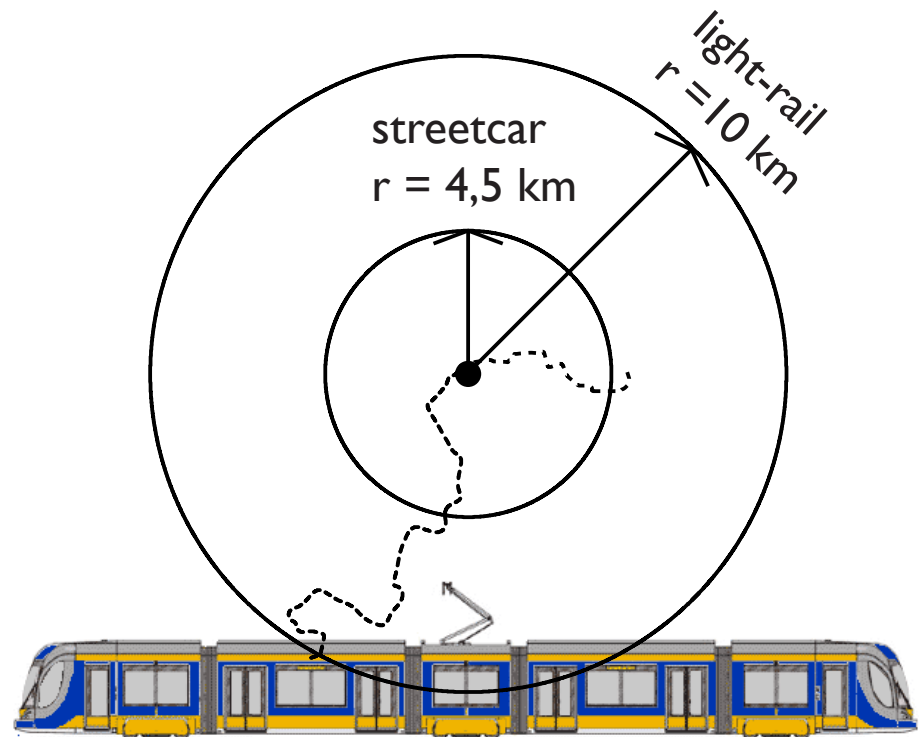


Figure 3.8: One technique, two modalities, streetcar and light rail

city of Utrecht with the suburban cores and connects the suburban cores and economical anchors. By using the same technique for the streetcar and agglomerative light rail it is possible to combine these two modalities. A certain public transport line could function partly as a streetcar and partly as a light rail modality. In that way the system is flexible and relatively quickly adaptable. (Figure 3.8).

3.1.6 Justification design agglomerative lines

Several reasons have led to the development of the regional design for the public transport system. These are: connecting (economic) anchor points of the Utrecht-region, the support of workers and inhabitants per transit line, existing flows of people by car and

transport value	excl. image	incl. image
Zuilen/Overvecht	29.000	38.000
Central city	27.000	35.000
Uithof	26.000	34.000
Nieuwegein/ IJsselstein	25.000	25.000
Papendorp	15.000	20.000
Zeist	12.000	16.000
Vianen	7.000	9.000
Bilthoven	5.000	7.000
Rijnenburg	4.000	5.000
Voordorp	2.000	2.000

Figure 3.9: Transport value according BRU, exclusive and inclusive light rail image
Source: BRU 2009

public transportation in the region, calculations of the transportation value of certain light rail lines by the BRU and the geographical fitting or positioning of the line within the urban or rural context. These topics will be elaborated in this paragraph.

Anchor points

Science centre “the Uithof” is an important (economic) anchor point of the Utrecht-region. It is one of the important features of this knowledge and service sector based city (PART II atlas). The proposed light rail network connects this important place with the central city and Utrecht Centraal. This is an example of connecting important anchor points of the region with a high quality public transport facility.

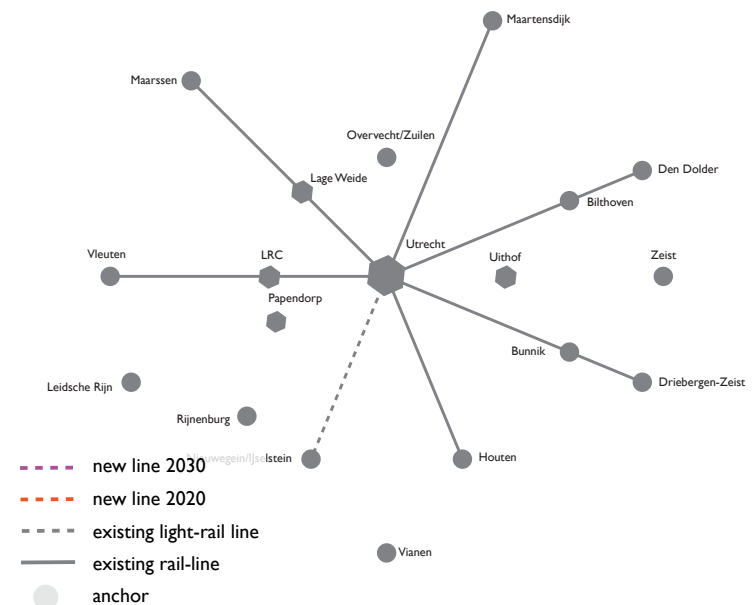


Figure 3.10: Situation 2010 public transport system, schematic representation

Transportation value

Next to this, the light rail lines of the Utrecht-region are reviewed on their transportation value. In a study, which is executed by the BRU, light rail connections are calculated on the expected amount of people that actually will use this connection. When more than 15.000 people are expected to use a certain connection, the line is valuable to develop as a streetcar or light rail connection (Figure 3.9).

The map illustrates the bus network around Utrecht city center. Key features include:

- Central Area:** Utrecht CS, Utrecht centre, and surrounding streets like Vaartsche-Rijn and Jaarbeurs.
- Northwest:** Maarsse, Vleuten, and De Uithof, connected by routes 3, 4, and 5.
- South:** IJsselstein, Nieuwegein, and Houten, connected by routes 2, 6, and 3.
- East:** Driebergen, connected by route 3.
- Transfer Points:** Utrecht CS, Utrecht centre, and various stops like Station Leidsche Rijn Centrum and Station Lunetten.

Support

Related to this transportation value is the support of a certain connection in its urban environment. The analysis of amount of workers and inhabitants for 2002 and 2020 is another determinant for the development of connections. When for instance a significant increase of the density of inhabitants and workers in a certain area is forecasted for 2020, it is likely that a connection will be feasible from the transportation point of view. For additional analysis concerning the support of workers and inhabitants is referred to the appendices.

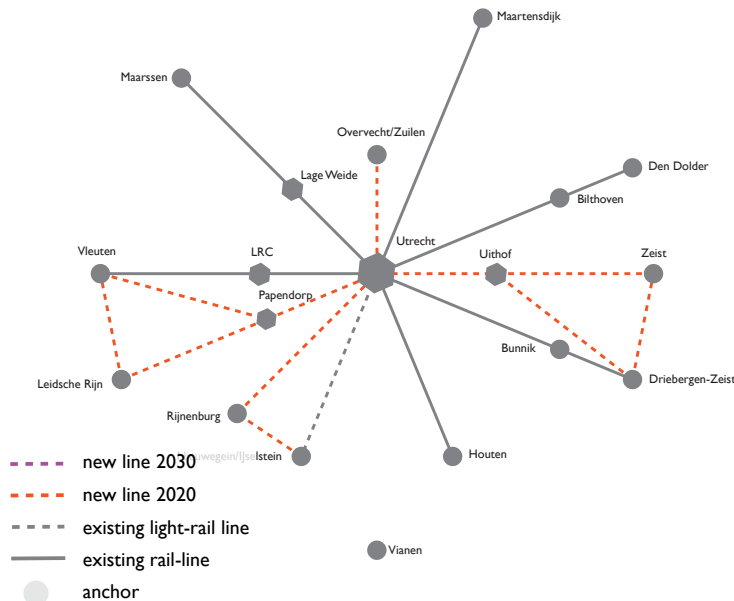


Figure 3.12: Proposed situation 2020 public transport system, schematic representation

Flows

Next to this, the actual flows in the region, e.g. between anchor points of work and living are determining the design proposal for the agglomerative public transport system. An example is the tangential connection between Nieuwegein and Houten. In 2020 a substantial increase of car movements between these towns is forecasted. This is an argument to think about a light rail connection between these places. The origin-destination analysis that is executed for the Utrecht-region is the result of this research about flows in the Utrecht-region.

Geographical integration

At last, the geographical situation plays an important role in the decision for a certain agglomerative public transportation line. Barriers, availability of space and the possibility of e.g. a road connection to expand this with a light rail system can determine the geographical fitting of the connection (Figure 3.7).

3.1.7 Proposed lines

This paragraph will describe the proposal of the different agglomerative public transport lines. Both, streetcar and light rail lines will be elaborated. In total, six new streetcar and light rail lines will be introduced (Figure 3.11). In Figures 3.10, 3.12 and 3.13 the development of the light rail lines is represented schematically.

Line 1: De Uithof - Utrecht - Nieuwegein - IJsselstein

A new streetcar connection will connect science centre “De Uithof” with the city centre of Utrecht and Utrecht Centraal. When the streetcar is connected to Utrecht Centraal, this connection will continue as a light rail

Figure 3.13: Situation 2010 public transport system, topographical representation



connection in direction of Nieuwegein. The existing light rail in the direction IJsselstein and Nieuwegein will be restructured. In the current situation, the light rail towards Nieuwegein and IJsselstein is only functioning well within the central city of Utrecht and in within IJsselstein and Nieuwegein separately. However, the system is disfunctioning as a connector between Nieuwegein and IJsselstein and Utrecht. In the proposed situation the amount of stops will be reduced to speed up the connection (old situation, new situation image). Transit line 1 will continue from the station area of Utrecht Centraal in direction of Utrecht South-West, the IKEA area and Nieuwegein.

Line 2: De Uithof - Maarschalkerweerd - Utrecht Centraal - IJsselstein

Line 2 contains an already planned light rail connection in the direction of “de Uithof” (HOV om Zuid). This light rail will serve as a fast connector between the station area of Utrecht Centraal and science centre “De Uithof”. The amount of stops is limited. This line will continue as a light rail in direction of Nieuwegein Centre and IJsselstein.

Line 3: Vleuten - Leidsche Rijn - Papendorp - Utrecht Centraal - De Uithof - Zeist - Station Driebergen-Zeist - Driebergen

Line 3 is the longest proposed line in the Utrecht-region. It is a connection from the city centre of Utrecht in direction of VINEX location Leidsche Rijn, Zeist and Driebergen. This connection relates important anchor points of the Utrecht-Region to each other, Driebergen, the station area of Driebergen-Zeist, Zeist, and the De Uithof. The line is functioning as a streetcar between “De Uithof” and Utrecht Centraal. In direction of business



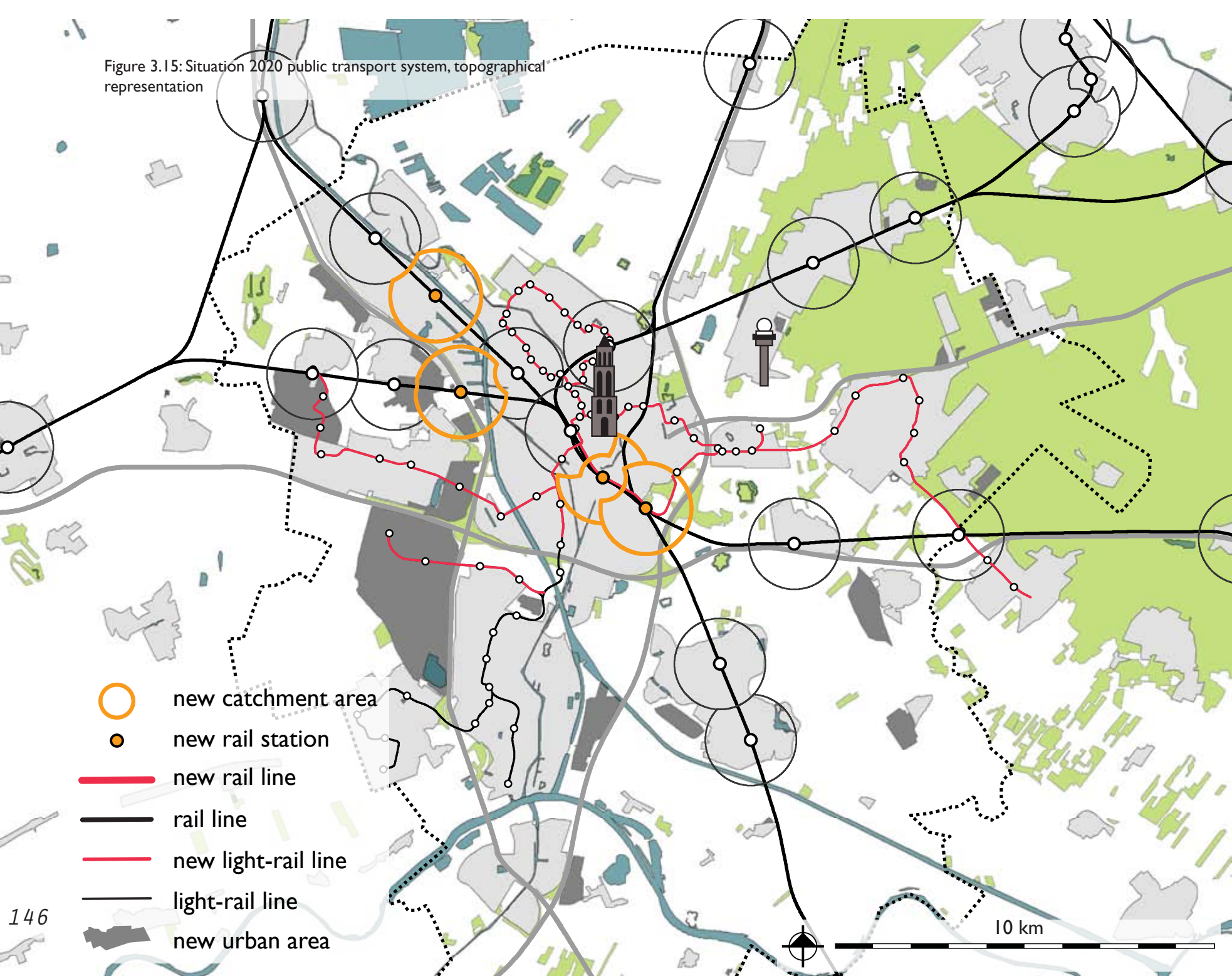
Figure 3.14: Proposed situation 2030 public transport system, schematic representation

location Papendorp the line is functioning as a light rail and connects the dwelling areas of Leidsche Rijn, De Meern and Vleuten.

Line 4: Maarssen - Leidsche Rijn Centrum - Rijnenburg - Papendorp - Utrecht Centraal

Line 4 is connecting Maarssen with Leidsche Rijn and the station area of Leidsche Rijn Centrum and it continues in direction of Rijnenburg, Papendorp and the station area of Utrecht Centraal. In the city centre of Utrecht and in direction of Voordorp the line functions as a streetcar.

Figure 3.15: Situation 2020 public transport system, topographical representation



Line 5: Maarssen - Leidsche Rijn Centrum - Utrecht Centraal - Zuilen - Overvecht

Line 5 also starts in Maarssen like line 4 as a light rail connection but is continuing after the Station area of Leidsche Rijn Centrum as a streetcar in direction of the station area of Utrecht Centraal. Furthermore, it continues in the direction of the districts Overvecht and Zuilen.

Line 6: Nieuwegein - Houten

One of the first tangential connections is proposed between Nieuwegein and Houten. This line connects the centre of Nieuwegein, business centre 't Klooster and Houten. In the origin-destination analysis a major increase of movements in car and public transport is seen between these anchor points. Houten is a major dwelling area, and Nieuwegein has some important places of work. A high quality public transport line is therefore introduced between these cities.

3.1.8 Proposed stations

Next to the proposed light rail lines, some new and planned traditional rail stations are introduced. The proposed stations should function as an extension on the existing stations and not as competitors. The competitiveness of stations will always appear, but the proposed stations are selected by their expected added value for the entire public transport network. In this way the competition between the existing and the proposed stations will be reduced.

Another important point is the consideration of prerequisites. An example is the planned rail line between Utrecht and Breda. In this project, this new line is

anticipated with the proposal to add two new stations at this line in the Utrecht-region.

Furthermore, the properties and potentials form the principles of transit-oriented development, mentioned in chapter 2.2.4, have played a significant role in the choice for developing of proposed stations. Existing densities of workers and inhabitants or the abilities for developing this support have been important in this choice. This paragraph will describe the developments and the phasing of these stations further. In Figure 3.13, 3.15 and 3.16 the development of the city regional public transport system is represented.

Planned

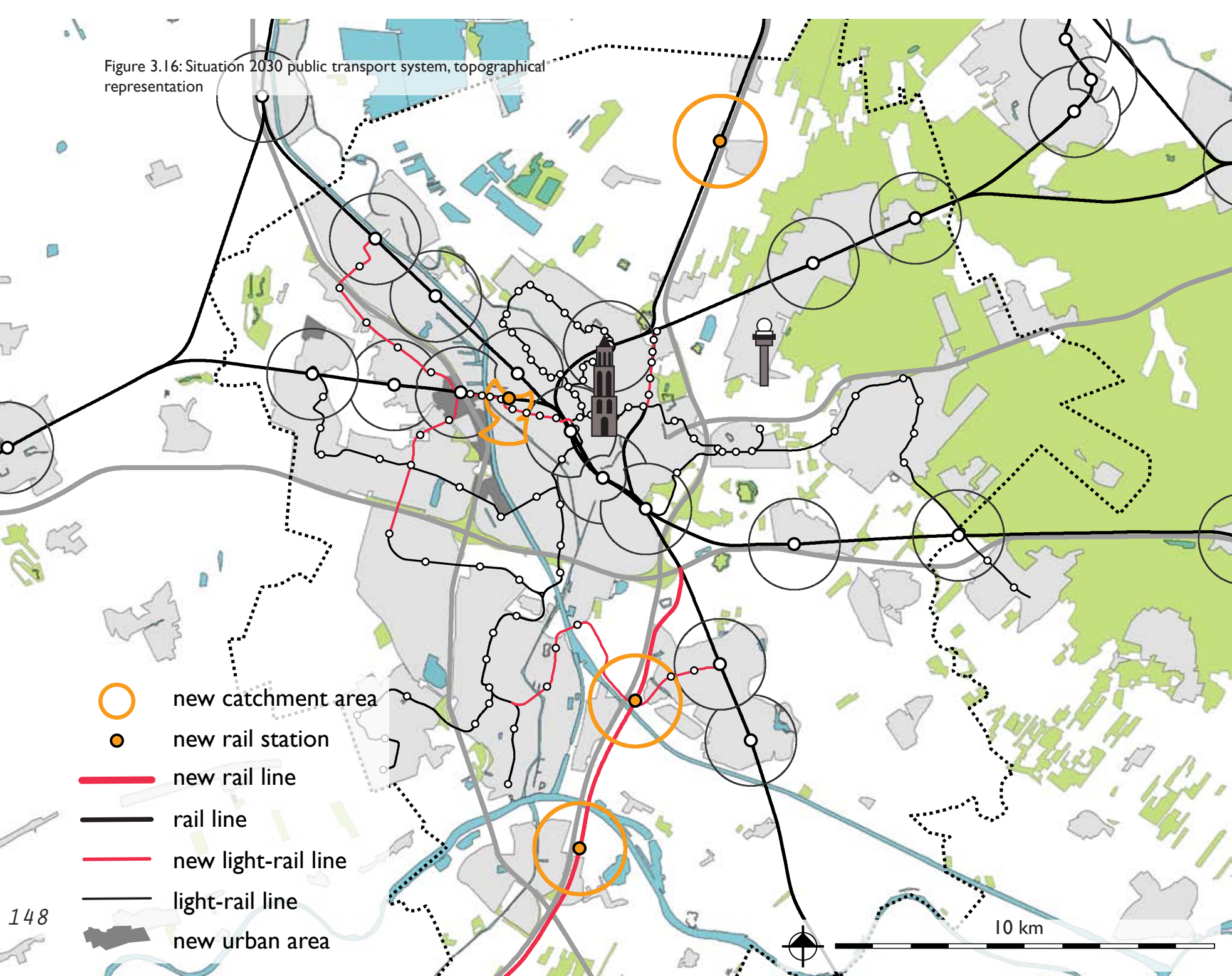
Utrecht Vaartsche Rijn

Utrecht Vaartsche Rijn is one of the planned stations that are introduced with the ideas of Randstad Spoor Stations (RSS) in the city-region of Utrecht. The station will be realized in the year 2015. The proposed spatial developments near Utrecht Vaartsche Rijn and the station can be developed simultaneously (NIROV, 2010a, Gemeente Utrecht, 2010b).

Utrecht Leidsche Rijn Centrum

The planned station in VINEX location Leidsche Rijn will be opened in 2012 (NIROV, 2010c). This station will be an important station and will function as an economic anchor for the city-region of Utrecht. The spatial developments around this station will continue until the year 2025. In this vision no additional developments are proposed for this station. The vision is taking these developments into account.

Figure 3.16: Situation 2030 public transport system, topographical representation



Utrecht Lage Weide

The station Utrecht Lage Weide is a new introduced station and is located on the connection between Amsterdam and Utrecht. The district Lage Weide is an outdated industrial location. The development of a station at this location creates opportunities for developing this industrial zone into a multifunctional station area.

Possible

Utrecht Majella

The proposed station Utrecht Majella is located in the urbanized area of the central city Utrecht. This station will be realized at the line between Utrecht and Rotterdam. The introduction of this station creates opportunities for the redevelopment of the so-called “Cartesiusdriehoek”. This old industrial location could be redeveloped as a multifunctional area.

Vianen

Another proposed station on the traditional rail line between Utrecht and Breda is Vianen. This station is like Houten West located nearby an exit of the A27 and has therefore opportunities to develop as an important multimodal node.

Houten West

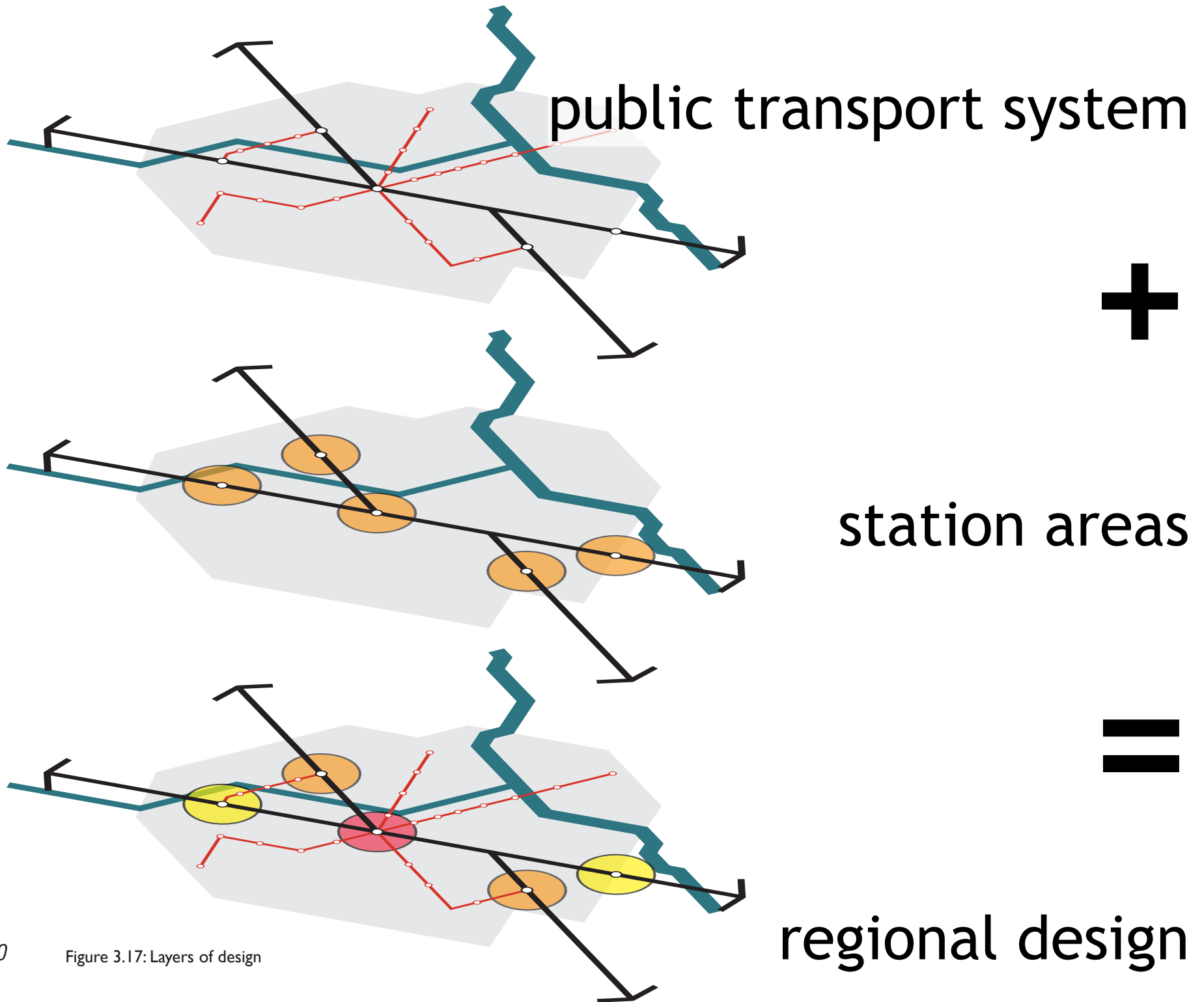
In 2030, Houten West is one of the two stations that are introduced in the city-region at the new rail line between Utrecht and Breda. This station is located nearby an exit of the A27 and has therefore opportunities to develop as an important multimodal node. Moreover, Houten West is connected to a new introduced tangential light rail line between Nieuwegein and Houten.

Utrecht Lunetten Beatrixpark

Utrecht Lunetten Beatrixpark is a station that will be the substitute of the already existing station Utrecht Lunetten. In fact, the station will be moved to the northwest. With the displacement of the Utrecht Lunetten it will be connected the light rail line in direction of “De Uithof” and with an extra already existing traditional rail connection towards Arnhem. In this way the station will acquire a much higher node value. Hence, intensive spatial developments near the new station are proposed to use its potentials.

Maartensdijk

Maartensdijk is a proposed station at the line between Utrecht and Almere. This station will replace the station Hollandsche Rading. There are several reasons for this. First, the station of Hollandsche Rading is a dependent station according the results of the node-place model of Bertolini (Chapter 2.1.3). Therefore, both node- and place value are very low. Furthermore, there are limited possibilities for spatial developments around this station, in other words to increase the place value of this station. Next to this, the amount of passengers using this station is limited, 850 per day. This amount is too small to function as a feasible station in the Netherlands. According the Dutch Railways (NS) an amount of 1000 boarding and unboarding passengers and more is enough to be feasible. A new station adjacent to the town of Maartensdijk will create more support in terms of workers and inhabitants. Furthermore, Maartensdijk has more possibilities for extension. The support will also increase with the proposed spatial developments near this station. The exit of the highway A27 is in the vicinity of the station.





3.2 Design proposal: spatial developments

3.2.1 Introduction

The introduction of new transit lines will be combined with spatial developments and redevelopments in the Utrecht-region. The public space will be renewed, and upgraded at the station areas. The retail functions and office space will be enlarged in the vicinity of the station areas. Housing will also be concentrated in the vicinity of public transport nodes. In terms of land use, densities and degree of functional mix should be the highest in the vicinity of the stations (Bruinsma et al., 2008).

The goal hereby is to provide a good alternative for the individual (car) transportation. Public transport fares have to be kept low while car use has to be made less attractive. The following chapter will tell something about the design of these spatial developments near the station areas (Figure 3.17).

3.2.2 Categorization of station areas

Qualitative and quantitative variables determine the potential of every station area. Qualitative variables are the node and place value of every station. Quantitative variables are summarized as space value, and consist of e.g. the availability of open space and the percentage of the build up area. The result of this research is described in chapter 2. The proposed typologies of the station areas are constructed with the qualitative and quantitative variables. If e.g. a node value of a station area is high compared with its place value, urban functions could be added to the station area to develop the station further. In this way the station area could be more in balance and its potentials can be utilized. The space value of the station

area can also influence this design decision. In some cases there are limited possibilities for extending the station area with urban functions, e.g. because of restrictions and limitations. In these cases, it is imaginable that the node value of this station will be reduced to create a more balanced situation. The entire process of developing the station areas of the Utrecht-region is illustrated in Figure 3.18.

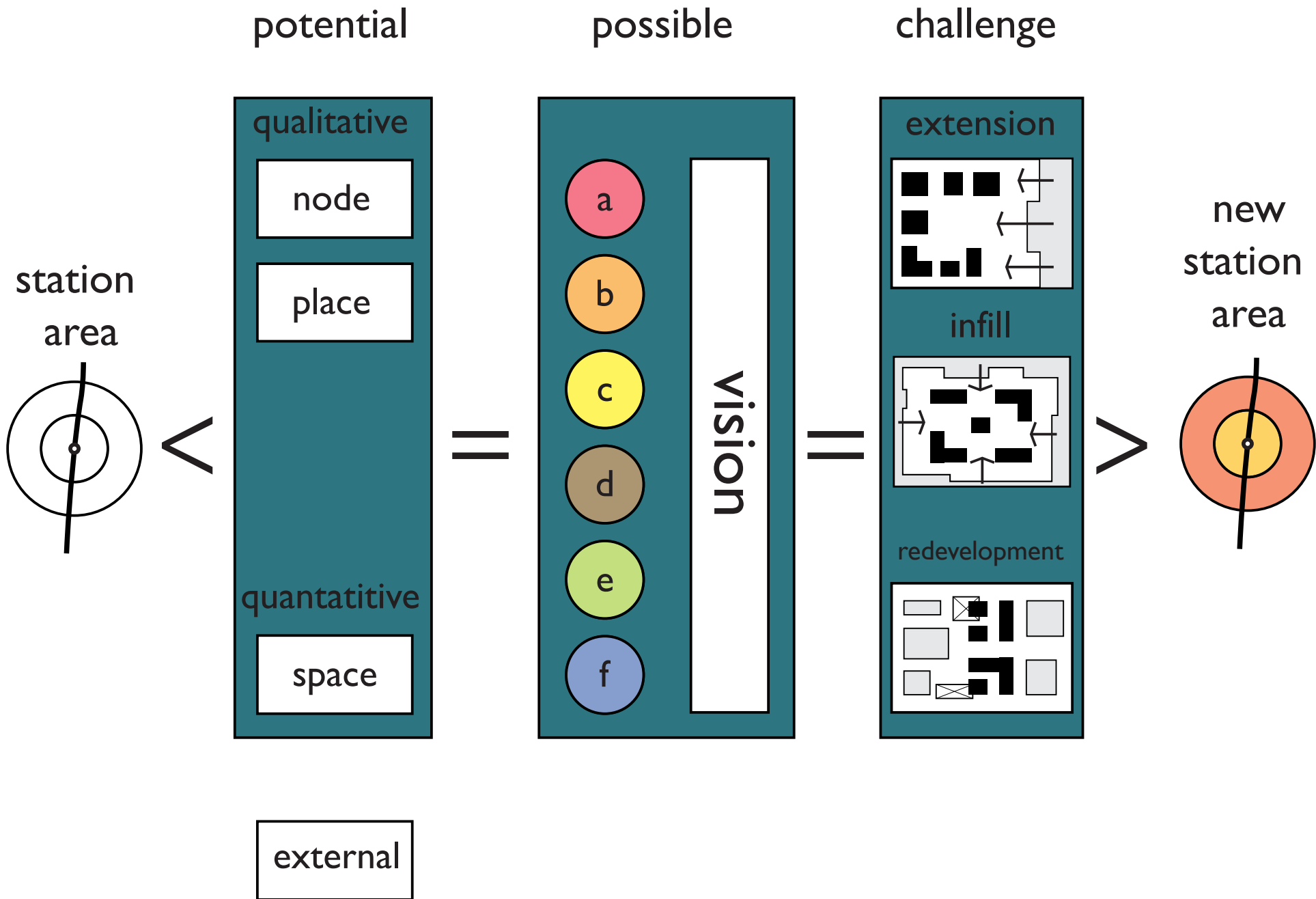


Figure 3.18: Process station areas, potentials, possibilities and challenges

3.2.3 TOD: local and regional goals

With the development of a certain station area, the discrepancy between the regional and the local goals of TOD are taken into account. On the local scale it is for a station area e.g. most likely to develop in a direction of a certain typology. Reason for this is that current place and node value are in the direction of the node and place value of a designed typology. However, the regional goals of the Utrecht-region could oblige a different development of the station area (Figure 3.19).

The focus of this research and design is on the regional scale. There are some specific reasons for this. In general, most daily interactions of households take place on the city-regional scale in the Netherlands. The majority of the daily trips that are undertaken by the households in the Randstad remain within the big cities. This means that the city-regional scale is an essential scale for research and design (Laan, 1996, Ruimtelijk Planbureau, 2006, Musterd and van Zelm, 2001). In this research, this scale level is spatially bordered by the BRU area (Figure 1.7).

3.2.4 Strategy: from extension to densification

One of the regional goals of TOD was to define the edge of the metropolitan area. In the Utrecht-region a maximum growth border will virtually bound the urbanized area. The urbanization can take place within this border. The advantage of this strict border is that the urbanization will be compact and in high density and in the vicinity of the public transport system. In this way fast transfer is possible between regional nodes and next to this, the node itself is highly accessible.

As mentioned in earlier chapters, the station area is an important node in terms of social-economic interactions

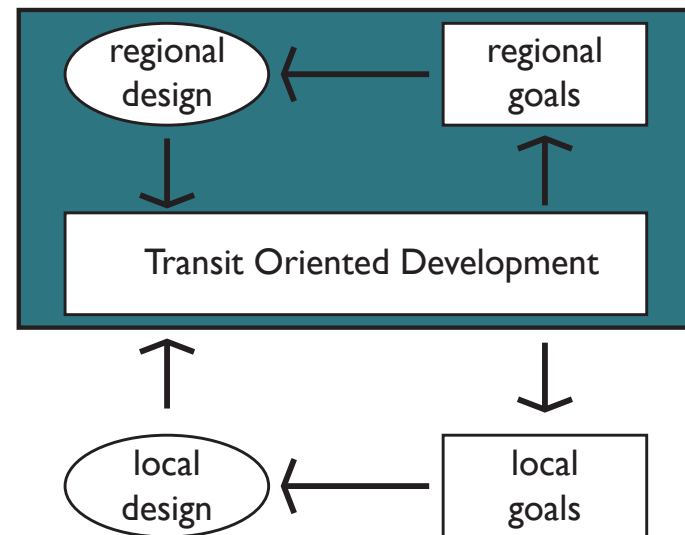
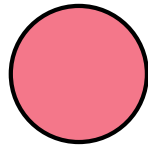
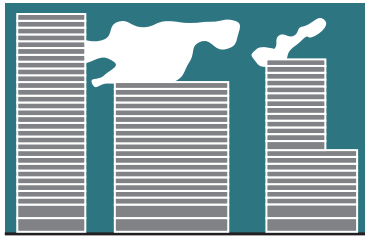


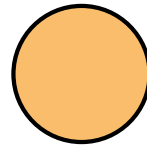
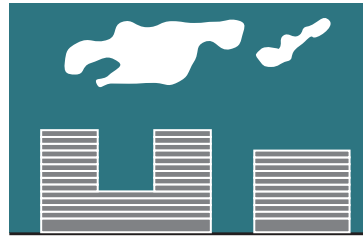
Figure 3.19 Regional and local goals of TOD

of people in space (chapter 2). Thereby these places should have the attention of spatial planners and urban designers. In the proposed regional design and strategy for the Utrecht-region the station areas play a crucial design in developing the region in a transit oriented way. Furthermore, the combination of spatial developments like housing with an integrated public transport system is one of the principles of this regional design. For the spatial developments of the region a 'list of rules' is made for implementing this strategy further.

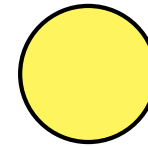
downtown centre



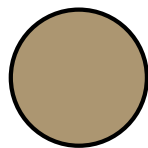
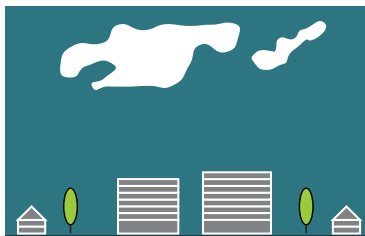
urban centre



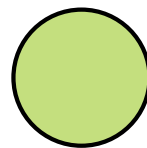
urban neighbourhood



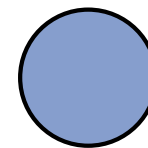
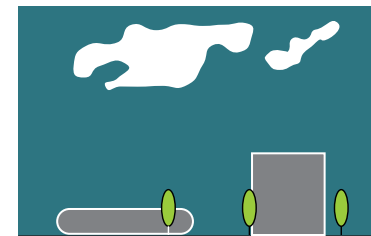
town centre



transit zone



special zone



3.2.5 Rules for spatial developments

The spatial strategy of the last decades of the Utrecht-region was to extend the city-region further. An example is the major dwelling extension Leidsche Rijn. This former agricultural land is now being transformed into a city-district with 80.000 inhabitants, a city with the size of Leeuwarden. Currently, Rijnenburg in the south-west of Utrecht is also a planned extension area which will be extensively developed with housing in low densities (NIROV, 2010b). In the present situation, it becomes more and more clear that the challenge for the future is to develop within the existing urbanized area of Utrecht (Bestuur Regio Utrecht, 2008c). Utrecht is more or less bordered by the so-called “Nationale landschappen” (PART II: Atlas) and therefore the challenge for the future is to develop within the existing urbanization.

The overall goals are to influence the movement or mobility patterns of people at the one hand, and create a support for public transportation at the other. For these goals the following rules are defined:

- Every traditional station area has two catchment areas, one with a radius of 1200 meters and another with a radius of 600 meters.
- Spatial developments should take place within the catchment area of a traditional station, preferably within the radius of 600 meters.
- The catchment area of 600 meters will be developed with mainly destination functions (e.g. retail, leisure and offices) and within the radius of 1200 meters especially the origin functions will be developed.

- In the station area the densities should be of the highest near the transit stop and should gradually decrease when the second catchment area with a radius of 1200 meters is reached. Furthermore, mixed use is higher within the 600 meters catchment area.
- Spatial developments should take place within the catchment area of the light rail with a radius of 600 meter and streetcar with a radius of 400 meters.

3.2.6 Design: Categorization of station areas

Six types of station areas are proposed. These are typologies in which an existing, planned or possible station area could develop. Next to this, the proposed station areas will have a certain housing typology, functional mix and outlook.

This chapter will describe the proposed station areas. Every station area within the Utrecht-region will develop in the direction of a certain station area. However, these six typologies will not function as a strict blueprint (Figure 3.20). Within a certain typology different variants can be developed. Local differences and interests of a certain station area are influencing the process of the development of the station areas.

downtown centre



5 - 30 stories

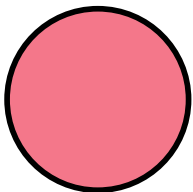
75 dwellings p/ha
multi-family, loft, apartment,
penthouses

1000 workers p/ha

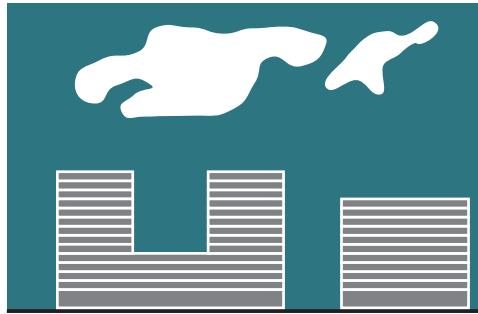
office, retail, leisure, civic use,
residential

95 % site coverage

international



urban centre



3 - 15 stories

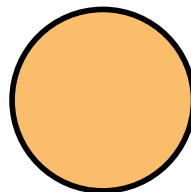
60 dwellings p/ha
multi-family, mansions, attics,
apartment

800 workers p/ha

office, retail, residential

85 % site coverage

interregional



urban neighbourhood



3 - 6 stories

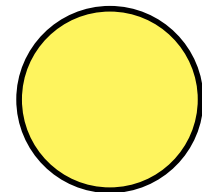
60 dwellings p/ha
multi-family, mansions, attics,
apartment

600 workers p/ha

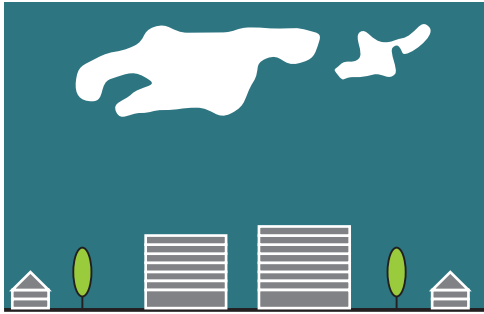
neighbourhood retail, residential

75 % site coverage

regional



town centre



2 - 8 stories

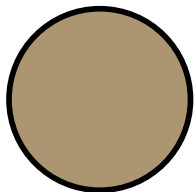
50 dwellings p/ha
multi-family, single family,
apartment

600 workers p/ha

office, retail, residential

80 % site coverage

regional



transit zone



2 - 4 stories

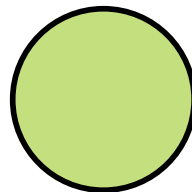
30 dwellings p/ha
single family

400 workers p/ha

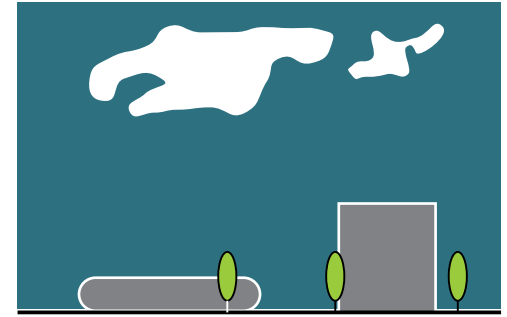
residential, neighbourhood retail

65 % site coverage

agglomerative, local



special zone



varies

limited

varies

office, public facilities

varies

agglomerative, local

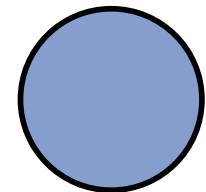
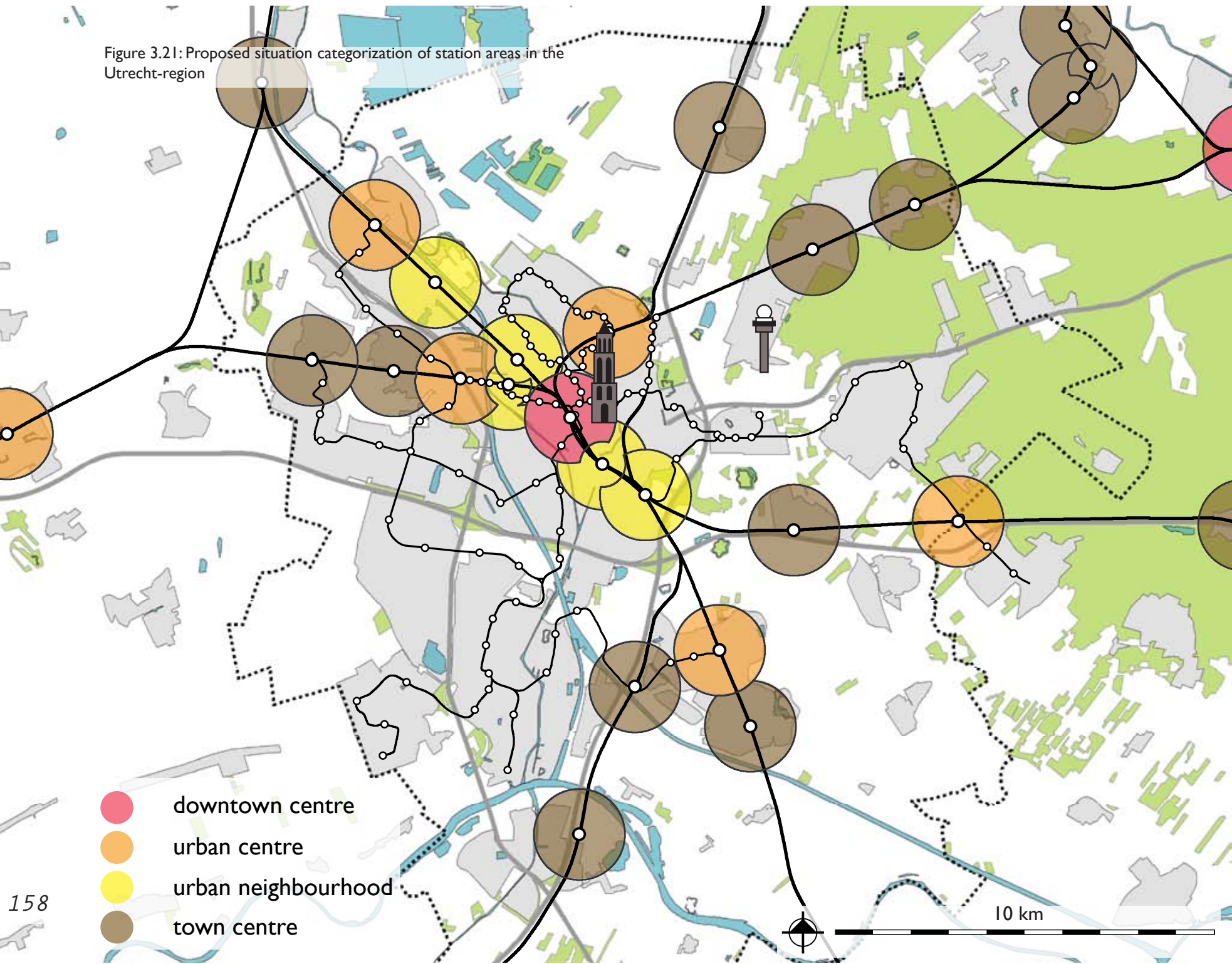


Figure 3.21: Proposed situation categorization of station areas in the Utrecht-region



Downtown centre

The Downtown centre is the most important station area in hierarchy. Both, node and place value are high, the station area has an international character. It functions as an economic and cultural centre. The Utrecht-region has one station area with these properties: Utrecht Centraal. High densities, and a high degree of functional mix characterize the living environment in the Downtown centre. The housing typologies in this centre are multifamily housing, apartments and penthouses. Utrecht Centraal will remain the most important station area of the Utrecht-region and will be proposed as a Downtown centre. Currently, there is an ambitious redevelopment plan that will approximately be realised in 2030. This will lead to a further increase of mainly the place value of this station area. New functions like offices, retail and cultural facilities are planned to develop at this station area (Gemeente Utrecht, 2010a). These developments will lead to a strong position of Utrecht Centraal in the public transport system of the Randstad and the Netherlands.

Urban centre

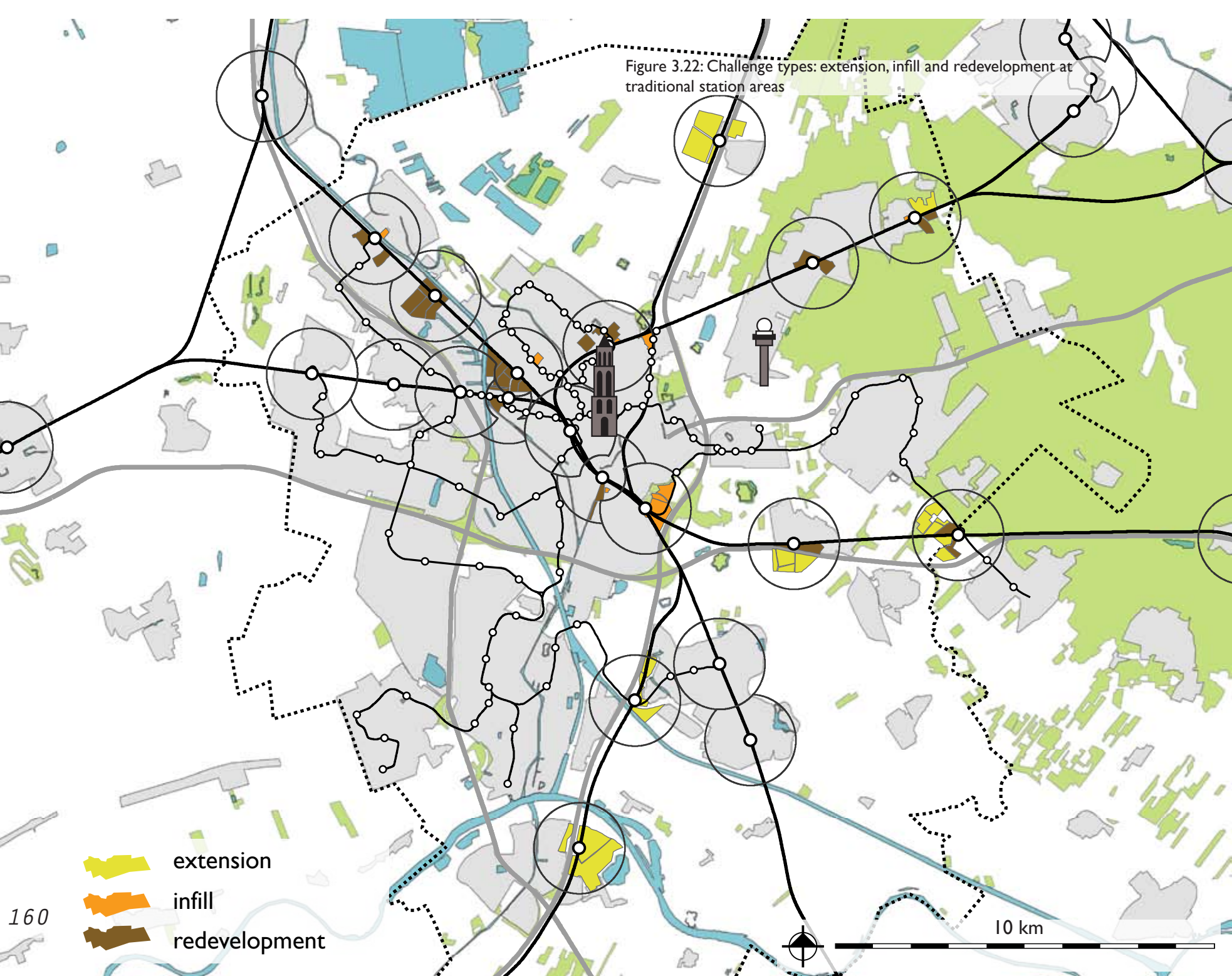
The type of Urban centre is the station area second in hierarchy. These station areas have a good position in the public transport system. They are connected by interregional, agglomerative and local public transport. Urban centres are important places of work, and have high densities of housing. Other urban functions provided by the Urban centre are retail and cultural activities (Dittmar and Ohland, 2004). The housing typologies in these station areas are multifamily housing, apartments and penthouses.

The Urban centres will develop as important nodes in the proposed agglomerative public transit system. These station areas are providing space for developments of housing and other functions that are highly accessible by public transportation. The station areas of Utrecht Leidsche Rijn Centrum, Driebergen-Zeist, Houten, Utrecht Overvecht, and Maarssen are proposed to develop as Urban centres.

Utrecht Leidsche Rijn Centrum is also a station area under construction. It is located within the planned new centre of Leidsche Rijn, a major new dwelling extension in the west of Utrecht. This station is proposed to develop as an Urban centre. Current planned developments by the municipality of Utrecht will increase the node and place value of this station in the future.

Driebergen-Zeist is also proposed to develop as an Urban centre. However, local plans and interests will probably create a different outlook of this station than e.g. Utrecht Leidsche Rijn Centrum. The station is located in the forests of the National Landscape “Utrechtse Heuvelrug”. The design of this station area could have a more green character. Local high quality urban design should take this green and vulnerable context into account.

Figure 3.22: Challenge types: extension, infill and redevelopment at traditional station areas



Urban neighbourhood

This type of station area is located within the urbanized area of the central city of Utrecht. It has a medium housing density and is located around the Urban downtown area. Commercial functions and retail can be found in the vicinity of these stations (Dittmar and Ohland, 2004). The stations are connected to the agglomerative and local public transport services. Transit services are frequent and the residents have good accessibility. The housing typology that occur on the urban neighbourhood station areas are mansions, attics, and apartments.

These stations are one step lower in hierarchy than the Urban centres. The place value of these stations is in the current situation often quite high. This is caused by the location of these station areas in the central city of Utrecht. (Figure 3.21). The Urban neighbourhood stations are the existing station Utrecht Zuilen, the relocated station Utrecht Lunetten Beatrixpark and the planned stations Utrecht Lage Weide, Utrecht Vaartsche Rijn, Utrecht Majella.

Town centre

A Town centre is a small, compact community in the vicinity of the central city. These places are served by agglomerative and/or local public transport services. The functions in the station area are on the local scale, e.g. neighbourhood retail and small offices. The housing typology of single-family housing is dominant in these kind of areas. New developments in these commuter towns will mainly involve housing. The housing typology that can be developed are apartments, multifamily and mainly single family housing.

Developing the station areas of these villages will better connect the surrounding villages in the Utrecht-region. Most of these station areas will be developed as Town centres. The stations of Bunnik, Den Dolder, Bilthoven, Vianen, Houten Castellum, Houten West, Utrecht Terwijde and Vleuten will be developed as Town centres.

Transit zone

The Transit zone is often located within a residential area with limited office and retail functions. This type is the lowest in hierarchy in terms of position in the public transport system. It is connected with only the agglomerative (light rail) and local public transport system. The housing typology that is dominant at these station areas are mainly single-family housing. Transit zones can be found along the light rail and streetcar lines. Traditional rail stations are not developed as Transit zones. Functions like retail and services are added marginal.

Figure 3.23: Phasing, situation 2010, public transport system and spatial developments



Special zone

Another station area is the Special zone. There are some important special anchor points in the region. These are for example science centre “de Uithof” and business centre “Papendorp”. These (economic) anchor points of the Utrecht-region can not be transformed into for instance an Urban centre or an urban neighbourhood because (i) functions in these kinds of environments are often more homogeneous and (ii) these environments are not located within the catchment area of a traditional station area. However, these areas are connected by the light rail or the streetcar system in order to facilitate the flows between these anchor points, e.g. Between “de Uithof” and the city centre of Utrecht. The transit stops on these light rail lines can be developed as Special zones.



3.2.7 Challenges

When the development of a station area in a certain direction is proposed, three main challenges can occur at the station area. These are extension, infill and redevelopment. In some cases, the environment or catchment area of a station area consists of a lot of open space. In these cases the development of a station area consists of an extension of the urbanized area. An example is the development of the station of Maartensdijk. In other cases, the station area is partly built and the challenge is to complement this built environment with some infill locations. The development of Utrecht Lunetten Beatrixpark is an example of this challenge. The third challenge consists of the redevelopment task. Some station areas are located within the existing urbanization. In some cases this urbanized area is out dated and needs redevelopment, like e.g. Utrecht Lage Weide (Figure 3.22).

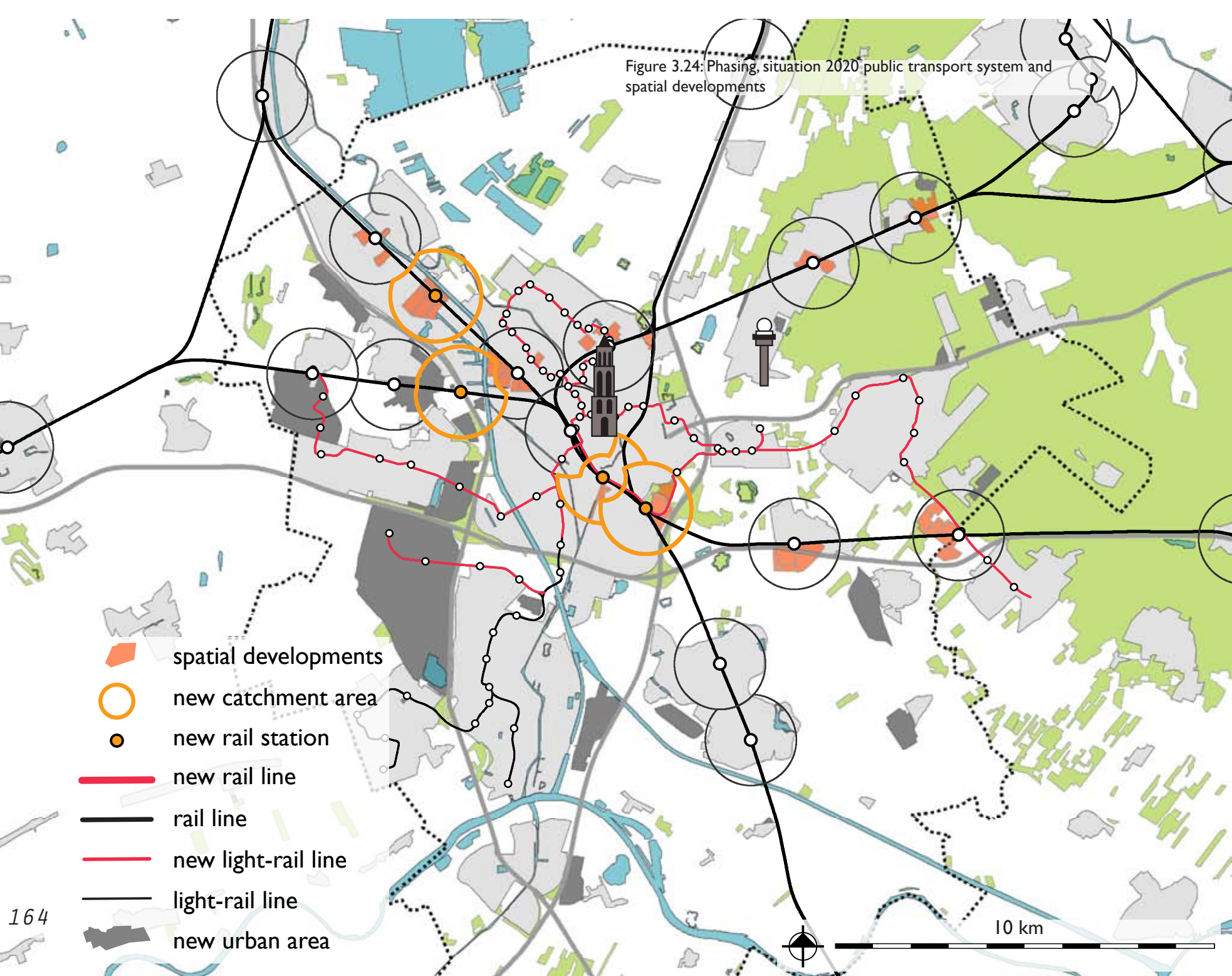
3.3 Phasing

The proposed regional design and strategy is a long-term vision for the Utrecht-region. In the next paragraph the different interventions will be described. As mentioned earlier, the proposed interventions will take place in the public transport system and the allocation of space for developments.

3.3.1 2010

This is the starting point of this vision. In the present situation the city-region of Utrecht consists of traditional railroads and one light rail connection in direction of Nieuwegein and IJsselstein (Figure 3.23). Some major extensions, like VINEX location Leidsche Rijn are almost finished at this stage.

Figure 3.24: Phasing, situation 2020 public transport system and spatial developments

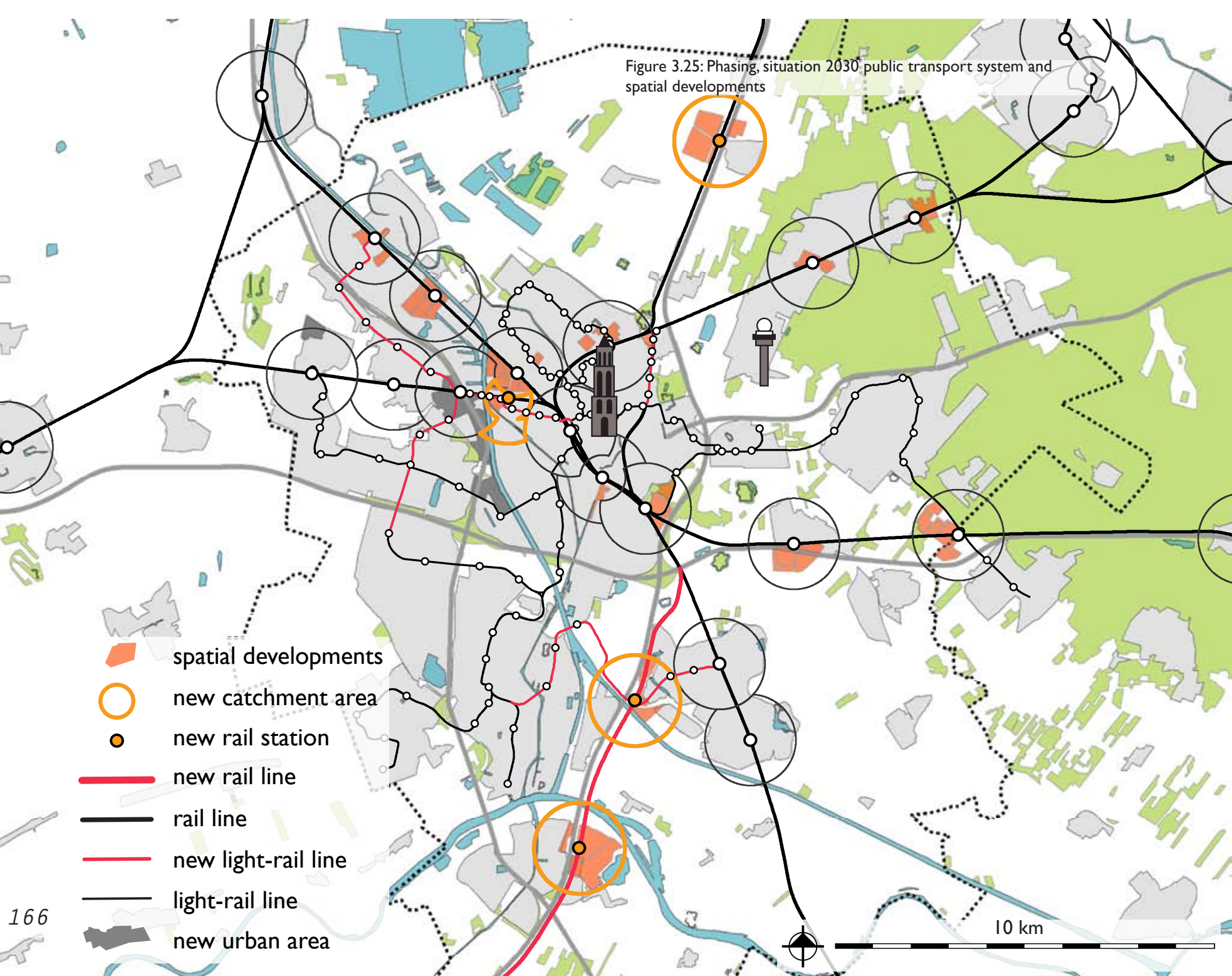


3.3.2 2020

In the proposed situation of 2020 some radial streetcar and light rail connections are introduced. The lines 1,2,3 and the part of line 5 from Utrecht Centraal towards Overvecht en Zuilen will be realized. The first introduced streetcar connections are connecting the central city of Utrecht with the Uithof and Overvecht and Zuilen. These areas will be the first to be connected with a streetcar connection because here the need for a new modality is the most urgent (chapter 3.1). Furthermore, new light rail connections in direction of Leidsche Rijn, Driebergen, Zeist and Rijnenburg are introduced. The existing light rail connection in direction of Nieuwegein and IJsselstein has undergone some changes. Some stops are skipped, and the line will function as a connecting modality. Furthermore, four new traditional rail stations will be opened. Some of them are already planned, and some stations are proposed in this vision (Figure 3.24). The planned stations are Utrecht Vaartsche Rijn, Utrecht Leidsche Rijn Centrum and Utrecht Lage Weide. These stations are actually scheduled to be open in the year 2020. The proposed station that will be realized in 2020 is Utrecht Lunetten Beatrixpark. The replacement of the station Utrecht Lunetten is coming together with the introduction of the new light rail connection the “HOV om de Zuid”, line 2. The development of this station is also anticipating on the introduction of the new traditional rail line in direction of Breda that will be ready in 2030.

Next to the development of new agglomerative public transport lines and stations, spatial developments in station areas of traditional train stations will be launched. The planned or proposed station areas will be developed next to the introduction of the transit stop. Besides, existing station areas will be developed further. There are differences in strategy and difficulty of development. For example, the redevelopment areas of station Utrecht Overvecht will demand more attention than extensions at the station area of Bunnik. For the comparison of the developed station areas with the spatial dispersion of office and retail is referred to the appendices.

Figure 3.25: Phasing, situation 2030 public transport system and spatial developments



3.3.3 2030

In the year 2030 the agglomerative public transport system is further extended. The lines 4 and 5 five are completed, and the first tangential connections are appearing, e.g. line 6 (chapter 3.1). The streetcar connections in direction of Utrecht Leidsche Rijn Centrum and Voordorp are realized. In 2030 Leidsche Rijn will largely be completed. For this reason this connection is introduced.

Furthermore, a new traditional rail line is opened in direction of Breda. The two adjacent stations, Houten West and Vianen are also proposed at this line. The tangential light rail connection between Nieuwegein and Houten will be connected with the station of Houten west. Next to this, two other traditional rail stations are realized in 2030. These are Utrecht Majella and Maartensdijk (Figure 3.25).

Simultaneously, these station areas of these stations will be developed to ensure a balanced development of these nodes of human interaction. Both, node- and place value have to be developed of every station to develop the region in a transit oriented way.

4 conclusion

4.1 Testing the design

4.2 Municipal plans versus regional design

4.3 Figures

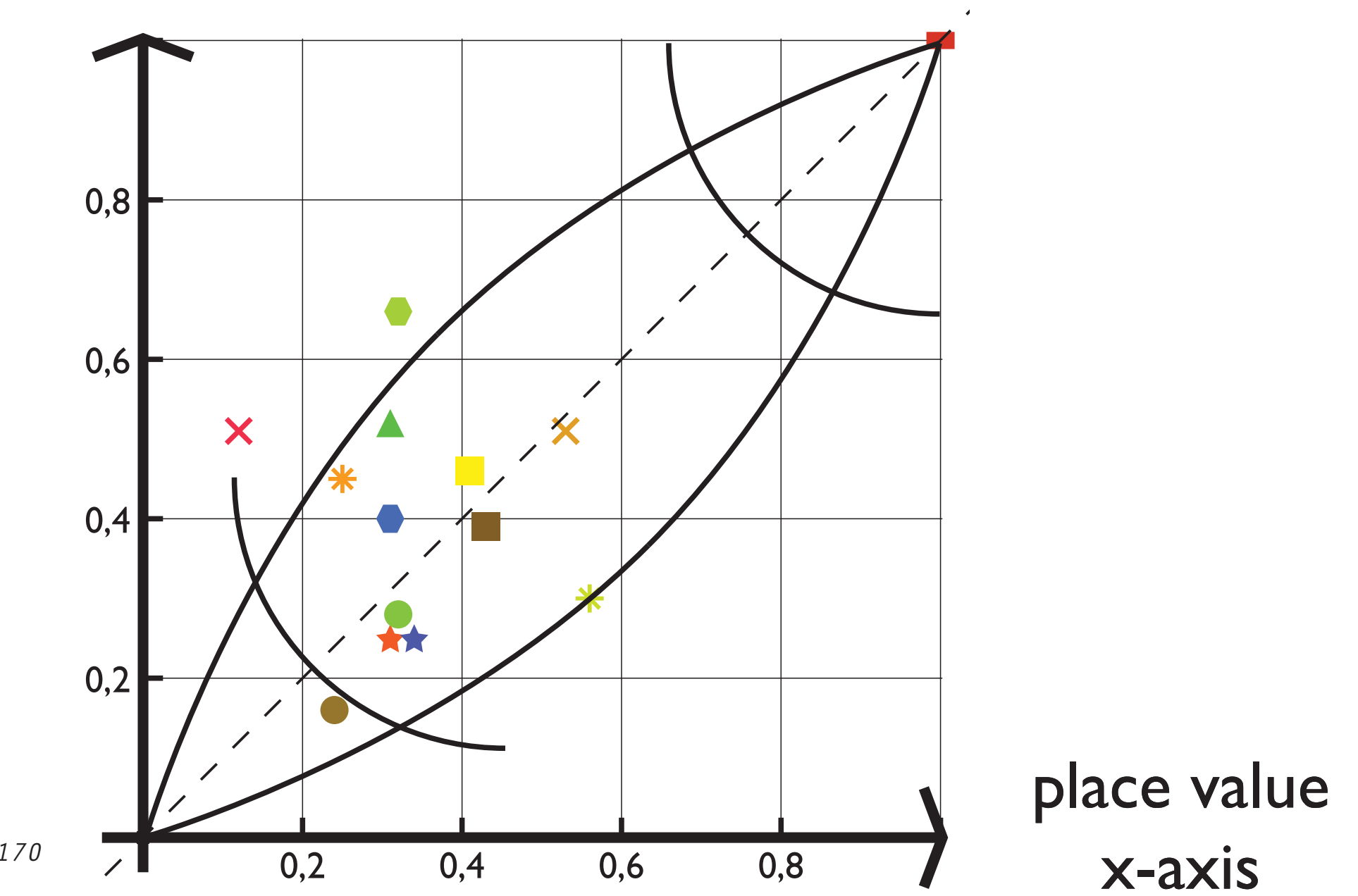
4.4 Recommendations BRU

4.5 Evaluation

4.6 Further research and design

node value
y-axis

2010



place value
x-axis

- ★ Bilthoven
- Bunnik
- ★ Den Dolder
- Driebergen-Zeist
- Hollandsche Rading
- Houten
- Houten Castellum
- Maarrssen
- Utrecht Centraal
- Utrecht Lunetten
- ✕ Utrecht Overvecht
- ✕ Utrecht Terwijde
- ✱ Utrecht Zuilen
- ✱ Vleuten
- Utrecht Vaartsche Rijn
- Utrecht Leidsche Rijn Centrum
- ✚ Utrecht Majella
- ✚ Utrecht Lage Weide
- ⊙ Vianen
- ⊙ Houten West
- ▲ Utrecht Lunetten Beatrixpark
- ▲ Maartensdijk

4. Conclusion

The conclusion of this master thesis consists of several parts. First, the regional design for the Utrecht-region will be tested. This is done by calculating the node- and place values of the station areas in the proposed situation of 2030. Next to this, the regional design proposal will be compared with the current municipal plans in the Utrecht-region. Furthermore, this conclusion contains some specific recommendations for the BRU. This chapter will finish with a critical reflection on the content and process of the research and design.

4.1 Testing the design

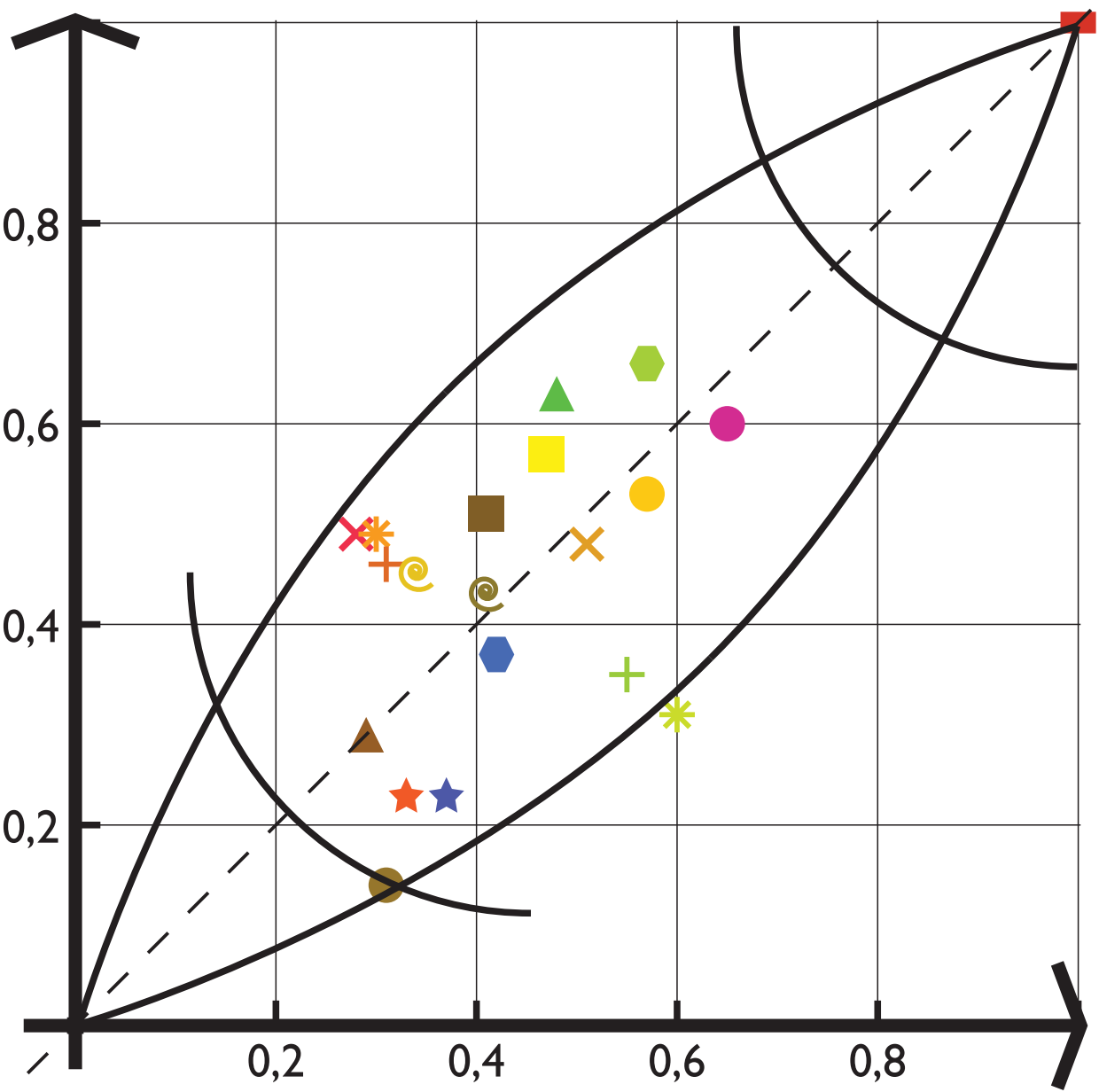
The regional design proposal for the Utrecht-region is tested with the node-place model of Bertolini. In the inventory, (chapter 2), the existing traditional station areas are researched, amongst others on their node- and place value. This research can also be executed for the regional design of the Utrecht-region by measuring the expected situation in 2030 with the use of the node-place model. In the situation of 2010, (chapter 2) two important conclusions were drawn. First, the station of Utrecht Centraal has a very dominant position within the city-region. In the region there is no variety in station areas. In fact, there are two categories: Utrecht Centraal and all the other station areas. Second, some station areas in the Utrecht-region are in an unbalanced situation. Node- and place value of the station areas are often not in balance. The regional design proposal of this project is partially solving these two problems. If we execute the node-place model for the design proposal of the Utrecht-region in 2030, two things are changing. First, there are



Figure 4.1: Utrecht-region situation 2010, node-place model

node value
y-axis

2030

place value
x-axis



-
-  Bilthoven
 -  Bunnik
 -  Den Dolder
 -  Driebergen-Zeist
 -  Hollandsche Rading
 -  Houten
 -  Houten Castellum
 -  Maarssen
 -  Utrecht Centraal
 -  Utrecht Lunetten
 -  Utrecht Overvecht
 -  Utrecht Terwijde
 -  Utrecht Zuilen
 -  Vleuten
 -  Utrecht Vaartsche Rijn
 -  Utrecht Leidsche Rijn Centrum
 -  Utrecht Majella
 -  Utrecht Lage Weide
 -  Vianen
 -  Houten West
 -  Utrecht Lunetten Beatrixpark
 - Maartensdijk

less unbalanced stations in the region. Every station area is developing in a certain direction, whereby more balance between node and place value is realized. With other words: by adding urban activities the potentials of the different nodes can be used. Otherwise, the urban activities that occur on a certain station area are better accessible by public transport (Figure: 2.13). For example, the station area of Driebergen-Zeist is in the situation of 2010 an unbalanced node (Figure 4.1). An unbalanced node appears when a station area has a disproportionate high node value in comparison to its place value or vice versa. In the proposed situation of 2030, the station area of Driebergen-Zeist is in a balanced state. This is the result of adding new urban activities that is moving this station away from an unbalanced node. The second change, the dominant position of Utrecht Centraal in the region is reduced. Utrecht Centraal is in the situation of 2030 still the most important node in the public transport system of the city-region (Figure 4.2). This dominant position of Utrecht Centraal will be maintained in the future (Bestuur Regio Utrecht, 2009). However, the introduced urban centres like e.g. Utrecht Overvecht and Houten are moving in the diagram of the node-place model in the situation of 2030. These stations are moving closer towards Utrecht Centraal. Furthermore, the introduction of these station categories has led to a diversification of station areas. It is no longer a matter of Utrecht Centraal and all the other stations. In the situation of 2030 there is a variety of station areas. The Urban centres function as important 'in between stations' between Utrecht Centraal and the other traditional station areas.

Figure: 4.2: Utrecht-region expected situation 2030, node-place model

Figure 4.3: Municipal plans until 2020
Source: (NIROV, 2010)

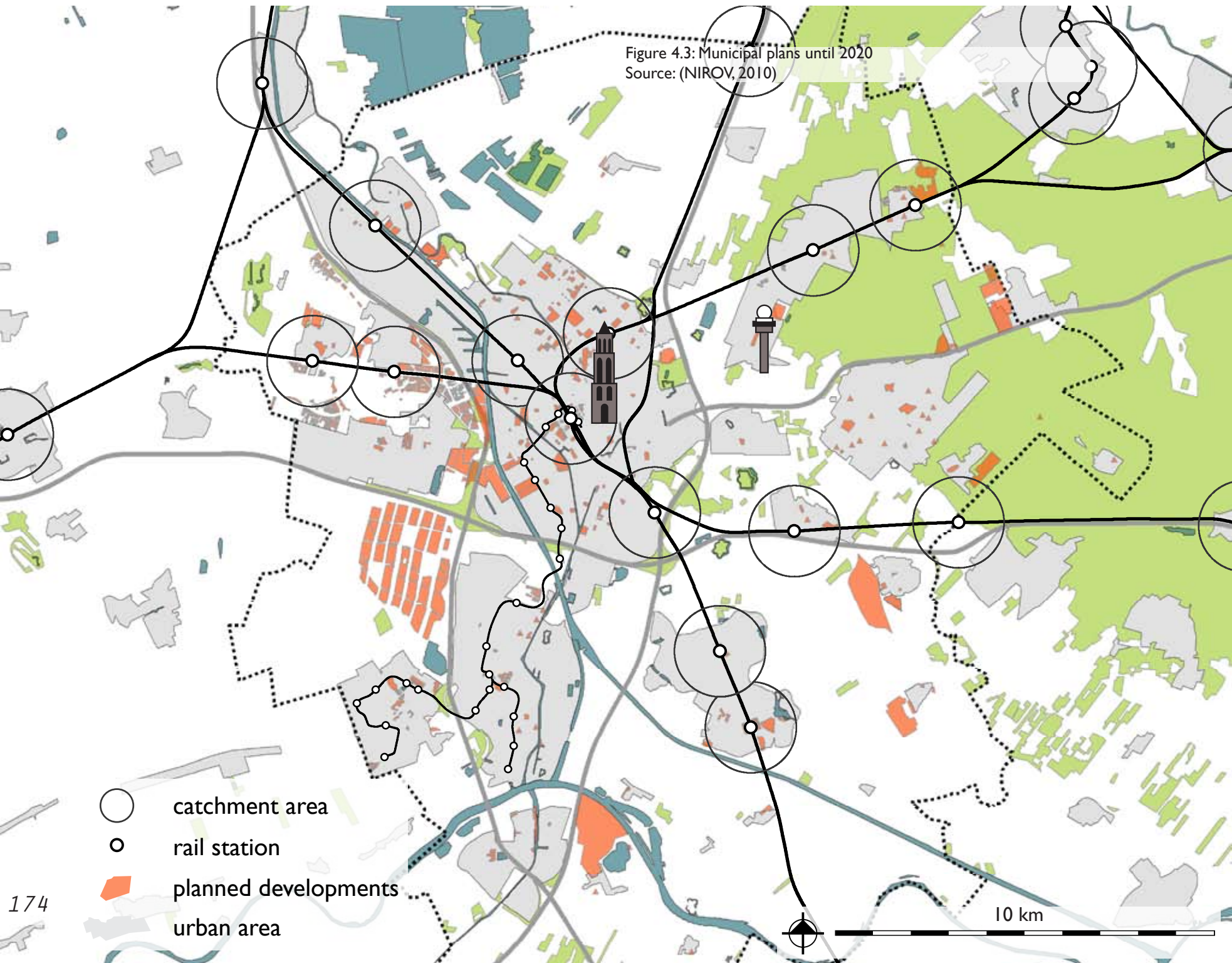




Figure 4.4 Proposed developments traditional station areas

The public transport system is one variable that is influencing the results of the node-place model. In the design proposal for the Utrecht-region the public transport system is restructured. All the interventions, laid out in the design proposal, should lead to an improvement of the attractiveness of public transport. Connectivity, reliability and capacity are improved with the introduction of the light rail system. Furthermore, the connectivity between the different layers in the public transport system should make public transport a worthy competitor for the car.

Besides the introduction of this agglomerative public transport system, several new traditional train stations are introduced. The proposed stations are selected by their expected added value for the entire public transport network. Station areas are becoming important places of activity in the city. For the development of the region in a transit-oriented way, the introduction of new stations in combination with the restructuring of the public transport system is essential.

Transit-oriented development seeks for the combination of spatial development and public transport. The concentration of spatial developments around transit in this research will probably lead to a decrease of the demand for mobility of people. Furthermore, the introduction of this concept will lead to less car dependency and a bundling of movements in the Utrecht-region. In this way, a more efficient use of mobility in the Utrecht-region is possible.

4.2 Municipal plans versus regional design

If the regional design proposal of the Utrecht-region is compared with the current municipal plans an important conclusion can be drawn. The developments of the municipalities are often not located within the catchment areas of the traditional train stations. Furthermore, a big part of the proposed developments of the municipalities have the characteristics of new VINEX locations. For example, developments like Rijnenburg, an extension near Odijk and Zeist have the properties of large low-density extensions (Figure 4.3).



Figure 4.5: Fact sheet, remaining shortages
Source: (Bestuur Regio Utrecht, 2008, NIROV, 2010)

These developments do not coincide with the principles of transit-oriented development. If these plans are executed the potentials of the several traditional station areas are not used for developing the region in a more transit oriented way.

On the other hand, the proposed regional design for the Utrecht-region is only focusing on spatial developments within the catchment areas of traditional stations. There are no spatial developments proposed outside the catchment area of a station. This will not solve the entire housing shortage, as we see in paragraph 4.3. However, when new developments around transit stops of the designed light rail system are taken into consideration, the housing shortage can be reduced further (Figure 4.4).

4.3 Figures

The total amount of dwellings that is planned until the year 2030 is 76.000 (Bestuur Regio Utrecht, 2008c). Until the year 2020 49.000 dwellings will be built. Next to this, there is an amount of 27.000 dwellings planned until 2030 without an actual physical place. Furthermore, there is a remaining shortage of 32.000 and this makes the total housing shortage in the region 59.000 dwellings (Bestuur Regio Utrecht, 2008c, NIROV, 2010b).

The proposed regional design will result of a decrease if this shortage of 37.000. The urban plans for Rijnenburg are modified in this regional design. There are 7.000 dwellings planned in this location and the proposal is to increase this to 20.000 dwellings, amongst others to create support for the agglomerative public transportation line (light rail). Eventually a shortage of 9.000 dwellings will remain in 2030 (Figure 4.5).

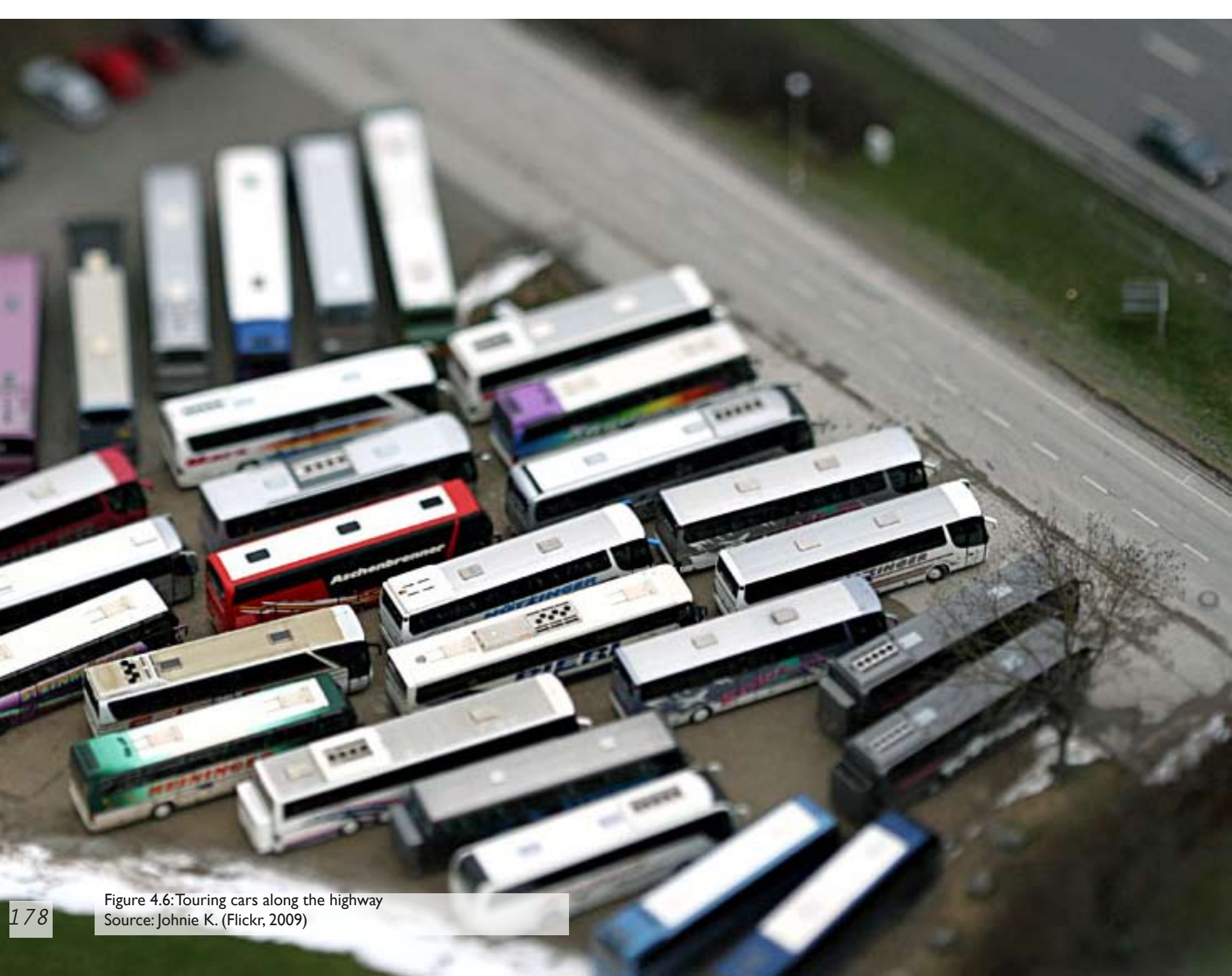


Figure 4.6: Touring cars along the highway
Source: Johnie K. (Flickr, 2009)

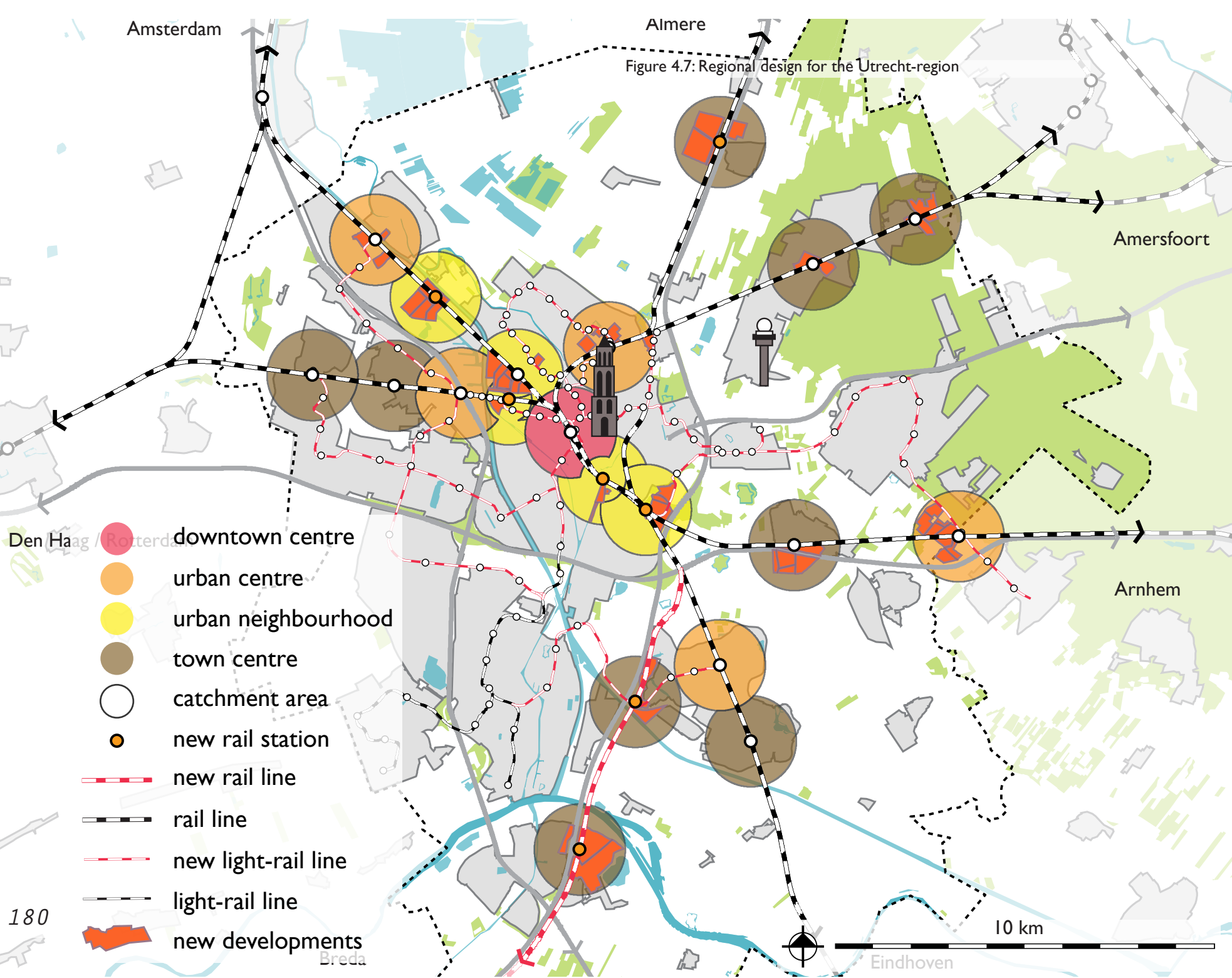
4.4 Recommendations BRU

The execution of a regional design whereby spatial developments and public transport are integrated requires a major effort. This integration is important because it can have some significant benefits as mentioned in chapter 3. The BRU is hereby one of the most important stakeholders considering the recent changes in ownership of the existing light rail. The BRU owns the infrastructure and a part of the equipment of the light rail system towards Nieuwegein and IJsselstein.

The integration of public transport and spatial development around transit could gain great successes as mentioned in chapter 3. The development of an agglomerative public transport system and the integration with spatial developments is essential for several reasons. First, the development of rail infrastructure is an expensive and complex challenge. If the development can be combined with spatial developments (e.g. housing) the costs could be partly covered by these spatial developments. Furthermore, the development of a high quality public transportation system has positive effect on its surroundings. A high quality public (rail) transportation system has a positive image; therefore it can improve the quality of its surroundings (chapter 3.1).

The Utrecht-region needs an approach whereby a development extends further than e.g. just the construction of a new transit line. The qualities of a transit line and new spatial developments reinforce each other. When a transit line is not functioning well, the asset value of real estate along a line or near a transit stop will decrease. The other way around: inadequate spatial developments will lead to less customers for a new transit line (Priemus et al., 1999). Spatial developments should

attract new customers which are the most necessary: travellers who use the public transport systems off peak, or in the opposite direction of the peak travellers (Priemus et al., 1999). A variation of functions in housing, work, retail and leisure should lead to a more efficient used public transport network. This creates liveliness and urban vitality. The principles of transit-oriented development on local and regional scale are guidelines to realize these objectives. Figure 4.7 shows the total proposal for the design of the Utrecht-region. For the implementation of the proposed developments, the BRU should function as a driver. The BRU should cooperate with municipalities, project developers, investors and public transport companies for the implementation of such a strategy. The municipality is an important stakeholder in this situation. A municipality wants e.g. to develop a certain location without the integration with the public transport network. In this case the BRU has no legal power to obligate the municipality to think about the relation of the spatial developments and agglomerative public transport. Hence, it is important to develop a spatial framework in cooperation with the planning power of the municipalities (land-use-plan). This power is necessary to direct the interaction between new public transport infrastructure and accompanying spatial developments.



The cooperation between several sectors of spatial planning is necessary by the execution of regional design. At this moment, a solid integration of several sectors, e.g. public transport and regional development is lacking. At this moment, the core business of the BRU is policy-making and setting goals and ambitions. For the development of a strong, sustainable and economic vital Utrecht-region, a strong planning department could be added at the BRU. This is desirable because the Utrecht-region lacks a strong driver that is steering the region with clear research and regional design. Furthermore, this planning department can bring different actors and interests together for the development of the city-region.

4.5 Evaluation

4.5.1 Reflection on content

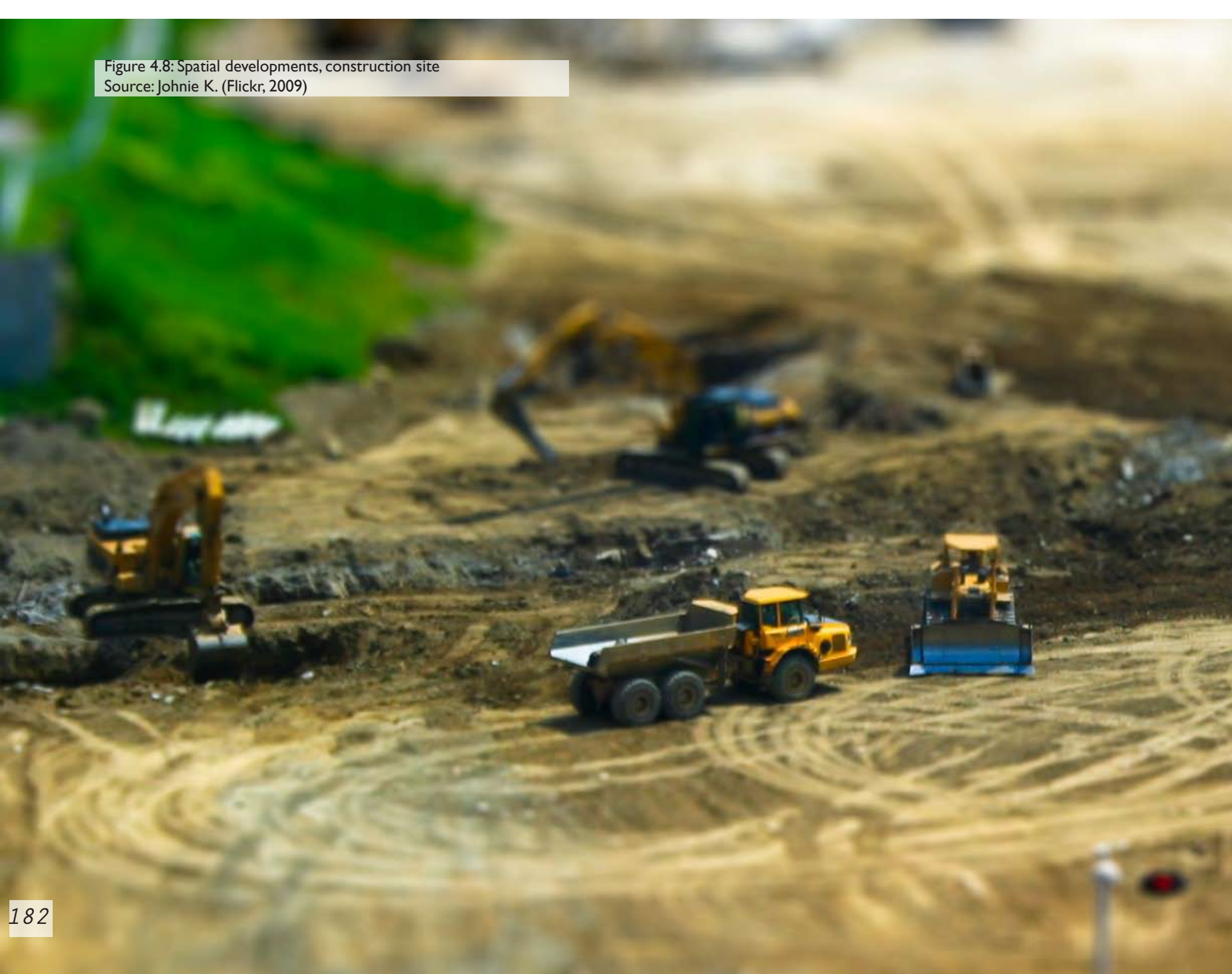
In this paragraph the content of the project will be evaluated. First, the strengths of this research will be addressed. After this, possible improvements of this thesis are enlightened.

One of the strengths of this research is the methodology. Before this master thesis, an extensive thesis plan is written with an explanation of problem, methodology and relevance. This was helpful during the actual research and design process. For example: the theoretical anchoring of the project was helpful to border and to focus the actual research and design. This theoretical research continued in the master 4. The theoretical node-place model of Bertolini was used for the development and argumentation of the regional design.

Another theoretical concept of this master thesis is the concept of Action Space, mentioned in chapter 2. At the start of the project, the goal was to use this theoretical concept also for the research and design of the Utrecht-region. However, during the process of research and design, this theory is addressed less than expected.

The difficulty of this concept from the time and space geography is the translation of this theoretical model to practice. The profession of urban and regional planning is practice-based. The data that is needed for this model is, even with an internship at the BRU, is not available. Very specific and precise data is necessary of the movements and interactions of people in space. In contrast, the node-place model of Bertolini proved to be an applicable model in developing the regional design.

Figure 4.8: Spatial developments, construction site
Source: Johnie K. (Flickr, 2009)



4.5.2 Reflection on process

This paragraph will evaluate the graduation process. From the beginning it was clear that the authors of this thesis had a lot of advantages. Shortly, these are (i) working in a team, (ii) working for the BRU with professional feedback, and access to all kinds of data.

The possibility of working with two persons on this project made it possible to do a lot of research. Moreover, the different interests of the authors made it possible to highlight different aspects of the regional design (see PART I thesis plan). Furthermore, working in a team can help to motivate each other. In this way the progress towards the completion of the project is guaranteed.

The possibility of working for the BRU was also a major advantage during this research and design process. First, we had a good workplace that facilitated our efforts on the project. Furthermore, working at the BRU made information and data about the region accessible. A lot of the data that is used in this research was a lot harder accessible if the work was not executed for the BRU.

4.6 Further research and design

In this research only spatial developments within the catchment areas of the traditional train stations are taken into account. For further research, the different light rail stops could be researched in terms of space for new developments.

Furthermore, strategic aspects of this regional design could be further researched and developed. Further research is necessary in what way the BRU could function as a strong driver within this regional design and strategy.

Urban planning language

Notions and their definitions

In contemporary urban and regional planning a lot of notions are mentioned. In this chapter various notions used in this graduation project will be defined. In this way an attempt has been made to get a clear and common understanding about the content of a certain notion.

Agglomeration: an extended city or town including a central place and several suburbs mostly in the form of dwelling areas.

City: a city is a historic centre of government, industry, commerce, residence, and culture. A city contains a significant number of jobs and households as well as a massive investment in public facilities and access to multiple transportation systems (Neuman, 2000).

Conurbation: a large urban agglomeration where the built-up areas of distinct cities or towns are connected by continuous built-up developments.

Concept: main idea or preliminary formulation of a collection of ideas, which is the basis for the preliminary design.

Daily Urban System (DUS): a focal point of different activities. Moreover, an urban system can be seen as an economic and societal system with many relations and interactions (Tordoir, 2005).

Design: in general designing is making decisions. Design in

strategic planning is programmatic, functional and system oriented (Jong T.M. de and Voordt D.J.M. van der, 2002).

Key projects: local interventions in a currently existing situation. The strategic value of projects is determined by their capacity of bringing a certain perspective closer (Delft University of Technology Faculty of Architecture., 2008).

Model: an empirical interpretation of a mathematical-logical system (Dale, 2008). A system of different variants on the described facets.

Metropolis: a metropolis is an urban system that is emerged out of one historic centre and grew to great extend (Musterd and van Zelm, 2001). A metropolis has often an important economical, political and cultural function and is an important hub for regional or international connections and communications.

Planning: an act of formulating a program for a definite course of action aiming at a particular goal or objective.

Perspective: a strategic document for regional development. The perspective has a clear problem statement. It also indicates and quantifies programmatic statements. The indicative maps show an overview of interventions. These interventions could bring about transformations from the present to a designed future situation. The strategic importance of projects is determined by economics and politics. The perspective is a representation of desired futures, which is drawn up by the originators (Delft University of Technology Faculty of Architecture, 2008).

Polynuclear urban region (PUR): different cities within the a complex urban form that are performing different functions (Hall, 2002a). A geographical unit with more than one centre (Musterd and van Zelm, 2001).: PURs can be defined as collections of historically distinct and both administratively and politically independent cities located in close proximity, well connected through infrastructure and lacking one dominating city in political, economic, cultural and other aspects (Kloosterman and Lambregts, 2001, Meijers, 2007b).

Polycentric urban region (PUR): see Polynuclear urban region

Scenario: a method to study the possible changes of tomorrow. A scenario provides an array of possible futures. These futures can be unlikely or extreme. The crucial question in scenario thinking is: what would happen if... The contrast of the extreme scenario is used in the systematic study of the future (Thierstein and Förster, 2008, Jong T.M. de and Voordt D.J.M. van der, 2002).

Strategy: a strategy is a long-term plan of action designed to achieve a particular goal.

Urban field: a pattern of specialized older urban established environments together with the intermetropolitan peripheries, without a clear hierarchy and a movement pattern characterized by criss-cross relations (Brand, 2002, Friedmann and Miller, 1965).

Urban system: collection of all types of spatial appearances of urbanization: village, city, agglomeration/conurbation, and metropolis.

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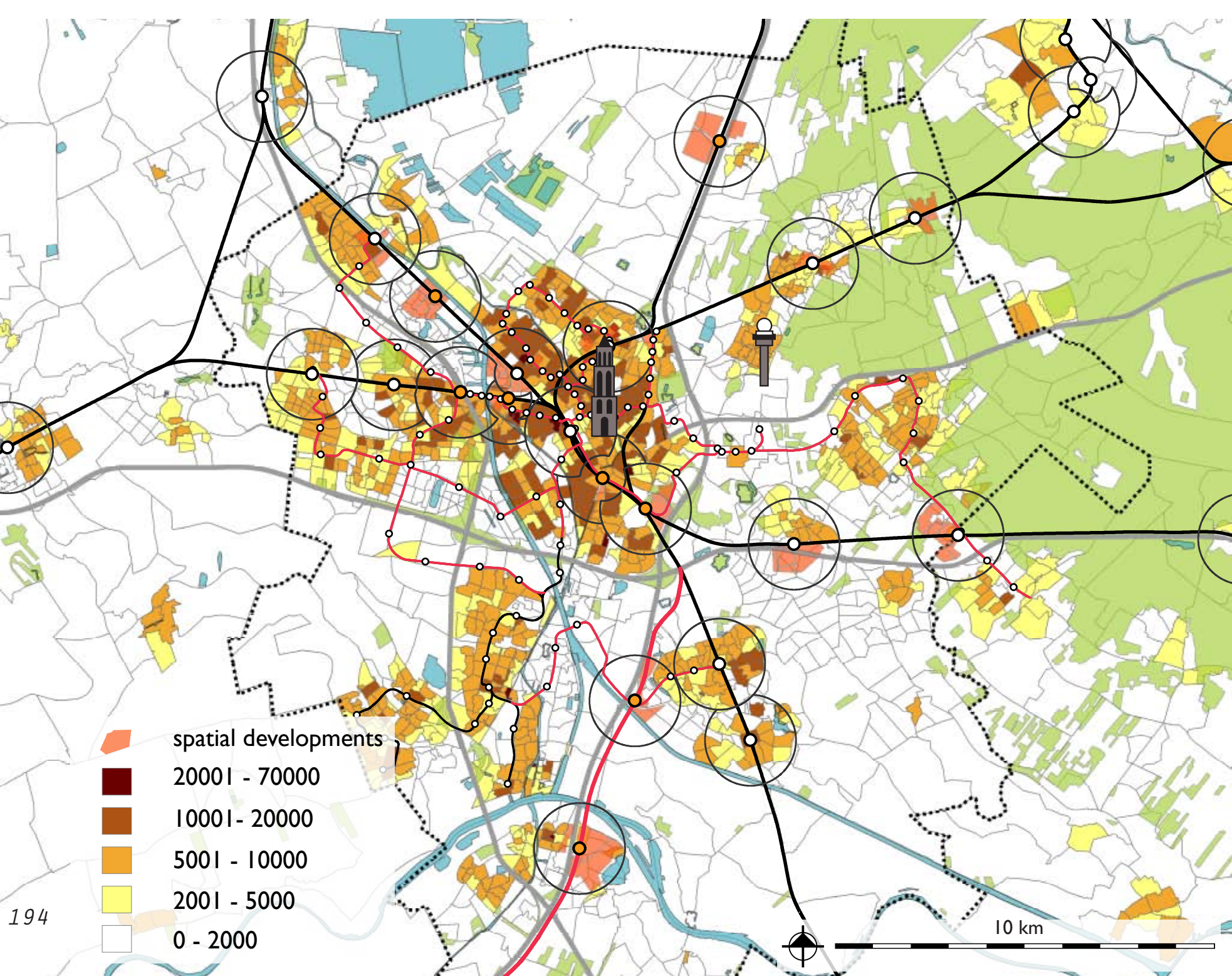
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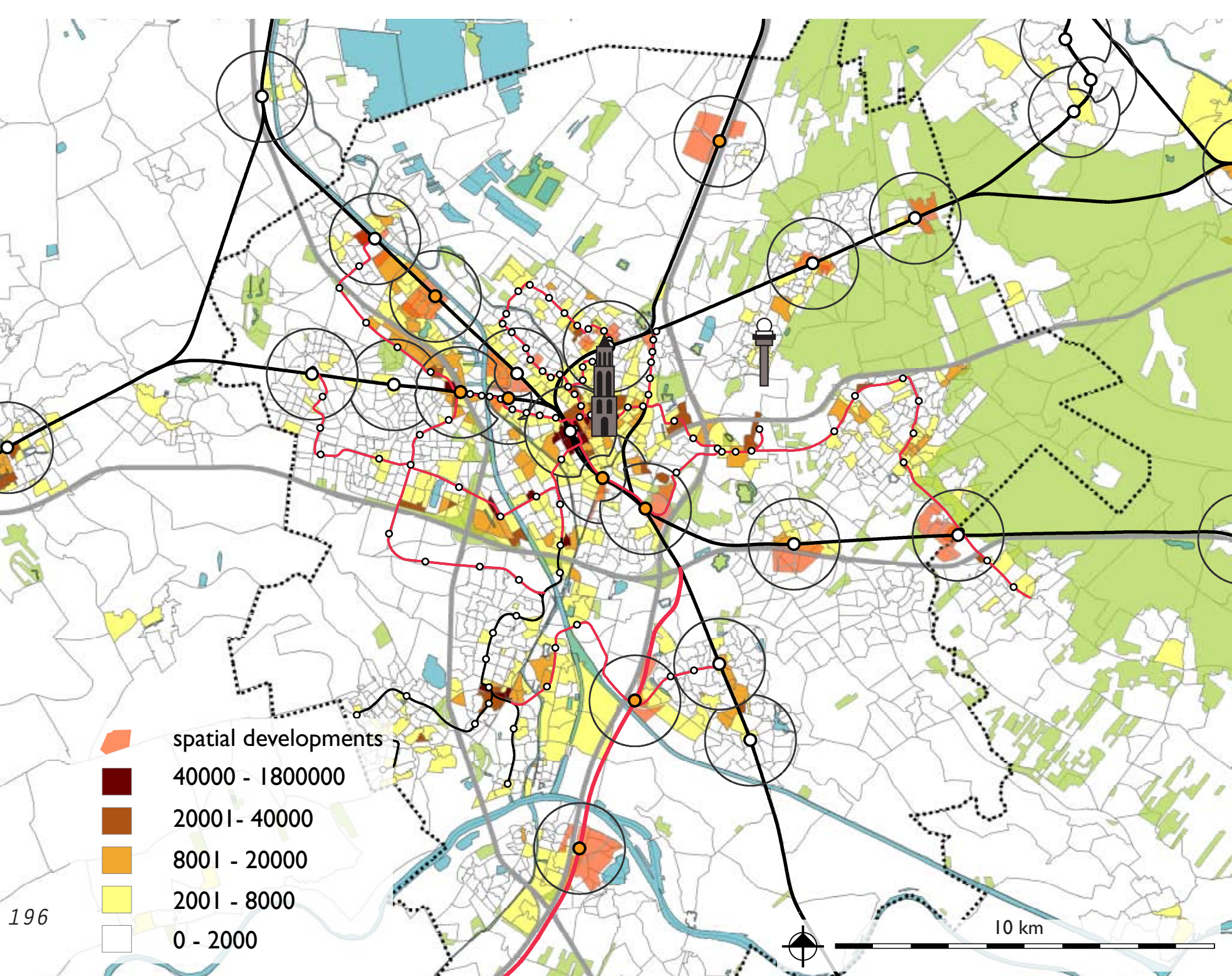


Appendices

Additional analysis:



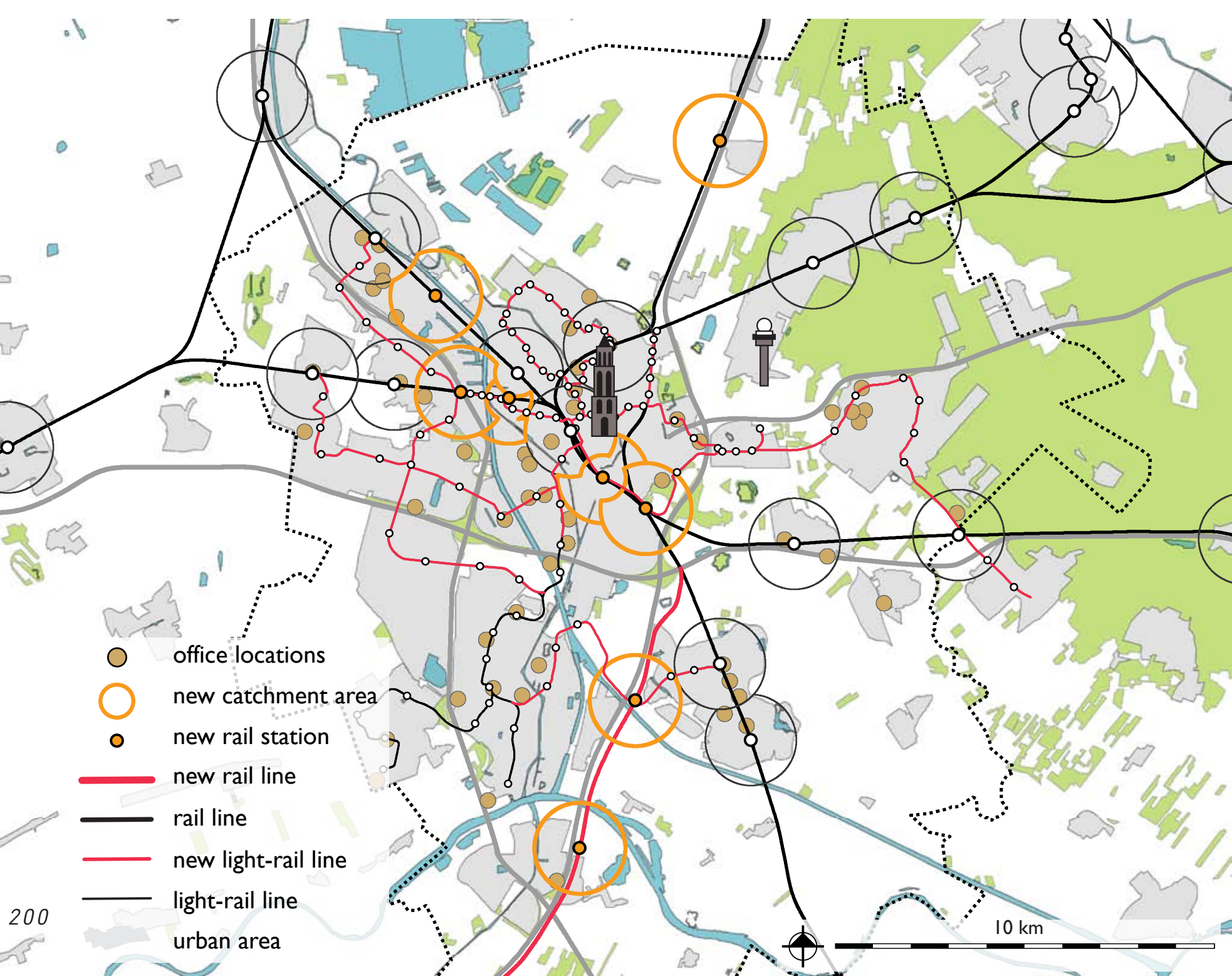
**Inhabitants density combined with
proposed spatial developments**



**Workers density combined with proposed
spatial developments**



**Retail locations combined with proposed
spatial developments**



**Office locations combined with proposed
spatial developments**

city	country	inhabitants city	inh./km ²	inh. agglomeration	students
Bordeaux	France	250.082	5.066	981.370	70.000
Mannheim	Germany	307.914	2.124	824.776	38.000
Geneve	Switzerland	186.825	11.710	812.000	15.000
Alicante	Spain	331.750	1.648	757.443	30.000
Nantes	France	281.800	4.318	751.085	33.000
Basel	Switzerland	167.365	7.357	751.000	11.000
Karlsruhe	Germany	286.327	1.651	712.475	24.000
Utrecht	Netherlands	300.000	3.136	650.000	60.000
Straatsburg	France	276.867	3.538	634.275	49.000
Gent	Belgium	235.000	1.506	594.582	30.000
Grenoble	France	157.900	8.709	541.888	23.000
Montpellier	France	251.634	4.425	533.000	49.000
Augsburg	Germany	262.512	1.787	629.139	18.000

# lines	length net	# trams	type	stop distance	line length
3	40	74	streetcar	0,5	10
11	73	212	streetcar	0,5	10
5	21	63	streetcar	0,35	6
4	98	41	light rail	1,2	14
3	41	79	streetcar	0,5	12
12	98	129	streetcar/light rail	0,4/2	5/12
8	68	138	streetcar/light rail	0,35/0,4	6/20
2	21	27	light rail	0,7	16
5	39	94	streetcar	0,6	7
4	30	72	streetcar	0,4	9
4	35	88	streetcar	0,45	13
2	34	54	streetcar	0,6	18
4	39	84	streetcar	0,5	10

**Comparison light rail system other
European agglomerations**

Station	2003	2004	2005	2006	2007	2004-2005
Abcoude	1.276	1.290	1.344	1.412	1.473	4,2%
Amersfoort	27.673	29.501	32.149	34.575	35.001	9,0%
Amersfoort Schothorst	4.455	4.664	4.976	4.893	5.111	6,7%
Amersfoort Vathorst				588	1.132	
Baarn	4.574	4.676	4.686	4.885	5.351	0,2%
Bilthoven	4.464	4.613	4.829	5.024	5.119	4,7%
Breukelen	1.980	1.800	1.969	2.225	2.487	9,4%
Bunnik	2.281	2.292	2.471	2.538	2.491	7,8%
Den Dolder	1.661	1.567	1.637	1.710	1.848	4,5%
Driebergen-Zeist	8.333	8.307	8.368	8.705	8.950	0,7%
Hollandsche Rading	735	772	848	889	940	9,8%
Houten	8.166	8.868	9.224	9.064	9.628	4,0%
Houten Castellum	728	822	992	990	945	20,7%
Maarn	1.762	1.553	1.590	1.317	1.502	2,4%
Maarssen	5.848	5.886	5.523	4.686	4.351	-6,2%
Rhenen	1.675	1.706	1.778	1.913	1.830	4,2%
Soest	356	417	425	378	368	1,9%
Soest Zuid	1.554	1.648	1.695	1.799	1.663	2,9%
Soestdijk	923	925	930	970	906	0,5%
Utrecht Centraal	132.153	137.298	144.543	151.228	157.522	5,3%
Utrecht Lunetten	2.376	2.412	2.637	2.623	2.341	9,3%
Utrecht Overvecht	4.204	4.521	4.714	4.907	5.320	4,3%
Utrecht Terwijde		434	663	821	1.080	52,8%
Utrecht Zuilen					830	
Veenendaal Centrum	3.339	3.423	2.324	2.531	2.541	-32,1%
Veenendaal West	1.414	1.416	1.440	1.544	1.522	1,7%
Vleuten	2.001	1.908	1.962	2.183	2.710	2,8%
Woerden	10.634	10.450	10.408	12.131	11.367	-0,4%

2004-2005	2005-2006	2006-2007	2004-2007
4,2%	5,1%	4,1%	15,4%
9,0%	7,5%	1,2%	26,5%
6,7%	-1,7%	4,3%	14,7%
		48,1%	
0,2%	4,2%	8,7%	17,0%
4,7%	4,0%	1,9%	14,7%
9,4%	13,0%	10,5%	25,6%
7,8%	2,7%	-1,9%	9,2%
4,5%	4,5%	7,5%	11,3%
0,7%	4,0%	2,7%	7,4%
9,8%	4,8%	5,4%	27,9%
4,0%	-1,7%	5,9%	17,9%
20,7%	-0,2%	-4,8%	29,8%
2,4%	-17,2%	12,3%	-14,8%
-6,2%	-15,2%	-7,7%	-25,6%
4,2%	7,6%	-4,5%	9,3%
1,9%	-11,1%	-2,7%	3,4%
2,9%	6,1%	-8,2%	7,0%
0,5%	4,3%	-7,1%	-1,8%
5,3%	4,6%	4,0%	19,2%
9,3%	-0,5%	-12,0%	-1,5%
4,3%	4,1%	7,8%	26,5%
52,8%	23,8%	24,0%	
-32,1%	8,9%	0,4%	-23,9%
1,7%	7,2%	-1,4%	7,6%
2,8%	11,3%	19,4%	35,4%
-0,4%	16,6%	-6,7%	6,9%

**Calculations passengers per station per day
2004-2007**



CV: JOHANAN VAN DIJK

Naam: J. van Dijk (Johan)
Adres: van Ginnekenlaan 30
Postcode: 3572 ZB
Woonplaats: Utrecht
Telefoonnummer: 085-7851613
Mobiel: 06-45043529
E-mail: johanandijk@gmail.com
Geboortedatum: 15 februari 1984
Geboorteplaats: Drachten
Nationaliteit: Nederlandse

OPLEIDINGEN

2/2008 - 2/2010 Technische Universiteit Delft
Master Architecture, Urbanism and
Building Sciences (*Cum Laude*)
10/2008 - 1/2009 Universiteit Utrecht
Bachelor Stadsgeografie, minor,
theoretische verbreding
2/2006 - 1/2008 Technische Universiteit Delft
Bachelor Bouwkunde, semester 3
en 6 als homologatie voor Master
9/2003 - 7/2007 Hogeschool Utrecht
Bachelor Ruimtelijke Ordening en
Planologie
9/1996 - 6/2003 Guido de Brès, VWO (Economie &
maatschappij)

WERKERVARING

9/2009 - 1/2010 Afstuderen ruimtelijke planning en
strategie
Bestuur Regio Utrecht (BRU),
Strategisch Beleid

6/2008 - 8/2008 Gemeente Utrecht, Dienst Wijken,
Wijkbureau Zuidwest:
communicatie, onderhoud website
2/2007 - 7/2007 Gemeente Den Haag, Dienst
Stedelijke Ontwikkeling (DSO),
9/2005 - 1/2006 Gemeente Amsterdam, Dienst
Ruimtelijke Ordening, stage (HU)
4/1999 - 6/2007 Henk Kros groente en fruit, bijbaan
zaterdagmarkt

AUTOMATISERINGSKENNIS

Adobe Illustrator: Uitgebreid
Adobe Indesign: Uitgebreid
Adobe Photoshop: Uitgebreid
Google Sketch-up: Gemiddeld
Autodesk Autocad: Uitgebreid
ESRI Arcgis: Uitgebreid
Microsoft Office: Uitgebreid

TALEN

Nederlands: Moedertaal
Engels: Goede beheersing in spreken,
schrijven en lezen
Duits: Redelijke beheersing in spreken,
schrijven en lezen

HOBBY

Windsurfen en zeilen, modelbouw



CV: REMKO STINISSEN

Naam: Stinissen
Voornaam: Remko
Roepnaam: Remko
Adres: Europaplein 42
3526 WB Utrecht
Mobiel: +31610365695
Email: r.stinissen@gmail.com
Geboren: 18 januari 1984
Geboorteplaats: Wisch
Persoonsnummer: 163468412
Nationaliteit: Nederlands
Rijbewijs: B

OPLEIDINGEN

2/2008 - 2/2010 Technische Universiteit Delft
Master Architecture, Urbanism and
Building Sciences (*cum laude*)
10/2008 - 1/2009 Universiteit Utrecht
Bachelor Stadsgeografie, minor,
theoretische verbreding
2/2006 – 1/2008 Technische Universiteit Delft
Bachelor Bouwkunde, semester 3
en 6 als homologatie voor Master
9/2003 - 7/2007 Hogeschool Utrecht
Bachelor Ruimtelijke Ordening en
Planologie

WERKERVARING

9/2009 - 1/2010 Afstuderen ruimtelijke planning en
strategie.
Bestuur Regio Utrecht (BRU),
Strategisch Beleid

2/2007 - 7/2007

Afstuderen stedenbouwkundig
ontwerpen.

Gemeente Den Haag, Dienst
Stedelijke Ontwikkeling (DSO),
Afdeling Stedenbouw beleid.

9/2005 - 1/2006

Stagiair ontwerp stedelijke
omgeving.

Gemeente Utrecht, Dienst
Stadswerken, Ingenieursbureau
Utrecht, Ontwerp Stedelijke
Omgeving (OSO).

VAARDIGHEDEN

Talen

Nederlands: moedertaal

Engels: goed

Duits: redelijk

Frans: matig

ICT

Microsoft Office pakket: goed

Autodesk Autocad: redelijk

Bentley Microstation: redelijk

Adobe Indesign: goed

Adobe Illustrator: goed

Adobe Photoshop: redelijk

Arcgis pakket: redelijk

NEVENACTIVITEITEN EN HOBBY'S

Sport

Roeien, hardlopen, skiën, windsurfen

