# DELIVERING THE FUTURE OF **URBAN FREIGHT**

Towards a ***strategic framework*** for multimodal consolidation in the MRDH

**TU Delft Urbanism**
**P5 Report**
M.L. DE GROOT

Source photo cover: *Mokum Maritiem & Shanks (2016)*

## *Colophon*


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| **Report** | P5 |
| **Title** | Delivering the future of urban freight<br>*Towards a strategic framework for multimodal consolidation in the MRDH* |



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| **Author** | M.L. (Marcel) de Groot<br>4377192 |
| **Research group** | Urban Metabolism |
| **First mentor** | Dipl.-Ing. U.D. (Ulf) Hackauf<br>Chair of Environmental Technology and Design<br>Section Environmental Modelling<br>Department of Urbanism |
| **Second mentor** | Dr.ir J.H. (John) Baggen<br>Civil Engineering and Geo Sciences<br>Department of Transportation & Planning |
| **Delegate of the Board of Examiners** | Ir. W. (Wouter) Willers<br>Chair of Heritage and Design<br>Department of Architectural Engineering +Technology |
| **Institute** | Delft University of Technology<br>Faculty of Architecture and the Built Environment<br>MSc Architecture, Urbanism and Building Sciences<br>Track Urbanism |




## *i* Preface and acknowledgements

We as residents of a city, consume resources and produce waste. But these resources are not always present in cities and waste does not remove itself. Therefore movement of goods in cities are necessary. Goods needs to come from the outside to the inside of the city, while waste needs to leave the city.

Let's take a moment to think about all the clothes we wear, the coffee we take every morning when we wake up and the laptops where we work on. Think about the frustration when there is no peanut butter in the supermarket anymore. Or think about the expectation of having a product tomorrow already when you ordered it online. Maybe you send Christmas postcards every year. As Ian Wright said, everything we consume, live in or wear somehow was transported over the road. Everyday, around 200.000 small trucks and 50.000 bigger trucks are supplying the Dutch inner cities (Walter Ploos-van Amstel via ING, 2015).

Urban freight transportation concerns the movement of goods through cities, generated by economic needs of businesses and people. Urban freight flows are with respect to sustainability, accessibility and liveability inherently connected with the performance of cities and their metabolism. However, most of the times we do not dwell on this and take all these urban freight transportation activities for granted. Without urban freight, shops have nothing to sell, restaurant have nothing to serve and we do not receive our parcels and letters. Our life is built on the various amounts of economies which require goods movement through our built environment.

During my life, I have been fascinated by the built environment with an interest in networks of transportation, infrastructure and logistics. These disciplines are, however, separated. By doing the architecture study in Delft including courses on civil engineering which have taught me about with integrated infrastructure design and knowledge about transportation and logistics, in this thesis I want to bridge the gap between both disciplines of urban planning and transport planning.

This report is written as a master graduation thesis for the MSc Architecture, Urbanism and Building Sciences, track Urbanism at the TU Delft and is the final product of a year-long research process, wherein I had the opportunity to explore topics that have interested me. Completing this thesis would not have been possible without the contribution and support of my graduation mentors. I would like to express my sincere thanks to my Urbanism mentor Ulf Hackauf and Transport mentor John Baggen. Our conversations and discussions have inspired, motivated and challenged me to continuously develop the work to a higher level during the year. Besides their formal support on the work, also their personal and compassionate support needs to be mentioned during this very agitated and tough year for me in a personal way. I really felt comfortable to work and talk with you.

I am grateful for the efforts and unconditional support my parents and sister have done and given to make this everything possible and to provide everything I needed. I cannot express with words the infinite gratitude to my beloved mother, who passed away just before my graduation. My prayer and heart will always be with you, Soffie.

Lastly, I would like to thank all my friends and all who I have met for their appreciating time for their support, feedback, discussions, conversations during my days as a (graduate) student in Delft.

Please enjoy reading my graduation work

**Marcel de Groot** | marcel_degroot@hotmail.com

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## iii Summary

*INTRODUCTION*

Urban planners and decision-makers face several challenges in keeping cities liveable. Getting a well-working urban freight system is one of these underexposed challenges, where there is still a lack of knowledge and awareness among them. Urban freight transportation represents the transport segments in the city and concerns vital and commercial movements of goods through cities, generated by the economic needs of businesses and people. Although urban freight transportation is supporting cities' activities, urban freight activities also have a high negative environmental, economic and social impact. Cities are now on the threshold that all the delivery of urban freight is becoming more challenging per day.

*PROBLEM STATEMENT*

With the adoption of automobile vehicles as the main mode of transportation, urban freight is considered as the generator of negative externalities in urban areas. Additional to this, economic and technological developments such as urbanisation, globalisation, internet technology and warehousing technology are exacerbating impacts on society. Although the international underpinning from the European Union on multimodal transportation, the truck is still the most popular mode in the Netherlands and thereby the roads are filling up with more trucks through the growth of freight. However, current freight policies are insufficient to tackle the increasing negative externalities due to lack of knowledge and awareness on urban freight and measures.

*LOCATION*

The problem of increasing urban freight activities in cities can be considered as a generic problem, however, it will need different solutions, dependent on the context of each urban area. In this project, the Metropolitan Area of Rotterdam-The Hague (MRDH) is chosen, which is one of the most urbanised (and still growing) areas of the Netherlands. The MRDH region is chosen because of its logistic character, the population density of the region and the presence of water- en inner-city rail infrastructure, which is a prerequisite for multimodal transport.

*RESEARCH METHODOLOGY*

With the MRDH as a case study for the project, the project aims to develop a strategic framework, including the concepts of urban consolidation and urban multimodality of urban freight transportation for local authorities in the MRDH to accommodate the increasing logistic demand of retailers, while mitigating/reducing negative externalities, led by the following main research question:

> *How can a strategic framework of urban freight transportation in the MRDH accommodate the increasing logistic demand of retailers in a sustainable and liveable way?*

The first part of the research is dedicated to the general understanding of urban freight on a spatial, conceptual and legal level. The second part of the research is proposing, testing and evaluating new components of the strategic framework. With performance analysis, designs and ideas are tested to provide new insights into the research and design process.

*CONCEPTUALISATION*

The research has proposed a two folded solution for the spatial organisation: the first one is the concept of urban consolidation, wherein urban consolidation centres at the outskirts of the city were introduced to remove unnecessary trips within the city. The second concept is the idea of encouraging urban multimodality, wherein alternative manners need to be found to transport urban freight as much as possible over the rail (by tram) and water (by boat) instead of the road within the city (FIGURE 0.1).



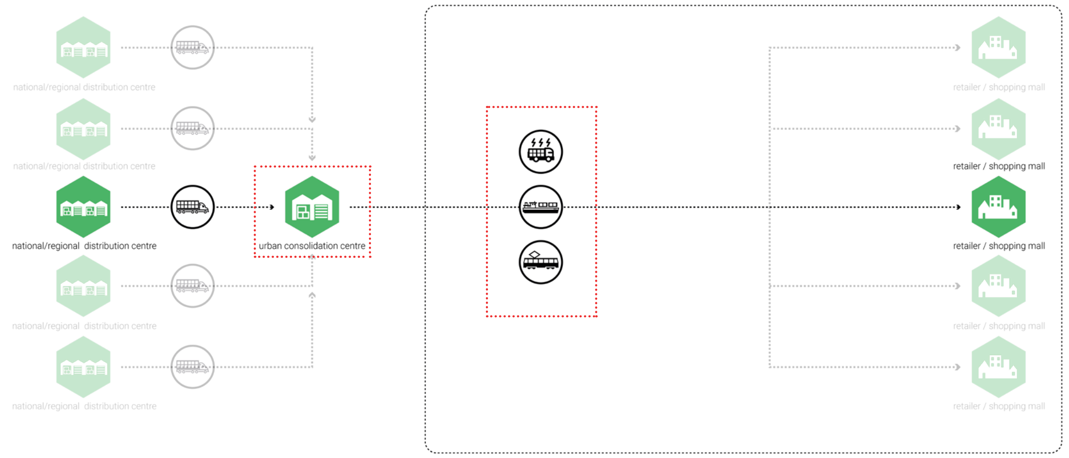


**FIGURE 0.1:**
Situation when urban multimodality is added (author's drawing, p. 129)

*STRATEGY COMPONENTS*

Thereafter, three types of nodes are proposed, wherein the spatial implication per type, activities, location factors, modal operation, other operational issues and a roadmap for allocation are addressed. The three nodes are:

1) UCCs: urban consolidation centres (road)
2) TCs: multimodal transhipment centres (water)
3) DoPs: drop-off points for trams and ships (water, rail, road)

Regarding the UCC's, two principles for UCC allocation were proposed in the research. These principles are:

1) urban consolidation centres situated near waste treatment facilities
2) urban consolidation centres situated along a waterway corridor

Both principles (FIGURE 0.2) have their spatial conditions and design requirements as well that every city has its characteristics in terms of morphology, available infrastructure and the degree of fine-grainess of the specific type of infrastructures. To find out the applicability per city of the principle and different modes, every possible variant needs to be tested in the urban regions of Rotterdam, The Hague and Delft.


**FIGURE 0.2:**
Two proposed principles
*(author's drawing, p. 133)*

*STRATEGY DEVELOPMENT*

The UCCs are recognised as the most crucial nodes since they partly determine the location of the other nodes. By showing the spatial interrelationships between the nodes, which consists of three separate generic steps by identifying (1) possible locations for UCCs, (2) the available transportation links and modes to the city and (3) the possible locations for drop-off points, it reveals the presence of the required facilities or infrastructures and if so, the specific location. The conclusions per urban region of the variants are translated into region-specific strategies and possible applications. The three urban regions are 'just' three cases, which means that the analysis and approach also can be used for other cities and urban regions to generate other region-specific strategies. The strategy of Rotterdam urban region is selected for elaboration (FIGURE 0.3).

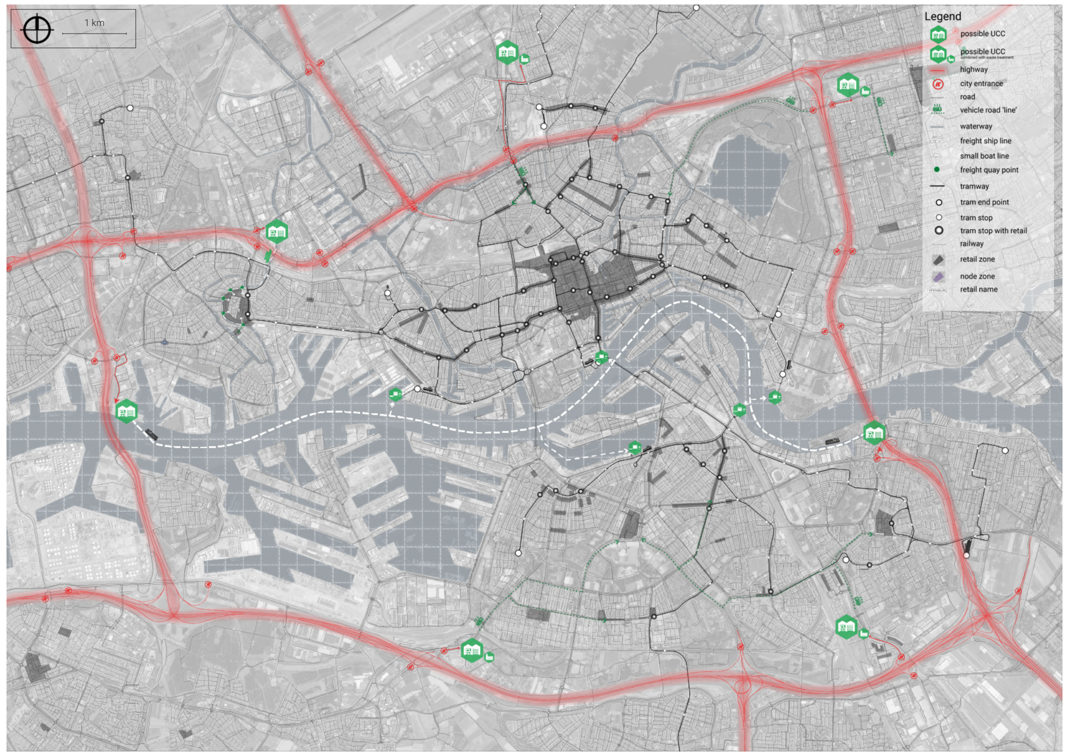

**FIGURE 0.3:**
Proposed strategy of Rotterdam
*(author's drawing, p. 170)*

*SPATIAL IMPLICATION*

The allocation of UCCs is important in the strategies. It determines and eventually limits the possible locations of other nodes. Urban multimodality has a big potential (especially on the water) when the location of the UCCs is chosen well-considered. Extra synergies can be generated when the location and processes of waste treatment facilities are also taken into account the allocation of UCCs.

Regarding the transhipment centres, it is important to consider the context and surrounding functions to find out which additional function could suit in the context. Instead of designing just a box where logistic activities are taking place, the project wants to make clear that it also can serve the city and its public space. With careful consideration, it could offer the possibility to incorporate them as a part of the public space. Additional functions on nodes could contribute to spatial and social quality. Including the strategic framework for urban freight in new projects can be environmentally, socially en economically beneficial by realising truck-free zones (FIGURE 0.4).

For drop-off points, the main challenge in implementation is to incorporate them in an already full and defined programmed area in the city, integrated into existing street and water profiles. It is worth it to analyse the existing freight system by mapping the flows and where currently freight is delivered physically. Current (un)loading zones (near tram stops) could be transformed into drop-off points. Less extra space is required and thus other functions and users have to give up less space to facilitate drop-off points. Relatively small interventions are required when mainly existing (infra)structures are (re-)used (FIGURE 0.5)

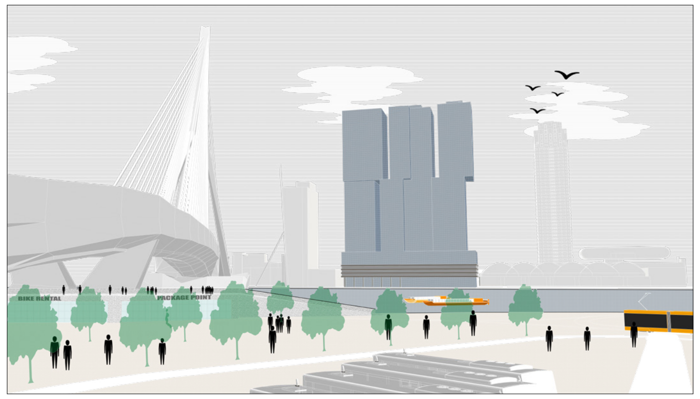

**FIGURE 0.4:**
Transhipment centre
Willemsplein (Rotterdam)
*(author's drawing, p. 195)*

**FIGURE 0.5:**
Drop-off point Taanbrug
(Schiedam)
*(author's drawing, p. 221)*

The several design proposals have demonstrated that for the most sites a new node with additional functions has the potential to contribute to the spatial quality. Relatively small interventions are required when existing structures are re-used, especially at the drop-off points are necessary to achieve this. With a different perspective on urban freight logistics, logistic functions can be gradually be considered as an urban function.

*CONCLUSION*

With taking the lessons learnt and results into account, it can be concluded that changing the spatial organisation of urban freight could potentially reduce the number of kilometres in the MRDH and thus negative externalities. Every shipment that can take place over water or rail reduces the number of trucks. Also, every shipment that can find synergy with waste reduces the number of trucks. Proposed interventions contribute to the liveability of the city by reducing the number of trucks in 'vulnerable' urban areas. Ultimately, the strategic framework gave new perspectives to urban freight and can be used by local authorities for the accommodation of increasing logistic demand of retailers and the mitigation/reduction of negative externalities.

This chapter introduces the research topic: urban freight. It will describe the outline of the thesis by giving the problem and location definition. With setting out the context, the research aim and research questions are given. The research questions will determine the structure of the report.

*chapter outline:*


1.1 introduction
1.2 problem defintion
1.3 location definition
1.4 research aim
1.5 research questions
1.6 research outline


# 01 INTRODUCTION

*source photo: Hennekijnstraat behind Lijnbaan (Google Earth, 2020)*

## 1.1 Introduction

Nowadays, urban planners and decisionmakers face several challenges on keeping growing cities liveable. Getting a well-working urban freight operation is one of those challenges. Urban freight is a segment of freight transport which takes places as one of the main users of the urban space (FIGURE 1.1-6) (Dablanc, 2009). It has got a strong relationship with the planning of cities since technical, economical, social and demographic trends always have been changing and determining the way people and goods are moving through cities (Bjørgen, Seter, Kristensen & Pitera, 2019).

A range of authors (Crainic, Ricciardi, & Storchi, 2004; Lindholm, 2012; Oliveira, Oliveira, & Correia, 2014) underpinned the importance of urban freight transportation activities regarding urban development and metropolitan economies because they generate trading activities and bring industrial competitiveness in the region. Urban freight is responsible for a continuous supply of commercial activities and waste collection while facilitating the growth of the urban population.

Although freight transportation is supporting cities' activities, urban freight activities also have a high negative environmental, economic and social impact. Well-known examples are air pollution (environmental); traffic congestion and delivery delays (economic); and safety and decrease of liveability on the overall built environment (social). All those flows occupy about 25% of the street traffic in a typical city and between 16% and 50% of the air pollution (dependent on the pollutant) (Dablanc, 2007). Urban freight has to share the space with pedestrians, cyclists, cars, public transportation and other vehicles.

Cities are now on the threshold that all the delivery of urban freight is becoming more challenging per day. Urban infrastructures are almost reaching their technical capacity. Implications and impacts of transportation' externalities are influencing cities in such a way that they already harming the quality of life, the liveability and the sustainability ambitions. With the global trends such as globalisation and urbanisation and peoples' behaviour affecting urban freight logistics, the question arises if the current urban freight activities, which nevertheless satisfy mobility needs and supports economic development are also still in accordance with on the other hand our ambitions regarding the environment and sustainability goals. Despite the critical necessity to rethink urban freight, there is a lack of attention paid in urban planning, which made this topic an critical issue in our field. Naturally, every citizen wants to live in an accessible city, wherein we can trade, meet our needs and move around safely. This, of course, will require a frequent delivery of goods. In the field of urban freight, the old challenges are still there, however, new ones have emerged.


(author's photo, 2019)

(author's photo, 2019)

(Evofenedex, 2019)

(Google maps, 2019)

(Jesper Neleman, 2017)

(author's photo, 2020)

**FIGURE 1.1.1-6:**
Urban freight in urban space
*(diverse photographers)*

## 1.2 *Problem definition*

The problem definition will address three issues going on in urban freight. These are illustrated in FIGURE 1.2. During the research, they all will addressed extensively. The issues are as follows:

With the adoption of automobile vehicles as the main mode of transportation, urban freight is considered as the generator of negative externalities in urban areas. It is the inescapable truth that these vehicles do make intensive use of depletable resources of energy, human and carbon (Goldman & Gorham, 2006). Urban freight transportation on the road has environmental, economic and social impact on cities (Taniguchi, 2014). Additional to this, economic and technological developments such as urbanisation, globalisation, internet technology and warehousing technology are exacerbating impacts on society even more since these dynamics are responsible for changing spatial logistic lay-out, modes and infrastructures and thus for an increase of flows and distances. Lowering transportation costs, however, has priority over efficiency in transportation flows and vehicle kilometres. According to the European Union, the growing amount of road transport is unsustainable and thus they support the use of multimodal transport (Dampier & Marinov, 2015). Although the international underpinning from the European Union on multimodal transportation, the truck is still the most popular mode in the Netherlands and thereby the roads are filling up with more trucks through the growth of freight.

These three issues are recognised by public and private stakeholders. However, it seems like that current freight policies are insufficient to tackle the increasing negative externalities due to lack of knowledge and awareness on urban freight and measures (Dablanc, 2007). Also insights of interests and interaction between urban freight stakeholders are limited. Decisions on transportation tend to focus on economic growth and the creation of jobs (Goldman & Gorham, 2006).

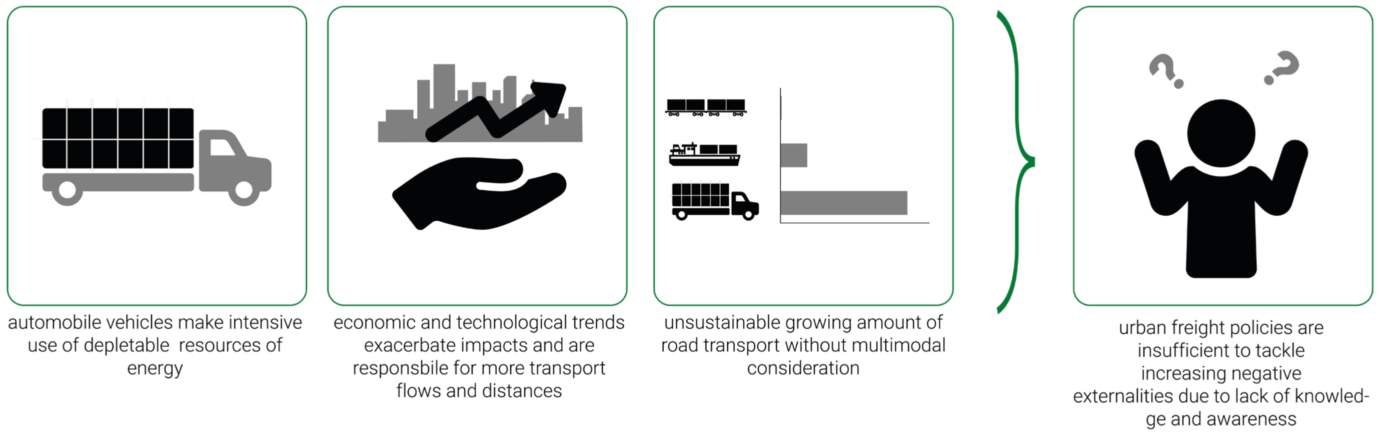


**FIGURE 1.2:**
Problem statement
*(author drawing)*



## 1.3.1 *Location definition context of the MRDH*

The location for the project is located in the South-Holland province of the Netherlands. This region is one of the most urbanised (and still growing) areas of the Netherlands and is an administrative collaboration of 23 municipalities around the metropolitan areas of Rotterdam and The Hague (MRDH).

The 23 municipalities share same ambition to improve accessibility and strengthen their economic business climate in this high dense area within other economic areas The region has 2.3 million inhabitants and 1.2 million jobs and has a 15% contribution to the GDP of the Netherlands (MRDH, 2019b). In the elaboration of the project, three main municipalities (urban regions) in the MRDH will be considered in particularly: Rotterdam, The Hague and Delft (FIGURE 1.3 and FIGURE 1.4).

The MRDH region is chosen because of its logistic character, population density of the region and the presence of water- en inner city rail infrastructure, which is a prerequisite for multimodal transport. The logistics sector is an important pillar of the agglomeration with a high logistic density in the area. With the port of Rotterdam, Greenports and a high population density, this will bring extra challenges to keep the region accessible and liveable with regards to freight transportation. The already relatively good working urban freight operation in this high dense area makes this region ideal to test alternatives and to search for further improvements to bring urban freight to an even higher level. The research can at the same time respond to some environmental ambitions in the region, which will be elaborated in the next paragraph.

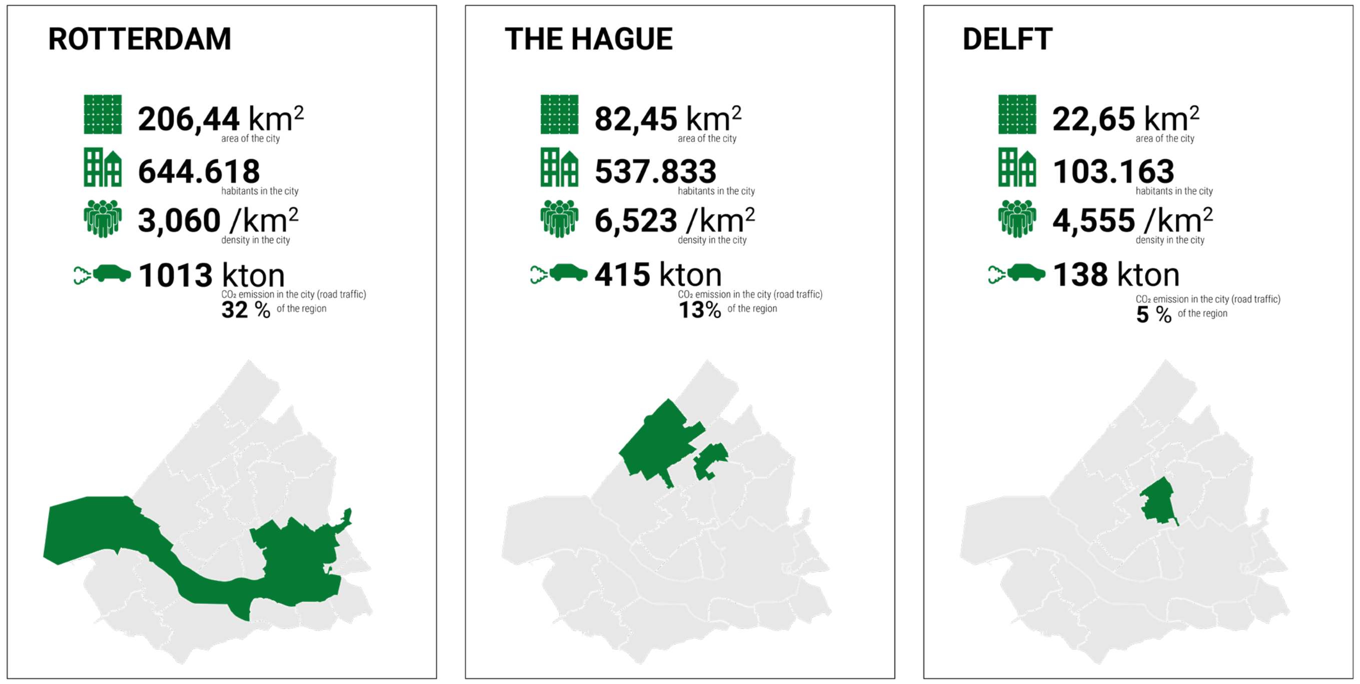


**FIGURE 1.3:**
Rotterdam, The Hague and Delft *(author's drawing; data from MRDH, 2018)*

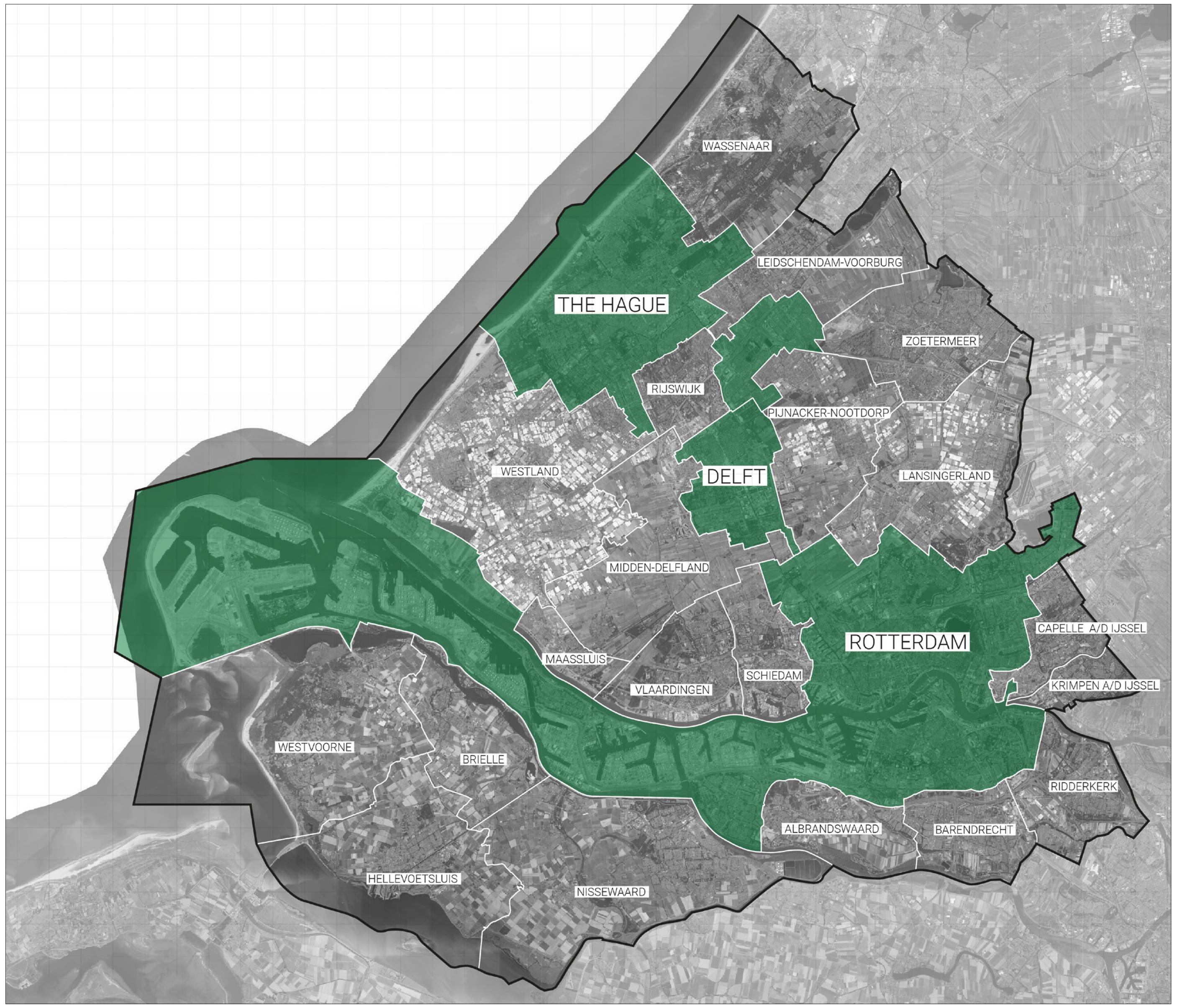


**FIGURE 1.4:**
Map of the Rotterdam-The Hague metropolitan area *(author drawing)*

## 1.3.2 **Location definition** *challenges of the MRDH*

The current $CO_2$ emission in the MRDH on road traffic is approximately 4250 kton per year in which around 80% is caused by road traffic and around 35% of this is related to freight traffic, port traffic included (FIGURE 1.5). The road traffic almost always have its origin or destination within the MRDH, just 4% of the region is ongoing traffic (MRDH, 2019a).

The MRDH aims to make passenger and freight mobility more sustainable in order to achieve a strong economy, accessibility and liveability. The municipalities in the MRDH have to contribute to the national and international Europe's climate goals in which they aim jointly at a $CO_2$ reduction in the whole transportation sector of 1400 kton in 2025. This is 30% of the current situation and quite ambitious but in large extent in accordance with national policy. The desired reduction is almost the whole $CO^2$ emission of Rotterdam and The Hague. At the same time, most municipalities agreed in the Green Deal Zero Emission Stadslogistiek (GDZES) to reduce the emission from urban freight to zero in city centres.

With the current policy, the $CO_2$ emission will increase slightly to 4330 kton in 2025, which is caused by freight transportation as shown in FIGURE 1.6 (MRDH, 2018). The targets for the $CO_2$ reduction do not stand alone, but is part of the 'Uitvoeringsagenda Bereikbaarheid' that also focusses on improving accesibility of economic areas and atractiveness of living and working locations (MRDH, 2018).

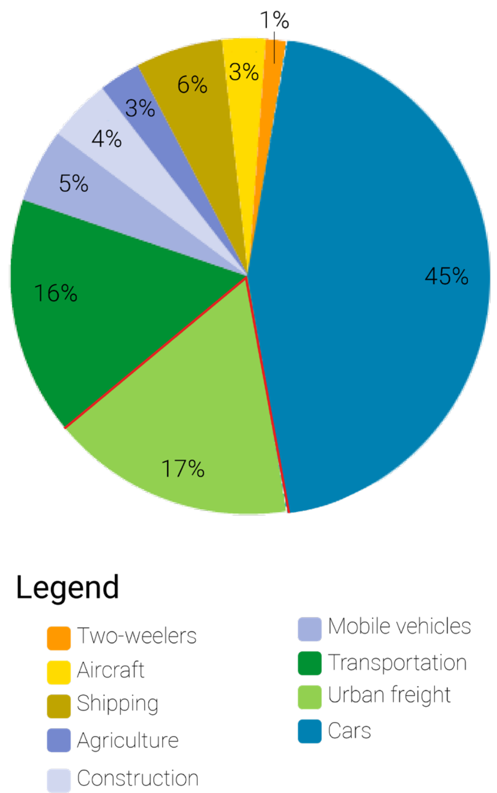


**FIGURE 1.5:**
Share $CO_2$ emission per motive *(MRDH, 2018)*

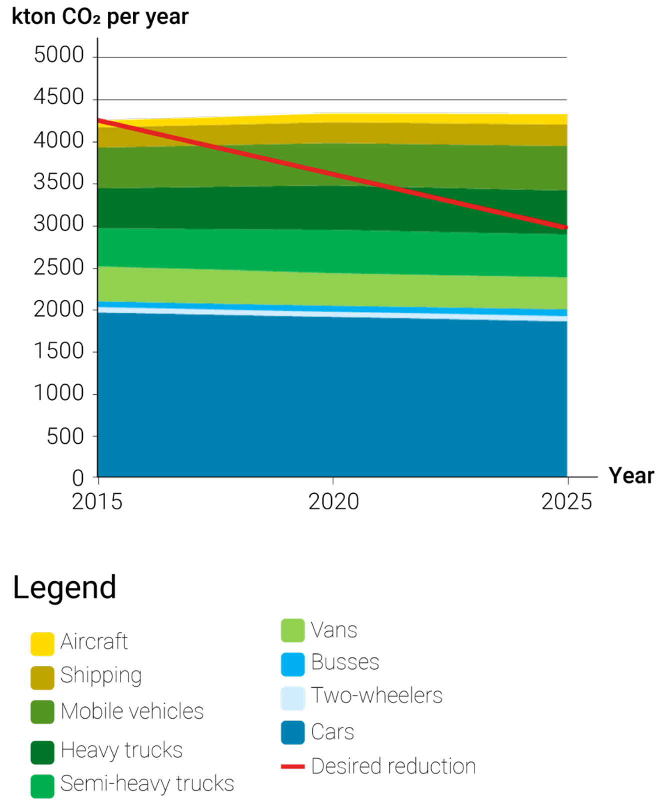


**FIGURE 1.6:**
$CO_2$ ambitions MRDH with reduction path *(MRDH, 2018)*

According to numbers, the city of Rotterdam generates the most $CO_2$ in the area with a share of around 32% percent. This is mainly due to traffic on the highways around the city related to port activities. Rotterdam has compared to The Hague around three times more highway emission (MRDH, 2018). According to Rotterdam municipal data (FIGURE 1.7), a relatively small amount of vehicles are responsible for a relatively large part of $CO_2$, $NO_2$ and PM10 emissions (Gemeente Rotterdam, 2019). This will be the case in most of the other cities as well. The MRDH and other cities in the Netherlands have recently recognized that sustainable urban freight logistics is becoming more important. Therefore a collaborative agreement is set up between logistic companies, authorities and knowledge institutes. At the end of 2014 around 50 parties have signed the **Green Deal Zero Emission Stadslogistiek** agreement on committing to the goal for emission-free urban freight logistics by setting up, implementing and evaluating pilots on city and regional scale. In today's city, it should be able to live, work, relax and learn in a healthy way. The problem of increasing urban freight activities in cities can be considered as a generic problem, however, it will need different solutions, dependent on the context of each urban area. Recognising the current challenges is the first step, which will ultimately lead to more sustainable solutions. But there is a lot work to do.

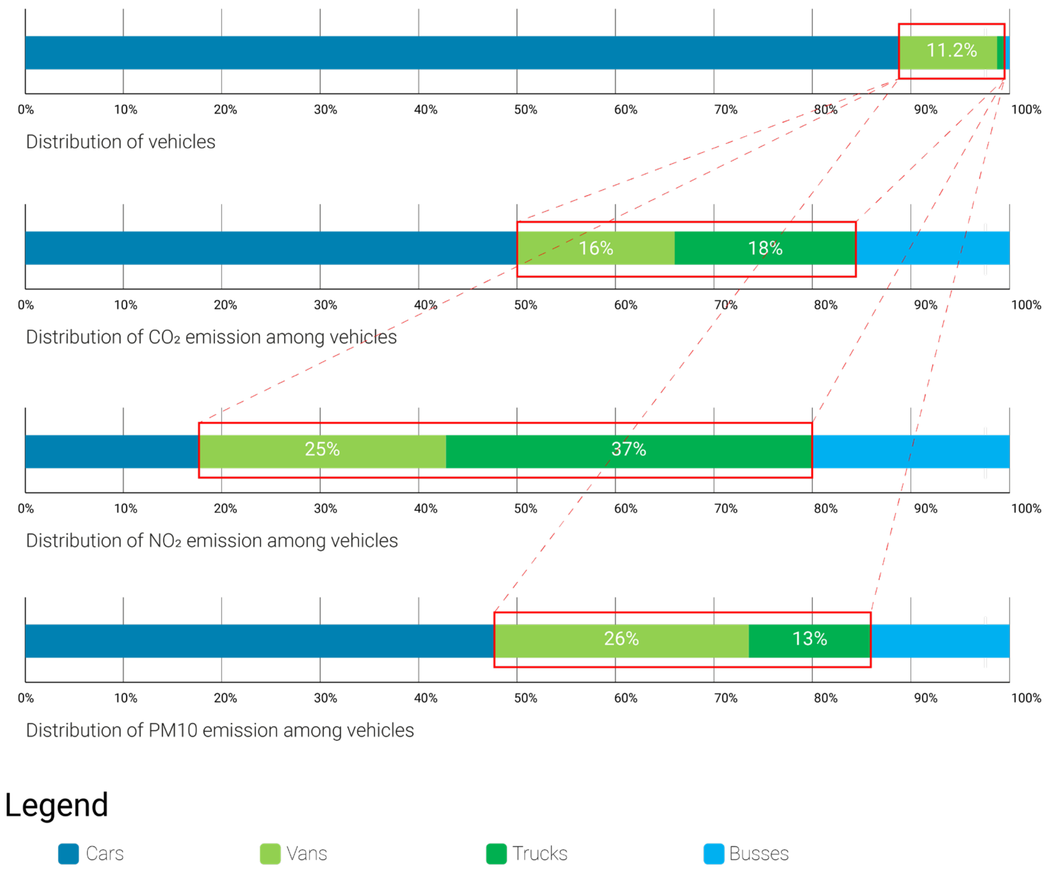


**FIGURE 1.7:** Distribution of vehicles and their emissions *(Gemeente Rotterdam, 2019a)*


*source photo: Trucks (HLN, 2017)*

## 1.4 Research aim

Since a few decades, principles of sustainable development became important for scholars, policy professionals and urban planners (Goldman & Gorham, 2006). It reflects a fundamental human desire in which humans want to create a future for our children wherein they are also able to supply their needs. However, negative externalities on the built environment are increasing through the increasing amount of urban freight operations. This poses extra challenges for urban planners in their mission for sustainable and liveable cities. In order to achieve to goals of sustainable logistic development, negative externalities and impacts of transportation need to be mitigated.

Various, independent measures are more or less taken by local authorities to reduce negative externalities of urban freight. However, measures are performed in a suboptimal way or are not appropriate for the local context, which results in unintended side-effects (Macharis & Melo, 2011), such as generating more traffic by replacing one big truck by smaller vehicles. The lack of understanding and alignment in measures and concepts from municipalities in spatial terms calls for a framework for urban freight that needs to be developed for mitigation. The research wants to implement two often suggested concepts of urban freight in the framework that responds to the stated problems: the concepts of urban consolidation and urban multimodality. Both concepts will be explained thourough in the thesis.

The research aims to develop a strategic framework, including the concepts of urban consolidation and urban multimodality of urban freight transportation for local authorities in the MRDH in order to accommodate the increasing logistic demand of retailers, while mitigating/reducing negative externalities.

The thesis also responds by means of urban freight to the Paris Climate Agreement, the Dutch government signed in 2015, the Coalition Agreement in 2017, the translation to the preliminary Dutch Climate Agreement in 2018 and the MRDH goals. With that, the Netherlands has set clear goals: a regional reduction of 30% of greenhouse emissions in 2025, a national reduction of 49% in 2030 and 95% in 2050, compared to 1990 (MRDH, 2018; Rijksoverheid, 2019).



## 1.5 Research questions

This paragraph shows the main research question and the relevant sub research questions for the proposed research. The next paragraph (outline of the thesis) will demonstrate that the research questions are used as the backbone of the report.

Main research question:

*MRQ:* **How can a strategic framework of urban freight transportation in the MRDH accommodate the increasing logistic demand of retailers in a sustainable and liveable way?**

Sub research questions:

*SRQ1:* **How do global trends and dynamics have influenced the operation of urban freight?**

*SRQ2:* **How is the urban freight transportation currently organised in the MRDH in terms of:**

a) initiatives, measures and concepts
b) spatial organisation of logistic facilities
c) stakeholder management

*SRQ3:* **What are spatial conditions and design requirements and for improved urban freight in the MRDH?**

*SRQ4:* **What are the spatial implications of the improved urban freight strategies in the MRDH**

## 1.6 *Research outline*

The introduction has stated that there is a need for an intervention to accommodate the increasing demand to keep growing cities liveable and to stay in line with environmental and sustainable goals. Since urban freight is affecting the quality of life and the liveability of cities, the role of the urban planner cannot be neglected in the field of urban freight.  Therefore, the research aims to develop a strategic framework for urban freight transportation, which could be used by local authorities in the MRDH (Metropolitan Region of Rotterdam and The Hague) to accommodate the increasing logistic demand from retail perspective, while reducing the negative externalities of transportation. At the same time, it also tries to respond to several national and international agreements on sustainability. Translating the research aim to the main research question has lead to the following one:

How can a strategic framework of urban freight transportation accommodate the increasing logistic demand of retailers in a sustainable and liveable way?

The answer to this research question, the report is structured as followed:
Chapter 2 sets up the methodological framework to support the conduct of the research. It elaborates more on the research methods, research output, relevance and ethics. The methodological chapter concludes with an overview of the methodology and acts as the research design.

Chapter 3 offers a broader view of the context of urban freight. It provides briefly an overview of the problems in urban freight and put them in the context of the MRDH region as well.  Furthermore, the scope of the project is explained in this chapter by defining urban freight and pointing the specific segments of urban freight that will be addressed in the project.

Chapter 4 has the purpose of answering the first research question in which the influence of trends and dynamics on urban freight are researched. It provides the theoretical background of transportation and logistics by describing the different drivers responsible for the development of increasing urban freight, which is required to understand the status quo of urban freight. This chapter will introduce the historical scene and describing the trends and dynamics that have affected/are affecting urban freight. The development of transport and logistics is illustrated and will be concluded with the status quo of urban freight.

Chapter 5 answers the second research question and is divided into three components. The main purpose of the chapter is to analyse and evaluate the current situation of urban freight logistics in the MRDH, based on 1) the current initiatives, measures and concepts, wherein the  2) the spatial organisation of facilities and 3) stakeholder management. This is done by using several (spatial) analysis techniques.

Chapter 6 addresses the third research question in which new nodes based on urban consolidation and multimodality are proposed. Together with the nodes, characteristics of urban regions will be defined and a roadmap applied step by step. The characteristics and the nodes are fundamental for the separate strategies, which will be tested systematically in Rotterdam, The Hague and Delft on spatial feasibility. The chapter will conclude with a region-pecific strategy for the three urban regions, which will be the basis for the next chapter.

Chapter 7 will address the fourth research question in which one of the region-specific strategies as it is formulated in the sixth chapter will be spatially elaborated. The chosen urban region is that of Rotterdam urban region, including Schiedam. The spatial elaboration consists of a site selection based on the city centre of both cities and their respective critical locations where urban freight take place to show its implications in the built environment. The goal of this chapter is to show and prove the spatial feasibility of the several solutions on urban freight in the MRDH. It will also reflect on the other cities in the MRDH.

Finally, chapter 8 provides the conclusions and evaluation of the research, wherein the main findings are summarised and recommendations for further research. Also the transferability of the strategical framework to other cities by a quick analysis. After the presentation of the main conclusions, a reflection will be given on several aspects on the process, the research design and the conduction of the research.

The methodological framework is set up to support the conduct of the research.  The problem statement made clear that there is a need for an intervention for the increasing demand for logistics as a result of the global trends to keep in accordance with the environmental and sustainability goals. This chapter elaborates on the methodological framework of the project which consists of the research methods and research limitations and explains the roadway tot the strategic framework.

*chapter outline:*


2.1 conceptual framework
2.2 research methods
2.3 research limitations
2.4 expected research output
2.5 methodological framework


# 02

# METHODOLOGY

*source photo: Eemhaven Rotterdam (Prologis, 2019)*

## 2.1 *Conceptual framework*

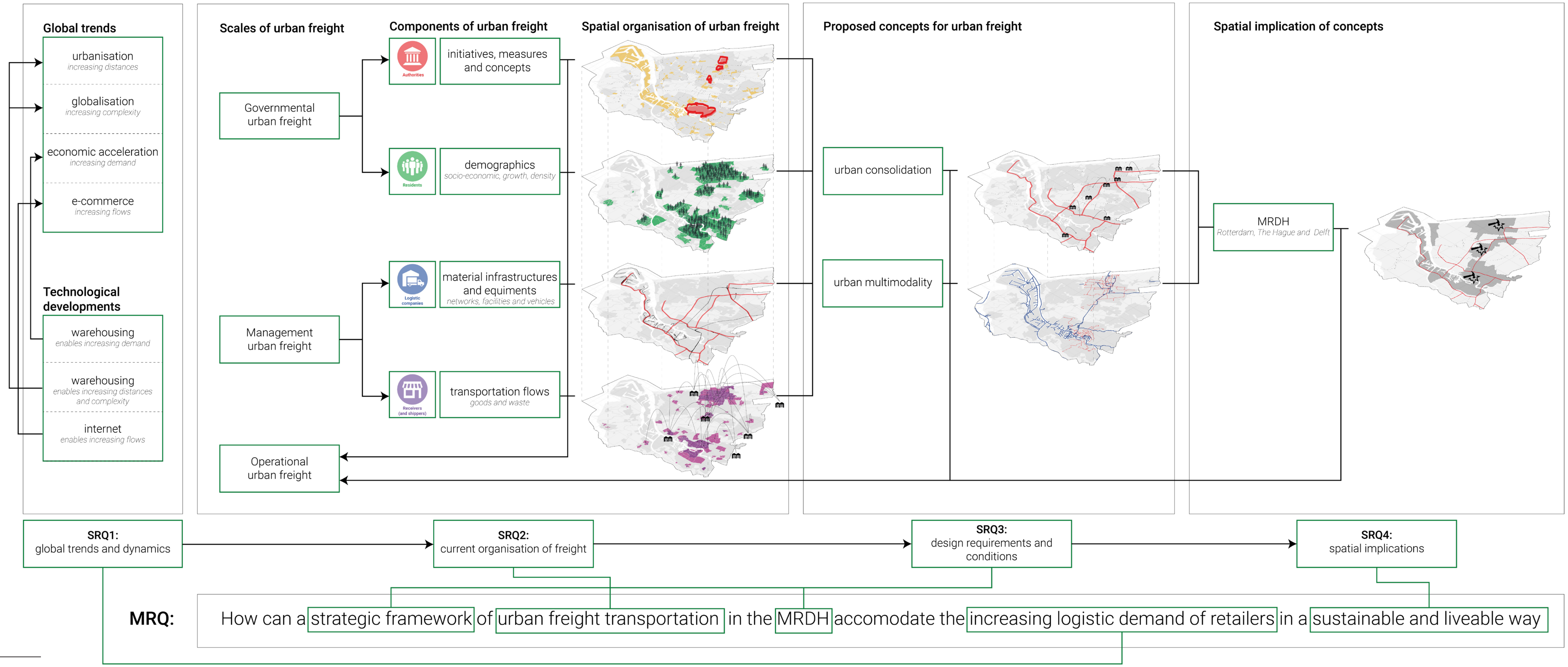


**FIGURE 2.1:**
Conceptual framework of trends - effects - impacts
*(author drawing)*

FIGURE 2.1 shows the conceptual framework of the project, which illustrates that currently the urban freight activities are influenced by global trends and technological developments. The current urban freight manifests itself in three scales: governmental (regulations and measures on activities), management (how to execute activities) and operational (the actual transport). Within the manifestation, stakeholders of urban freight are connected to the different components, showing that the activities are a result of physical interactions between the different stakeholders.

It turns out, the current spatial organisation of the components is harming the quality of life, the liveability and the sustainability ambitions and therefore the urban freight operation needs to be rethought, wherein new, innovative concepts are applied. Future concepts for urban freight could be urban consolidation and urban multimodality, which are going to be researched and explained in the thesis. It turns out that the MRDH region is a convenient test area for these two concepts.

## 2.2 Research methods

This paragraph will address the different methods used in the research. There is a distinction made in two different categories of research methods/analysis: general analysis, which are studies dedicated to a general understanding of urban freight on a spatial, conceptual and legal level. They analyse e.g. different maps, data, documents or literature to synthesise new information. Performance analysis are studies dedicated to the performance of different knowledge. They test designs or ideas and could provide new insight into the research and design process. The following research methods are applied for each of the categories (FIGURE 2.2):

A part of the methods are dedicated to deriving numbers, facts, causes and identifying the specific components of urban freight, including their performance. Main methods are linked to the spatial analysis of urban freight and are related to the supply chain and its stakeholders. The outcome of the project will be a strategic framework of urban freight transportation for every of the three urban regions in the MRDH.

To come to this point, an understanding of current logistic flows, supply chain and its spatial organisation need to be acquired. Also, important stakeholders need to be identified. From a general idea, the next step will be spatialising the supply chain and stakeholders which will turn the research from general understanding to a specific understanding. Location-specific optimisation techniques and measures could be generated and applied directly. Parallel on this, research and a collection will be done on the current concepts and methods of sustainable freight transportation. Combining and integrating the knowledge, innovative concepts and location-specific findings into a complete framework should result in fulfilling the research aim. FIGURE 2.3 shows the four research questions connected to the research methods.

**GENERAL ANALYSIS**

| | |
|---|---|
| spatial analysis | policy analysis |
| theoretical analysis | demographic analysis |
| flow analysis | stakeholder analysis |

**PERFORMANCE ANALYSIS**

| | |
|---|---|
| case study | scenario thinking |
| feasibility analysis | impact analysis |

**FIGURE 2.2:**
Different methods
*(authors' drawing)*

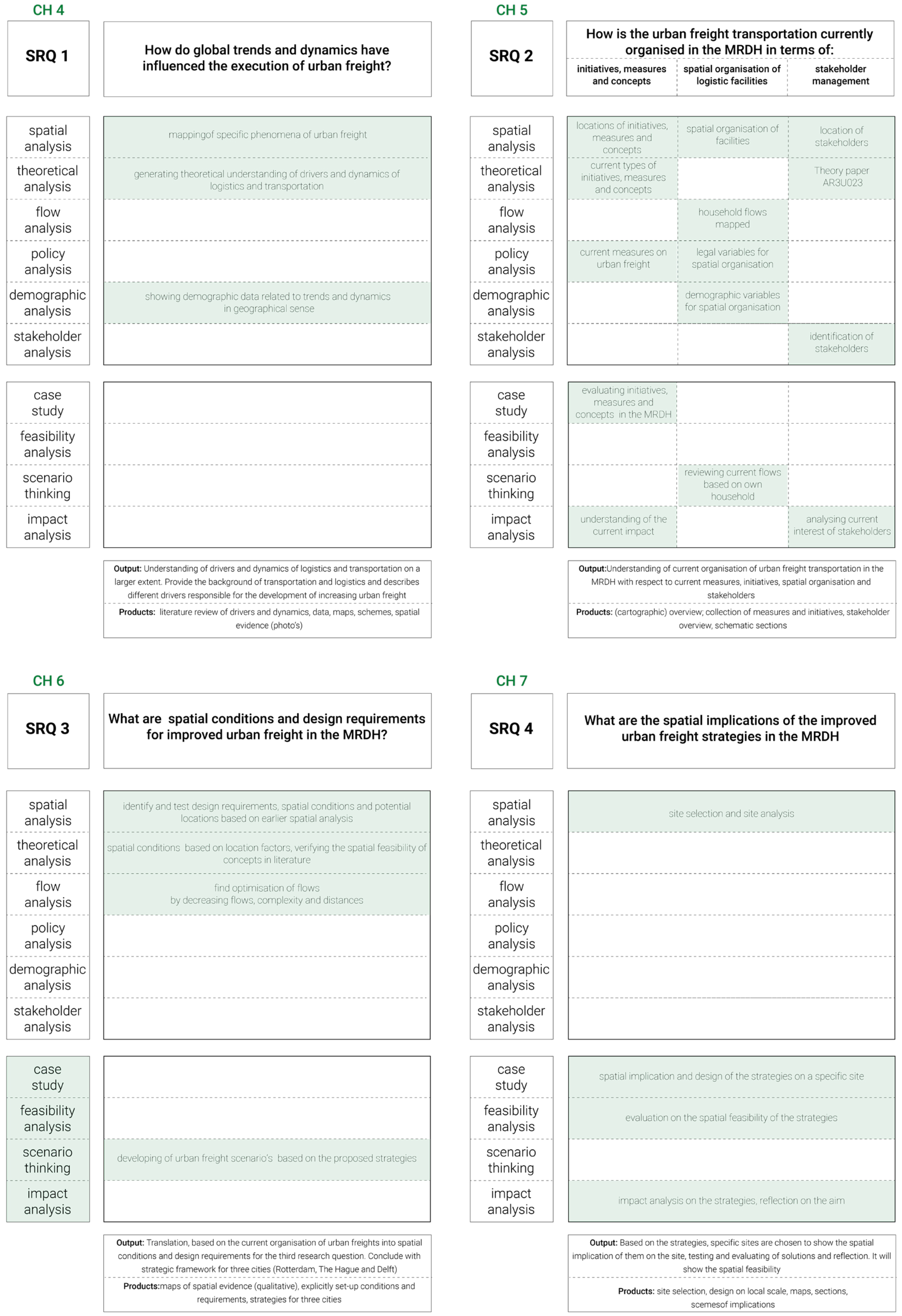


**FIGURE 2.3:**
Research questions connected to methods
*(authors' drawing)*

## 2.3 Research limitations

Urban freight logistics is a multidisciplinary field, which covers the fields of geography, economics, urban planning, logistics and supply chain management in which they tackle spatial, social, infrastructural, organisational, legal and technical perspectives of logistics. Due to the multidisciplinary approach of a relatively rigid and rough topic, it can be hard to come with a complete understanding of logistic processes. The purpose of the project is to come with a strategic transportation framework rather based on especially a spatial, social and legal understanding of urban freight and not on technical and mathematical terms. The research in fact will show the spatial feasibility. Thus, calculations on optimisation of inventory, shipments and distribution are not taken into account. Additional to calculations, some data, which are based on calculations and wherein mathematical understanding is required, will also be neglected. The research limitation is based on discrepancy on the 'languages' of the different fields. However, this does not have to exclude possible explorations in other fields beyond the field of urbanism. Additionally, the research will not include an extensive financial and logistical underpinning either. A business model for instance will not be included in this research but should of course be considered as well in further implemental research. For implementation and feasibility, these aforementioned disciplines of course needs to be consulted.

## 2.4 Expected research results

At the end of the research, a strategic framework for urban freight will be proposed proposed for three urban regions (Rotterdam, The Hague and Delft) in the MRDH, based on the analysis of concepts, measures, spatial organisation and stakeholders. The three frameworks for every urban region should be able to mitigate negative externalities of transportation and on the same time accommodate the increasing logistic demand and ultimately reflect on the spatial feasibility of the proposed urban freight concepts. Methods used for creating this framework should be useful for other authorities of urban, metropolitan and regional areas as well. Deliveries of urban freight to retailers is becoming challenging and the research will find ways to accommodate this in cities in a more liveable and sustainable way by testing urban consolidation and urban multimodality.

## 2.5 Methodological overview

The topic of urban freight (transportation) is a relatively technical, objective oriented theme in the urbanism discipline. That is why it is all the more important to set up a well-structured and systematic methodology. Different parts of the methodological framework were set up in this chapter to support the conduct of the research. The following spread (FIGURE 2.4) will summarise and conclude the methodological chapter with the overview of the research framework. The methodology chapter has explained the roadway of the research towards the strategic framework of eco-friendly transportation.




*source photo: PostNL pakketpunt (PostNL, n.d.)*

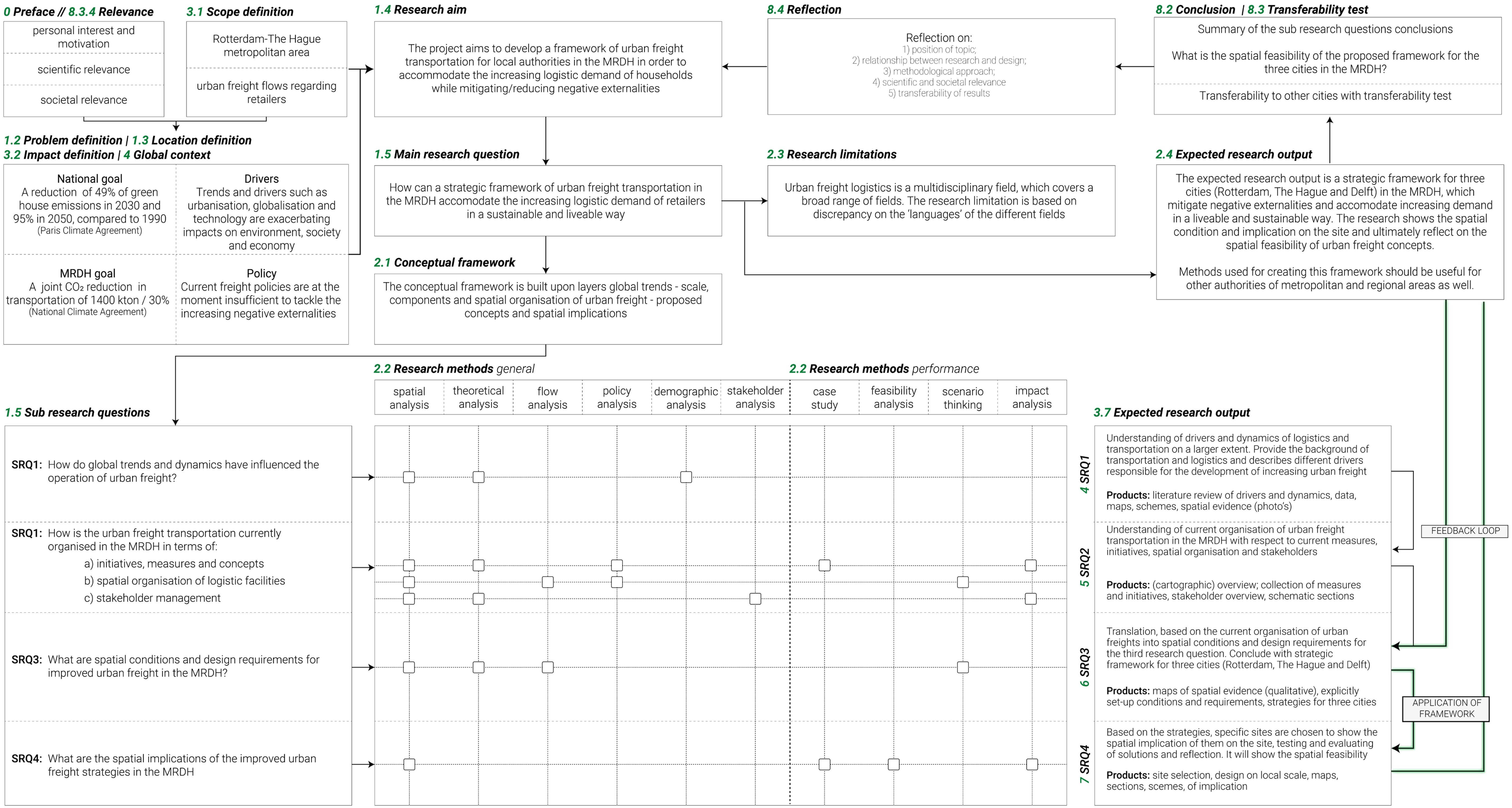


**FIGURE 2.4:**
Methodological overview
*(author drawing)*

To get a grip on the complexity and the very diverse field of freight transportation, the definition, specific components and the impact of urban freight need to be clarified. This chapter defines the relevant segments of urban freight for the thesis and illustrates the impact it has on the MRDH region.

*chapter outline:*

3.1 scope definition
3.2 impact definition

# 03
# DEFINITIONS

*source photo: Waalhaven (Port of Rotterdam, 2019)*

## 3.1 **Scope definition** *urban freight*

To get a grip on the complexity and the very diverse field of freight transportation, the definition, specific components and the impact of urban freight need to be clarified.

Firstly, urban freight transportation is one of the processes within the supply chain. The supply chain is the economic process from producer to consumer and consists of steps like production, transportation, distribution and consumption (FIGURE 3.1). The (transport) activities of urban freight take place in the last part of the supply chain, namely between distributing and consumption. Urban freight is defined as the (commercial) movement of goods and services for commercial entities between consumers and distributors that have an origin or destination in urban areas. Movement of goods and resources between these actors is necessary to keep cities and people running. And a part of the transportation takes place in cities' boundaries, which is called urban freight. This consists of consumer logistics, facility logistics and construction logistics and concerns the supply of fresh goods, general goods, home deliveries, construction, facility logistics and the collection of waste and all the returning flows (reverse logistics). This does not include private trips (shopping) by people to acquire goods, nor does the through traffic (freight traffic through the city without serving it) which is likely the case with the proximity of the port of Rotterdam (Dablanc, 2009). Most of the activities in the port of Rotterdam such as transhipments or cargo and bulk transferring to the hinterland are thus left out of consideration in the project since they do not have a direct connection to consumers.

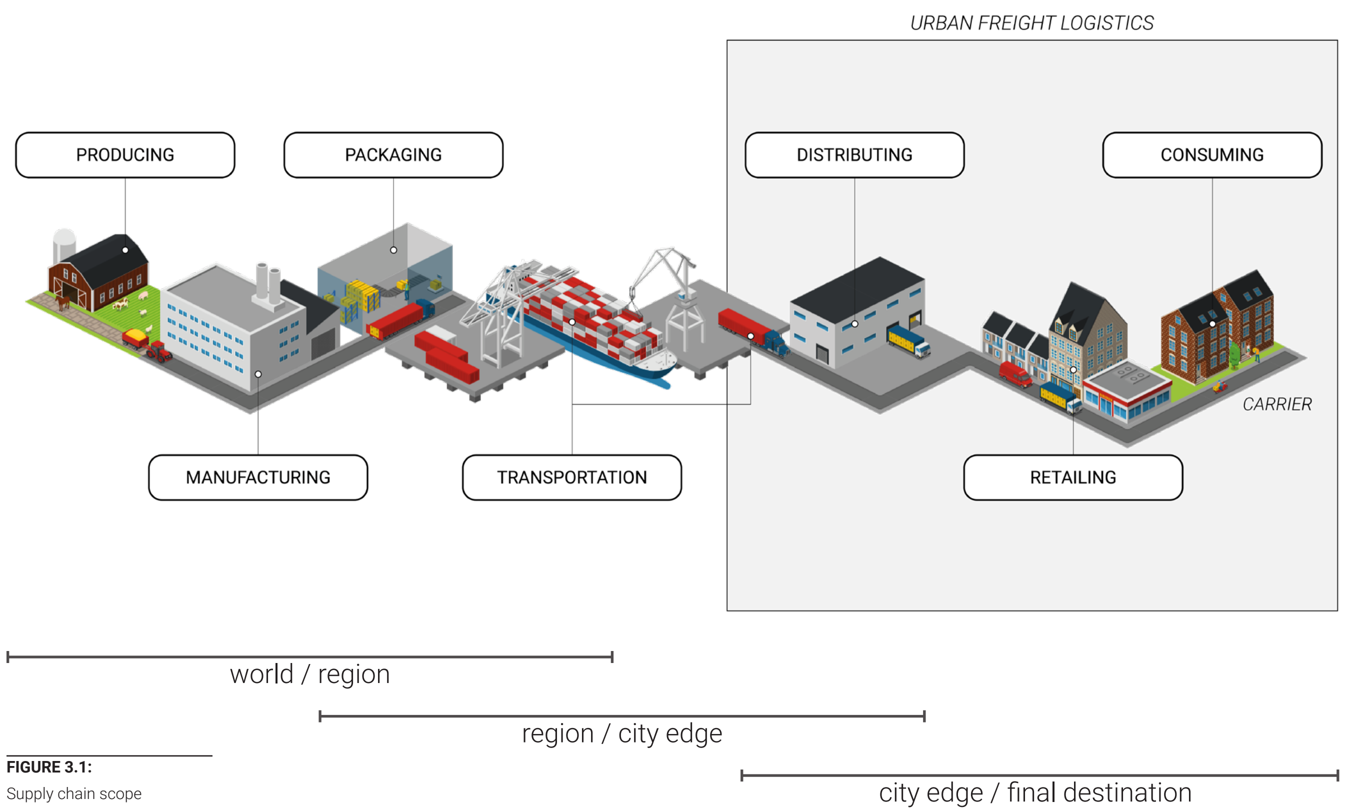


**FIGURE 3.1:**
Supply chain scope
*(author's drawing, made in Icogram)*

In this project, urban freight will be understood as all the freight kilometres and impacts within cities that have an origin or destination in the cities of the MRDH region related to retail logistics. The research will focus on the retail supply and waste collection in the MRDH and in particular the cities Rotterdam, The Hague and Delft. Although the growing e-commerce, the choice for retail supply is based on the fact that express and parcel deliveries are already quite efficient, while for retail supply several improvement steps still needs to be taken. The selected sectors are highlighted in grey in FIGURE 3.2. As shown in FIGURE 3.3 and FIGURE 3.4, the chosen flows have a significant footprint on the environment.

| Segment | Subsegment | Most common type of vehicle |
|---|---|---|
| Fresh goods (conditioned) | Retail (fresh) | Trailer<br>Truck |
| | Specialists (vegetables, butcher) | Truck<br>Van |
| | Fresh home deliveries (groceries and meals) | Delivery van<br>Bike / moped |
| General goods | Retail (non-fresh) | Trailer<br>Truck |
| | Specialists (incl. mode and hanging) | Truck<br>Van |
| | Two man deliveries (furniture, white goods) | Truck |
| Waste | Waste collection consumers | Heavy truck |
| | Waste collection businesses | Heavy truck |
| Express and parcels | Express and parcels | Van |
| Facility and service logistics | Maintenance | Delivery van<br>Bike / moped |
| | Office supply, public sector and hospitals | Very divers vehicles |
| Construction | Infrastructure | Heavy truck |
| | Reado to build | Heavy truck |
| | Under construction | Truck<br>Van |
| | Finishing | Van |

**FIGURE 3.2:**
Urban freight scope
*(adapted from Topsector Logistiek, 2017)*

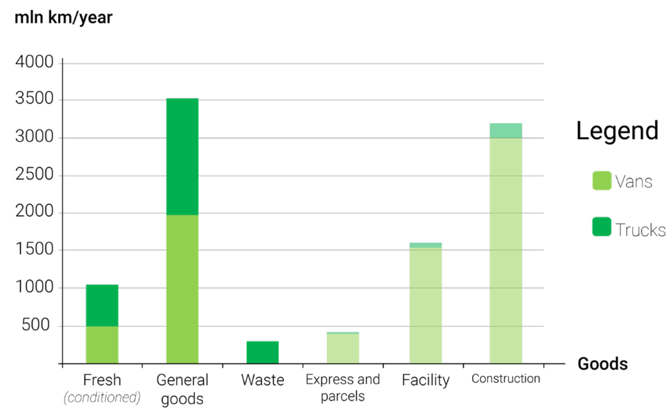


**FIGURE 3.3:**
Estimated amount mln km per year per segment
*(Topsector Logistiek, 2017)*

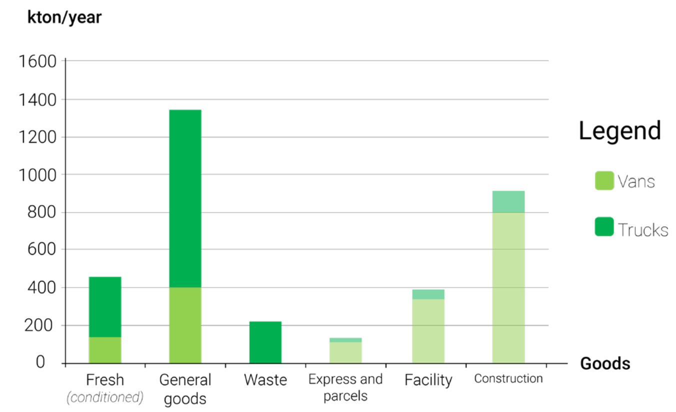


**FIGURE 3.4:**
Estimated amount $CO_2$ in kton per year
*(Topsector Logistiek, 2017)*

## 3.1.2 ***Scope definition*** *household metabolism*

Cities consume resources and excrete waste and thus the analogy of the metabolism of organisms can be made (Kennedy, Pincetl, & Bunje, 2011). The metabolism in this case refers to quantification of ingoing and outgoing flows and storage of (natural) resources, waste and emissions within a process of a specific economy such as a city, industry or household. Since the main purpose of retailers is to serve households, the metabolism of household could give insights in the types and scope of retailers.

The metabolism of households can be quantified in terms of the total energy requirement. The total energy requirement for households is the sum of direct and indirect energy requirements. Direct household energy consumption refers to the energy consumption in households (electricty, gas, car fuels), which is about 35% of the national energy consumption. The other 65% refers to the indirect energy consumption of households and is related to the energy used for producing and distributing consumer goods and handling consumer waste. As this project is about the urban freight transportion and its negative externalities as a consequence of supplying households, the concept of metabolism can be used for the inputs and the outputs of in particularly indirect energy consumption in households (Moll et al., 2008). It is in the end naturally that consumer behaviour determines the demand for transportation, since they determined what and where to buy goods (Visser & Hassall, 2005).

FIGURE 3.5 shows a simplified overview of the metabolism of households, which illustrates the urban freight transportation moments for retailers within the supply chain. This is elaborated on the next page on FIGURE 3.6 with a specification of the different retail flows from household (and author's) perspective. These flows will be used in fifth chapter for the analysis and understanding of the urban freight system.

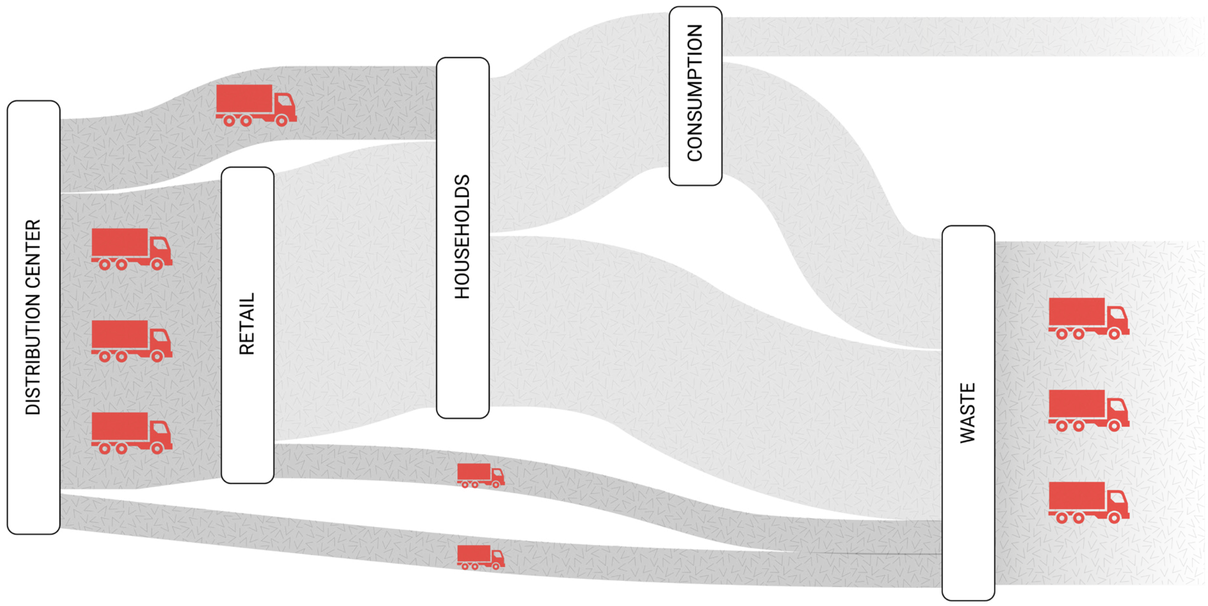


**FIGURE 3.5:**
Simplyfied overview of metabolism of households
*(author's drawing)*

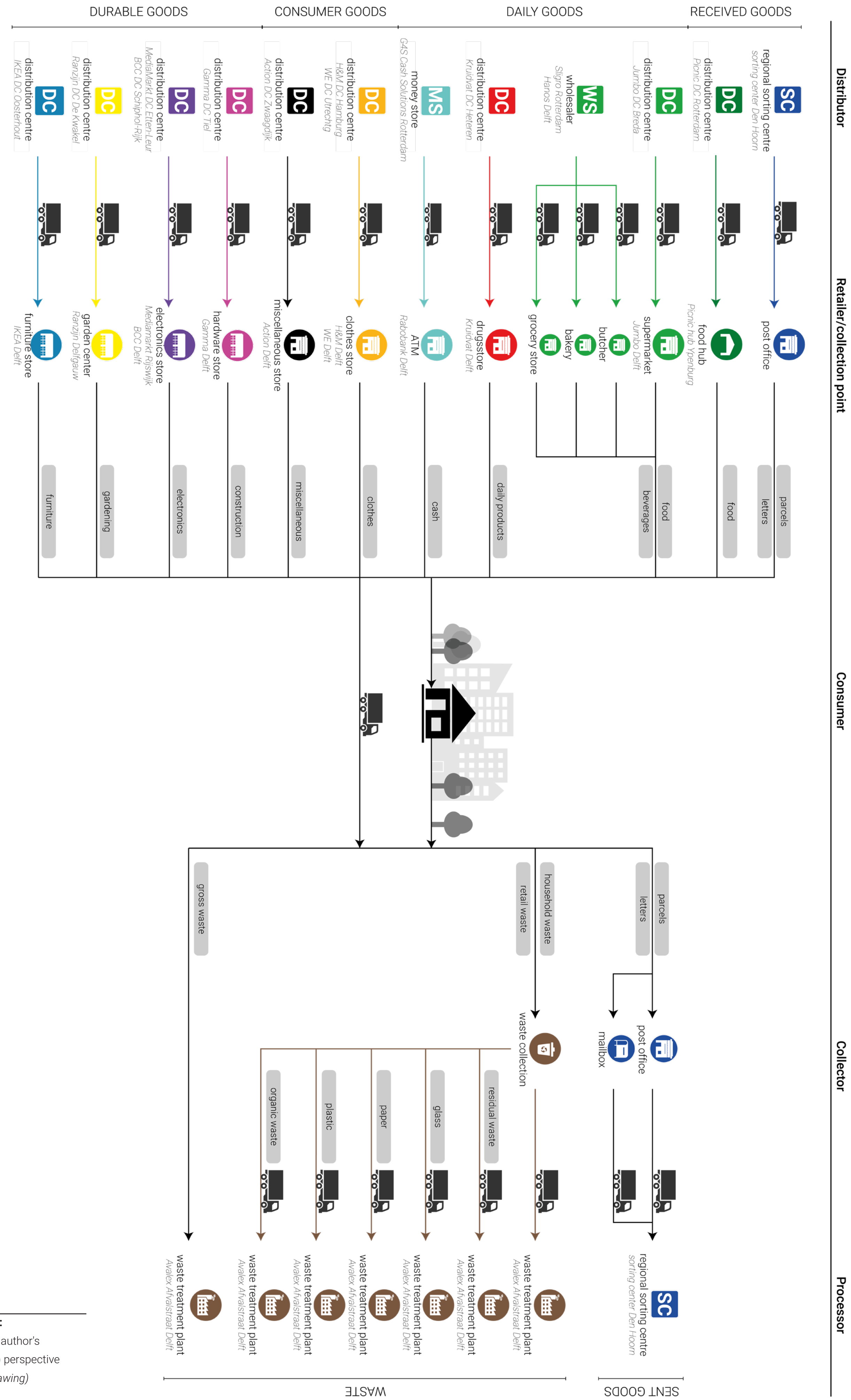


**FIGURE 3.6:**
Flows from author's (household) perspective
*(author's drawing)*

## 3.2 *Impact definition*

After giving the definition of urban freight, the next step will be to address the impacts of urban freight (in the MRDH region). Therefore, an overview of indicators are given in order to give some weight on the impact. Figure 3.7 shows some impacts with their respective indicators.

The subchapter attempts to indicate the size and (quantitative) characteristics of freight transportation flows. Altough most of the maps are showing the impacts on general road transport (instead of urban freight transport in particular), it can be concluded that some aspects the values are just exceeding or almost reaching the EU/WHO health standards. Thus, with the increasing stake of urban freight transport in mind, interventions to reduce the urban freight impacts are justified in order to meet the standards of several impacts.

| Impact | Type | Quanti-/Qualitative | Indicator |
|---|---|---|---|
| Environmental | Climate change | Quantitative | Total $CO_2$ from transport |
| | | | Vehicle kilometres |
| | Air pollution | Quantitative | Emissions of $NO_x$ $PM_{10}$ |
| | | | External costs |
| | | | Vehicle kilometres |
| | Noise pollution | Quantitative | dB's |
| | | | External costs |
| Social | Human health impacts | Quantitative | External cost of health issues |
| | Community liveability | Qualitative | Quality of life |
| Economic | Traffic congestion | Quantitative | Average speed and use of available capacity |
| | | | Economic damage due delay |
| | Depletion of non-renewable resources | Quantitative | Energy/fuel demand |
| | | | Energy/fuel production split by source |
| | Transportation facility costs | Qualitative | Transportation costs for companies |
| | Consumer transportation costs | Qualitative | Transportation costs for consumers |

**FIGURE 3.7:**
Indicators for impacts
*(adapted from Russo & Comi, 2012)*

In appendix I, the $CO_2$ emissions of every municipality in the MRDH can be found in a table. The numbers in this table are regarding Tank-to-Wheel (TTW) and gives a total $CO_2$ emission of 3212 kton, while the earlier mentioned number of 4250 kton is based on a Well-to-Wheel (WTW) calculation. WTW also includes indirect emission caused by fuel production or electricity generation. Excessive emission of $CO_2$ has the following impacts in the Netherlands:

- Heavier peak rainfall in the summer (water damage, falling trees, overflow)
- Weather becoming more extreme (, heat waves, heat island, health issues)
- New animals and plant types
- Flowering will take place earlier in the year
- More animals that were previously found in south
- The need of adaption for forests, plants and animals (change of eco-systems)
- Increasing prices of food due to failed harvests elsewhere
- Political unrest and pressure

### 3.2.1 **Impact definition** traffic congestion

Drivers stuck 20 minutes per day in a traffic congestion on average, which cost logistic companies around 4 to 6 per cent of the total transport costs (Ploos Van Amstel, 2018). Additionally, stop and go traffic could increase fuel consumption by 140% when a truck stops five times over 10 km (Barone & Roach, 2016).

However, almost 80% of the hours are driven in the built environment, which raises the importance of urban freight logistics. A study from Mercedes-Benz showed that drivers in London are losing more than one hour due to congestion on a daily basis (CityLogistics, 2018). For the Netherlands, the direct cost due to transport delay is around 2 to 3 billion. Also, 80% of the trips are shorter than 100 kilometres, which makes the waiting time and driving time ratio around 50-50. In the Netherlands, 80 per cent of the lorries make journeys that are shorter than 100 kilometres. The ratio of driving time to waiting time at distribution centres is around fifty-fifty. Besides traffic jams, actions should also be taken on urban freight delays by shorting waiting time, using vehicle technology, better information provision, optimal use of capacities and bundling of flows in order to bring improvements on the freight sector, which requires public-private collaboration (Ploos Van Amstel, 2018a).

## 3.2.2 **Impact definition** *health*

Health costs are social impacts, although they are strongly related to environmental impacts such as air pollution and noise pollution. According to the Atlas Leefomgeving (2019), the air quality is judged as bad in the MRDH region. The 'Rijksinstituut voor Volksgezondheid en Milieu' (RIVM) has estimated that on average around 5 to 6% of the issues regarding health (disease and mortality) are related to environmental factors (Atlas Leefomgeving, 2019). Air pollution can cause e.g. suffering from asthma symptoms and a lower age expectation, while noise harms night's rest and can be responsible for cardiovascular diseases. FIGURE 3.8 shows to what extent the risk factors influence health. Main locations for attention seems locations of roads, industrial areas and the surroundings of (air)ports. Also, inner cities where urban freight takes place, suffer from relatively high health risks.

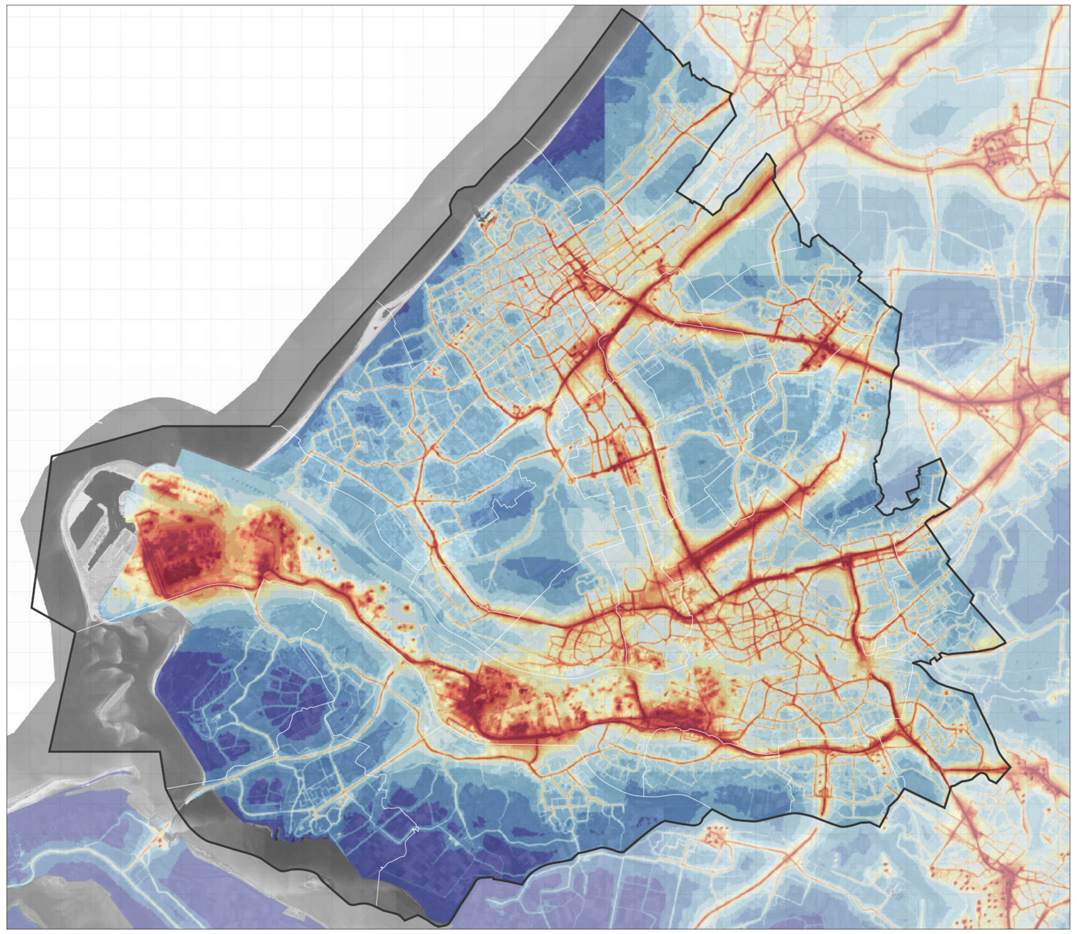


**FIGURE 3.8:**
Environmental health risks *(Retrieved from Atlas Leefomgeving, 2019)*

## 3.2.3 **Impact definition** *air pollution*

Air pollution occurs when harmful or excessive amounts of substances, including gasses and particles, are entering the atmosphere. Substances entering the atmosphere as a consequence of transportation are for instance sulfur dioxides ($SO_2$), nitrogen oxides ($NO_x$), both contributing to acidification $CO_2$, and small particles such as PM10 and PM2,5. The degree of air pollution has a negative impact on air quality and thus affects people's health and life expectations. Chronic exposure to particles appears to be the biggest source of health damage. To maintain the air quality, maximum standards for the different pollutants are set up: The World Health Organisation (WHO) recommended value and the EU standard (FIGURE 3.9). The WHO standards are standards with no harmful health effects and are scientifically determined, while EU standards are more political determined (based on feasibility, costs and economic interests). EU standards are often way higher than recommended by the WHO. Therefore, EU standards are not that representative for the air quality (European Environment Agency, 2017).

| Parameter | Concentration | Status |
|---|---|---|
| $NO_2$ | 40 µg/m³ | EU standard<br>WHO recommended value<br>*World Health Organisation* |
| PM10 | 40 µg/m³<br>20 µg/m³ | EU standard<br>WHO recommended value |
| PM2,5 | 25µg/m³<br>20µg/m³<br>10µg/m³ | EU standard<br>IndicatedEU Standard 2020<br>WHO recommended value |
| soot | 1,03 µg/m³ | WHO recommended value |
| benzene | 5 µg/m³ | EU standard |

**FIGURE 3.9:**
Air quality standards
*(Rijkswaterstaat, n.d.)*

FIGURE 3.10 till FIGURE 3.13 show the concentrations of $NO_2$, soot, PM10 and PM2,5. Regarding the standards, the whole region meets the EU-standards, although it seems like that city centres regarding WHO-values are reaching the limits or just exceed it. Although, the shown concentrations are contain every source, it is assumed that the high concentrations in city centres are related to (road) transportation. Considering the stake of urban freight transport, it contributes in a significant way to exceedance.

Legend

- < 10 µg/m³
- 10 - 12 µg/m³
- 12 - 14 µg/m³
- 14 - 16 µg/m³
- 16 - 18 µg/m³
- 18 - 20 µg/m³
- 20 - 25 µg/m³
- 25 - 30 µg/m³
- 30 -35 µg/m³
- 35 - 39 µg/m³
- > 39 µg/m³ WHO-value/ EU standard
- big DC
- small DC

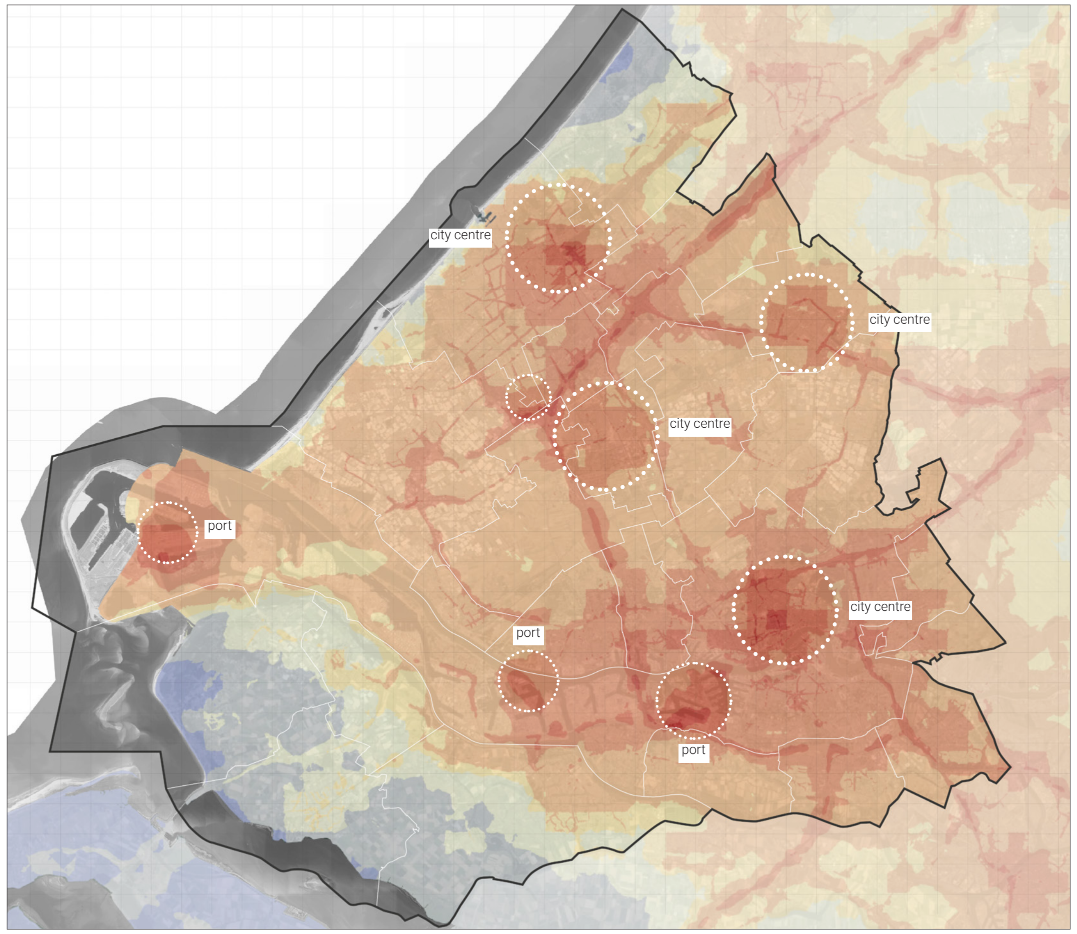


**FIGURE 3.10:**
$NO_2$ pollution
*(Retrieved from Atlas Leefomgeving, 2019)*

Legend

- < 0,4 µg/m³
- 0,4 - 0,5 µg/m³
- 0,5 - 0,6 µg/m³
- 0,6 - 0,7 µg/m³
- 0,7 - 0,8 µg/m³
- 0,8 - 0,9 µg/m³
- 0,9 - 1,0 µg/m³ WHO-value
- 1,0 - 1,2 µg/m³
- 1,2 - 1,5 µg/m³
- > 1,5 µg/m³
- big DC
- small DC

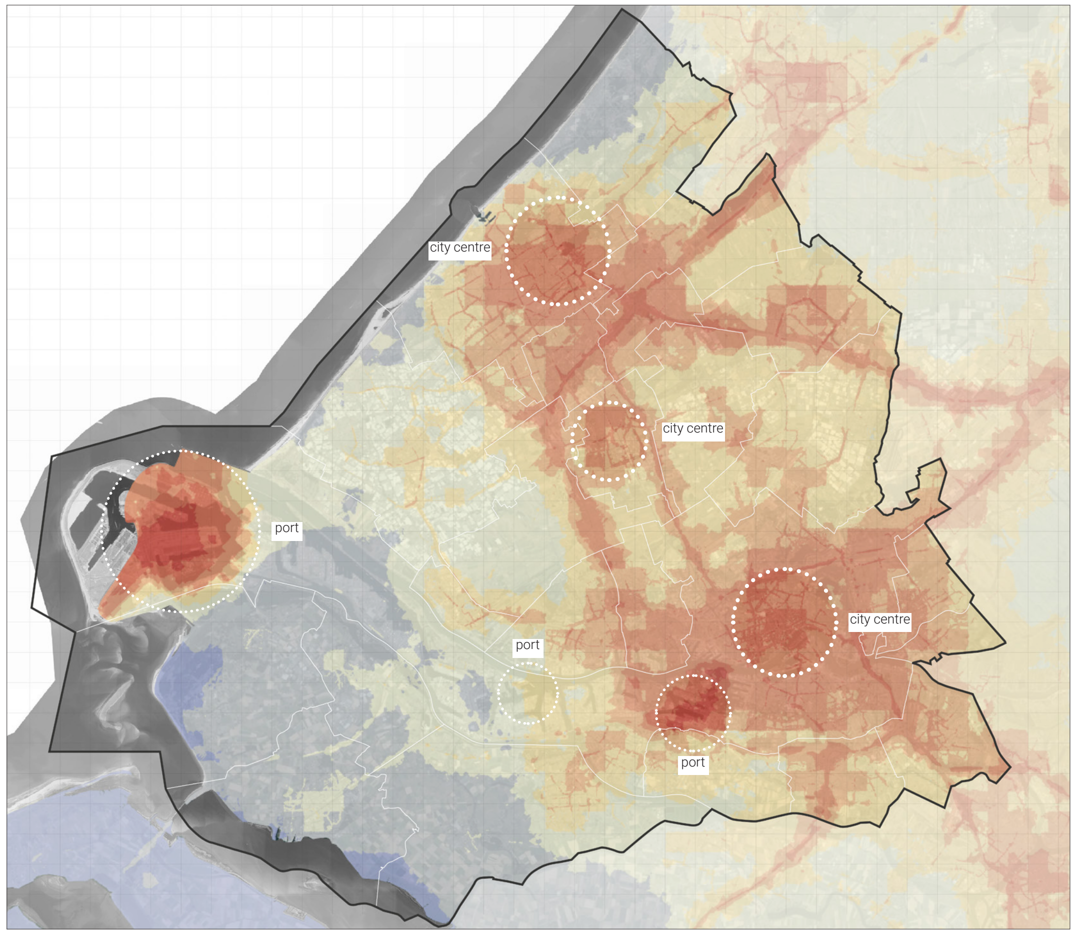


**FIGURE 3.11:**
Soot pollution
*(Retrieved from Atlas Leefomgeving, 2019)*

Legend

- < 15 µg/m³
- 15 - 17 µg/m³
- 17 - 18 µg/m³
- 18 - 19 µg/m³
- 19 -20 µg/m³
- 20 - 21 µg/m³
- 21 - 22 µg/m³
- 22 - 23 µg/m³
- 23 - 25 µg/m³
- 25 - 39 µg/m³
- > 39 µg/m³ EU-standard
- big DC
- small DC

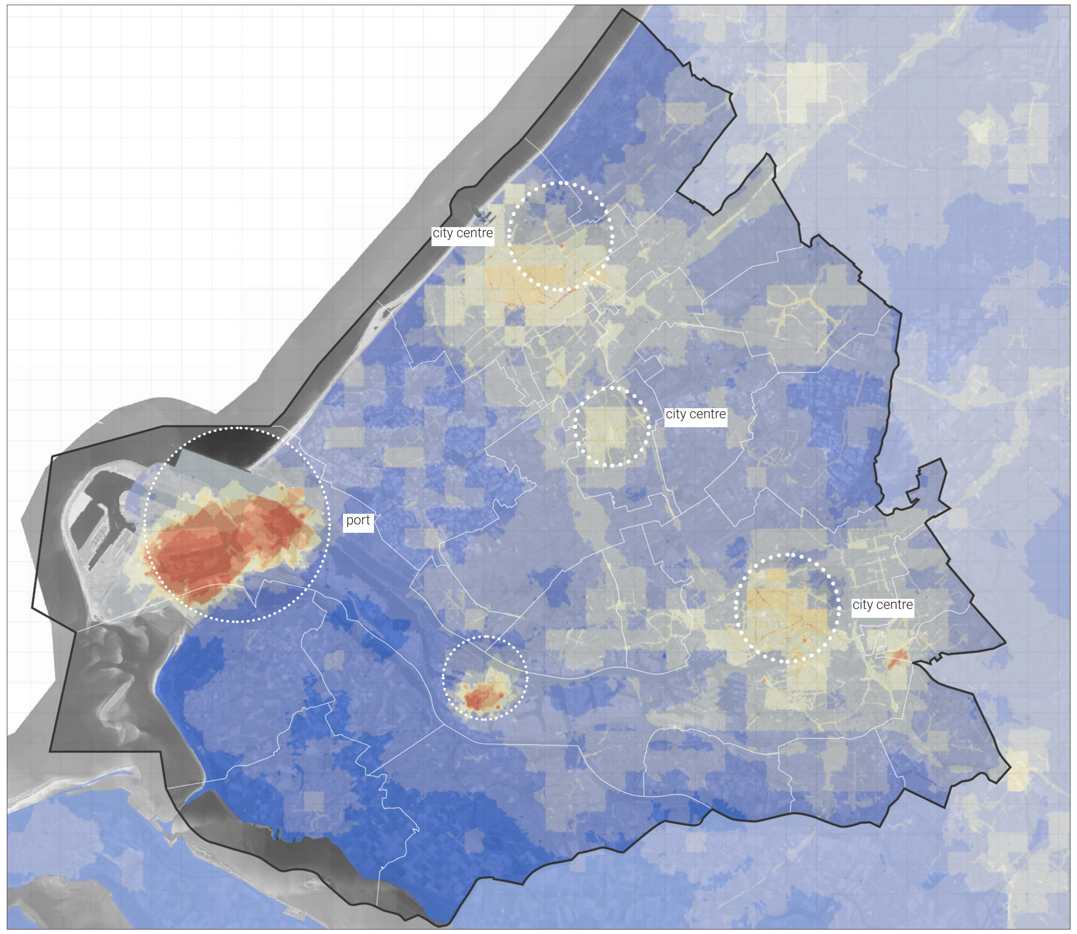


**FIGURE 3.12:**
PM10 pollution
*(Retrieved from Atlas Leefomgeving, 2019)*

Legend

- < 8 µg/m³
- 8 - 10 µg/m³ WHO-value
- 10 - 11 µg/m³
- 11 - 12 µg/m³
- 12 - 13 µg/m³
- 13 - 14 µg/m³
- 14 - 14,5 µg/m³
- 14,5 - 15 µg/m³
- 15 - 15,5 µg/m³
- 15,5 - 16 µg/m³
- > 16 µg/m³ EU-standard
- big DC
- small DC

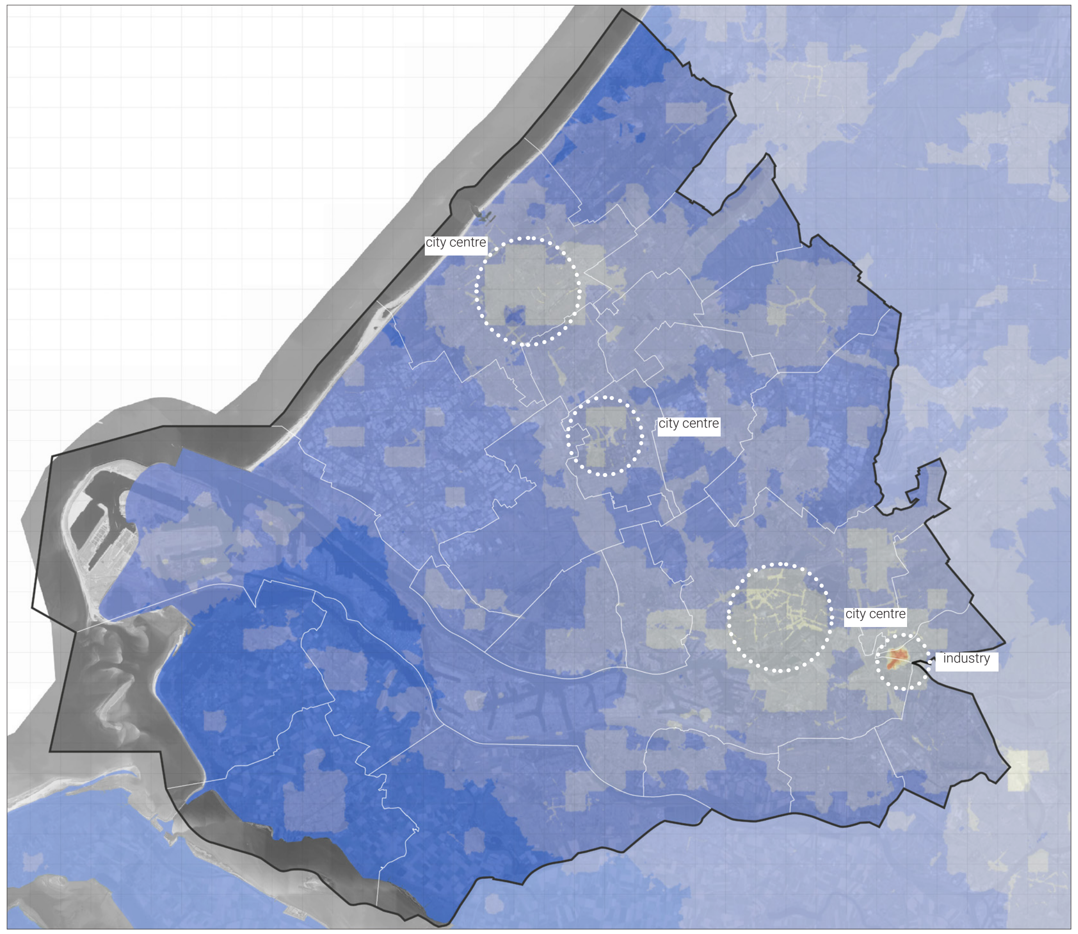


**FIGURE 3.13:**
PM2,5 pollution
*(Retrieved from Atlas Leefomgeving, 2019)*

## **2.2.4 Impact definition** *noise pollution*

Noise is important in the built environment: it determines the atmosphere and has a signalling function. It is also invisible, which makes the impact difficult to recognize in comparison with air or water pollution. According to the WHO standards, noise is perceived as a nuisance on around 55 dB (FIGURE 3.14). The biggest source of noise pollution is road traffic. The noise production in vehicles has two sources: rolling noise, which is the noise from the interaction of tires and the road and the propulsion noise, which is generated by engines, gearboxes, cooling systems etc. (Van Blokland & Peeters, 2009). Urban freight transport is included in road traffic and thus has a significant influence on the amount of noise as illustrated in FIGURE 3.15.

The 'Wet geluidhinder' en de 'Wet milieubeheer' contain standards on how much noise is allowed on roads (and railways) and are dependent on the type of road and the surrounding functions. The noise pollution is highest in the proximity of roadways, railways and surroundings of (air)ports, but also could be found around distribution centres, which comes from e.g. moving and reverse signalling trucks, cooling installations, loading and unloading and internal transport with carts. FIGURE 3.16 shows some noise generators associated with urban freight activities. Depending on the road conditions, on average, the noise of 'heavy/large goods vehicles' (HGV/LGV) are 2 - 10 times higher than passengers cars in which a weight of 2 indicates around + 3 decibels (dB) (Schoemaker, Allen, Huschebeck, & Monigl, 2006). The dB scale is logarithmic, which means that the intensity of noise doubles every 10 dB (Edmonton Trolley Coalition, n.d.). With a truck that produces noise of 8 ($2^3$) times higher than a car, it will be a difference of approximately 9 dB. FIGURE 3.17 shows the noise levels of various vehicles and FIGURE 3.18 shows the noise levels in the MRDH region.

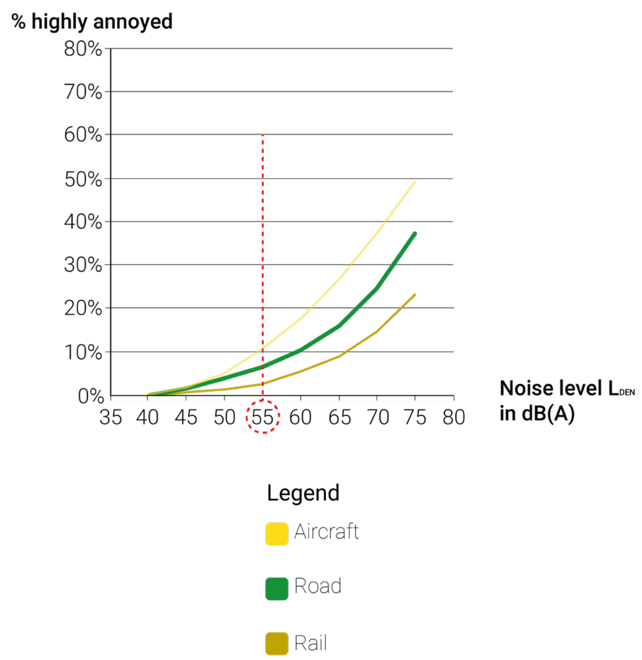


**FIGURE 3.14:**
Relationship between noise level and annoyance
*(Presentation W. Babisch via Pötscher & Ortner, 2012)*

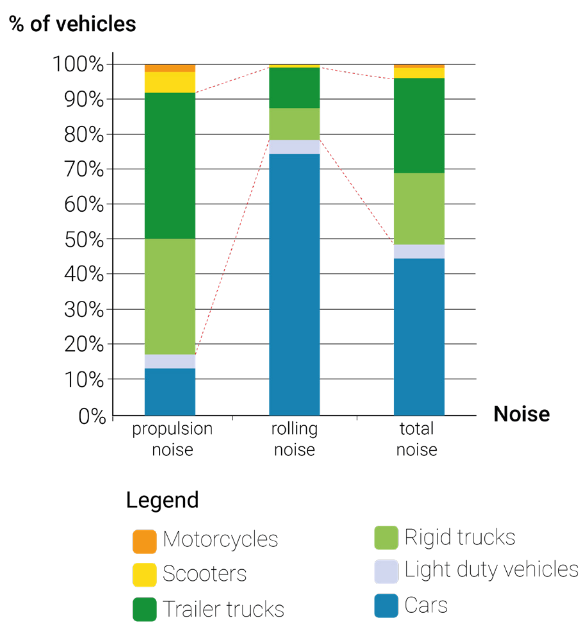


**FIGURE 3.15:**
Noise emission in road traffic by source
*(Presentation H. Steven via Pötscher & Ortner, 2012)*

| Noise generator | Noise level in dB |
|---|---|
| Drivers behaviour (radio, jelling etc.) | variable |
| Slamming with doors | ca. 74 |
| Driving and maneuvering the truck | 67 – 83 |
| Controlling the tailboard | 65 – 92 |
| Using pallet truck within the vehicle | 74 – 85 |
| Transport cooling | 70 – 78 |
| Using pallet truck on the pavement | 72 – 81 |
| Attach load locks | |
| Attach/use pallet trucks | 77 – 82 |
| Using pallet trucks | ca. 75 |
| Mobile shop trolley | 53 – 77 |

**FIGURE 3.16:**
Noise levels of distribution activities (dB(A) at 7.5m distance)
*(Retrieved from Piek via Schoemaker et al., 2006)*

| Noise generator | Noise level in dB |
|---|---|
| Gasoline passenger car | 62 – 67 |
| Electric trolley bus | 60 – 70 |
| LRT car | 72 – 75 |
| Medium-sized truck | 73 – 78 |
| Urban diesel bus | 80 – 85 |
| Heavy truck | 80 – 85 |

**FIGURE 3.17:**
Noise levels of vehicles
*(Retrieved from Edmonton Trolley Coalition, n.d.)*

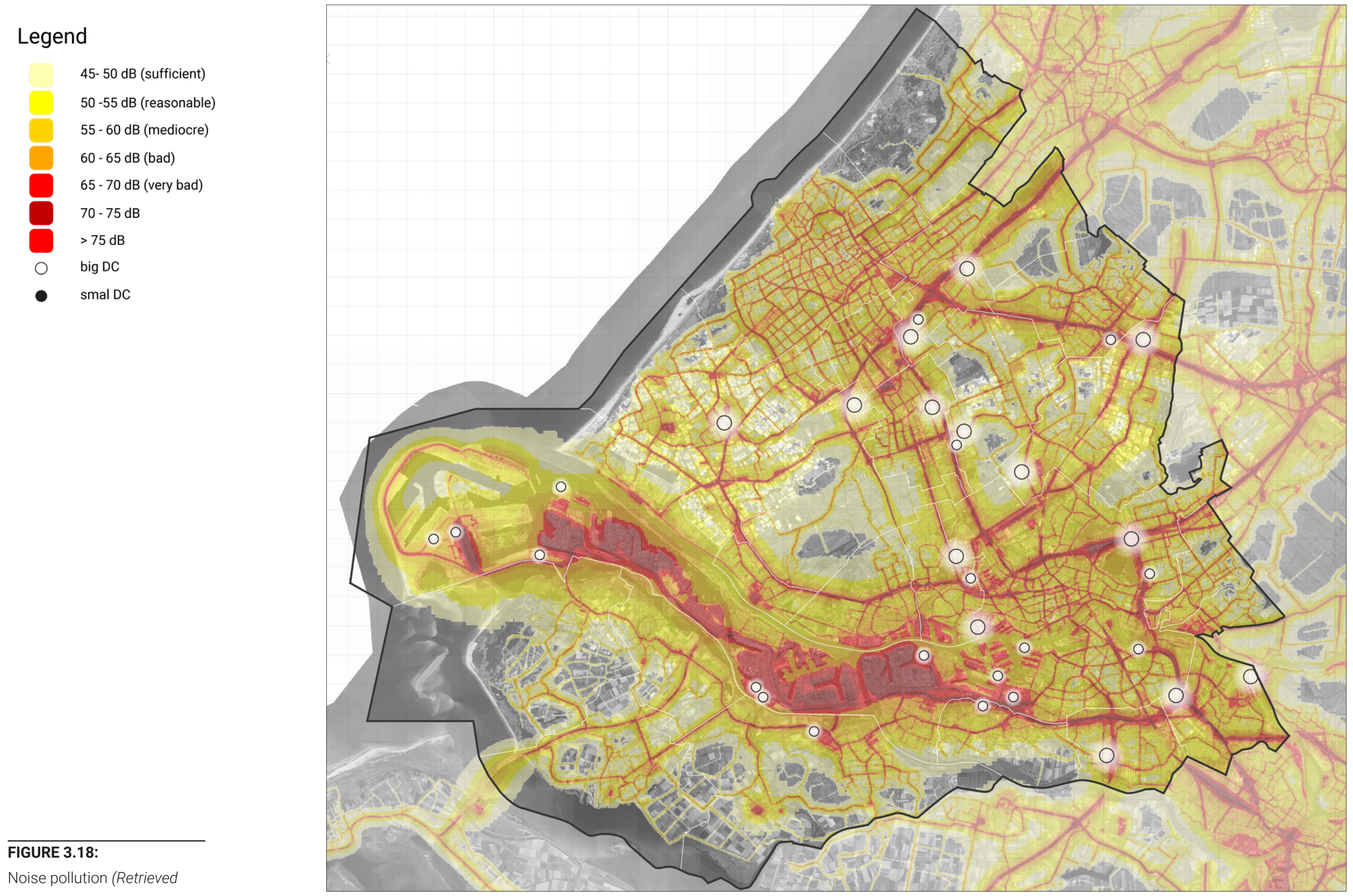


**FIGURE 3.18:**
Noise pollution *(Retrieved from Atlas Leefomgeving, 2019)*


This chapter has the purpose of adressing sub research question 1:

*How do global trends and dynamics have influenced the execution of urban freight?*

The chapter provides the background of freight transportation and describes the different drivers responsible for the development of increasing urban freight, which is required to understand the status quo of urban freight. It sets the historical scene and describing trends and dynamics that are affecting urban freight.

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*chapter outline:*

4.1 historical logistics and transport
4.2 trends and dynamics
4.3 conclusion

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# 04 GLOBAL CONTEXT

*source photo : cargo ship (author's photo)*

## 4.1 Historical logistics and transport

Transportation of freight (and people) in urban regions always have been crucial in maintaining the cohesion of empires, nations and economic blocs (Rodrigue, Comtois, & Slack, 2013). Technological and economic developments have influenced the way this has been done. This chapter addresses these technological and economic developments and answers the first research question:

How do global trends and dynamics have influenced the operation of urban freight?

Transportation used to be dependent on physical restraints of topography. Cities were developing at junctions were several flows of interaction come together. The morphology of cities was determined by the extent to which transport was possible. The thriving cities were mostly cities located along strategic intersections and rivers.

In the Middle Ages, the location of natural elements such as waterways, mountains and other topographical barriers determined transportation lines. Motorised transportation did not exist before industrialisation and thus transportation was only limited to harnessing animal labour for land and wind for maritime movement. Autonomic economies and basic subsistence did not generate much trade. Transportation quantities were low and so was the movement speed (Rodrigue et al., 2013). The timeline on the previous page (FIGURE 4.1) illustrates that the scale of economy is depedent on several transportation and logistical technologies.

Before the 1970s, logistics used to take place on a smaller scale where distances in the supply chain are close to each other. Storage of goods was relatively decentralised with intermediate warehouses positioned close to the manufacturing and the receiver's site in the proximity of industrial areas. Most of those warehouses were relatively small and are located in inner urban areas (Dablanc & Rakotonarivo, 2010). They were small due to the 'supply-push' nature of supply chain management, in which the expected demand based on forecasts determines the production rate to prepare the location for the stock.

The supply chain used to be small. Production and consumption took place close from each other, mostly within the borders of the city. Nevertheless, the benefits and (technical) restraints such as speed, capacity, routes, the efficiency of transportation always have determined the scale of the supply chain. The topography of geographical area is fixed, however with technological developments on vechicles and some advanced civil engineering, more and further distances can be bridged. Economic acceleration is at the same time responsbile for more demand on 'exotic' products.

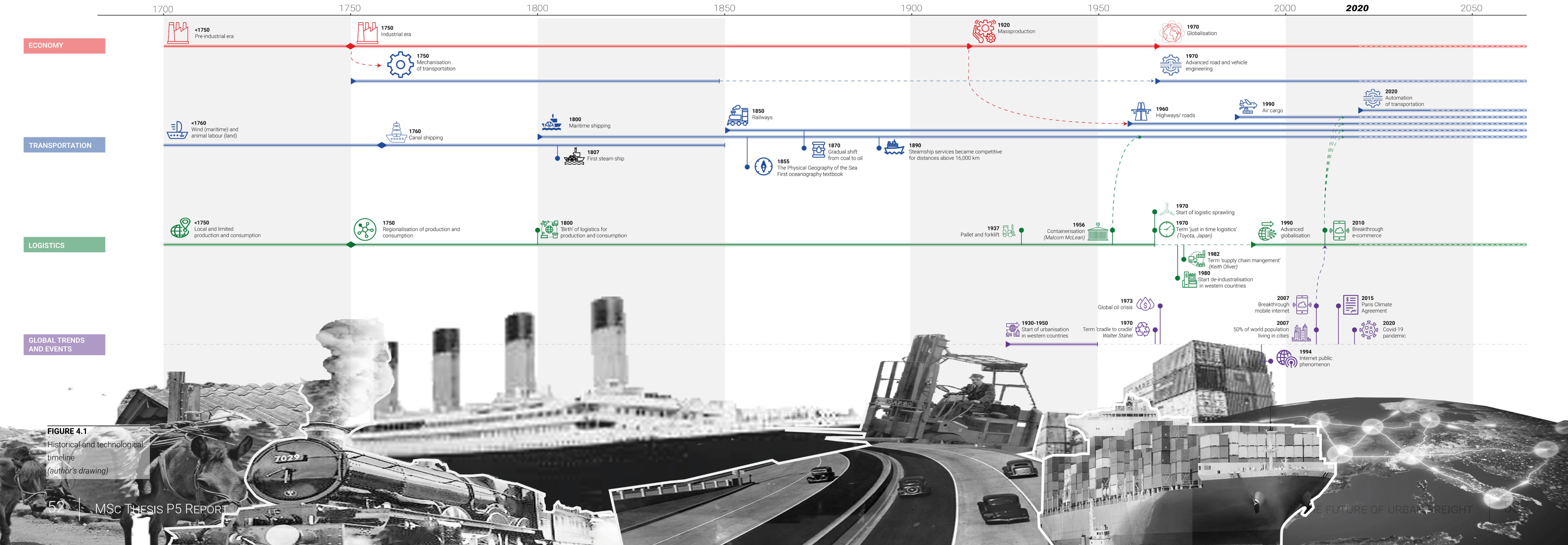



**FIGURE 4.1**
Historical and technological timeline
*(author's drawing)*

## *4.2.1* **Trends and dynamics** *globalisation*

International trade already took place in the ancient eras, however, the quantity was limited in comparison with contemporary standards. The scale of trade increased over the last 600 years. Though, it was that after the 1970s, the scale, volume and efficiency started with growing at a way faster rate (Rodrigue et al., 2013).

Main drivers for globalisation are economic acceleration and advanced technological developments in transportation (He, Shen, Wu & Luo, 2018). Through economic acceleration, the prosperity of people increases. The consequence is a higher consumption level, a higher demand and thus an increased quantity of goods moving at local, regional and international levels (FIGURE 4.2) (Rodrigue et al., 2013). The current consumption rate and a fragmented supply chain have considerable implications for the transportation demand since it entails a practice wherein goods have to be transported over longer distances in an multimodal way (Bjørgen et al., 2019). With on the same time the increased mobility and accessibility of people within cities, this has lead to growing numbers of individual means of transport and flows of goods. Individualization of production does increase the number of flows even more (Kauf, 2016).

The logistics sector dealt with de-industrialisation in the 1980s. Herein the urban interior transformed from industrial space to non-industrial space structures because of the decreasing demand for industrial space (He et al, 2018). This goes along with the increasing housing demand as a result of urbanisation. The demand also decreased because some industrial activities in developed economies are moved to East-Europe and Asia where labour costs are lower (Allen et al., 2012a). The higher transportation costs were compensated with lower labour costs. This entailed extra transportation demand and relatively new logistic practices such as the just-in-time paradigm and standardisation (i.e. Euro Pallet and TEU containers) which require a restructuration and transformation of logistics industries (Aljohani & Thompson, 2016). Due to the global scale of goods movement, the current supply chain management, therefore, needs to integrate the various logistic components within the complex system of production and transportation (Sakai, Kawamura & Hyodo, 2017). Consequently, this has led to an increase in amount and types of logistics facilities, more companies and higher service quality, which has changed the spatial configuration of facilities dramatically (He et al., 2018).

Today, the supply chain comprises fragmented spatial locations for production, organising, consumption and an international division of labour on a global scale. Globalisation is responsible for more products circulating around the world within a bigger market coverage.

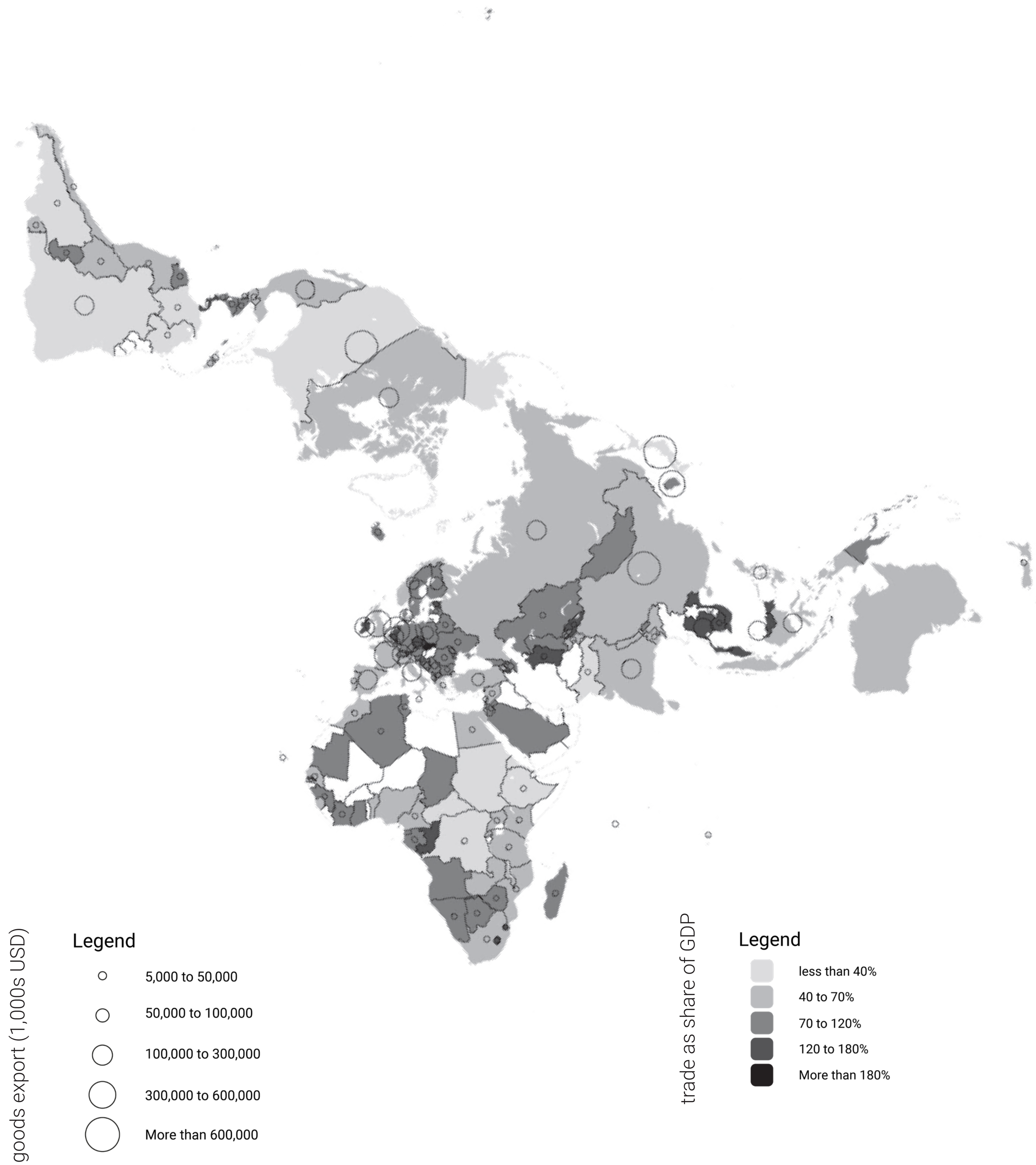



**FIGURE 4.2**
Global trade, 2009
*(World Trade Organization, via Rodrigue et al., 2013, p. 160)*

## 4.2.2 ***Trends and dynamics*** *urbanisation*

Growing cities are indisputable. Cities become more crowded, due to the migration of people from rural areas to cities. In 2010, about the half of the world population is living in urban areas, whereas this number will be 60% in 2030 and could even reach 85% in 2050 (Taniguchi, 2014; Lindholm, 2012). Although an uncertain future, the number of urban areas is rising and more cities are exceeding the border of one million citizens (Kauf, 2016). In the Netherlands, a small but dense country, a huge part of the population already lives in urban areas and it is predicted to increase to 93% in 2025 (Van Duin, 2005). The MRDH region can be considered as a very densed region with municipalities reaching 2.500 households per km$^2$ (FIGURE 4.4) and this amount is still growing (FIGURE 4.5).

The rising number of urban areas leads to gradual saturation of urban areas and increased land prices due to decreasing availability of land in the dense areas of the city. The consequence of these phenomena is urban deconcentration to accommodate population growth (Heitz et al., 2017). Despite the benefits of urbanisation in terms of resource efficiency, increased economic development and increased accessibility, the liveability and sustainability in cities still needs to be guaranteed and there is a growing necessity for dealing with climate goals: requirements for environment and climate protection get higher (Kauf, 2016; Browne & Sanchez-Diaz, 2019). Nevertheless, the migration of people to cities leads to increasing demand for vehicles and driving cars is increasing in cities (FIGURE 4.3). With a larger population in cities and extensive commercial establishments, the requirement for a larger quantity of goods and services for commercial and private use increases (Allen, Browne, Nemoto, Patier, & Visser, 2012). Traffic jams in cities and economic damage are inevitable outcomes.

More people in cities also means that more urban freight is required and thus more traffic. The urban road infrastructures as they are now already having troubles with processing the current traffic flows. Traffic jams are already damaging the economy and environment. With the expectation of more people and traffic in cities, this problem will increase.


**FIGURE 4.3**
Congestion in Rotterdam A16
*(ANP, 2018)*



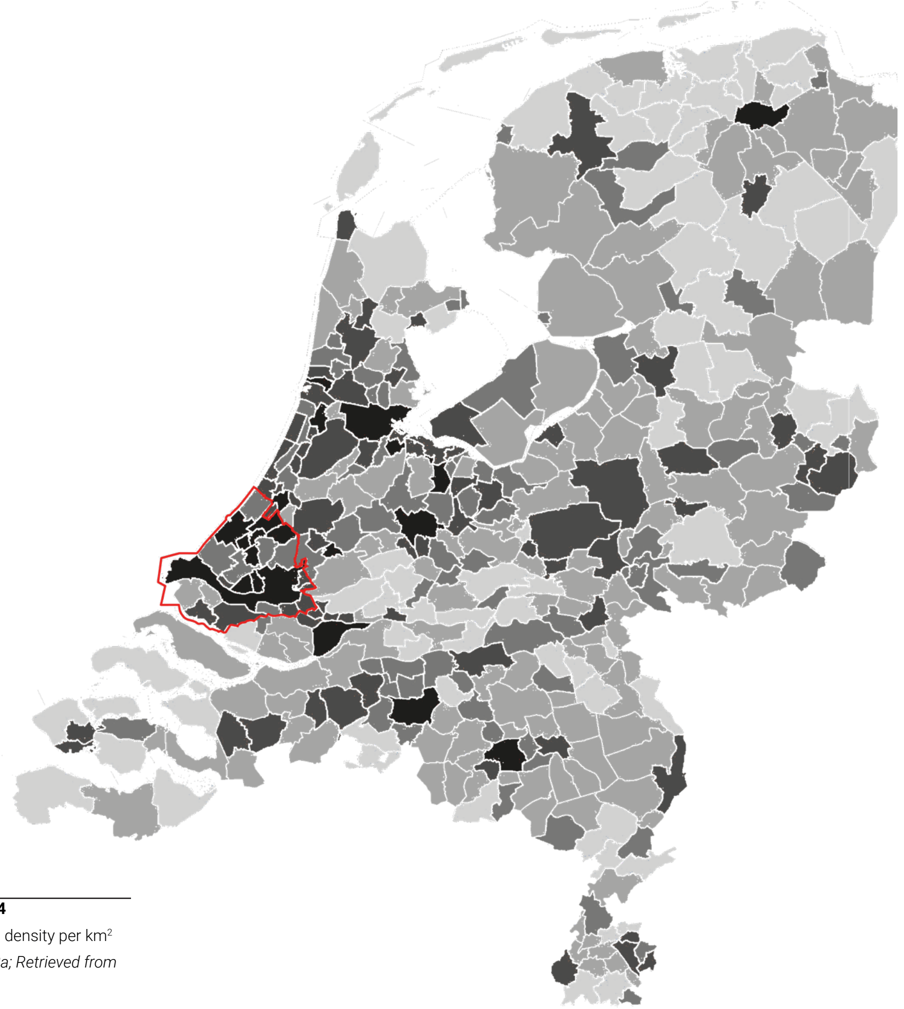



**FIGURE 4.4**
Household density per km$^2$
*(CBS, 2018a; Retrieved from QGIS)*

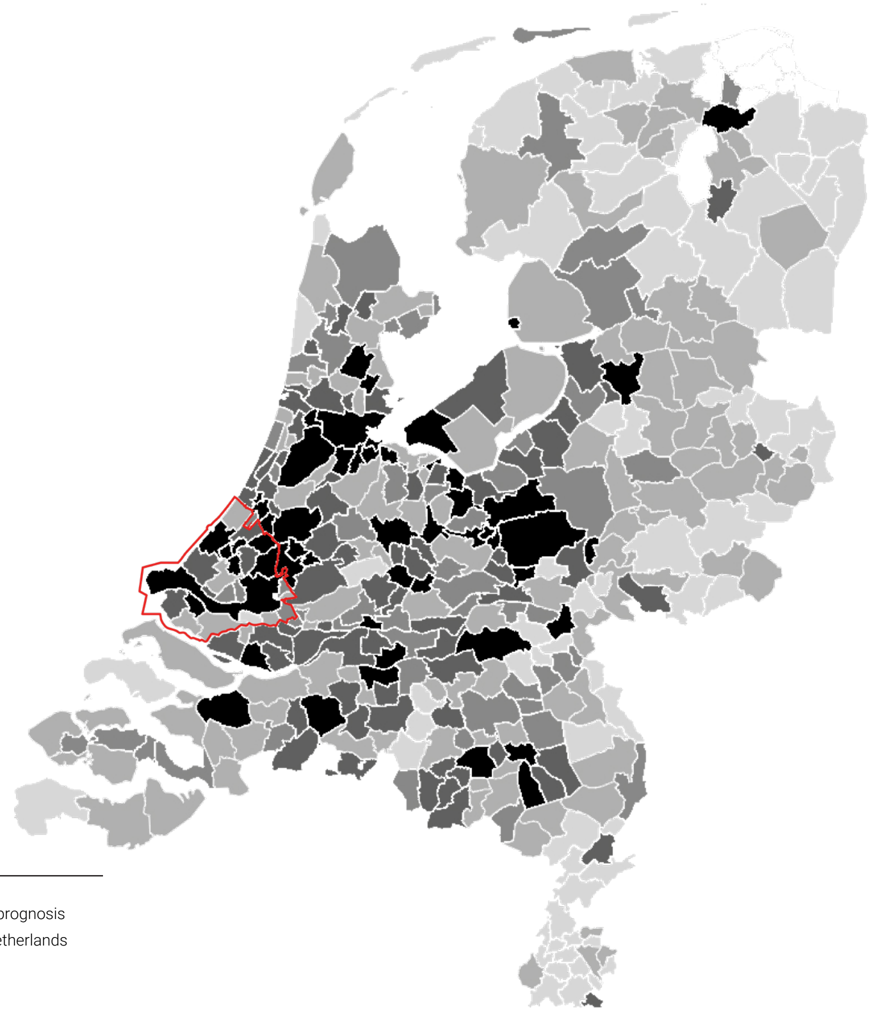



**FIGURE 4.5**
Urban growth prognosis 2035 in the Netherlands
*(CBS, 2019a)*

## 4.2.3 **Trends and dynamics** *logistic sprawl and XXL-warehousing*

Land use trends have contributed to more urban freight issues. The price of the land is a crucial location factor of logistic facilities. In general, logistic activities have low profitability, which is challenging for the economic viability of logistics in urban real estate. It cannot afford to pay as much as residential and commercial real estate can do (Dizian, Ripert & Dablanc, 2012). Warehouses used to be decentralised, close to both producers' or receivers' sites. A shift has occurred in which warehouses moved away from these sites and are relocated centralised outside the inner city. Two reasons have been identified for this shift.

Firstly, urbanisation has led to decreasing land availability and increasing land prices, this has resulted in the relocation of warehouses to locations with lower prices. With the territorial expansion and population growth, logistic centres are moved away from urban areas (Oliveira et al., 2014). At the same time, logistic facilities desire larger footprints to meet modern requirements. Since appropriate sites are rarely found anymore near urban centres, relocation is inevitable (Sakai et al., 2017). This phenomenon is called logistic sprawl and is the trend of the increasing number of outward movements of logistic facilities from inner-city centres towards suburban areas and its dispersion (Heitz et al., 2017). With the joint outward movement, the growth of bigger warehouses has started (FIGURE 4.6), which are warehouses according to CRa (2019) larger than 40.000 $m^2$. The growing amount of XXL-warehousing (FIGURE 4.7) is also consequence of rising popularity of e-commerce, which will be discussed later on in this chapter.

With a growing demand for logistic land while fewer available land due to the need for housing, it is for companies more attractive to move to suburban areas, where land is cheaper and logistic facilities can be allocated close to strategic infrastructures (Bjørgen et al., 2019). This made suburban areas supporting territories for urban freight as they are the last intermediate point in the supply chain before final distribution to the city centres (Heitz et al., 2017) (FIGURE 4.8).

Next to the increasing prices, Heitz et al. (2017) have observed that decentralisation of transport infrastructures such as freight rail already brought logistic facilities from urban areas to peripheral areas. Facilities now often tend to locate in clusters close to highway networks, ensuring access to labour and consumer markets. Companies try to compensate for distance to the city centre with accessibility.

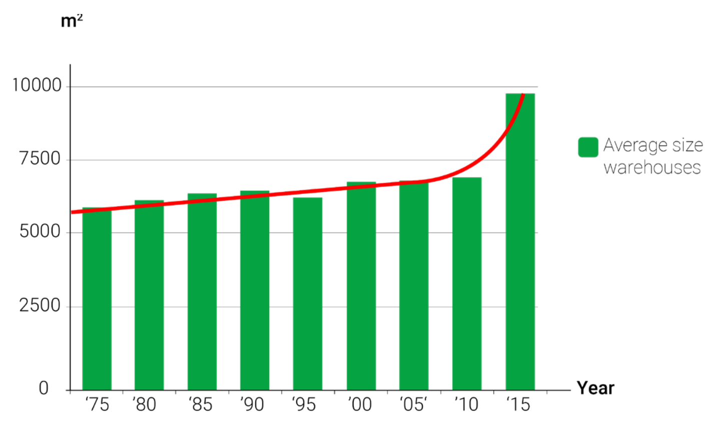



**FIGURE 4.6:**
Growing average size of warehouses in $m^2$ in the Netherlands *(CRa, 2019)*

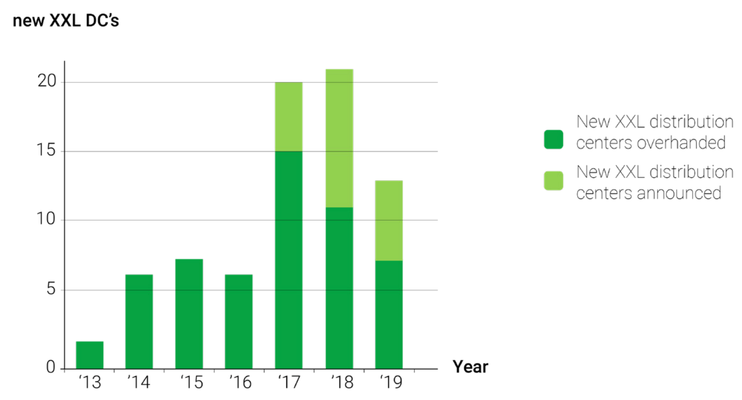



**FIGURE 4.7:**
New XXL-distribution centres identified in the Netherlands *(Buck Consultants International via RTL Z, 2019)*

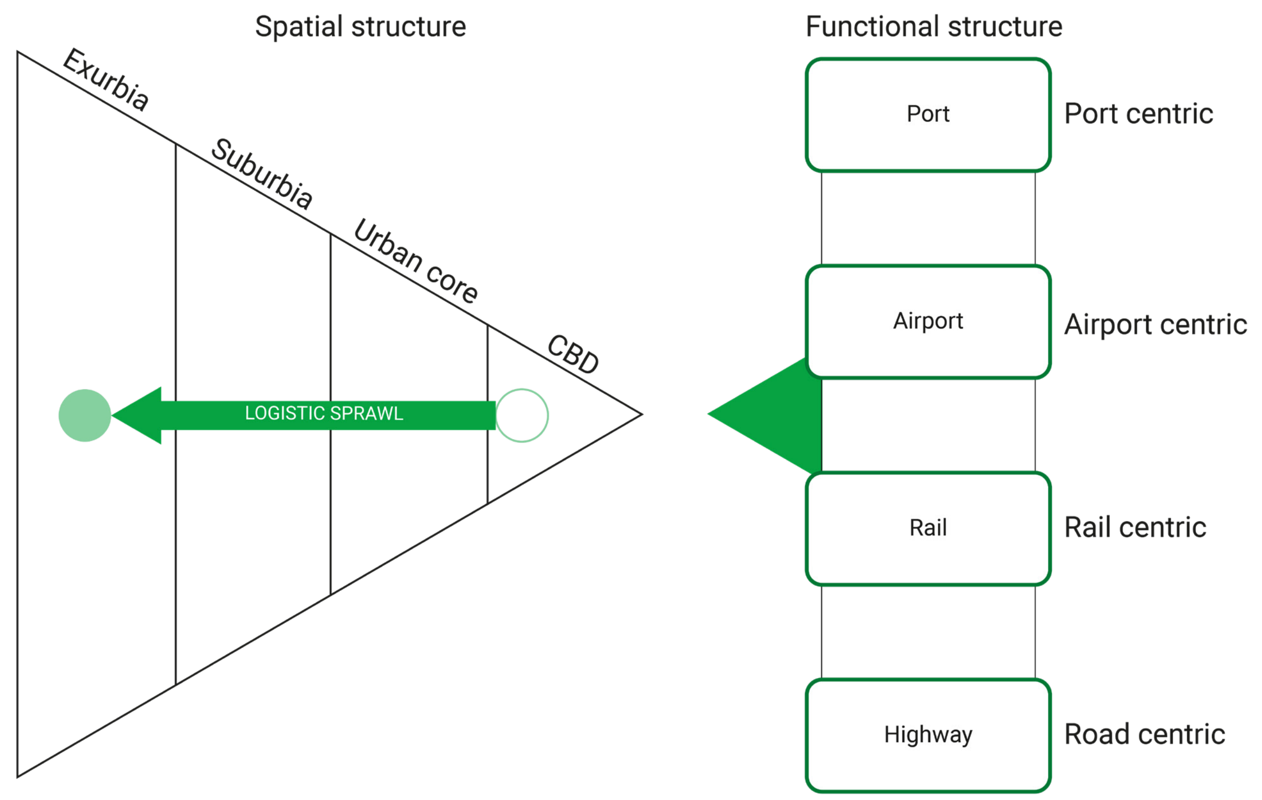



**FIGURE 4.8:**
Logistic sprawl in the spatial and functional structure *(adapted from Rodrigue et al., 2013, p. 73)*

This has induced an increase of fewer, but on average larger warehouses that serve geographical areas on regional and national scale (Allen et al., 2012a; He et al., 2018). This has led to geographical dispersion of logistic facilities in the supply chain with increasing distances between producers, manufacturers, distributors and consumers (He et al., 2018) (FIGURE 4.9).

Space was needed in the city to accommodate population growth and the growing service economy. This has resulted in centralising and consolidating warehouses: logistic sprawl and XXL warehousing are responsible for the increasing distance travelled to deliver freight to urban centres/the markets they serve where households remain concentrated (Dablanc & Rakotonarivo, 2010). The increasing distances causes exacerbation of negative externalities such as increased mileage, additional carbon emissions, growing road congestion (due to more flows) which inducing economic, social and environmental damage for the community (Dizian et al., 2012).

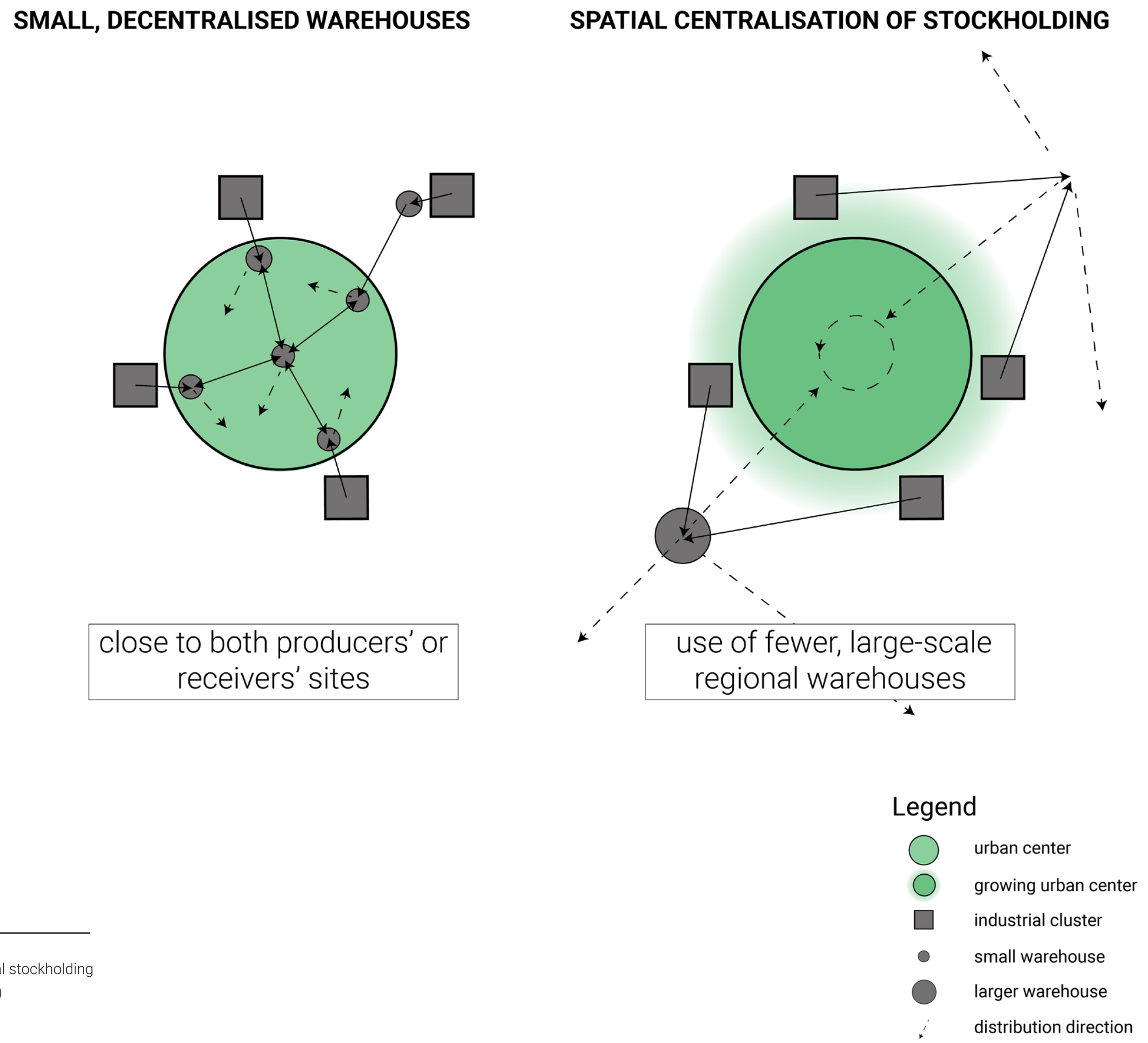



**FIGURE 4.9:**
Trends of spatial stockholding
*(author drawing)*

## 4.2.4 Trends and dynamics *advancing technologies*

This section elaborates on three technologies that have influenced the logistics and have technologically and economic enabled and catalysed the above mentioned global trends. It has enabled acces to new resources and markets (FIGURE 4.10).

### #1 *Transportation technology*

Technological development on modes and (civil) instructures have enabled transportation overcome physical environment and has led to faster ways of transportation. In the industrialisation the use of canals and railways made trade over longer distance possible. Mass production within an assembly line of automobile vehicles in the Fordist era (1920-70) has benefited transportation substantially even more (Rodrigue et al., 2013). After the adoption of automobile vehicles as main mode of (individual) transportation, this had led to growing mobility, but at the same time also to more congestion and more oil consumption.

After 1970, there was a gradual technical progression on road freight transportation and road engineering. Vehicles became able to transport goods over a longer distance and competed with shipping (and later on with freight trains), which is normally the mode used for longer distances. Additionally, vehicles can carry increasingly heavier load and drive faster (Allen et al., 2012a). It also ensured the importance of highway accessibility, since this has become a very important location factor for logistic facilities (Aljohani & Thompson, 2016). Technological improvements on vehicles and facilities allowed bridging increasing distances faster within the supply chain and thus let distribution centers serving larger geographical areas. Since 1960s efforts such as containerisation are done to work towards an integrated multimodal transportation system, wherein a variety of modes are combined so that advantages of each modes are advantaged (Rodrigue et al., 2013). Transportation made an extension of the supply chain possible in first instance to the outskirts of the city and later on abroad.

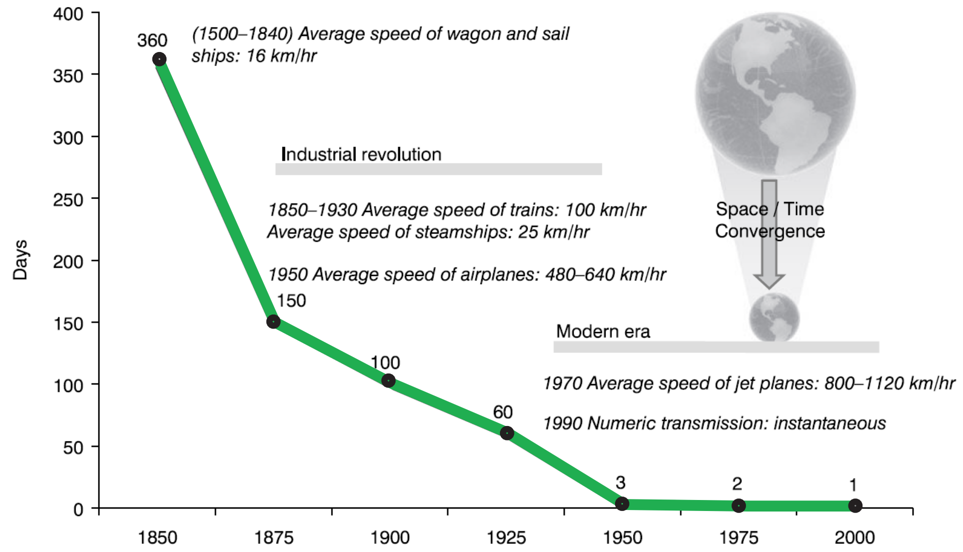



**FIGURE 4.10:**
Transportation developments: days to circumnavigate the globe
*(Rodrigue et al., 2013, p. 16)*

**#2** ***Warehousing technology***

Yet, the land utilisation became more efficient through improved storage technology (He et al., 2018). As earlier stated, the average size of warehouses increased. This is beneficial for companies, since logistic companies can profit from different advantageous economies (FIGURE 4.11), wherein they can improve their competitiveness and increase their market share (Rodrigue et al., 2013).

Regarding the increasing size of warehouses, one can recognize the economies of scale, scope and agglomeration. It is more cost effective in terms of duplication of labour, management, equipment and safety stock to store the inventory under one single roof instead of spreading it. With one bigger warehouse, the inventory can be lower, while still offering a diversity of products. Although there is an aim to minimize the stocks, the demand for logistic land is still significantly increasing due to replacement of logistic activities such as transhipment space between different modalities, goods handling, outdoor storage and parking for vehicles (He et al., 2018). These new operations sometimes require single-story facilities, high ceilinged with a size of 10,000 to 100,000 m2 (XXL-warehouses) (Aljohani & Thompson, 2016). Another development in warehousing is the increasing scale of automation and the use of robots in warehouses. Repetitive tasks can be executed by robots, which goes along with the internet technology.

**#3** ***Internet technology***

The internet technology have changed the logistics industry since it has influence on the scale of production and consumption. On the production side recently, it became more resource efficient, faster and responsive to the needs of customers through automation and robotisation in distribution centers. These innovations such as automated forklifts and fulfillment robotos for warehouses also aim to solve labour shortage as consequence of economic growth (Zhang, 2019). The use of computer software and automated machinery improve the logistic operational effiency (FIGURE 4.12)

On the consumption side an advanced level of internet technology together with globalisation introduced alternative ways of commerce, such as e-commerce and trading from home (Kauf, 2016). The changed behaviour of people and reduction of stockholding requires an appropriate urban freight system for flexible just-on-time deliveries. E-commerce, social media and mobile devices take an important role in good and service distribution today. The effects of e-commerce will be elaborated in the next section.

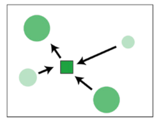
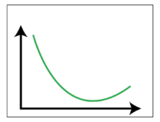
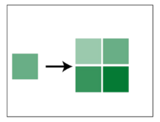
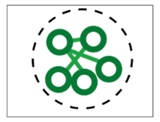
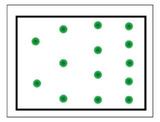
| | | |
|---|---|---|
| **Economies of transportation** |  | relates to the location that minimises transport costs and thus lowers production unit costs |
| **Economies of scale** |  | relates to the size of a facility that minimises unit costs since fixed costs are spread over a larger quantitity of units |
| **Economies of scope** |  | relates to the product diversification and manufacturing able to produce a variety of products in changing demand |
| **Economies of agglomeration** |  | relates to the clustering effects and involves sharing common infrastructures and service linkages |
| **Economies of density** |  | relates to increasing density of features that minimises costs, such as labour, resources or customers. |

**FIGURE 4.11:**
Main types of economies
*(author drawing, based on Rodrigue et al., 2013, p. 75)*

**FIGURE 4.12**
Automation in Amazon
*(Industryweek, 2018)*

## 4.2.5 ***Trends and dynamics*** *new forms of commerce*

New forms of commerce have recently been emerged. The volume of freight movements in urban areas has increased due to economic, operational and social progression (Aljohani & Thompson, 2016). The rise of consumerism and the service sector imposes an even bigger demand (Barone & Roach, 2016). The digitisation has created well-informed consumers that are able to orientate well on the market. This strengthens their position and thereby their demands regarding the customisation of the products and the whole transportation and delivery process. An effect is the (super) specialisation of stores, which results in a lot of small shops with a wide variety of one specific product instead of a variety in different products with more transport demand as consequence (Field Factors, 2017).

Another effect is the demand on a just-in-time (creating a faster alignment in production and consumption) transportation system in which goods supply is geared more to its demand (Allen et al., 2012a). This explains the transformation in nature of supply chain management from "supply-push" to "demand-pull", which is an inventory management strategy wherein the focus lies on last-second deliveries in order to minimize stocks instead of an inventory based on forecasts (Heitz et al, 2017).

The growth in distance shopping through e-commerce (B2C-commerce) and online trading (C2C-commerce), in special regard through e-commerce, should be seen within a general trend, where customers can choose their places and alternative ways to shop (Dablanc, 2007). Nevertheless, e-commerce is becoming more mainstream since ordering goods is not only limited to classic products such as books, clothing and devices anymore but increasingly food and other temporary products are ordered and transported more often (Kauf, 2016). E-commerce has become a popular mean of shopping in the Netherlands and it is still growing (FIGURE 4.13).

Extra challenges are put forward in the logistic process regarding last-mile (delivery to end-user). About 60% of the logistics costs are made in last-mile transportation (Roland Berger, 2017). In the last-mile transportation of a delivery, consumers can have a significant impact on the negative externality footprint. The problem in this is that consumers mostly opting for convenience and speed, which has a major impact because it is a totally inefficient way of delivery, when everyone e.g. decides to go to a pick-up point by car (FIGURE 4.14 and FIGURE 4.15).

With new emerging forms of commerce such as specialisation and digital commerce, the future of urban freight with respect to the means of shopping is uncertain. Several scenarios are possible in this. Only thing what is sure is that there still will be a need to move goods from production site to consumption site. The question arises is to where and how e-commerce eventually will have influence on the physical stores and thus the traditional urban freight activities.

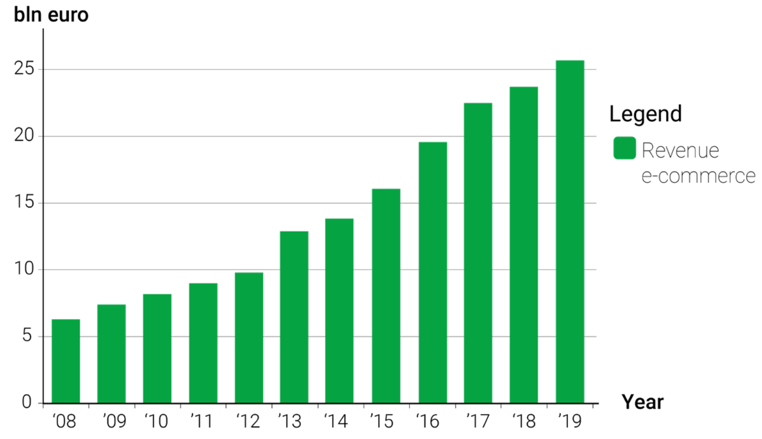



FIGURE 4.13:
Total revenue of e-commerce in bln euro's in the Netherlands
*(Thuiswinkel, 2019)*

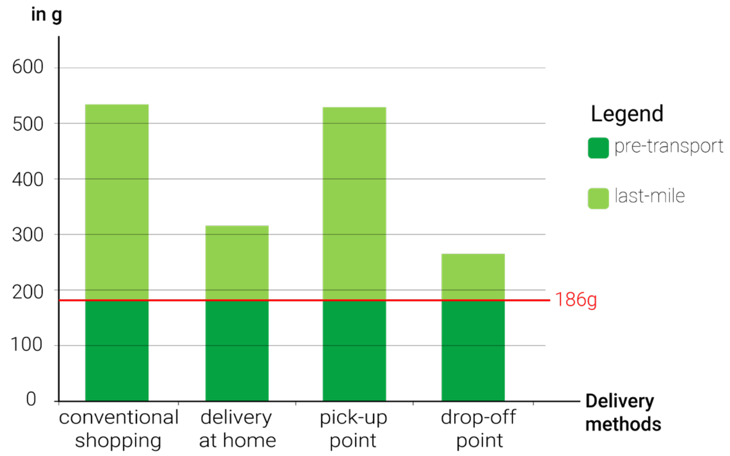



FIGURE 4.14:
$CO_2$ emission per parcel in grams per delivery method
*(EY, 2015)*

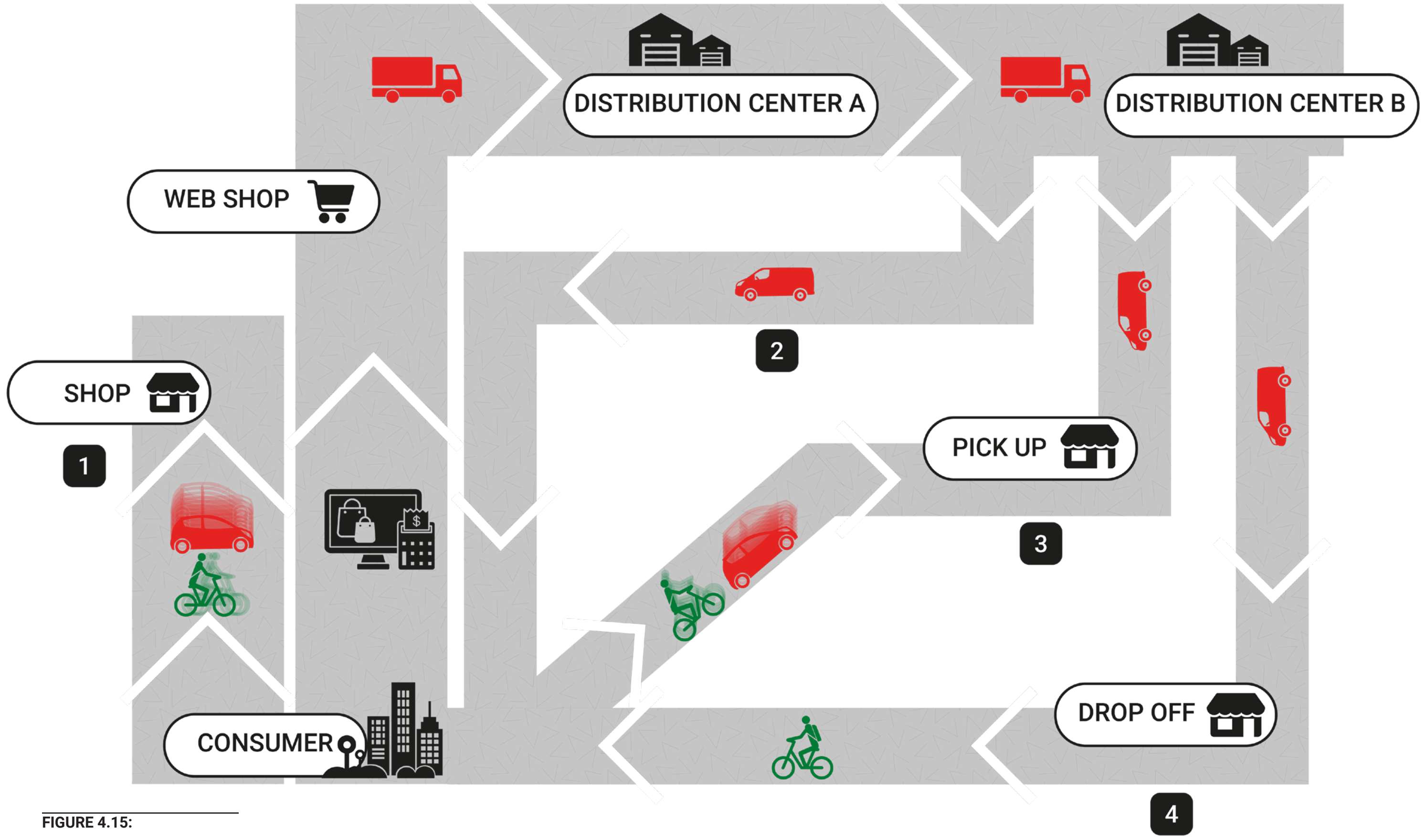



FIGURE 4.15:
Alternative forms of commerce and delivery
*(EY, 2015)*

**4 WAYS OF COMMERCE AND DELIVERY**

1. convential shopping; in a **physical shop**
2. online shopping and **delivery at home**
3. online shopping and get delivery from **pick-up point**
4. online shopping, delivered to a **drop off point** and transported by bike

Emission and monetary damage (EY, 2015)

**260-530g**
$CO_2$ emission per parcel

**50-100mln kg**
Total $CO_2$ emission

**3,3-4,5ct**
Environmental damage per parcel

**6.3-8.6mln euro**
Total environmental damage

According to a research of ING (2015), there is a slow, but gradual shift from physical shopping to online shopping and thereby a shift from delivery to retailers to delivery to consumers at home, depending on the product segment. The share of orders and purchases online has continuously increased over the years and it is expected to increase the coming years even more with the younger generations buying more online (FIGURE 4.16). Due to the increasing e-commerce, ING foresees implications on the size and composition of urban freight flows in urban areas. They state that the future of shopping streets will consist of a smaller number of traditional stores with more pick-up points. Furthermore, they expect a demand for fine-grained urban freight distribution with smaller, but more frequently supplies of shops. Speed and service will be important criteria.

It is not unthinkable in an extreme case that there is a future without urban freight supply (in the most extreme case), since stores have the potential to turn into showrooms, wherein customers only buy goods at large shopping centres on the outside of the city, together with home deliveries from e-commerce (Thooft, 2019). Physical shops could get a different purpose. By becoming a showroom, shops can become places to stay and experience the goods, while the actual buying will take place online. This showroom can even decrease the size of the current stores and the stockholding, while less supply is required. However, it is clear that the arising e-commerce (and decreasing physical commerce) give an opportunity to rethink the current way of supplying retailers.

Changes in the retail sector directly affect the activities of logistics companies (ING, 2015). Alternative forms of commerce have special requirements for the transportation sector. The growth of revenues and thus significant volumes of personal deliveries pose new challenges for planners and decision-makers in cities. With the possibility to order products online from retailers around the world and the reduction of stockholding, this resulted in the requirement on the increasing demand for reliable, frequent and flexible package deliveries, which are most of the times relatively small and less economical and environmentally friendly (Allen et al., 2012a). In the future, this could change the way of physical commerce, the role of physical shops and thus the urban freight operation. However, for the time being, urban freight will remain a combination of distribution to both stores and consumers and thus urban freight to supply stores are still important. Strategies aimed at the delivery at physical shops could be eventually extended to e-commerce and delivery of parcels.

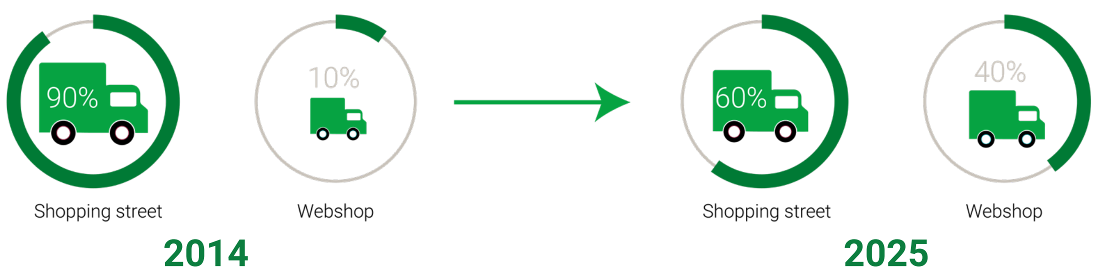



**FIGURE 4.16:**
Share of physical and online purchases *(adapted from ING, 2015)*

## 4.3 Conclusion

This chapter had the purpose to research how global trends and dynamics have influenced the execution of urban freight.

First, it can be concluded that technological and economic developments evidently have influenced urban freight (transportation) and are responsible for an increasing scale of consumption and production. Several trends have shown that urban freight is continuously growing and that the whole freight industry produces a significant portion of greenhouse gas emissions, increasing faster than passenger vehicle emissions.

Globalisation has led to fragmented spatial locations for production, distribution and consumption and thereby more products circulating the world. At the same time, cities become more crowded due urbanisation. Urbanisation leads to more people in a limited amount of space, which puts a lot of pressure on the supply and delivery. The cities' population can order 24 hours per day what they want, due to consumerism in a digitised society (Kauf, 2016). Consequently, the freight volume moving through cities is expected to grow at a fast rate. Consumers expect complete, just-in-time and frequent deliveries and in environmental sense, it also needs to be efficient to make urban freight activities cleaner, safer and invisible without traffic jams. The number of vehicles and vehicle kilometres through cities is growing fast, causing bad traffic conditions in the cities (FIGURE 4.17). Through this, cities have to face an increasing level of negative externalities (FIGURE 4.18) (Crainic, Ricciardi, & Storchi, 2004). The combination of all the drivers make it inevitable that urban freight requires a higher sustainable and operational level of performance.

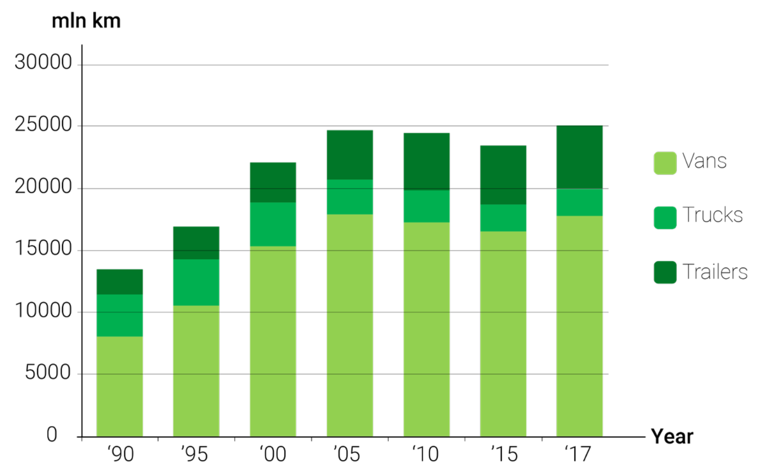



**FIGURE 4.17:**
Total vehicle kilometers per type vehicle in mln km
*(CBS, 2018b)*

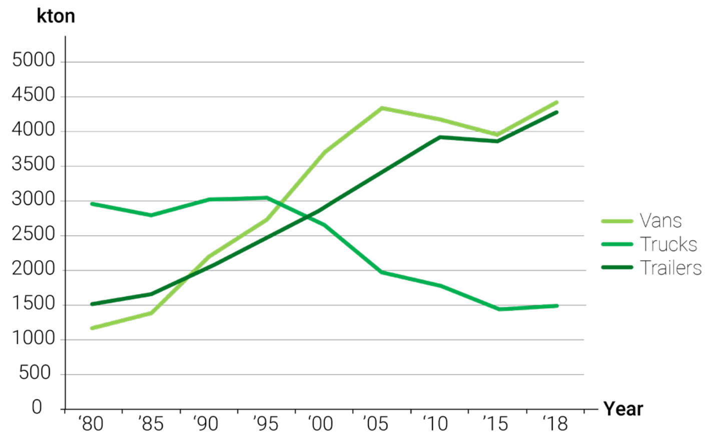



**FIGURE 4.18:**
Total $CO_2$ emission per type vehicle in mln kg
*(CBS, 2019b)*


This chapter has the purpose of adressing sub research question 2:

*How is the urban freight transportation currently organised in the MRDH*

The chapter analyses and evaluates the current situation of urban freight in the MRDH, based on the current initiatives, measures and concepts, the spatial organisation and stakeholders. The chapter ends with a conclusion that illustrates how urban freight currently is organised in conceptual, spatial and legal sense and the status quo

*chapter outline:*


5.1 introduction
5.2 initiatives, measures and concepts
5.3 spatial organisation
5.4 stakeholder management
5.5 conclusion


# 05 URBAN FREIGHT STATUS QUO

*source photo: Milieuzone Rotterdam (ANP via AD, 2019)*

## 5.1 Introduction

The aim of this chapter is to provide an overview and understanding of the status quo of urban freight in the Dutch context and with special regard to the MRDH. The urban freight system will be analysed according to the second sub research question:

How is the urban freight transportation currently organised in the MRDH?

To create an understanding of urban freight transport activities, the author has identified three components that shape the organisation of urban freight transportation. The three identified components are:

1) initiatives, measures and concepts executed concerning urban freight

*This component is related to (regulatory) actions done by the stakeholders of urban freight and can be considered as the conceptual, regulatory and legal elements of urban freight*

2) spatial organisation of logistic elements

*This component is related to the locations of production, consumption and transportation, the physical places where urban freight takes place and thus can be considered as the spatial element of urban freight*

3) stakeholder management

*This component is related to the actors of urban freight and involves their relationship, interests, behaviour and attitude towards each other.*

These three components will be used throughout the chapter as the structure of the research with respect to the analysis of the current organisation. To come to an overview of 1) a spatial analysis, literature analysis and policy analysis will be done. With these analyses, the type and the location of 1) can be collected. This will be done by researching (policy and private) documents. After creating the overview, measures and initiatives will be evaluated on their effectiveness in MRDH context.

The understanding of 2) will be generated based on spatial and flow analyses on the metabolism of households (bottom-up), while also taking into consideration location factors of companies with respect to demographics and policy (top-down). This also will be evaluated. Lastly, a stakeholder analysis will be done for 3) using the essay of the course AR3U023 as main product for the argument, which identifies the stakeholders in urban freight, their interests and how they interact.

## 5.2 Initiatives, measures and concepts

This paragraph will describe the current initiatives, measures and concepts applied in the MRDH by several national and local governments and private companies.

### 5.2.1 Initiatives, measures and concepts *initiatives in the MRDH*

#### # Green Deal Zero Emission Stadslogistiek (GDZES)

The national GDZES ambition is an agreement signed at the end of 2014 by 54 parties, including the municipalities and other freight actors in the MRDH, in which a collaboration is set between governments, logistic companies, knowledge institutions and other stakeholders. It also can be seen as a declaration of intent for the participants. At the same time, this agreement emphasises again that the steering on urban freight issues is shifted from the national government to municipalities.

The participants of the collaboration aim to realise, monitor and evaluate a zero-emission urban freight in cities centres with 2025 as time horizon. They investigate possibilities for logistic improvements through Living Labs (pilots). With new ways of organising transportation, new vehicle technology and optimal truck utilisation, they test innovative solutions. In 2020, parties will present the first results of the Living Labs. Within the scope of policy, regulations, technology and safety, projects and initiatives are tested by affiliated organisations. The ones which are applicable and feasible can then be upscaled (Green Deal ZES, 2016). Several living labs already have been started up with a large scale use of electric vehicles and the promise of more efficient driving and loads.

According to Green Deal ZES (2016), several initiatives for zero emission city logistics are already taken by private companies, entrepreneurs and authorities, mostly based on the delivery of fresh food, parcels and packages. Many projects have been started as pilot within one or more municipalities and were subsequently implemented or stopped. Figure 5.1 shows a map of the current initiatives known by Green Deal ZES in the municipalities of the MRDH. On the next page on figure 5.2, a list including a short description of the initiatives is provided.

As can seen on this list, most of the initiatives are related to the use of cleaner (electric) vehicles or bikes. There also can be noticed that there are almost no initiatives concerning waste logistics yet. Only the municipality of Rotterdam has a municipal plan on (zero-emission) urban freight.

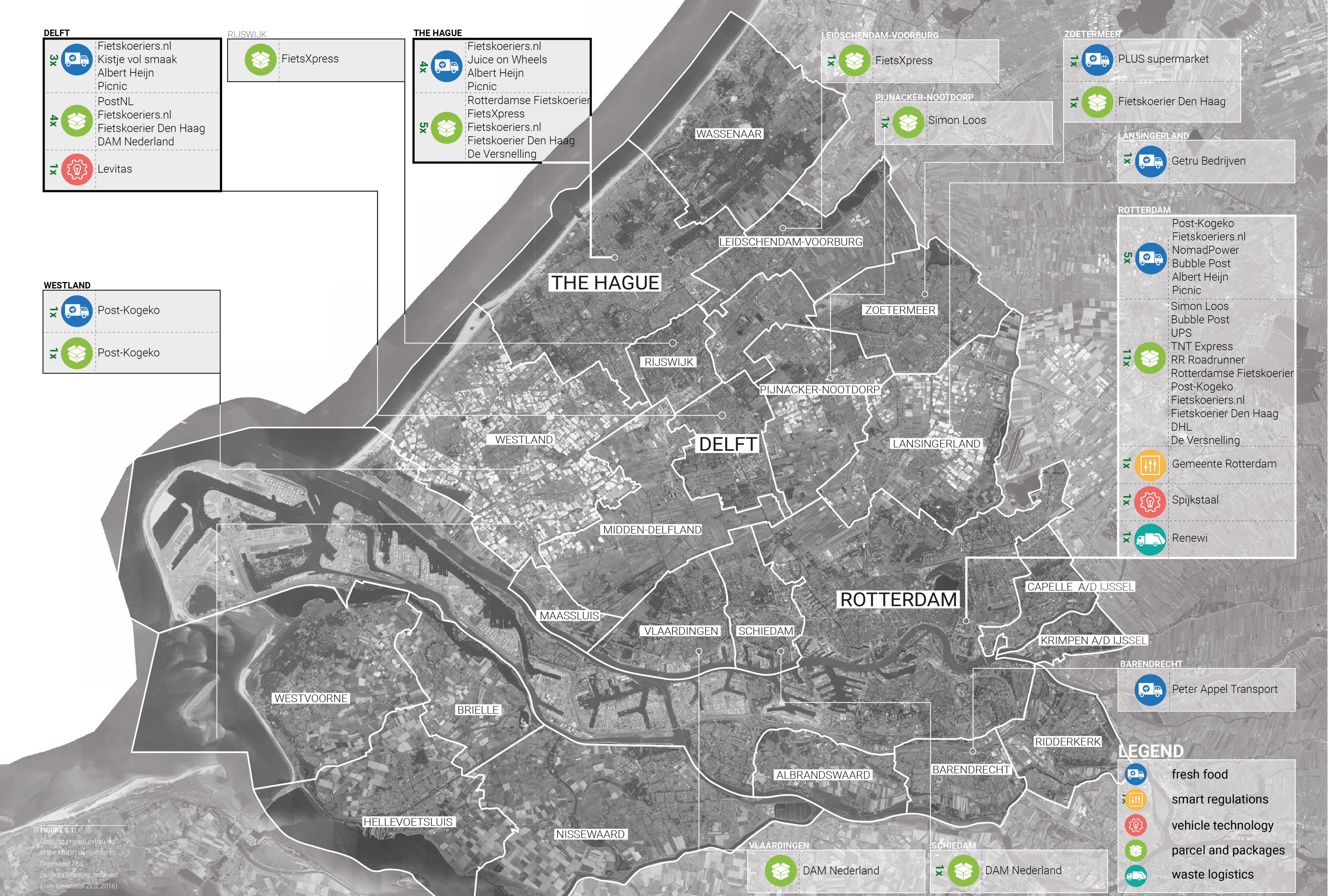



**FIGURE 5.1:** Ongoing private initiatives in the MRDH according to Greendeal ZES *(authors' drawing, retrieved from Greendeal ZES, 2016)*

| Municipality | Type | Private party | Description |
|---|---|---|---|
| Barendrecht | fresh food | Peter Appel Transport | Transport comany using electric, LNG *(liquid natural gas)* and LBG *(liquid bio gas)* trucks |
| Delft | fresh food | Fietskoeriers.nl | Parcel delivery service using bicycle couriers |
| | | Kistje vol smaak | Weekly delivery by cargo bike of fresh and healthy products from the region |
| | | Albert Heijn | Delivery service using hybrid vehicles, some trucks on bio-gas |
| | | Picnic | Delivery of fresh products using small electric vehicles |
| | parcel and packages | PostNL | Pilot with small electric cars, efficient routes, e-scooters and biogas vehicles |
| | | Fietskoeriers.nl | Parcel delivery service using bicycle couriers |
| | | Fietskoerier Den Haag | Parcel delivery service using bicycle couriers |
| | | DAM Nederland | Offer passenger transport combined with parcel service |
| | vehicle technology | Levitas | Using their aerospace background to find solutions on reducing fuel consumption, increasing load capacity and broaden range of transport vehicles |
| Lansingerland | fresh food | Getru Bedrjiven | Limit their emission by smart IT systems, monitoring fuel consumption and behaviour of drivers |
| Pijnacker-Nootdorp | parcel and packages | Simon Loos | Retail supplying by LNG *(liquid natural gas)* cars and using electric vehicles for catering distribution |
| Rijswijk | parcel and packages | FietsXpress | Parcel delivery service using bicycle couriers, green gas outside city |
| Rotterdam | fresh food | Post-Kogeko | Delivery service using cooling trailers, LNG trucks and Technical Support Program (registering behaviour of drivers) to reduce $CO^2$ emissions |
| | | Fietskoeriers.nl | Parcel delivery service using bicycle couriers |
| | | NomadPower | Provide power supplies for road transport for electric charging |
| | | Bubble Post | Consolidation service on the outskirts of the city, using smart IT systems |
| | | Albert Heijn | Delivery service using hybrid vehicles, some trucks on bio-gas |
| | | Picnic | Delivery of fresh products using small electric vehicles |
| | parcel and packages | Simon Loos | Retail supplying by LNG *(liquid natural gas)* cars and using electric vehicles for catering distribution |
| | | Bubble Post | Consolidation service on the outskirts of the city, using smart IT systems |
| | | UPS | They have converted diesel-trucks into electric trucks in Rotterdam |
| | | TNT Express | They have electric cars and offer services to companies by providing insights in $CO^2$ emissions |
| | | RR Roadrunner | Delivery service using electric vehicles and bicycle couriers, compensate their emissions with own forest |
| | | Rotterdamse Fietskoerier | Parcel delivery service using bicycle couriers |
| | | Post-Kogeko | Delivery service using cooling trailers, LNG trucks and Technical Support Program (registering behaviour of drivers) to reduce $CO^2$ emissions |
| | | Fietskoeriers.nl | Parcel delivery service using bicycle couriers |
| | | Fietskoerier Den Haag | Parcel delivery service using bicycle couriers |
| | | DHL | Parcel delivery service using electric vans and bicycle couriers |
| | | De Versnelling | Parcel delivery service using bicycle couriers |
| | waste logistics | Renewi | Waste treatment company, using electric waste trucks |

**FIGURE 5.2:**
List of Greendeal ZES initiatives in the MRDH
*(authors' drawing, based on Green Deal ZES, 2016)*

| Municipality | Type | Private party | Description |
|---|---|---|---|
| | smart regulations | Gemeente Rotterdam | Developing to an healthy and sustainable city, working together with partners, entrepreneurs and residents who want to think, do and experiment |
| | vehicle technology | Spijkstaal | Developing and producing electric vehicles, focussing primarly on rental of electric tractors and platform trucks |
| Schiedam | parcel and packages | DAM Nederland | Offer passenger transport combined with parcel service |
| The Hague | fresh food | Fietskoeriers.nl | Parcel delivery service using bicycle couriers |
| | | Juice on Wheels | Selling orange juice by transporting solar-powered trikes |
| | | Albert Heijn | Delivery service using hybrid vehicles, some trucks on bio-gas |
| | | Picnic | Delivery of fresh products using small electric vehicles |
| | parcel and packages | Rotterdamse Fietskoerier | Parcel delivery service using bicycle couriers |
| | | FietsXpress | Parcel delivery service using bicycle couriers, green gas outside city |
| | | Fietskoeriers.nl | Parcel delivery service using bicycle couriers |
| | | Fietskoerier Den Haag | Parcel delivery service using bicycle couriers |
| | | De Versnelling | Parcel delivery service using bicycle couriers |
| Vlaardingen | parcel and packages | DAM Nederland | Offer passenger transport combined with parcel service |
| Voorburg | parcel and packages | FietsXpress | Parcel delivery service using bicycle couriers, green gas outside city |
| Westland | fresh food | Post-Kogeko | Delivery service using cooling trailers, LNG *(liquid natural gas)* trucks and Technical Support Program (registering behaviour of drivers) to reduce $CO^2$ emissions |
| | parcel and packages | Post-Kogeko | Delivery service using cooling trailers, LNG trucks and Technical Support Program (registering behaviour of drivers) to reduce $CO^2$ emissions |
| Zoetermeer | fresh food | PLUS supermarket | Delivery service using (cool) cargobikes |
| | parcel and packages | Fietskoerier Den Haag | Parcel delivery service using bicycle couriers |

**Legend**
- fresh food
- smart regulations
- vehicle technology
- parcel and packages
- waste logistics

## Governmental documents

In the research on governmental publications and reports explicitly propose strategies concerning urban freight transportation, two documents in which the ambition to reduce their $CO^2$ footprint are published. The third one is published by SamenwerkingsProject Expertpool Stadslogistiek (SPES) on behalf of the Ministerie van Infrastructuur en Waterstaat (Ministery of I&W) (Ministry of Infrastructure and Water Management), which provides guidelines for implementing:

***Aanpak $CO^2$ reductie verkeer***
*Approach to reducing $CO^2$ in mobility* (MRDH, 2019a)

***Stappenplan ZES***
*Roadmap to zero-emission urban freight* (Gemeente Rotterdam, 2019b)

***Stappenplan voor invoeren ZE zone voor stadslogistiek***
*Guidelines to establish zero emission zones for urban freight* (SPES, 2019)

The report of the MRDH (FIGURE 5.3) provides a collection of 40 generic measures that can contribute to the reduction of $CO^2$ in road traffic. The measures are not only related to urban freight but also the use of public transport, bicycle and parking are included. The report represents a catalogue of solutions, which have a huge potential to contribute effectively to the reduction of $CO_2$ in the region. The measures are still dependent on the administrative support of MRDH municipalities and thus the purpose is to show the measures and impact to incite discussion(MRDH, 2019a).

The report of the municipality of Rotterdam (FIGURE 5.4) describes the roadmap and an overview to come to zero-emission in the city centre of Rotterdam and thus fully dedicated to urban freight. This report is the strategic elaboration regarding their approach to urban freight and is part of the Rotterdamse Mobiliteit Aanpak (RMA). The roadmap of Rotterdam is in line with the political and national GDZES agreement, aimed at 2025 (Gemeente Rotterdam, 2019b).

The report of SPES (FIGURE 5.5) is commissioned by the Ministry of I&W and provide guidelines in order to help municipalities with successful implementation of zero-emission zones. It provides generic guidelines with local customisation for municipalities. They believe that establishing a zero-emission zone is one of the pillars to make zero-emission urban freight transportation succesfull (SPES, 2019).

The municipalities of The Hague and Delft do not have documents providing explicitly their ideas (and ambitions) on urban freight strategies, initiatives and measures.


**FIGURE 5.3:**
Approach to $CO_2$ reduction in MRDH *(MRDH, 2019a)*


**FIGURE 5.4:**
Roadmap to zero emission in Rotterdam *(Gemeente Rotterdam, 2019b)*


**FIGURE 5.5:**
Stappenplan voor invoeren ZE zone voor stadslogistiek *(SPES, 2019)*

## # *Use of electric vehicles*

A lot companies have found clever ways to enhance their delivery services by using light electric vans and bikes. Online supermarket Picnic delivers their products by using light electric vehicles. Also, parcel delivery services such as DHL and PostNL are using electric cargo bikes and vans (FIGURE 5.7). PostNL aspires to deliver emission-free in 2025 in the Netherlands. Progressive developments are seen in the meal service industry, where meals of Thuisbezorgd.nl and Picnic are all delivered by using clean vehicles, such as electric scooters, bicycles and small vans (FIGURE 5.8).

The use of electric vehicles is often connected with implemetation of low emission zones. These kind of vehicles are required for succesfull operation of these zones. Nowadays the amount of electric large trucks and delivery vans is limited. Although there is not yet a large-scale production of zero-emission vehicles, there is an expectation that around 2025, delivery vans are sufficiently available, however, the availability of electric trucks is less promising (FIGURE 5.6). In order to keep the emission zero, alternatives such as locations for changing modality or engine (transferpoints) are required for the last-mile (MRDH, 2019a).

The technological development and availability of clean (electric) vehicles therefore needs to be taken into account by implementing measures and concepts. Also the presence of enough charging points is one of the prerequisites for succesfull implementation of electric vehicles.

| Fuel type | Trucks > 3.5 ton | | Delivery van | |
|---|---|---|---|---|
| | # | % | # | % |
| Diesel | 192.880 | 98,1% | 877.532 | 94,1% |
| Gasoline | 2.151 | 1,1% | 32.004 | 3,4% |
| CNG (compressed natural gas) | 528 | 0,3% | 2.821 | 0,3% |
| LPG (liquid petroleum gas) | 473 | 0,2% | 18.991 | 2,0% |
| Dual fuel | 346 | 0,2% | | |
| LNG (liquid natural gas) | 273 | 0,1% | | |
| Electricity | 69 | 0,0% | 1.487 | 0,2% |
| Hydrogen | 6 | 0,0% | 7 | 0,0% |
| Alcohol | 3 | 0,0% | 12 | 0,0% |
| Total | 196.729 | 100,0% | 932.854 | 100,0% |

**FIGURE 5.6:**
Amount of trucks and delivery vans per fuel type in the Netherlands
*(Panteia, 2017, p. 13)*


**FIGURE 5.7:**
DHL Cubicycle
*(Fietsdiensten, 2017)*


**FIGURE 5.8:**
Delivery of fresh products by picnic using electric vehicles
*(Picnic, 2019)*

## 5.2.2 **Initiatives, measures and concepts** *measures in the MRDH*

### # *Low Emission Zones in the MRDH*

Several regulations are made to influence urban freight in the MRDH. One to mention is the National Act on the Air Quality, which had an impact on the efforts in urban freight. This act, in particular, has provided an extensive subsidy, called 'Nationaal Samenwerkingsprogramma Luchtkwaliteit' (NSL) which has made a billion euro available for the national and regional governments to improve air quality. With the funding from the NSL low emission zones were established in several city centres of the Netherlands (MRDH, 2017) Low emission zones are geographical areas set in cities where too much polluting vehicles are banned or have to pay for an exemption (Barone & Roach, 2016). The low emission zones are introduced in 2007 with a legal basis in 'Reglement Verkeersregels en Verkeerstekens 1990' (RVV1990) and the 'Wegenvekeerswet 1994' (WVW1994) (MRDH, 2017). More and more municipalities (at the moment 13) have established low emission zones. In the MRDH, Rotterdam, The Hague (including Rijswijk) and Delft have a low emission zone in their inner city. The low emission zones are shown in FIGURE 5.9, indicated in red. The rules per zone differ a bit per municipality, due to missing national guidelines. According to the Green Deal ZES agreement, at least an EURO IV engine is required, while time windows for instance are not aligned.

Some municipalities have other zones as well with some vehicles restrictions (for example: Logistieke zone Delft, FIGURE 5.9, indicated in yellow). These specific zones have again other rules and so are there several zones set-up with different rules (FIGURE 5.10). Also, traffic signs to indicate the zone are different per city. This generates annoyance among suppliers and causes more logistical effort and a sub-optimal use of the truck fleet. Therefore, there will be an attempt in 2020 to align the rules and signs (Milieuzones in Nederland, n.d.). These low emission zones are enforced by cameras and special officers.

| Municipality | Low emission zone | Vehicle restrictions | Time windows |
|---|---|---|---|
| Gemeente Rotterdam | - Low emission zone in the city centre and Maasvlakte<br>Restriction based on engine | Engine:<br>min EURO IV (city centre)<br>min EURO VI (Maasvlakte)<br>Complete truck ban 's-Gravendijkwal | Mo - Su 05.00 - 10.30<br>Additonal exemption zero emission vehicles:<br>Mo - Th 18:00 - 20:00 |
| Den Haag (Vrede en Recht) | - Low emission zone in the city centre<br>Restrictions based on engine and age | Engine: min EURO IV<br>Age: max 13 years | Mo - Fr 5.00 - 11.30<br>Sa - Su 6.00 - 11.30<br>Around Central Station instead:<br>Mo-Fr 5.00 - 7.00, 10.00-11.30 |
| Gemeente Delft | - Logistic zone in city centre<br>- Low emission zone in south east of the city centre<br>Restrictions based on size | Weight: max 3.5 ton<br>Length: max 10 m<br>Width: max 2.20 m | with exemption: Mo - Fr 7.00 - 12.00<br>Sa 7.00 - 11.00<br>Official Holidays 10.00 -12.00 |

**FIGURE 5.10:**
Regulatory measures of municapalities
*(authors' drawing, based on municpal information.)*

ROTTERDAM | THE HAGUE + RIJSWIJK | DELFT

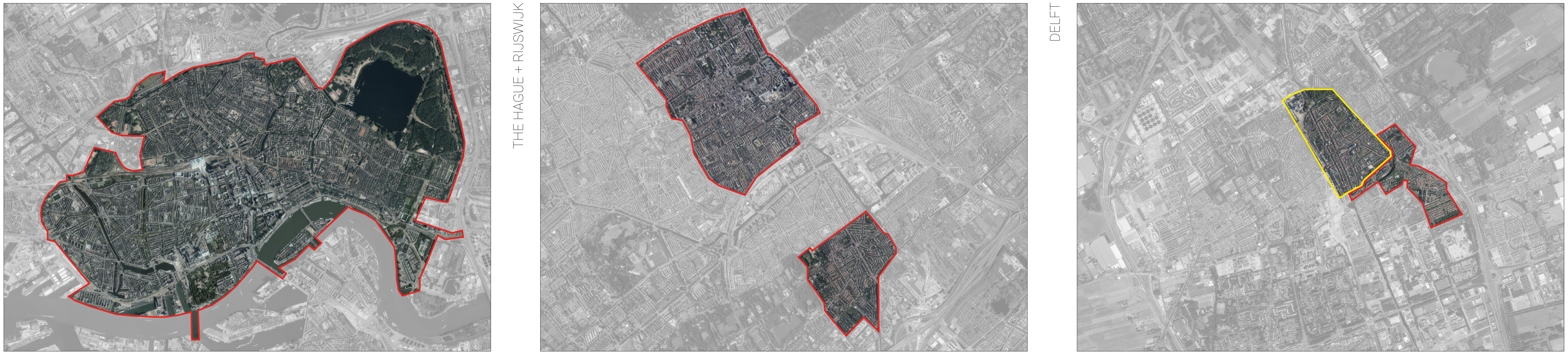


**FIGURE 5.9:**
Low emission zones in Rotterdam, The Hague and Delft *(adapted from Milieuzones in Nederland, n.d.)*

# Vehicle restrictions

Additionally, on low emission zones, the RVV1990 offers more possibilities for regulations on urban freight transportation, since it can be used for setting vehicle restrictions, time windows and in particular access bans. Low emission zones are in fact access bans based on restrictions. Restrictions on vehicles and time always have been one of the most popular regulation in Dutch cities (Van Duin, 2005). As already illustrated on the last page (FIGURE 5.10), regulatory measures per municipality are different. Rotterdam has restrictions in their city centre (min EURO IV) and the Tweede Maasvlakte (min EURO VI) There is also a complete truck ban on the 's-Gravendijkwal. The Hague has restrictions in their city centre based on the engine (min EURO IV, FIGURE 5.11) and age.  Delft has a historical and touristic city centre. The streets along the canals are dimensioned and designed according to the standards of the 16th  and 17th  century, which kept unchanged in the last centuries. They are now too small for heavy trucks nowadays. Therefore the municipality has set vehicle restrictions based on dimensions in their city centre (Gemeente Delft, 2019).  All three cities have implemented different time windows in their city centres as well.

# Privileges

Subsidies and privileges are given by the municipality Rotterdam to promote zero-emission vans and trucks in their city. Firstly, by purchasing or leasing a fully electric van, a grant of EUR 5.000,- is given. With an exemption, extra privileges can be given to entrepreneurs. Electric taxis and trucks are then allowed to use the 19 bus lanes in the city to avoid congestion delays (FIGURE 5.12).  They also can profit from the possibility of extending their loading and unloading times in the pedestrian areas (TDA, 2019).

# Decentralised measures

As earlier stated and illustrated in FIGURE 5.10 in the vehicle restrictions of low emission zones, time windows and vehicle restrictions, the rules differ per municipality. It shows that The Netherlands have decentralised policies and measures concerning urban freight, which give local authorities the possibility to make their own policy and measures. This indicates somehow the low attention for urban freight on national scale. At the same time, the current policy and lacking alignment in measures are for logistic companies are experienced as annoying, inflexible, and inconvenient (ING, 2015). Some municipalities have a roadmap/specific plans on urban freight, while other do not have a political/strategic agenda on urban freight at all. It gives the impression that they let the activities just happen or using the convential measures, without contextual consideration.

| Stage | Starting date | CO (g/kWh) | HC (g/kWh) | NOx (g/kWh) | PM (g/kWh) |
|---|---|---|---|---|---|
| EURO I | 1992 | 4.5 | 1.1 | 8.0 | 0.36 |
| EURO II | 1996 | 4.0 | 1.1 | 7.0 | 0.25 |
| EURO III | 1999 | 2.1 | 0.66 | 5.0 | 0.10 |
| EURO IV | 2005 | 1.5 | 0.46 | 3.5 | 0.02 |
| EURO V | 2008 | 1.5 | 0.46 | 2.0 | 0.02 |
| EURO VI | 2013 | 1.5 | 0.13 | 0.4 | 0.01 |

**FIGURE 5.11:**
Engine type standards
*(Dieselnet, n.d.)*


**FIGURE 5.12:**
Regulations through zero emission privileges by the municipality of Rotterdam
*(Logistiek 010, 2019)*

## 5.2.3 ***Initatives, measures and concepts*** *concepts in the MRDH*

# ***Consolidation of goods***

The idea of consolidating goods has been applied earlier cities and is done in urban consolidation centres (UCC). The UCC is a distribution centre on the outskirts of a city and brings bundled deliveries to a whole city, the city centre or a specific place. Instead of every shipper taking care of their delivery to the receiver in the city centre, all the goods will be consolidated at the edge of the city and brought bundled from there to the final customer in the city centre (FIGURE 5.13).

In 2015 the municipality of Delft started a collaboration with PostNL to improve logistic services (Stadslogistiek Delft). From a distribution hub on the outskirts of the city centres, situated on the Staalweg, close to the A13, they both want to supply the city centre with bundled flows by (small) electric vehicles, small vans and bicycles. Additional on the shops affiliated by Stadslogistiek Delft, there are also separate shops and bigger retailers, such as Albert Heijn and Jumbo taking care of their distribution and transportation.

However, the municipality has sold the land to real estate developers to redevelop the area with housing. The consolidation centre is closed  at the end of 2019, without a proper alternative. The distribution in Delft will be done by another facility in Ypenburg, which is now 12 kilometres away from the city centre Delft (FIGURE 5.14). The distance becomes bigger and thus the transportation with electric vehicles will become less efficient as well. This has eliminated the huge potential of the concept of such an urban consoldiation centre close to the city centre.

The implementation of this UCC seems to be not succesfull yet. In the next chapter, the concept of urban consolidation will be reintroduced and be positioned in a larger strategic framework to increase the chance of succes.

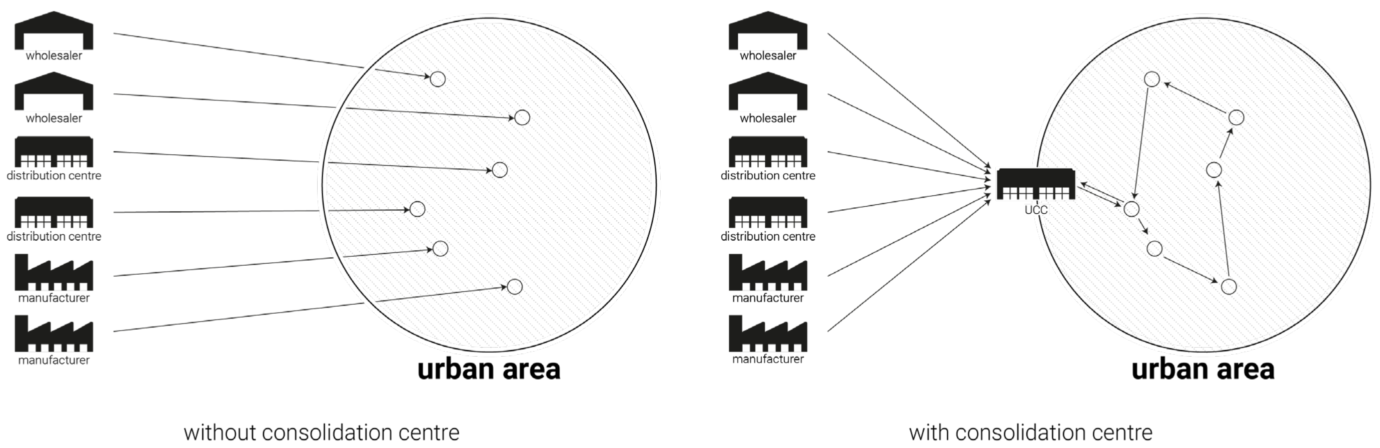



**FIGURE 5.13:**
Consolidation centre
*(author's drawing)*

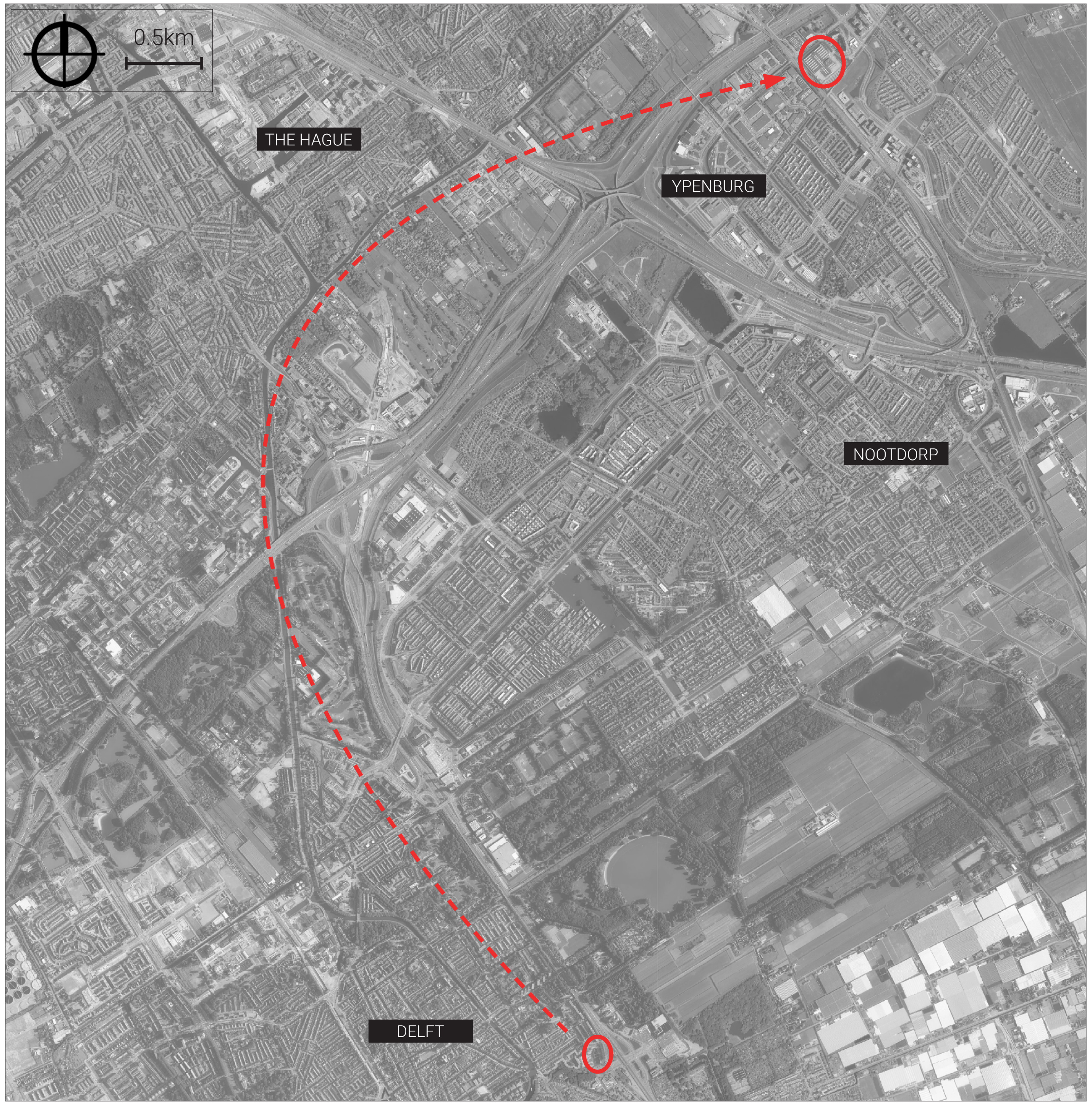



**FIGURE 5.14:**
Parcel, package deliveries and retail supply by consolidation centre in Delft
*(Google maps, 2019)*

# *Pick-up points*

This concept is more suitable for home deliveries, which are due to consumer expectations not necessarily done most efficiently and cost-effectively, since small packages are mostly desired to be delivered one-by-one. E-commerce has led to fragmentation an higher frequency in e-commerce deliveries (TDA, 2019).  Although FIGURE 4.14 has shown earlier that pick-up points are on average not the cleanest way of delivery. Since the high number of emission is related to the travel mode when going to the drop-off point, an integrated and fine-grained system with national coverage on pick-up points can generate more efficient processes for delivery companies.

Instead of home deliveries, goods are now delivered to an automated drop-off point, preferably positioned close to (daily) facilities or services (such as supermarkets or public transportation stops). A higher productivity with less vehicles can be acquired by eliminating the delivery to every home. On the first hand, it allows receivers to pick a convenient time, while on the other hand, options are there to plan delivery in non-conventional hours.

Critical issuess on this delivery method are e.g. the ownership of those pick-up points and thereby the coordination of receiving goods from several companies. The direct contact and thus the customer service disappears with the automated pick-up points. Also the space they take and the costs of the drop-off points needs to be considered. Local traffic generation needs to be avoided (Allen, Browne & Thorne, 2007). FIGURE 5.15.1-2  show first pilots from PostNL and DHL in the Netherlands with automated drop-off point deliveries. There are some of those located in the region, but it's not yet implemented as the conventional method of delivery.

PostNL automated drop-off point (PostNL, 2018)


DHL parcel drop-off point (Wehkamp, 2015)

**FIGURE 5.15.1-2:**
Drop-off points of post companies
*(several photographers)*

## 5.2.4 ***Initatives, measures and concepts*** *intermediate conclusion*

A lot of initiatives have been started with subsidies from the government, however, when the funding drought up, this also meant the end of the initiative, since logistic activities have low direct profitability. This has happened with the CargoTram in Amsterdam, The Netherlands (Ploos van Amstel, 2015), but we also see this happening in Delft, where an attempt for consolidation is done but has failed through replacing the consolidation centre by housing real estate without a proper alternative.

As found out in the cities of Rotterdam, The Hague and Delft, almost all the measures on urban freight implemented are regulations based on vehicle restrictions and time windows in the city centre which can be considered as a low emission zone. A remarkable fact is that rules differ per municipality, due to missing national guidelines.  Municipalities use different standards and characteristics of vehicles for their restrictions of low emission zones. Rotterdam uses the type of engines, The Hague uses the age while Delft uses vehicle dimensions. Also, traffic signs to indicate the zone are the different per city, which makes this measure confusing.

Here and there, one can see the rise of zero-emission vehicles, such as electric and hydrogen vehicles. However, the production of these vehicles is yet limited (and especially the production of larger vehicles). The targets of Green Deal ZES are in line with the targets of urban planners: both are committed to liveable and sustainable cities and for this, negative externalities need to be mitigated.

At the moment it is not sure if the targets will be reached. The agreement/declaration of intent aspires urban freight activities with zero-emission, which is promising, however, it doesn't come with concrete measures on how to come to zero-emission urban freight (MRDH, 2017). Both companies and authorities are enthusiastic about innovative solutions.  There is a missing consistent long term (national) policy within all the cities. Investment decisions in companies can be based on those consistent regulations.

## 5.3 *Spatial organisation*

This paragraph will address the spatial organisation of the relevant (logistic) facilities in urban freight. This will be done by first identifying location factors of companies (distribution centres and retailers) and elaborate on these location factors with respect to the MRDH. Secondly, an analysis based on the authors' household flows will be done in order to understand the operational scale of retailers and distribution centres. Changing the regional and national structure will not improve urban freight directly, however, understanding this, will create conditions for suitable solutions. At the end of the chapter, there should be an understanding of the spatial organisation of urban freight and why it is organised in this way. The findings will be input for the next research questions related to the requirements, conditions and the actual improvement.

### 5.3.1 ***Spatial organisation*** *location factors for companies*

Logistics is a market-driven and competitive sector, which means that from a business point of view, the location of their facilities is crucial. The location of logistic facilities is not random and is determined by a priori the logistic activity itself and by location factors like characteristics of the site (micro scale), accessibility (meso scale) and socioeconomic environment (macro scale), illustrated in FIGURE 5.16 (Rodrigue et al., 2013):

In the micro scale, requirements are associated with local geographical characteristics of the site. This includes the availability of land, presence of basic utilities, visibility (prestige-related activities) and local access to infrastructures and how urban freight distribution actually take place. The meso scale stands for accessibility. The key determinant in accessibility is the capacity and presence of logistic infrastructure networks, such as highways, but also waterways and railways. Well-established networks ensure the proximity of labour, consumers, materials, energy and access markets. (He et al., 2018; Rodrigue et al., 2013). The macro scale is related to municpal, regional and national jurisdictional measures and context concerning capital, subsidies, regulations, taxes and technology (Rodrigue et al., 2013).

According to a research of Prologis (2017), the five most important location factors are the proximity to consumers, regulations, labour availability, transportation infrastructure and the costs. The Netherlands and in particular the southern part provinces (South-Holland, North-Brabant and Limburg) has a high score on those location factors and is therefore part of the logistic corridor in Europe (FIGURE 5.17). The Netherlands provides in terms of regulations, environmental rules and costs an attractive environment for distribution centres.

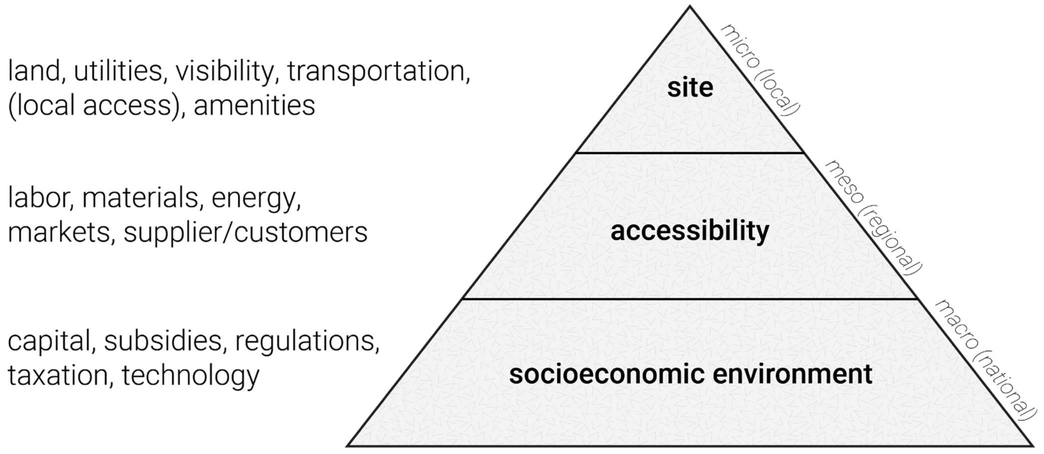



**FIGURE 5.16:**
Location factors
*(adapted from Rodrigue et al., 2013, p.73)*

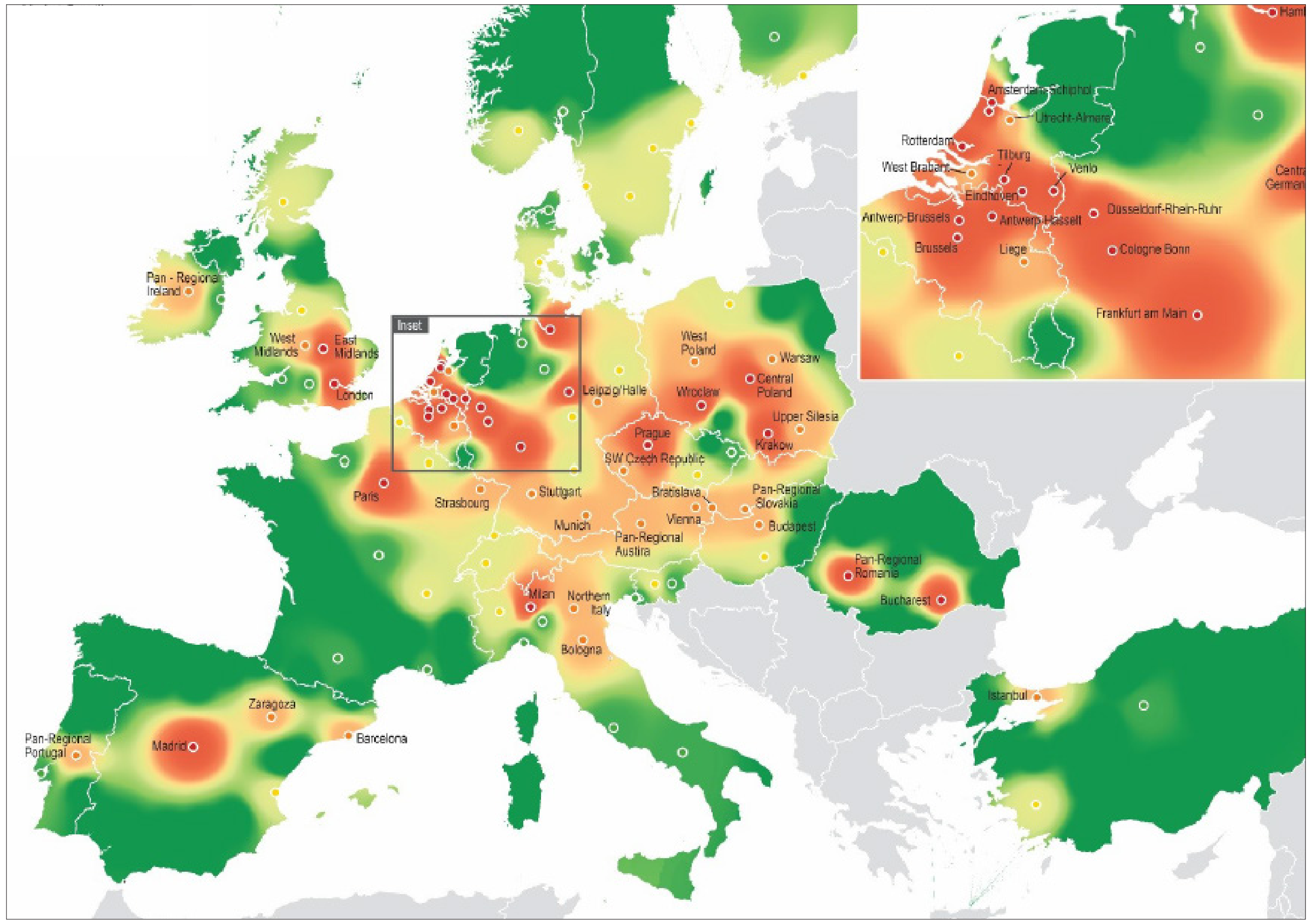



**FIGURE 5.17:**
The Netherlands logistic corridor *(Prologis, 2017)*

## **5.3.2 Spatial organisation** *macro scale (national)*

This paragraph highlights some aspects of the Dutch socioeconomic enviornment. The location of distribution centres is determined by policy and regulations.

An important act in spatial decision-making is the Wet Ruimtelijke Ordening (Wro). This is an instrument in which spatial themes such as living, working, mobility and nature are regulated in a policy. The Dutch spatial planning is – preferably - decentralised. Although the national government is responsible for the national needs, in which they can act via the Structuurvisie Infrastructuur en Ruimte (SVIR), actually the municipalities are responsible for the implementation and spatial planning of an area and thus are they responsible for the urban freight.

Municipalities are powerful in the decision of zoning industrial areas (logistics). The spatial planning of distribution centres depends on the zoning of industrial areas and environmental regulations. The zoning of extra industrial areas is however political since this is predominantly related to financial and employment motives. Also, the land costs need to be considered since it is a considerable part of the operational costs and thus decides the industrial layout. The joint outward movement to the periphery together with an attractive establishment climate and lacking regional and national regulation and planning, has resulted in unconscious chosen locations for distribution centres and development without proper vision on the context, added value, urban freight and the landscape (FIGURE 5.18). In a concrete sense, this means extremely large distribution centres (XXL-DC's, >20.000 $m^2$) in the Netherlands, the sprawl of facilities and other unintended side effects. In the Netherlands, this is called 'boxification of the landscape' (CRa, 2019). The boxification of the landscape is considered as part of the current spatial organisation of logistics. The awareness for this phenomenon just arose, wherein intervention and better control from higher governments are desired. FIGURE 5.19.1-2 shows such boxes (XXL-warehouses).

In 2021, a new act will be implemented: the 'Omgevingswet'. This act replaces the Wro and combines the 26 smaller acts related to mobility, construction, environment, water, spatial planning and landscape into one act (Rijksoverheid, 2018). This act requires an integrated approach to the living environment but will give municipalities more freedom of consideration in their decision-making for specific (private) cases. Municipalities, provinces and the national government have to develop an 'omgevingsvisie' which replaces the 'Structuurvisie' and other spatial visions. The 'omgevingsvisie' is an integral vision that shows the main strategic choices for the whole living environment. In this vision, the issues, measures and concepts of urban freight could be included as well. Municipalities also make an 'omgevingsplan', which replaces the 'bestemmingsplan'. Provinces and the national government have a development-oriented planning instrument (projectbesluit) in which they can designate new infrastructural projects.

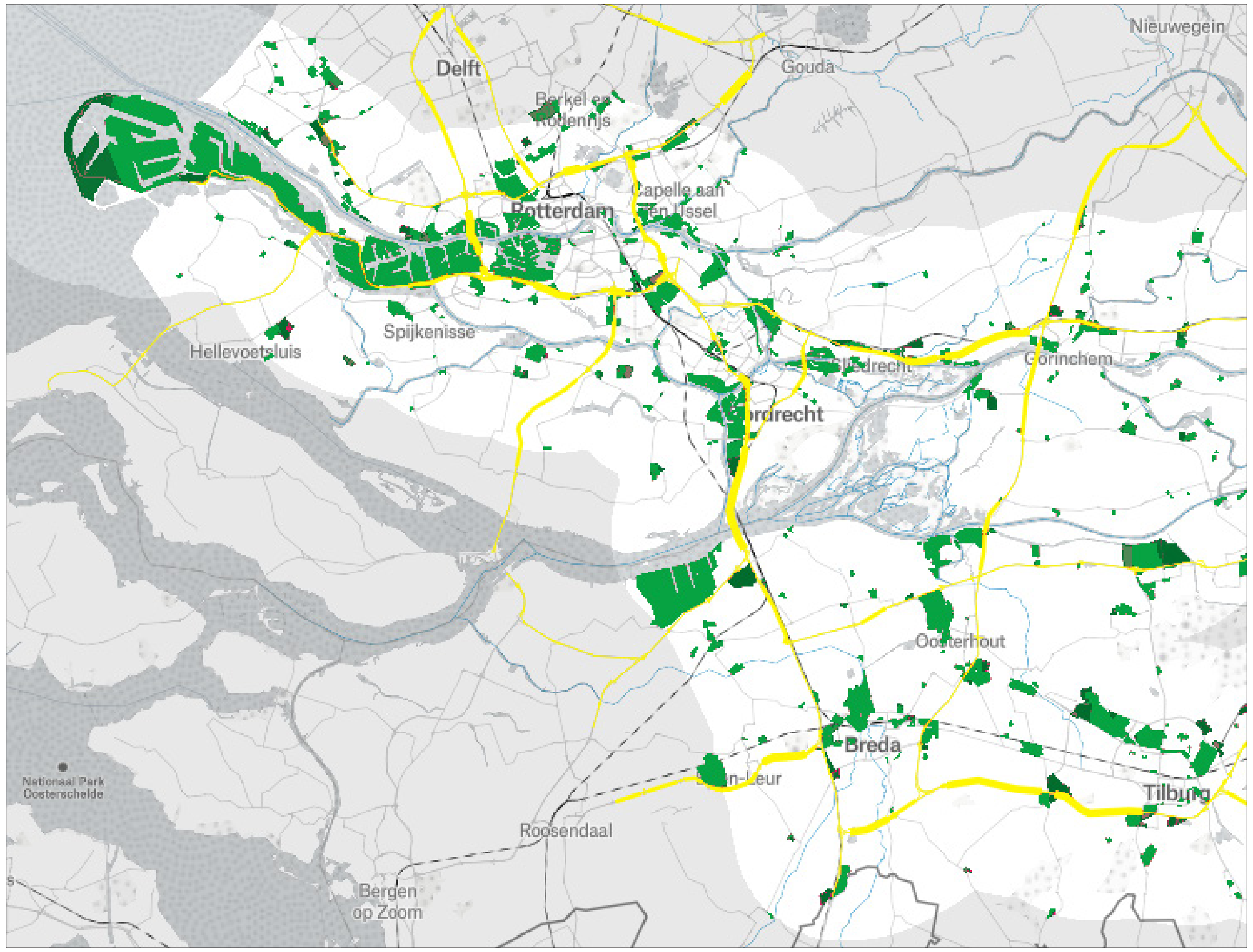
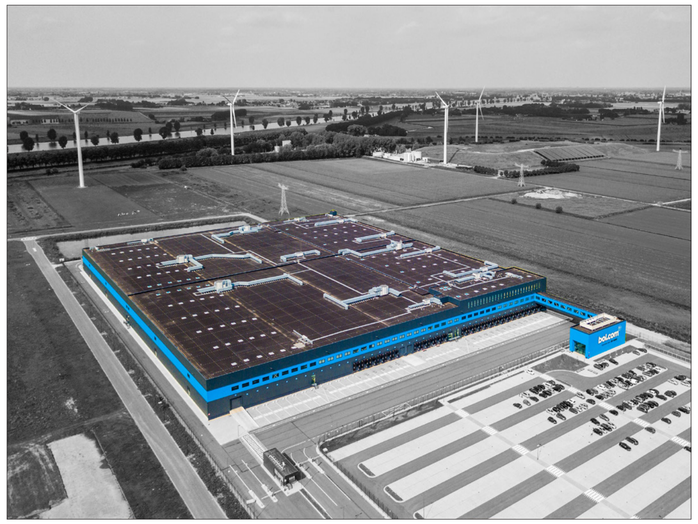



**FIGURE 5.18:**
Sprawling logistic facilities
*(Nefs, 2019)*



bol.com distribution centre (Logistiek.nl, 2019)

Wehkamp distribution centre (Eissens, 2019)

**FIGURE 5.19.1-2:**
Boxification of the landscape:
bol.com distribution centre
*(several photographers)*

## 5.3.3 **Spatial organisation** *meso scale (regional)*

This paragraph analyses spatial aspects regarding the meso scale of location factors. The distribution principles need to revealed by addressing the logistic elements of urban freight: this paragraph will show the location of distribution centres, accessibility of regional infrastructures (highways, waterways and railways) and then the accessibility of people (customers/retailers).

### # *Distribution centres and post sorting centres*

Freight is becoming urban when it leaves the distribution centre and have destination in urban areas. To understanding the processes of distribution, first different type of retail and distribution based on the scale of operation are distinguished. This distinction is useful to understand and estimate supply characteristics such as local (supply) challenges, frequency and the respective goods. Goods can then be classified on their needs. Figure 5.20 show the three sccales of retail and distribution.

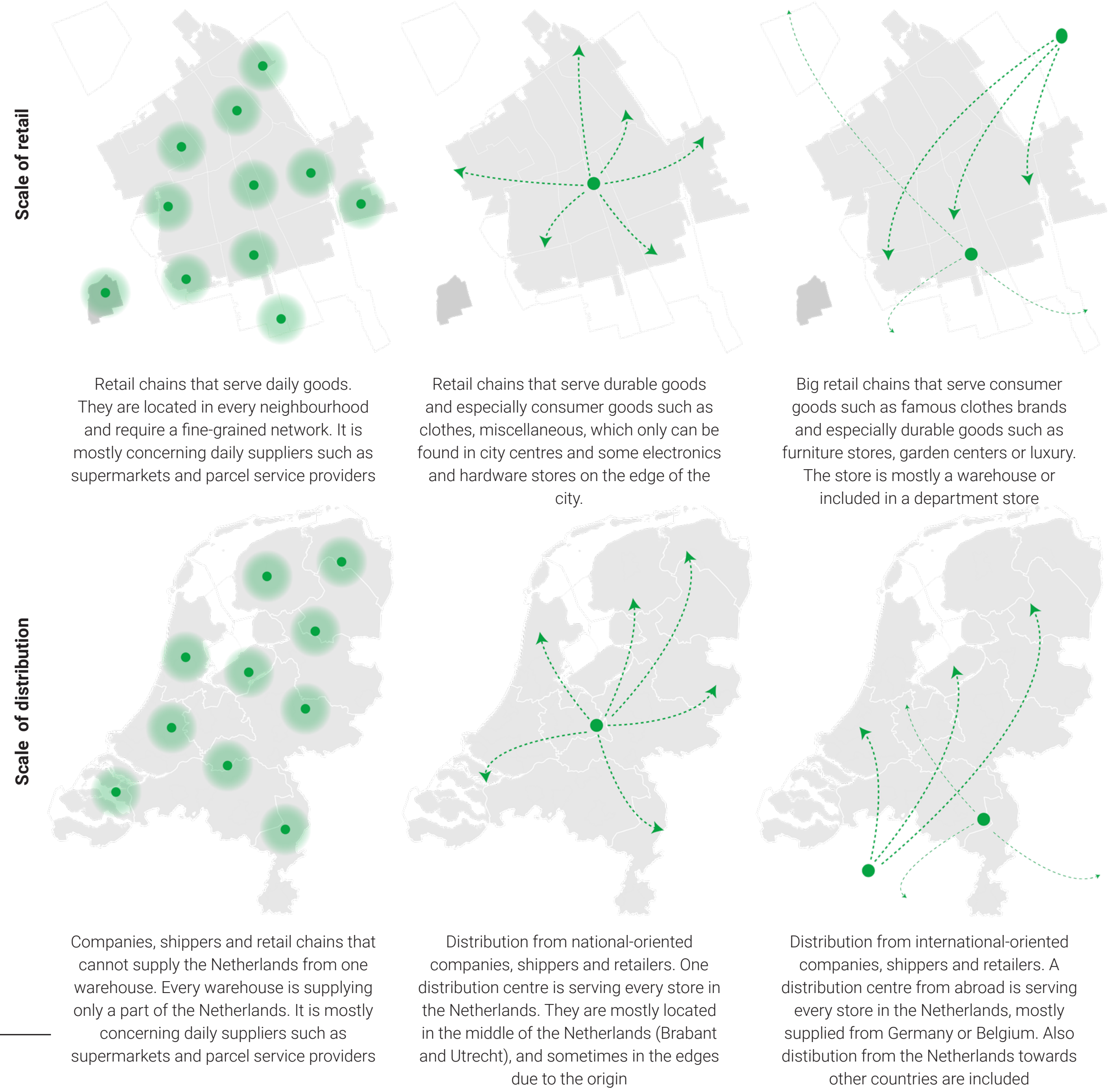



**FIGURE 5.20:**
Types of retail and distribution centres
*(author drawing; adapted from CRa, 2019)*

In figure 5.21, the geographical location of relevant distribution centres and post sorting centres for the MRDH region are shown in the Netherlands. Reasonably, it can be stated that the high level of urbanisation and high household density are arguments on the relatively high amount of distribution centres in the MRDH region. At the same time, most of the distribution centres for retailers are located along the highways as well. Appendix II shows an overview of the exact places. The goal is to create a rough idea of transportation distances and understanding of how retailers are supplied in the Netherlands.

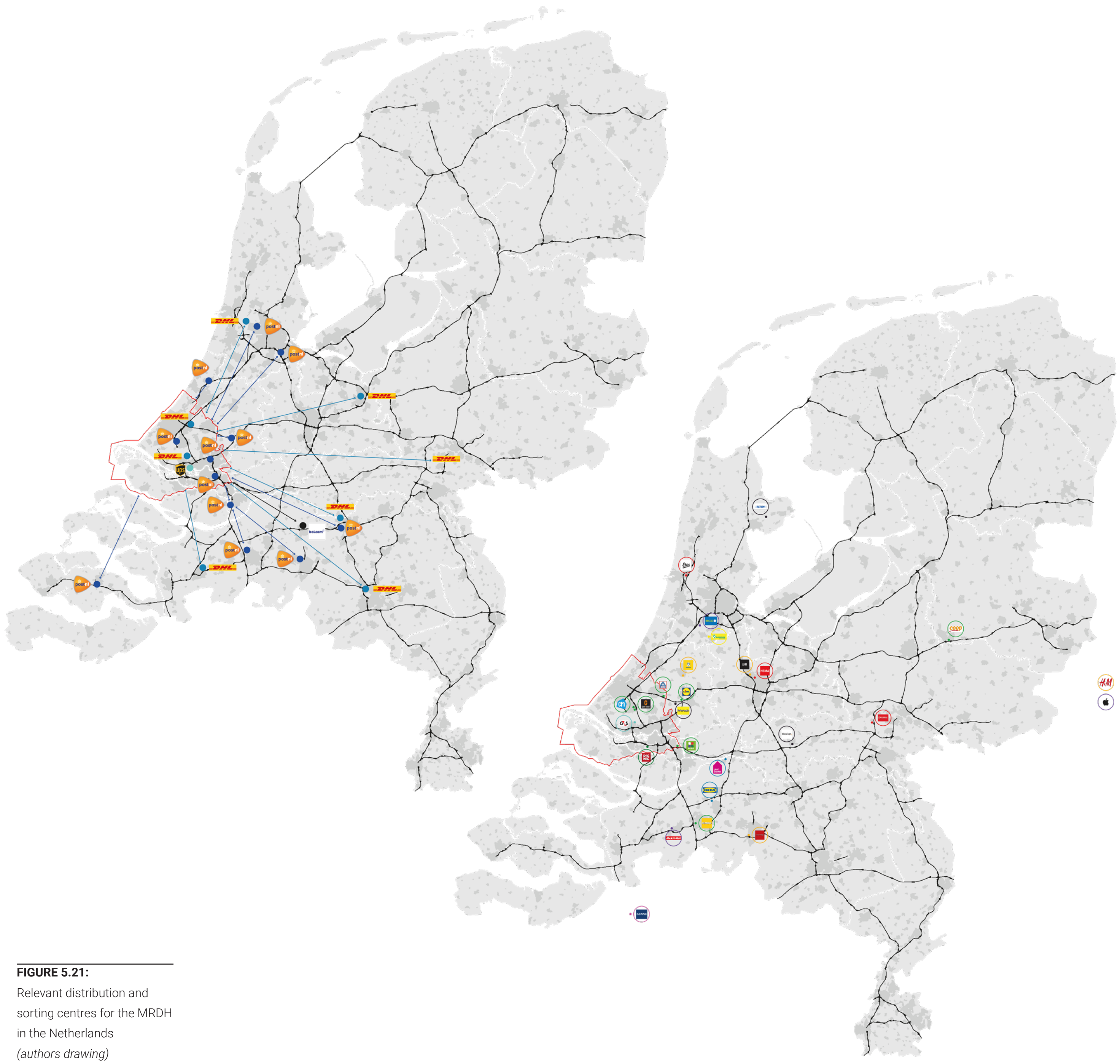


**FIGURE 5.21:**
Relevant distribution and sorting centres for the MRDH in the Netherlands
*(authors drawing)*

# *Multimodality in urban freight activities*

Figure 5.22 shows the current modal split for freight transport. It shows that the truck is still the most popular mode in the Netherlands and thereby the roads are filling up with more trucks through the growth of freight. This has resulted in an increase of traffic congestion and their corresponding impacts on the logistic sector. The high dependency on road traffic also increase a vulnerability of the logistic system (CRa, 2019). This makes the share of road traffic is too high in comparison with the share of rail and water traffic and therefore a modal shift should be a welcoming solution. Reasons for the disappointing modal split are e.g. an insufficient understanding of the competition between road and rail, a lack of commercial freedom of railways owned by the government or inadequate long-term stable access to rail capacity at strategic times (Sjöstedt, 2003).

Looking spatially to the location of logistic facilities overlapping with highway infrastructures, it can be concluded that the structure and distribution of urban freight is predominantly determined and utilised by highway infrastructures, while the structures of railways and waterways are less dominant in the location choice of logistic facilities and the actual urban freight transport (figure 5.23). Figure 5.24 and figure 5.25 show the relevant infrastructure lines and how they overlap with retail areas. Chapter 6 will dive deeper into retail locations.

The MRDH region however shows an huge potential for multimodal transportation, since all the three necessary types infrastructures are widely present in the cities of the MRDH. The largest cities (Rotterdam and The Hague) both have an extensive tram network, while also sattelite cities such as Delft, Schiedam and Vlaardingen are somehow connected to these tram networks. Also the water corridors and canal structures in some historic cities offer opportunities for urban multimodality.

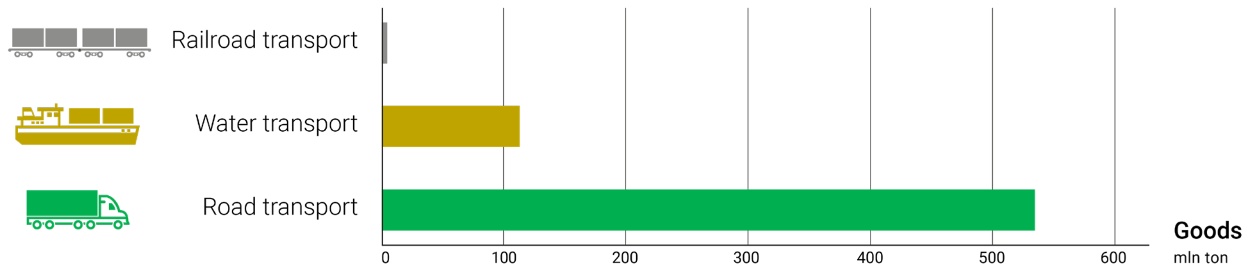



**FIGURE 5.22:**
Modal split in freight transport *(CBS, 2019c)*

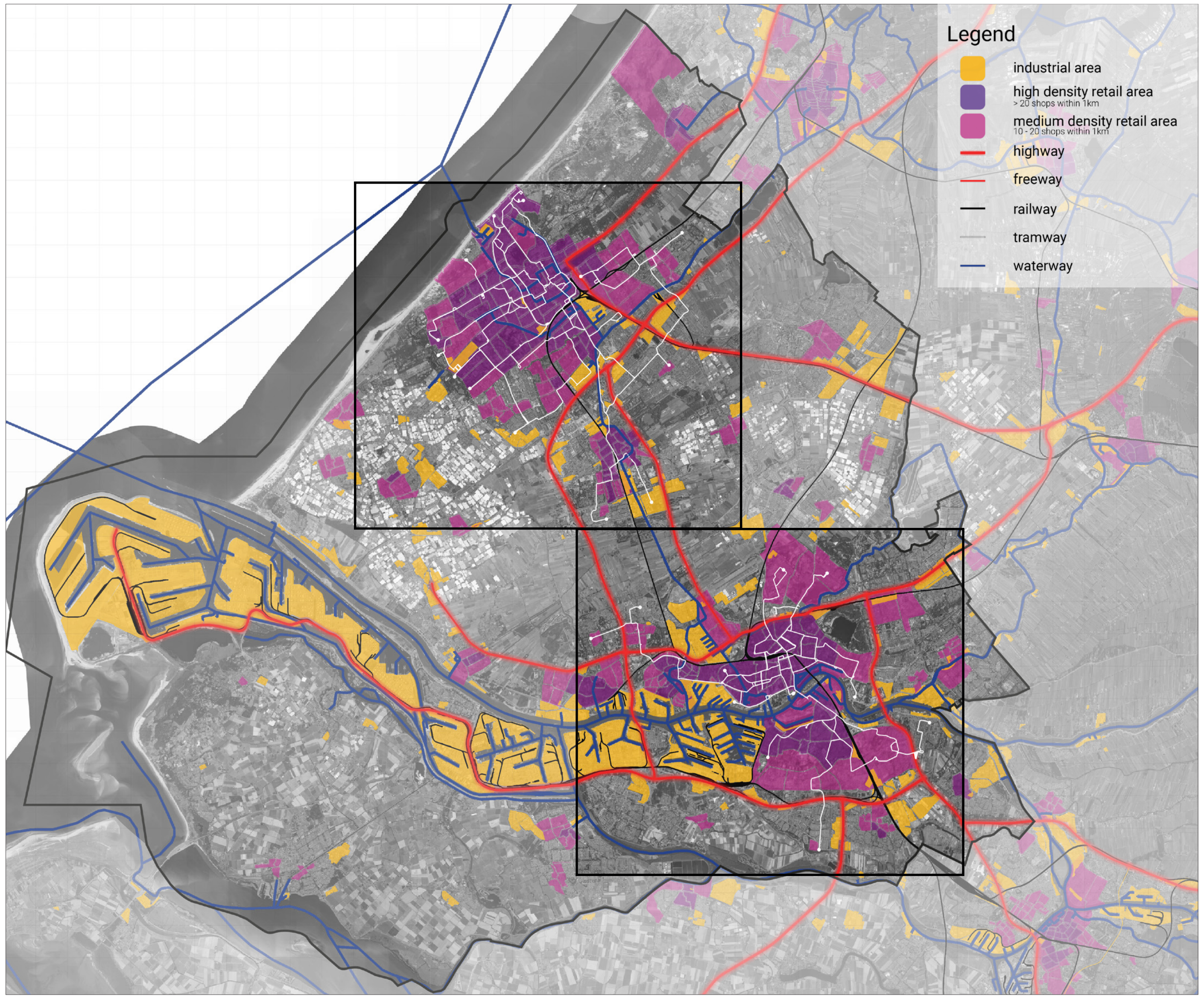



**FIGURE 5.23:**
Potential freight infrastructure in MRDH
*(author's drawing)*

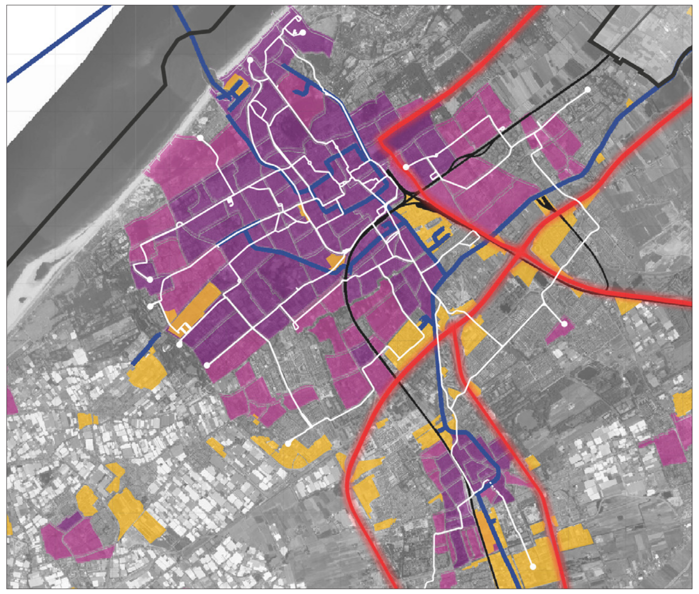


**FIGURE 5.24:**
Potential urban freight infrastructures in The Hague and Delft
*(authors's drawing)*

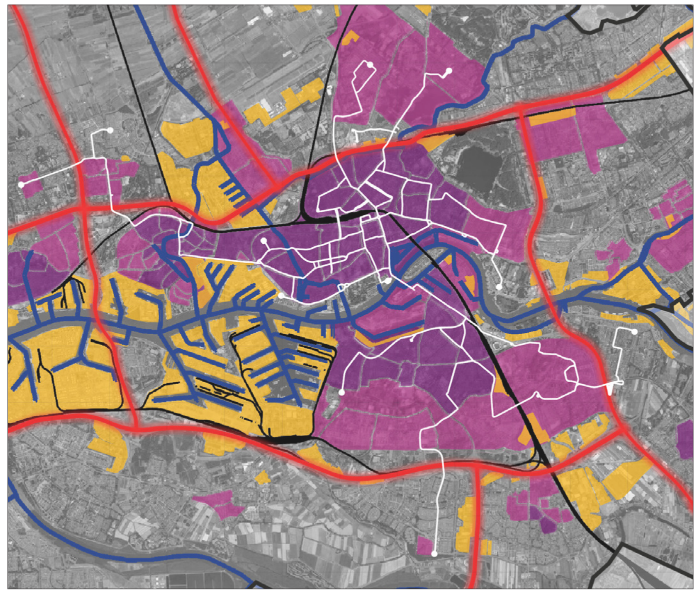


**FIGURE 5.25:**
Potential urban freight infrastructures in Rotterdam
*(author's drawing)*

# Proximity and density of suppliers and customers

Urban freight is considered as a customer-oriented service. Therefore, the proximity and density of households and retailers/stores can be seen as an important structural element for the spatial organisation of urban freight. The population density has a non-linear relationship with the transportation costs of urban freight. FIGURE 5.26 shows that with a low density the costs are higher, since longer distances are required for the same number of deliveries, while with a large density, the logistic demand increase, including the spatial constraints and the impacts (Rodrigue & Giuliano, 2019).

The concentration of households determines the concentration of retailers/stores and thus the amount of freight that has to be transported within a particular area. It also determines the concentration of distribution centres, since distribution centre can serve a maximum demand of retailers.

According to FIGURE 5.27 which shows the household density per km2, the MRDH-region has many high urbanised clusters with more than 2.500 households. Consequently, FIGURE 5.28 shows that most households in urbanised areas also have many stores for daily goods in their proximity. A high density of households, however, also means a limited amount of space available for storage, limited amount of parking and competition with other means of transportation and users on the road (Rodrigue & Giuliano, 2019). This means that all these stores for daily goods in very urbanised areas need to be supplied on a frequent level and are thus relying on well-working urban freight transport operation

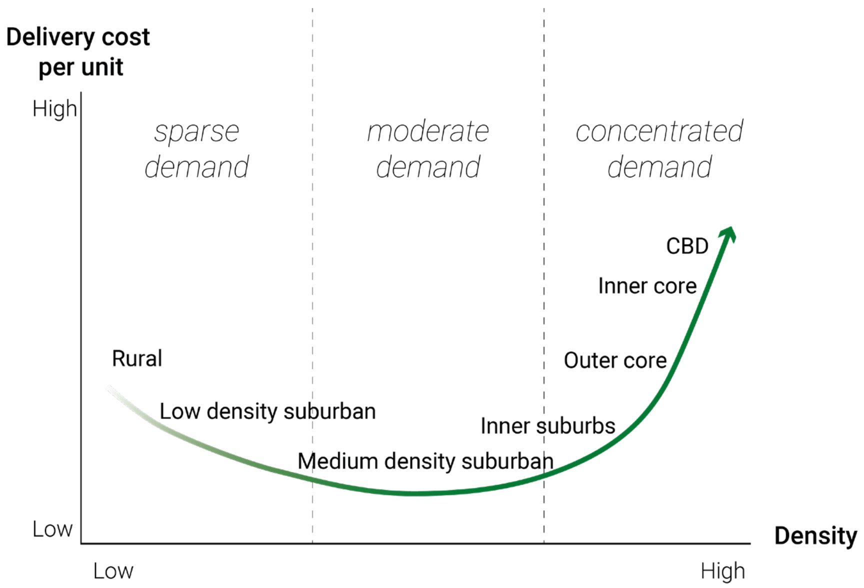



**FIGURE 5.26:**
Relationship urban density and delivery cost *(Adapted from* Rodrigue & Giuliano, *2019)*

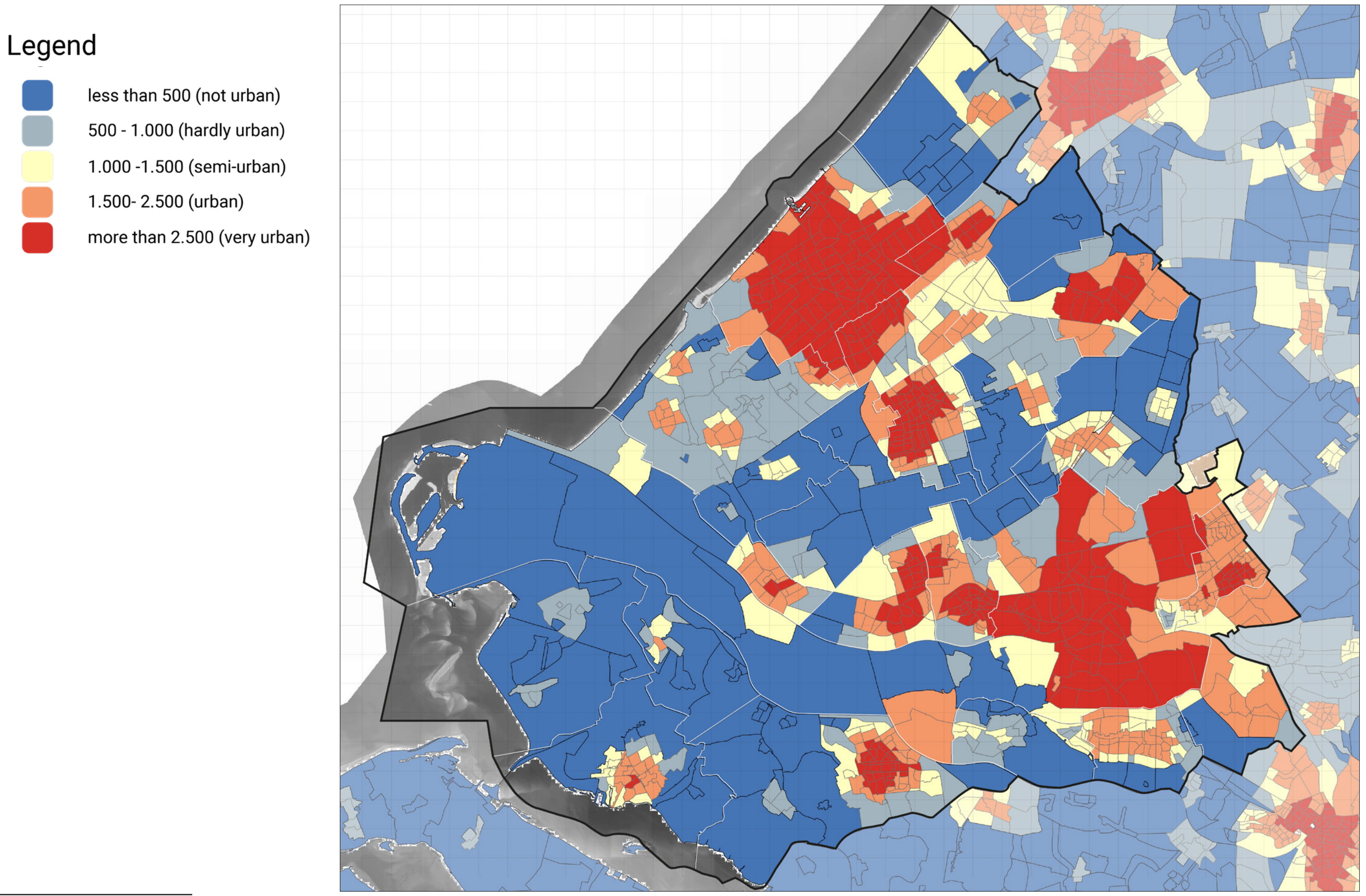



**FIGURE 5.27:**
Consumer household density per km² *(CBS, 2018a; Retrieved from QGIS)*

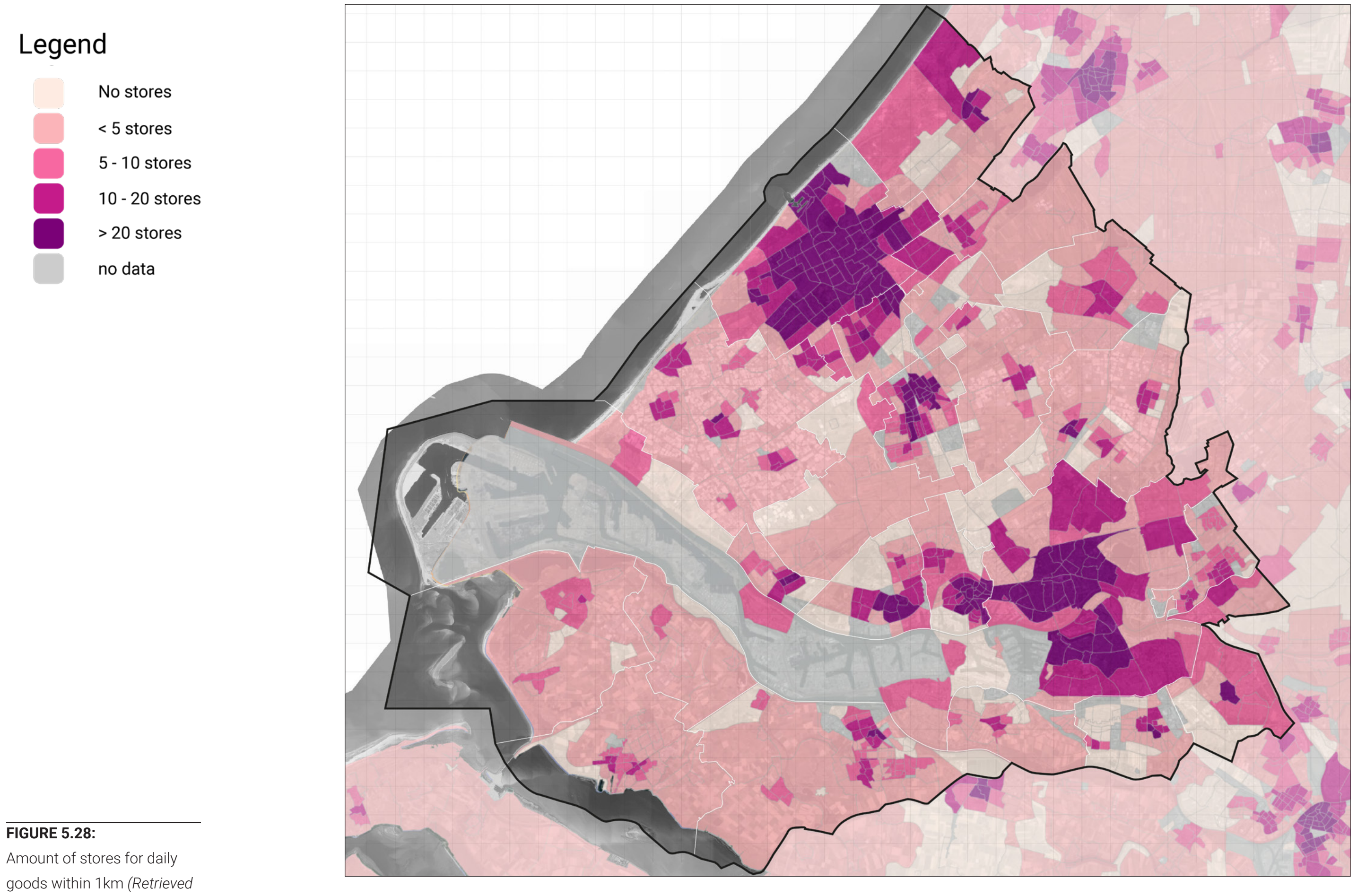



**FIGURE 5.28:**
Amount of stores for daily goods within 1km *(Retrieved from Atlas Leefomgeving, 2019)*

## **5.3.4 Spatial organisation** *micro scale (local)*

The micro scale is associated with local geographic characteristics of the site. Concerning the spatial organisation of facilities in the supply chain, a distinction in typology of retail is relevant to identify local challenges regarding urban freight distribution. Based on the distiction of Evers (2004), four typologies of retail can be distinguished with respect to the amount of buildings, amount of occupiers and the size of the buildings, wherein the stores are established. These are shown in an overview in FIGURE 5.29 on the next page.

**1)** ***Free standing stores***

The first group are free standing stores. They can be found here and there in different neighbourhoods, representing fine-grained locations for daily products/items such as food, parcels, packages and provisions. Supply takes place from the street, sidewalk or dedicated loading and unloading areas. These spaces have to be shared with other functions such as parking and users such as pedestrians. Conflicts between different functions are inevitable. Main issues are the low number and the size of loading and unloading spaces, traffic flows and the design of the public space around the shop.

**2)** ***Shopping centres***

The second group represents the shopping centres. They can be found at specific centralities and are representing a wide variety of retailers in one building, mostly including daily and consumer goods, such as food (supermarkets and catering), cosmetics, clothes, miscellaneous etc. Supply mostly takes place from a central shipping yard on the backside of the stores. These stores mostly have some warehouse space. The supply of shops in shopping centres is dependent on the opening times of the building. Distances can become big due to size and the amount of shops in one building. In the design of shopping centres, the logistics and supply are mostly considered last.

**3)** ***Traditional shopping street***

The third group represents the regular shopping streets. These also include a wide variety of retailers, but seperated, each in their own building. Supply takes place mostly on the frontside of the shop, during specific time windows. In some cases (for instance in fragile historical centres), also vehicle restrictions are applied. Main issues are the frequent supply while dependent on the performance of regulations (time windows and restrictions). The short time windows and lack of space in the public space are critical.

**4)** ***Retail parks***

The fourth group represents the larger retail parks. These mostly contain the more bigger retailers such as hardware stores, giant furniture stores, electronics stores, mostly located on the outskirts of the city. Supply mostly also takes place from a central shipping yard on the backside of the stores. These stores mostly have some warehouse space. They don't have problems with opening times, since the buildings are separated. Since supply take place on the backside, problems are less visible. Some issues are related to capacity of warehouses and walking distances due to size.

**#1 free standing stores**

| single building |
| --- |
| one occupier |


**#2 shopping centres**

| single building |
| --- |
| several occupiers |


**#3 traditional shopping street**

| group of buildings |
| --- |
| small |


**#4 retail park**

| group of buildings |
| --- |
| large |


**FIGURE 5.29:**
Retail typologies for supply
*(adapted from Evers, 2004)*

Photo's from diverse authors

## 5.3.5 **Spatial organisation** *household flows*

### # *Flows on local, city and regional scale*

As defined earlier in the scope, this project will examine the urban freight in the MRDH, which is the last part of the supply chain, the link between the distribution centres and consumers (via retailers). To come with interventions and improvements, the current spatial organisation and system need to be understood.

A way to understand the spatial organisation is visualising the metabolism of a household. In the visualisation, the most common flows for households, introduced on PAGE 29, are revealed. The analysis is done from the authors' household perspective. The household is located near the city centre of Delft. The flows are analysed on three scales: local [city centre], city [Delft] and regional [South-Holland] scale. The following maps (FIGURE 5.30, FIGURE 5.31 and FIGURE 5.32) show the journey of the goods from the distribution centres to stores en finally the author's household and waste from household to treatment plant. The situation from author's perspective may be a little biased, since the author is living close to the city centre and thus all the amenities are relatively close situated to this household, while this is not counting for every household. However, it is still possible to distillate some general conclusions in distribution scales. Furthermore, the location of the closest distribution centre as they are mapped is used to give direction to the flows. It will give a rough idea of the location of amenities and the diversity of flows on several spatial scale levels.

The spatial flow analysis will then be translated into separate generic systematic sections which should count for more or less every retailer so that it can give insight in retail and distribution scales and characteristics. Also a principal scheme will be presented per type of good that positions the different distributional components in the supply chain relative to each other based on the number of distribution centres, their (geographical) location and the area they serve. By understanding the spatial relationship within the supply chain and the operational characteristics per type of urban freight good, several group of goods can be created with common characteristics to determine suitable distribution requirements and spatial conditions for urban consolidation.

In the first part of the analysis, the visualisation of household flows, it can be observed that every retailer seems like to ship their goods from their distribution centre to their store, which causes a lot of freight movement in the city if it is done frequently and for every store. Especially on the regional scale, but also visible on a city scale, freight movements make use of the same highway corridors and seem like to use the same city entrances as most of the stores are likely concentrated. There is no general distribution for all the goods on the city scale since the distribution per type of good only takes place on at least a regional scale. There is neither distribution of urban freight taking place over water nor over rail.

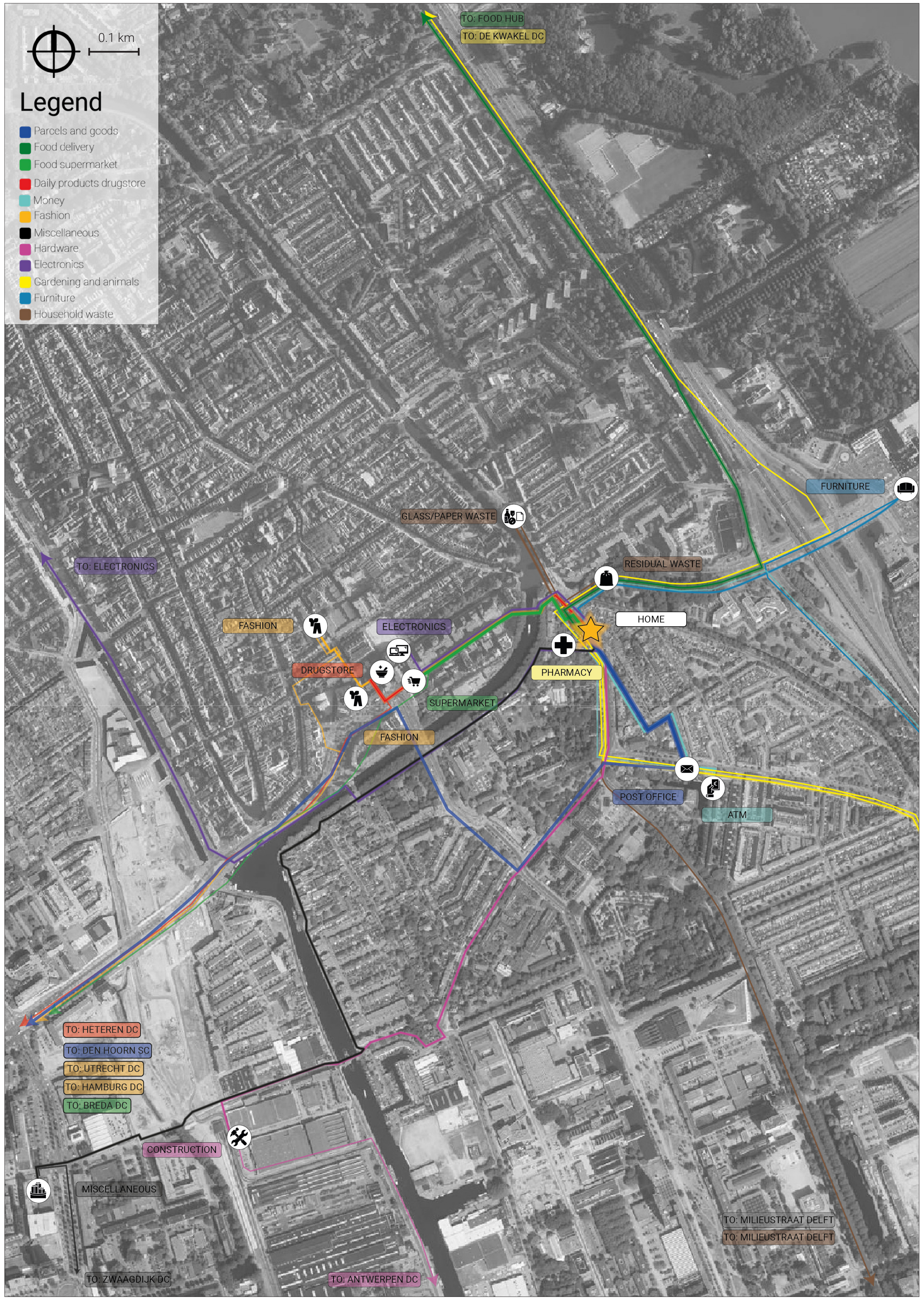



**FIGURE 5.30:**
Relevant flows from author's household (local sale)
*(authors drawing)*

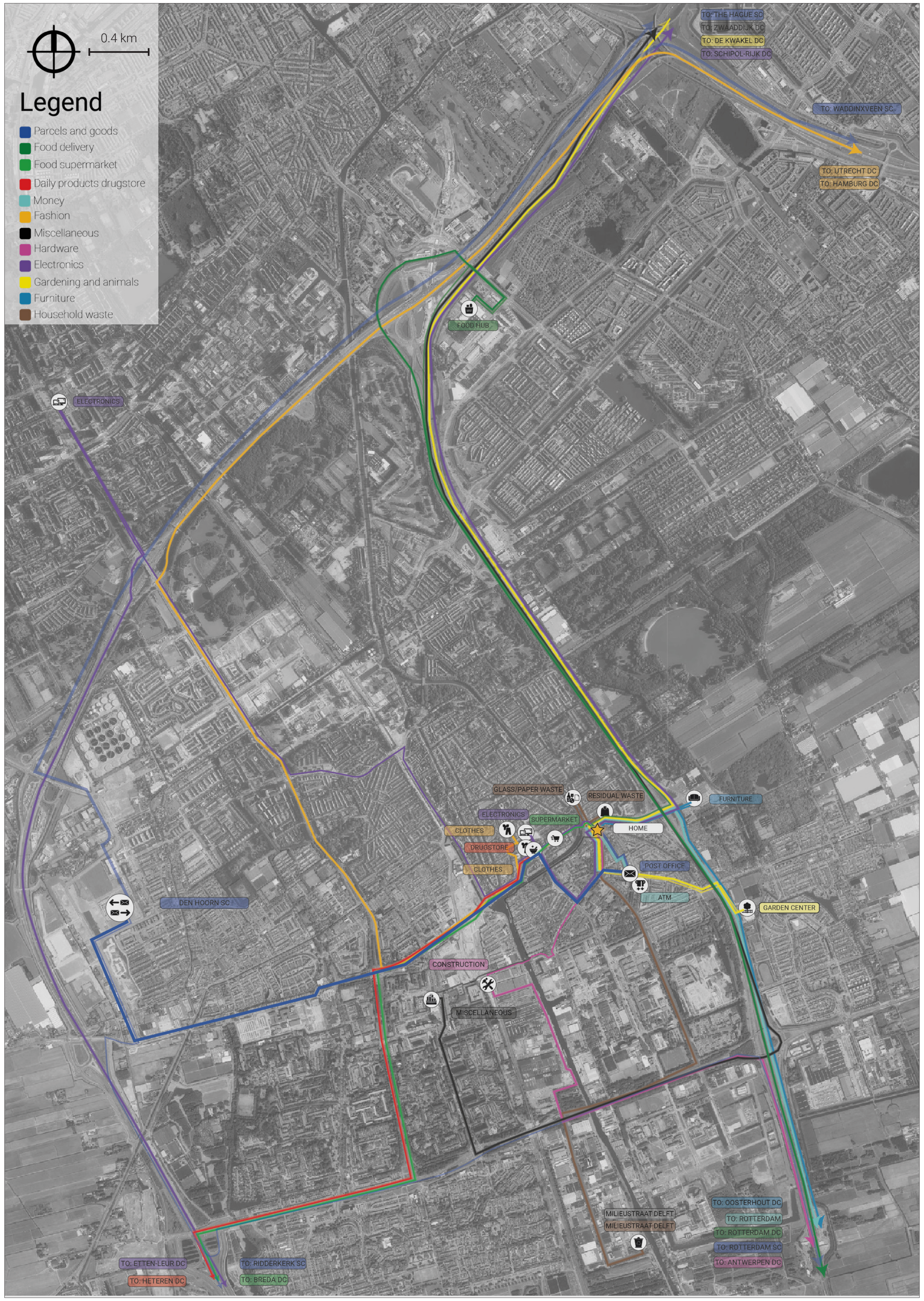



**FIGURE 5.31:**
Relevant flows from author's household (city scale)
*(authors drawing)*

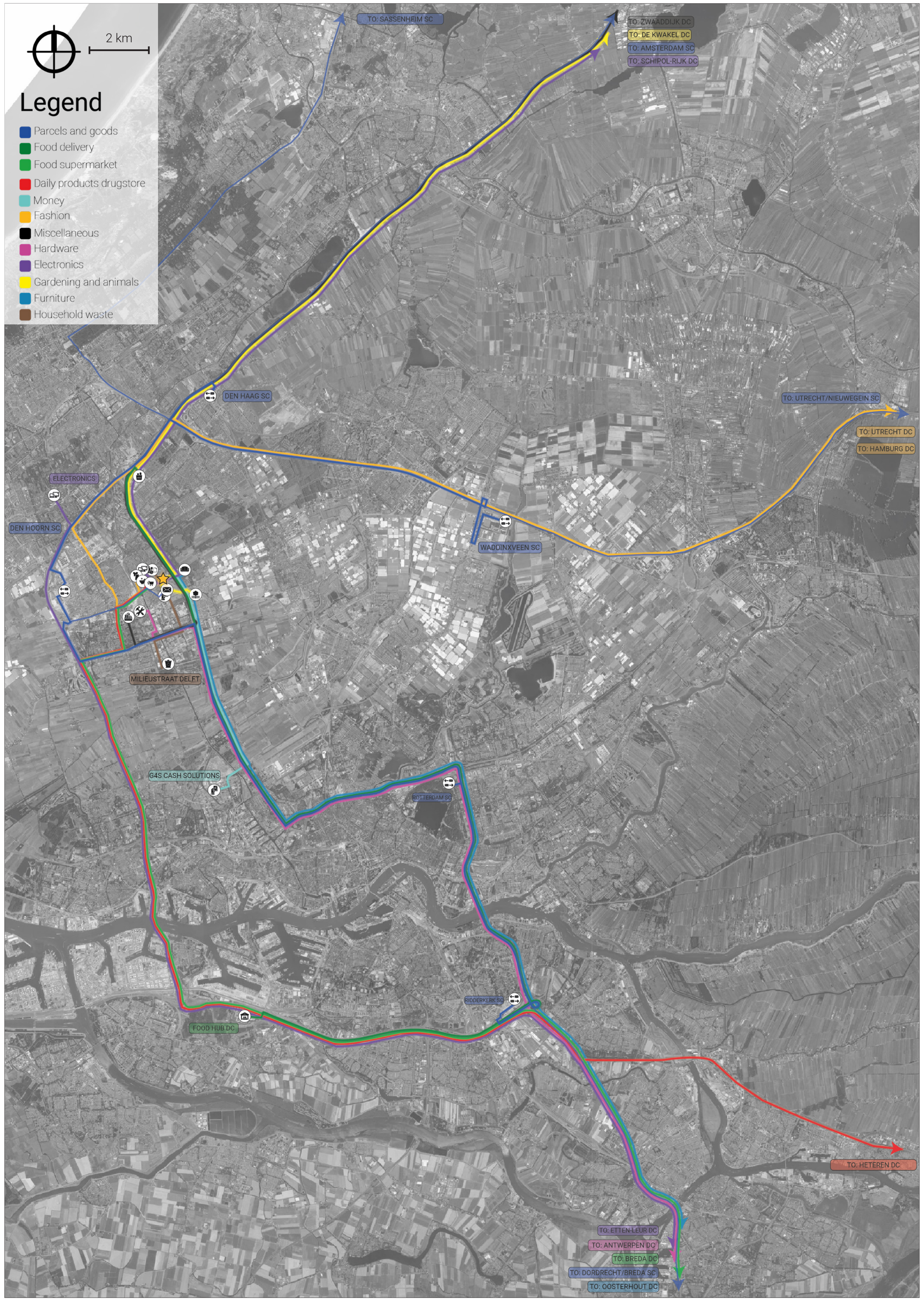



**FIGURE 5.32:**
Relevant fows from author's household regional scale)
*(authors drawing)*

## # *Operational scale of retailing and distribution*

Every flow is put in a separate section, which make use of spatial scales from street to international scale to show the spatial range of a specific supply chain. The sections show again the supply chain from the distribution centre to the consumer. The household flow analysis, the location and amount of distribution centres will be used to create a classification of products based characteristics of retail and distribution in terms of frequency of service, scale and typology of retail, shipment size and scale of distribution. The characteristics are shown in FIGURE 5.33 and the separate sections for every flow are shown in FIGURE 5.34.1 till FIGURE 5.34.12.

The amenities for goods that are needed frequently (daily; e.g. food) are located closer the author in single standing stores. With mapping the locations of the distribution centres of these amenities, it can be concluded that they have a regional and thus fine-grained distribution network which is a condition for frequent distribution. This is the case with supermarkets, post offices and to a smaller extent with daily products in e.g. drugstores. There are also goods that are needs to be bought on monthly basis such as clothes, miscellaneous and some products in electronics stores. These stores are mainly located in the city centre (traditional shopping streets) or at specific centralities (shopping malls). For the most households, this will mostly take a longer trip. This type of stores have distribution on national scale and sometimes international, since they have to cross the borders of the MRDH. Lastly, there are some stores visited rarely (monthly to yearly) such as garden markets, hardware and furniture stores. Even fewer of them are situated close to households, depending on where the consumers live. These are however mostly bigger stores in retail parks on the outskirts of the city, serving bigger geographical area. They have distribution on national and international scale.

Based on findings, it can be concluded that the spatial range of retail and distribution depends on characteristics (such as frequency of use and size) of the product. When combining all the sections into one figure (FIGURE 5.35), this automatically classifies different retail based on the spatial range of their supply chain, which are waste, daily retail, consumer retail and durable retail. The distribution centres can also be classified on their market orientation, which is based on regional, national or international coverage, as shown in FIGURE 5.36.

| Characteristics | Variables | | | |
|---|---|---|---|---|
| Frequency of service | Daily use of service | Weekly to monthly use of service | Montly to yearly use of service | Irregular use of service |
| Scale of retail | On neighbourhood level as amenity | On city level in shopping entities | On city level in outskirts of city | On city level both in shopping entities and outskirt |
| Typology of retail | Appears in every typology | Appears in free standing stores | Appears in shopping streets/centres | Appears in retail parks |
| Size of shipments and products | Small shipments small products | Small shipments large products | Large shipments small products | Large shipments large products |
| Scale of distribution | Regional oriented | National oriented | International oriented | National and international oriented |

**FIGURE 4.33:**
Characteristics and variables for the classification of goods *(author drawing)*

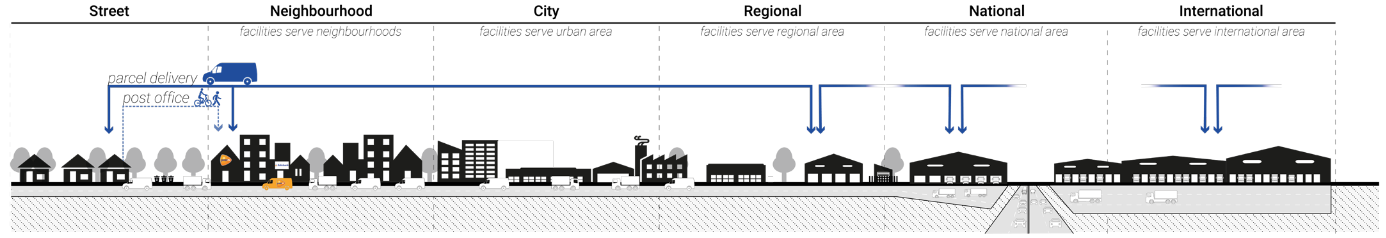



**FIGURE 5.34.1:**
Section post-office
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Daily use of post service |
| Scale of retail: | Appear frequent as pick-up point in supermarkets or small retailers |
| Typology of retail: | Appear mostly as pick-up point in every retail typology |
| Size of shipment and products: | Small shipments, small products |
| Scale of distribution: | Sorting centres are located in every region, not far away from each other |

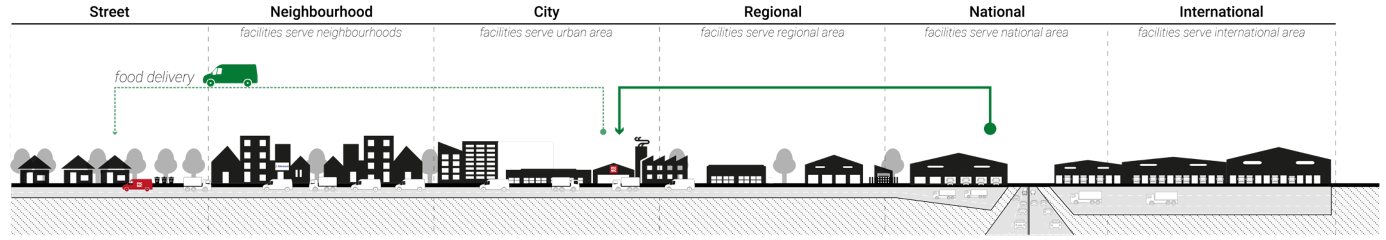



**FIGURE 4.34.2:**
Section food delivery
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Daily delivery to customers of fresh goods |
| Scale of retail: | Appear as hub and mostly located one per city and serve that city |
| Typology of retail: | Appear mostly as warehouse on a industrial area/retail park |
| Size of shipment and products: | Small shipments, small products |
| Scale of distribution: | Due to frequent, quick and fresh products, serving on regional scale |

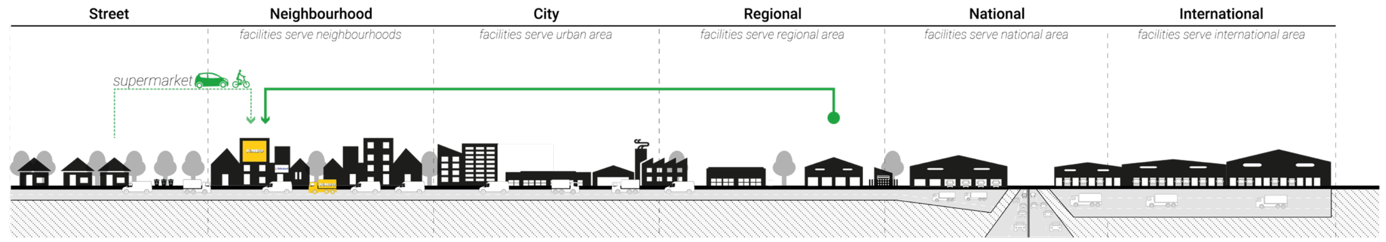



**FIGURE 4.34.3:**
Section supermarket
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Daily use of supermarkets of fresh goods |
| Scale of retail: | Appear on neighbourhood level and mostly close to households |
| Typology of retail: | Appear mostly as a free standing store |
| Size of shipment and products: | Large shipments, small products |
| Scale of distribution: | Due to frequent, quick and fresh products, serving on regional scale |

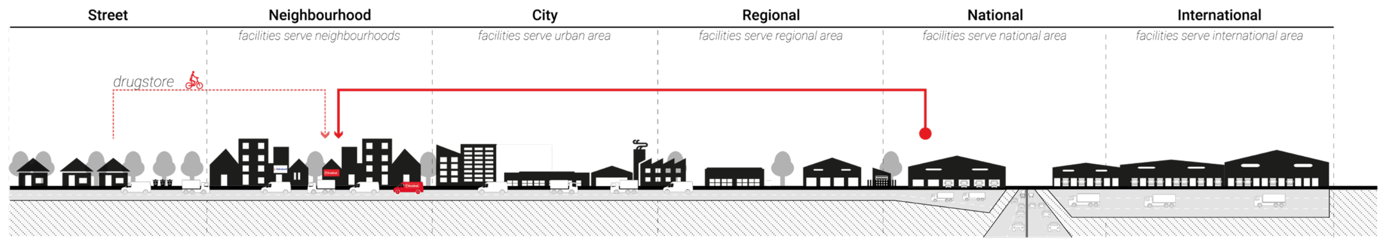



**FIGURE 4.34.4:**
Section drugstore
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Weekly use of drugstores of daily non-food products |
| Scale of retail: | A few of them appear mostly in the city centre, relatively close to households |
| Typology of retail: | Appear mostly as a small shop in a shopping centre or in a traditional shopping street |
| Size of shipment and products: | Small shipments, small products |
| Scale of distribution: | Most of the drugstores have one or two distribution, serving on almost national scale |

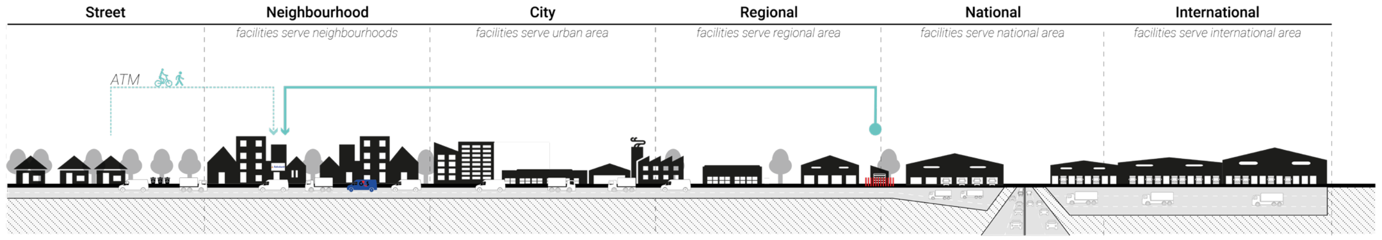



**FIGURE 5.34.5:**
Section ATM
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Irregular use, dependent on the need of money per person |
| Scale of retail: | Appear on various places in the city and neighbourhoods |
| Typology of retail: | Appear on various places in every retail typology |
| Size of shipment and products: | Small shipments, small products |
| Scale of distribution: | Money depots are located on a limited amount of places and serving on regional scale |

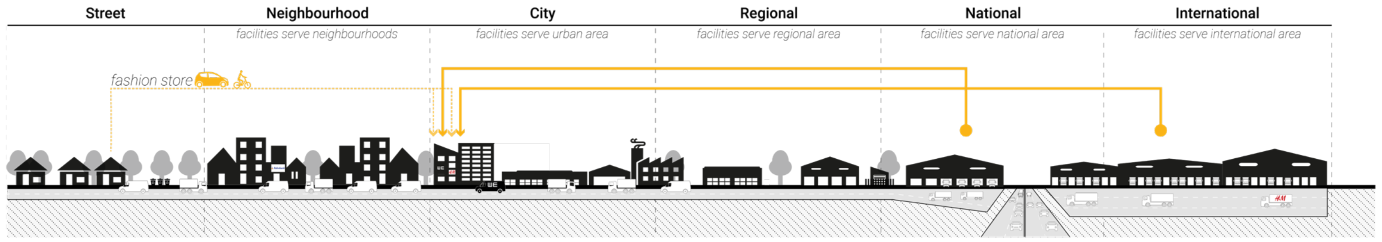



**FIGURE 5.34.6:**
Section fashion store
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Weekly to monthly use of clothes stores |
| Scale of retail: | Appear on city level and there are lot in city centres or shopping areas |
| Typology of retail: | Appear mostly as a small shop in a shopping centre or in a traditional shopping street |
| Size of shipment and products: | Small shipments, small products |
| Scale of distribution: | Most of the stores have one distribution centre, serving on national scale |
| | Dependent on the size of the brand, it also can be internationally |

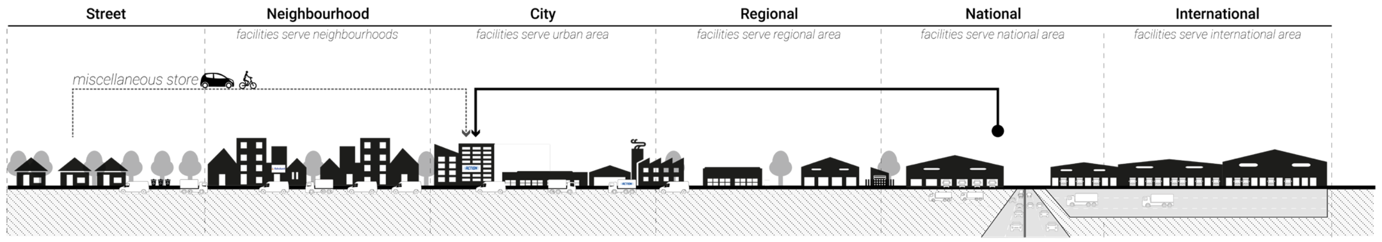



**FIGURE 5.34.7:**
Section misc store
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Weekly to monthly use of miscellaneous stores, they have a huge range of different goods |
| Scale of retail: | Appear on city level and mostly in city centres or shopping areas |
| Typology of retail: | Appear mostly as a small shop in a shopping centre or in a traditional shopping street |
| Size of shipment and products: | Small shipments, small products |
| Scale of distribution: | Most of the stores have one distribution centre, serving on national scale |

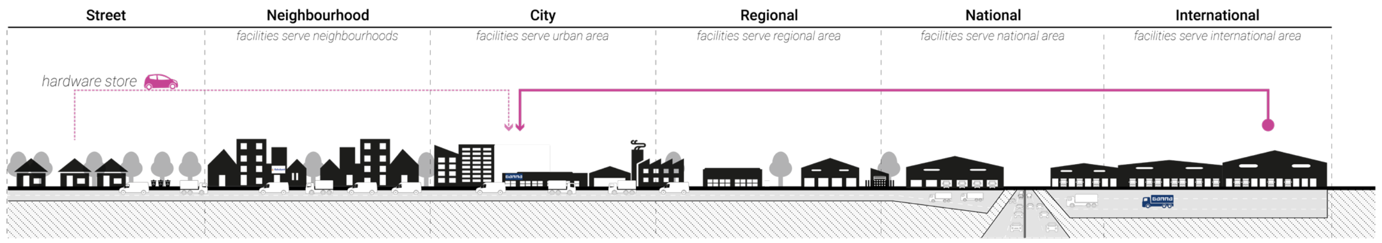



**FIGURE 5.34.8:**
Section hardware store
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Monthly to few times per year used |
| Scale of retail: | Appear on city level and are together located in the outskirts of the city |
| Typology of retail: | Appear mostly as a large shop at a retail park |
| Size of shipment and products: | Large shipments, diverse products |
| Scale of distribution: | Mostly one distribution centre in the Netherlands/abroad, serving on international scale |

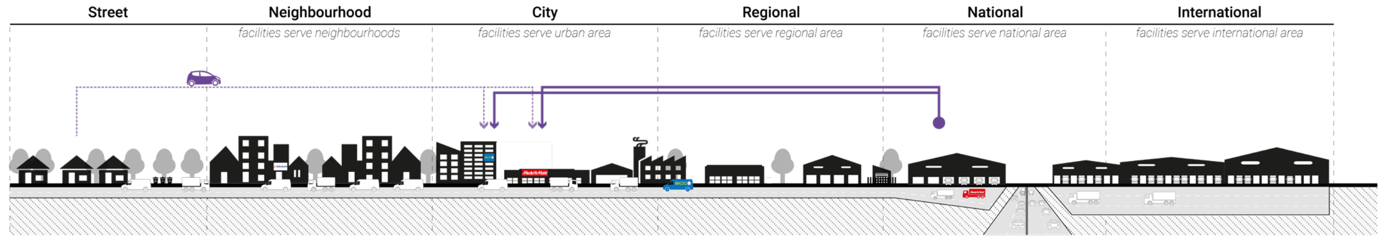



**FIGURE 5.34.9:**
Section electronics store
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Monthly to yearly use of electronics store, dependent on the type and size of the products |
| Scale of retail: | A few can be found in cities in the centre or outskirts, dependent on the store |
| Typology of retail: | Appear mostly as a small shop in a shopping street or in a large shop at a retail park |
| Size of shipment and products: | Large shipments, diverse products |
| Scale of distribution: | Most of the stores have one distribution centre, serving on national scale |

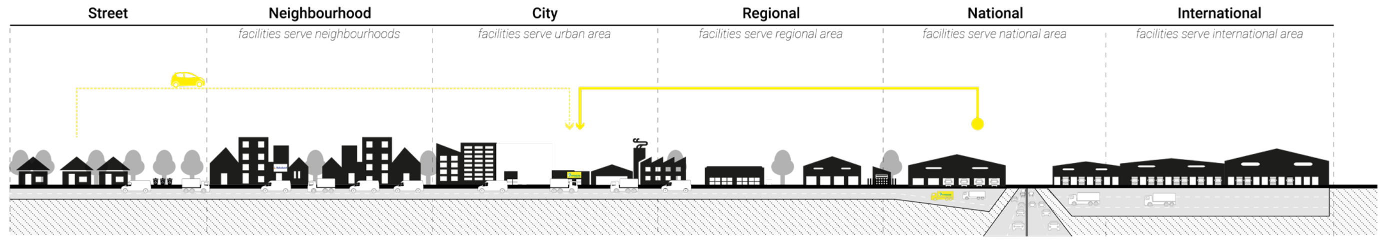



**FIGURE 5.34.10:**
Section gardeing store
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Towards a yearly use of garden centres, dependent on season |
| Scale of retail: | Serving on regional scale, mostly can be found on the outskirts of the city |
| Typology of retail: | Appear mostly as a large shop at a retail park |
| Size of shipment and products: | Large shipments, medium to large products |
| Scale of distribution: | Most of the stores have one distribution centre, serving on national scale |

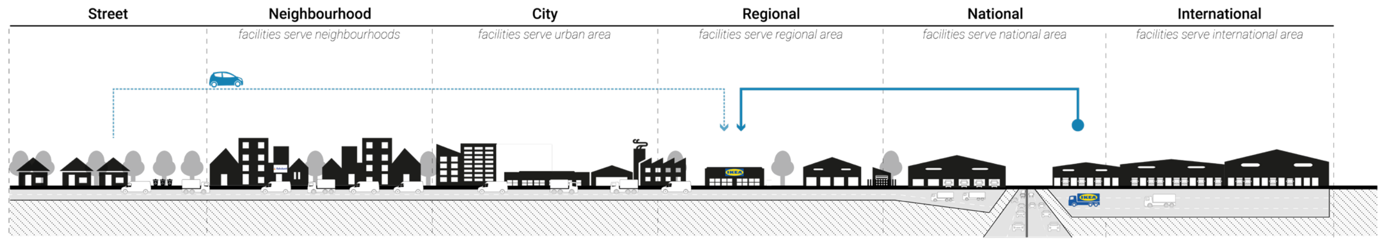



**FIGURE 5.34.11:**
Section furniture store
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Towards a yearly use of furniture stores, dependent on consumer stage of life |
| Scale of retail: | Serving on regional scale, mostly can be found on the outskirts of the city |
| Typology of retail: | Appear mostly as a large shop at a retail park |
| Size of shipment and products: | Large shipments, large products |
| Scale of distribution: | Most of the stores have one distribution centre, serving on national scale |

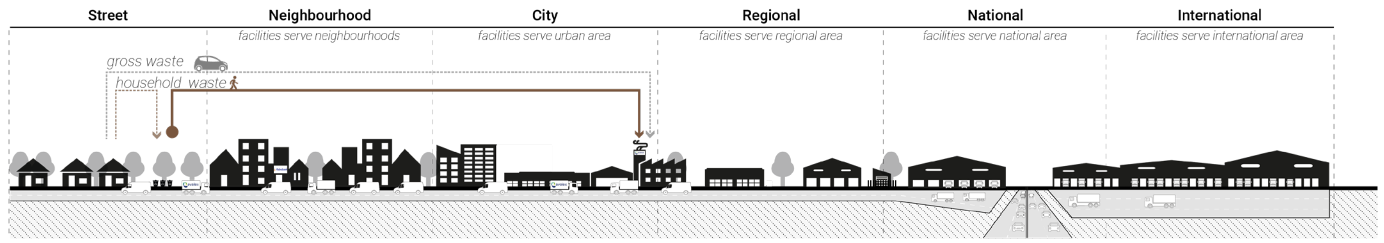



**FIGURE 5.34.12:**
Section waste collection
*(author drawing)*

| | |
|---|---|
| Frequency of service: | Daily (couple times per week) delivery of waste to the collection points |
| Scale of retail: | Waste collection points can be found in the most streets |
| Typology of retail: | n/a |
| Size of shipment and products: | small shipments, small portions of waste |
| Scale of distribution: | Most of the waste is collected in the own city or neighbouring cities |
| | Further processing and recycling can happen on regional level |

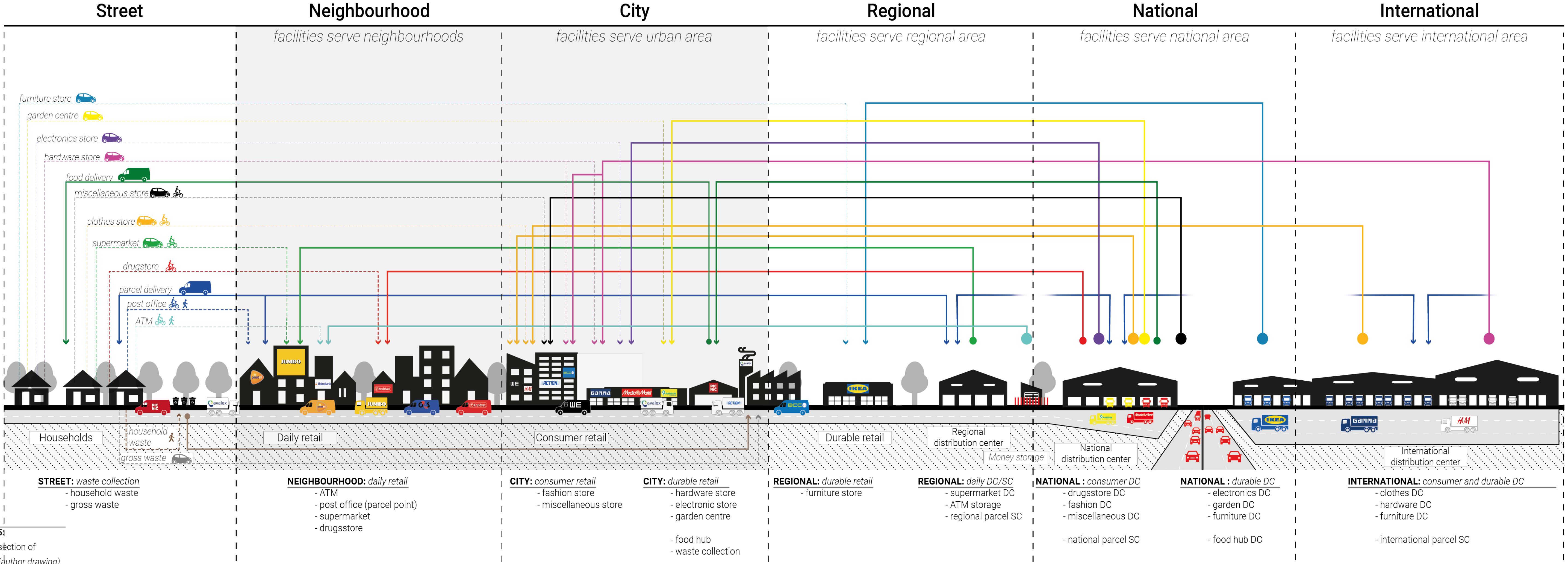



**FIGURE 5.35:** Systematic section of distribution (*author drawing*)

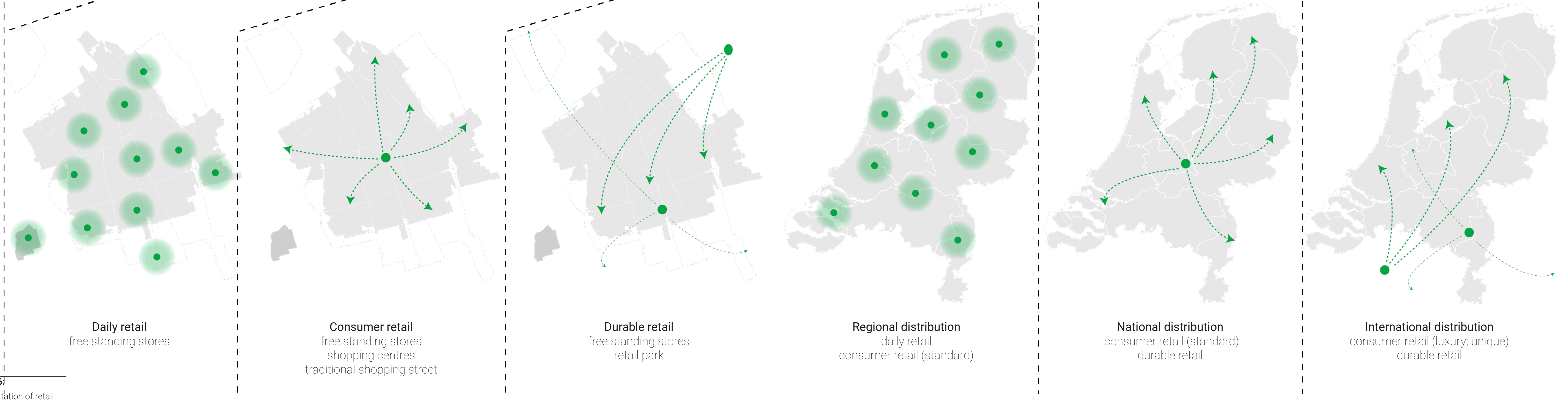



**FIGURE 5.36:** Market orientation of retail and distribution centres (*author drawing; adapted from CRa, 2019*)

## **5.3.6 Spatial organisation** *synthesis*

Based on the characteristics and variables for the classification of goods, this principal scheme (FIGURE 5.37) is made. It conceptualises the last part of the supply chain on their operational scale relative to each other. Input for each supply line are the scale of retail and distribution, the number of distribution centres, their (geographical) location and the area they serve. The analysis is done in order to create insights in every type of good and to find out clusters of goods that could be appropriate for urban consolidation due the logistic operation on the same scale. This analysis together with the findings of FIGURE 5.34.1 till FIGURE 5.34.12 result in three groups of goods, which all have a different potential for consolidation.

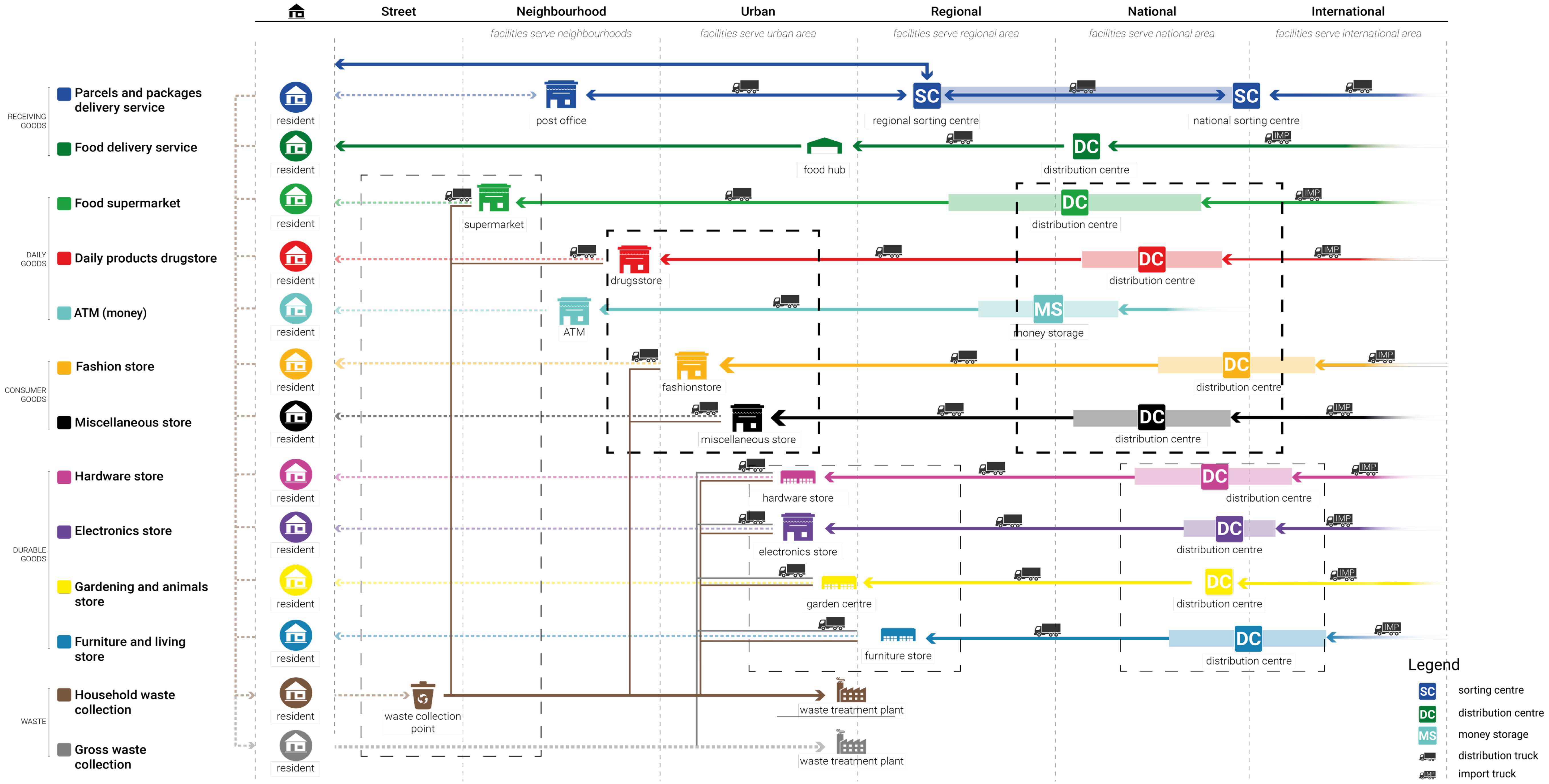



FIGURE 5.37:
Principal section of distribution
*(author drawing)*

The types of goods are shown in the diverse figures on this page (FIGURE 5.41 till FIGURE 5.43). Left outside consideration are parcel and packages service, food delivery service and money supply for ATMs. The first two, parcel and packages delivery and food delivery services are not supplying any retailers and are directed to customers. The delivery of freight to consumers falls out of the scope of the research and moreover, they already have an efficient system. The supply of money to ATM's belongs to secured goods: they need special secured delivery methods and thus there is no need to include this in the standard supply.

| Type of goods | Service frequency | Retail scale | Retail typlogy | Shipment size | Distribution scale |
|---|---|---|---|---|---|
| Food supermarket (3) | Daily use of service | On neighbourhood level as amenity | Appears in free standing stores | Large shipments small products | Regional oriented |
| Waste (12) | Daily use of service | On neighbourhood level as amenity | n/a | Small shipments small portions of waste | Regional oriented |

**FIGURE 5.38:**
Group 1: daily goods
*(author drawing)*

This group has in common that these two types are operating both on the daily frequency and that they can be considered as vital and fall under daily goods, as earlier stated. They have the same retail and distribution scale (for consumers in the neighbourhood scale and distribution on the regional scale). Although the shipment size of supermarkets is large and the supply efficiency is already high, improvements can be made to utilise the opportunity to integrate waste (reverse) in the food chain.

| Type of goods | Service frequency | Retail scale | Retail typlogy | Shipment size | Distribution scale |
|---|---|---|---|---|---|
| Drugstore (4) | Weekly use of service | On city level in shopping entities | Appears in shopping centre/street | Small shipments small products | National oriented |
| Fashion store (6) | Weekly to monthly use of service | On city level in shopping entities | Appears in shopping centre/street | Small shipments small products | National and international oriented |
| Miscellaneous store (7) | Weekly to monthly use of service | On city level in shopping entities | Appears in shopping centre/street | Small shipments small products | National oriented |
| Electronics store (9) | Monthly to yearly use of service | On city level in shopping entities and outskirts | Appears in different forms in every typology | Large shipments diverse products | National oriented |

**FIGURE 5.39:**
Group 2: consumer goods
*(author drawing)*

These four types are consumer goods and are mostly considered as essential provisions. This is also the largest group of goods with a substantial amount of generated freight movements. A big advantage is that these stores are often concentrated in a retail entity (shopping centre/street) with relatively frequent deliveries in the form of small shipments and small products. This gives the group of consumer goods a huge potential for consolidation in which a large, substantial part of these retailers could participate in the consolidation of goods.

| Type of goods | Service frequency | Retail scale | Retail typlogy | Shipment size | Distribution scale |
|---|---|---|---|---|---|
| Hardware store (8) | Monthly to yearly use of service | On city level in outskirts of city | Appears in retail parks | Large shipments diverse products | National and international oriented |
| Electronics store (9) | Monthly to yearly use of service | On city level in shopping entities and outskirts | Appears in different forms in every typology | Large shipments diverse products | National oriented |
| Gardening store (10) | Towards yearly use of service | On city level in outskirts of city | Appears in retail parks | Large shipments diverse products | National oriented |
| Furniture store (11) | Towards yearly use of service | On city level in outskirts of city | Appears in retail parks | Large shipments large products | National oriented |

**FIGURE 5.40:**
Group 3: durable goods
*(author drawing)*

The third group includes stores with basically (large) durable goods and are characterised by being visited by consumers on a monthly to yearly basis. This type of stores is mostly located on the outskirts of the city. Consolidation of the smaller products of these stores could work, however, it will become inefficient to consider the whole assortment (of large products). Therefore there is a partial potential and thus concerning consolidation, it needs to be considered per case.



## 5.3.7 **Spatial organisation** *intermediate conclusion*

The spatial organisation is visibly organised according to the specific location factors for (logistic) companies. This paragraph has attempted to understand and to translate these location factors for the Dutch context. The Netherlands, and in particular the southern provinces, tends to be a highly interesting place for logistic companies and thus it is proven to be an interesting case study for urban freight. The presence of high dense areas is relevant as well. Higher population density means a higher density of stores, which also means a higher density of urban freight activities.

On the macro scale, the location of distribution centres and other logistic facilities is determined by policy and regulations. In the Dutch context, this is in broad lines done by municipalities who are responsible for the implementation and spatial planning and thus the zoning of industrial areas (logistics). This planning is based on environmental regulations, but also the political aspect takes a huge part in the decisionmaking. The direct role of provinces and the national government, however, remains limited and is more facilitating and advisory.

The (Dutch) government, however, influences in the particular road (highway) infrastructure planning and since the infrastructure is an important criterion for the structure of distribution centres, they influence the location of distribution centres. Nowadays, the distribution of urban freight still relies on road traffic for both outside and inside urban areas, in which the truck is the most popular mode (in the Netherlands) and is still growing. This is logical since the structure of distribution centres for urban freight is also mostly determined by highway infrastructures, while the structure of railways and waterways seem to be less relevant. The dominance of highway infrastructure is also visible in the local analysis where the household flows are visualised. There can be seen that urban freight movements all make use of the same highway corridors, without urban freight transported over rail and water. The potential of multimodality within urban areas is not utilised since there is no application of freight boats (water) and freight trams (rail). At the same time, every retailer transports its goods from their distribution centre to their store, which generate a lot of freight movements. Furthermore, there are no distribution centres on the city scale, they all distribute on at least a regional scale. The division of retail typologies makes the challenges and difficulties in terms of supplying per sector also more insightful.

With analysis on a household level, firstly the metabolism of the authors household is shown. Then the flows per type of good are illustrated in a simplified way to understand the frequency of use, typology, the scale of retailing and distribution and shipment size. It can be concluded that the spatial range within the supply chain depends on the characteristics of a good. The last part of the supply chain tends to be shorter when the frequency of use is higher.

Furthermore, goods are categorised into three groups, based on their characteristics, the potential for every group is different. Consumer goods (drugstores, clothes stores, miscellaneous and electronics stores) tend to have the highest potential for consolidation based on their spatial and operational organisation since they are concentrated in cities, their goods have more or less the same shipment size and frequency and they are distributed from the national scale.

## 5.4 *Stakeholder management*

Within the planning of freight, there is a complex network of stakeholders that needs to be considered. They are important factors in the planning procedure since the consequences and outcomes of decisions are affecting all the stakeholders (Lindholm, 2012). This paragraph identifies the stakeholders including their influence and interests. It also will discuss the relationship between the stakeholders and the role of the urban planner in urban freight.

### 5.4.1 *Stakeholder management* identification of stakeholders

Combining the stakeholder distinction of Taniguchi (2014) and Bjørgen et al. (2019)., stakeholders can be divided into four groups: authorities, residents, receivers and logistic companies. All the stakeholders of urban freight have the common objective of taking care for the transportation of goods in urban areas at the right time and place in the right quantities. Nevertheless, the individual interests of the stakeholders are often conflicting, since they all have different perspectives on urban freight transport. The stakeholders are somehow particiating, being affected or carry responsibility in urban freight operations (Anand et al., 2012).

Basically, the stakeholders with direct influence can be divided into two important groups, the private stakeholders and the public stakeholders, which are capable of inciting changes and having the rationale to go towards a sustainable urban freight system. Policy makers can fund or invest in initiatives, shippers can change logistics, while consumers can exert indirect influence by voting or buying and receivers can pick their shippers. The following page gives an overview of the (direct or indirect) influence and interests of stakeholders (FIGURE 5.41).

| | | Actor | Description | Influence | Interest | I/D* | Interest in project/goals |
|---|---|---|---|---|---|---|---|
| Public stakeholders | Authorities | Dutch Government | Authorities that are responsible for the general management of the Dutch nation state | ●●●○○ | ●●●○○ | D | Implement sustainable development (economic, social and environmental) Make the Netherlands circular and reliable on reneweble energy resources |
| Public stakeholders | Authorities | Province of South-Holland | Authorities that are responsible for the general management of the province of South-Holland | ●●●○○ | ●●●●○ | D | Improve accesibility and strengthen their economic business climate in this high densed area. |
| Public stakeholders | Authorities | MRDH | Municipal collaboration in the province aiming at a accesible and strong economic region | ●●○○○ | ●●●●○ | I | Aims jointly for a $CO_2$ reduction in transportation of 1.4 Mton in 2025, while strengthening the economic business climate and accessibility |
| Public stakeholders | Authorities | Involved municipalities | Seperate authorities that are responsible for the general management of the 24 cities in the MRDH | ●●●●● | ●●●●● | D | Aim equally for an optimal liveability of the city, attractive places for residents and economic development |
| Public stakeholders | Authorities | Ministry of Infrastructure and Water Management (Rijkswaterstaat) | National and executive authority on infrastructural and environmental issues in the Netherlands | ●●●○○ | ●●●●○ | I | Aims equally for a optimal liveability of the city, attractive places for residents and economic development |
| Private stakeholders | Residents | Inhabitants | Inhabitants of the MRDH and consumers of goods and services. They are represented by the government | ●●●●○ | ●●●●○ | I | Get quick and frequent deliveries, access to a wide variety of goods at affordable cost and a proper liveability in cities (no air and noise pollution etc.) |
| Private stakeholders | Residents | Temporary residents | This are people not living in the MRDH, but spending some time in the MRDH (tourists/ commuters) | ●○○○○ | ●●●○○ | I | Access to a wide variety of goods at affordable cost and a proper liveability in cities (no air and noise pollution etc.) |
| Private stakeholders | Receivers (and shippers) | Physical retailers | High heterogeneous entities that provide and sell consumer goods to residents via a physical shop | ●●○○○ | ●●●○○ | I | Offer excellent customer service (supplied on time) and consumer goods to residents, make profit and be recognised as a 'sustainable company' |
| Private stakeholders | Receivers (and shippers) | Online retailers | High heterogeneous entities that provide and sell consumer goods to residents via an online shop | ●●○○○ | ●●○○○ | I | Offer excellent customer service (supplied on time) and consumer goods to residents, make profit and be recognised as a 'sustainable company' |
| Private stakeholders | Receivers (and shippers) | Supermarkets | Entities that provide and sell food and daily goods to residents | ●●○○○ | ●●○○○ | I | Offer excellent customer service (supplied on time) and consumer goods to residents, make profit and be recognised as a 'sustainable firm' |
| Private stakeholders | Logistic companies | Post/packages carriers | Entities that provide the distribution and transportation of packages and parcels | ●●●●○ | ●●●○○ | D | Minimise logistic costs and maximise offered service performance and customer happiness. Their behaviour is reflected by customer needs' |
| Private stakeholders | Logistic companies | retail carriers | High heterogeneous entities that provide the supply of physical retailers (transport) | ●●●●● | ●●●●○ | D | Minimise logistic costs and maximise offered service performance and customer happiness. Their behaviour is reflected by customer needs' |
| Private stakeholders | Logistic companies | distributors | High heterogeneous entities that provide the storage and distrbution of retailers | ●●●●○ | ●●●○○ | D | Minimise logistic costs and maximise offered service performance and customer happiness. Their behaviour is reflected by customer needs' |

* Direct or Indirect influence

**FIGURE 5.41:** Overview of stakeholders with power and interest *(authors' drawing)*

## 5.4.2 **Stakeholders** *interaction of stakeholders*

This paragraph examines the interaction between urban freight stakeholders in physical (how they affect each other) and behavoral (how they stand to each other) terms (FIGURE 5.42) . These are derived from the identification of stakeholders, which are shown in a involvement-influence and interest-influence diagrams (FIGURE 5.43.1-2), showing that there is a discrepancy in the degree of involvement and the contrary degree of interest to change urban freight. Another way for understanding the interaction between stakeholders is done by literature research, which resulted in the theory paper of the course AR3U023 THEORIES OF URBAN PLANNING & DESIGN which can be found in APPENDIX III. Two issues have been identified within the stakeholders of urban freight:

1) lacking attention to urban freight of policy makers (and urban planners)

2) conflicting (contrary) interests between all the stakeholders

Several passages are shown in this paragraph to elaborate on those two issues. The complete theory paper can be found in APPENDIX III.

### # *Abstract*

Below the abstract of the theory paper written for the course AR3U023 THEORIES OF URBAN PLANNING & DESIGN


Stakeholder management in urban freight

How freight planning can be improved through stakeholder management

Cities around the world are at the point that delivery of urban freight is reaching the limit of their capacity to accommodate the growing transportation demand. This has challenged decision-makers to improve the logistical performance and reduce the social, economic and environmental impacts of transportation. Therefore clear policies on urban freight become crucial in cities. With multiple stakeholders having conflicting interests, a comprehensive understanding of the interactions between private and public stakeholders is necessary. The purpose of the paper is to provide a foundation in the research of the integration of stakeholders within urban freight transportation by identifying them and explaining their role, goals and focus in the urban freight sector. By identification of stakeholders and their interests, it becomes clear that although the growing significance of urban freight transport in cities, the efforts of authorities done to and understanding of urban freight activities are insufficient. Local authorities have to acknowledge the need for integrating urban freight in urban planning. With a new organisational model for freight management in cities, they have to play a pro-active role and become facilitators of sustainable transportation. When authorities are aware of the needs of key stakeholders in urban freight, this can lead to better collaboration.



*Keywords: Urban freight transportation, freight planning, stakeholder management, public authorities, integration*

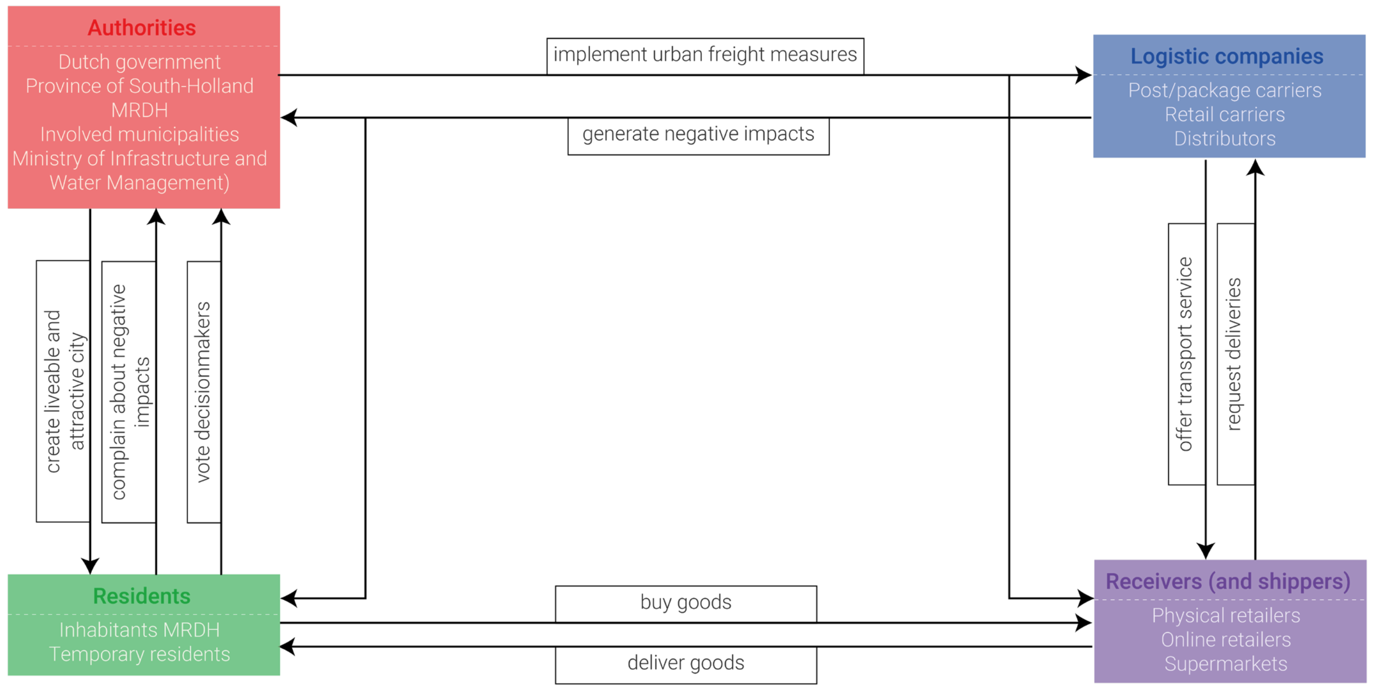




**FIGURE 5.42:**
Interaction among important stakeholders *(adapted from Suksri & Raicu, 2012 and de Oliveira & de Oliveira, 2017)*

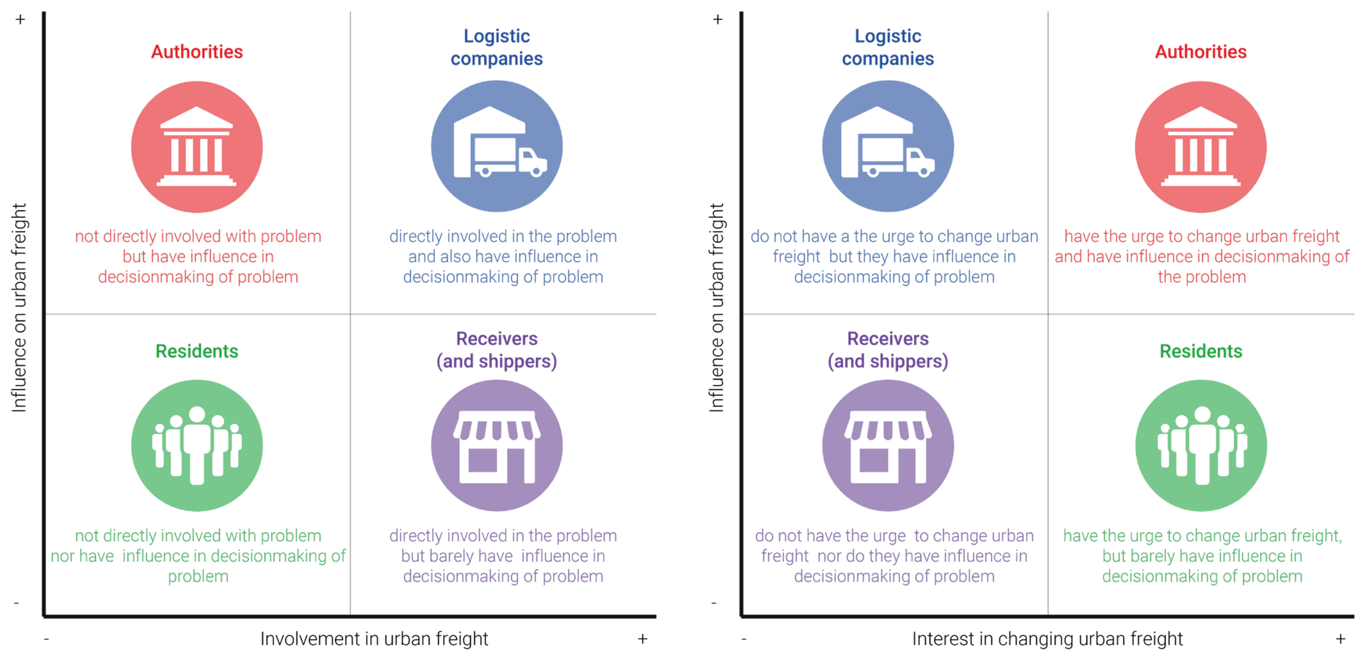



**FIGURE 5.43.1-2:**
Influence and involvement/ interest diagram *(adapted from Van Den Bossche et al., 2017)*

# *Lacking attention to urban freight of policy makers (and urban planners)*

Several reasons can explain the lack of attention to urban freight. As earlier mentioned, transportation planning consists of passenger transport and freight transport. Almost all the attention so far, however, has gone to optimisation of passenger transporation (movement of people) systems instead of urban freight. The focus of urban transportation lays more on public transportation since cities are seen as locations of human interactions with traffic patterns related to commuting, commercial and leisure/cultural movement and activities. Though, cities are at the same time inherently connected to production, consumption, distribution, which rely on movements of freight (Rodrigue et al., 2013).

At the same time, people transportation is considered by authorities as a public service, while the transportation of goods is in the private sector (Allen et al., 2012b). Since it is considered as a service in the private sector, local authorities have invested so little in the planning of urban freight transportation (Oliveira, Oliveira, & Correia, 2014). Authorities do not feel any involvement yet with the operations of private stakeholders. Freight transportation is often seen as a market and business-driven interest with bare connections to local authorities. Local authorities failed in seeing possibilities for improvements in regulations and policies (Lindholm, 2012).

Another reason for the lack of freight planning is the political layer of public transportation. Individual mobility in the form of automobile and public transportation have preoccupied local authorities (and thus transportation and urban planners). Public transportation has a social purpose by providing equal accessibility and social equity. Since users of the automobile and public transportation services are also voters for (local) elections, public transportation has a higher priority on the political' and planners' agenda. In practice, passengers' trains for instance have priority over freight trains, since freight trains are excluded from day-time slots due to passenger demand and lower operational speed (Rodrigue et al., 2013). Freight transportation usually does not have political influence and are therefore more 'regulated' (MDS Transmodal Limited, 2012). Early applications of regulations in urban freight logistics are taken in Japan and Western Europe. They were constrained with a lack of available land and have an established urban planning tradition (Rodrigue et al., 2013).

Nevertheless, in the Dutch context, Van Duin (2005) showed that cities just have copied each other's freight regulations without sharing experiences and taking into account that measures have a different impact on different city characteristics. At the same time, those regulations are scarce and out-of-date. Most of the regulations are related to restrictions on vehicles, based on size or weight and delivery time windows mostly in the morning (Dablanc, 2007; Lindholm, 2012). These regulations are just tackling the problem at the edges with suboptimal solutions. Since there is a lack of proper data on freight traffic, this makes the planning and regulations inevitably precarious in cities (Rodrigue et al., 2013).

Thus, it can clearly be stated that the preponderance is devoted to optimal passenger transportation, while freight is left out of the field. This is a critical issue for local authorities because, with the absence of clear authority on freight planning, all the stakeholders will act autonomously which makes urban freight even a more complex and unsustainable system (Anand et al., 2012).

### # *Conflicting interests*

Conflicting interests between stakeholders groups arise inevitably. These different interests have made the search for solutions regarding sustainable urban freight transportation even more complex (MDS Transmodal Limited, 2012). When comparing the interests of the private and the public stakeholders, it can be noticed that private stakeholders want to benefit from mainly economic sustainability wherein they want to satisfy their customers with high quality and fast deliveries in the competitive market, while public authorities put effort into the attractiveness and liveability of their city on behalf of their residents and visitors, mainly related to environmental and social sustainability, (Russo & Comi, 2012). They need to attempt with interventions to balance the interest of both. Cities' authorities are aware that they need freight transportation for economic purposes, but most of the cities regard truck traffic as something that needs to be banned or strictly regulated, while just a few consider freight activities as a service, which they should support in their goals. Truck operators believe that cities only will take measures related to access restrictions, leaving the global and innovative freight management out of consideration (Dablanc, 2007).

It is for local authorities a complex challenge to develop measures on the incitement of better efficiency and sustainability due to different characteristics of urban freight in different sectors (MDS Transmodal Limited, 2012). Though, the efforts and the current organisation of public authorities also can be criticised. In the organisation of local authorities, freight planning responsibilities tend to be divided across different departments. This causes a lack of overview by individuals in the whole domain of freight transportation at the city level. At the same time, there is a missing continuity and uniformity in freight politics of cities since freight planning is performed on a case-to-case basis and with lack of holistic consideration, this makes it more difficult to come with comprehensive solutions. The impact of freight is barely considered in daily planning activities due to lack of experience and involvement of private stakeholders. Also regarding the national governmental body, guidance on urban freight management in practice is missing. Strategies and planning are having a limited overlap at the different scales (local, regional and national) (Bjørgen et al., 2019).

There seems like a discrepancy in the responsibility, jurisdiction and perceived ownership over local urban freight issues (FIGURE 5.44). National governments leaving the responsibility to local governments, since they see it as a local problem, while the local governments consider this as a private-sector problem since problems are generated by private commercial activities. However, the private sector believes that urban freight is an infrastructural and regulatory issue, which needs to be addressed by governments (Smart Freight Centre, 2017).

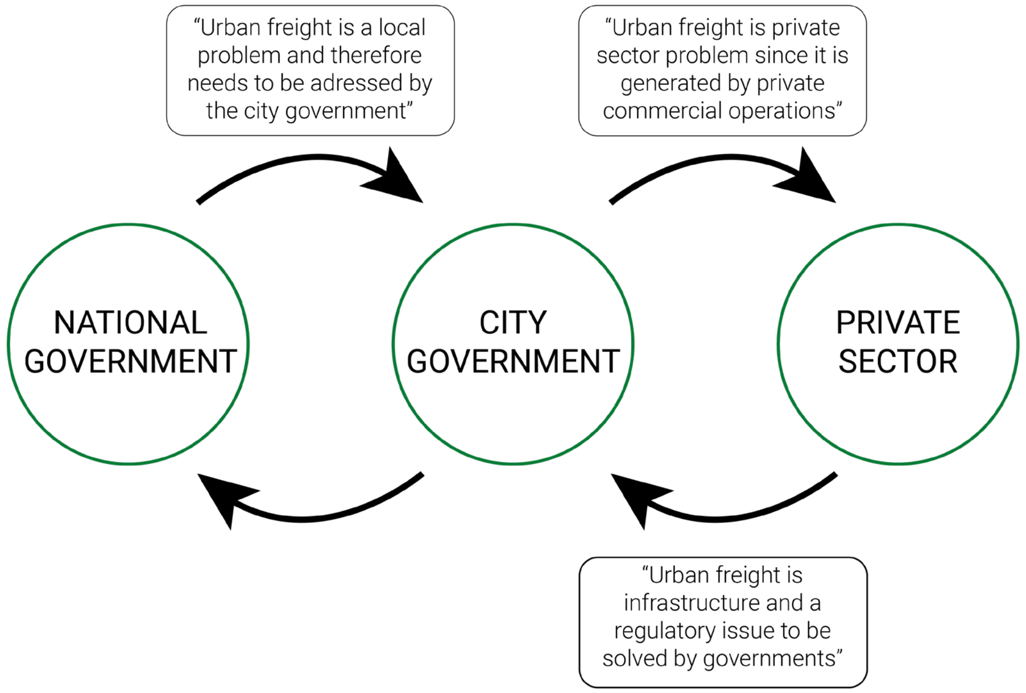



**FIGURE 5.44:** Dynamics between different stakeholders *(adapted from Smart Freight Centre, 2017)*

According to Dablanc (2007), stakeholders are willing to change, but it seems like that the stakeholders also have different expectations to each other on taking initiatives for change. On the first-hand authorities expect private stakeholders to set up sustainable operations to accommodate the increasing needs of customers and retailers. At the same time, those companies expect from authorities that they initiate (and subsidise) regulations on sustainable operations, because companies do not want to take high risks in their operations and do not want to invest high amounts on this, without the certainty of benefitting from it. The awaiting and passive attitudes toward each other make changes in the behaviour of logistic stakeholders are slow.

## 5.4.3 **Stakeholder management** *intermediate onclusion*

The understanding of stakeholders is important due to the necessity of good decision-making and policies on freight with respect to the ongoing trends. Four important groups of stakeholders have been identified: authorities, residents, receivers and logistic companies. All four have a same common objective in urban freight, but individual interests are often conflicting due to different perspectives on urban freight. By identifying the different stakeholders and their interests, it became clear that although urban freight transportation has got a growing significance in cities, the efforts of authorities done to urban freight is still insufficient. Two main issues have been identified within urban freight:

1) lacking attention to urban freight of policy makers (and urban planners)
2) conflicting (contrary) interests between all the stakeholders

The planning of public transportation is more advanced and has received more attention, since the transportation of people is considered by authorities as a public service, while the transportation of goods is in the private sector. Through this, authorities do not feel any involvement yet with the operations of private stakeholders. Also, peoples' well-being got priority over sustainable delivery of goods.

Within the urban freight sector, there are different interests of public and private stakeholders. Due to a lack of proper data, experience and knowledge, it is unsure if applied measures actually work. Cities copies each other's freight regulations without sharing experiences. All the stakeholders are willing to change, however, expectations on initiatives are not clear to each other, while responsibilities on urban freight are shifted to another stakeholders since the stake of the several stakeholders in the problem is not directly recognized nor do they feel responsible for it to solve the problem. The awaiting and passive attitudes toward each other make changes in the behaviour of logistic stakeholders slow.

## 5.5 **Conclusion**

This chapter had the purpose to research how is the urban freight transportation currently organised in the MRDH in terms of its initiatives, measures and concepts, its spatial organisation and its stakeholder management.

As earlier shown in the third chapter, urban freight volumes are growing. Despite the increasing demand, neither research from urbanism nor transport paid attention to this topic until the last decade. The number of vehicle kilometres and negative externalities will somehow lead to sustainable solutions or at least the urge to do so will grow. But this does not occur automatically. Authorities do not feel any involvement yet with the operations of private stakeholders.

Logistics and urban freight distribution raised awareness after the mid-1990s. There have been attempts to pinpoint urban freight problems and potential solutions, such as a declaration of intent in the form of the Green Deal ZES agreement. Successful implementation of this agreement also goes along with the availability of zero-emission vehicles. Nowadays the production of these vehicles (especially the large trucks) is yet limited.

On the policy side, there is a lack of national alignment and guidelines in the whole urban freight sector. There is a missing alignment in the measures. The municipalities in the MRDH have applied comparable measures, such as low emission zones and time windows but based on different parameters, which is confusing and frustrating for logistic operators. There is also a lack of national alignment in the spatial organisation of logistic facilities. This has resulted in a sprawl of distribution centres in the Dutch landscape along highways. The truck is the most popular mode (in the Netherlands) and has by far the biggest stake in urban freight. The structure of railways and waterways seem to be less relevant. The dominance of highway infrastructure is also visible on the local scale wherein urban freight is dependent on highway corridors, while there is no freight transported over rail and water. Retailers barely work together and they take all care for their own distribution, which generates a lot of (small, unnecessary) movements. The spatial organisation and the type of goods have determined which goods have and which goods do not have potential for consolidation.

Urban freight transport is mostly considered as a local problem, making local authorities responsible for regulations and implementation of measures. Both companies and authorities are enthusiastic about innovative solutions. However, expectations on initiatives are not clear to each other and responsibilities on urban freight are shifted to other stakeholders. This slows down shifts in urban freight operation.


This chapter has the purpose of adressing sub research question 3:

*What are spatial conditions and design requirements for improved urban freight in the MRDH?*

The chapter will use urban consolidation and urban multimodality to propose three new nodes in urban areas. The spatial interrelationship of the nodes lead to new strategies based on urban consolidation and multimodality. The chapter wil conclude with a strategic framework for the three urban regions.

*chapter outline:*

6.1 introduction
6.2 present and future of urban freight
6.3 proposed nodes
6.4 spatial interrelationship
6.5 region specific strategy
6.6 conclusion

# 06 DEVELOPING STRATEGIES FOR MRDH

*source photo: cargo tram (NL Architects, 2009)*

## 6.1 Introduction

This chapter aims to provide design requirements and spatial conditions for the improvement of urban freight in the MRDH according to the third sub research question:

WHAT ARE SPATIAL CONDITIONS AND DESIGN REQUIREMENTS FOR IMPROVED URBAN FREIGHT IN THE MRDH?

This will be done by recapping on the current operation of urban freight while introducing the future of urban freight as well. As will be explained in the next paragraph, the future should be based on the concepts of urban consolidation and urban multimodality. Both concepts will be elaborated in the chapter, starting with operational assumptions, which are important for the implementation of both concepts. The next part of the chapter addresses the proposed nodes. For each type of node - urban consolidation centre, transhipment centre and drop-off point - the spatial implication of different types, location factors, modal operation, other operational issues and a roadmap for allocation are adressed.

The second part of the chapter concerns the spatial interrelationship of the three nodes in the three test cases, which are Rotterdam urban region, The Hague urban region and Delft. The possible locations of nodes will be revealed based on the roadmaps. The spatial interrelationship has to lead to a strategic framework for the three urban regions, which will form the basis for the next chapter.

## 6.2 Present and future of urban freight

In the previous chapter, it has been concluded that every retailer ships their goods from their distribution centre to their store, causing a lot of freight movement in the city if it is done frequently and for every store apart. At the same time, freight movements lack on the modal split, since the distribution of urban freight is mainly done over the road. There is no distribution taking place over water nor over the rail. All the freight use the same highway corridors and the same city entrances as most of the stores are likely concentrated. There is no general, co-operative distribution for all the goods on urban scale since the distribution per type of good only takes place on a regional scale (FIGURE 6.1).

The present configuration of urban freight is reaching unsustainable levels due to the global trends and dynamics (Nathanail & Papoutsis, 2013). The increasing logistic demand will make urban freight transportation as it is operating now even more complex and costly. The number of vehicle kilometres and negative externalities will somehow lead to sustainable solutions or at least the urge to do so will grow. But this does not occur automatically. Therefore, attempts to find horizontal collaboration between stakeholders will be necessary for the future for the last mile distribution (Kin et al., 2018). Instead of separate transportation, the future of urban freight will need more bundling, multimodality and micro-distribution in urban areas (James, 2015). This means an effective implementation of urban consolidation centres, multimodal hubs and more locker-boxes, in which every stakeholder, even inhabitants, are encouraged to commit on sustainable freight distribution through multimodal bundling and locker boxes for consumers.

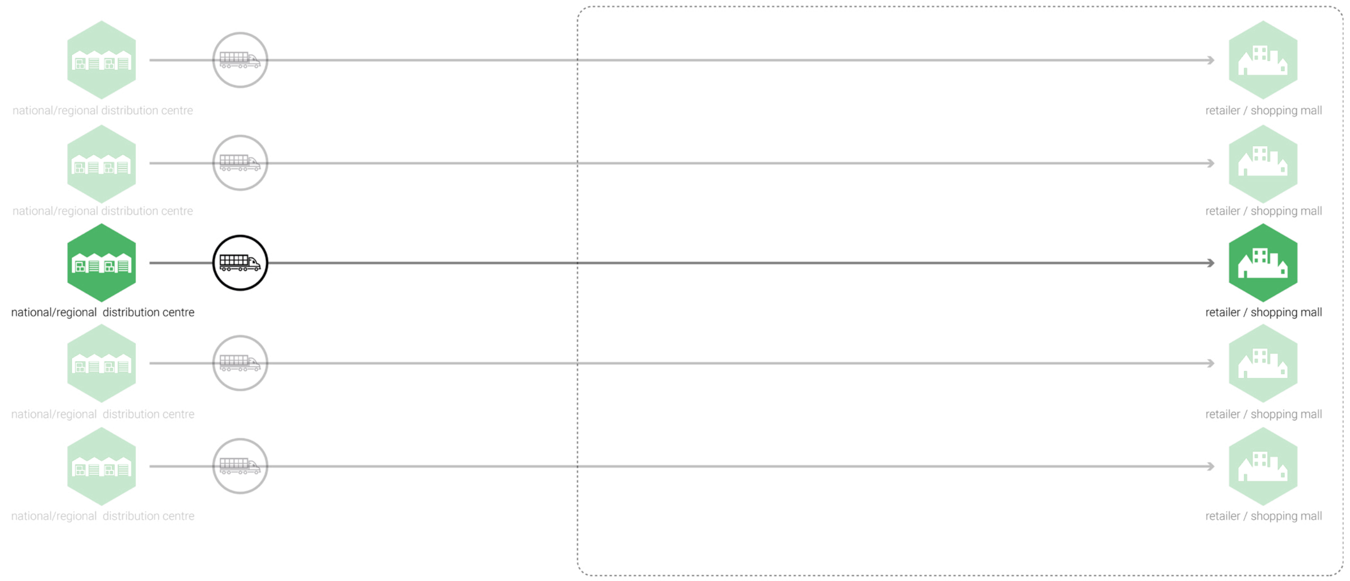



**FIGURE 6.1:**
Current urban freight
(author's drawing)

One often suggested concept in the field of urban freight is the consolidation of freight through urban consolidation centres (UCCs) (Kin et al., 2018). Freight of different suppliers are brought to an UCC, just before it enters the city.  Instead of every shipper taking care of their delivery to the receiver in the city centre, all the goods will be brought together at the edge of the city. From there, bundled deliveries are made to the city centre with low emission vehicles or ideally other transportation modes (FIGURE 6.2)

Using UCCs are an effective way to reduce the number of unsuitable vehicle trips and kilometres. At the moment it is a loose concept without political backing. Van Heeswijk (2017) advocates for a national or European alignment in the policy with respect to UCCs. Leaving the transportation activities to the market will make a UCC less profitable. The concept of UCC needs to find a way in which on the one hand subsidies are given, while on the other hand own transportation to the city centre is made financially less attractive. Nevertheless, the financial consideration of UCCs that serve (a part of) a city are complicated since they might rely on-going public subsidy (Allen et al., 2012c). Although the earlier pilots with UCC's are rather negative experienced, due to the lack of awareness on the potentials that UCCs might have, when they are established in the right way and right context. They reduce trips and kilometres while using more sustainable vehicles. It requires an overall consideration of the complete nature of the facility in organisational, financial, logistic, technical and spatial sense, in which the urbanist is responsible in particular for the spatial implication (location and impacts).

However, the high set-up costs concerning the land price in urban areas, organisational and contractual problems with stakeholders and likely a time penalty due to an extra point in the supply chain have to be taken into account (Allen, Browne & Thorne, 2007).  Collaboration with the complete set of stakeholders is the key. For the field of urban planning,  it would be interesting to research the spatial implication and feasibility of an UCC.

Each mode has their advantages in operational sense in which an optimal combination of transportation means need to be found (Rodrigue et al., 2013).  A modal shift is a term for replacing a mode of transport with another mode to relieve the first one from some congested pressure. In freight transport, multimodality is often considered for larger distances (between producer and distributor) which are executed by large cargo ships or international cargo trains. However, the same idea can be used for freight transport, since in fact urban freight transportation does not necessarily have to be taking place over the road (FIGURE 6.3). Therefore, besides urban consolidation, also urban multimodality will be used to make freight transport more sustainable. Transport over water is the most energy efficient since a ship uses 1 to 2 times less fuel than a train and 3 to 5 times less fuel than a truck and can be economically competitive (European Commission and PLANCO Consulting GmbH in Janjevic & Ndiaye, 2014).

The waterways through the cities just as the public transportation are not utilised when it comes to urban freight transportation,  while these also have a huge potential since they seem to cover most of the densified retail areas. Public transportation lines are based on movement of people. The destination of people are inherently connected to the need of goods. Thus, where people are going to, there also will be need to transport goods to.

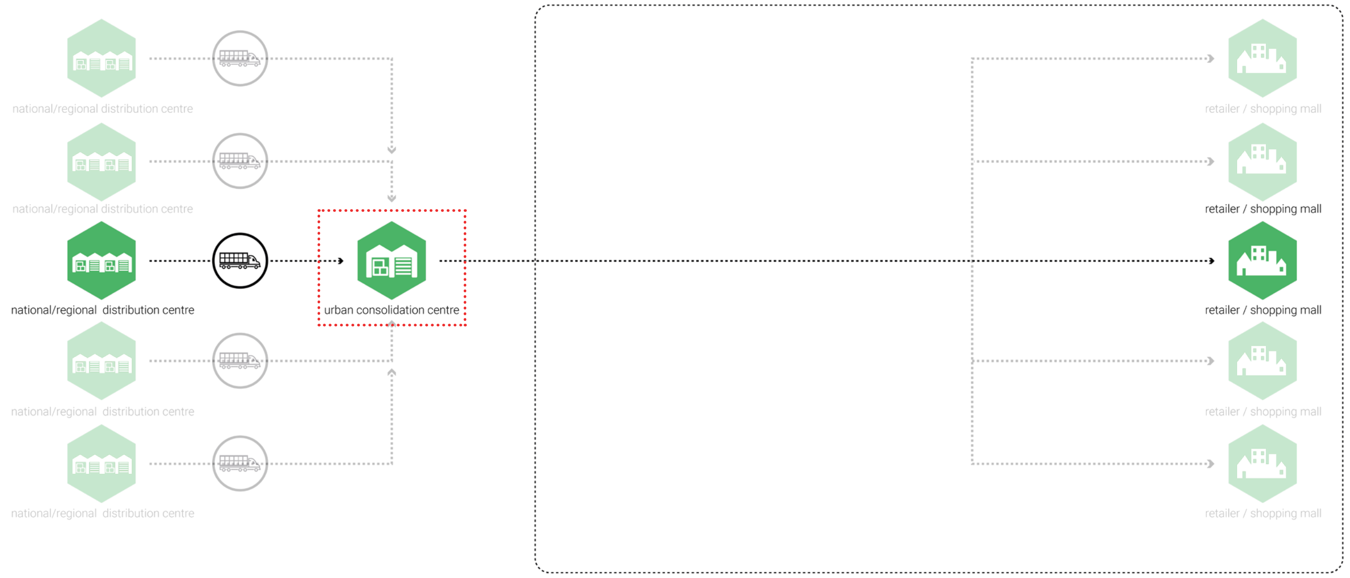



**FIGURE 6.2:**
Situation when urban consolidation is added (author's drawing)

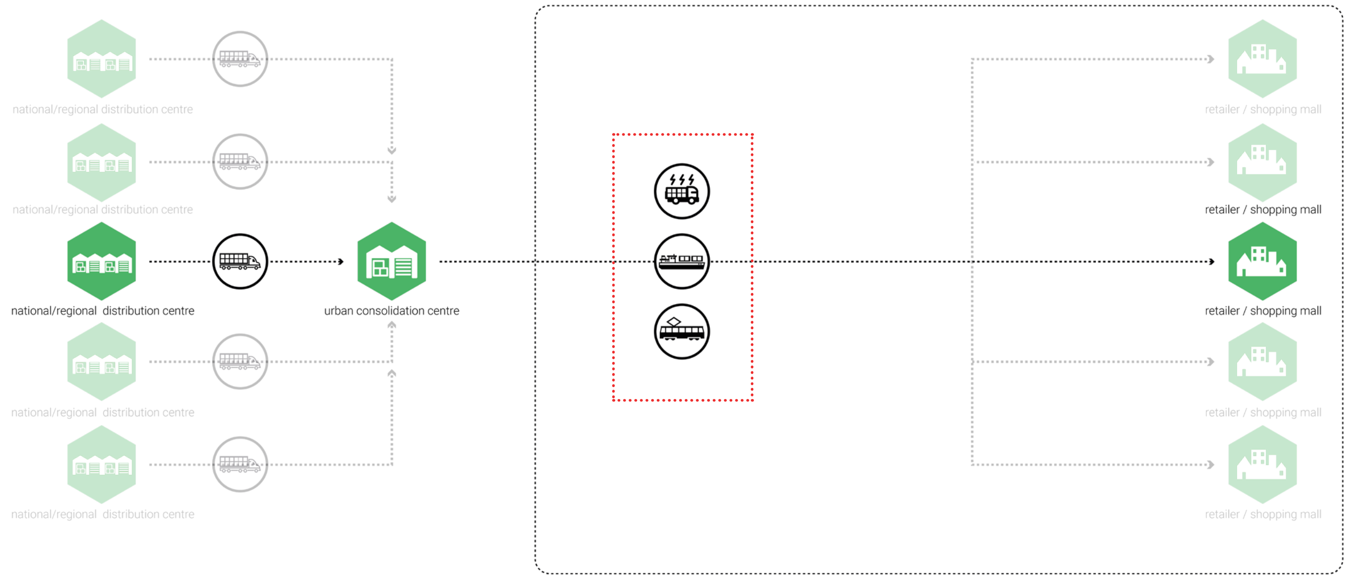



**FIGURE 6.3:**
Situation when urban multimodality is added (author's drawing)

## 6.2.1 ***Present and future of urban freight*** *operational conditions*

WIth proposing a new system of urban consolidation and urban multimodality, several (operational) conditions are required. This paragraph will list these (operational) conditions.

Some of the conditions actually require an extensive financial, organisational, technical or mathematical/logistical underpinning, but are left out of the research scope. These however need to be highlighted to make the proposed strategies working by showing authors' awareness of the operational and organisational elements. This includes the following:

**1) standardisation of freight**

For multimodal operation of urban freight, several authors (De Langhe, 2019; He & Haasis, 2019; Quak, 2008) have underpinned the importance of standardisation of freight units. Just as the multimodal long-distance transport has profited from containerisation of goods (sea container), they believe that, especially for rail transport, standardised containers are a key element for the integration of distribution innovations. According to Quak (2008), easier, more efficient and cheaper transhipment between the modes are enabled and thus is beneficial for multimodal transportation. The government should set a standard accepted by all the stakeholders on a large scale since it is only then feasible. De Langhe (2019) has argued that the use of portable standardised units is a critical success factor for rail transport as well. The project will assume the implementation of such a standardised unit (FIGURE 6.4).


**FIGURE 6.4:**
Standardised boxes in the CityCargo tram Amsterdam
*(CityCargo Amsterdam, 2015)*

**2) ownership of new nodes and modes**

The project aims to incorporate all the needs and interests of stakeholders and therefore it is desired to give the urban consolidation centres and other nodes an neutral character towards government and private companies to keep everyone closely involved in the process. A non-profit sustainable and independent organisation could work with all stakeholders. Concerning the modes, existing (public) transportation companies such as RET, HTM or GVB could extend their services by adding a cargo branche to play a larger role in the transport of goods and people.

**3) use digital information technology for synchromodality**

There have been emerged various supporting technologies in the field of urban freight, such as telematics for vehicles, global positions systems (GPS), smart cards and traffic/freight management systems. Provisions of these maps and systems can be used by logistic companies (at their office and drivers) and urban authorities to go beyond multimodality: synchromodality. Synchromodality is an integrated transportion way by using various transport modalities in an optimal way under the direction of a third transportation party. This party decides, without intervention of the retailer, which mode suits the best for the transport.

**4) alignment in regulation of measures**

Regulatory measures are related to access conditions such as spatial restrictions as we have seen in the three cities based on weight, volume, width, height, length, age, engine or total ban of trucks. Also, time restrictions can regulate the freight traffic in the form of time slots in load zones, night deliveries or time windows. All these constraints form the basis of environmental and social friendly delivery zones. As earlier concluded, every municipality has its own regulations on low emission zones. The crux in this assumption lies in the need for national alignment in these restrictions. For shippers, the supply becomes easier and more efficient when the restrictions are clear, aligned and the same for every municipality.

**5) financial incentivation**

Due to low margins in the urban freight sector, the financial incentivation by the government is important for companies to incentivise them to do the right investments in green freight. Companies often lack capital or do not want to take too high financial risks in their investments, without the certainty of benefitting from it. With on the one hand charging for road access, environmental unfriendly vehicles and parking and on the other hand rewarding or subsidising companies that develop multimodal facilities, joint delivery systems or use low emission vehicles, companies are forced to change their operations to more sustainable ways. Furthermore, municipalities can incentivise existing public transportation companies to extend their transport services to urban freight deliveries by intensify their role as shareholder and investor for the public good.

## 6.3 *Proposed nodes*

This paragraph lists the spatial conditions for the proposed nodes in urban freight. Basically, three types of nodes can be distinguished in the section: urban consolidation centres (UCCs), transhipment centres (TCs) and drop-off points (DoP). The subchapter will address the spatial implication per type of nodes, activities, modal operation, other operational issues, location factors and a roadmap for allocation of the specific facilities.

The spatial conditions of these nodes are comparable on the classification made by Buck Consultants International (2018). According to Marcel Michon from Buck Consultants International (2018), there was a lot of uncertainty about the size, square meters and specific characteristics of distribution centres. He advocates for adding the field of real estate to the logistic discussion. In the real estate approach, it is important to determine the required size and function. For real estate developers, this can be translated to the quest to optimal locations for storage with respect to investment values. For an urbanist, this can be used to also considering spatial implementation and establishing spatial quality to logistic real estate. Marcel Michon has developed a model in which five different real estate concepts of urban freight are illustrated (FIGURE 6.5).

With respect to urban freight and the proposed principles, the urban distribution centre, freight transfer hubs and the pick-up/ drop-off points are relevant for this project, wherein the facilities of 3) and 4) respectively correspond with the urban consolidation centres and the transhipment centres. The used sizes of such facilities will be based on these assumptions.

| Type / scale level | Location | Size | Characteristics |
|---|---|---|---|
| 1. E-fulfilment centre | Corridor | > 40.000 $m^2$ | Decoupling point towards urban centers |
| 2. Regional distribution centre | In large cities<br>Between cities | > 20.000 $m^2$ | Combined store delivery and home delivery<br>Combined with intermodal |
| 3. Urban distribution centre | Edge of cities<br>Medium-sized cities | >5.000 - 10.000 $m^2$ | Decoupling point towards urban centers |
| 4. Freight transfer hub | Within cities | 1.000 $m^2$ | Flexible and sometimes mobile<br>Multiple hubs per city possible |
| 5. Pick up / drop off points | Shops, apartments | 100 $m^2$ | Work unmanned with codes via mobile communication |

**FIGURE 6.5:**
Classifcation of hubs
*(adapted from Buck Consultants International, 2018)*

## 6.3.1 *Proposed nodes* urban consolidation centres

The UCC is an urban distribution centre on the outskirts of a city. It brings bundled deliveries with better-loaded vehicles to a whole city, the city centre or a specific site (Allen et al., 2012c) and can be dedicated to the retail supply or construction supply.

UCCs can be seen as city entrance for freight and is an urban drop off point wherein freight companies can deliver their goods to a specialist centre for final bundled deliveries. Large volumes of trucks from different kind of participating retailers bring their goods to the closest specialist centre of their final destination, where it will be divided efficiently into smaller, but frequent and bundled shipments, transported by other cleaner modes or vehicles to the city centre. The desired amount of UCCs per city is 1 to 6.

The expected required size for UCCs is around 5.000 to 10.000 m2 (Buck Consultants International, 2018). The logistic activities that take place there need relatively many square metres. This makes it inevitable that also optimisation is required that results somehow in a square-formed building. In such industrial buildings, the extra focus will lie on sustainable performance. Besides sustainable transport, also sustainable consideration of the consolidation centre is desired. Smart use of the roof, energy-neutral operation of distribution activities multifunctional use of the leftover spaces could be considered in this.

Both assumptions for size and amount are dependent on the demand for urban freight, the coverage area of the city and the amount of UCCs per city. The maximum serving distance of an UCC should be around 6.0 km if served over land and 10 km over water with large ships. At the facility, it needs to be possible to on some UCCs to transfer to water or rail. The research will propose two different UCC principles (FIGURE 6.6) both related to a specific type of synergy. Both principles will be explained on the next pages.


**FIGURE 6.6:**
Two proposed principles
*(author's drawing)*

# *Primary location requirements UCC*

UCCs are the most important nodes in the principles which needs to be constructed, thus they need an elaborated consideration of their allocation. This section lists the primary location requirements for UCCs. These are most of the times comparable with general location factors for companies, earlier mentioned. To make the basis of the concept of UCC work, it has to made sure that UCCs by all means are:

**1) located at the outskirt of the city and when possible, at the border of low emission zones**

Clarity on borders of low emission zones and served area is necessary. It is dependent on the served area of the zone. Sometimes, it could not be desired to put it at straight at the border of the low emission zone or served area if the low emission only covers the city centre, as it is for example now for Delft. For these principles, an UCC needs to serve (a part of) a city (Rotterdam, The Hague or Delft). A location on the outskirts of the city allows a substantial size to accommodate all the incoming goods (Sładkowski et al., 2014).

**2) located at the proximity of highway infrastructure and city entrances**

The goods need to be delivered from distribution centres over the highway corridors to the city, so they have to be located on the route of national/regional distribution centre to a retail location. They are important links to the supply routes.

**3) located at the proximity of retail locations such as the city centre and shopping malls**

The distance between UCC and retail location needs to be proportional. In general, this means that the UCC needs to be situated close to retail locations. It is, however, argued by Allen et al. (2012c) that the distance does not have to be minimised since this will reduce the benefits of the UCC. With significant distance, large trucks do not have to enter urban areas and thereby the operational distance of environmentally friendly vehicles can be maximised.

**4) preferably located at an industrial area**

Situating UCCs in an industrial area is obvious. Most of the times it already satisfies the three earlier location factors. Industrial areas are already located outside the city centre and can handle a lot of traffic. At the same time, they do not bother residents.

# *Additional location requirements UCC*

This sections lists some additional location requirements for UCCs based on the created principles. These are additional to the primary location factors and are added by the author to create multimodal UCCs that eventually synergises with waste and are according to the extra sustainability goals made. Thus, it is also desired that UCCs are:

principal

multimodal

**1) located at the proximity of a waste treatment facility**

In the first principle, synergy is sought between the supply of goods to retailers and the collection of retail waste. For this requirement, the location of waste treatment facilities needs to be found and per facility, the location needs to be accessed in terms of availability of other (water and rail) infrastructures, space and highway accessibility. The analysis and argumentation for the strategies is based on existing facilities, however, additional facilities to construct could be considered as well

**2) located at the proximity of a main water corridor through the city**

In the second principle, it is proposed to transfer freight at the edge of the city to the water and to bring it to the middle of the city over water instead of over land to spare unnecessary kilometres.  The first step is to identify the main water corridors per city and where they cross a highway. In the proximity of that crossing, available space needs to be found to settle an UCC.

**3a) preferably located at the proximity of railway (tram) infrastructure to the city**

The guiding idea will be a modal split, wherein whenever it is possible, freight is preferably transported over the rail (freight tram) instead of road vehicles to the final destination in the city or to the next node in the supply chain. The spatial analysis will determine the possibilities of transporting goods from the UCC outside the city centre to the retail areas within the city borders by a tramline.

**3b) preferably located at the proximity of canal/waterway (ship) infrastructure to the city**

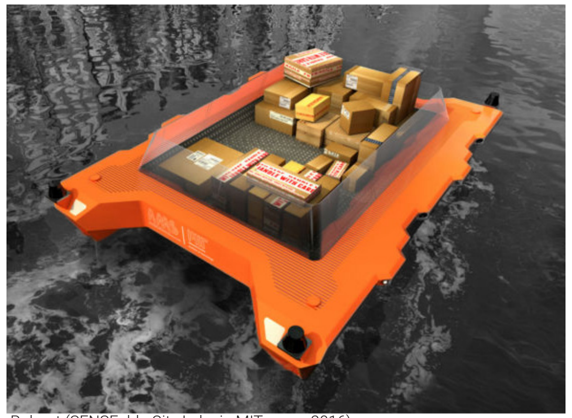
The guiding idea will be a modal split, wherein whenever it is possible, freight is preferably transported over water (freight ship/boat) instead of the road vehicles to the final destination in the city or to the next node in the supply chain. The spatial analysis will determine the possibilities of transporting goods from the UCC outside the city centre to the retail areas within the city borders by the water/canal structure.

## # *Operational assumptions*

Regarding the operational assumptions in UCCs, two issues needs to be adressed. These are related to the the traffic around the urban consolidation centre and the type of ships that will be deployed for this system.

First, careful consideration in terms of the capacity of adjacent roads, due to generation of more traffic is required. The area will experience more vehicle traffic growth since the supply of freight will be concentrated towards the UCC, while the served area will gain benefits (Allen et al., 2012c). An increase in outbound vehicles/modes from the UCC to the city centre should be taken into account. In the research, exact calculations on the increasing traffic are left out of consideration. It is assumed that the area around the UCC is able to handle the increasing traffic as industrial areas are used to handle large traffic.

Secondly, the type of freight boat/ships needs to be discussed. Large volumes of freight for a dedicated neighbourhood or demarcated zone needs to be transported by urban freight ships from the urban consolidation centre (FIGURE 6.7.1-3). The freight ships need to carry standardised units. The spatial restrictions are dependent on the existing water network. They have to fit in the local waterway network and thus do they need to be smaller than an inland ship. The expected length is 8 to 25m, width 3 to 4m and depth 1 to 2m (volume: 24 $m^3$ to 200 $m^3$). Dependent on the operational area - city, district or shopping street - a boat/ship is estimated to carry around 10 - 85 $m^3$ (9 - 75 t; conversed by conversion.org) freight. A fully loaded van carries 1.5t, based on the table of PSD/TLN (1999) in van Binsbergen & Visser (2001), thus a freight boat/ship could replace 6 to 50 fully loaded vans.



Roboat (SENSEable City Lab via MIT news, 2016)


(sustainabletransport, n.d.)


(Bestfact, 2015)

**FIGURE 6.7.1-3:**
Possible freight ships
*(several photographers)*

## # *Selection of involved freight in urban consolidation*

In practice, UCCs don't need to take over all deliveries as the concept is not applicable to all types of goods. Quak highlighted in Macharis & Melo (2011) that a full truck doesn't necessarily have to be replaced by two smaller vehicles, when these two vehicles pollute more and pressurise congestions, which is the case on large retailers, which already have a quite efficient way of distribution. Browne et al. (2005) have listed some organisations for whom UCC are not benficial, which are major supermarkets, similar outlets and department stores who have their stock consolidation centres (regional distribution centres) with already fully load vehicles. As illustrated in FIGURE 6.8, the operational scale and the shipment size of goods are decisive for the applicability of a specific type of goods. Together with the conclusions in previous chapter regarding the characteristics of good it can be confirmed that the focus in urban consolidation need to be on especially consumer goods with small to medium sized goods and a retively long transportation distance regional to national distribution. Therefore, there will be assumed that stores of consumer goods will be the main users of the concepts. Since the analysis is based on a generalisation of goods, of course a customisation per store still should be required. However, the applicable and type of goods as described are supposed to use the system.

Since the waste collection in the proposal only takes place at entities where also goods are brought to, the collection of waste is in first instance limited to these entities to create a one-to-one synergy between waste and goods. However, there are possibilities to extend the system to for instance consumer waste, where the shops or drop-off points (which also act as pick-up point for waste) can function as additional waste collection points for consumers to reduce the amount of waste on the regular collection points. In an extreme case, the proposed water and public transport (this thesis is just limited to tram) drop-off points can also be proposed as the only waste collection point, wherein the regular ones will be gradually removed. Then also the waste collection is completely integrated in the strategy. When speaking about (un)loading freight, this also could include waste transport besides goods if transport in reverse direction is mentioned in the first principle.

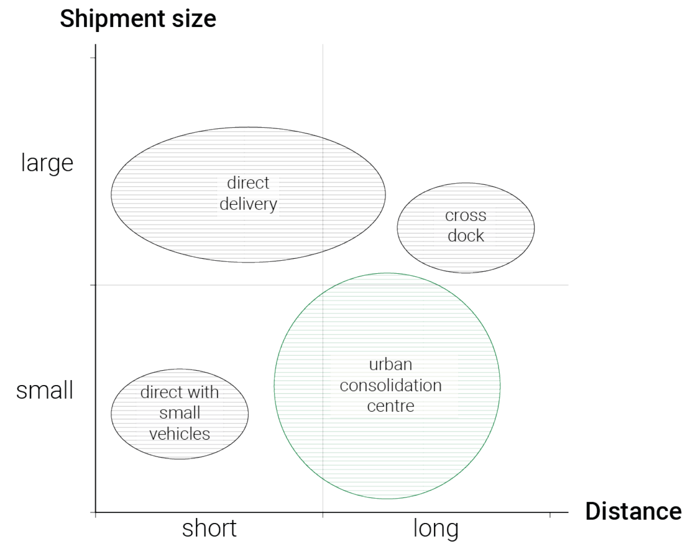



**FIGURE 6.8:**
Distribution ways for urban freight
*(Kin et al., 2018)*

# Roadmap for principle selection and urban consolidation allocation

FIGURE 6.9 will conclude the section of UCCs by bringing forward a roadmap for principle selection and allocation of the UCCs in a city. It is important to map the spatial elements in order to find which principle is suitable for a city. These elements also should be analysed in relationship to each other. Starting point of the strategy development in the thesis is to use already constructed amenities and infrastructures, such as existing waste treatment facilities, highway entrances, rail infrastructures and relevant waterways. It is of course possible to manually construct new waste treatment facilities, highway entrances and other necessary infrastructures.

The spatial analysis determines whether specific modes (rail and water) are relevant for allocation or not. The modes are relevant when the specific infrastructures are extensively enough present and are dependent on the selected principle(s). Options and relevance could be tested by analysing the possible variants with respect to the two principles and the three modes.

Furthermore, the proposed principles should be able to operate on their own in a city, as they are explained seperately. In every case, both pinciples could be complimented by (convential) road transportation. However, within certain conditions in specific cities, it could be possible to propose whether a combination or even a hybrid system of principles for freight. The choice of a combined or hybrid system can be determined in the region-specific strategies. This could happen when for instance there is a high potential for both strategies in a city; with any optimisation, both principles could then be used hybridly to become more beneficial to a city.

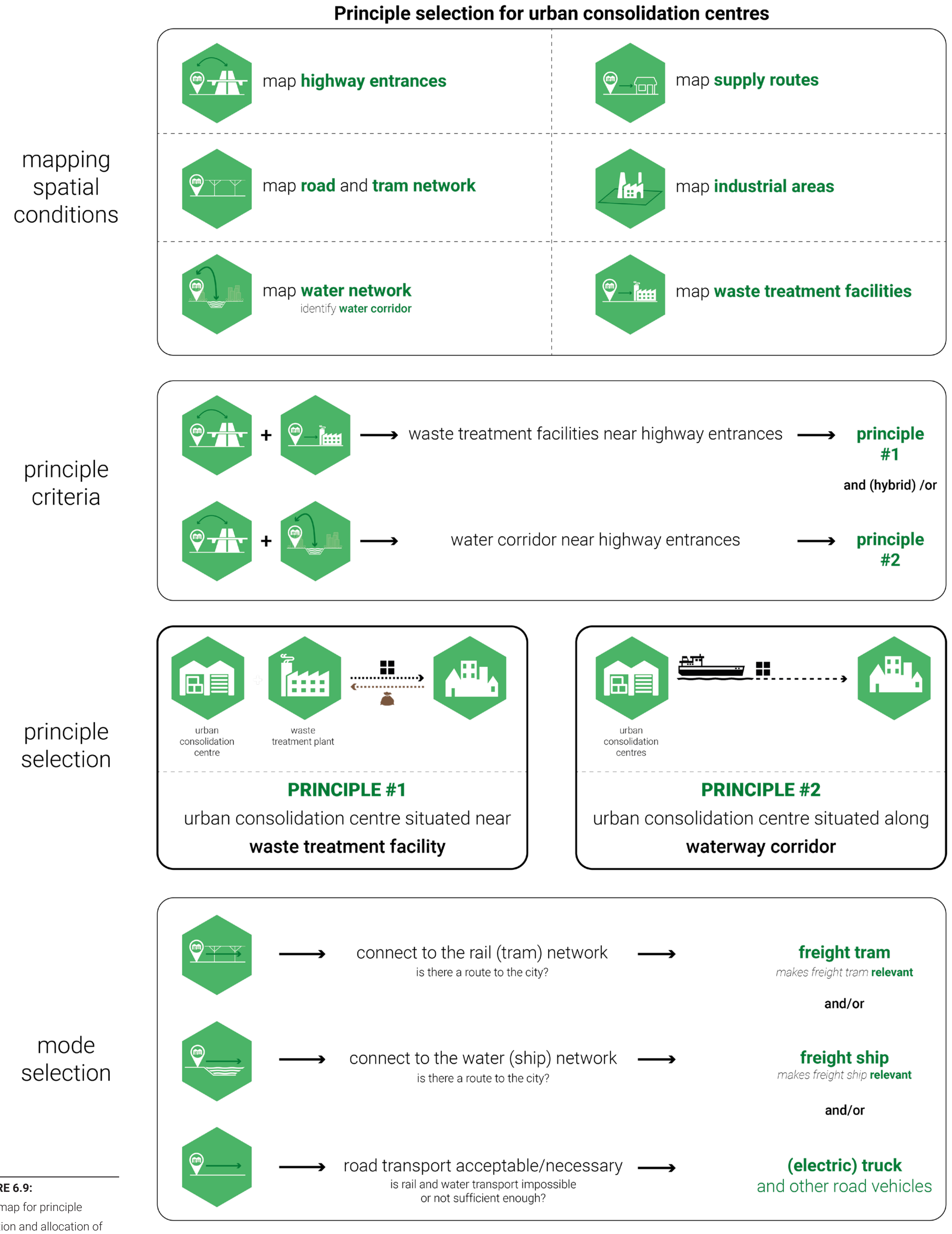



FIGURE 6.9:
Roadmap for principle selection and allocation of the UCCs in a city
*(author's drawing)*

## 6.3.2 **Proposed nodes** *transhipment centres*

Transhipment centres are intermediate nodes in the system and are situated at strategic points in the city. Main reason for transhipment centres are the transhipment function of transferring freight from water to land (or in some limited cases from water to water). They are also required in larger cities to bridge distances from UCC to the final retailer efficiently. They need to be constructed when the serving distance of an UCC will be exceeded (6km for land transport; 10km for water transport) and therefore are not always necessary to be constructed within a system.  In other cases, freight could go straight to drop-off points to avoid unnecessary transfers.

Most of the times, large volumes of freight for a dedicated neighbourhood or demarcated zone will enter a transhipment centre by urban freight ships from the urban consolidation centre and will be transferred to smaller, frequent last-mile modes. Within these last-mile modes, the freight tram is newly introduced in the system and will therefore be clarified later on in the paragraph.

A basic transhipment centre needs docking possibilities for the UCC ships. They need space to be unloaded and with small temporary storage in the facility. The transhipment centre also needs to facilitate transfer possbilities to other modes, which means space for parking and (un)loading trams and some other small road vehicles. With this, also charging infrastructure is required. The facility needs to be completed with an office. All these logistic assets needs to be constructed on the ground floor level. This gives the opportunity to come with additional programme on the top/roof of the transhipment centre  to give it more than a logistic function. Depedent on the context and the surrounding functions, a temporary or permanent function can be constructed. One could think about a public space on the roof with temporary events or on a residential/office building at the riverfront. Some suggestions for possible functions are given in FIGURE 6.10 on the next page.

Transferring, (un)loading and storing freight are logistic activities which are nowadays perceived by most people as something industrial. They do not belong in the city centre, but need to be allocated in industrial areas. For the sake of a transhipment centre, this means that logistic activities need to brought back to the city centre. However, they use relatively large space in dense urban areas, (expected around 500 - 1.000 m2, - according to Buck Consultants International, 2018). Therefore, a multimodal transhipment centre spatially has more impact on the urban landscape than UCCs (which are normally situated in industrial areas). Hence, it is important to fully consider their presence and design of these and make sure that these transhipment centres smartly share the space with other functions.

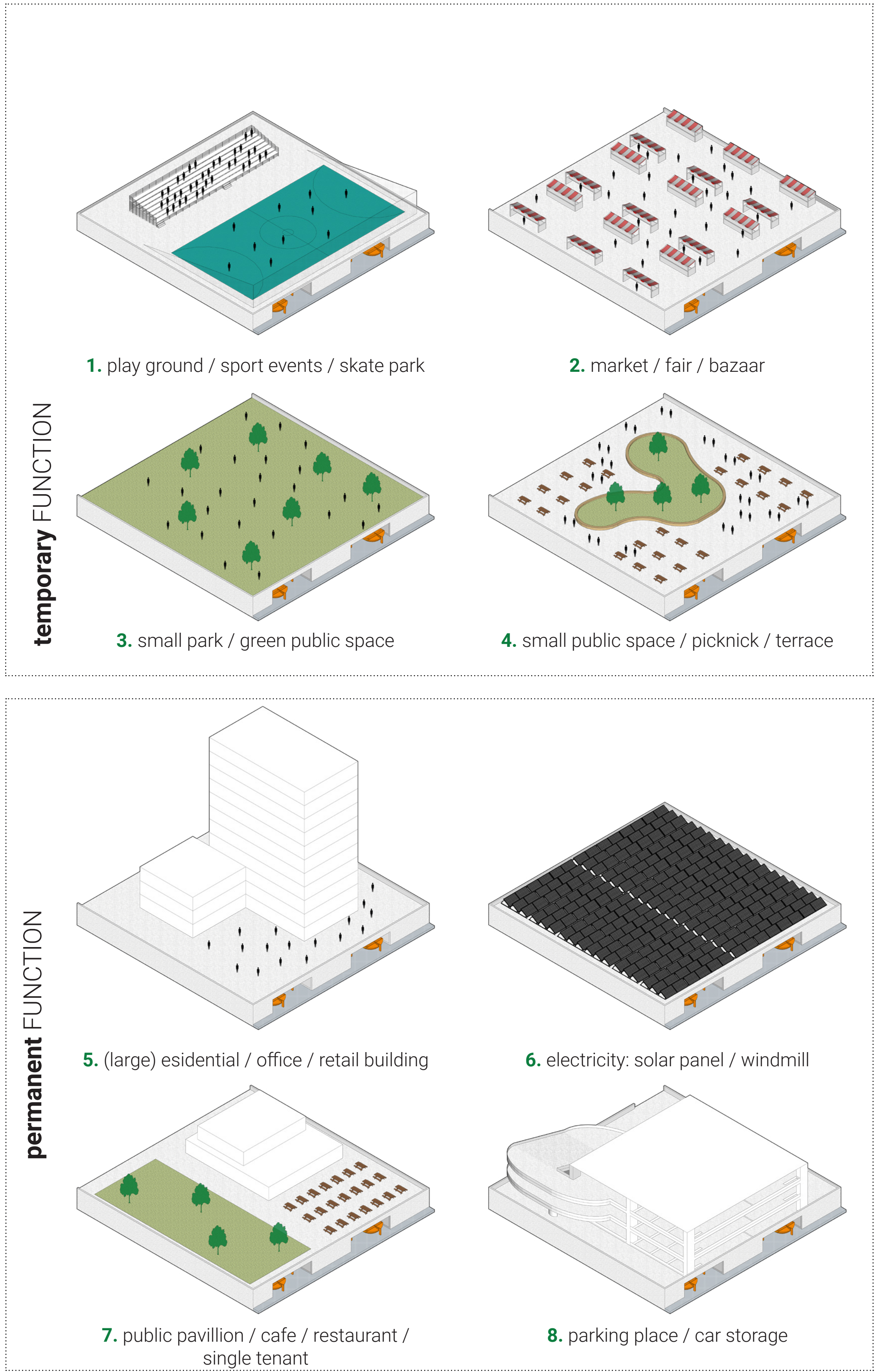



**FIGURE 6.10:**
Possible formats of drop-off points
*(author's drawing)*

## *Location requirements transhipment centres*

Transhipment centres are especially necessary in the second principle, where the water corridor of the city is involved. In fact, the location of a transhipment center follows from the chosen modes. They are mostly located within the city borders where two different infrastructures meet each other.Some requirements are only relevant under specific selected principles and modes at the UCC allocation.  Basically, transhipment centres needs to be:


1) **located at the proximity (<6km OR 10km) of a constructed urban consolidation centre**
As earlier stated, the maximum serving distance of an UCC should be around 6.0 km if served over the road and 10 km over water with large ships (principle #2). This means that the location of transhipment centres are also dependent on the location of urban consolidation centres. The distance does not to be too small, since then the transhipment centre could be considered as unnecessary. However, from the planning point of view, there is no minimum set. Mathematical logistic calculations could indicate this.

2) **located at the chosen water corridor through the city [with principle #2]**
According to the second principle, from the UCC, freight will be brought over water to the land. To reach the final destination, freight somehow needs to be transferred to the land. Transhipment centres, therefore, needs to be situated along the water corridor and make a transfer from water to land possible.

3a) **located at the proximity of an tram end stop of a fine-grained tram network**
When using freight trams, freight can be loaded into a freight tram at any point on the line, but it is highly recommended to use an end stop. The tram end stop offers room in the time schedule to load freight to a freight tram, which transports the freight towards the city centre to their destination. An end stop is often situated at an intermediate location and not directly in the city centre or final destination. This end point of course needs to lead to a fine-grained tram network.

3b) **located at the proximity of a fine-grained canal/water (ship) infrastructure**
When using freight ships (less conventional), freight can be loaded at any location at the water as long as it is connected to a fine-grained canal/water network and meet other requirements. This requirement is less applicable, since the transfer from large ships to smaller ships is likely to be rare.


4) **located at the proximity (<6 km) of drop-off points / retail areas**
These transhipment centres have the purpose to serve drop-off points or final customers directly. Therefore, they have to be constructed in the proximity (max 6 km) of those entities.

## *Use of tram infrastructure for freight purposes*

Freight could leave the transhipment centre by different last-mile modes. Besides the conventional small modes on the road, such as an (electric) freight bike. These modes will be touched in the drop-off point section. More important for transhipment centres and a less conventional transportation mode is the freight tram. The freight tram is an outcome of modal shift where public transit models are extended to distribution and eventually waste collection processes. Using rail traffic for urban freight is a less environmental damaging mode than road traffic. With underutilised trams infrastructure, this concept can be exploited, whereby freight trams potentially can reduce commercial road vehicle kilometres and thus reduce environmental, social and economic impacts (Regué & Bristow, 2013).

Many cities have underused rail infrastructure, seldom utilised for freight activities. (De Langhe et al., 2019). Due to the organisation of public transportation stops, the catchment area of public transportation stops gives a potential to combine this concept with special drop-off points at public transport stops to cover a part of the retailers. The backside is the other part of the retailers who are not directly connected to the tram network and thus need post-transport (Behrends, 2012).

De Langhe (2014) stated that transport with trams needs to become more economically attractive in comparison with road transport as the presence of congestion could favour rail transport. Regué & Bristow (2013) described - based on earlier experience of projects - that a city already needs to have an extensive fine-grained tram network through commercial zones, which is also connected to highly efficient road or rail facilities for consolidation. Rotterdam and The Hague already have such tram network through their city centres and commercial zones. Other barriers mentioned are the resistance and lacking commitment from different stakeholders, the financial implications (a division of costs and benefits) and political backing (De Langhe, 2014; Regué & Bristow, 2013).

Freight trams need to operate under mixed traffic conditions while loading and unloading. Passenger transport must not be hindered (too much) with the combined interaction. This makes it challenging to use every tram stop as a drop-off and pick-up point (Regué & Bristow, 2013).  Also a specific location at the tram line - preferably at an end stop - needs to be chosen to load freight to the tram and unload from the tram and whether goods are only transferred or also needs to be stored temporarily (De Langhe, 2019).

There are still a lot of financial, organisational and operational uncertainties left. The thesis will elaborate more on the spatial variables, while assuming that the tram is considered as a possible more sustainable mode than the traditional truck.  To illustrate, one dedicated freight tram of 50 - 60 m with a capacity of 214 $m^3$ / 60 t could already replace around 2,5 fully loaded lorries (De Langhe, 2014). However, the purpose is to investigate how the tram possibly can work within the proposed strategical framework.

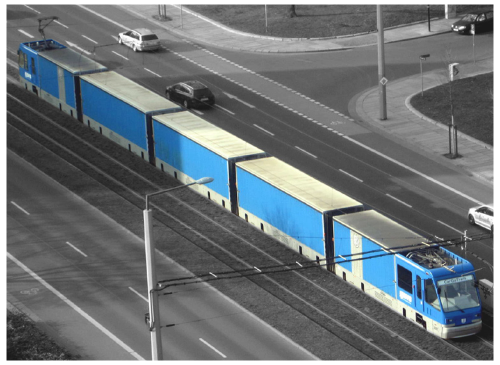
There are various variables on the use of freight tram that needs to be mentioned with a spatial consequence. In the first instance, there are three different freight tram configurations distinguished by De Langhe (2014): 1) with a dedicated freight vehicle, 2) with a wagon attached to a passenger vehicle or 3) freight alongside passengers. For the urban freight system proposed in this research, only the dedicated freight vehicle and a freight wagon attached to a passenger vehicle will be considered (Figure 6.11).

Concerning the tram network, the capacity is one of the variables in the selection. For dedicated freight vehicles, it depends on the available tracks on the rail network, whether there is space available in the schedule for another tram. For a wagon attached to a passenger vehicle, it depends on the 'free available space' behind the tram. Also, the routing per tram is different. In the case of a dedicated tram, the tram can use - as long as there are tracks available - the fastest route to the destination, while an attached freight wagon is bounded to the route and schedule of the line, which is not always the fastest route to its final retailers. Looking closer to energy usage of the tram configurations, some differences can be found: a dedicated freight tram needs to power itself (although it is cleaner than the trucks), while an attached wagon does not cost significant power since it is already powered by the passenger tram that drives anyway. The total freight capacity of an attached wagon is likely to be lower, while dedicated tram could use its full length.

Secondly, the way of unloading needs to be considered. In practical terms for unloading, De Langhe (2014) mentioned that it could take place during the night, quickly during the day at the transit network or on a special constructed sidetrack. With some of these options, it could be possible to leave a dedicated freight tram for the needed time of the unloading. With an attached wagon or at the transit network during the day, the unloading must be done generally between 17 and 30 seconds, which is the average stop time of a passenger tram, which could become technologically possible. With this, freight needs to be handled and stored for a while.

The final operation depends on technical, practical and organisational performance of tram lines. The following system is proposed/assumed in the thesis:

The freight system could be formed by one TC that serve several DoPs. It is at the beginning of the project more likely to pick specific stops, close to larger shopping entities to release the freight in once. DoPs could be served once or twice a day, depending on the demand and could take place in non-peak hours. A fully-loaded wagon



Dedicated freight tram Dresden (Frze, 2014)

Wagon attached to passenger tram (Dowideit, 2017)

**FIGURE 6.11.1-2:**
Possible freight trams
*(several photographers)*



would then be the load for one DoP. With slow upscaling the amount of retailers, the system can be phased. With using both tram configurations, it could be organised in a way that freight will be transported by a dedicated tram to the DoP, since supplies are possibly more bounded by time and thus do they need the shortest route to the shop. When freight is unloaded at the DoP, the freight tram could be attached to an incoming passenger tram in the opposite direction that drives back to the TC (handling at the DoP (assuming this system) will be shown at page 150). It is recommended to detach the freight tram before arriving at TC, otherwise eventually extra spatial measures need to be taken to bring the engine of the tram to the front (Figure 6.12). It is also possible to operate with only dedicated trams, detaching is not necessary anymore while it does not have to follow a specific route, but then the energy efficiency advantage will disappear. Therefore, it is recommended to implement a system with at least one trip with an attached wagon to an existing tram to make use of the tram transport potential. However, this variant entails some operational complications with for instance the driver, de-ataching and the (un) loading processes and details. This will need more context related research with as base the both researches of De Langhe (2014, 2019). The chosen configuration will determine the actual spatial implication for the DoPs.

The dedicated tram is the most examined and practised configuration at the moment. However, both configurations have their operational advantages and disadvantages. With balancing the length and taking into account the tram network capacities, it is suggested to find a way to use the advantages of both tram configurations by developing a system of attaching and detaching freight wagons, while having one engine in one direction (single ended), taking into account more context-related research.

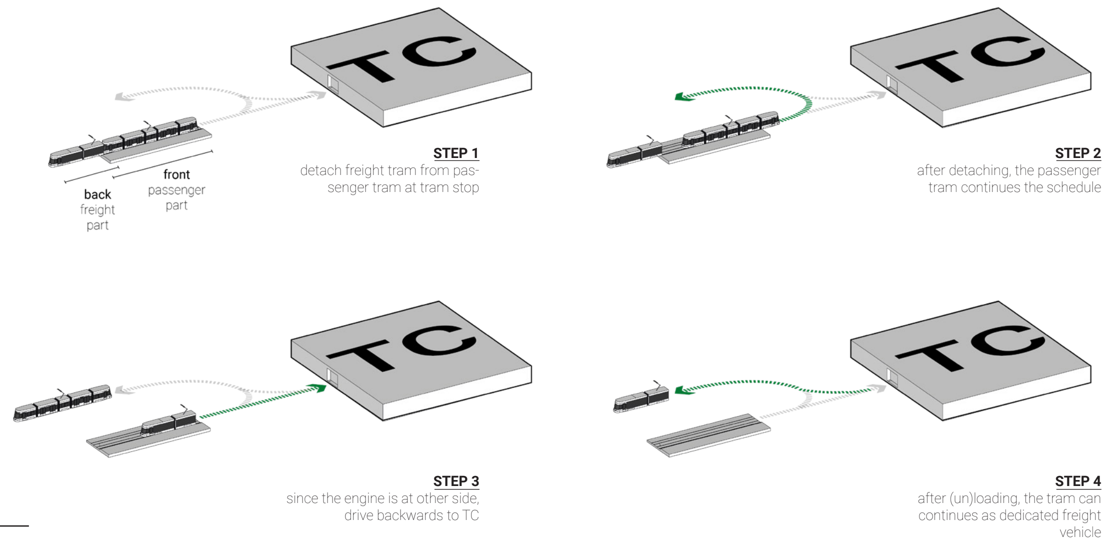



**FIGURE 6.12.1-4:**
Tram system around TC
*(author's drawing)*

### # *Roadmap for transhipment centre allocation*

Figure 6.13 will conclude the section of TCs by bringing forward a roadmap for allocation of the TCs in a city. Next to the mapped aspects for the UCC, also the retail areas and the tram stops (possible DoPs) need to be revealed. The need of TCs is dependent on the transportation distance between UCC and final destination (max 6 km) and the selected principle. The principles have slightly different location requirements. The selected mode from the UCC and the degree of available infrastructure influences the allocation of TCs.

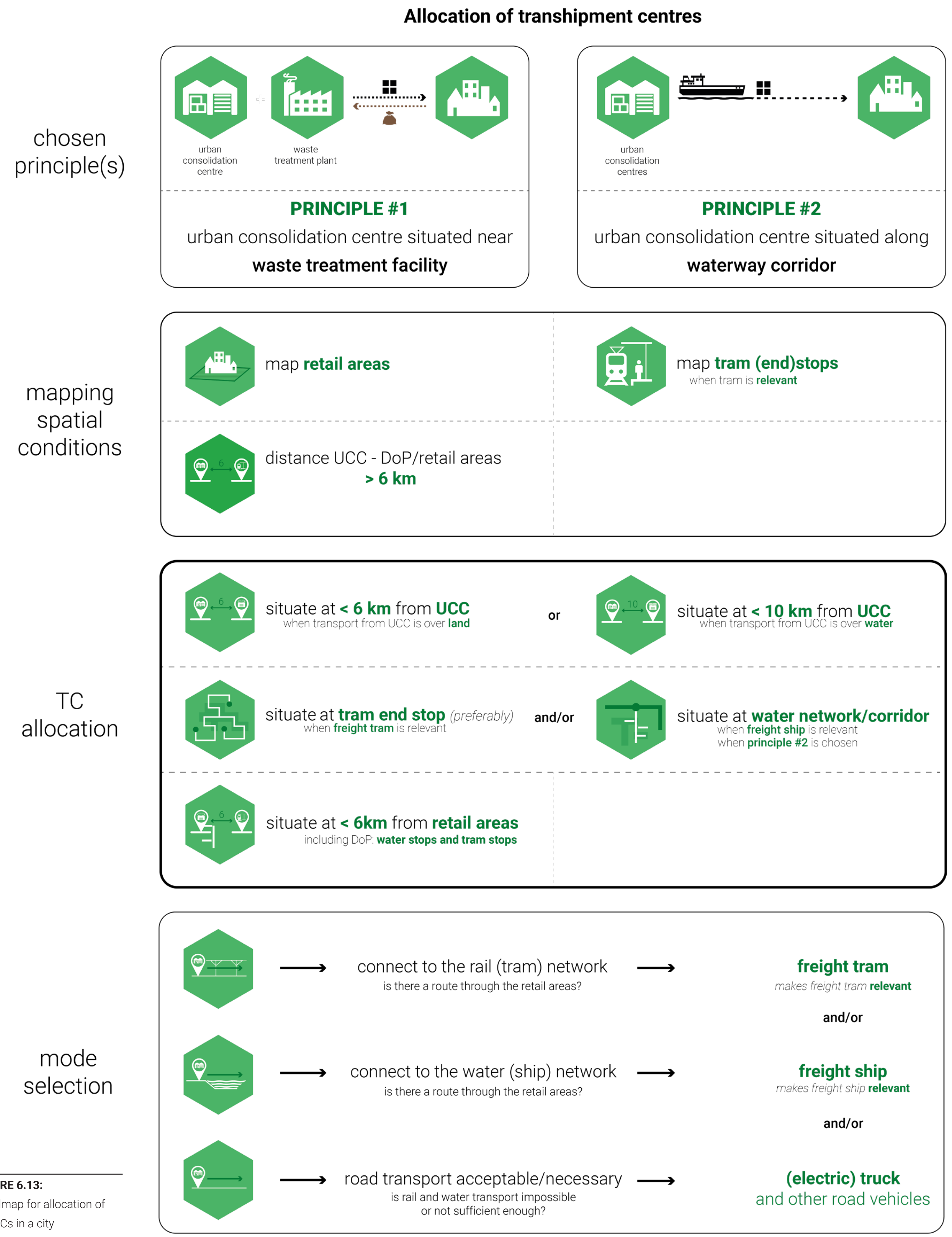



**FIGURE 6.13:**
Roadmap for allocation of the TCs in a city
*(author's drawing)*

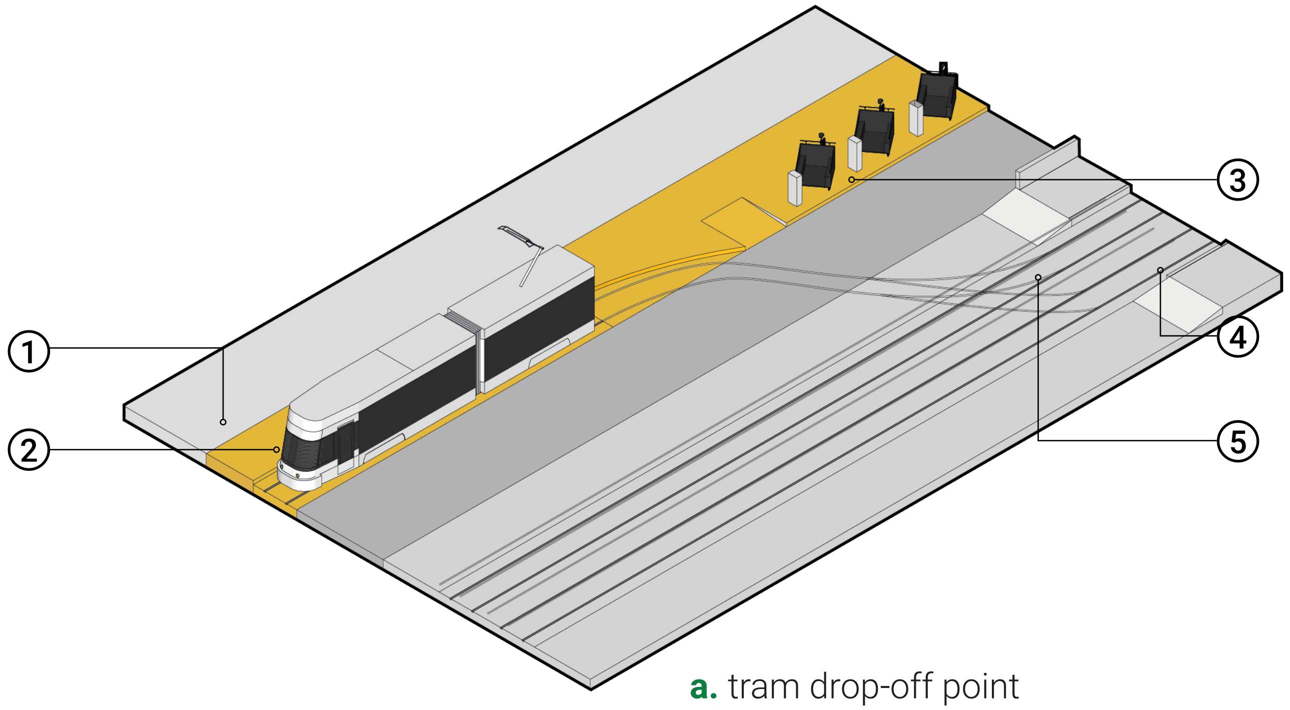
## 6.3.3 **Proposed nodes** *drop-off points*

Drop-off points are small final nodes (around 50 - 100 m²) and considered as the end point of the new system before it arrives at the retailer. They need to be available on a higher frequency in retail areas. The drop-off points provide the final delivery where freight arrives from UCCs or transhipment centres over rail or over water. At the drop off point, freight need to be transferred to small convential and electric road vehicles such as freight bikes or electric vans for final transport. Drop-off points can appear in the form of an extended tram stop or as a platform functioning as water stop. The drop-off point will operate as a place where freight can whether be picked up by shopkeepers or be delivered to the store on demand. Challenges in the spatial implementation are that they have to be put in already fully and defined programmed areas in the city centre, where they need to be integrated into an existing street (and water) profile. Due to the limited space in a historic and vulnerable environment of cities, these drop-off points needs to be dimensioned small with a limited spatial impact. This could be achieved by making drop-ff points removeable as well.

A drop-off point needs to receive other modes than road vehicles from the UCC or transhipment centre and therefore they need space to load and unload these vehicles/modes. Space availability is therefore an important criteria for the location. General conditions for drop-off points are that the activities on the drop-off points need to be safe and are not allowed to interfere with other traffic.

The tram stop (FIGURE 6.14) will need space to park the tram at extra side track (already present or the possibility to contruct one), a switch to drive back in opposite direction and a dedicated platform for loading and unloading whether as extension in line or parallel, depending on the chosen tram configuration. The space can be found in parking places or the current (un)loading zones for trucks and vans, which are now released due to the new system. The required impact of the intervention depends on the size of the tram (lenght and width) and arc radius of the tram. Close to the unloading zone, charging equipment for (electric) freight bikes is required. The tram itself will stay at the drop-off point for a specific time slot and therefore acts as main temporary storage. When the demand is big and there is space left, additional storage can be considered.

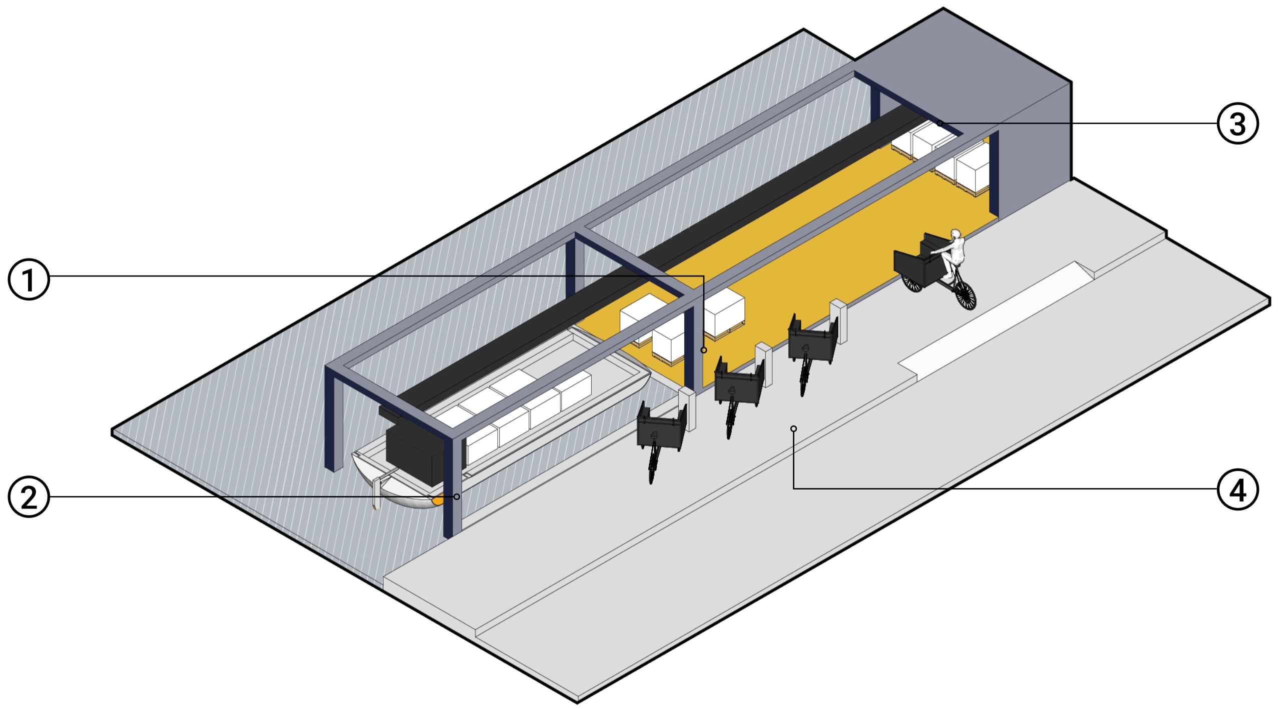
The water stop (FIGURE 6.15) will need space to moor a boat at a dock and for a new (floating) platform on the water in a canal that is broad enough to prevent interfering other sail traffic. It is desirable to do the mooring behind the platform to keep the canal passable. At the platform some facilities are required: a crane to unload freight and charging equipment for (electric) freight bikes. Since goods are transferred from the ship to the land, small temporary storage is needed. This can be in the form of safe lockers at the platform or an underground/basement storage dedicated for surrounding retailers, when eventually the structure is already there.




**a.** tram drop-off point

**1.** loading/unloading zone
**2.** extra side track for freight
**3.** cargo bike charging point
**4.** passenger tram stop
**5.** switch for the opposite direction

**FIGURE 6.14:**
Drop-off point 1:
freight tram drop-off point
*(author's drawing)*




**b.** water drop-off point

**1.** floating boat platform
**2.** moring space + (un)loading) crane for freight boat
**3.** temporary storage
**4.** cargo bike charging point

**FIGURE 6.15:**
Drop-off point 2:
freight boat drop-off point
*(author's drawing)*



# ***Location requirements drop-off points***

Although the high frequency of drop-off points, they are also limited to some location requirements. These are based on the earlier defined locations of UCCs and transhipment centres on the one hand and on the other hand on the existing infrastructure and retail areas on location. Therefore, some requirements are only relevant under specific selected principles and modes at the UCC allocation. Drop-off points therefore only can be constructed when they are:

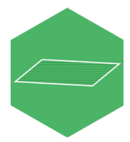
**1a) located at the proximity (<6 km) of a constructed urban consolidation centre**
Without transhipment centre, the maximum travel distance is assumed and set at 6.0 km between a drop-off point and an UCC to ensure the efficiency of transportation.

**1b) located at the proximity (<6 km) of a constructed transhipment centre**
With transhipment centre, the maximum travel distance is assumed and set at 6.0 km between a drop-off point and an UCC to ensure the efficiency of transportation.

**2) located at the proximity (<0.5 km) of a final retailer**
The transport from the drop-off point needs to be as short as possbile to make it even possible to let the retailers collect their own freight by foot. Therefore, the maximum travel distance is assumed and set at 0.5 km between a drop-off point and final destination.

**3a) located at the proximity of a fine-grained rail (tram) infrastructure**
Freight is preferably transported over the rail (freight tram) instead of road vehicles to the final destination in the city. The spatial analysis will be evaluating the presence and the degree of fine-grainess of the network in relation with the retail areas and determine whether the tram network is appropriate enough to transport goods over to reach the final retailer.

**3b) located at the proximity of a fine-grained canal/water (ship) infrastructure**
Freight is preferably transported over water (freight ship/boat) instead of the road vehicles to the final destination in the city. The spatial analysis will be evaluating the presence and the degree of fine-grainess of the network in relation with the retail areas and determine whether the water/canal network is appropriate enough to transport goods over to reach the final retailer.



**4) located where there is enough space available**
The availability of space to load and unload is important. In some cities, they need to be allocated in a historical city centre at canals, wherein the space is limited and at some places an extra constructed tram track is needed. Traffic safety needs to be guaranteed and the environment may not be damaged.

## # *Handling and storage at tram drop-off point*

As earlier suggested, freight tram leave the TC as a dedicated freight tram. Dependent on network capacity, they drive to one of their served drop-off points. The dedicated freight tram arrives at a selected drop-off point at a separate side track preferably after the tram stop. This dedicated track must not interefere with regular passenger traffic and thus a freight wagon has the possibility to stay at the side-track for the needed time of gradual unloading (e.g 30 minutes). The tram itself could act as temporary storage at the drop-off point. When there is enough space available, also temporary storage can be considered so that the tram can be unloaded. Retailers receive a time slot wherein they can get their goods or hire a third party to bring their goods to their store. When unloading is finished, the freight tram will be attached to a tram, driving in the opposite direction back to the TC. With this, all advantages of both configurations are used to optimise the service of the freight tram. These steps are demonstrated in FIGURE 6.16. Furthermore, De Langhe (2014) lastly emphasises on the importance of handling technology concerning the external noise and the speed.

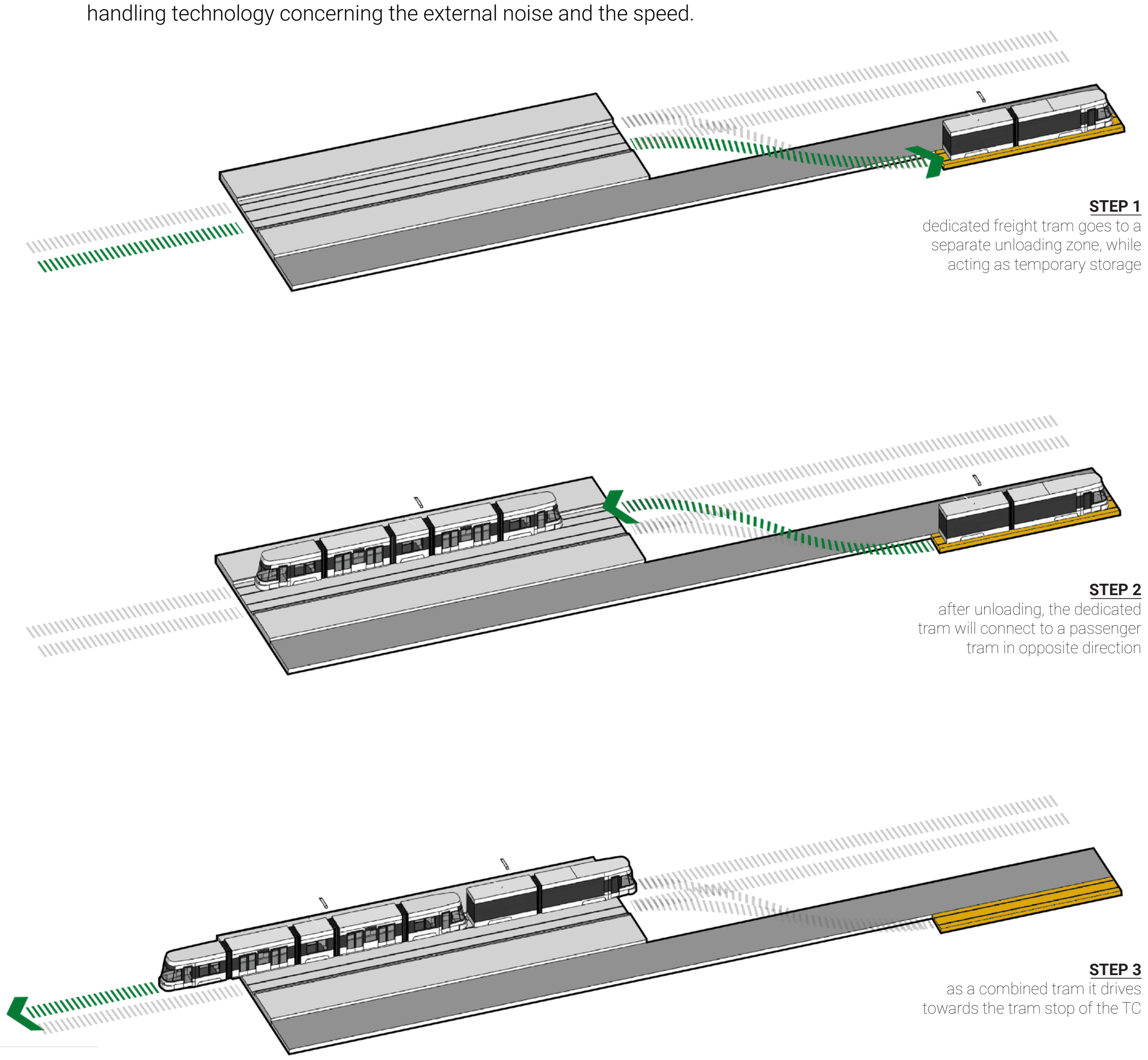



**FIGURE 6.16:**
Freight tram drop-off point handling and storing
*(author's drawing)*



## # *Handling and storage at water drop-off point*

FIGURE 6.17 demonstrates the handling and storage at a water drop-off point. Freight boats are operating on their own and have more freedom in their movement compared with trams. Freight boats sail from the UCC or TC to a water drop-off point, where freight will be transferred to land and where it is made ready for post transport to its final destination. It was already suggested to do the mooring in the extension of the platform to keep the canal passable. The dock will be oriented to the UCC or TC where a freight boat can moor straight in the docks. Freight will then be unloaded by a crane and will be put at the platfrom for direct transport or temporarily stored in the lockers at the platform. When the (un)loading) has finished at this drop-off point, the freight boat will continue its journey to the next drop-off point or goes back to the UCC or TC.

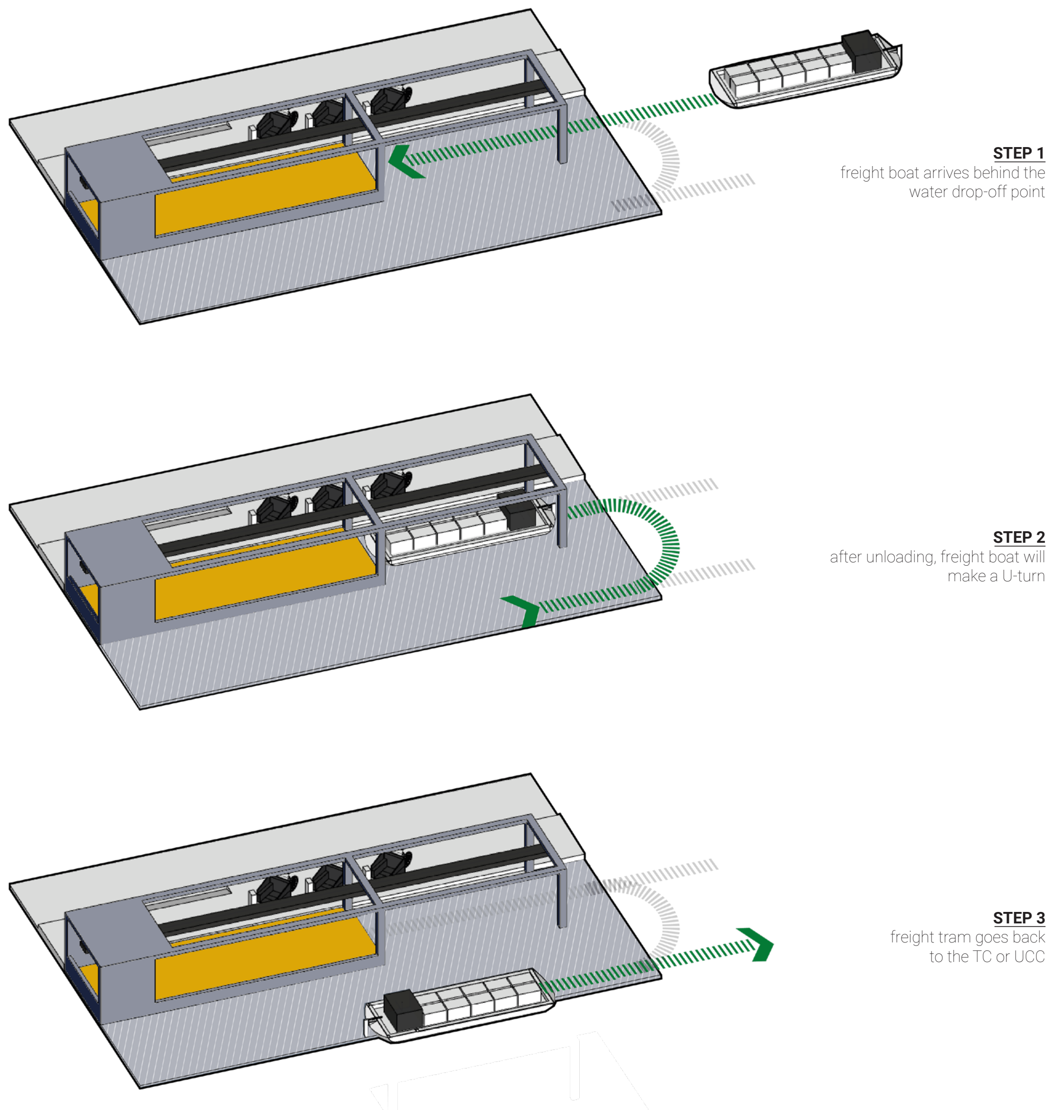



**FIGURE 6.17:**
Freight boat drop-off point handling and storing
*(author's drawing)*

# *Post-transport after drop-off*

Freight arriving at a drop-off point will be stored temporarily there. Depending on the mode, this will be whether the mode itself (tram) or an temporary locker at the stop (boat). From there, there are several options for post transport after the drop-off. The choice is dependent on the transportation mode, the distance to the store (when the store is close situated at a drop-off point, also weight equipment such as a hand truck or a roll container, eventually powered, can be considered for carrying goods), availability of staff and (financial) willingness to leave it to a third party. The possbilities are as follows:

- Freight can be picked directly after the tram/boat arrives at the drop-off point by an employee of the shop and can walk or use their own freight bike to bring it to the store. At the same time, they also could bring their waste to the drop-off point, which will be taken by the (next) freight tram or boat.

- Freight can be picked later after the boat arrives at the drop-off point by an employee of the shop and can walk or use their own freight bike to bring it to the store. The freight then needs to be temporarily storaged at the platform in the lockers. At the same time, they also could bring their waste to the drop-off point, which will be taken by the next freight boat. For the tram, a time slot of e.g. 30 minutes will be reserved to get your freight, since the freight tram itself acts as a moving storage.

- An external party for last-mile delivery can be used. Freight can be brought by a cargo bike service or small electric vans to the final retailer. This can be done immediately after arrival of the freight. Important for these third parties is to provide facilities regarding equipment for loading and vehicle charging at location. In the future, it could be imaginable to do this fully automated.

Figure 6.18 on the next page shows some of the possible modes ranging from weight equipment, cargo bikes, electric vans or even automated vehicles that can be used for the last-mile transportation. These vehicles operate on the road traffic in the neighbourhood and thus are there no infrastructural limitations. There are some spatial restrictions in terms of distance due to their dependence on electric battery. Expected load capacity is 0.1 t (cargo bike) to 0.85 t (e-worker; Eco-mobiliteit, n.d.).

Hand truck

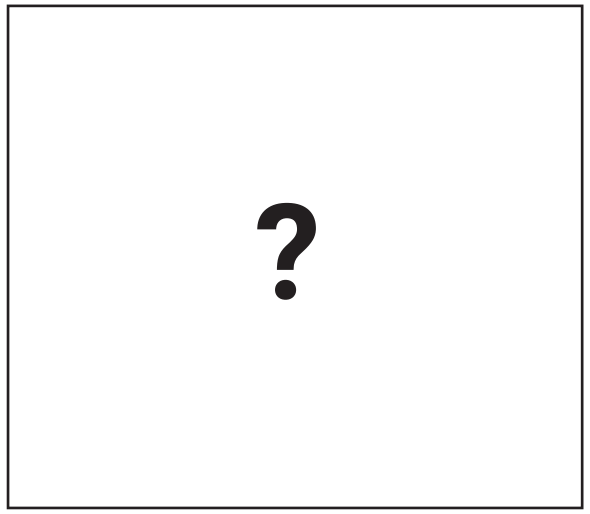
Roll container

Gazelle D-10 (Gazelle via Tweewieler, 2018)


BikePortland (2019)

E-worker (Hofstede-Timmerman, 2016)


Cargo bike (Diederik van der Laan via Telegraaf, 2019)




Automated freight robot

**FIGURE 6.18:**
Post-transport vehicles
*(diverse authors/ photographers)*

## # Roadmap for drop-off point allocation

FIGURE 6.19 will conclude the section of DoPs by bringing forward a roadmap for allocation of the DoPs in a city. Some requirements are only relevant under specific selected principles and modes, dependent on the UCCs, transhipment centres and the existing infrastructures. The need for drop-off points depends on whether rail and water transport is used or not. With purely road transport, it is assumed that a drop-off point as a newly introduced node is not necessary, although it could be considered as an already familiar pick-up point. Nevertheless, they could be placed anywhere and are thus left outside consideration.

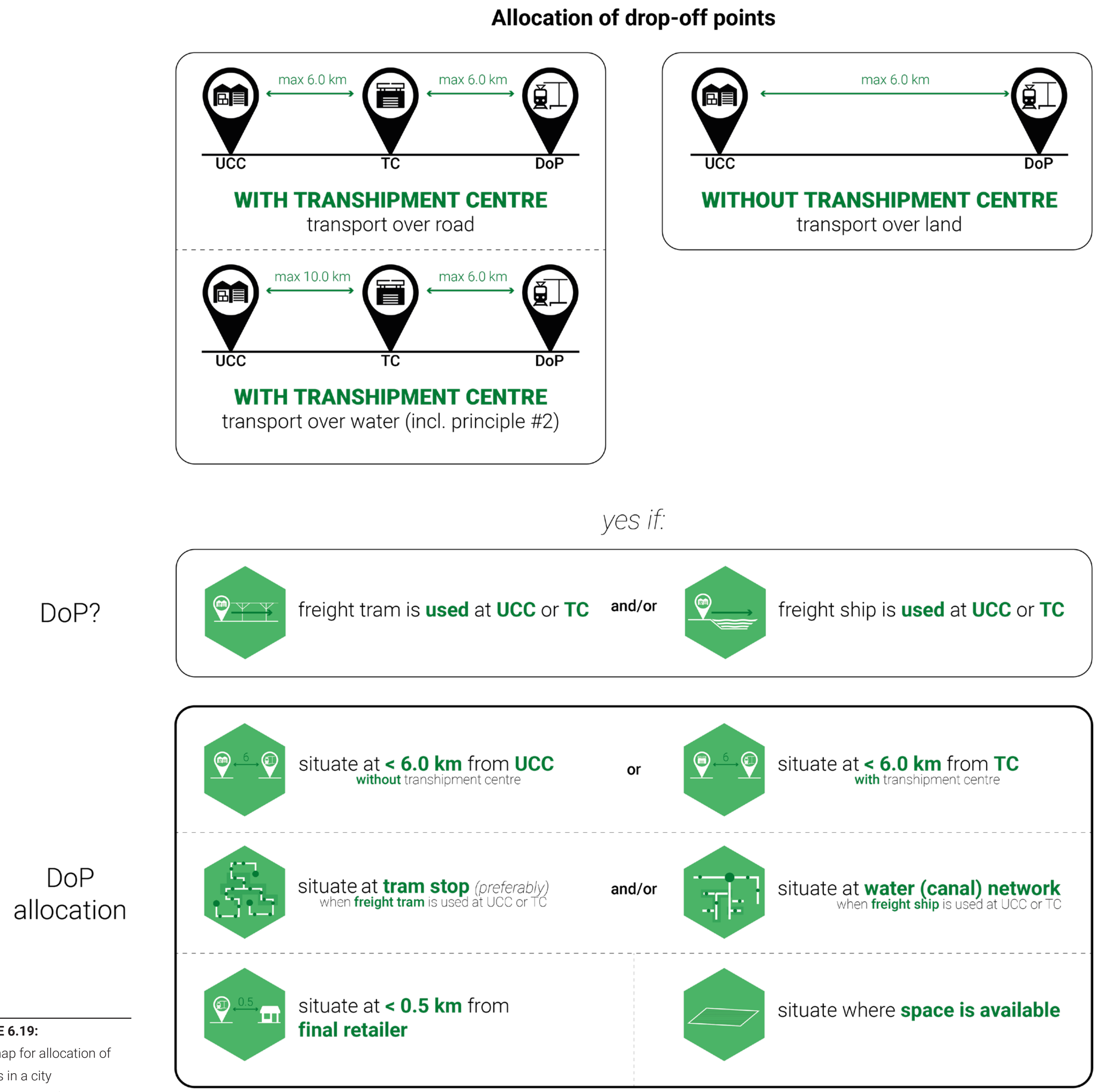



**FIGURE 6.19:**
Roadmap for allocation of the TCs in a city
*(author's drawing)*

## 6.3.2 ***Proposed nodes*** *intermediate conclusion*

This subchapter has address three types of nodes that will be implemented in the new urban freight system: urban consolidation centres (UCCs), transhipment centres (TCs) and drop-off points (DoP).
The description is based on their spatial implication, activities, modal operation, operational issues and their location factors.

There are two principles developed for UCCs, which determine the course of the proposed system in an area. The intermediate conclusion will discuss the possible variants and possibilities within these principles:

1) Urban consolidation centres situated near waste treatment facilities
2) Urban consolidation centres situated along a waterway corridor

As explained earlier, these two types of UCCs, three modes can be chosen for further transport: over road, but preferably over water or rail. When considering land modes (rail and road), this results in these four pure variants for the two principles, whose two options persection are illustrated in FIGURE 6.20 for principle 1 and in FIGURE 6.21 for principle 2:

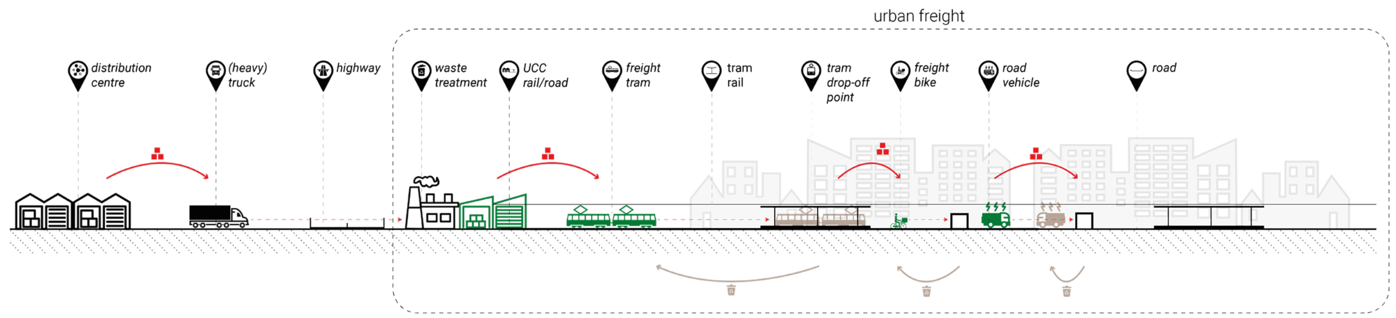



**FIGURE 6.20:**
Principle 1 with a freight tram and or road vehicle as post transport
*(author's drawing)*

*Trucks bring goods to an UCC that is connected to the tram and/or road network. Then the goods will be transported over the tram or road network to a tram drop-off point/final destination. After delivery to a drop-off point, smaller vehicles bring the goods to the final destination.*

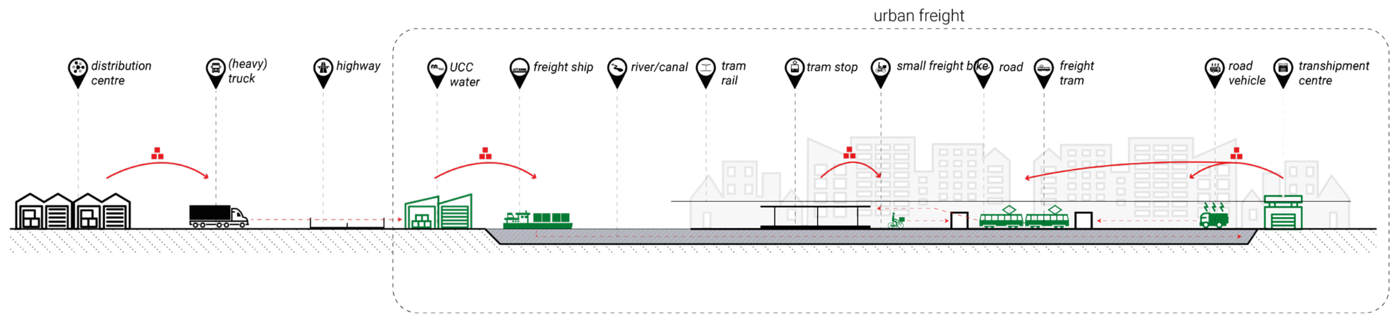



**FIGURE 6.21:**
Principle 2 with a freight tram and or road vehicle as post transport
*(author's drawing)*

*Trucks bring goods to an UCC along a large water corridor through the city. Then, the goods will be transported over the water corridor to a transhipment centre in the middle of the city. From there, the goods continue over the tram or road network to a tram drop-off point/final destination. After delivery to a drop-off point, smaller vehicles bring the goods to the final destination.*

It is also possible that a situation occurs where a waste treatment plant is situated close to a waterway. A strategy wherein the principles are combined could then be the most beneficial for a city. It means that in FIGURE 6.21 a waste treatment facility need to be added to come to the the section for combined principless. Considering the water modes, there are several variants possible, since this is dependent on the location. In purest form this can lead to the following system as shown in FIGURE 6.22.

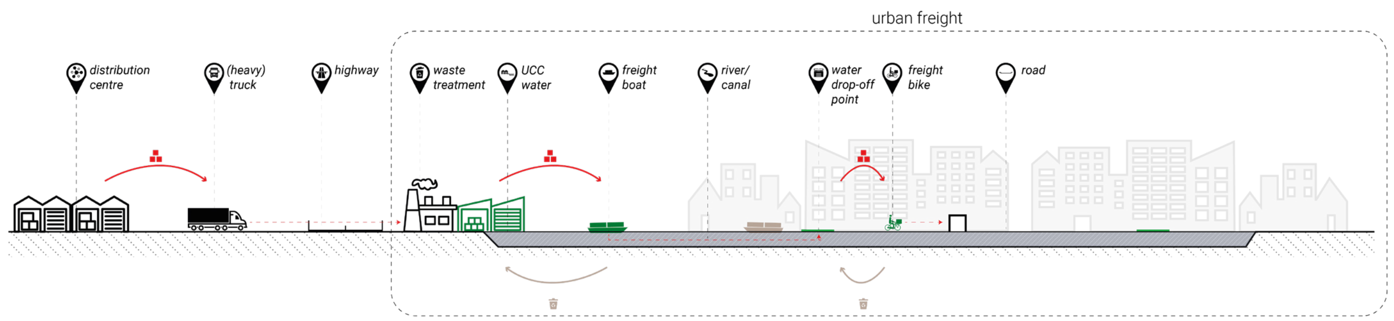



**FIGURE 6.22:**
Principle 2 with a freight tram and or road vehicle as post transport
*(author's drawing)*

*Trucks bring goods to an UCC that is connected to the water network. Then the goods will be transported over the water network to several water drop off points in the city. After delivery to a drop-off point, smaller vehicles bring the goods to the final destination.*

Literally, this section shows the first principle connected to the water mode. However, it turned out that variants do not always fit in a specific principle and so there is some overlap in the different variants, especially on the water modes. Variables in the variants are whether or not

- the presence of waste treatment facilities
- the use of transhipment centres
- the use of drop-off points.

Theoretically, it is also possible to continue with freight boats after application of the second principle. However, transferring from a large mode to a smaller mode on the water often does not make sense on city scale and will therefore not considered as a realistic option.

In APPENDIX IV, every possible variant with respect to the two principles, three modes and the three urban areas are explored and evaluated. The findings of this analysis are put in a matrix including every variable to generate an overview of possibilities and impossibilities per city. This matrix will be input as well for the region-specific strategies in PARAGRAPH 6.5.

## 6.4 Spatial interrelationship

This paragraph will incorporate the three nodal roadmaps based on the location requirements to map the spatial interrelationships between the different nodes for the urban regions of Rotterdam,The Hague and Delft to a general applicable step-by-step plan.

As have been demonstrated, the three nodes (UCCs, transhipment centres and drop-off points) have different operational scales (from city scale to street scale) with different spatial requirements. The presence of the required facilities or infrastructures and if so, the location need to be revealed per city. The revealed locations are input for the region-specific strategies.

1) The first step is to find out possible locations for urban consolidation centres per city and to what extent a principle can be applied in the city. This step goes along with the roadmap of UCCs [PARAGRAPH 6.3.1] and determines the chosen application of the principles. For this step, it is important to map the highway and waterway infrastructures (identify potential water corridor), city entrances, waste treatment facilities, low emission zones and industrial areas.

2) The second step will address transportation from UCCs, eventually via transhipment centres to the city, where retail entities are present. This step determines which modal requirements are relevant and wether a transhipment centre is necessary or not. If so, then the steps in the TC roadmap need to be taken [PARAGRAPH 6.3.2]. In this step, it is important to map available infrastructures, such as rail and water connections between the edge of the city (UCC locations) towards the city centre, where retail entities are situated.

3) The third step includes the identification of possible locations for drop-off points, corresponding with the DoP roadmap [PARAGRAPH 6.3.3]. Also post transport needs to be taken into account. The type of drop-off point is depedent on the available infrastructures in the cities. Important is the presence and a certain degree of fine-grainess of local infrastructures for rail, water and road modes to reach as much as possible entities in retail areas. Also the location of these retail entities are important. As stated before, conventional road transport could be used anyway.

*For all the cities counts that naturally (conventional) vehicles over the road can transport goods from the edge to the city to the city centre. However, the goal is multimodality and therefore, solutions over rail and water are preferred. Nevetheless, road transport only has to be established in situations in where rail nor water are applicable.*

After this paragraph, the spatial conditions will be evaluated and translated to a strategy for each of the three urban areas (Rotterdam, The Hague and Delft).

## 6.4.1 **Spatial interrelationship** *possible locations of UCCs*

# ***Rotterdam urban region***

Rotterdam does have an enclosed highway structure (diamond) around the city and has most of its waste treatment facilities located along these highways and city entrances in industrial areas. This creates five possible UCC locations related to waste [1-5]. The city also has an important water corridor through the city, The Maas, which enables two more possible locations according to the second principle as well [6-7]. For the supply of Schiedam, also an UCC could be situated along the Schiedamse Schie [1]. Seven possible locations for UCCs can be derived, based on these location factors (FIGURE 6.23).

# ***The Hague urban region***

The Hague does not have a clear highway structure, which put pressure on the highway tracks directed to the city. There are two waste treatment facilities [1] situated in the Binckhorst at the edge of the low emission zone in the proximity of the Haagse Vliet, which is an important water corridor. through the city. Also two other waste treatment facilities [2-3] situated along the highway in the south between Delft and The Hague can be potential locations. Three locations for UCCs can be derived, based on the location factors (FIGURE 6.24).

# ***Delft***

Delft does have an enclosed highway structure around the city with waste treatment facilities [1-2] located in the north and the south in the proximity of an important water corridor. Important water corridor is De Schie, which goes through the city centre. For Delft, two possible UCCs can be derived, based on the location factors (FIGURE 6.25). Delft and The Hague could share a waste treatment facility.

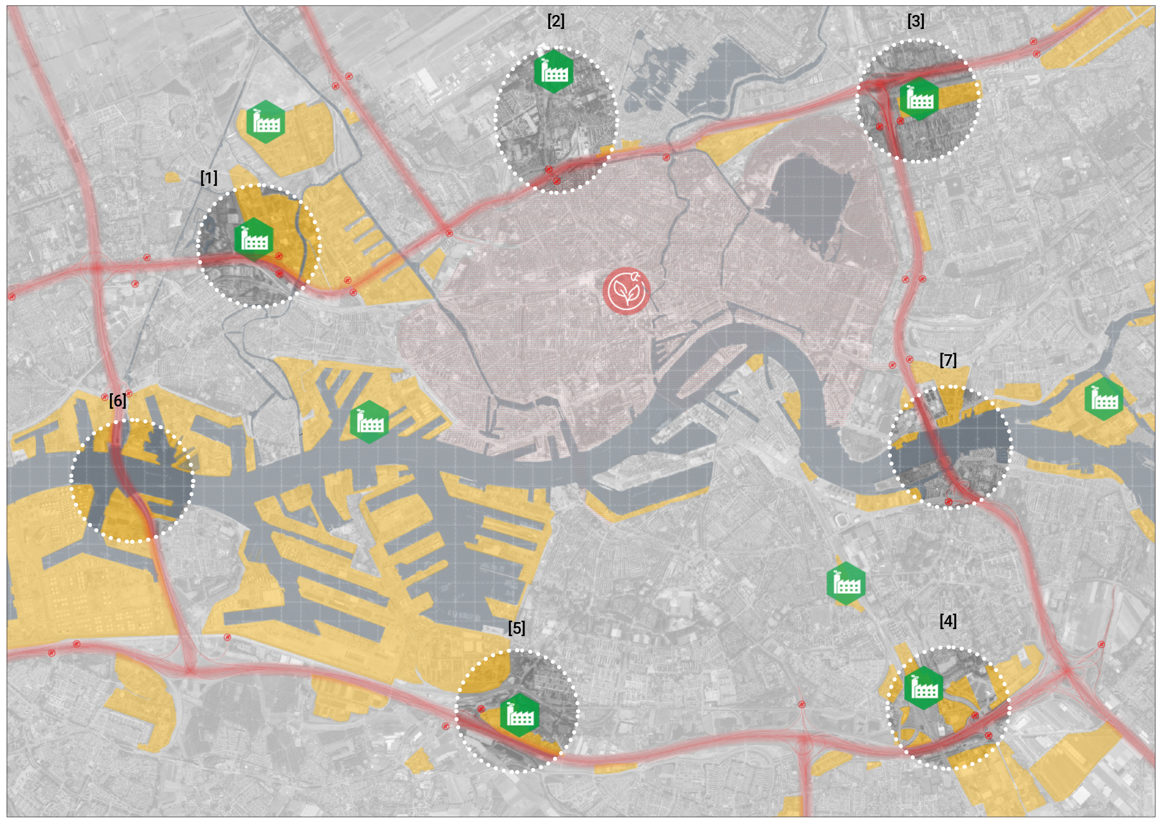



FIGURE 6.23:
Rotterdam
DC > UCC
*(author's drawing)*

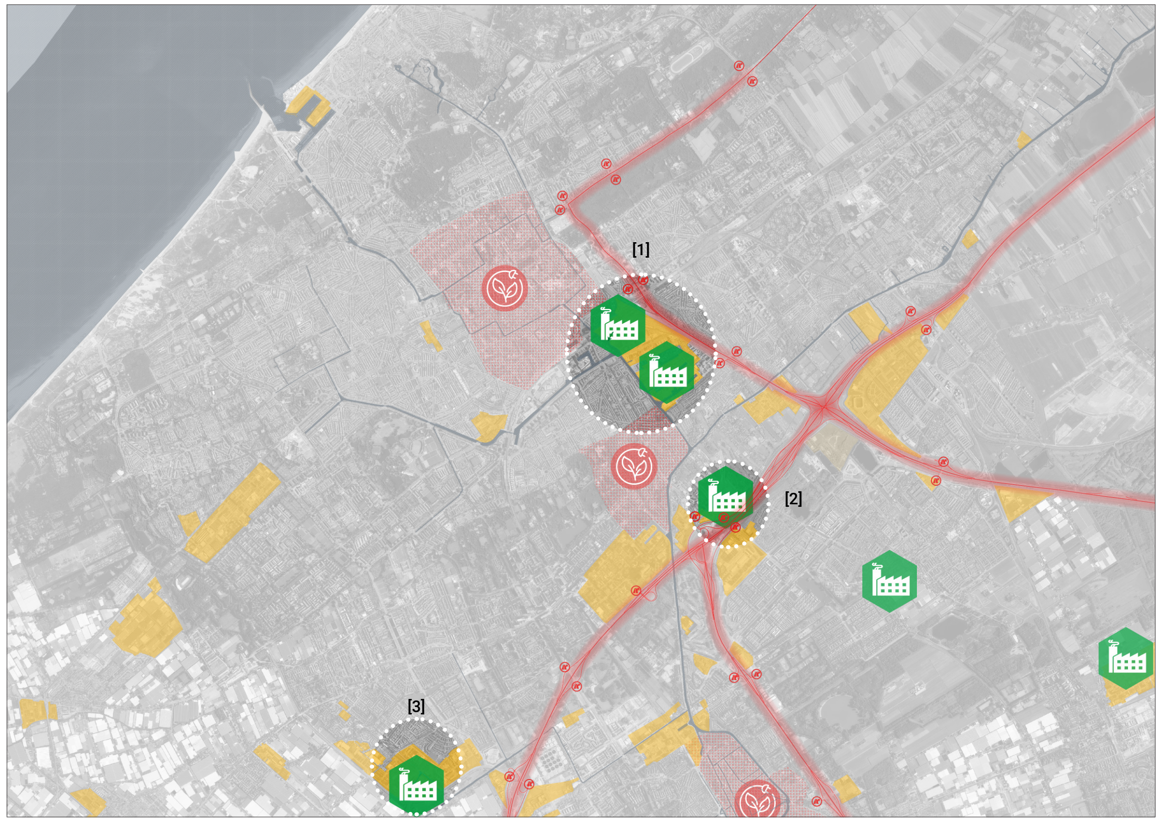



FIGURE 6.24:
The Hague
DC > UCC
*(author's drawing)*

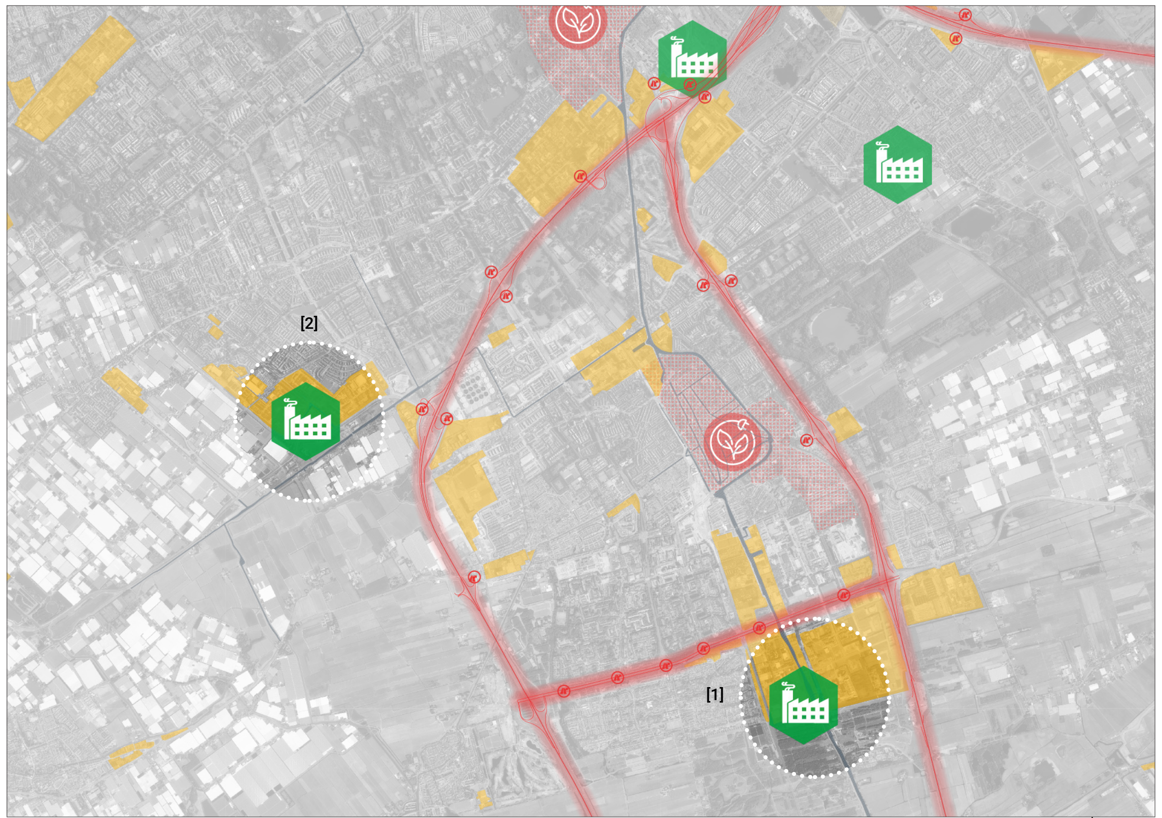



FIGURE 6.25:
Delft
DC > UCC
*(author's drawing)*

## 6.4.2 ***Spatial interrelationship*** *transport from UCCs to the city*

### # *Rotterdam urban region*

In Rotterdam, the waste treatment facilities are situated along the highways. They are not connected to the tram network nor the water network. There is just one waste treatment facility located at the northern river bank [1]. Opportunities can be seen in the tram end stops connected to the water corridor (M4H [2], Willemsplein [3], The Esch [4]), which gives possibilities to establish connections over water towards the northern part of the city. There are tramways in the southern part available which are fine-grained enough. However, additional tram connections need to be constructed to the river or to waste treatment plants.  Schiedam is smaller and thus the canal structure could be sufficient [5], which makes it not unthinkable to supply over water (FIGURE 6.26)

### # *The Hague urban region*

In The Hague, the waste treatment facilities are situated along the highways as well. Only the southern waste treatment facility is somehow situated close to an end stop of a tramline [1]. Two other waste treatment facilities at the Binckhorst are situated close to the Haagse Vliet waterway, which directs to the water ring around the city centre [2]. This gives The Hague the possibility to combine both principles in their region-specific strategy (FIGURE 6.27).

### # *Delft*

In Delft, there are two waste treatment facilities identified in the north and the south. Although there is no connection with the tram network, they are well located along De Schie [1] and De Zweth [2]waterways, which gives Delft also the possibility to combine both principles in their region-specific strategy (FIGURE 6.28).

Legend
- road
- waterway
- tramway
- tram end point (on dedicated lines)
- waste treatment facility

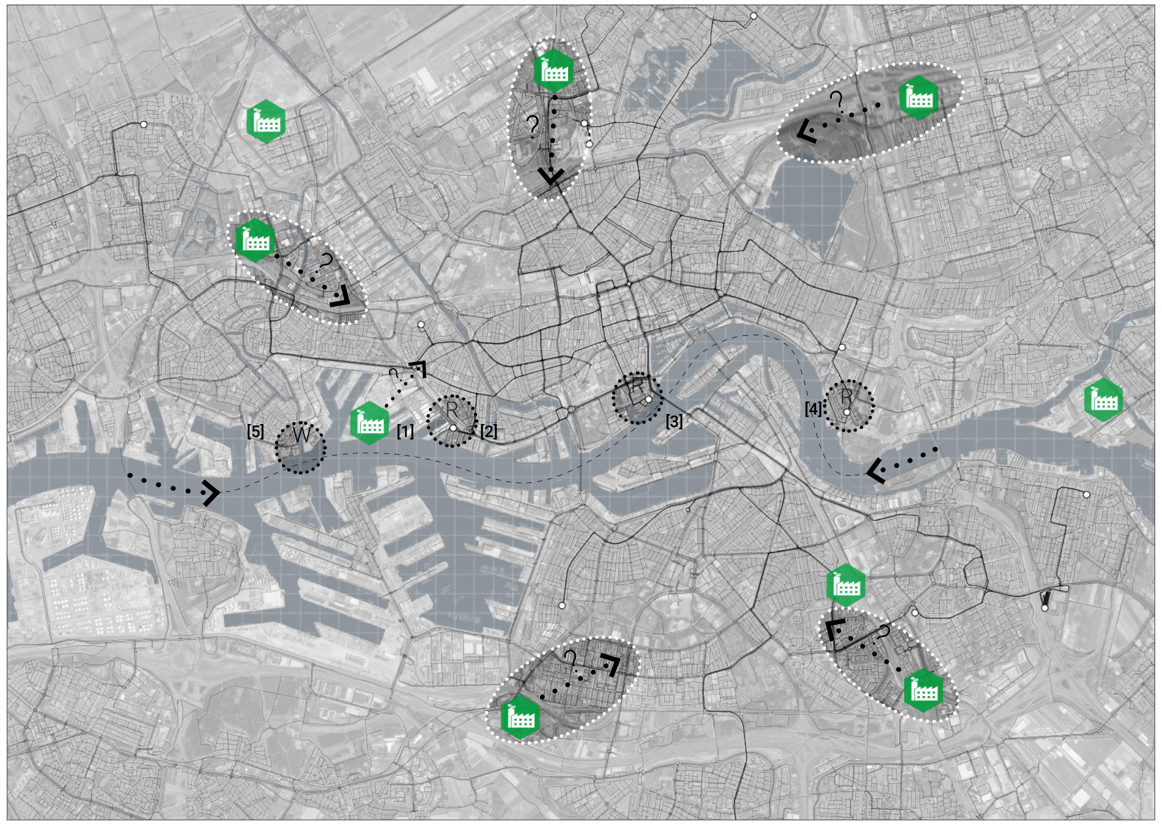



**FIGURE 6.26:**
Rotterdam
UCC > city centre
*(author's drawing)*

Legend
- road
- waterway
- tramway
- tram end point (on dedicated lines)
- waste treatment facility

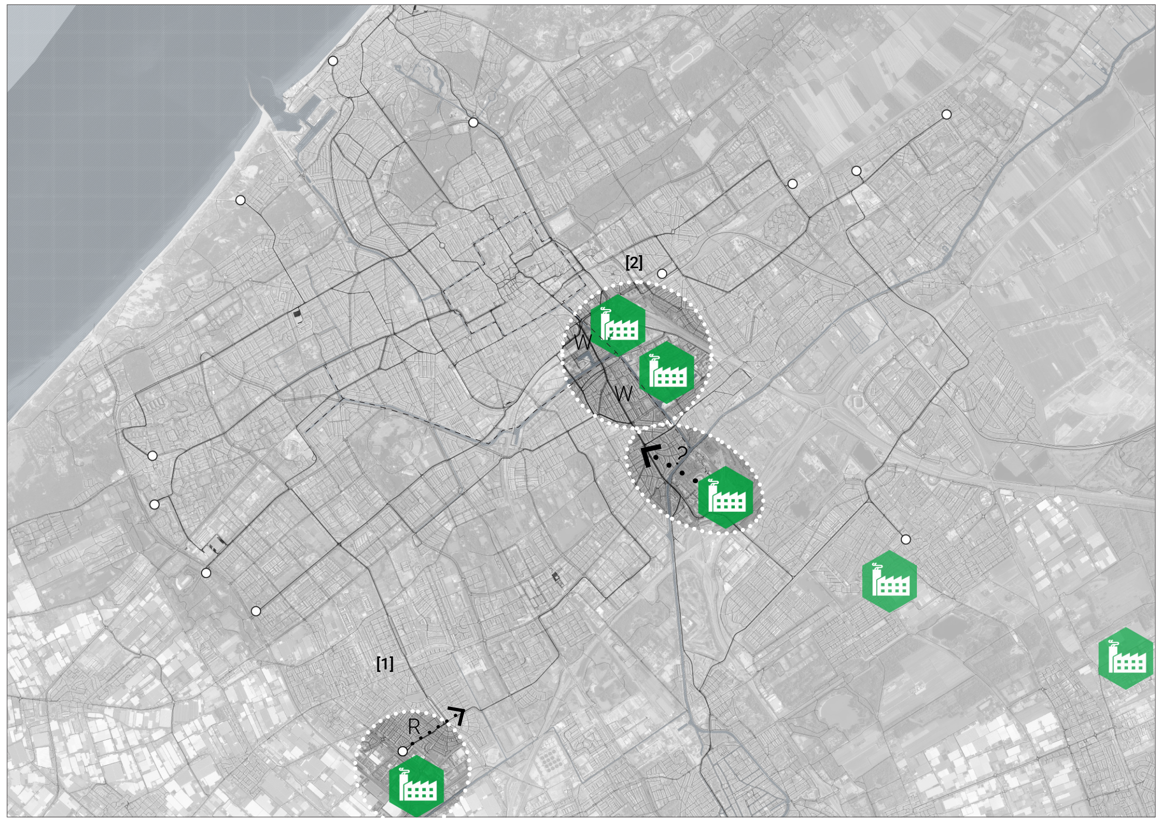



**FIGURE 6.27:**
The Hague
UCC > city centre
*(author's drawing)*

Legend
- road
- waterway
- tramway
- tram end point (on dedicated lines)
- waste treatment facility


**FIGURE 6.28:**
Delft
UCC > city centre
*(author's drawing)*

## 6.4.3 **Spatial interrelationship** *possible locations drop-off points*

#	***Rotterdam urban region***

Rotterdam has extensive retail areas, in which they also have in terms of available infrastructure a fine-grained tram network, especially in the city centre. When establishing tram connections from the river or waste treatment plants, the tram stops could facilitate the city centre [1] (Lijnbaan, Coolsingel etc.). For the southern part, other solution need to be found (e.g. complement with road transport), especially for two large retail entities Zuidplein and Keizerswaard [2], since there is no tram connection.  There is no extensive canal structure that can cover every retail area (FIGURE 6.29). For Schiedam, tram and water drop-off points need to be created [3].

#	***The Hague urban region***

The Hague has extensive retail areas. The outstreched and fine-grained tram network of The Hague could help the city with supplying the retail entities outside the city centre [1] (for instance: shopping malls). The city has a water ring around the city centre, which is connected to the Haagse Vliet. This gives the possibility to bring goods closer to the city centre over water [2]. The Hague does not have an extensive water (canal) structure to cover every retail area and thus is the use of trams and road vehicles necessary to complement the proposed system (FIGURE 6.30).

#	***Delft***

Delft has a limited amount of large retail areas. The city does not have a fine-grained tram network to cover these areas, but the city has a extensive water network that can reach the whole city centre well [1]. This makes it more difficult to put transfer and drop-off points. For De Hoven [2] in Delft, other solutions need t obe found (FIGURE 6.31).


**FIGURE 6.29:**
Rotterdam transhipment centre > drop-off point
*(author's drawing)*

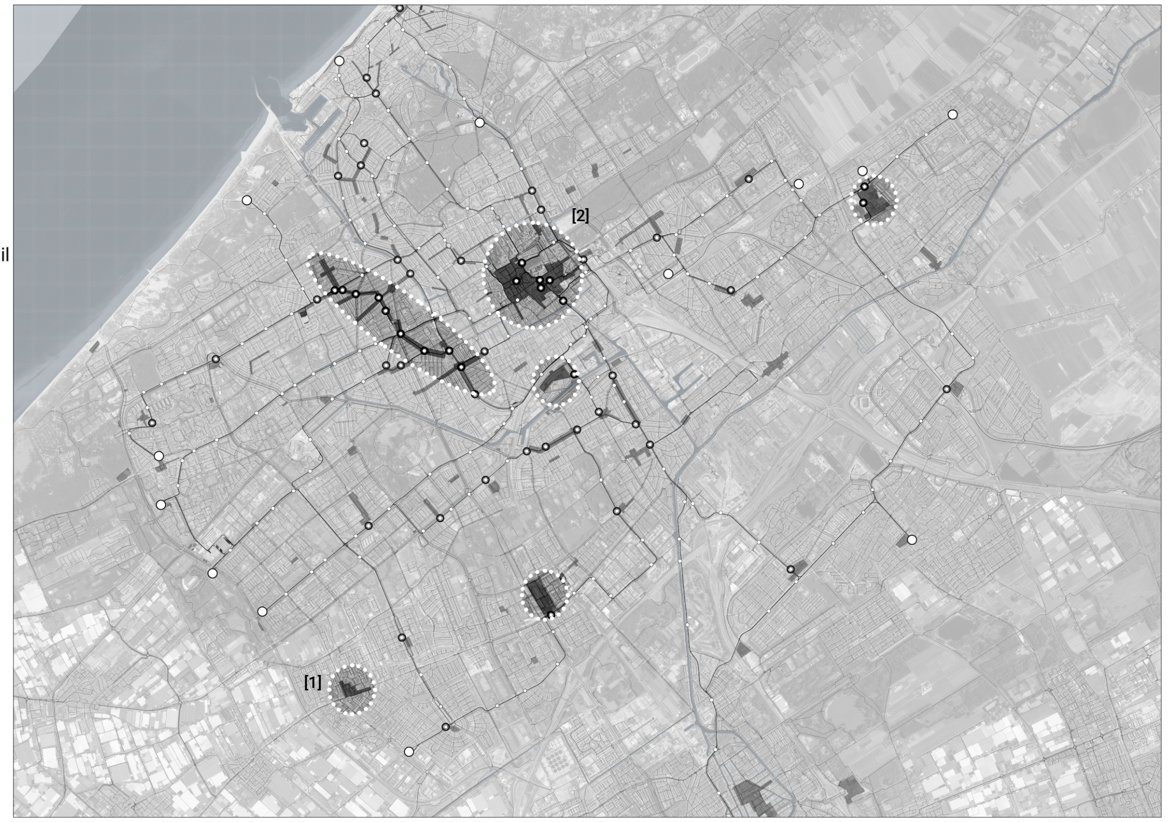



**FIGURE 6.30:**
The Hague transhipment centre > drop-off point
*(author's drawing)*


**FIGURE 6.31:**
Delft transhipment centre > drop-off point
*(author's drawing)*

## 6.5.1 **Region specific strategy** *Rotterdam urban region*

### # ***Spatial conditions***

There are several possibilities to arrange the supply of the Rotterdam urban region. In this region, the city of Rotterdam has extensive retail areas concentrated on several locations. Rotterdam has their waste treatment plants situated close to the highways and city entrances, but they are not connected to the tram and water network. There is also a water corridor with tram connections at the northern part. The inner canal structure is not fine-grained enough to cover every retail area. The tram network of the city is fine-grained. According to the matrix, the waste principle is likely to work only with road transport, which result in a missing multimodality, while the waterway princple is likely to work with rail, wherein road transport can complement this. However, in Schiedam, this principle could work with water transport, due to the smaller size of the city.

### # ***Proposed strategy and requirements***

FIGURE 6.32 shows the conceptual scheme developed for Rotterdam urban region. Based on the spatial conditions, tested variants and the degree they could cover the retail areas, a hybrid model will be proposed, wherein both principles will be utilised in co-existence. Both, the situation of the waste treatment plants as the river have a huge potential, wherein the one can complement the other, when the other falls short. Due to the application of mainly the second principle in the city centre, this will be considered as the predominant principle.

The components of the second principle are shown in FIGURE 6.33. The Maas river is a crucial asset of this principle. The principle requires two new UCCs close at the crossings of the A16 and A4 with the Maas (FIGURE 6.35.1-2). From there goods will be transported over water to several multimodal transhipment points, situated at the river bank, to other modes or boat. In Rotterdam, goods will be mainly transferred to trams, as there are tram endpoints situated along the river bank (M4H, Willemsplein, The Esch; FIGURE 6.36.1-3). This requires multimodal transhipment points and a transformation of tram stops in retail areas. Possibilities in the south part of Rotterdam needs to be explored to connect existing rail infrastructure to the river. Identified exploration areas are the Brielselaan and in Feijenoord (FIGURE 6.36.4-5). Goods to Schiedam will get there by boats via another UCC at the crossing of the Schiedamse Schie and A20 in the 's-Gravenlandse polder (FIGURE 6.35.3), which has good access to the canals of Schiedam, while also being assisted by tram infrastructure at the edge of the city centre. The goods can go directly from UCC towards the drop-off points.

Additional to this system, it needs to be complemented with road vehicles to enlarge the tram coverage and give extra possibilities to supply the city. The components of the first principle are shown in FIGURE 6.34. With respect to the synergy with waste, Rotterdam has 4 potential locations, situated close to the highways and its city entrances (FIGURE 6.37.1-4). The synergy between the supply of goods and waste collection needs however to be found on the road since the waste treatment plants are not properly connected to rail nor water infrastructures. They could be built to cover every retail area in the city, in additional sense or when it is not possible to conduct the waterway principle especially in the south and outskirts of the city. With these movements, also the collection of waste is included. In fact, this is the application of the urban consolidation concept in its simpliest form. FIGURE 6.38 shows the proposed total region-specific strategy map of Rotterdam urban region.

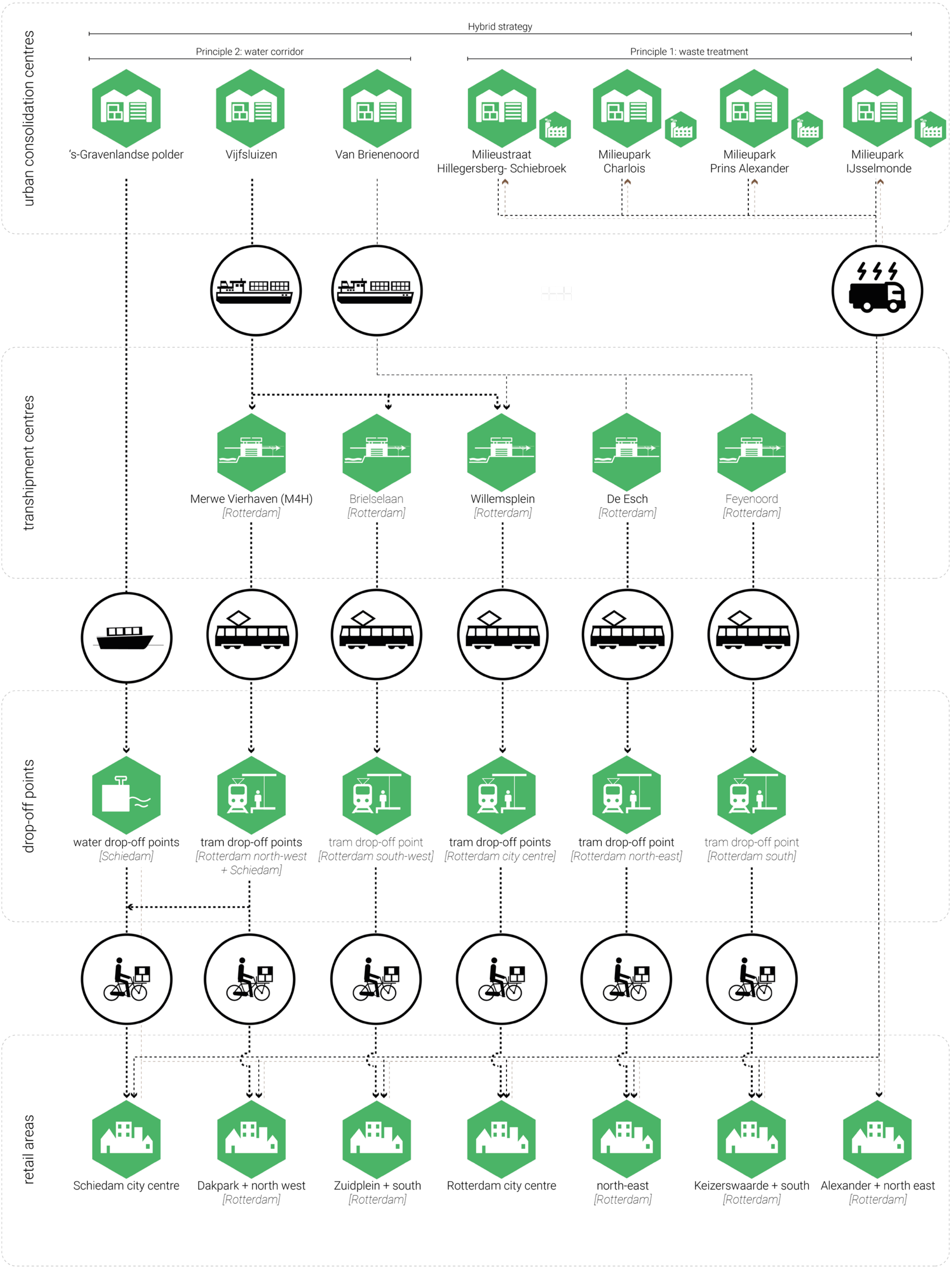



**FIGURE 6.32:**
Conceptual strategy scheme of Rotterdam
*(author's drawing)*

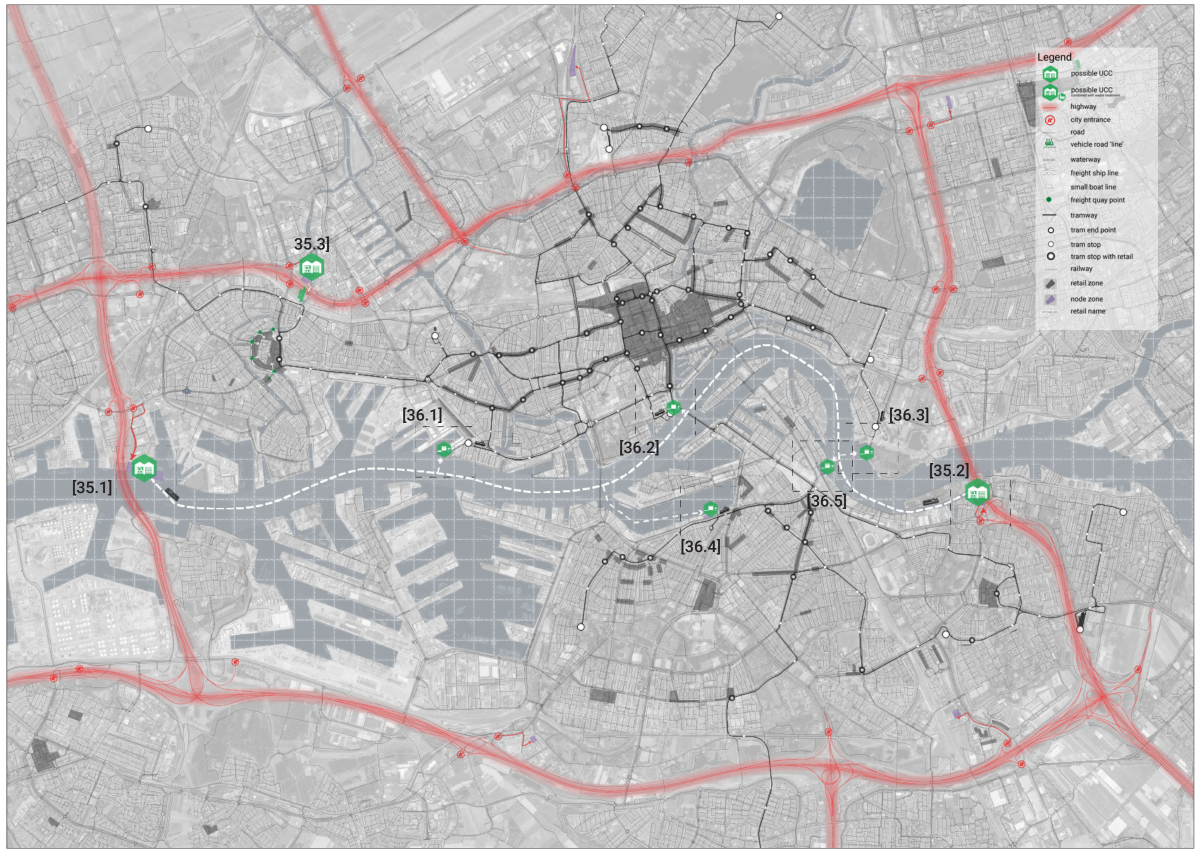



**FIGURE 6.33:**
Part of the strategy related to the utilisation of the water corridor in the city
*(author's drawing)*

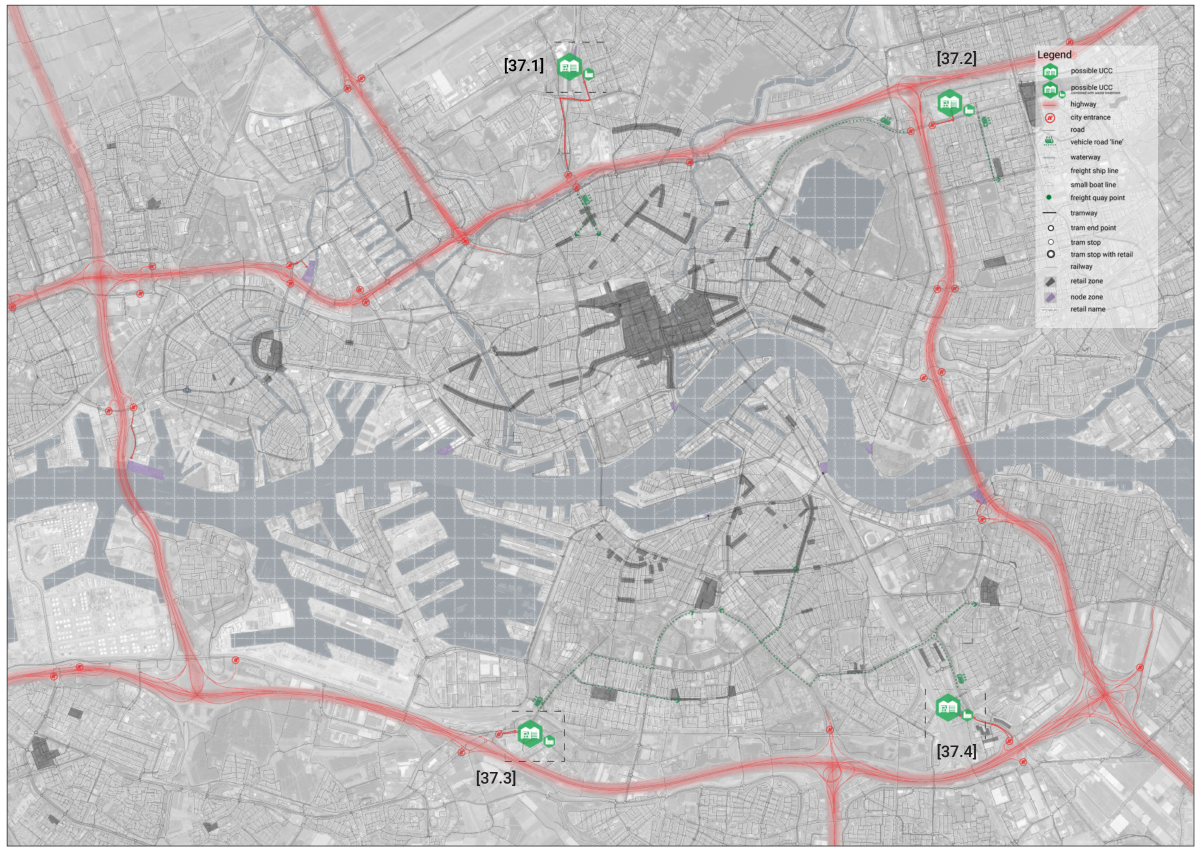
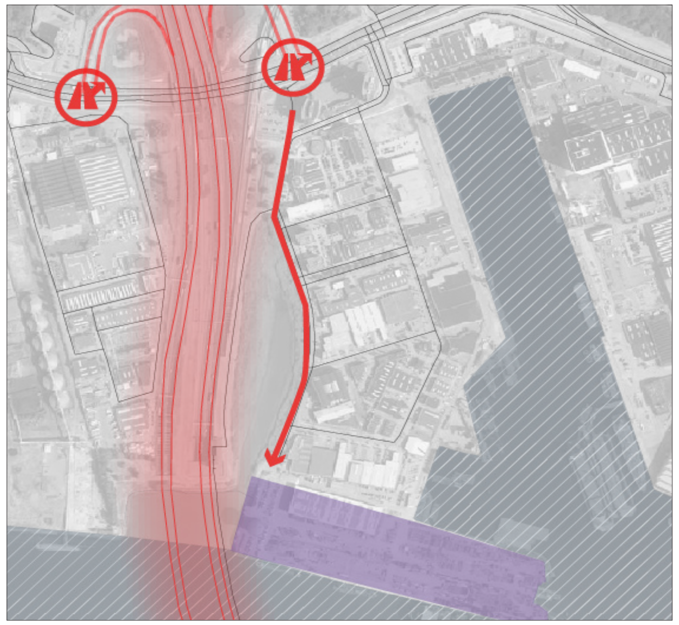



**FIGURE 6.34:**
Part of the strategy related to the location of waste treatment facilities
*(author's drawing)*





### 1. Vijfsluizen (west)

| | |
|---|---|
| Location: | Vijfsluizen |
| Situation: | transportation company |
| Highway: | A4 |
| Distance to highway: | ca. 1.0 km |
| Serving TC | Merwevier TC; Brielselaan TC; Willemsplein TC |
| Distance to TC | resp. ca. 4.5 km, 8.0km and 8.0 km |
| Directions: | Delft / The Hague / Amsterdam / Schiphol / north of the Netherlands / Port of Rotterdam / Antwerp / Belgium |

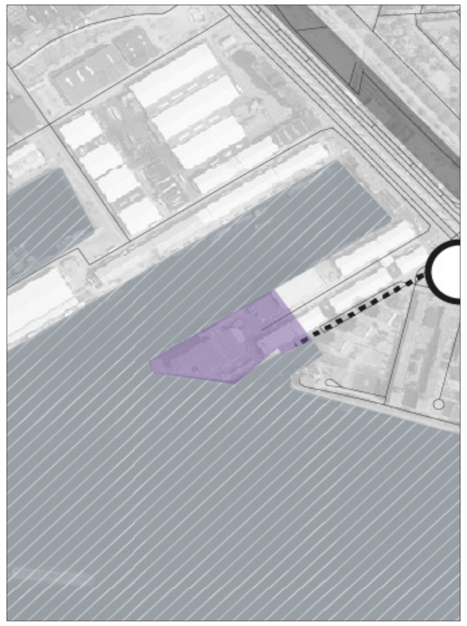
### 2. Van Brienenoord (east)

| | |
|---|---|
| Location: | De Veranda |
| Situation: | residential area |
| Highway: | A16 |
| Distance to highway: | ca. 0.5 km |
| Serving TC | De Esch TC; Feijenoord TC; Willemsplein TC |
| Distance to TC | resp. ca. 2.0 km, 2.5 km and 6.0 km |
| Directions: | Gouda / Waddinxveen / Arnhem / Nieuwegein / Utrecht / east of the Netherlands / Germany / Breda / Dordrecht / Etten-Leur / Waalwijk / Tilburg / Den Bosch / Eindhoven / Venlo / Nijmegen / Antwerp / Belgium |

### 3. 's-Gravenlandsepolder (north)

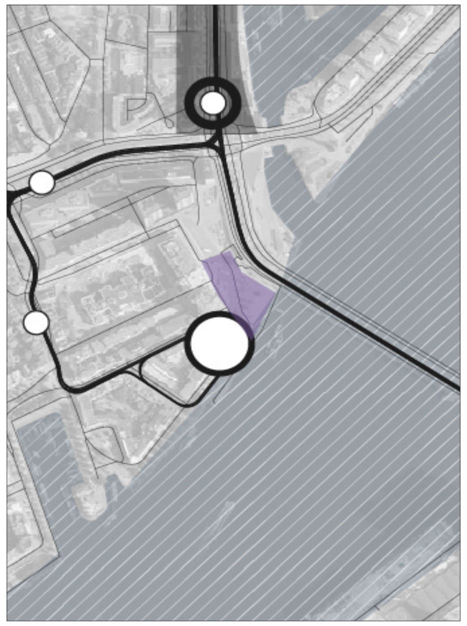
| | |
|---|---|
| Location: | Spaanse Polder |
| Situation: | (partly) vacant land |
| Highway: | A15 |
| Distance to highway: | ca. 1km |
| Serving TC | n/a |
| Distance to TC | n/a |
| Directions: | Delft / The Hague / Amsterdam / Schiphol / Zoetermeer / Leiden / north of the Netherlands |

**FIGURE 6.35.1-3:**
Chosen locations for UCCs based on the utilisation of the water corridor in the city
*(author's drawing)*



**1. Merwe Vierhaven (R'dam north)**

*Location:* Nieuw-Mathenesse
*Situation:* industry park
*Served by:* Vijfsluizen UCC
*Distance to UCC:* ca. 4.5 km
*Serving:* R'dam NW, R'dam and S'dam city centre
*Tramline* 8
*Distance to DoP:* ca. 4.0 km to both city centres



**2. Willemsplein (R'dam north)**

*Location:* Scheepvaartskwartier
*Situation:* public space at riverbank
*Served by:* Vijfsluizen UCC, Van Brienenoord UCC
*Distance to UCC:* resp. ca. 8 km and 6 km
*Serving:* R'dam city centre
*Tramline:* 7
*Distance to DoP:* ca. 1.8 km to R'dam city centre

**3. De Esch (R'dam north)**

*Location:* De Esch
*Situation:* construction company
*Served by:* Van Brienenoord UCC
*Distance to UCC:* ca. 2 km
*Serving:* R'dam W, R'dam city centre
*Tramline:* 21 and 24
*Distance to DoP:* ca. 4.1 km to R'dam city centre

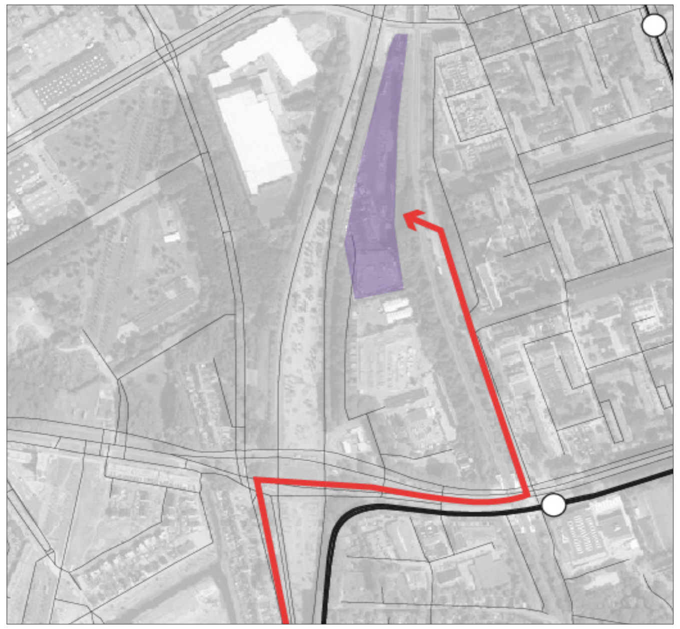
**4. Brielselaan (R'dam south)**

*Location:* Tarwewijk
*Situation:* vacant area
*Served by:* Vijfsluizen UCC
*Distance to UCC:* ca. 8 km
*Serving:* R'dam S/SW
*Tramline:* 2
*Distance to DoP:* various *(ca. 2 km to several shopping streets)*

**5. Feijenoord (R'dam south)**

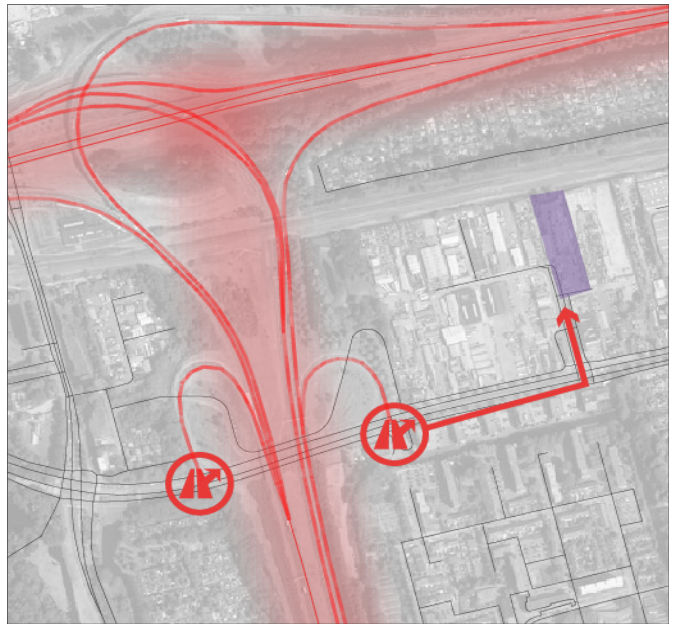
*Location:* Feijenoord
*Situation:* green public space integration new Kuip
*Served by:* Van Brienenoord UCC
*Distance to UCC:* ca. 2.5 km
*Serving:* Rotterdam S/SE
*Tramline:* 20, 23 and 25
*Distance to DoP:* various

**FIGURE 6.36.1-5:**
Chosen/Potential locations for transhipment centres
*(author's drawing)*



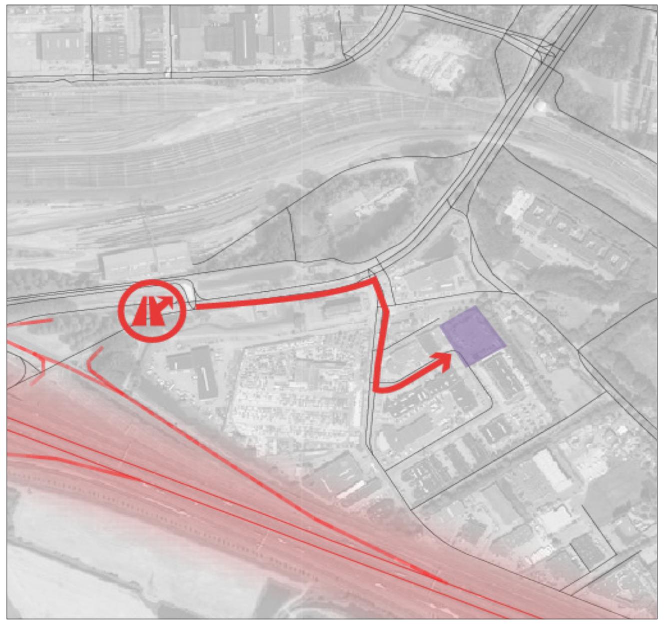
**1. Milieupark Hillegersberg- Schiebroek (R'dam north)**

Location: Schiebroek
Situation: waste treatment at small industrial park
Highway: A20
Distance to highway: ca. 1.5 km
Directions: Delft / The Hague / Amsterdam / Schiphol / Zoetermeer / Leiden / north of the Netherlands



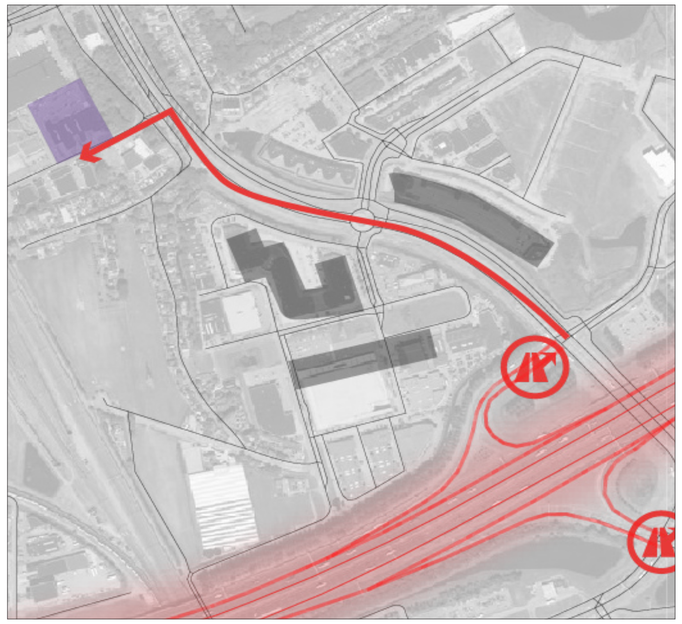
**2. Milieupark Prins Alexander (R'dam north)**

Location: Het Lage Land
Situation: waste treatment at small industrial park
Highway: A16
Distance to highway: ca. 0.5 km
Directions: Gouda / Waddinxveen / Woerden / Arnhem / Nieuwegein / Utrecht / east of the Netherlands / Germany



**3. Milieupark Charlois (R'dam south)**

Location: Poort van Charlois
Situation: waste treatment at small industrial park
Highway: A15
Distance to highway: ca. 1km
Directions: Port of Rotterdam / Roosendaal / Bergen op Zoom / Vlissingen / Antwerp / Belgium



**4. Milieupark IJsselmonde (R'dam south)**

Location: IJsselmonde
Situation: waste treatment at small industrial park
Highway: A15
Distance to highway: ca. 2km
Directions: Breda / Dordrecht / Etten-Leur / Waalwijk / Tilburg / Den Bosch / Eindhoven / Venlo / Nijmegen / Antwerp / Belgium

**FIGURE 6.37.1-4:**
Chosen locations for UCCs based on waste treatment facilities
*(author's drawing)*

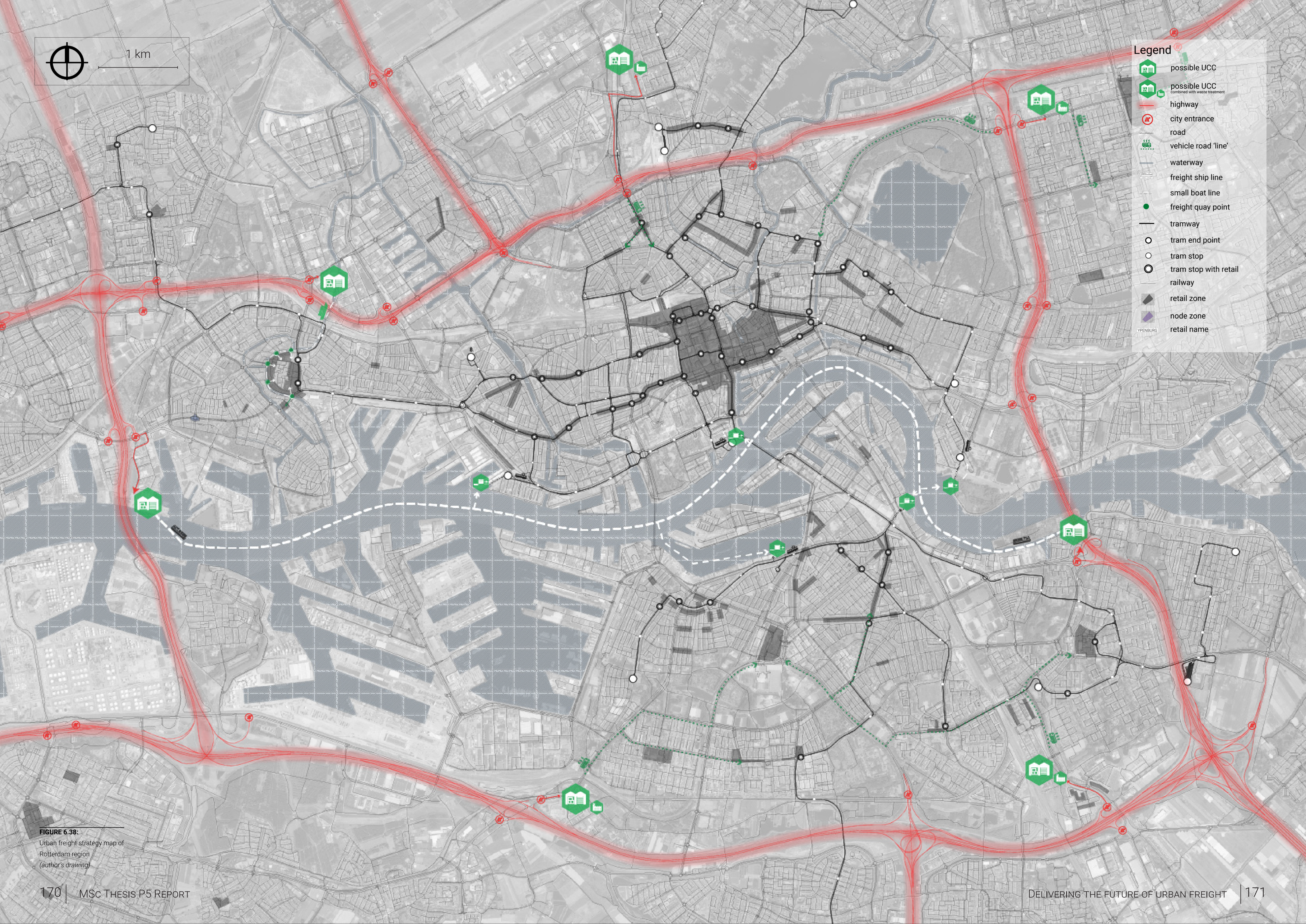



**FIGURE 6.38:**
Urban freight strategy map of Rotterdam region
*(author's drawing)*

## 6.5.2 **Region specific strategy** *The Hague urban region*

### # *Spatial conditions*

The Hague urban region also has several possibilities to supply itself. The Hague is a large city with extensive retail areas here and there spread over the city (especially south), without a clear highway structure around the city, since it is located at the sea. This makes the supply of this city more challenging than Rotterdam. The Hague has waste treatment facilities close to the highways and city centres, wherein the facilities on the Binckhorst are relatively close to the city centre.  These waste treatment facilities are also situated to a waterway and also the borders of the low emission zone of The Hague ends there. Although the inner canal structure is not fine-grained, a waterway structure to and around the city centre is identified, which makes this network sufficient for the second principle.  Furthermore, the tram network is fine-grained, but they are barely connected to waterways nor railways.

According to the matrix, the waste principle is likely to work with water transport with road transport as post-transport and complemented with solely road transport. By extending the tram network to waste treatment plants, this also could be used. The second principle only will work with road transport, but this is due to the fact that the water network is not fine-graned enough and there is barely a connection with the tram network. To conclude, both principles can be combined, but post transport will be necessary.

### # *Proposed strategy*

Figure 6.39 shows the conceptual scheme developed for The Hague. Based on the spatial conditions, tested variants and the degree they could cover the retail areas, a mainly combined model will be proposed, wherein both principles will be combined in the strategy. The waste treatment facilities situated at the Binckhorst close to the Haagse Vliet waterway created this opportunity. The strategy of The Hague is two-folded:

The city centre will be supplied from the Binckhorst which is situated between the A12 and the Haagse Vliet (Figure 6.40.1). This will be the key location in the strategy. Goods will be brought to the constructed UCCs (one or two) at the Binckhorst, which pressurises the A12. Eventually, the highway network needs to be appropriate for this. From there, transportation takes place over water to the several drop-off points across the water ring around the city centre and the area in the south-west of the city centre. These drop-off points will need loading and unloading quays where goods are unloaded and are transferred to post transport vehicles to the final destination (Figure 6.41). At the same time, waste will be brought to  these drop-off points and be loaded on the boats to go back to the waste treatment facilities. Another UCC location is the Milieustraat in Rijswijk, close to the A4 (Figure 6.40.2). From there, goods are transported by trams to the city centres of The Hague and Rijkswijk.

For a lot of other commercial zones spread over the southern outskirts of the city such as shopping streets and malls, the fine-grained tram infrastructure can be used to reach these retail areas. There is a waste treatment facility in the south, close to waterways to Delft and several endpoints of the tram network of The Hague (Figure 6.40.3). With the assist of special (road) vehicles, all these tram endpoints can be reached to upscale the range of this location (Figure 6.42). Figure 6.43 shows the proposed region-specific strategy map of The Hague urban region.

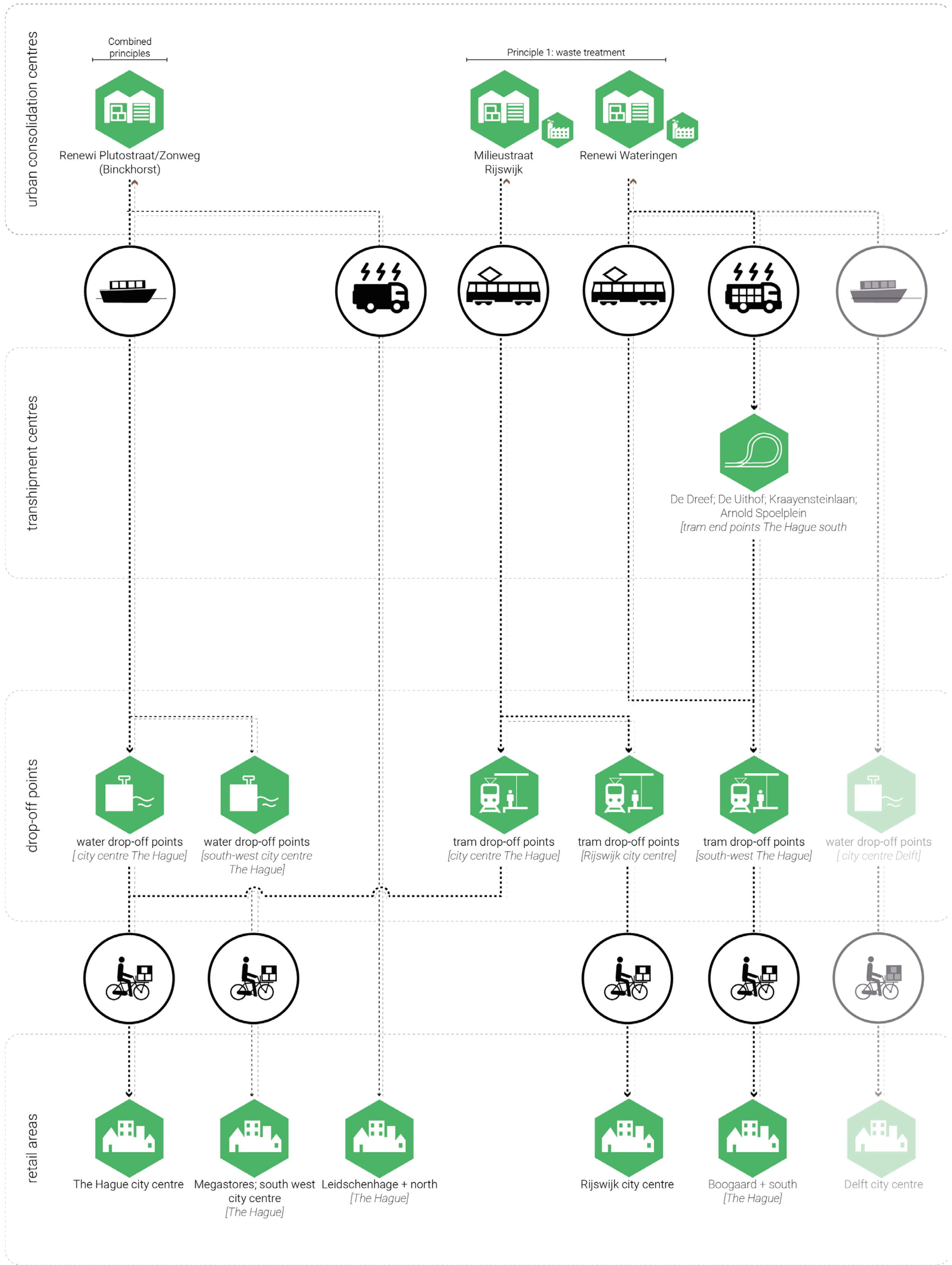
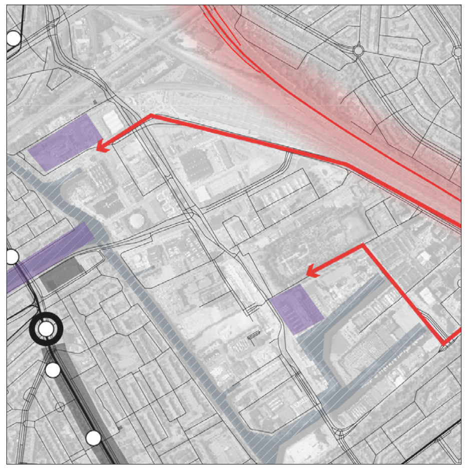
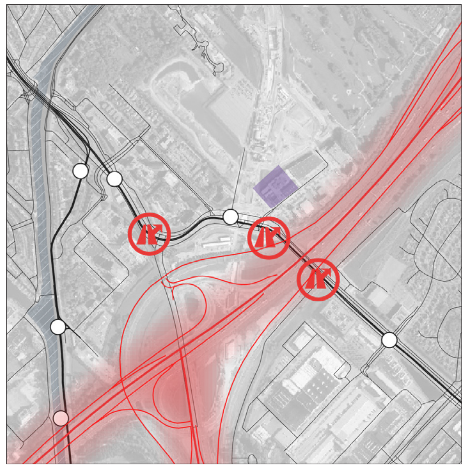



**FIGURE 6.39:**
Conceptual strategy scheme of Rotterdam
*(author's drawing)*



**1. Renewi Plutostraat/Zonweg**

Location: Binckhorst
Situation: waste treatment at industrial park
Highway: A12
Distance to highway: ca. 1.5 km



**2. Milieustraat Rijswijk**

Location: Hoornwijck
Situation: waste treatment at highway exit
Highway: A4
Distance to highway: ca. 0.5 km

**3. Renewi Wateringen**

Location: Zwethove
Situation: waste treatment at industrial park
Highway: A4
Distance to highway: ca. 1.5 km

**FIGURE 6.40.1-3:**
Chosen locations for UCCs
*(author's drawing)*


**FIGURE 6.41:**
Possible areas for drop-off points city centre
*(author's drawing)*

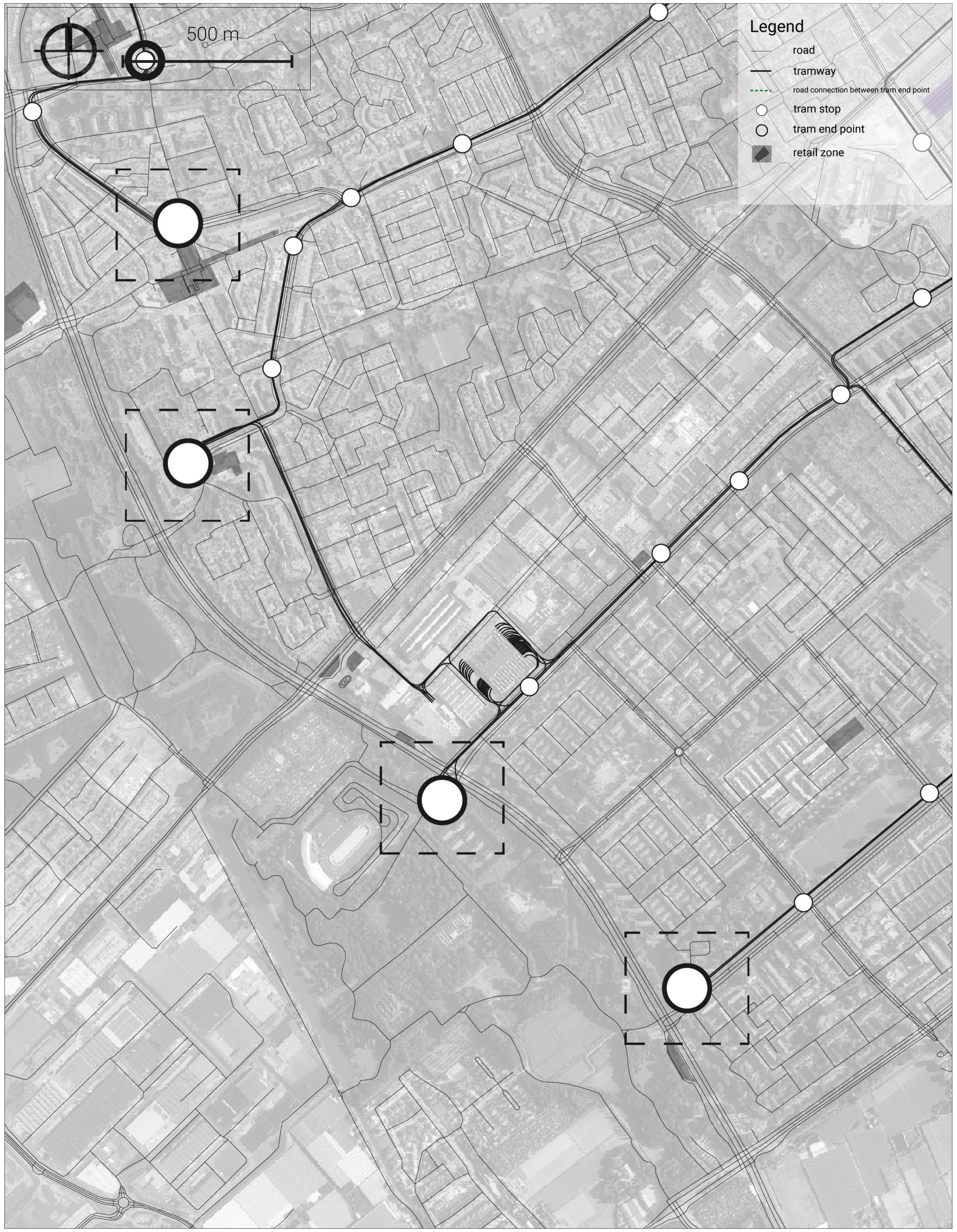



**FIGURE 6.42:**
Chosen locations for UCCs based on waste treatment facilities
*(author's drawing)*

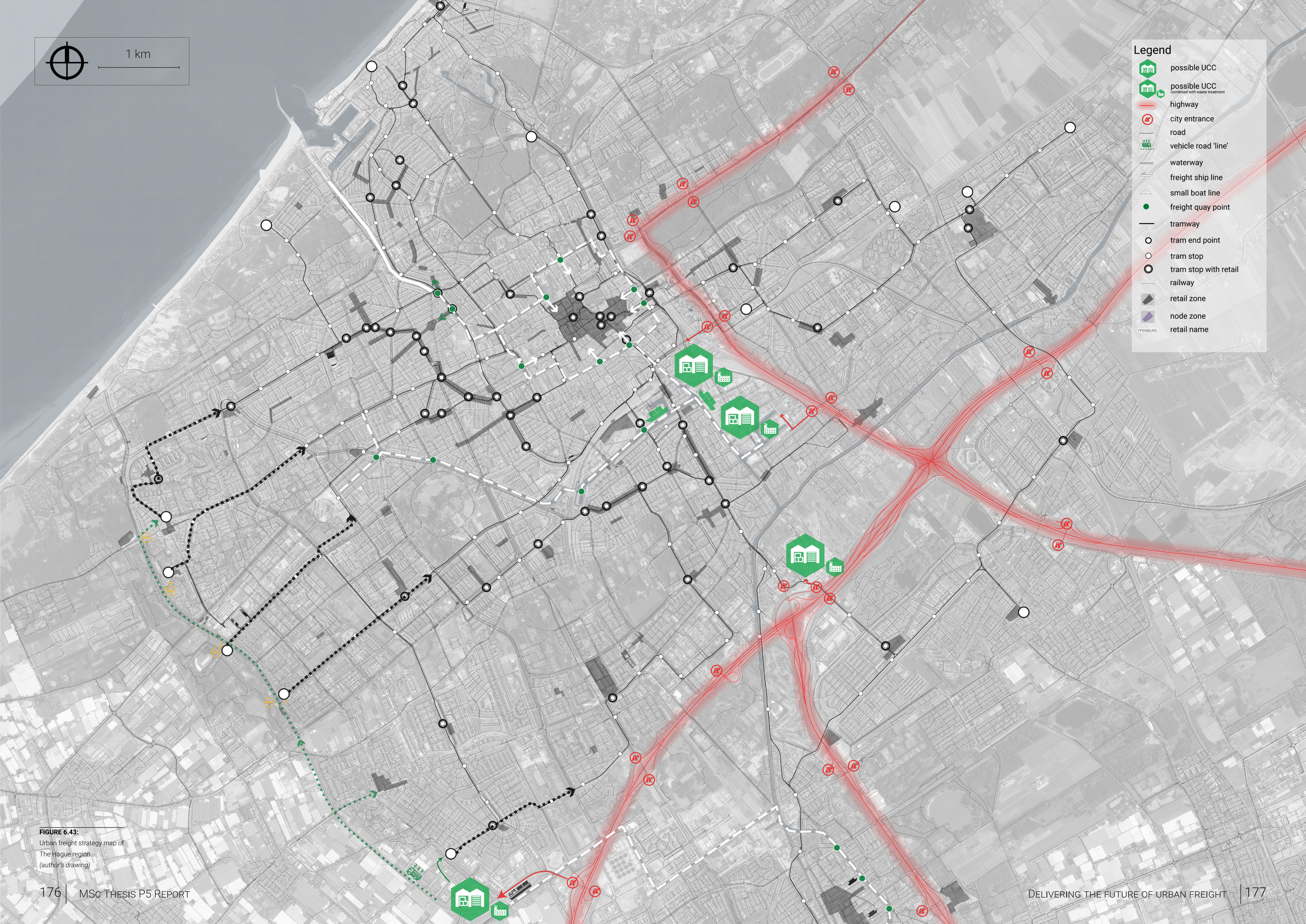



**FIGURE 6.43:**
Urban freight strategy map of The Hague region
*(author's drawing)*

## 6.5.3 *Region specific strategy* Delft

### # *Spatial conditions*

Delft is a smaller city than Rotterdam and The Hague and is also quite compact. The retail areas are countable and concentrated in the city centre, The Hoven and Leeuwenstein at the Schie. Delft has their waste treatment facilities close at the Zweth (north) and the Schie (south), which is an important water corridor through the city. Although there is only one tramline present along the city centre, the city is characterised by a fine-grained canal structure, which actually covers a substantial part of the city centre.

According to the matrix, it can be noticed that the possible variants of Delft are based on water solutions. Both principles are able to take care of the supply of Delft when the water and road network are used. In fact, since the waste treatment facilities are situated along the waterway, the principles can be combined as well. The tram is less likely to work in Delft.

### # *Proposed strategy and requirements*

Figure 6.44 shows the conceptual scheme developed for Delft. Based on the spatial conditions, tested variants and the degree they could cover the retail areas, a combined model based on water transportation are proposed, wherein the two principles will be combined in the strategy. The strategy is similar to the strategy of The Hague but performed on a smaller scale. The waste treatment facilities situated along the Zweth (north) and The Schie (south) waterway created this opportunity figure 6.45.1-2.

Close to these waste treatment facilities, there will be UCCs constructed. Dependent on the scale and amount of goods, it can be determined to take just one of the two locations. Goods will be brought to the constructed UCCs (one or two) and from there transferred to ships. The ships will bring the goods to several drop-off points within the city centre. These drop-off points will need loading and unloading spaces where goods are unloaded and are transferred to post transport modes such as smaller boats or other road vehicles to the final destination (FIGURE 6.61.3). At the same time, waste will be brought to these drop-off points and be loaded on the boats to go back to the waste treatment facilities. De Hoven needs to be reached by vehicles over the road, due to a missing water link and the low potential of freight trams in Delft. Figure 6.46 on the next page shows the proposed total city-specific strategy map of Delft.

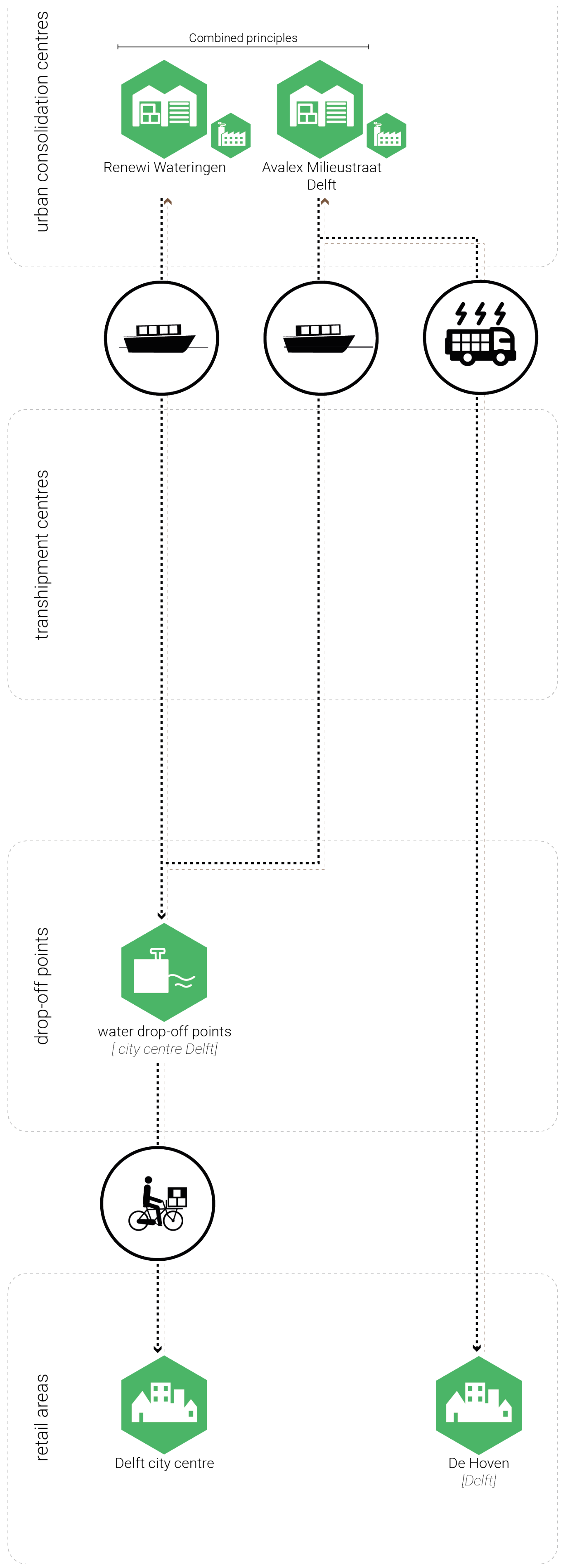



**FIGURE 6.44:**
Conceptual strategy scheme of Delft
*(author's drawing)*

**1. Renewi Wateringen**
see FIGURE 6.40.1-3 at PAGE 173

**2. Avalex Delft**

| | |
|---|---|
| Location: | Schieoevers |
| Situation: | waste treatment at a waterway and industrial park |
| Highway: | N470 (between A13 and A4) |
| Distance to highway: | ca. 1 km to N470; 3.0 and 4.0 km to resp. A13 and A4 |

**3. City centre Delft**

| | |
|---|---|
| suitable canals | Rijn-Schiekanaal / Achterom / Oude Delft / Nieuwe Delft / Voldersgracht / Molsgracht / / Gasthuisgracht / Westsingelgracht / Rietveld |

**FIGURE 6.45.1-3:**
Chosen locations for UCCs and drop off points
*(author's drawing)*


**FIGURE 6.46:**
Urban freight strategy map of Delft region
*(author's drawing)*

## 6.6 *Conclusion*

The purpose of the chapter was to provide spatial conditions and design requirements for the improvement of urban freight in the MRDH in order to develop city-specific strategies.

The chapter has proposed a twofolded solution for the current urban freight organisation. The first one is the concept of urban consolidation, wherein urban consolidation centres at the outskirts of the city were introduced to remove unnecessary trips within the city. Second concept is the idea of encouraging urban multimodality, wherein alternative manners need to be found to transport urban freight as much as possible over the rail (by tram) and water (by boat) instead of the road within the city.

Before introducing the nodes, some operational assumptions are made. In general operation, it will be assumed for the strategies that in a way standardisation of freight, further alignment in regulations and measures, eventually support of financial incentivisation take place and that digital maps and information technology are used. The strategies will focus on consumer freight (goods and waste) from retailers.

Thereafter, three types of nodes are proposed, wherein the spatial implication per type, activities, location factors, modal operation, other operational issues and a roadmap for allocation are addressed. The three nodes are:

1) UCCs: urban consolidation centres (road)
2) TCs: multimodal transhipment centres (water)
3) DoPs: drop-off points (water, rail, road)

Regarding the UCC's, two principles were proposed in this chapter. These principles are:

1) Urban consolidation centres situated near waste treatment facilities
2) Urban consolidation centres situated along a waterway corridor

Both principles have their spatial conditions and design requirements as well that every city has its characteristics in terms of morphology, available infrastructure and the degree of fine-graininess of the specific type of infrastructures. In order to find out the applicability per city of the principle and different modes, every possible variant needs to be tested in the urban regions of Rotterdam, The Hague and Delft.

These are divided into primary location factors and additional location factors. Primary location factors are comparable with general location factors for distribution centres, whereby UCCs need to be:

1) located at the outskirt of the city and when possible, at the border of low emission zones
2) located at the proximity of highway infrastructure and city entrances
3) located at the proximity of retail locations such as the city centre and shopping malls
4) preferably located at an industrial area

Additional location factors are added to the primary location factors to create multimodal UCCs that eventually synergises with waste and are responding to extra sustainability goals made:

1) located at the proximity of a waste treatment facility *[principle 1]*
2) located at the proximity of a main water corridor through the city *[principle 2]*
3) located at the proximity of a fine-grained railway (tram) infrastructures *[multimodality]*
4) located at the proximity of a fine-grained canal infrastructures *[multimodality]*

In a strategy, the UCCs are recognised as the most crucial nodes since they partly determine the location of transhipment centres and drop-off points. Also the current infrastructures and the fine-grainess of those are relevant for the location. The required fine-grainess depends on the freight demand and the degree of distribution of the retailers. Moreover, it is important to consider practical and spatial issues regarding the freight tram, additional functions at the transhipment centre and the limited space at a drop-off point location.

By showing the spatial interrelationships between the nodes, which consists of three separate steps by identifying ((1) possible locations for UCCs, (2) the available transportation links and modes to the city and (3) the possible locations for drop-off points), it reveals the presence of the required facilities or infrastructures and if so, the specific location. The conclusions per urban region of the variants are translated into region-specific strategies and possible applications of strategies for Rotterdam urban region, The Hague urban region and the city of Delft. The possible region-specific urban freight strategies were elaborated in this chapter as well and form an important base for the next chapter.

The required spatial conditions are the same for the concepts. The chapter has reflected the conditions on Rotterdam urban region, The Hague urban region and Delft by showing the spatial interrelationship between the different steps for the formulation of new urban freight strategies. However, the three urban regions are 'just' three cases, which means that the analysis and approach also can be used for other cities and urban regions to generate other region-specific strategies.


This chapter has the purpose of adressing sub research question 4:

*What are the spatial implications of the improved urban freight strategies in the MRDH?*

The chapter shows the spatial implications of the strategy of Rotterdam urban region. The chapter starts with a site selection and analysis of key locations in the strategy and then shows possbile design proposals for some nodes. The chapter will conclude with the impact it has on the city.

*chapter outline:*

7.1 introduction
7.2 site selection
7.3 site proposal
7.4 conclusion

# 07 SPATIAL IMPLICATIONS FOR MRDH

*source photo: Lijnbaan (O. van Duivenbode, 2014)*

## 7.1 *Introduction*

This chapter aims to address the spatial implications and feasibility of the strategies, developed in the previous chapter. With showing this, the fourth research question will be answered:

WHAT ARE THE SPATIAL IMPLICATIONS OF THE IMPROVED URBAN FREIGHT STRATEGIES IN THE MRDH?

This chapter will specifically elaborate on the strategy of the Rotterdam urban region by showing a design proposal and spatial implication of the necessary nodes to demonstrate its feasibility. In the end, the chapter will reflect on the spatial feasibility in the other cities in the MRDH.

The next paragraph will shortly describe the strategy and site selection. The chosen retail areas for elaboration are the city centre of Rotterdam (with special attention to Lijnbaan) and the city centre of Schiedam. The last paragraph will describe and analyse the required nodes for the three retail areas and directly propose some directions for the design, whose design will be elaborated in the fourth paragraph.

## 7.2 *Site selection*

The thesis wants to work out one strategy to show the spatial implication and prove the spatial feasibility of the proposed strategical framework. Therefore, the strategy of Rotterdam urban region is selected for elaboration in the thesis. This urban region consists of the cities of Rotterdam and Schiedam and is chosen due to the hybrid character of the strategy. The elaboration thereby could demonstrate the implementation of the most aspects of the nodes. Also, the city characteristics of Rotterdam as analysed in the last chapter seems to have a more generic and representative structure than the other cities.

According to the possible multimodal drop-off locations, two retail areas, which are the city centre of Rotterdam (with special attention to the Lijnbaan) and the city centre of Schiedam will get a closer look. The selected retail locations all have different approaches and modes for their supply, which should give a broad picture of the possibilities of both developed principles.



### 7.2.1 **Site selection** *two city centres*

This paragraph illustrates the proposed supply chain for the retailers in both the city centres of Rotterdam and Schiedam. The elaboration focusses on the northern part of the river since the southern part (e.g. Zuidplein shopping centre) relies on UCCs combined with waste treatment facilities and the transport over the road by electric vehicles. An UCC according to the first principle is beside the proximity of a waste treatment facility not spatially different than an UCC close to water. The differences are rather organisational than spatial and thus, this type of UCC does not need a separate elaboration, when according to its strategy, the chosen transportation link is the road. A modal shift as proposed in the second principle for the north, however, has more spatial implications, due to extra transhipment points that need to be showed. Therefore, it has been decided to emphasize on the northern part of Rotterdam, although the same design criteria and considerations apply in the south as well. This means that for the two city centres only the application of the second principle, whereby freight is transported over the water, will be demonstrated.

For the city centre of Rotterdam, the two northern locations of the waste treatment plants Hillegers-berg-Schiebroek and Prins Alexander) within the first principle and the both proposed UCCs in the west (Vijfsluizen) and east (Van Brienenoord) within the second principle are necessary for the supply of retailers. For the city centre of Schiedam, the 's-Gravenlandsepolder UCC and indirectly the Vijfsluizen UCC via Merwe Vierhaven transhipment are required. For both city centres apply that they can be supplied by both principles separately and thus for the sake of showing the spatial implications, the Vijfsluizen UCC and the 's-Gravenlandsepolder UCC are selected in this chapter.

The next step in the chain is the transhipment centres along the Maas river banks. For the city centre, there will be a transhipment centre proposed at the Willemsquare close to the Willemsplein. The city centre of Schiedam does not need a transhipment centre since its UCC transports goods directly to the final destination. It has, however, the possibility to get goods from the transhipment centre at the M4H (to rail). Concerning transhipment centres, the Willemsquare transhipment centre will be designed.

From the transhipment centre, goods move dependent on the characteristics of the retail area by different modes to their final destination. To generalise the principles of a drop-off point, for Rotterdam city centre, there will be made a design for a tram stop drop-off point, while for Schiedam, there will be made a design for a water stop drop-off point.

These nodes give a broad idea of the application of the Rotterdam urban region strategy. As mapped in FIGURE 7.1 and illustrated in FIGURE 7.2 (Schiedam city centre) and FIGURE 7.3 (Rotterdam city centre), the following elements will be elaborated in this chapter:

1. UCC water (Vijfsluizen and 's-Gravenlandsepolder)
2. transhipment centre (Willemsplein and XXX)
3. drop-off points (Lijnbaan and XXX (Rotterdam) and Schiedam water stop).

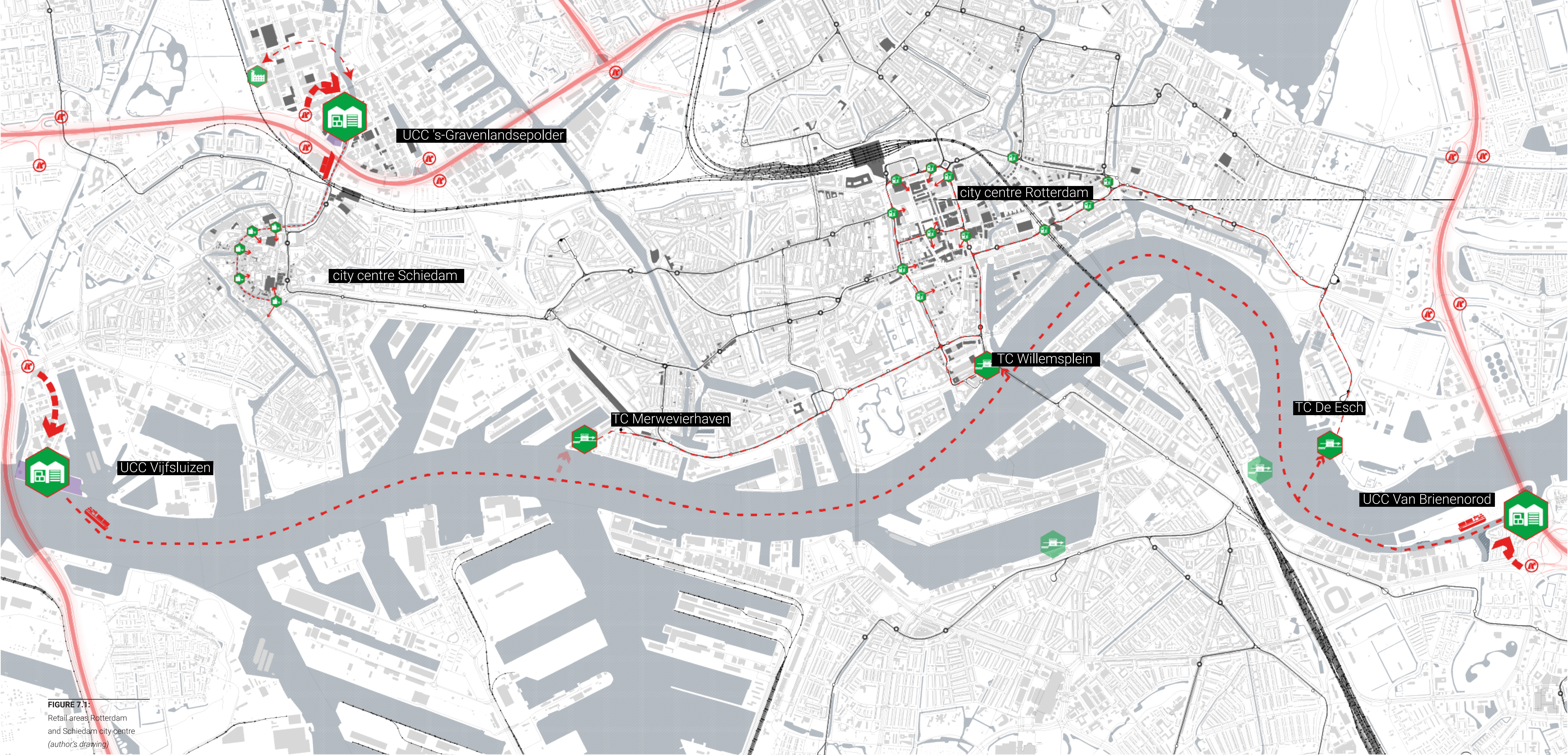



**FIGURE 7.1:**
Retail areas Rotterdam and Schiedam city centre
*(author's drawing)*

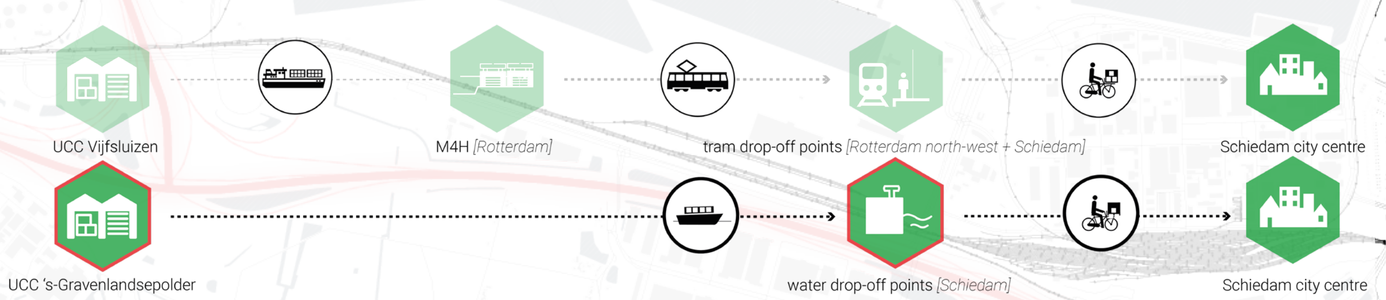



**FIGURE 7.2:**
Supply lines of the city centre of Schiedam
*(author's drawing)*

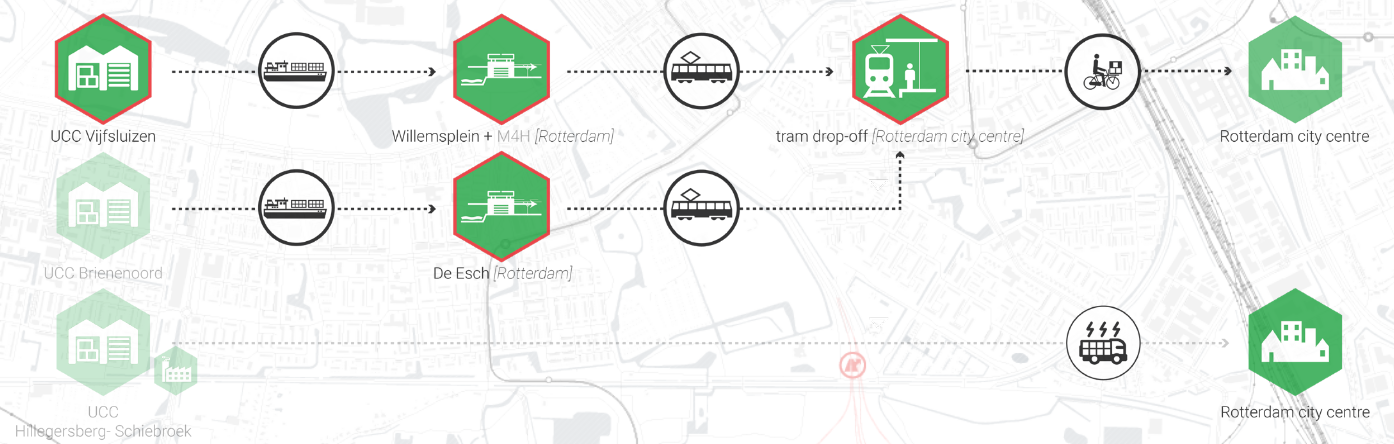



**FIGURE 7.3:**
Supply lines of the city centre of Rotterdam
*(author's drawing)*

## 7.3.1 ***Site proposal*** *urban consolidation centres*

Figure 7.4 and figure 7.5 show two of the three locations of the chosen UCCs for Rotterdam and Schiedam. These two sites of the 's-Gravenlandsepolder and Vijfsluizen, together with the Brienenoord UCC, could become important for the supply of Rotterdam and Schiedam. The design of such UCCs need to incorporate consolidation centres integrated into their surroundings and connected to their respective links. In the case of UCC, the main challenge is to find enough space for such a distribution centre, which are also connected to specific infrastructures towards the city centre.

### # *UCC Vijfsluizen [for Rotterdam]*

Vijfsluizen is the area between Schiedam and Vlaardingen and is situated north of the Maas and the of highway A4. The buildings there have mainly an industrial function. The location of Vijfsluizen is suitable for an UCC since there is enough space available for an UCC and it is situated in the proximity of a highway-waterway crossing. The sites are located about 1 km away from the A4 highway and around 8.0 km from the transhipment point in the city centre, which is more or less considered as the limit. The other transhipment centres (M4H and Brielselaan) that will be served by this UCC are situated closer than 8.0 km.

Three possible options with more than 10.000 m2 are available on this site. Currently, there is a transportation and lifting company situated on the site. A warehouse for temporary storage, docking possibilities and transfer cranes need to be constructed there. A large number of ships will be expected to be operational for the supply of Rotterdam.

### # *UCC 's-Gravenlandsepolder [for Schiedam]*

's Gravenlandsepolder is a business park in Schiedam and is situated at the Schiedamse Schie in the east and the railway to Delft on the west. There are around 200 companies settled, mainly wholesalers, automobile companies and services. The sites are located about 0.5 km from the A20 highway and around 1.5km from the core of the city centre. This UCC can directly supply goods to the city centre of Schiedam. Also, three possible locations for the UCC are considered. The most of those locations, UCC#1 [according to Google Maps Streetview, 2020] and UCC#3, are vacant land and could perfectly fulfil this function. They are however smaller than UCC#2, which still is used by a company. Also on this site, a warehouse for temporary storage, docking possibilities and transfer cranes are needed. Schiedam is smaller than Rotterdam and since there are no transhipment centres involved in this supply chain, also some space to park the freight boats might be required.

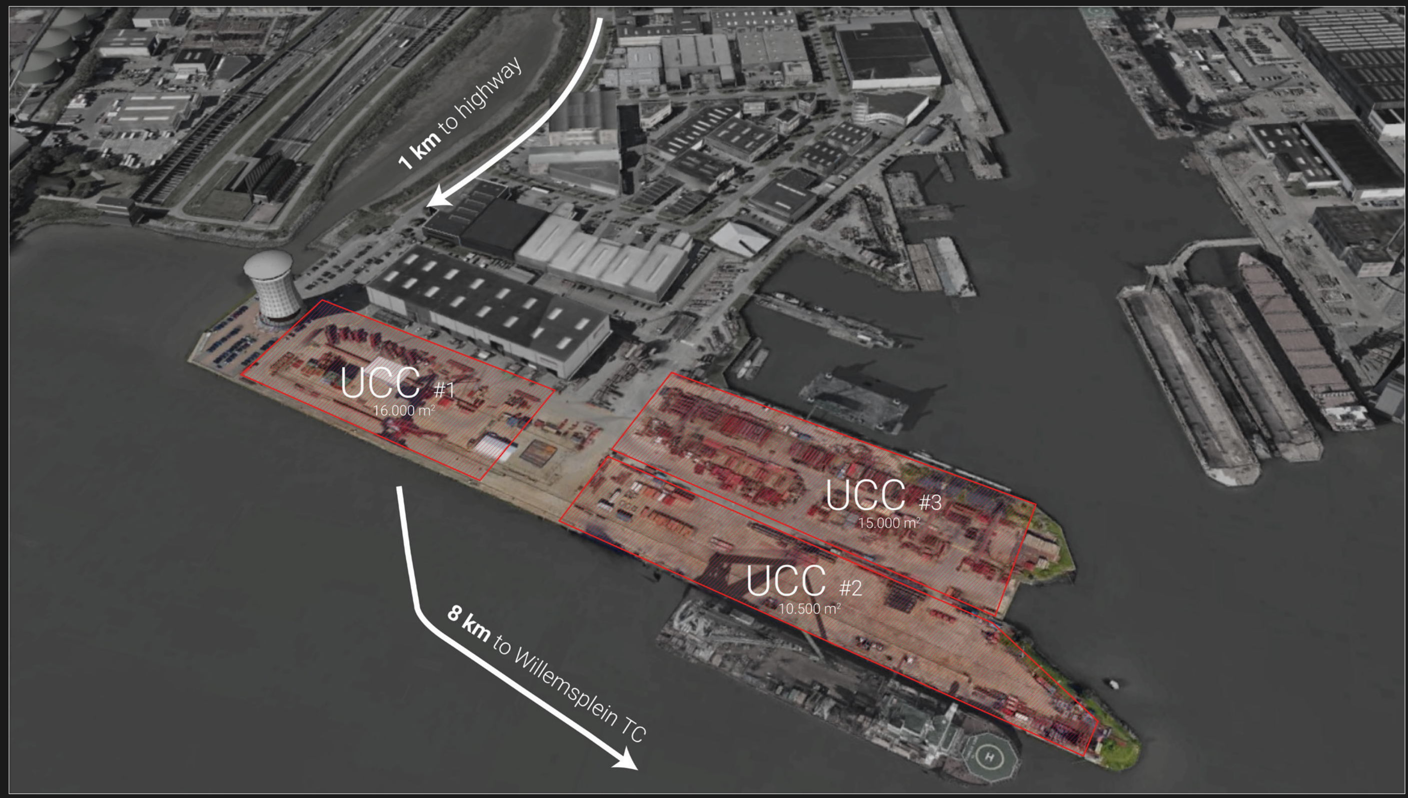



**FIGURE 7.4:**
UCC Vijfsluizen
*(author's drawing, based on Google Earth, 2020)*

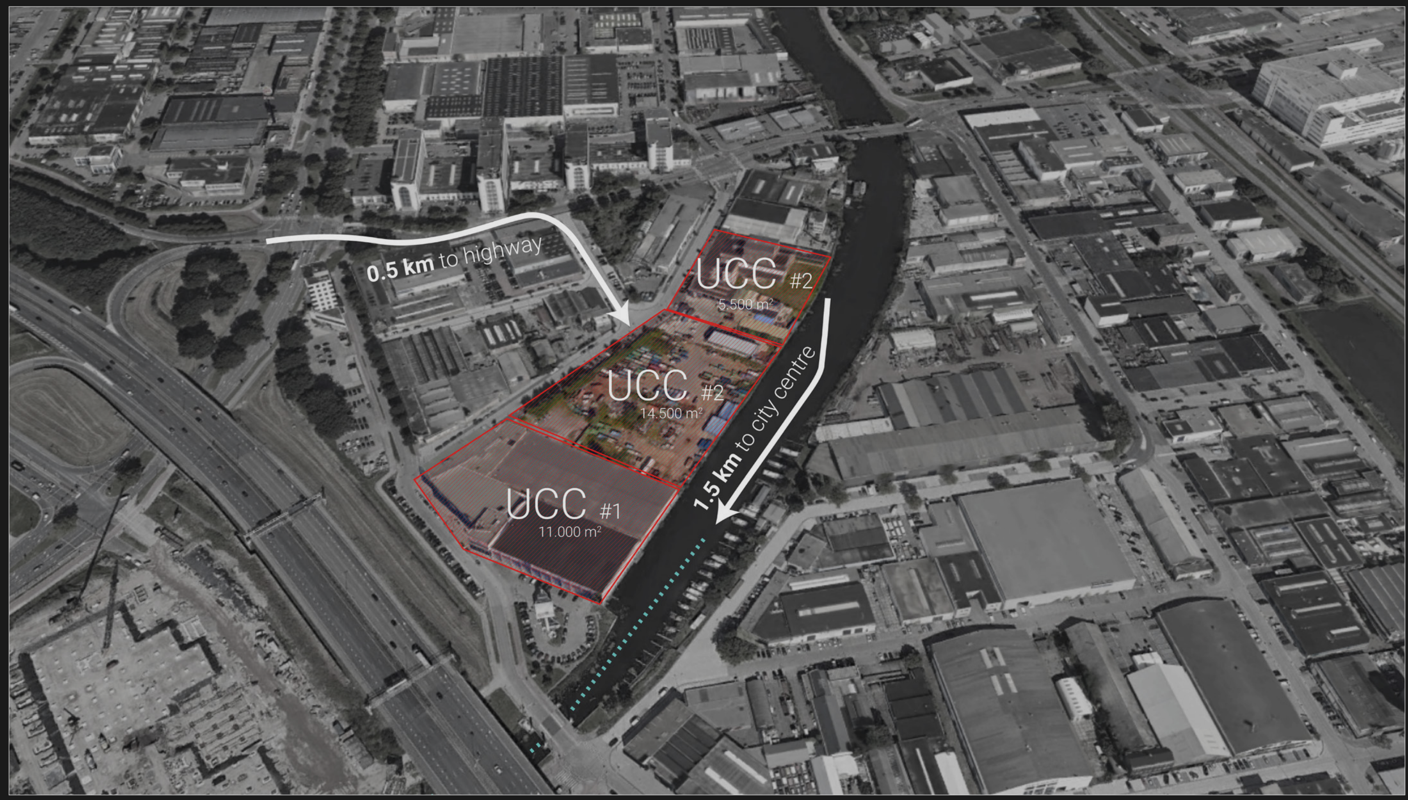



**FIGURE 7.5:**
UCC 's-Gravenlandsepolder
*(author's drawing, based on Google Earth, 2020)*

## 7.3.2 **Site proposal** *transhipment centre*

In this paragraph, the transhipment centres of Willemsplein and De Esch will be specifically addressed. Together with de M4H transhipment centre, all three TCs are serving the northern part Rotterdam including its city centre. They are served by Vijfsluizen (Rotterdam-West) and Van Brienenoord (Rotterdam-East) UCC. Depending on the supply route from the distribution centre to the UCC, one of these TCs will be used to transport freight to the city centre.

Freight will arrive at one of the three TCs and from there, goods are transported in small shipments over the rail (and eventually over the road) to the city centre of Rotterdam in dedicated freight tram configuration. The three TCs have in common that they are situated at end stops of a few passenger tram lines through the city centre. The passenger tram line at a drop-off point determines to which TC a freight tram returns. Currently, the passenger lines of 7, 8, 21 and 24 in the city centres are serving the TCs. The surroundings and location determine the additional characteristics of the transhipment centre.

### # *Transhipment centre Willemsplein*

The Willemsplein is a square situated at the northern waterfront and is part of the basement of the Erasmusbrug in het Scheepvaartskwartier. It is a part of the public space at the Maas, surrounded by residential towers and enjoys the view of the Maas waterfront. It is also a node for public transportation. The square consists of parking places for large busses, which serve the boat tour stop of Spido and the waterbuses. Also, the end stop of [currently] tram line 7 is situated here, which is an important starting point for the strategy since this line is crossing through the city centre. There is also an extra sidetrack available at the tram stop of Willemsplein. The square is around 5.500 m2, which means that there should be enough space to construct a transhipment centre of 500 - 1000 m2. FIGURE 7.6 shows the location of the proposed transhipment centre at the Willemsplein. Some important qualities of the Willemsplein are the view on the iconic Erasmusbrug, the river and (buildings of) the Wilhelminakade (FIGURE 7.7)


**FIGURE 7.6:**
TC Willemsplein
*(author's drawing, based on Google Earth, 2020)*

**FIGURE 7.7:**
View from the Willemsplein
*(Google Earth, 2020)*

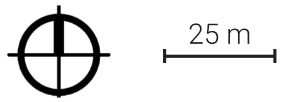



**FIGURE 7.8:**
Map TC Willemsplein
*(author's drawing)*

A possible design for a transhipment centre at the basement of the Erasmusbrug is shown on the map in FIGURE 7.8. The starting point for the design will be the character of the Willemsplein. The Willemsplein is defined by the basement of the Erasmusbrug, Zalmstraat, Willemskade and the Maas river. The proposed transhipment centre at the Willemsplein will act as part of public space (FIGURE 7.9). This is done by partly lifting the square. At the ground level of the square, there will be room for transhipment activities (boat and tram loading/unloading) and other functions like a small office, package point, bike rental or other small amenities. At the roof, another square can be constructed. It is at this location not desirable to construct a building (residential/offices) on top of the transhipment centre. There are also some loose ramps to the Erasmus bridge on the Willemsplein, which can be replaced in the proposed situation by three large ramps to the lifted square. An additional ramp can be constructed to the Erasmusbrug from the lifted square. It also needs to be possible for a tram to enter the transhipment centre. Transferring from ship to tram and road vehicles takes place here (FIGURE 7.10). The actual size and scale of the transhipment centre can be determined by the freight demand and construction possibilities on the current square.

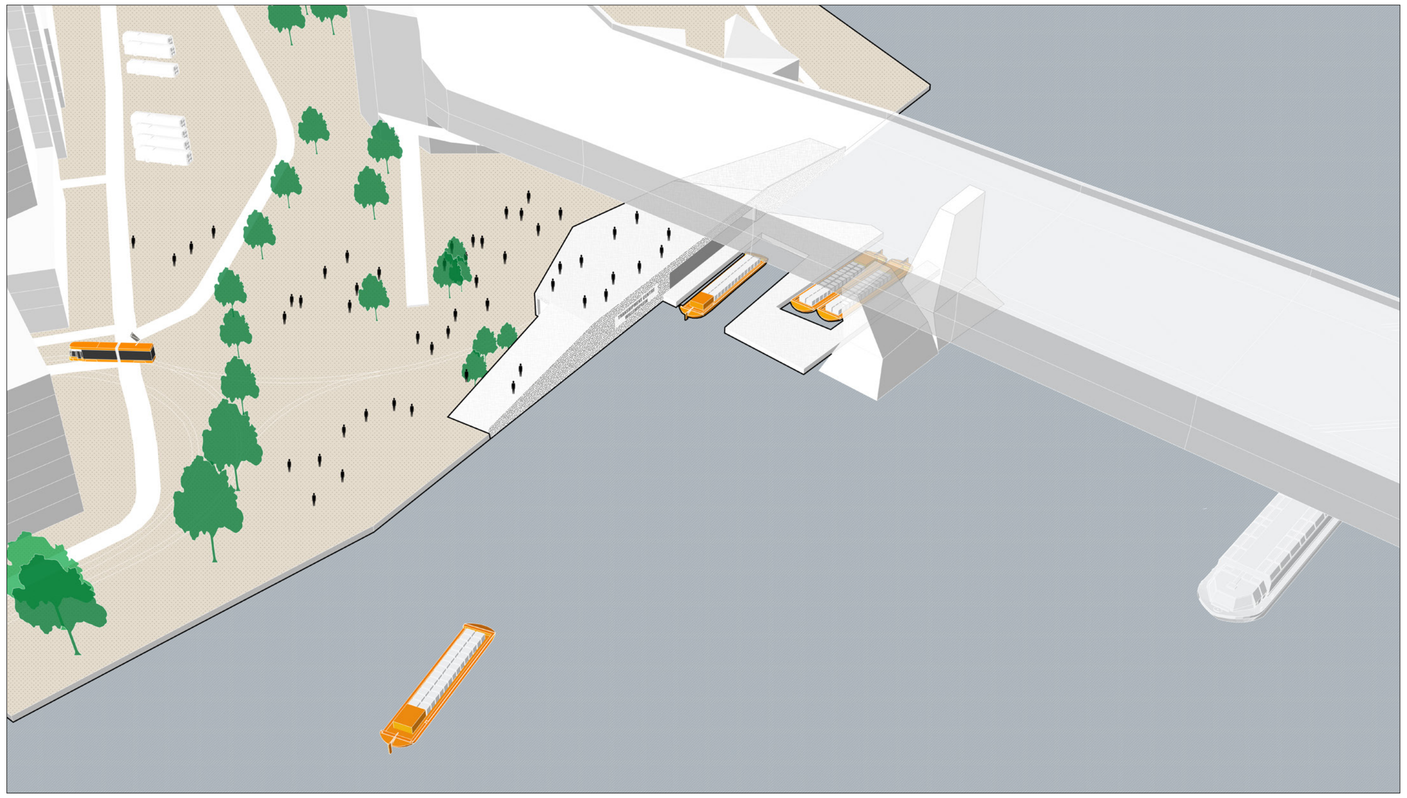


**FIGURE 7.9:**
Willemsplein possible design
(author's drawing)

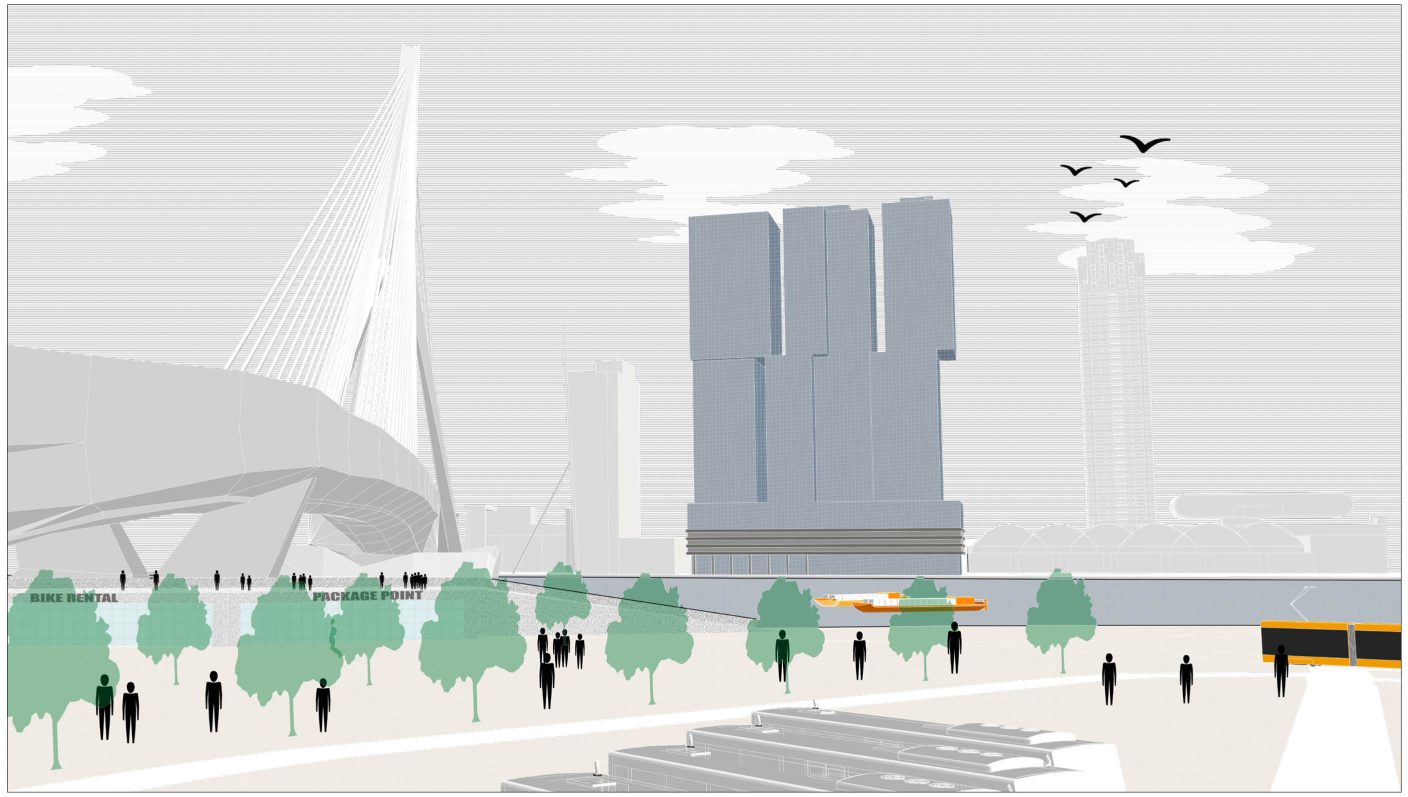



**FIGURE 7.10:**
Willemsplein view to
Wilhelminakade
*(author's drawing)*

**1.** Hongkou North Bund Waterfront, Shanghai (worldlandscapearchitect)

**2.** Pearl River Beer Factory Landscape, Guangzhou (Atelier cnS)

**FIGURE 7.11.1-4:**
Reference projects/buildings
or public spaces
*(several photographers)*



**3.** Platz der Deutschen Einheit, Hamburg (Ole Storjohann)

**4.** Waterfront, Yangtze (Yoji Sasaki)

**SOURCES:**

1. https://worldlandscapearchitect.com/hongkou-north-bund-waterfront-masterplan-and-public-realm-shanghai-china-hassell/
2. https://www.archdaily.com/351368/pearl-river-beer-factory-landscape-atelier-cns?ad_medium=gallery
3. http://www.urbanspacearchive.com/downloads/platz-der-deutschen-einheit-hafencity-hamburg-de-miralles-tagliabue/
4. https://www.archdaily.com/910565/sasaki-transform-the-yangtze-waterfront-with-flood-friendly-masterplan

### # *Transhipment centre De Esch*

Another proposed transhipment centre that potentially can serve the city centre is De Esch. Although de Esch is situated 4 km away, it has a direct tram connection to the city centre. De Esch has [currently] a connection from endpoint De Esch via Coolsingel/Weena/Rotterdam CS/Kruiskade to line 21 to Woudhoek (Schiedam) and line 24 to Holy (Vlaardingen).

De Esch is an area situated in the east of Rotterdam at the northern riverbank of the Maas and is part of the Kralingen-Crooswijk neighbourhood. It is situated at the south of the Maasboulevard/Abram van Rijckevorselweg between the Oude Plantage and the Brienenoord corridor (FIGURE 7.12). De Esch is at the south covered by a nature reserve (highlighted in green) that is surrounded by dikes to protect it against the river. The area was a former drinking supply site of the city of Rotterdam. The area consists of several pockets, which consists of several functions. At the east, one can find a cluster of car companies, a drinking water company and other businesses. In the middle of De Esch, there is a nature reserve, some sports fields, allotments and barracks situated. The west is characterised by residential apartments and urban villas, constructed in the '80s (highlighted in red).

The intended location of the transhipment centre is situated at the terrain of a construction company in the extension of the residential zone (highlighted in red) and the tram endpoint in De Esch, situated next to the nature reserve and along the Nesserdijk (FIGURE 7.13). The current construction terrain does not fit in the residential and natural surroundings and therefore, this will create an opportunity to construct a transhipment centre with on top additional social functions. From this location, a potential view of the qualities of the area development at Feijenoord can be created.

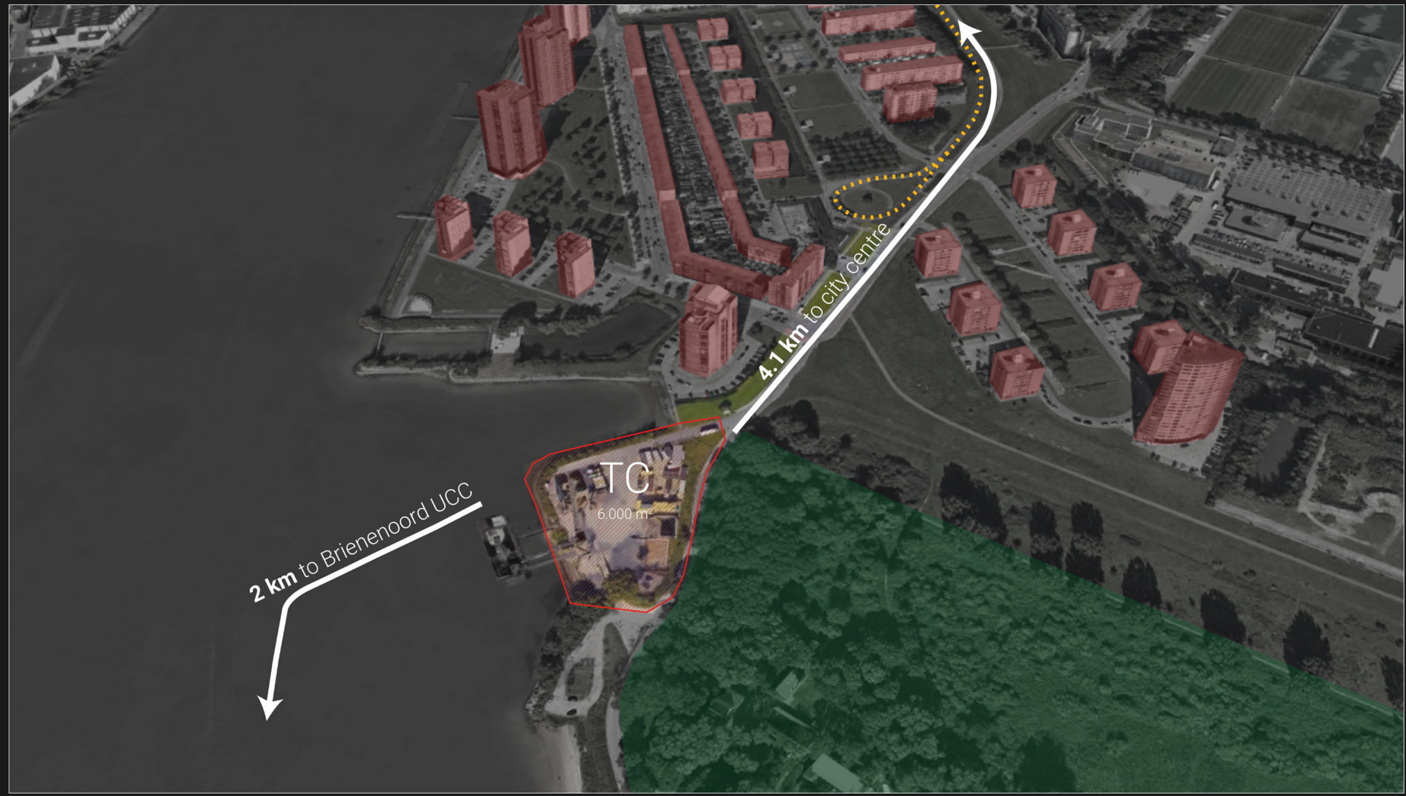



**FIGURE 7.12:**
TC De Esch
*(author's drawing, based on Google Earth, 2020)*

**FIGURE 7.13:**
View from the De Esch
*(De Ster Online, 2018)*

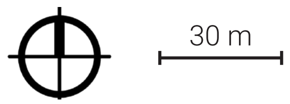



**FIGURE 7.14:**
Map TC De Esch
*(author's drawing)*

A possible design is shown in FIGURE 7.14. This location can act as a connection between the river, the nature reserve and extension of other residential buildings. This location asks for a small, subtle transhipment centre using the scale of a pavilion with a community centre or small cafe for the neighbourhood. Architectural freedom can be given here. It also can become a viewpoint over the river. Next to the transhipment centre, there is also space for a supermarket for the neighbourhood, fully supplied by the system (over the water) as an example.

To reach the facility by tram, the tram line that currently ends at the stop of Nesserdijk needs to be extended to the transhipment centre. This extension will take about 300m. FIGURE 7.15 and FIGURE 7.16 will give an impression of the proposed location. In the surrounding of the transhipment centre, there is some space to dedicate to its previous function, parking or as public space.


**FIGURE 7.15:**
De Esch possbile design
*(author's drawing)*


**FIGURE 7.16:**
De Esch view to transhipment centre
*(author's drawing)*

**1.** Gallery of Cultural Center, Nevers (Ateliers O-S architectes)

**2.** Ferry Terminal, Stockholm (CF Møller)

**FIGURE 7.17.1-4:**
Reference projects
*(several photographers)*

**3.** Gallery of Città della Scienza, Rome (Gallery of Città della Scienza)

**4.** Marina Barrage, Singapore (Greenroofs)

**SOURCES:**

1. https://www.archdaily.com/294892/cultural-center-in-nevers-ateliers-o-s-architectes?ad_medium=gallery\
2. https://www.archdaily.com/75000/new-terminal-for-stockholm-c-f-m%25c3%25b8ller-architects
3. https://www.archdaily.com/611976/vincent-callebaut-masterplan-predicts-future-of-self-sustaining-cities?ad_medium=gallery
4. https://www.greenroofs.com/projects/marina-barrage/

## 7.3.3 **Site proposal** *drop-off points Rotterdam city centre*

FIGURE 7.18 shows the city centre of Rotterdam. The city centre is covered by the districts of Cool, Stadsdriehoek and lastly het Scheepvaartskwatier. The focus of the city centre will mainly lie on Cool. Cool is situated in the south of the Central Business District of Rotterdam and between de Oude Westen and Stadsdriehoek. It is an important part of the vibrant Rotterdam city centre. The district is characterised by shops, restaurant and cultural buildings. The whole area consists of several retail entities (FIGURE 7.19). The tramway network in the city centre of Rotterdam is extensive as earlier concluded in the spatial analysis of Rotterdam (FIGURE 7.20). They are in the case of the city centre located around the the centre and are serving all relevant shopping shopping entities within 300 metres (FIGURE 7.21). This makes the most of the tramway stops appropriate as drop-off point for urban freight. Especially the Lijnbaan and Beurs can serve many (small) shops that sell applicable goods for urban consolidation. Two expedition streets are also connected to the tram network, which give extra potential space to eventually store or load/unload cargo trams. The district also have been heavily damaged by the bombardment of Rotterdam during WWII. After the war, some damaged buildings are demolished in order to reconstruct the district. The bombardment of the city centres gave urban planners opportunities to try-out new urban concepts, which nowadays characterise the not-historic city centre of Rotterdam.

The site proposal of the Rotterdam city centre will demonstrate two drop-off points: the tram stops of Kruisplein and Lijnbaan. The design of both tram stops present the possible spatial implications within the city centre.

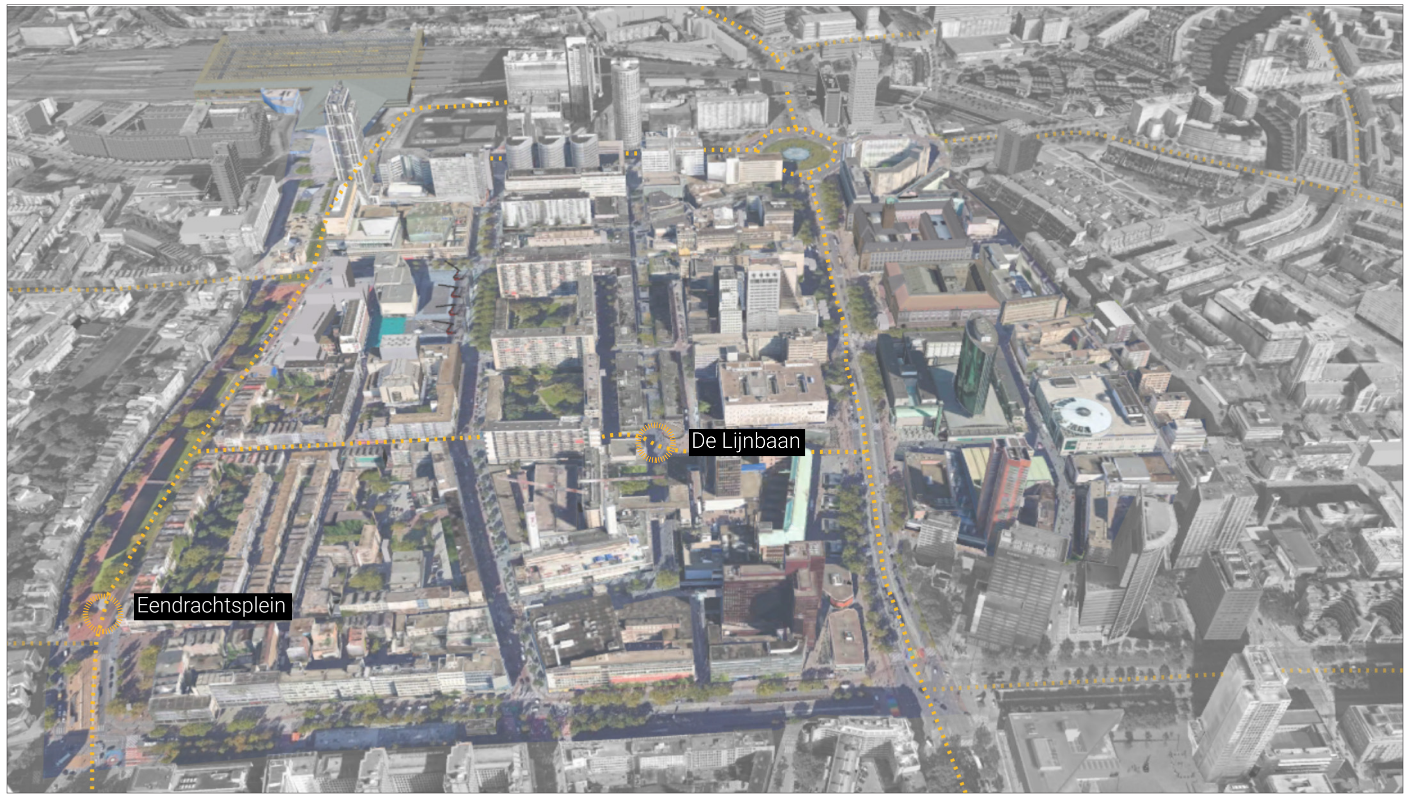



**FIGURE 7.18:**
Sattelite Rotterdam city centre
*(author's drawing, based on Google Earth, 2020)*

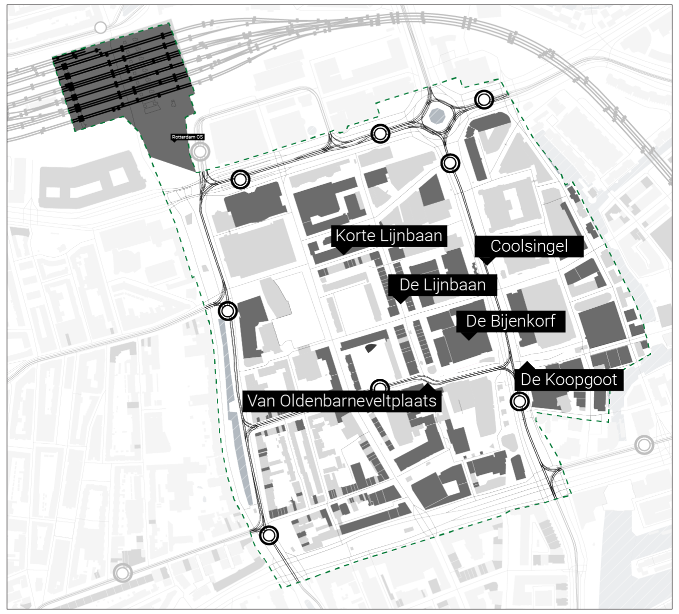



**FIGURE 7.19:**
Retail entities highlighted
*(author's drawing)*

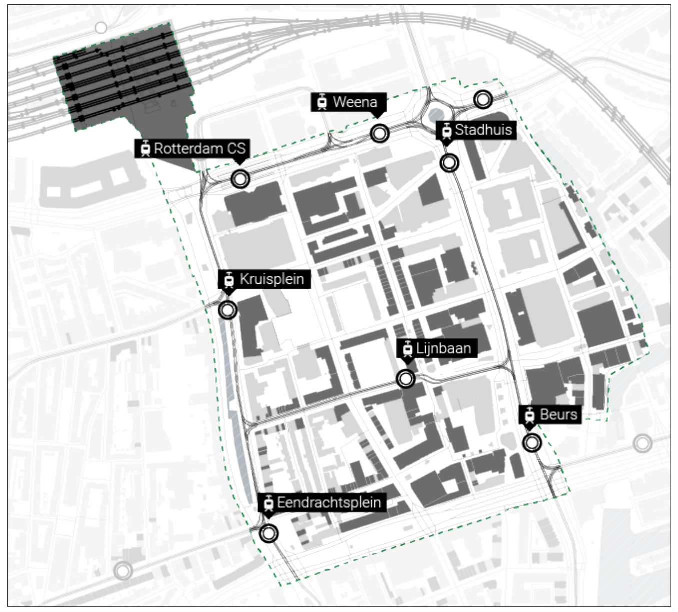



**FIGURE 7.20:**
Tram stops highlighted
*(author's drawing)*

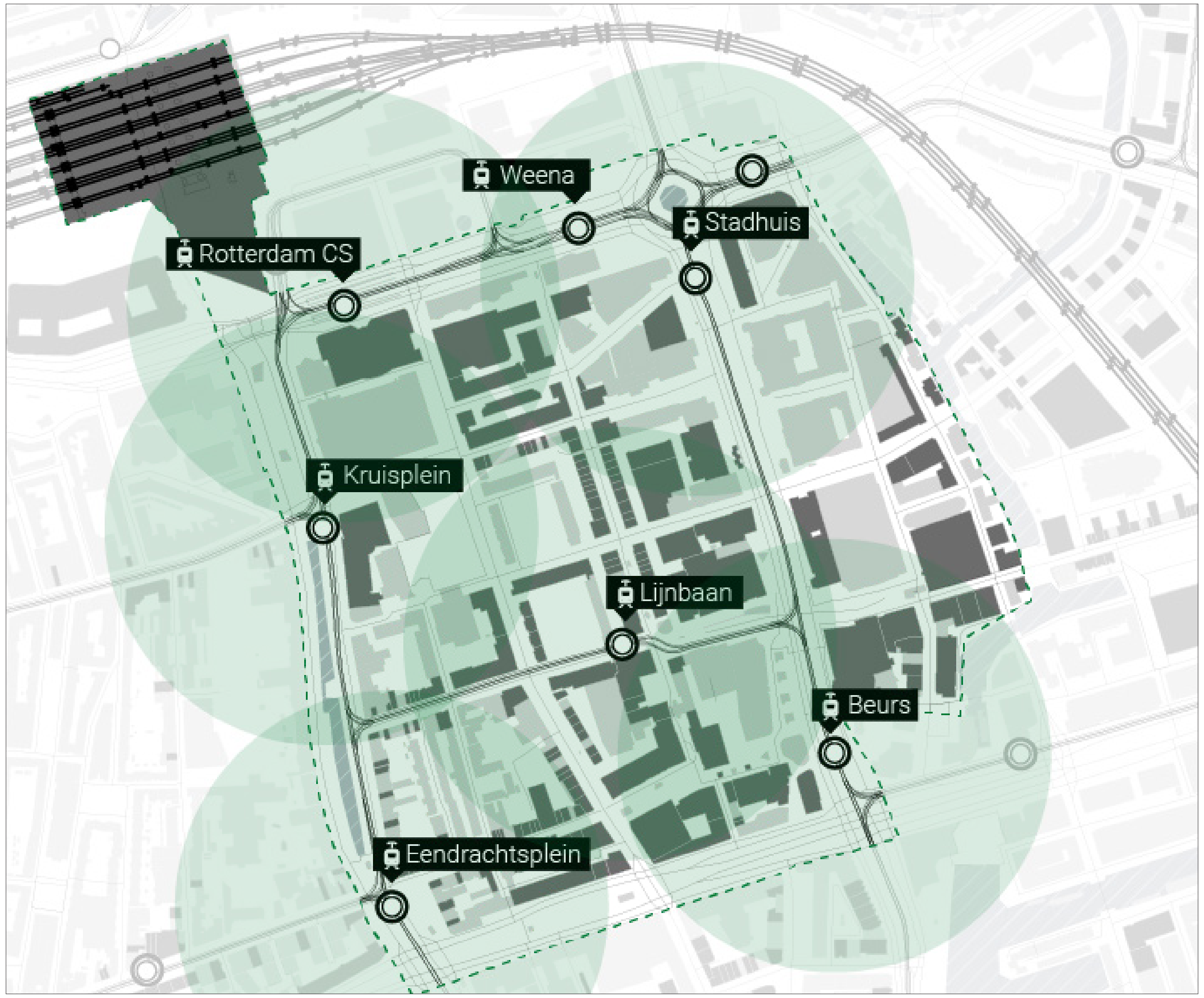



**FIGURE 7.21:**
Map city centre of Rotterdam with 300m circles around tram stops
*(author's drawing)*

100 m

This section demonstrates two examples of tram drop-off points wherein the current freight loading and unloading zones are re-used as drop-off point for the freight system. Re-using the current zones within a limited street profile reduces the amount of space other functions and users have to give up for the facilitation of the tram drop-off points.

### *Drop-off point De Lijnbaan*

The first drop-off point that will be addressed is a tram stop situated south of the Lijnbaan. The drop-off point at this location mainly serves the Lijnbaan, the Koopgoot and the Bijenkorf. The Lijnbaan is a modern shopping street, which is a passage only for pedestrians with a variety of shops on both sides of the street (FIGURE 7.22). Second retail entity is the Koopgoot (Beurstraverse), which is a shopping street below street level that crosses the Coolsingel. The Koopgoot originally was part of the Beurs metro station, but is nowadays filled with shops. Furthermore, there is a Bijenkorf (large department store) at the corner of the Coolsingel and Van Oldenbarneveltplaats (FIGURE 7.23). The Coolsingel is an important traffic vain in the inner city of Rotterdam.

The pedestrian area in a shopping street was a revolutionary post-war concept applied in de Lijnbaan, completed in 1953 to the design of architecture firm van den Broek & Bakema. They introduced a traffic free shopping street wherein shops are situated along pedestrian walkways (Platform Wederopbouw Rotterdam, n.d.). It is considered as the first car-free shopping promenade in the world. The pedestrian area is extended to other shopping entities in the city centre.

In plans of Rotterdam, one can see an increasing attention to the quality of public spaces and streets regarding the movement of pedestrians. Remarkable spaces are the so-called expedition streets within building blocks. This are streets situated behind shops (of the Lijnbaan), intented for supply, parking, waste collections and to leave containers. The idea is a precursor to use urban planning for urban freight purposes as a letter from 1941 of ir. W.G. Witteveen is mentioned in Platform Wederopbouw Rotterdam (2018) (SEE PAGE 208) . Although these streets are a signifcant part of the public space, they are nowadays unattractive and not a place to be there. These streets are mainly designed as backside and thus for functional purposes.

The expedition streets take a relatively huge part in the public space (in some quarters around 10%) and thus there are opportunities to give a new interpretation to these places. The municipality of Rotterdam feels the ambition and sees opportunities to use these spaces as an extra quality in the area, wherein there is a quest to find balance between functionality and spatial quality (Gemeente Rotterdam, n.d.). The general appreciation of those areas is nowadays low. Most expedition streets are functionally designed as building backs together with a lacking attention to aesthetics. It is characterised as a messy place with warehouses, garages, containers (Platform Wederopbouw Rotterdam, 2018).

**FIGURE 7.22:**
View towards Lijnbaan
*(van Duivenbode, 2014)*

**FIGURE 7.23:**
View from the Van Oldenbarneveltplaats
*(Google Earth, 2020)*

*“Om de belemmeringen weg te nemen, die het verkeer ondervindt van het laden en lossen van goederen aan de straatzijde van gebouwen in drukke winkelstraten, zijn in het stadsplan in de winkel- en bedrijfswijken terreinen geprojecteerd, die, binnen een bouwblok gelegen, ten doel hebben de goederenexpeditie aan de achterzijde van de belendende gebouwen te doen plaats hebben”*

*“In order to remove the obstacles that the traffic is experiencing from the loading and unloading of goods on the street side of buildings in busy shopping streets, the urban plan has projected some areas in the shopping and business districts, which are situated within a building block, meant for freight expedition taking place at the backside of the adjoining buildings”*

*ir. W.G. Witteveen in a letter to the mayor and councilors in 1941 from Platform Wederopbouw Rotterdam (2018)*



# ***Drop-off point Eendrachtsplein***

The first drop-off point that will be addressed is the drop-off point at the tram stop ‘Eendrachtsplein’, which is located at a square situated in the middle of the Westersingel at the borders of the Centrum, Cool, Dijkzigt and Oude Westen neighbourhoods. The square is characterised by small-scale catering and retail, but also can be considered as a large traffic junction with cars, cyclists, pedestrians, public transport and a taxi stand. The tram stop is [*currently*] connected to line *4 and 7*. Also a bus stop and a large metro station, constructed in 1982, is included at this square. The drop-off point at this location could serve the supply of the stores at the Westersingel/Mauritsweg, Oude Binnenweg and Westblaak, which make this strategically seen a suitable location as drop-off point for surrounding stores.

The starting point of the design for the drop-off point at the Eendrachtsplein will be the existing freight (un)loading zone at the Mauritsweg, at the north of Eendrachtsplein (FIGURE 7.24). This (unloading) zone is a strip with a length of 27m, which is suitable for a freight tram and the corresponding curve radius for the tram tracks. Using this strip will limit the extra required space: there is mainly space required for charging facilities for freight bikes.


**FIGURE 7.24:**
Existing freight zone at the Mauritsweg
*(Google Earth, 2020)*

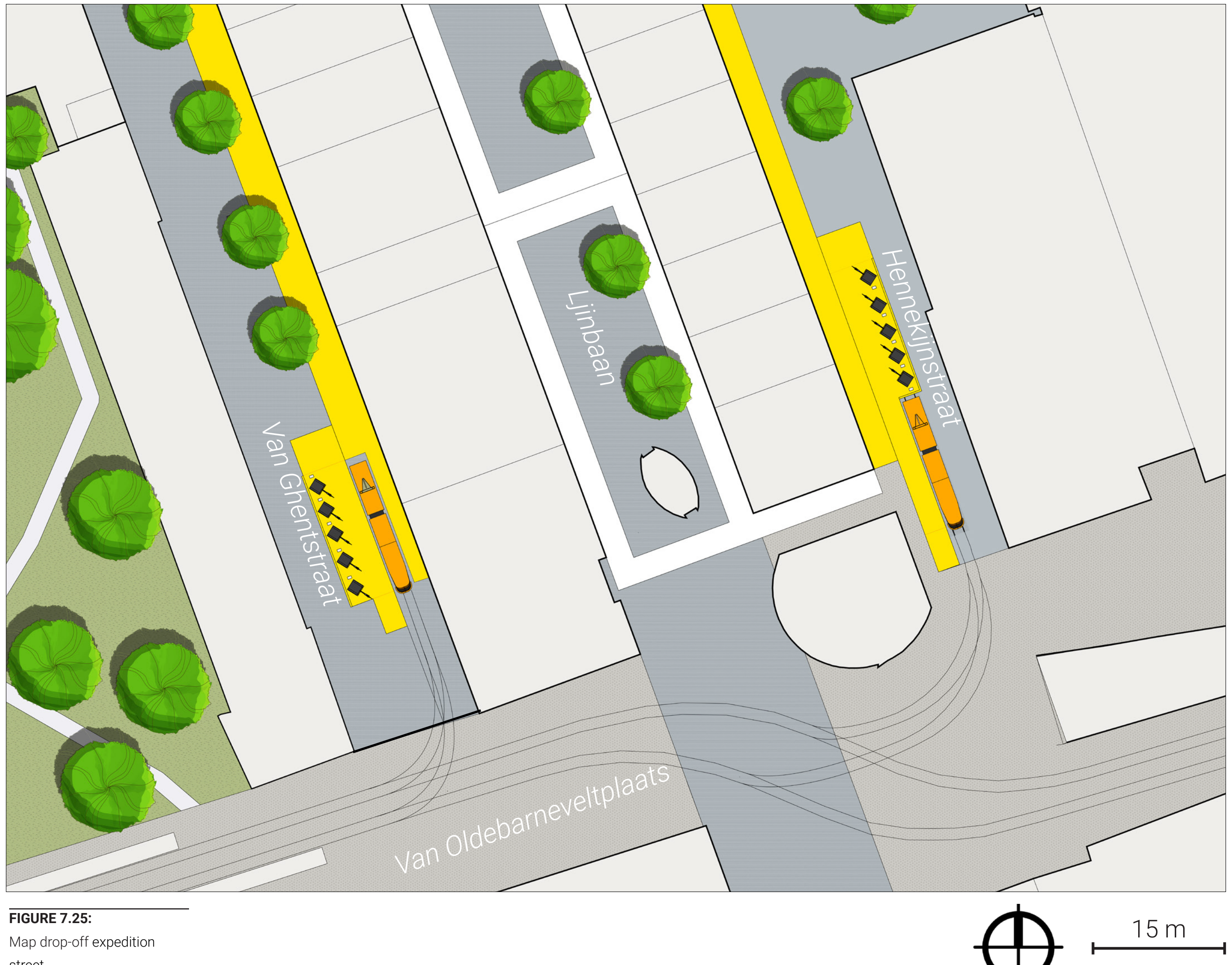



**FIGURE 7.25:**
Map drop-off expedition street
*(author's drawing)*

The starting point of the design will be the expedition streets behind the Lijnbaan. As these expedition streets already have a function related to the supply of retailers, these streets can be benifical for the implementation of the strategy at the Lijnbaan. By reducing the amount of trucks (or in ideal and preferred situation eliminating), the way these streets are used could be changed. The possible design in FIGURE 7.25 shows the possibility by using some of these expedition streets by offering some space for the loading and unloading of trams as extension of the Lijnbaan tram stop. This will require some space in the street, but since trucks are removed, the rest of space can be used to raise the quality. By adding more functions to those streets and more consideration to aesthetics , while reconsidering the way of supplying, a better appreciation of those spaces can be realised.

Challenges on this site are related to technical issues concerning the tram. The expedition streets are more or less perpendicular situated to the Oldenbarneveltplaats, which require significant space for the right curve radius. The limited space and the presence of pedestrians and the Koopgoot make this even more complex. In the technical design it is likely to take the minimum railway curve radius, governed by amongst other things the operational speed, which is low at this point. Furthermore, the proposal is based on the current tram services. The current tram service determines the direction of the trams towards the Willemsplein transhipment centre. The direction of the servicesdetermine the connection of the drop-off point to the network, which is in the case of the Lijnbaan to the east (to Mauritsweg). FIGURE 7.26 til FIGURE 7.30 give an impression and proposed atmossphere for the Lijnbaan expedition streets.

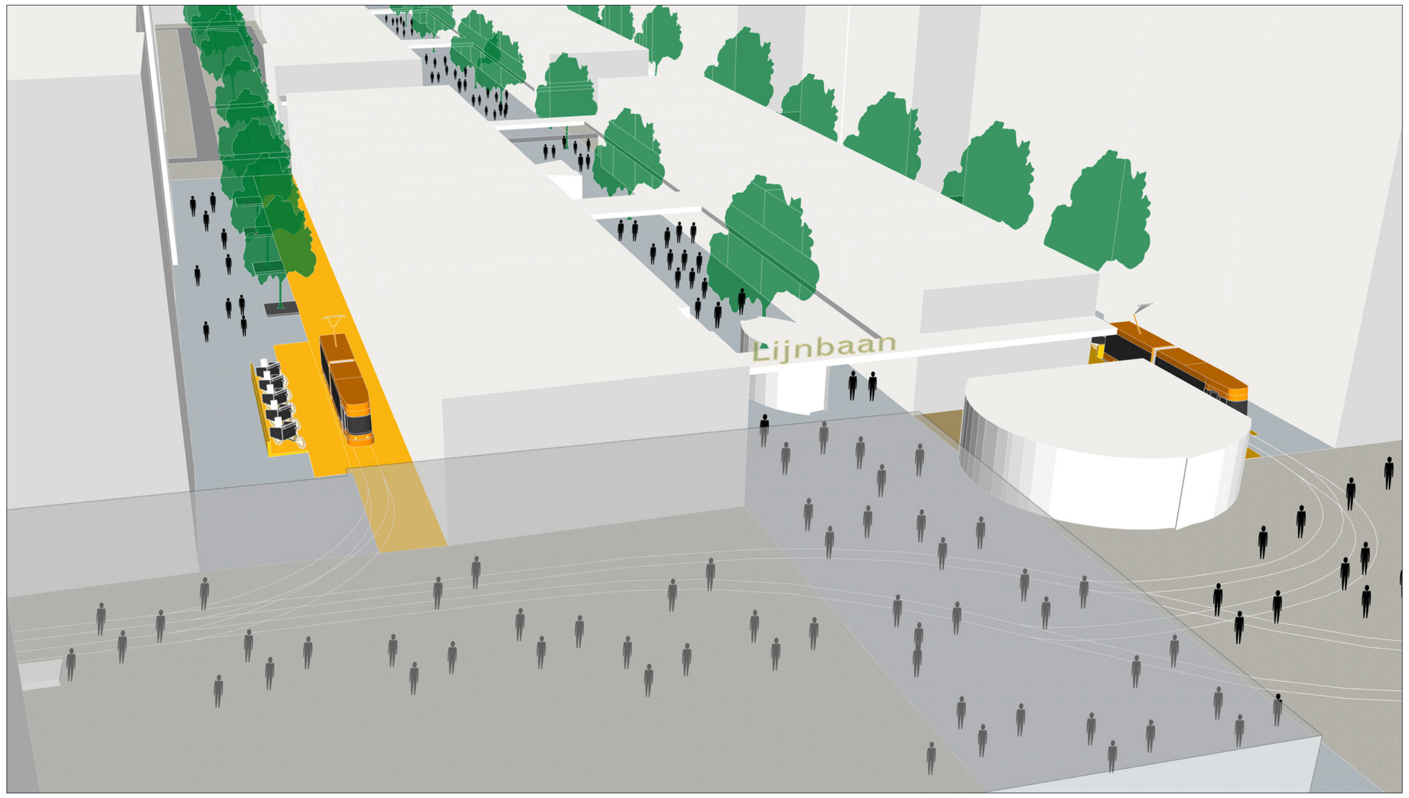



**FIGURE 7.26:**
Drop-off point expedition street possbile design
*(author's drawing)*


**FIGURE 7.27:**
View to the drop-off point expedition street
*(author's drawing)*

**FIGURE 7.28:**
Current impression expedition street
*(Google Earth, 2020)*

**FIGURE 7.29:**
New impression expedition street
*(based on Google Earth, 2020)*



**1.** Slabtown Marketplace, Portland (GBD Architects)



**2.** Reposessing the Realm-Fused Grid, Athens (UrbanGrammar)

**3.** Public Space Public Life, Seattle (Gehl Architects for International Sustainability Institute)

**4.** Centro Street, Santiago (María González)

**5.** Unknown (Yoji Sasaki)

**FIGURE 7.30.1-5:**
Reference projects
*(several photographers)*

**SOURCES:**
1. http://www.gbdarchitects.com/portfolio-item/block-296/
2. https://www.flickr.com/photos/22392855@N08/6049878544/
3. https://issuu.com/gehlarchitects/docs/565_seattle_pspl/142
4. https://images.adsttc.com/media/images/5a3b/2330/b22e/384b/3a00/0124/slideshow/IMG_1265.jpg?1513825050
5.http://2.bp.blogspot.com/-9gqWmRQuM8Y/T06phOwBwxI/AAAAAAAAIcI/8Pkaoe9Sj6Y/s1600/%25E4%25BD%2590%25E4%25BD%2590%25E5%258F%25B6%25E6%259C%25A8%25E4%25BA%258C+%25282%2529.jpg


**FIGURE 7.31:**
Map drop-off Eendrachtsplein
*(author's drawing)*

**FIGURE 7.32:**
Drop-off point Eendrachtsplein possbile design
*(author's drawing)*

**FIGURE 7.33:**
View to the drop-off point Eendrachtsplein
*(author's drawing)*

A possible design for a drop-off point at the Eendrachtsplein is shown at the plan on FIGURE 7.31. At the Eendrachtsplein, it is attempted to incorporate the extra sidetrack for the tram drop-off at an existing (un)loading zone near a tram stop. There are currently several zones reserved for (un)loading: at the Mauritsweg, Ouden Binnenweg and the Eendrachtsplein itself. As earlier mentioned and showed in FIGURE 7.24, the starting point of the design for the drop-off point at the Eendrachtsplein will be the existing freight (un)loading zone at the Mauritsweg, at the north of Eendrachtsplein. This (un)loading zone is a strip with a length of 27m, suitable for the freight activities. From the perspective of tram line 4 and 7 (starting point Willemsplein), this side track is situated behind tram stop 'Eendrachtsplein'. The charging equipment will be situated behind the strip at the 6m wide pavement. FIGURE 7.32 and FIGURE 7.33 give an impression of the Eendrachtsplein.

The essence of the proposal is to identify existing (un)loading zones for trucks. These zones are often large enough to transform them into a temporary place for trams. In the transition phase towards a truck-free supply or a co-existence between truck and tram supply, the same space can be shared among both modes. Otherwise, extra space also needs to be retrieved from current parking places.

## 7.3.4 **Site proposal** *drop-off points Schiedam city centre*

Cities that comprise a extensive network of canals will use water drop-off points to get freight to their stores. According to the spatial analysis, this will be the case in Delft and in Schiedam. This subchapter will address the spatial implications for Schiedam. Important for the proposed strategy in Schiedam are The Schie and the Lange Haven. Along these waterways, the water drop-off points needs to be constructed.

The in FIGURE 7.34 illustrated city centre of Schiedam is the historical centre of Schiedam with many historic buildings, designated as 'beschermd stadsgezicht'. The city centre district is situated in the south of Nieuweland and between Schiedam-West and Schiedam-Oost neighbourhoods. It is founded and situated along De Schie and de Lange Haven, which ends in the Maas. The Grote Markt and the city hall, close at the Schie, are the oldest places of the city. The Broersvest, which bounds the city centre on the east, is part of a tramline that connects the city centre with the Rotterdamse Dijk, the Schiedam Centrum railway station and the north of Schiedam. The two tram stops, Broersvest and Koemarkt could act as additional drop-off point to the transport over water. The retail entities of Schiedam city centre are shown in FIGURE 7.35. They are mainly concentrated at the Hoogstraat [1] and Broersveld (extension of the Nieuwe Passage) [2], which both have established time windows and vehicle/car restrictions. There are also soms stores located at the Koemarkt [3], Broersvest [4] and de Lange Kerkstraat [5], where also the ABC (Albert Heijn, Blokker and C&A) is situated. The retail entities are connected with tram stops within 300 metres (FIGURE 7.36 and FIGURE 7.37) or situated close to the canal structure.

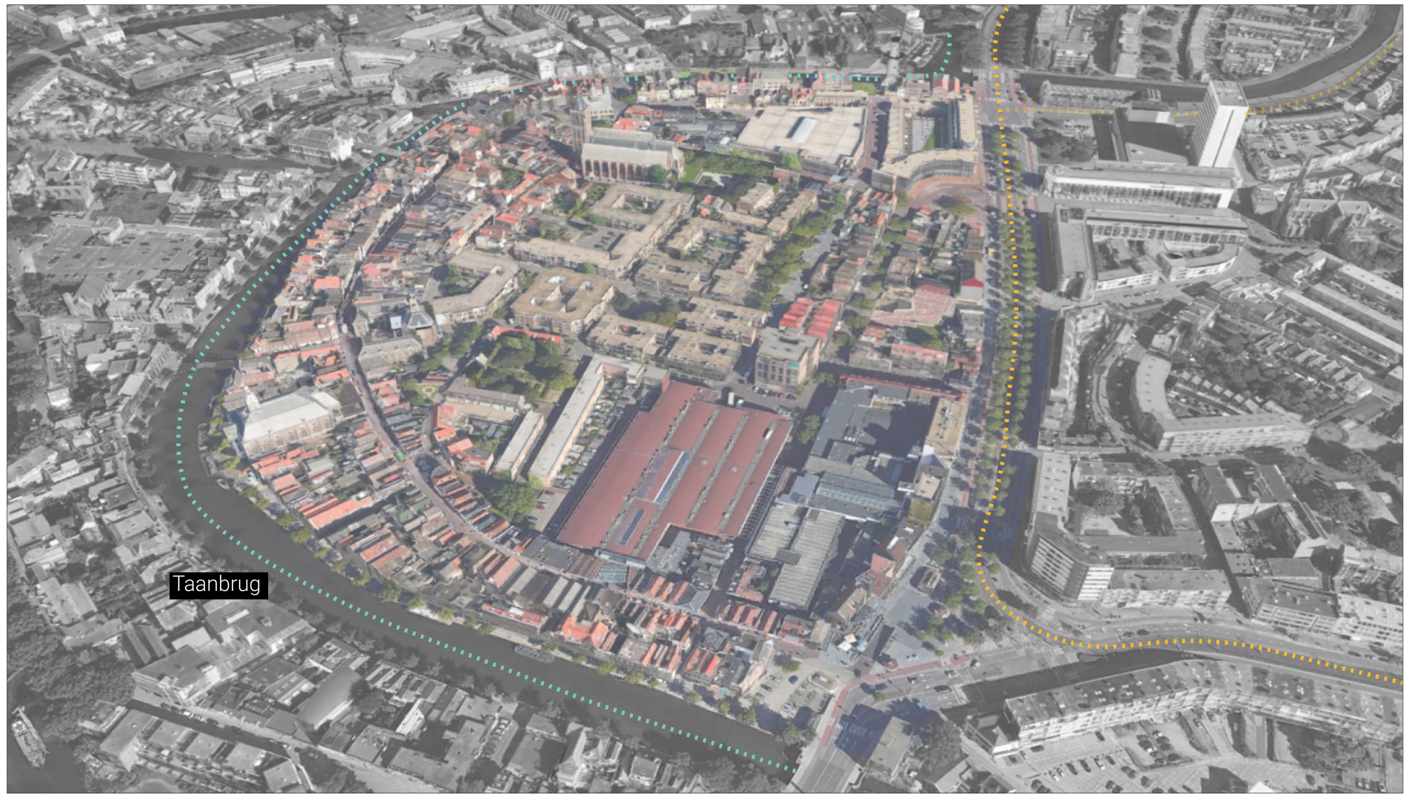



**FIGURE 7.34:**
Schiedam city centre
*(author's drawing, based on Google Earth, 2020)*

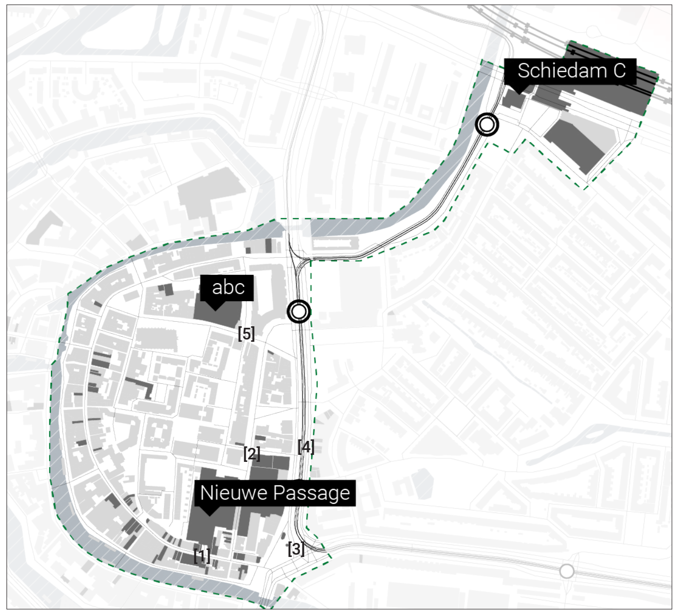



**FIGURE 7.35:**
Retail entities highlighted
*(author's drawing)*

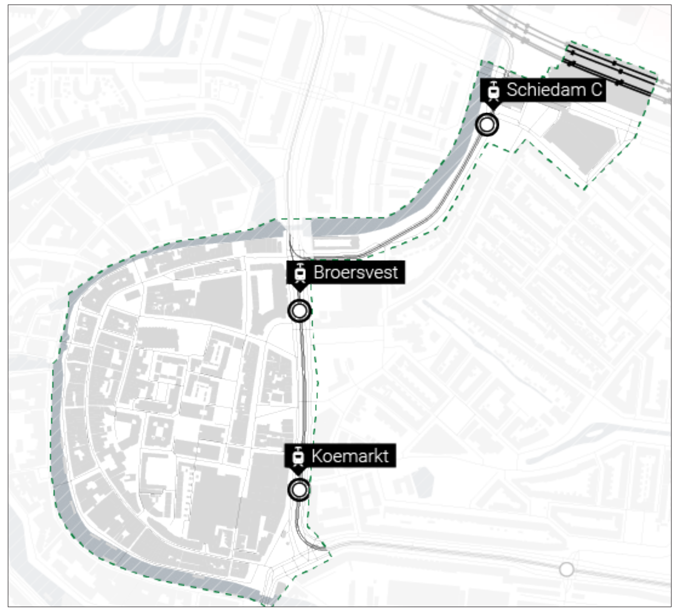



**FIGURE 7.36:**
Tram stops highlighted
*(author's drawing)*


**FIGURE 7.37:**
Map city centre of Schiedam with 300m circles around tram stops
*(author's drawing)*

100 m

Currently, the Lange Haven along the canal is used for urban freight movement. The city centre is built in a way that the residential buildings are located in the core, while retail entities are situated at the edge of the city. However, most retailers are not directly situated along the Lange Haven, but on the street behind at the Hoogstraat. Some are even more directed to the core, such as the Passage and the ABC building. This means that another condition for the allocation of water drop-off points will be the presence of cross streets or alleys to reach the streets behind the canals. Figure 7.38 illustrates potential locations and with overlaying it as shown in figure 7.39 with retail entities could destillate possible locations for water drop-off points. The water drop-off points together with the tramline on the Broersvest, whose entry points for urban freight is the transhipment point of Merwevierhaven, could reach the city centre of Schiedam, since the most retailers are situated at the edge.

The analysis of Schiedam made clear that the public space, pedestrian streets and the canal roads are pressurised by the necessary supply trucks.To a smaller extend, the situation of Schiedam is comparable with Delft, since they also have a historical city centre that is suitable for a strategy based on supply over water. Also in Schiedam, the quays on the canals are old, small and vulnerable. With respect to space, the supply modes needs to be re-considered as well. As the street profile in figure 7.40 shows, the waterways have way more space than the roads. This emphasises the pressure on the current supply along canals. Every drop-off point at the water covers a little amount of small local stores, which implies that the drop-off does not have to be large. The larger retailers, concerning the larger shipments, are situated in the Passage, which also can be assisted by the Koemarkt tram stop.

As example, the implementation of the design for the drop-off point at the height of the Taanbrug (figure 7.41) will be illustrated on the following pages.

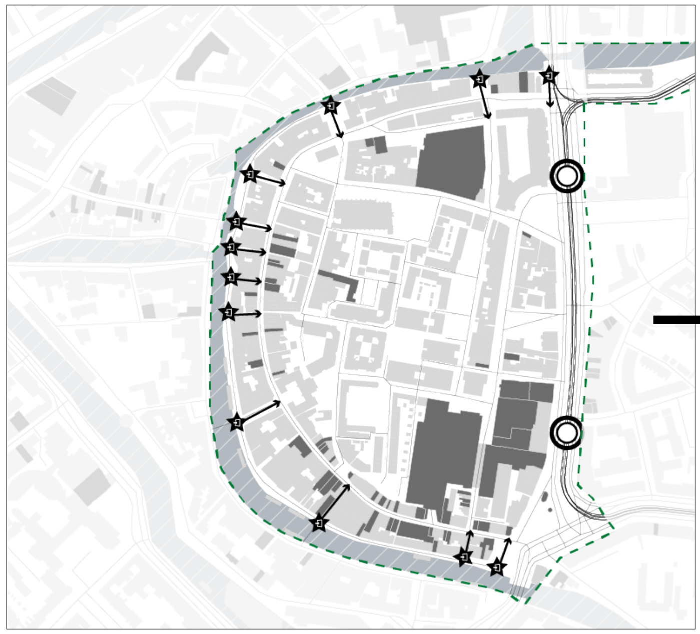


**FIGURE 7.38:**
Potential drop-off points
*(author's drawing)*

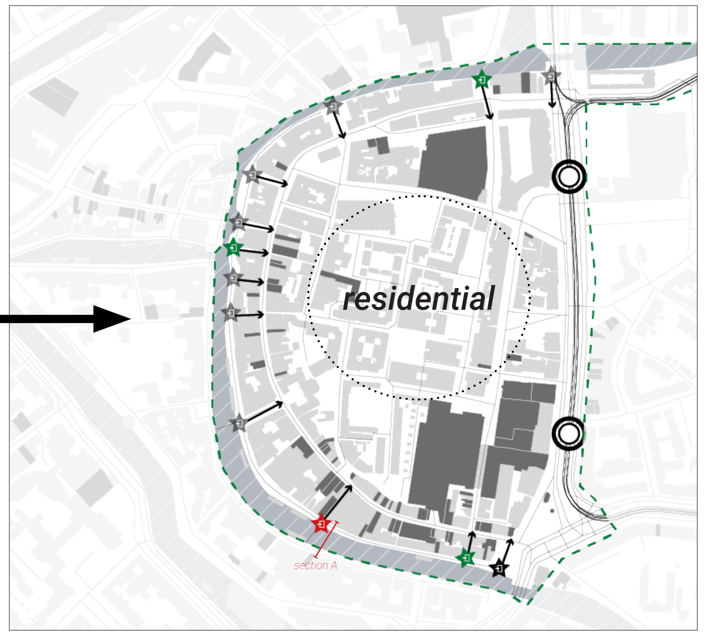



**FIGURE 7.39:**
Chosen drop-off points
*(author's drawing)*

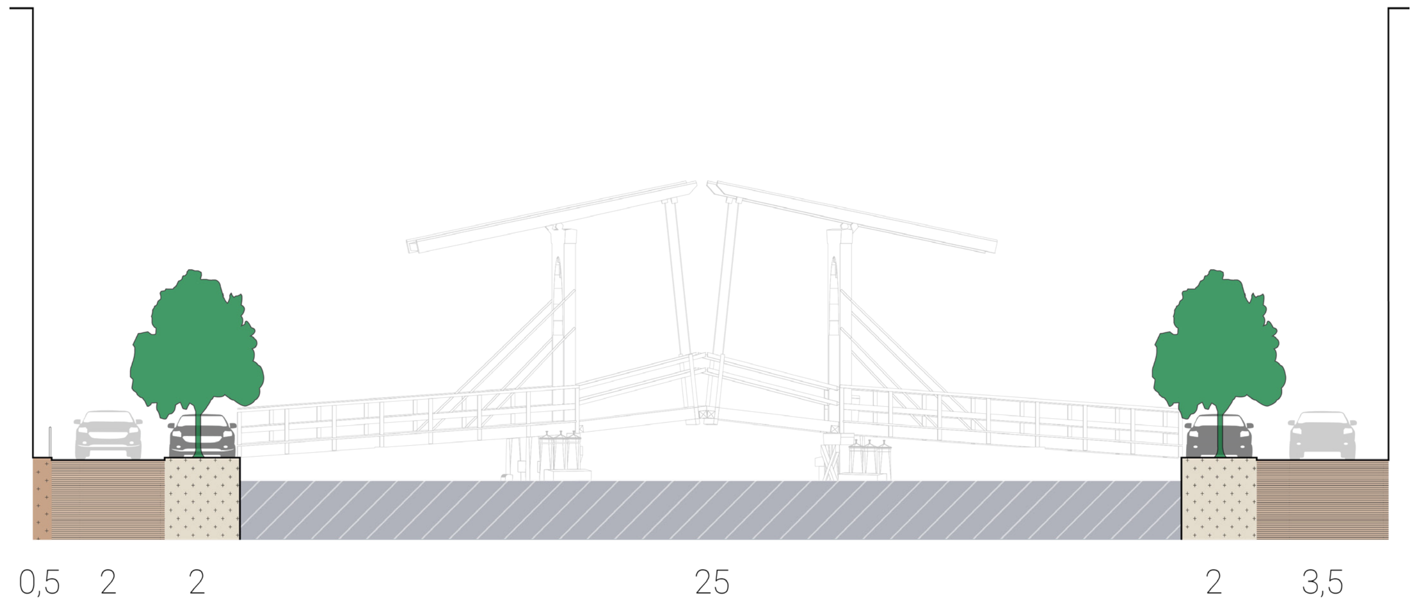



**FIGURE 7.40:**
Section A Taanbrug, Schiedam
*(author's drawing)*

**FIGURE 7.41:**
Taanbrug, Schiedam
*(Sluijter, 2017)*


**FIGURE 7.42:**
Map drop-off point Taanbrug
*(author's drawing)*

**FIGURE 7.43:**
Drop-off point Taanbrug possbile design
*(author's drawing)*

**FIGURE 7.44:**
View to the drop-off point Taanbrug
*(author's drawing)*

FIGURE 7.42 shows a possible design for a water drop-off point, situated at the Lange Haven. The water drop-off point will appear as a dedicated platform on the water, where the activities are limited to transferring freight from ships to the land. The placement of the platform involves an entrance at the canal quay. The current canal quay is filled with car parking alternating with trees. In the proposed plan, around two parking places need to be replaced by a parking spot for cargo bikes and an entrance to the freight platform on the water. As earlier described, such a platform need small storage facilities, a crane and charging equipment and the possibility to remove it. The ships through the canals of Schiedam, originated from the 's-Gravenlandsepolder UCC need to be relatively small with a maximum expected length of 10 m and width of 3.5m.

On the land, small-scale electric transport drives back and forth from the drop-off point to the stores. Due to the situation of the stores in the city centre of Schiedam, most of the freight will be transported through the alleys to the shopping streets. At this location, this will be the Taansteeg (approximately 3-3.5m wide). FIGURE 7.43 and FIGURE 7.44 give some impressions of the proposed drop-off point.

## 7.4 Conclusion

The purpose of the chapter was to show the spatial implications and feasibility of the strategies that are developed in sixth chapter. With showing this, the fourth research question will be answered:

What are the spatial implications of the improved urban freight strategies in the MRDH?

The chapter started with the site selection in which the strategy of Rotterdam urban region is selected for elaboration. The elaboration has followed the supply line consisting of the three nodes from the city edge towards the city centres of Rotterdam and Schiedam. This has resulted in a demonstration of the spatial considerations for urban consolidation centres (Vijfsluizen and 's-Gravenlandsepolder), transhipment centres (Willemsplein and De Esch) and drop-off points (Lijnbaan, Eendrachtsplein and Taanbrug). The conclusion will discuss findings and explain the impacts on the site of the proposed interventions for transhipment centres and drop-off points.

Urban multimodality has a big potential (especially on the water) when the location of the urban consolidation centre is chosen well-considered. Extra synergies can be generated when the location and processes on waste treatment facilities are also taken into account of the allocation of urban consolidation centres. Moreover, the location of the consolidation centre also determines and eventually limits the possible locations of other nodes. The research does not have demonstrated any spatial proposal, since these facilities could be placed on industrial sites for the nearby future. Therefore, the research aims to emphasize the importance of well-considered allocation rather than showing an elaborated design on the urban consolidation centre.

Regarding the transhipment centres, it is important to consider the context and surrounding functions to find out which additional function could suit in the context. With 500 - 1000 $m^2$, they will use a relatively large space in (dense) urban areas and thus they have a serious impact on the urban landscape. Instead of designing just a box where logistic activities are taking place, the project wants to make clear that it also can serve the city and its public space. With careful consideration, it could offer the possibility to integrate urban freight logistics within a city by stacking functions instead of putting them next to each other. An important condition for successful implementation is to design the transhipment centres along the water corridor and incorporate them as a part of the public space. This has been demonstrated at the Willemsplein and the Esch.

For drop-off points, the main challenge in implementation is to incorporate them in an already full and defined programmed area in the city, integrated into existing street and water profiles. In the case of the allocation of a water drop-off point, the spatial considerations are the location of retailers, the width and (water) traffic on and around the canal. Due to the increasing logistic demand in a lot of historical city centres, trucks are currently damaging and pressurising the roads and quays along the canal since the space for supply activities is limited. By drawing a section of a canal, it turns out that the water infrastructure often is wider than the roads along the canal. With small one-direction road traffic on both sides of the canal, it loses flexibility and efficiency, while the water infrastructure seems like a better passage for freight traffic since it is wide enough for ships to pass each other.

Also, there is no need to construct new infrastructures, since the current water infrastructure can be used again for the purpose it initially was designed for at that time. Investments need to be made on the drop-off points and the quay connection. The drop-off point itself is a platform that carries all the necessities. This platform can be (re)moved and is thus not permanent. Ultimately, the connection to the quay will be a small intervention as well. Some (parking) spaces need to be transformed into charging points for electric cargo bikes.

In the case of tram stops, the proposed urban freight system needs some more interventions and space for an extra sidetrack and unloading plus a detailed technical plan for the limited space for the construction of tram tracks and switches. The two examples however have demonstrated that for making supply by tram possible, it is worth it to analyse the existing freight system by mapping the flows and where currently freight is delivered physically. These could be transformed to drop-off points for trams. With using them, less extra space is required and thus other functions and users have to give up less space to facilitate tram drop-off points. In general, the spatial impact of the interventions is unrelated to operational decisions concerning the type of tram.

For the Lijnbaan, the starting point for the intervention is the use of surrounding expedition streets (van Ghentstraat and Hennekeinstraat), which are already designed for supply and waste collection. These expedition streets are a significant part of the public space, but are designed as a functional backside for stores and are thus perceived as unattractive. With implementing a new freight system, this has created the opportunity to rethink these streets and improve the spatial quality since the (un)loading will not take place anymore along the whole street, but just at the beginning close to the Van Oldebarneveltplaats. This leaves the rest of the street available for reconstruction and other functions. At the Eendrachtsplein, it is attempted to incorporate the extra sidetrack for the tram drop-off at an existing (un)loading zone near the tram stop at the Mauritsweg, which is, in this case, a strip of 27m long. The sidetrack needs to be connected to the tram network and requires one crossing at the Mauritsweg. The sidewalk is at this location large enough to facilitate loading equipment for cargo bikes.

The several design proposals have demonstrated that for the most sites a new node with additional functions has the potential to contribute to the spatial quality. Relatively small interventions are required when existing structures are re-used, especially at the drop-off points are necessary to achieve this. With a different perspective on urban freight logistics, logistic functions can be gradually be considered as an urban function.

In a phased manner, it also can be decided to start with just consolidation centre nodes (eventually situated close to waste treatment plants) at the edge of the city to improve the efficiency of trucks to achieve already the indirect beneficial effects related to fewer trucks driving into the city. During the process towards a truck-free supply or a co-existence between truck and tram supply, the same space can be shared for both modes as well. Multimodality can be considered for some reasons as a lower priority or to create extra time to make the necessary infrastructure ready for operation.

This chapter has the purpose of concluding the main research question :

*How can a strategic framework of urban freight transportation in the MRDH accommodate the increasing logistic demand of retailers in a sustainable and liveable way?*

This chapter has the purpose of providing the conclusion, reflection of the research. The conclusion will give an answer on the main reseaarch questions and generalise the results of the findings in Rotterdam to a large extent. The reflection positions the research within the urbanism discipline by reflecting on its programme, the methodology and describing the societal, scientific and ethical relevance of the project.

*chapter outline:*


8.1 introduction
8.2 conclusion
8.3 transferability test
8.4 reflection


# 08

# CONCLUSIONS & REFLECTIONS FOR MRDH

*source photo: Taanbrug (J. Sluijter, 2017)*

## 8.1 *Introduction*

The core of the capter will be the completion of the thesis by formulating a conclusion based on the earlier formulated research design and a reflection on the process, the research design and the conduction of the research.

The research has aimed to develop a strategic framework, including the concepts of urban consolidation and urban multimodality of urban freight transportation for local authorities in the MRDH in order to accommodate the increasing logistic demand of retailers, while mitigating/reducing negative externalities. The conclusion will ansering the following main research question:

HOW CAN A STRATEGIC FRAMEWORK OF URBAN FREIGHT TRANSPORTATION IN THE MRDH ACCOMMODATE THE INCREASING LOGISTIC DEMAND OF RETAILERS IN A SUSTAINABLE AND LIVEABLE WAY?

The conclusion paragraph is built up in a way that it summarises the results of the four sub research questions, wherein the (spatial) potential of the proposed freight system is revealed. Also recommendations for further research are given on this topic. The paragraph ends with the lessons learnt of implementing urban consolidation and urban multimodality in urban freight. Ultimately, a transferability test on the strategic framework to four other cities is demonstrated to give clearer recommendations on what kind of urban freight systems can be developed, based on existing infrastructures and facilities.

After the presentation of the main conclusions, a reflection will be given on several aspects on the process, the research design and the conduction of the research. The reflection is related to the following aspects:

1) the relationship between the graduation topic, studio topic, master track and master programme
2) the relationship between research and design
3) the methodological approach of the research
4) societal, scientific and ethical relevance
5) transferability of project results

## 8.2 *Conclusion*

*SRQ1* **In the following section, the most important conclusions of the four sub research questions will be summarised. Together they formulate the conclusion of the main research question. Based on these conclusions, four important lessons will be drawn. Finally, recommedations for further research are given.**

In the first research question, global trends and dynamics are examined. It can be concluded that technological and economic developments evidently have influenced urban freight (transportation) and are responsible for an increasing scale of consumption and production. Cities become more crowded due to urbanisation, which puts a lot of pressure on supply and delivery. At the same time, consumers expect complete, just-in-time and frequent deliveries and in an environmental sense, it also needs to be efficient to make urban freight activities cleaner, safer and invisible without traffic jams. The number of vehicles and vehicle kilometres through cities is growing fast, causing bad traffic conditions in the cities and thus cities have to face increasing levels of negative externalities. All these drivers make it inevitable that urban freight requires higher sustainable and operational performance levels.

*SRQ 2* The second research question has revealed the current organisation of urban freight (in the MRDH) in terms of 1) initiatives, measures and concepts, 2) spatial organisation and 3) stakeholders. The main finding in this section is the lack of coherence within the organisation of those three aspects. Although growing negative externalities, there seems like no obviousness for sustainable solutions. Authorities do not feel any involvement yet with the private stakeholders, nor do they understand the interests and interaction between stakeholders completely. This has resulted in a lack of national alignment and guidelines which become clear in the taken measures and initiatives. Municipalities have applied comparable measures, but executed with different parameters, leaving urban freight stakeholders frustrated. Some of them are insufficient to tackle the increasing negative externalities due to lack of knowledge and awareness from urban planners and decision makers on urban freight and measures. Also, lack of national steering in the spatial organisation has caused an uncontrolled sprawl of distribution centres in the Dutch landscape along highways without consideration of water and rail infrastructures. It has resulted in the dominance of transportation by trucks, which is also visible on the urban scale wherein there is no freight transported over rail and water. Furthermore, retailers seem to barely work together since they take all care for their own distribution and supply, which generates a lot of (small and unnecessary) movements in cities.

*SRQ3* The third research question has set up the strategic framework by translating the two proposed concepts [1) URBAN CONSOLIDATION AND 2) URBAN MULTIMODALITY] into spatial strategies by listing the spatial conditions and design requirements. For the strategic framework, three nodes [1) UCC, 2) TRANSHIPMENT CENTRE AND 3) DROP-OFF POINT] are proposed, manifesting in two different freight principles [1) SITUATED NEAR WASTE TREATMENT PLANT AND 2) SITUATED NEAR WATER CORRIDOR] and all acting on different scales. Dependent on the principle, different spatial conditions are set up. These spatial conditions are tested in three MRDH regions of the with each different characteristics and morphology. The urban consolidation centres are considered as the most crucial node since they partly determine the locations of other nodes. Still, within this strategic framework some operational decisions need to be made. The spatial conditions are set up in a way that these three urban regions are 'just' cases which means that the analysis and approach also can be used for other cities and urban regions to generate other urban region-specific strategies.

*SRQ4* The Rotterdam urban region is selected in the fourth research question to show the spatial implications and spatial considerations of its strategy. It has lead to an elaboration of spatial considerations for urban consolidation centres (Vijfsluizen and 's-Gravenlandsepolder), transhipment centres (Willemsplein and De Esch) and drop-off points (Lijnbaan, Eendrachtsplein and Taanbrug). Since transhipment centres use a relatively large space in urban areas, careful consideration of the context is necessary to integrate them in the city and include them as part of the public space. Additional functions for the transhipment centres can be designed. Drop-off points need to be incorporated in an already full and defined programmed area in the city. There is a potential in transporting urban freight over water. The waterways can be used again for the purpose it initially was designed for at that time. The roads along the canals are vulnerable and pressurised, while there is enough space on the water. Investments need to be made on the drop-off points and the quay connection. The drop-off point itself is a platform that carries all the necessities and can be (re)moved and is thus not permanent.

Concerning tram stops, there are more interventions and space required for an extra sidetrack, unloading zone and charging facilities. With analysing the existing freight system by mapping the flows and where currently freight is delivered physically, current (un)loading zones nearby tram stops could be transformed to drop-off points for trams. Less extra space is then required and thus other functions and users have to give up less space to facilitate tram drop-off points.

The two examples, however, have shown that for making supply by tram possible, it is worth it to analyse the existing freight system by understanding the flows and where currently freight is (un)loaded at the site. Current (un)loading zones (near tram stops) are potential places to be used as drop-off points for trams. The several design proposals have demonstrated that for the specific sites, a new node with additional functions has the potential to contribute to the spatial and social quality. Relatively small interventions are required when mainly existing (infra)structures are (re-)used, especially at the drop-off points, this is necessary to achieve this. With a different perspective on urban freight logistics, logistic functions can gradually be seen as an urban function.

*CONCLUSION* The urban consolidation centre is the most important node. It can already be beneficial to start constructing these nodes to already improve the efficiency of trucks by bundling to eliminate small and unnecessary truck movements in cities. During the process towards a truck-free supply or a co-existence between truck and tram supply, the same space can be shared with both modes as well, while the freight network on the water can slowly but certainly be implemented next to the freight network on the land.

With taking the lessons learnt on the next page into account, it can be concluded that changing the spatial organisation of urban freight could potentially reduce the number of vehicle kilometres in the MRDH and thus negative externalities. Every shipment that can take place over water or rail reduces the number of trucks. Also, every shipment that can find synergy with waste reduces the number of trucks. Proposed interventions contribute to the liveability of the city by reducing the number of trucks in 'vulnerable' urban areas. Ultimately, the strategic framework gives to local authorities new perspectives on urban freight and can be used by local authorities for the accommodation of increasing logistic demand of retailers and the mitigation/reduction of negative externalities.

### # *Recommendations for further research*

As the research limitations (CHAPTER 2.3) have explained, urban freight logistics is a multidisciplinary field. Since the research is yet considered from a regional and an urban planning perspective, validation on the project by other disciplines is necessary before implementation. Especially urban consolidation, but also urban multimodality are widely incorporated in the academic literature of logistics and supply chain management. Also, more research on financial and technical (operational) underpinning is recommended. There already have been separate pilot projects established on both urban consolidation or urban multimodality. However, most of the times, they failed due to lacking financial underpinning and lacking comprehensive research. Regarding the operational underpinning, a better understanding of practical issues such as tram technology, labour and actual implementation in the current timetable needs more research as well. Also, quantitative research on the real supply and demand of urban freight in an urban region would be useful to determine the size of the project.



# LESSONS LEARNT

**01**

*There is a huge potential for urban multimodality (especially on the water) when integrated into urban consolidation strategies*

**02**

*A well-considered allocation of urban consolidation centres and other proposed nodes can create several synergies and strengthen this potential*

**03**

*Relatively small interventions are required when mainly existing (infra)structures are (re-)used. Additional functions on nodes could contribute to spatial and social quality*

**04**

*Besides policies, a spatial strategic framework for urban freight can be environmental, social en economical beneficial and improve liveability*

## 8.3 *Transferability test*

This subchapter in the conclusion and reflection chapter has the purpose to (quickly) demonstrate the strategic framework method based on the first two steps of the developed steps in paragraph 6.4: Spatial interrelationship. It will quickly analyse the important location factors for UCCs to determine the potential urban freight system to come with a brief advise for four more different kinds of cities, based on their size, density, historical context, pre/absence of rail and/or water infrastructure and city typology. There is chosen to limit this test to Dutch cities, due to the author's background. The four chosen cities are Amsterdam, Groningen, Lelystad and Sneek (author's hometown), all located in the Netherlands (figure 8.1).

Amsterdam is the largest city and the capital of the Netherlands with a historical city centre and an extensive tram and water network (river + canals). The second city, Groningen is a large city in the north of the Netherlands. It represents a lot of Dutch cities characterised by a historical city centre surrounded by a large canal and expanded by the same typology of residential areas as a consequence of industrial and service sectors (e.g. Amersfoort, Leeuwarden, Leiden, Utrecht, Zwolle). Lelystad is a relatively new city and designed from scratch - the construction started in 1967 - and thus does not have a historical city centre structure. It could represent cities that do not have a clear water network based on historical context (e.g. Assen, Almere, Amstelveen, Hoofddorp, Hilversum, Zoetermeer and some industrial cities). Lastly, Sneek is a small city in Friesland and represents the hometown of the author to test as well. Apart from Amsterdam, all the cities are lacking a tram network.

### # *Recap on the three steps*

1. Identify possible locations for UCC and to what extent the principles can be applied

   **important to map:** highway/ waterway infrastructures (identify potential water corridor), city entrances, waste treatment facilities, low emission zones and industrial areas.

2. Identify transportation methods from UCCs, eventually via transhipment centres to the city / shopping entities

   **important to map:** available infrastructures, such as rail and water connections between the edge of the city and city centre

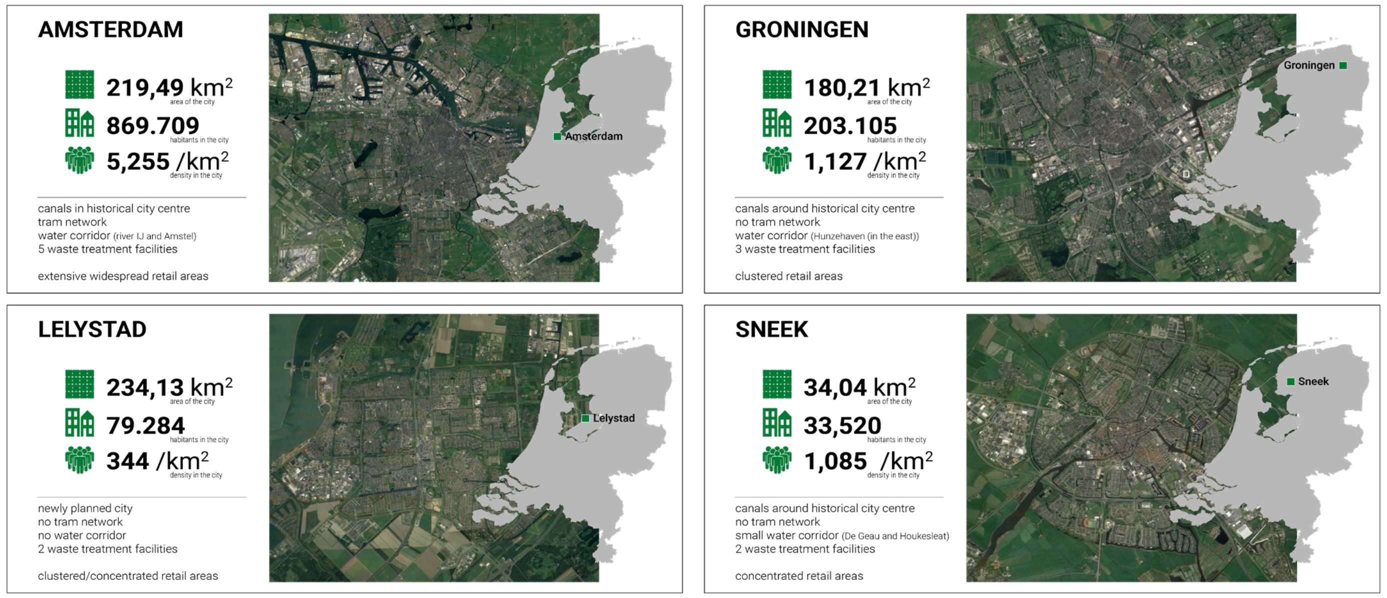



**FIGURE 8.1:**
Characteristics and location of the four selected cities
*(authors' drawing)*

## 8.3.1 *Transferability test* analysis on the four cities

Amsterdam (figure 8.2.1) can be characterised just as Rotterdam as a city that got it all for the proposed principles in the framework. The capital of the Netherlands has both an extensive water and tram network in its city centre. The city is bounded by the A10 highway, where most of the waste treatment facilities are situated as well.

Similarities can be seen in Groningen (figure 8.2.2) and author's hometown Sneek (figure 8.2.4), which are cities with a historical city centre and a surrounding canal, which are both connected to a large waterway to the outside the city. They are infrastructurally similar in the sense that they are connected on one side to the Dutch highway network (supply route) and that they have a ring road around the city. The most retail is situated in the city centre, some are part of a retail park in the industrial areas, where also the waste treatment is facilitated.

Lelystad (figure 8.2.3) has no water network either, which makes the principle with the water corridor impossible. There is one waste treatment facility located close to the highway.

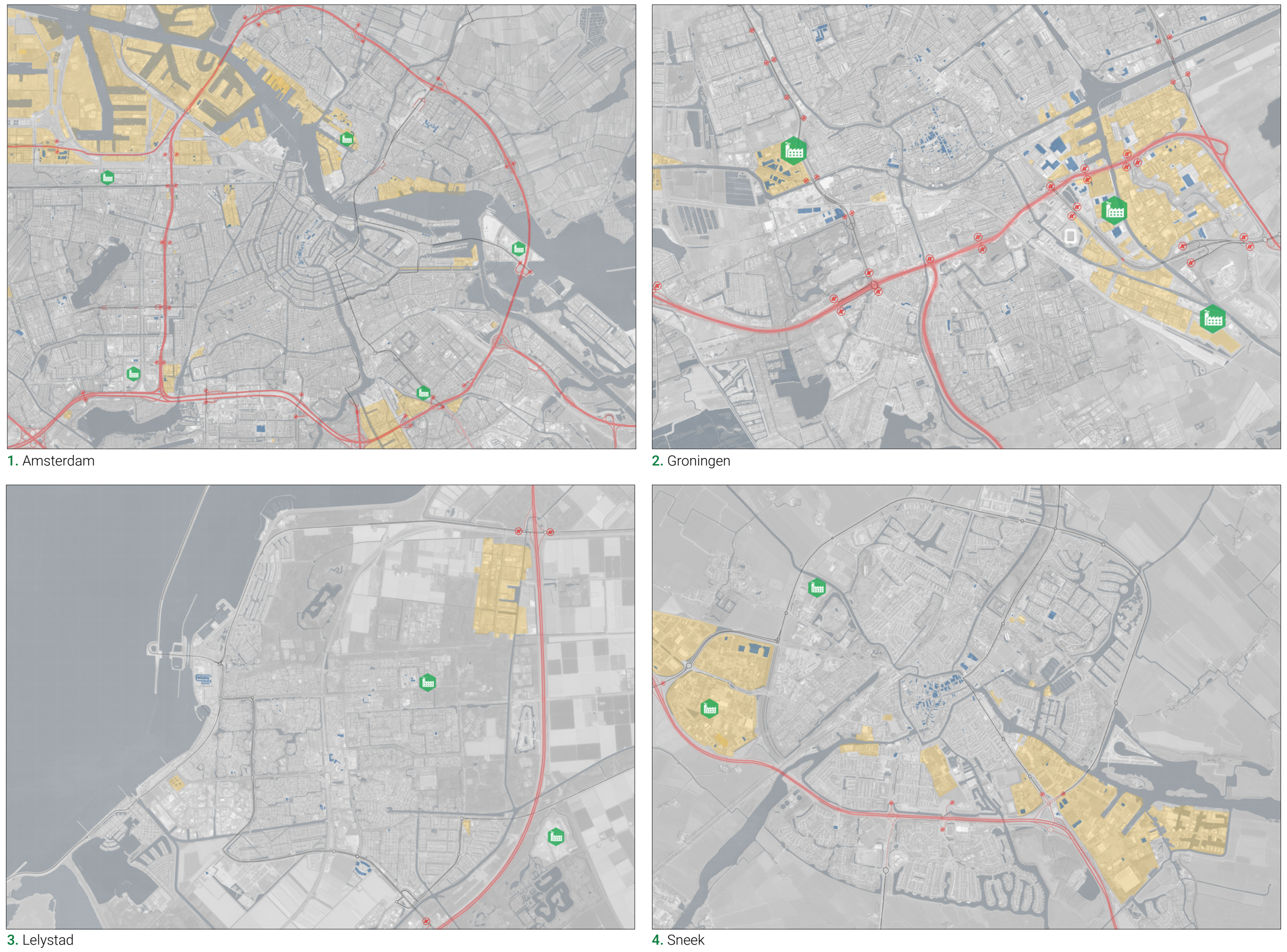
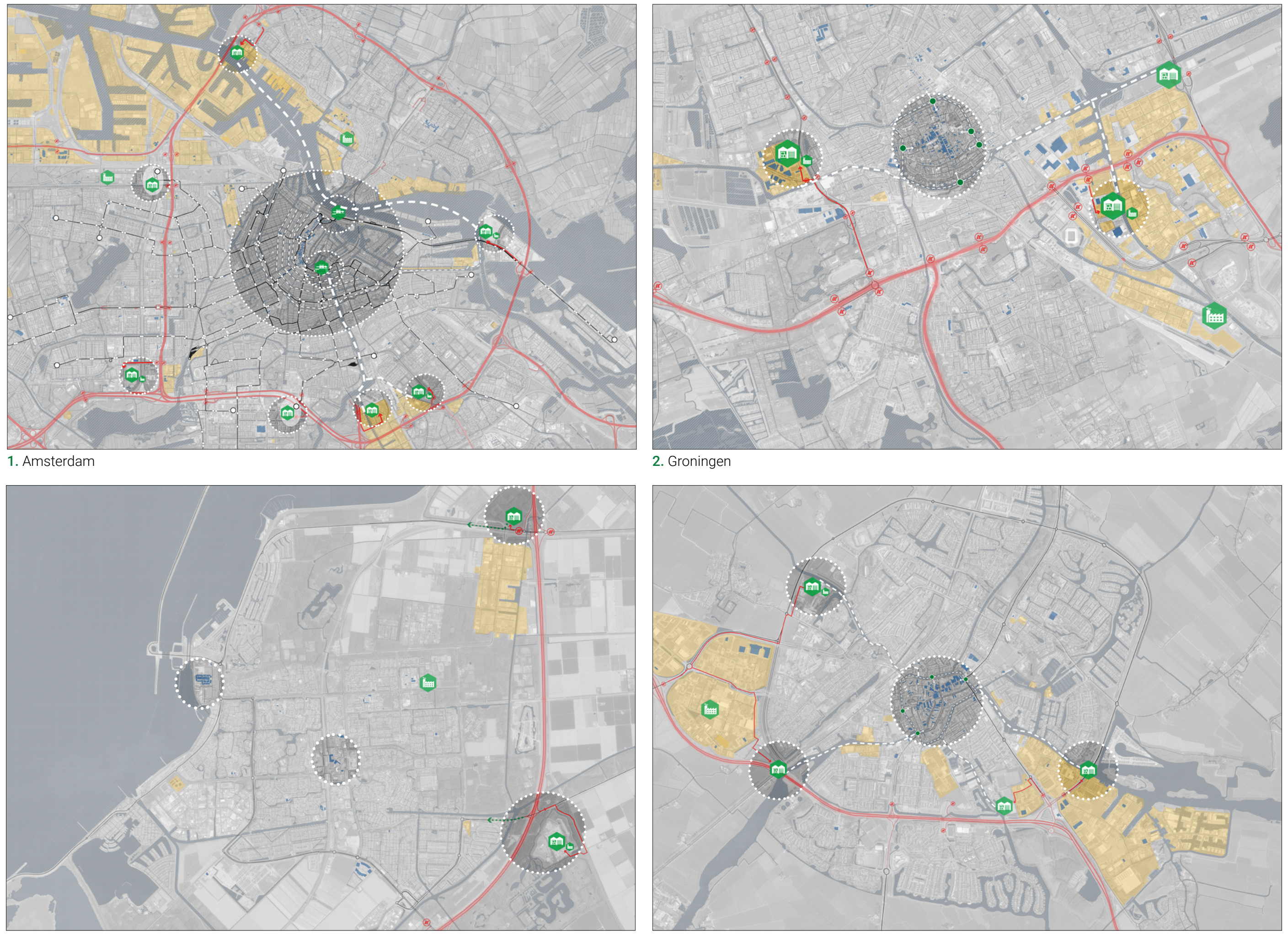



**FIGURE 8.2:**
UCC location factors of the four selected cities
*(authors' drawing)*

The most potential for both concepts and principles are found in Amsterdam (FIGURE 8.3.1), which is a very diverse city with a wide variety of extensive infrastructures for urban consolidation and multimodality. In further research, Amsterdam definitely needs extra research and analysis to explore the full potential and possibilities of the city.

The cities of Groningen and Sneek (FIGURE 8.3.2 and FIGURE 8.3.4) have potential to use their water network and the location of waste treatment facilities - of which some are situated close to the water - to come with a combined system of urban freight. Both cities have several options to construct their UCCs and it will depend on the specific sites.

Lelystad (FIGURE 8.3.3) is the most difficult city, wherein it seems like even unfeasible to find synergies by combining with waste or using a water corridor. The waste treatment facility is oriented on the city instead of the region, which makes combining it with supply not feasible. For Lelystad, this means that they only can use urban consolidation in their simplest form or that they have to move their waste treatment. This type of cities will be the most difficult.



**1.** Amsterdam **2.** Groningen **3.** Lelystad **4.** Sneek

**FIGURE 8.3:**
Characteristics and location of the three selected cities *(authors' drawing)*

## 8.3.2 ***Transferability test*** *conclusion*

Analysing four more cities outside the MRDH (Amsterdam, Groningen, Lelystad and Sneek) with different characteristics and structures together with the already researched cities in the MRDH (Rotterdam, Schiedam), The Hague, Rijswijk and Delft) should result in clearer recommendations on what kind of alternative urban freight systems can be developed, based on existing infrastructures and facilities. Such recommendations would be a valuable step to make full use of the research in a broader Dutch context.

From all the analysed cities, it can be concluded that specific characteristics of cities are crucial for the transferability to other cities than Rotterdam, the city that been a case study in this research. As the concept of urban consolidation potentially could work in every city with a considerable number of retailers, the concept of urban multimodality will not work everywhere when a specific type of infrastructure is lacking. This makes that the full proposed concept in the research will not work in every city. On the other hand, from the analysis to Amsterdam, it can be made up that this city meet all the location factors and is thus suitable to test all the concepts as well. If we dive deeper into the characteristics of Amsterdam, the following city characteristics can be found:

- *presence of a historical city centre consisting an extensive network of canals for water transport*
- *presence of two rivers (IJ and the Amstel) that cuts through the city, connected to the edge of the city*
- *presence of a fine-grained tram network through the city centre for transport by tram*
- *presence of some waste treatment facilities in the proximity of city entrances at the highways*

Since the most cities outside the MRDH (except for Amsterdam and Utrecht) don't have an existing tram network, urban multimodality has only potential when possibilities over water are further explored. Especially in the Netherlands, there are many cities characterised by a historical city centre with an undamped network of canals that are not uncommonly connected to industrial areas with one or more large waterways as the examples Delft, Schiedam, Groningen and Sneek (see also their examples) have demonstrated. This type of city offers an opportunity for an urban freight system based on using water corridors while implementing water drop-off points.

Another category of Dutch cities are cities that don't have a water/canal structure (anymore) around their city centre. This can be cities with a historical city centre, whose canals are damped (e.g. Arnhem, Maastricht and Nijmegen), situated at a large water corridor (river). This type of city also can choose an urban freight system based on using water corridors. These cities, however, need last-mile transport over the road. Rotterdam also falls in this category, but is, in this case, fortunate with its tram network. It can also be relatively new founded cities or urban development centres (see examples Lelystad), which don't have an extensive or clear water network around and through their city centres, while also lacking on a tram network. This type of city is not suitable for urban multimodality but will need to take more advantage of waste synergy with transport over land.

Admittedly, another category of cities like industrial cities is not taken into consideration in this analysis. Industrial cities are characterised by cities that are expanded as a result of industrial activity. This could be historical cities that expanded during the industrial revolution (e.g. Eindhoven, Enschede) or cities that were only small villages during medieval ages or were settled as industrial settlements, mostly situated near raw materials or labour locations (e.g. Hengelo, Tilburg). Port cities such as Rotterdam are also industrial cities. Regarding their spatial characteristics, they are a mix of historical cities and newly created cities and thus are they already represented by those two categories.

## 8.4 **Reflection** *introduction*

This subchapter within this conclusion chapter has the purpose to reflect on several aspects on the process and the conduction of the research. It will provide the following reflections on:

1) the relationship between the graduation topic, studio topic, master track and master programme
2) the relationship between research and design
3) the methodological approach of the research
4) societal, scientific and ethical relevance
5) transferability of project results

### 8.4.1 **Reflection** *relationship graduation topic, studio topic, master track and master programme*

Cities consume resources and excrete waste. However, resources are not always present in cities and waste does not remove itself. Therefore, urban freight transportation is necessary to keep cities and people running. Urban freight transportation concerns vital movements of goods through cities, generated by economic needs of businesses and people. As one of the main users of the urban space, it is inherently connected with the performance of city since urban freight activities also generate high negative environmental, economic and social externalities. The planning of urban freight logistics affects sustainability, liveability and climate goals we aspire as urbanists and therefore emphasises the urgency to find integration with our discipline. Most of the times, the spatial manifestation within the transportation and logistic discipline tends to be neglected. Urban freight also have been influenced through technical, societal, political and economic events, which are also relevant drivers for urbanism.

In urban metabolism, the analogy with the metabolism is projected on cities, which refers to the quantification of ingoing and outgoing flows and storage of (natural) resources, waste and emissions. In the thinking process, it is extended to the metabolism of a household, where ingoing and outgoing flows of goods are illustrated in which well-supplied retailers play an important role. At the same time, it gave another perspective on the metabolism of cities on a consumer level. Ultimately, the goal of the urban metabolism graduation studio is to improve these flows in urban systems to sustainable and healthy (less damaging) levels based on energy flows and cycles of materials.

With the examination of the flows of goods in a very urbanised context (MRDH), the research combined two often suggested freight concepts and proposed a new strategic framework wherein freight is delivered to the retailers in a more sustainable and liveable way, while accommodating the increasing demand. With the approach of urban metabolism from urban planning point of view, a closer integration between earlier fields of urban planning, logistic planning, supply chain management and even transit planning can be emerged to achieve more efficiency in the urban freight system. The result is hopefully less negative externalities.

### 8.4.2 **Reflection** *relationship research and design*

The project started initially with some research. Research is used to understand the drivers of several phenomena and the current organisation of urban freight. At the strategy forming, it became evident that the pragmatic approach provided conditions for the interaction between research and design. In this phase, design and research became interwoven in each other. The research provided guidelines for the design and made sure that every design variant is considered and evaluated. At the same time, the design provided directions for the research while giving feedback to the provided guidelines, which needed to be changed afterwards sometimes. The design acted as a test for the research. Reports are linear structured, which could give the impression that the starting assumtions are also formulated prior to testing the variants. However, some of the assumptions were in fact not always formulated at the beginning, but came up when doing the design. Within the design phase, additional (practical) problems and findings were revealed that did not appear in the research phase. To provide a complete overview of starting assumptions, these need to be embedded as well in the reserach.

### 8.4.3 **Reflection** *methodological approach of the research*

When reflecting on the methodological approach of the research, it turned out that few research methods have not worked well as planned or are conducted in another way than intended. Some methods could have been useful afterwards to conduct, but are somehow not considered.

Firstly, in the beginning, it took an effort to come with a clear scope definition. Urban freight (city logistics) is, in fact, a different discipline, which made the scope too large, when it is considered in its entirety. At the same time, it is also a too complex urban system to understand completely. It is difficult to choose a certain scope or to place it in a broader logistic context, partly, to the intention to tackle to whole urban freight sector and partly, due to unfamiliarity and lack of knowledge.

Evidently, urban freight is created by and necessary for people and thus the sustainable performance is dependent on the choices made by its stakeholders. The behaviour of stakeholders is the key determinant and therefore the stakeholder analysis could have been complemented with interviews to confirm and better understand the specific interactions and reactions to several statements in a practical way rather than just theoretical and generalised.

Thirdly, urban freight is a quantitative (urban) system and is thus mostly mathematically considered. In the methodological approach, it was intended to measure the performance on a quantitative basis. During the research, it turned out that it was hard to find the necessary data, which could contribute to spatial interventions and strategy development. Even when there was data available, which is mostly generated from logistic engineering disciplines, rather than spatial data, it also needed to become understandable without the mathematical foreknowledge. The result is now a more qualitative and explorative view on this rather mathematical topic, based on some operational logistic assumptions. However, revealing the spatial, social and legal dimensions was also favorable and will definitely has its contribution to the complete understanding.

## 8.4.4 **Reflection** *societal, scientific and ethical relevance*

### # ***Societal relevance***

Urban freight affects sustainability, liveability and traffic performance of cities. It has a direct impact on human health, an estimation of 0.5 million people die each year from air pollution as a consequence of urban freight transport (Kauf, 2016). Urban freight transportation is supporting cities' activities, however, they also have a high negative environmental, economic and social impact. Examples of impact are air pollution (environmental); traffic congestion and delivery delays (economic); and safety and decrease of liveability on the overall built environment (social).

With trends of increasing freight volumes through cities as consequence of urbanisation and globalisation, urban planners and decision-makers face the challenge to mitigate negative externalities before it becomes unbearable in cities, since the emission of road transport by trucks will grow without proper intervention (FIGURE 8.4). Optimisation of the urban freight system regarding distribution and management of flows like waste, food and goods are necessary to on the one hand make the transition towards sustainable development and on the other hand practically accommodate this increasing demand.

Therefore, the research tries to develop this strategic framework as an example for decisionmakers with special regard to the supply of their retailers to make cities more liveable and sustainable, while accommodate the current and future's demand. It tries to come with a spatial understanding of the used concepts, instead of just conceptually. At the same time, the thesis also responds on several climate goals concerning greenhouse emissions on global, national and regional and city scale (Paris Climate Agreement, National Climate Agreement, Green Deal Zero Emission Stadslogistiek (FIGURE 8.5).

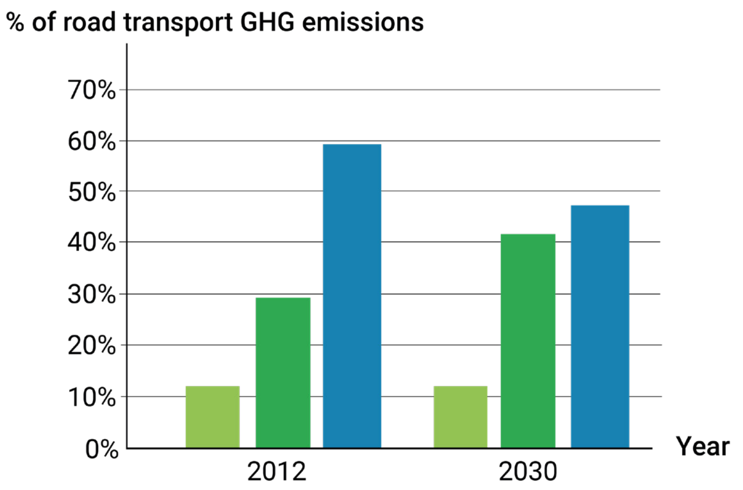



**FIGURE 8.4:**
Increasing stake of GHG emissions in trucks
*(Transport Online, 2015)*


**FIGURE 8.5:**
Green Deal Zero Emission Stadslogistiek
*(Green Deal ZES, 2016)*



### # ***Scientific relevance***

Transportation planning consists of planning for passenger transport and freight transport. Both planning fields are important for the liveability and accessibility in cities and are thus important themes in the field of urbanism. There is, however, a tendency to neglect freight planning in urban planning (Bjørgen et al., 2019). Urban transportation is usually associated with public transportation, as illustrated on FIGURE 8.6. The consideration of urban freight within the planning discipline remained limited up to the twenty-first century. Issues related to urban freight transportation were neglected by urban planners (Rodrigue et al., 2013). Various, independent taken measures are performed in a suboptimal way or are not appropriate for the local context, which resulted in unintended side effects.

The lack of knowledge and the lack of awareness at local authorities and planners are one of the largest barriers nowadays in planning a proper urban freight strategy. With new emerging challenges in the field of urban freight, a better understanding of current urban freight problems by urban planners needs to be gained by searching more overlap in both transport planning and urban planning disciplines in order to find alignment to come with a strategy to mitigate negative externalities. The lack of understanding and alignment in measures from municipalities calls for an integrated approach, which is built upon a comprehensive understanding of urban freight transport. Although, the project does not come with mathematical and 'technical logistic' understanding, it will be required for an urbanist to understand the spatial, social and legal aspects of it completely.

The project contributes by showing ways and methods for urban planners to look at urban freight issues from a spatial perspective. From urbanism point of view, this also can be considered as an exploration in other foreign fields, an attempt to bridge the scientific discrepancy between the different 'languages' within the urban freight field.

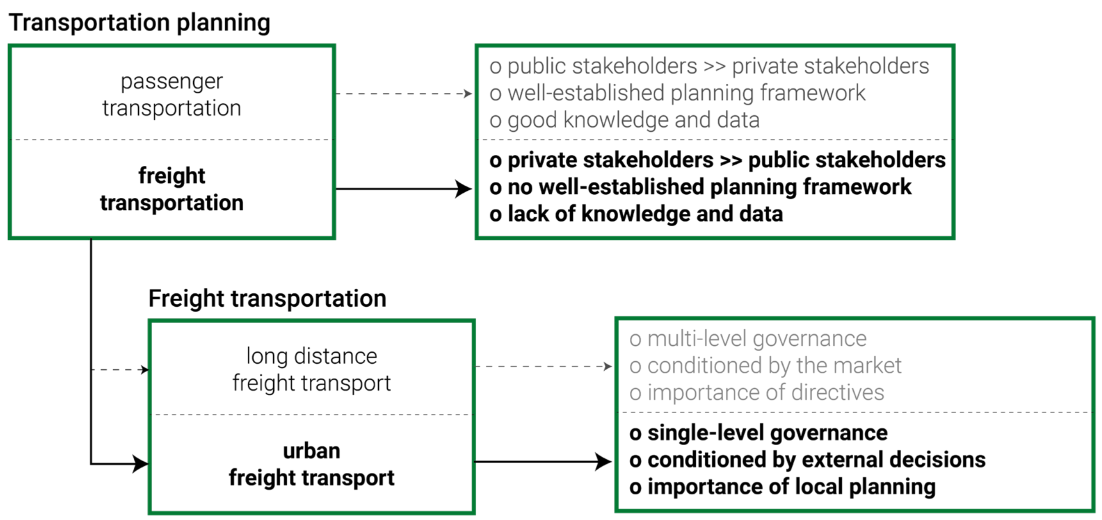



**FIGURE 8.6:**
Contextualization of urban freight transport in the framework of transport planning *(adapted from Le Pira et al., 2017)*

**#** ***Ethical relevance***

Urban freight activities are important for the economic well-being of cities and people living in the cities. A certain dependency has emerged on the delivery of goods. Interventions on the urban freight organisation always evoke the tension between stakeholders with different interests, because, in fact, everyone is a stakeholder, whether actively or passively. Changing the urban freight also often requires investments from private parties (eventually subsidised), which is dependent on the offered conditions by public parties. Of course, this cannot be forced blindly, without overall consideration of the stakes and context. Also, the logistic labour and the generated economy of companies should be considered. Do interventions hamper the growth of private companies? When it comes to the point of automation or banning a significant number of trucks, a lot less human hands are necessary anymore in the logistics sector, so how about these jobs (FIGURE 8.7).

Furthermore, urban freight activities are considered as a customer-oriented service, which means that a balance between conflicting objectives of logistic companies and their customers needs to be found. This balance is hard to reconcile, since on the first hand there one target is the minimization of costs, which does not always mean sustainable solutions and on the other hand the aim to maximize the customer service, which relies on the paradigm of ordering 24 hours per day and on the same time deliver as complete, quick and frequent as possible to satisfy consumers and keep stock in stores. Nevertheless, these necessary services also need to comply with governmental standards to keep cities liveable and safe for their inhabitants.

Lastly, also ethical consideration needs to be made on the fact that transportation of goods (with special regard to waste) and people could possibly take place in the same space. The idea of taking public transportation with the presence of waste could generate logically a defensive reaction at people due to their waste perception.

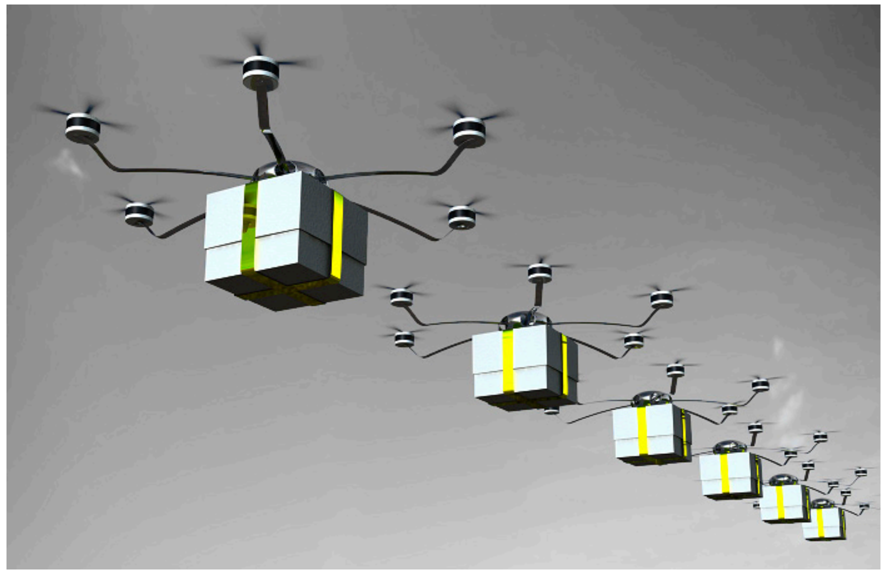


**FIGURE 8.7:**
Are new freight modes replacing labour?
*(Rednewswire, 2018)*

## 8.4.4 *Reflection* transferability of project results

**After the transferability test, this paragraph describes a general interpretation on the transferability of the project results. These results can be made transferable by ignoring the notion of location in the main research question: How can a strategic framework of urban freight transportation accommodate the increasing logistic demand of retailers in a sustainable and liveable way.**

As already earlier stated, the problem of increasing urban freight activities (and thus its negative externalities) in cities can be considered as a generic problem. Challenges regarding the topic are for every local authority and urban planner the same. They all face the challenge of keeping growing cities liveable, wherein urban freight activities must operate well. Local authorities all share the mission to minimise the negative externalities of transportation. However, the solutions for this generic problem are different and are dependent on the context of each urban area. The proposed concepts, including urban consolidation and urban multimodality, are one of these solutions concerning sustainable freight transportation. Urban consolidation is a widely suggested solution and its success factors seem to be more dependent on its stakeholders rather than the spatial feasibility, while the degree of success on multimodality is more spatial context-dependent, as the transferability test has demonstrated. These two concepts work separately from each other but could generate synergies when they are combined in a strategic framework.

In the first instance, the project aimed to develop a strategic framework for local authorities. The research has elaborated on urban region-specific strategies and their spatial implications in the MRDH. The MRDH region is chosen as a case study due to its particular context: the MRDH is a highly dense urban area, wherein the logistic sector is important and the conditions are there to propose urban consolidation and urban multimodality. The provided strategies are specific per urban context and are thus dependent on the cities' characteristics. With using the MRDH as a case study and the transferability test, this allowed me to show the different characteristics and structures of cities in the Netherlands.

Before the conceptualisation, the current situation (spatial and organisational) is analysed. The findings of the current organisation were somehow generic since the organisational differences in urban freight are more present in terms of efficiency rather than in the last part of the supply chain itself. For strategy development, the spatial conditions are set up in a way that the analysis and approach also can be used for other cities and urban regions to generate other urban region-specific strategies. The considerations per city made in the matrix could also be done for other cities by local authorities. The result would then be a customised strategy, based on the provided findings in the research.

I would say that the research has tried to come with a step-by-step plan for a re-organisation of urban freight. Urban freight issues are increasingly recognised and instead of and instead of trying to resolve it only with policy, I attempted to include urban planning in this issue by spatialise some suggested solutions in the logistic discipline. The result is a quite new perspective on how urban freight could be re-organised in a way that the increasing logistic demand of retailers can still be accommodated in a sustainable and liveable way.

chapter outline:

9.1 bibliography

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source photo: Schiedam canal (enmorgen, 2019)

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*chapter outline:*

I. $CO_2$ emission per municipality per modality
II. location of distribution centres
III. Theory paper  AR3U023
IV. Testing variants and principles

# APPENDIX

*source photo: Truck Rotterdam (Evofenedex, 2019)*

## I $CO_2$ emmission per municipality per modality

| | $CO_2$-emission (TTW, 2015) | | $CO_2$-emission per mobility (kton) | | | | | | stake per mobility | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kton | % of regional emission | road traffic non-highways | road traffic highways | mobile vehicles | shipping | aircraft | urban freight (17% of total) | road traffic non-highways | road traffic highways | mobile vehicles |
| Rotterdam | 1220 | 38% | 391 | 388 | 234 | 131 | 77 | 207 | 32% | 32% | 19% |
| The Hague | 415 | 13% | 234 | 132 | 49 | 0 | 0 | 71 | 56% | 32% | 12% |
| Zoetermeer | 151 | 5% | 80 | 60 | 12 | 0 | 0 | 26 | 53% | 40% | 8% |
| Delft | 139 | 4% | 48 | 80 | 10 | 1 | 0 | 24 | 35% | 58% | 7% |
| Ridderkerk | 139 | 4% | 33 | 96 | 4 | 5 | 0 | 24 | 24% | 69% | 3% |
| Westland | 138 | 4% | 115 | 12 | 11 | 0 | 0 | 23 | 83% | 9% | 8% |
| Leidschendam-Voorburg | 129 | 4% | 48 | 73 | 8 | 0 | 0 | 22 | 37% | 57% | 6% |
| Barendrecht | 125 | 4% | 31 | 77 | 4 | 13 | 0 | 21 | 25% | 62% | 3% |
| Schiedam | 91 | 3% | 33 | 50 | 7 | 0 | 0 | 15 | 36% | 55% | 8% |
| Lansingerland | 86 | 3% | 57 | 23 | 6 | 0 | 0 | 15 | 66% | 27% | 7% |
| Rijswijk | 75 | 2% | 43 | 26 | 5 | 0 | 0 | 13 | 58% | 35% | 7% |
| Nissewaard | 75 | 2% | 55 | 0 | 10 | 11 | 0 | 13 | 73% | 0% | 13% |
| Capelle aan den IJssel | 62 | 2% | 41 | 13 | 6 | 1 | 0 | 11 | 67% | 21% | 10% |
| Vlaardingen | 59 | 2% | 26 | 26 | 6 | 1 | 0 | 10 | 45% | 43% | 11% |
| Wassenaar | 58 | 2% | 48 | 7 | 3 | 0 | 0 | 10 | 84% | 11% | 5% |
| Midden-Delfland | 55 | 2% | 21 | 30 | 4 | 0 | 0 | 9 | 38% | 55% | 7% |
| Albrandswaard | 43 | 1% | 18 | 5 | 3 | 17 | 0 | 7 | 41% | 12% | 6% |
| Hellevoetsluis | 39 | 1% | 24 | 10 | 4 | 0 | 0 | 7 | 63% | 27% | 10% |
| Pijnacker-Nootdorp | 39 | 1% | 33 | 0 | 5 | 0 | 0 | 7 | 87% | 1% | 13% |
| Brielle | 27 | 1% | 22 | 4 | 2 | 0 | 0 | 5 | 78% | 14% | 7% |
| Westvoorne | 18 | 1% | 16 | 0 | 2 | 0 | 0 | 3 | 87% | 0% | 13% |
| Krimpen aan den IJssel | 17 | 1% | 12 | 0 | 2 | 2 | 0 | 3 | 71% | 0% | 14% |
| Maassluis | 14 | 0,4% | 11 | 0 | 3 | 0 | 0 | 2 | 80% | 0% | 20% |
| Total MRDH-regio | 3212 | 100% | 1440 | 1112 | 400 | 183 | 77 | 546 | 45% | 35% | 12% |

## II Location of distribution centers

*RECEIVING GOODS*

| PostNL | | | UPS |
|---|---|---|---|
| Almere | Elst | Sassenheim | Amsterdam |
| Amersfoort | Goes | s-Hertogenbosch | Deventer |
| Amsterdam-ZO | Halfweg | Son (Eindhoven) | Eindhoven |
| Apeldoorn | Hengelo | Tilburg | Heerenveen |
| Assen | Kolhalm | Utrecht | Schiedam |
| Born | Leeuwarden | Venlo | Utrecht |
| Breda | Nieuwegein | Waddinxveen | |
| Den Haag | Opmeer | Zwolle | |
| Den Hoorn | Ridderkerk | | |
| Dordrecht | Rotterdam | | |

| DHL | | Sandd | |
|---|---|---|---|
| Alkmaar | Maastricht | De Zilk | Schiedam |
| Amersfoort | Roosendaal | Den Bosch | Utrecht |
| Amsterdam | Rotterdam | Deventer | Zwolle |
| Arnhem | s Hertogenbosch | Diemen | |
| Den Haag | Utrecht | Eindhoven | |
| Drachten | Zaltbommel | Hardinxveld | |
| Eindhoven | Zwolle | Roosendaal | |

| Albert Heijn | Jumbo | Aldi | Picnic hub |
|---|---|---|---|
| Delfgauw | Breda | Best | Den Haag |
| Geldermalsen | Woerden | Culemborg | Gouda |
| Nieuwegein | Den Bosch | Drachten | Leiden |
| Tilburg | Elst | Groenlo | Rotterdam |
| Zaandam | Veghel | Ommen | Ypenburg |
| Zwolle | Beilen | Roermond | Zoetermeer |
| | Raalte | Roosendaal | |
| | Nieuwegein | Zaandam | |
| | | Zoetermeer | |

*DAILY GOODS*

| Picnic DC | PLUS | Waardetransport | |
|---|---|---|---|
| Diemen | Hendrik-Ido-Ambacht | Amsterdam | Hoogeveen |
| Eindhoven | Middenbeemster | Capelle a/d Ijssel | Nieuwegein |
| Nijkerk | Ittervoort | Duiven | Rotterdam |
| Rotterdam | Haaksbergen | Helmond | |
| Utrecht | | | |

| Lidl | | COOP | Kruidvat |
|---|---|---|---|
| Waddinxveen | Tiel | Deventer | Heteren |
| Etten-leur | | Gieten | Ede |

| Etos | HEMA | Gall & Gall |
|---|---|---|
| Beverwijk | Nieuwegein | Delfgauw |

*WHOLESALERS*

| Sligro | Makro | Hanos |
|---|---|---|
| Rotterdam | Rotterdam | Delft-Den Haag |
| Den Haag (3x) | Den Haag | |
| Berkel en Rodenrijs | Delft | |

*CONSUMER GOODS*

| H&M | WE | Zeeman | Action |
|---|---|---|---|
| Hamburg | Utrecht | Alphen a/d Rijn | Zwaagdijk |
| Tiel (aanvullend) | | | Echt |

| Mediamarkt | BCC | Gamma | Ranzijn |
|---|---|---|---|
| Etten-Leur | Schiphol-Rijk | Antwerpen | De Kwakel |

| Coolblue | | IKEA | Leenbakker |
|---|---|---|---|
| Amsterdam | Rotterdam | Oosterhout | Raamdonksveer |
| Apeldoorn | Tilburg | Genk | |
| Groningen | Utrecht | | |

*in grey, the relevant distribution and sorting centres for the MRDH are highlighted*

## III Theory paper: AR3U023 Theories of Urban Planning & Design

**Stakeholder management in urban freight**
How freight planning can be improved through stakeholder management

*AR3U023 Theories of Urban Planning & Design*
*MSc Architecture, Urbanism and the Building Sciences*

Cities around the world are at the point that delivery of urban freight is reaching the limit of their capacity to accommodate the growing transportation demand. This has challenged decision-makers to improve the logistical performance and reduce the social, economic and environmental impacts of transportation. Therefore clear policies on urban freight become crucial in cities. With multiple stakeholders having conflicting interests, a comprehensive understanding of the interactions between private and public stakeholders is necessary. The purpose of the paper is to provide a foundation in the research of the integration of stakeholders within urban freight transportation by identifying them and explaining their role, goals and focus in the urban freight sector. By identification of stakeholders and their interests, it becomes clear that although the growing significance of urban freight transport in cities, the efforts of authorities done to and understanding of urban freight activities are insufficient. Local authorities have to acknowledge the need for integrating urban freight in urban planning. With a new organisational model for freight management in cities, they have to play a pro-active role and become facilitators of sustainable transportation. When authorities are aware of the needs of key stakeholders in urban freight, this can lead to better collaboration.

**Keywords:** *Urban freight transportation, freight planning, stakeholder management, public authorities, integration*

## #1 Introduction

One of the most present and visible complex systems are the flows and networks of urban transportation with special regard to urban freight. Urban transportation is inherently connected to cities since demographical, economic and technological trends constantly reorganising the way people and goods are moving across cities (Bjørgen, Seter, Kristensen & Pitera, 2019). The growing transportation demand of urban freight as a result of those trends has challenged cities to improve their logistical performance and reduce the social, economic and environmental impacts of transportation. Although urban transportation is harming the quality of cities, it supports extremely important (economic) activities in urban areas, such as supplying consumers and retail. Those activities, however, induces a fast growth in the number of vehicles and thus also the congestion and pollution levels (Crainic, Ricciardi & Storchi, 2004). This has some serious implications on the traffic conditions and thus the liveability of cities. With the changing trends in mind, the question arises if the current urban freight systems are still in accordance with the ambitions regarding the environmental and sustainability goals.

Freight deliveries have got a growing significance in cities, therefore good decision-making and clear policies on freight also become more crucial. With multiple stakeholders having conflicting interests, while at the same time a lack of knowledge on urban freight transportation within authorities, freight becomes a more and more critical issue wherein challenges become bigger. Therefore a comprehensively understanding about the interactions and motives between different stakeholders in the supply chain is necessary so that they could provide new insights and strategies for the performance and execution of urban freight (Anand, Quak, van Duin, & Tavasszy, 2012).

The purpose of the paper is to provide a foundation for the thesis in the research of stakeholders within urban freight transportation by identify them and explain their role, goals and focus in the urban freight sector and how they are interrelated. In the first section, the stakeholders and their perspectives will be identified. The second section addresses the different problems in the interrelationship between the stakeholders are pointed out. Finally, the paper will conclude with some suggestions and recommendations on better stakeholder integration.

## #2 Identification of stakeholders

Within the planning of freight, there is a complex network of stakeholders that needs to be considered. They are important factors in the planning procedure since the consequences and outcomes of decisions are affecting all the stakeholders (Lindholm, 2012).

Different classifications of stakeholders in urban freight could be made. According to Taniguchi (2014), stakeholders can be divided into four groups: shippers, freight carriers, administrators and residents. Another classification can be made in the form of authorities, carriers and receivers (Bjørgen et al., 2019). Urban freight traffic is a result of physical interactions between those different stakeholders. All the stakeholders of urban freight have the common objective of taking care of the transportation of goods in urban areas at the right time and place in the right quantities. Nevertheless, the individual interests of the stakeholders are often conflicting, since they all have different perspectives on urban freight transport. (Anand et al., 2012).

Basically, the different interests can be divided into two important groups of stakeholders: the private stakeholders and the public stakeholders. Those two groups, which need to be carefully considered, are capable of inciting changes and having the rationale to go towards a sustainable urban freight system. On the first hand, private stakeholders could implement measures to reduce the impact on their activities and on the other hand, public stakeholders can use policies and measures to enforce a change in the overall activities. The two groups will be elaborated in the following paragraphs.

### #2.1 Identification of stakeholders *private stakeholders*

The first group is the group of private stakeholders that include producers, suppliers, shippers, logistics and transportation firms and receivers, dependent on their stake in the supply chain. For the logistic firms, the total logistic cost of all their operations is more relevant than the transportation cost itself. It is not directly their goal to minimise the transportation costs since transportation is just a small segment of their activities, which make it possible to trade higher transportation costs (and impacts) off against other internal costs (Anand et al., 2012). Since logistics is a customer-oriented service, the balance between the minimisation of cost, which does not always mean sustainable solutions and on the other hand the aim to maximize the customer service, relying on the 24-hours paradigm and at the same time demanding as complete, quick and frequent deliveries as possible, does not mean sustainable solutions either. This means that logistic activities mostly are done with the best efficiency of the commercial shipper or receiver. Low considerations are made on the environmental and social impact it could have on the transportation system and the city (Crainic et al. 2004). Since the trucking industry is extremely competitive, especially for small and medium-sized firms, the economic interests (reduction in costs) have a higher priority than the environment and social interests (Dablanc, 2007). Logistic decisions are based on commercial and operational factors rather than they take into account sustainability factors which are concerns of city authorities (MDS Transmodal Limited, 2012).

Private stakeholders are also mainly concerned with legal constraints. Congestion can impose additional cost due to operational delay. Restrictions on accessing streets and vehicles also bring additional challenges for private stakeholders (Rodrigue et al., 2013).

### #2.2 Identification of stakeholders *public stakeholders*

The second group consists of public stakeholders, which can be termed as 'authorities' (decision-makers and planners) on the city, regional and national levels. It includes municipalities, traffic authorities, infrastructure authorities, railway/port authorities. In this section, particularly the transportation planning departments of municipalities will be considered, because they have a direct impact on the execution and performance of urban freight activities in cities. Their interconnection with regional and national bodies will be addressed as well.

Local authorities are interested in the overall objectives of the city. They are aiming equally for the liveability of the city, attractive places for inhabitants and economic development, which naturally requires frequently delivered goods to its habitants (Anand et al., 2012). However, this is conflicting to reduce transportation impacts, mainly regarding environmental and social impacts such as congestion, pollution and traffic accidents to create an attractive city (Russo & Comi, 2012). This is where two different interests within local authorities are conflicting. At the same time, the interests and behaviour of other (private) stakeholders are left out of consideration in their decision making (Anand et al., 2012).

Although local authorities are becoming increasingly aware of the impacts of freight on the built environment and that they attempt to take control over transportation activities, most of them do not know how to do so (Dablanc, 2007). Additionally, according to Van Duin (2005), around one-third of the municipalities have no proper political agenda for freight.

## #2.3 **Identification of stakeholders** *transportation planning*

Transportation planning departments within municipalities can enforce relocation of logistic facilities by policy measures such as land price and land use to reduce freight flows through cities. With that, they could create space for housing to sustain population growth as a result of urbanisation (Oliveira et al., 2014). On the other side, this tool, positively used in the form of regulating, funding or planning, can also be used to encourage the location of facilities in pre-determined areas (Heitz et al., 2017). Logistic companies remain constrained by the availability of logistic zones offered by local authorities (Aljohani & Thompson, 2016). However, it seems that the government has blindly planned logistic facilities to speed up urbanisation (He, Shen, Wu, & Luo, 2018). With the outside blindly allocation of facilities, a link between local and regional planning is still missing concerning the integration of land use and transportation (Bjørgen et al., 2019).

The field of urban transportation planning generally consists of public transportation planning, freight transportation planning and infrastructure planning. The infrastructure planning is more straight forward and addresses at network level the civil (engineered) infrastructures. This involves physical (line) infrastructures such as roads and waterways, but cables and pipes are included as well. Public transportation and freight transportation planning are more complex and also take place on a system-level. Urban freight transportation makes use of the same complex transport system as public transportation as freight carried by vehicles are moving on the same streets as private and public vehicles transporting people (Russo & Comi, 2010; Crainic et al., 2004).

Nevertheless, the term urban transportation is usually associated with public transportation. The consideration of urban freight within the planning discipline remained limited up to the twenty-first century. Issues related to urban freight transportation were neglected by urban planners (Rodrigue et al., 2013). A critical notion of urban transportation planning, therefore, can be made on the exclusion of freight planning in which a growing role is reserved for urban planners and local authorities . The lack of knowledge and the lack of awareness at local authorities and planners are one of the largest barriers nowadays in planning a proper urban freight strategy. Issues such as industry and tourism dominated the infrastructure planning. Therefore, in the last years, much attention is paid to optimised transportation of passengers (movement of people) systems instead of urban freight. The transportation of urban freight remains under-researched due to the lack of focus (Lindholm, 2012).

Secondly, the focus of urban transportation lays more on public transportation since cities are seen as locations of human interactions with traffic patterns related to commuting, commercial and leisure/cultural movement and activities. Though, cities are at the same time inherently connected to production, consumption, distribution, which rely on movements of freight (Rodrigue et al., 2013). At the same time, people transportation is considered by authorities as a public service, while the transportation of goods is in the private sector (Allen, Browne, Nemoto, Patier, & Visser, 2012). Since it is considered as a service in the private sector, local authorities have invested so little in the planning of urban freight transportation (Oliveira, Oliveira, & Correia, 2014). Authorities do not feel any involvement yet with the operations of private stakeholders. Freight transportation is often seen as a market and business-driven interest with bare connections to local authorities. Local authorities failed in seeing possibilities for improvements in regulations and policies (Lindholm, 2012).

Another reason for the lack of freight planning is the political layer of public transportation. Individual mobility in the form of automobile and public transportation have preoccupied local authorities (and thus transportation and urban planners). Public transportation has a social purpose by providing equal accessibility and social equity. Since users of the automobile and public transportation services are also voters for (local) elections, public transportation has a higher priority on the political' and planners' agenda. In practice, passengers' trains for instance have priority over freight trains, since freight trains are excluded from day-time slots due to passenger demand and lower operational speed (Rodrigue et al., 2013). Freight transportation usually does not have political influence and are therefore more 'regulated' (MDS Transmodal Limited, 2012). Early applications of regulations in urban freight logistics are taken in Japan and Western Europe. They were constrained with a lack of available land and have an established urban planning tradition (Rodrigue et al., 2013). Nevertheless, in the Dutch context, Van Duin (2005) showed that cities just have copied each other's freight regulations without sharing experiences and taking into account that measures have a different impact on different city characteristics. At the same time, those regulations are scarce and out-of-date. Most of the regulations are related to restrictions on vehicles, based on size or weight and delivery time windows mostly in the morning (Dablanc, 2007; Lindholm, 2012). These regulations are just tackling the problem at the edges with suboptimal solutions. Since there is a lack of proper data on freight traffic, this makes the planning and regulations inevitably precarious in cities (Rodrigue et al., 2013).

Thus, it can clearly be stated that the preponderance is devoted to optimal passenger transportation, while freight is left out of the field. This is a critical issue for local authorities because, with the absence of clear authority on freight planning, all the stakeholders will act autonomously which makes urban freight even a more complex and unsustainable system (Anand et al., 2012).

## #3 Conflicting interests

Conflicting interests between stakeholders groups arise inevitably. These different interests have made the search for solutions regarding sustainable urban freight transportation even more complex (MDS Transmodal Limited, 2012). When comparing the interests of the private and the public stakeholders, it can be noticed that private stakeholders want to benefit from mainly economic sustainability wherein they want to satisfy their customers with high quality and fast deliveries in the competitive market, while public authorities put effort into the attractiveness and liveability of their city on behalf of their residents and visitors, mainly related to environmental and social sustainability, (Russo & Comi, 2012). They need to attempt with interventions to balance the interest of both. Cities are aware that they need freight transportation for economic purposes, but most of the cities regard truck traffic as something that needs to be banned or strictly regulated, while just a few consider freight activities as a service, which they should support in their goals. Truck operators believe that cities only will take measures related to access restrictions, leaving the global and innovative freight management out of consideration (Dablanc, 2007).

It is for local authorities a complex challenge to develop measures on the incitement of better efficiency and sustainability due to different characteristics of urban freight in different sectors (MDS Transmodal Limited, 2012). Though, the efforts and the current organisation of public authorities also can be criticised. In the organisation of local authorities, freight planning responsibilities tend to be divided across different departments. This causes a lack of overview by individuals in the whole domain of freight transportation at the city level. At the same time, there is a missing continuity and uniformity in freight politics of cities since freight planning is performed on a case-to-case basis and with lack of holistic consideration, this makes it more difficult to come with comprehensive solutions. The impact of freight is barely considered in daily planning activities due to lack of experience and involvement of private stakeholders. Also regarding the national governmental body, guidance on urban freight management in practice is missing. Strategies and planning are having a limited overlap at the different scales (local, regional and national) (Bjørgen et al., 2019). There seems like a discrepancy in the responsibility, jurisdiction and perceived ownership over local urban freight issues. National governments leaving the responsibility to local governments, since they see it as a local problem, while the local governments consider this as a private-sector problem since problems are generated by private commercial activities. However, the private sector believes that urban freight is an infrastructural and regulatory issue, which needs to be addressed by governments (Smart Freight Centre, 2017). The dynamics are shown in FIGURE 1.

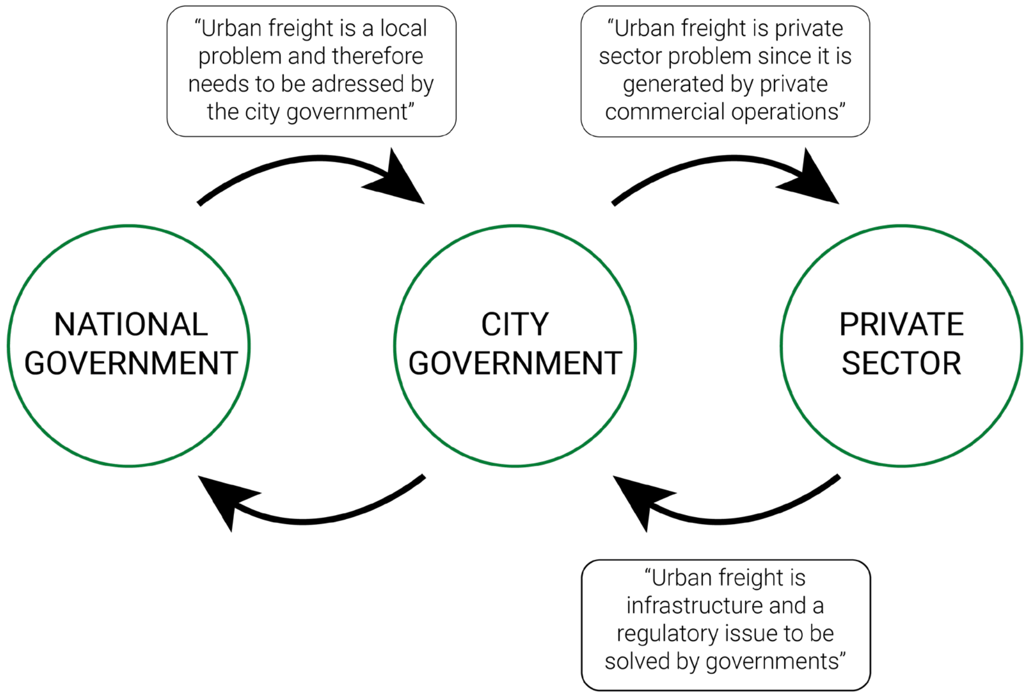


**FIGURE 1:**
Dynamics between different stakeholders
*(Smart Freight Centre, 2017)*

According to Dablanc (2007), stakeholders are willing to change, but it seems like that the stakeholders also have different expectations to each other on taking initiatives for change. On the first-hand authorities expect private stakeholders to set up sustainable operations to accommodate the increasing needs of customers and retailers. At the same time, those companies expect from authorities that they initiate (and subsidise) regulations on sustainable operations, because companies do not want to take high risks in their operations and do not want to invest high amounts on this, without the certainty of benefitting from it. The awaiting and passive attitudes toward each other make changes in the behaviour of logistic stakeholders are slow.

## #4 *Integration of stakeholders*

Since freight logistics are a vital and visible component in our built environment and it is affecting it with negative external effects, it needs to be integrated carefully within the field of urban planning. Public authorities first have to acknowledge that there is a justification to intervene in the transportation market to balance the cost and benefits derived from urban freight. Planners tend to frame the problem as an infrastructural or as a not existing problem at all (Lindholm, 2012). Nevertheless, they have to realise that the old urban freight challenges are still there, but that new ones also have emerged. They need to change their planning style from traditional planning (being doctors) to negotiative planning (being facilitators) (TABLE 1).

Although urban freight is a private industry, there is a call for new organisational models for management wherein local authorities have to play a pro-active role, like they already relatively fulfil in public transportation (Crainic et al., 2004). A prerequisite for successful collaboration is the neutrality of authorities in the relationship with stakeholders. Local authorities need to find the drive to act as a leader in freight activities (Lindholm, 2012). Their task is to promote sustainable urban freight transportation, which of course find the balance between economic, environmental and social interests and impacts concerning every serious stakeholder (MDS Transmodal Limited, 2012). Therefore the next step in the integration comes from transportation practitioners wherein they have to recognize the means they can work closely with urban planning departments of the city (Dablanc, 2007). Planning departments need to understand the spatial interrelationships between logistic components and activities and how they influence each other (Aljohani & Thompson, 2016). They also need to determine logistic parameters of measuring the impact of sustainable strategies. This requires knowledge of transportation practitioners, which needs to be considered as well. At the same time, national guidelines on freight generate possibilities to share knowledge among cities. The knowledge transfer between municipalities needs to be improved. A clear overview of which measures are taken and their performance (whether positive or negative) needs to be collected and shared.

**TABLE 1:**
Different types of planning styles and the role of authorities *(Visser, van Binsbergen & Nemoto, 1999)*

| **Type of planning** | Traditional planning | Progressive planning | Negotiative planning |
|---|---|---|---|
| **Role of authorities** | Doctors<br>*Control processes and try to solve problems with public measures* | Educators<br>*Provide information to relevant actors and try to let them solve the problems* | Facilitators<br>*Present a window of opportunity and provoke public participation* |

The overall vision of national bodies guides local authorities to initiate collaboration with stakeholders (Bjørgen et al., 2019). When creating urban freight policies, the concerns and interests of stakeholders need to be taken into account (Stathopoulos, Valeri, & Marcucci, 2012). Coordinating multiple stakeholders with different objectives and perspectives is essential to progress on establishing an eco-friendly way of transportation (Taniguchi, 2014). For each city, it is important to map expectations and role of their stakeholders to create collaborative logistics planning, since measures also need to be adjusted to the local context. This requires a well understanding of the cities' of the region's needs. Established cooperation is required between stakeholders for knowledge transfers across wider regions to reduce complexity and to come with different synergies (Bjørgen et al., 2019). Implementation of concepts should be discussed and planned carefully with stakeholders to prevent sub-optimal solutions. There will be concepts that will change the total perspective on urban freight, but this should be implemented within careful integration and transparent change management. Early involvement of stakeholders in the planning process seems very appreciated by the private stakeholders (Bjørgen et al., 2019).

After acknowledging that local authorities must make urban freight as one of their main priorities and the integration with stakeholders, authorities are then able to explore new strategies to increase the life quality of citizens with respect to economic competitiveness (Schliwa, Armitage, Aziz, Evans, & Rhoades, 2015). Future concepts of urban freights are likely to be based on synergies generated by supply chain participants. It will require openness to change and readiness to compromise (Kauf, 2016). Effective policy measures provide incentives to increase distribution efficiency that could both reduce costs for private companies and at the same time reduce negative externalities for public companies.

## #5 Conclusion

The purpose of the paper was to provide a foundation for the research of stakeholders within urban freight transportation. The understanding of stakeholders is important due to the necessity of good decision-making and policies on freight with respect to the ongoing trends. By identifying the different stakeholders and their interests, it became clear that although urban freight transportation has got a growing significance in cities, the efforts of authorities done to urban freight is still insufficient. Ironically, the planning of public transportation is more advanced and has received more attention, since peoples well-being got priority over sustainable delivery of goods. Within the urban freight sector, there are different interests of public and private stakeholders. Due to a lack of experience and knowledge, it is unsure if applied measures actually work. At the same time, the expectations on initiatives are not clear to each other, while responsibilities on urban freight are shifted to another stakeholders since their stake in the problem is not directly recognized nor do they feel responsible for it.

Thus, authorities have to acknowledge the need to integrate the field of urban freight properly into urban planning which needs to include the knowledge of transportation as well. With a new organisational model for freight management in cities, they also have to play a pro-active role and become facilitators of sustainable transportation, which more or less already happening to a larger extent in public transportation. When authorities are aware of the needs of their stakeholders, this can lead to better collaboration between them and private stakeholders.

Taking stakeholders into consideration should lead to logistic process wherein activities performed by public and private stakeholders are considering in a balanced way social, environmental, economic impacts, with taking into account the accommodation of the increasing logistic demand even though to the inevitable global trends.

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# IV Testing variants and principles

In this appendix, every possible variant with respect to the two principles, three modes and the three urban areas (Rotterdam, The Hague and Delft) are analysed and evaluated. These analyses are shown in FIGURE IV.1 to FIGURE IV.18.The findings of the analysis are put in a matrix including every variable to generate an overview of possibilities and impossibilities per city.  Based on the findings and conclusions, a final strategy can be proposed in advance per city, which are likely to work. These strategies form the basis for the further elaboration of the project. This matrix will be input as well for the region-specific strategies in PARAGRAPH 6.5.1(Rotterdam urban region) 6.5.2 (The Hague urban region) and 6.5.3 (Delft).

This initial analysis done to generate insights and explore possibilities in every possible variant with respect to the two principles, three modes and three urban regions in the MRDH. The roadmaps per node and the step-by-step plans are based on this first spatial analysis.

## IV.a **Testing variants and principles** Rotterdam urban region

### # ***Urban consolidation centres situated near waste treatment facilities***

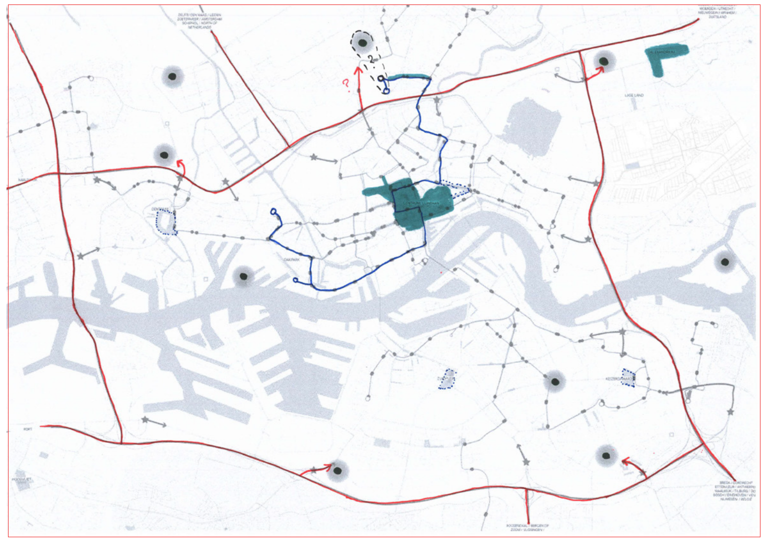

**FIGURE IV.1:**
Principle 1: UCC situated near waste treatment facility illustrated with tram network
*(author's drawing)*

The waste treatment facilities are well located along the highways and the entrances to the city. The tram network of Rotterdam is fine-grained as well, but there are barely connections between the waste treatment facilities and the network of the tram, which makes other modes from the waste strategy point of view more appropriate. Thus, this strategy in combination with the tram will not work.

**FIGURE IV.2:**
Principle 1: UCC situated near waste treatment facility illustrated with water network
*(author's drawing)*

The waste treatment facilities are well located along the highways and the entrances to the city. There are also some waste treatment facilities located along the river, but there are no proper connections between the facilities, highway entrances and the (main) water infrastructures to cover the city since a lot of post transport will be required. Thus, this strategy in combination with water will not work (in an optimal way)

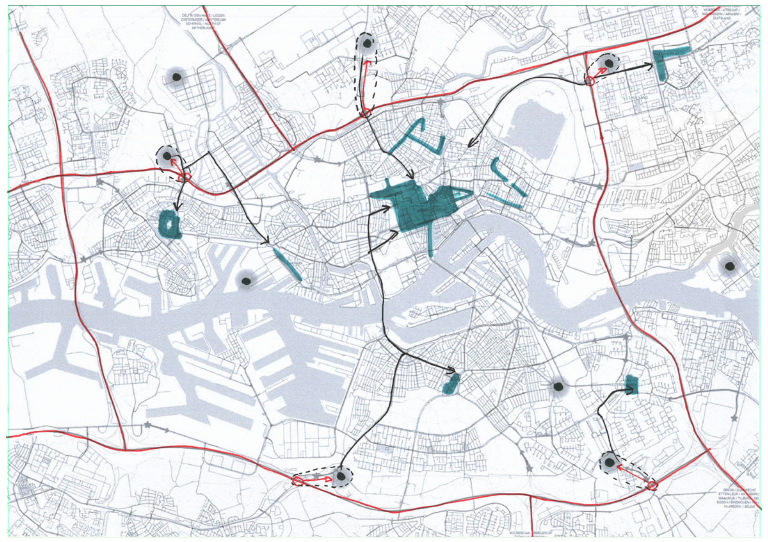

**FIGURE IV.3:**
Principle 1: UCC situated near waste treatment facility illustrated with road network
*(author's drawing)*

The waste treatment facilities are well located along the highways and the entrances to the city, which create a high potential for the first strategy in terms of road transport. With using the road infrastructure, the whole city can be covered and synergy with the waste collection can be reached. However, this variant is not engaging multimodal transport and is also dependent on the technology on (electric) road vehicles. Thus, this strategy could work on its own in Rotterdam, but it will mainly be single modal.

### # ***Urban consolidation centres situated in the middle of the city along a waterway***

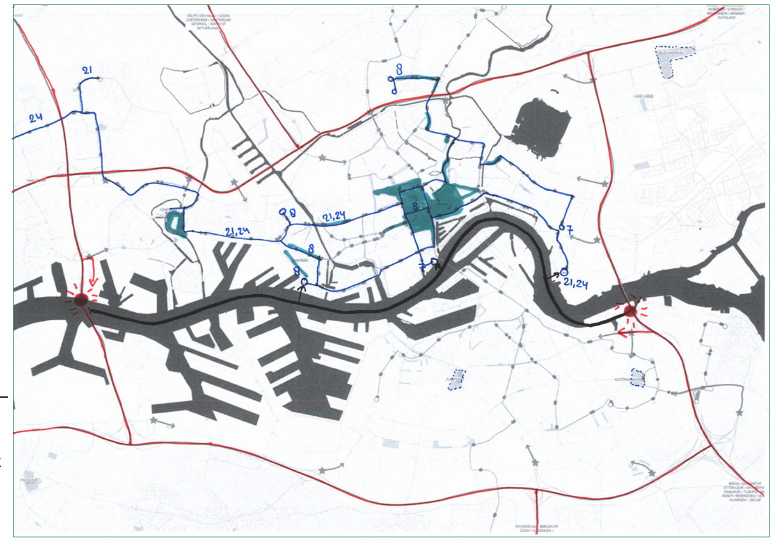

**FIGURE IV.4:**
Principle 2:
illustrated with tram network
*(author's drawing)*

There is a high potential in Rotterdam for this concept through the river Maas, which will be the corridor to bring goods to the centre of the city with an UCC on the river bank. The tram network of Rotterdam is fine-grained and there are also some tram endpoints close to the river bank on the north side of the city, which could work for the north. For the southern bank, another mode or strategy needs to be applied. Also, post transport from tram stops to the final destination needs to be considered as well.

**FIGURE IV.5:**
Principle 2: UCC situated along a waterway corridor illustrated with water network
*(author's drawing)*

There is a high potential in Rotterdam for this concept through the river Maas, which will be the corridor to bring goods to the centre of the city with an UCC on the river bank. The canal structure in Rotterdam is however not fine-grained enough to cover every retail area. However, the commercial zones in Schiedam are covered through the canals, which is a potential solution for Schiedam. Furthermore, this variant cannot work on its own in Rotterdam and needs to be combined.

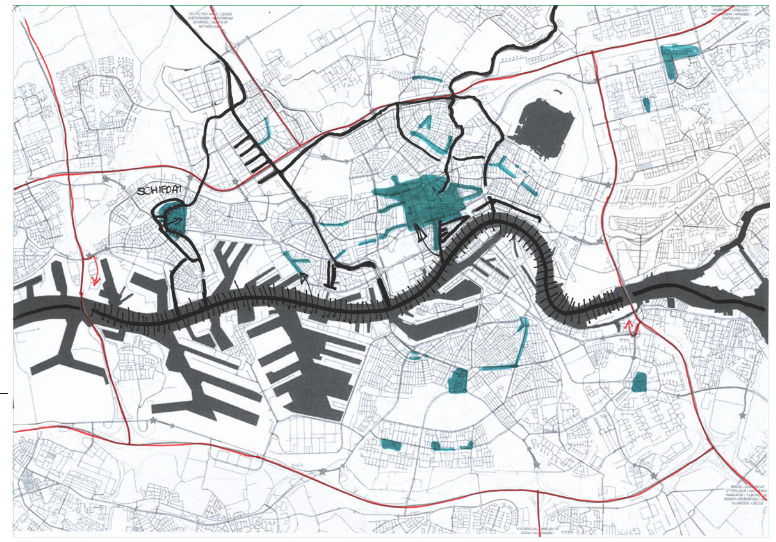

**FIGURE IV.6:**
Principle 2: UCC situated along a waterway corridor illustrated with road network
*(author's drawing)*

There is a high potential in Rotterdam for this concept through the river Maas, which will be the corridor to bring goods to the centre of the city with an UCC on the river bank. With using the road infrastructure, the whole city can be covered. Several dropping points need to be created, dependent on the availability of space. This variant could work on its own, but it is better to use this to complement other  modes. This variant coul for instance be combined with rail (north) and boat (Schiedam)

# IV.b **Testing variants and principles** *The Hague urban region*

## # *Urban consolidation centres situated near waste treatment facilities*

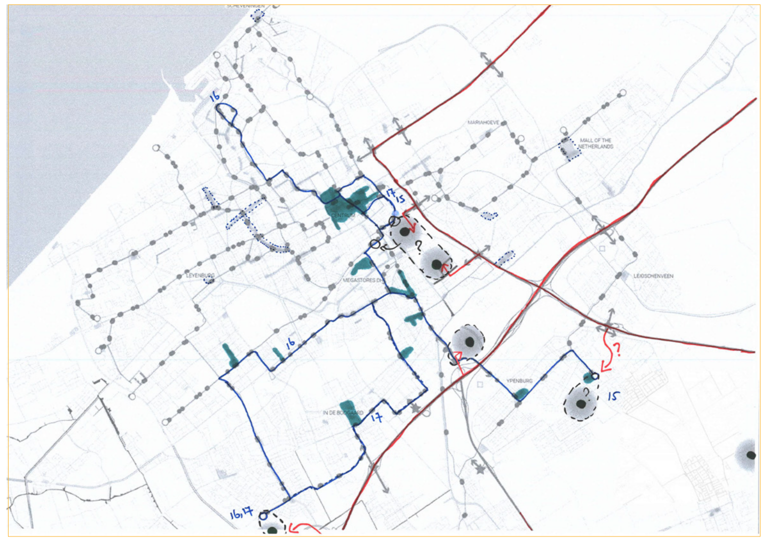

**FIGURE IV.7:**
Principle 1: UCC situated near waste treatment facility illustrated with tram network
*(author's drawing)*

The waste treatment facilities are somehow located along the highways. Valuable are the two waste treatment facilities  on the Binckhorst on the edge of the low emission zone of The Hague. Although the fine-grained tram network of The Hague, there are a limited amount of end points of tram lines connected to waste treatment facilities and some distances are still discussable. In the end, it could work for delivery to large shopping entities/centres outside the city centre.

**FIGURE IV.8:**
Principle 1: UCC situated near waste treatment facility illustrated with water network
*(author's drawing)*

The waste treatment facilities are somehow located along the highways. Valuable are the two waste treatment plants on the Binckhorst on the edge of the low emission zone of The Hague. The waste treatment facilities are well connected to water and also the water ring around the city centre is a valuable asset. The canal structure is not fine-grained, so post transport needs to be considered, just as the shopping entities outside the city ring.

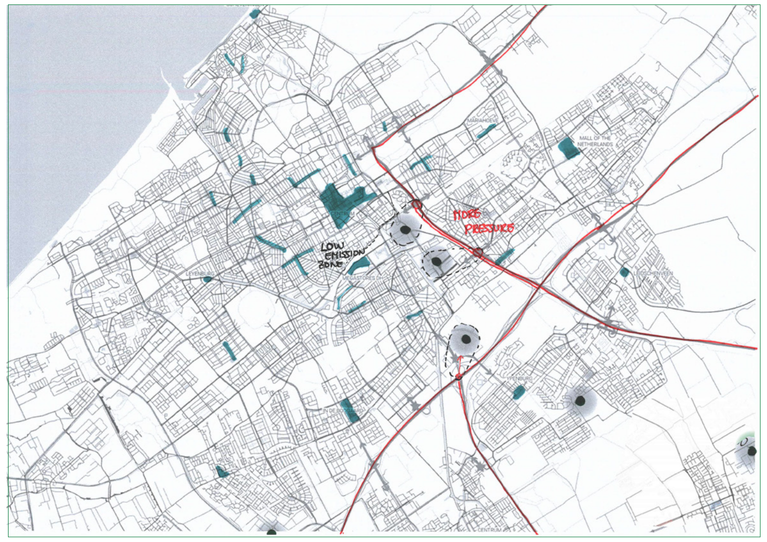

**FIGURE IV.9:**
Principle 1: UCC situated near waste treatment facility illustrated with road network
*(author's drawing)*

The waste treatment facilities are somehow located along the highways. Valuable are the two waste treatment facilities on the Binckhorst on the edge of the low emission zone of The Hague. With using the road infrastructure, the whole city can be covered and synergy with the waste collection can be reached. However, this variant is not engaging in multimodal transport and is also dependent on zero-emission vehicle technology. This strategy works, but it is better to complement other variants.

## # *Urban consolidation centres situated in the middle of the city along a waterway*

**FIGURE IV.10:**
Principle 2: UCC situated along a waterway corridor illustrated with tram network
*(author's drawing)*

The Hague has one water corridor towards its city centre (Haagse Vliet) and a water ring structure around their city. The Haagse Vliet offers possibilities to transfer goods from truck to boat at the edge of the city since it crosses the highways. Although the water structure could offer some potential for this strategy, there are however no endpoints of tram lines connected along the water corridors, which makes this variant not feasible at all for the city of The Hague.

**FIGURE IV.11:**
Principle 2: UCC situated along a waterway corridor illustrated with water network
*(author's drawing)*

The Hague has one water corridor towards its city centre (Haagse Vliet) and a water ring structure around their city. The Haagse Vliet offers possibilities to transfer goods from truck to boat at the edge of the city since it crosses the highways. Due to the limited degree of fine-grainess of the water infrastructures to reach every commercial zone in The Hague, it does not make sense to transfer here from large freight ships to smaller freight ships.

**FIGURE IV.12:**
Principle 2: UCC situated along a waterway corridor illustrated with road network
*(author's drawing)*

The Hague has one water corridor towards its city centre (Haagse Vliet) and a water ring structure around their city. The Haagse Vliet offers possibilities to transfer goods from truck to boat at the edge of the city, since it crosses the highways. The system could work for the city centre when there is space available for several drop-off points. For the outskirt commercial zones,  another concept could complement the freight system. As earlier shown, it seems like that combination with tram and smaller boats will work.

## IV.c *Testing variants and principles* Delft

### # *Urban consolidation centres situated near waste treatment facilities*

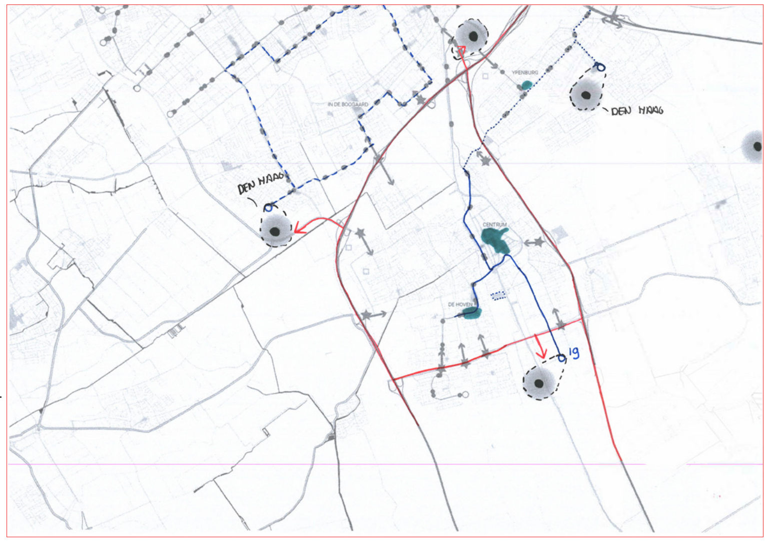

**FIGURE IV.13:**
Principle 1: UCC situated near waste treatment facility illustrated with tram network *(author's drawing)*

Most of the waste treatment facilities are located well along the highways and entrances to the city. For Delft, there are several options in the north and the south and if possible, to share the facilities with The Hague. In Delft, the tramline goes along the city centre, although it does not reach the front door of retailers. The distance of the waste treatment facilities and the endpoint of the tram is too big and therefore the tram is possibly not the right mode to serve Delft.

**FIGURE IV.14:**
Principle 1: UCC situated near waste treatment facility illustrated with water network *(author's drawing)*

Most of the waste treatment facilities are located well along the highways and entrances to the city. For Delft, there are several options in the north and the south and if possible, to share the facilities with The Hague. The waterways in Delft are fine-grained and also the appropriate connections of the Schie to the highways and the waste treatment facilities are present in north and south of Delft, which gives this variant a high potential

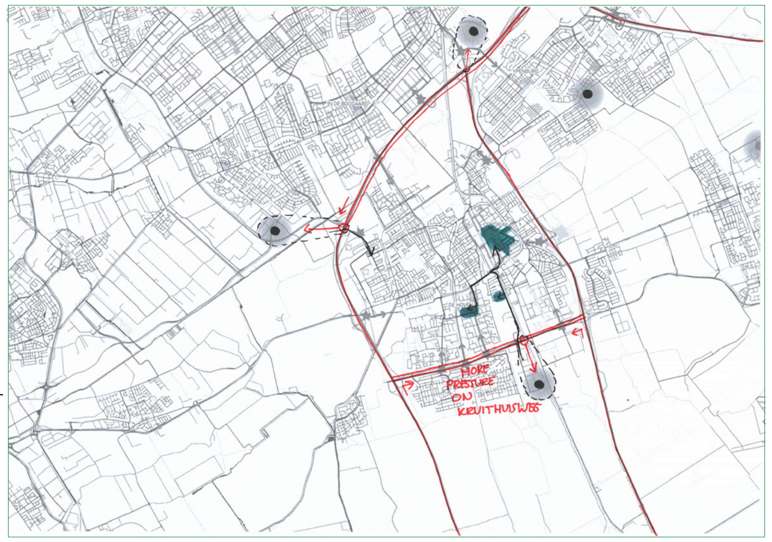

**FIGURE IV.15:**
Principle 1: UCC situated near waste treatment facility illustrated with road network *(author's drawing)*

Most of the waste treatment facilities are located well along the highways and entrances to the city. For Delft, there are several options in the north and the south and if possible, to share the facilities with The Hague. With using the road infrastructure, the whole city can be covered and synergy with the waste collection. It can support/complement the modes over the water to reach for instance De Hoven, which is not situated in the proximity of water infrastructure

### # *Urban consolidation centres situated in the middle of the city along a waterway*

**FIGURE IV.16:**
Principle 2: UCC situated along a waterway corridor illustrated with tram network *(author's drawing)*

In Delft, the Schie is considered as the main water corridor embracing the city centre. Due to the size of the city, it doesn't make sense to propose an extra transfer from water modes to rail modes and thus, this variant will not work here. Other ways of post transport need to be found

**FIGURE IV.17:**
Principle 2: UCC situated along a waterway corridor illustrated with water network *(author's drawing)*

In Delft, the Schie is considered as the main water corridor embracing the city centre. The fine-grained structure of the city centre allows smaller boats to be used for post transport, while the Schie can be used for bigger freight ships. In the old historical centre, there could arise a need for some water to water transfer points and several final drop-off points (quays along the canal). Thus, this variant could work in Delft, if there is space available for the drop-off points.

**FIGURE IV.18:**
Principle 2: UCC situated along a waterway corridor illustrated with road network *(author's drawing)*

In Delft, the Schie is considered as the main water corridor embracing the city centre. The system could work for the city centre when there is space available for several drop-off points. Then distances can be kept small. With using the road infrastructure, the whole city can be covered. It can support/complement the modes over the water to reach for instance De Hoven, which is not situated in the proximity of water infrastructure

## IV.c **Testing variants and principles** *overview of findings and conclusions*

Figure IV.19 shows an overview of findings and conclusions on the analysis of the variants on the three modes within the three urban regions (figure IV.1 to figure IV.18). The next step will be to develop a preliminary strategy per city, which is elaborated in the extend of the report.

| Principle | Mode | Rotterdam (urban region) | The Hague (urban region) | Delft |
|---|---|---|---|---|
| [1]<br>UCC situated near waste treatment facility | Cargo tram [rail] | - waste treatment facilities well-located along highways around the city<br>- tram network of Rotterdam is fine grained<br>- tram network has limited connections with waste treatment facilities<br>- post transport from tram stops to final destination needs to be considered<br>**--> principle in combination with rail will not work (figure 6.25)** | - most waste treatment facilities well-located along highways<br>- tram network of The Hague is fine grained<br>- two valuable waste treatment facilities at the edge of the low emission zone<br>- limited amount of tram lines connected to the waste treatment facilities<br>**--> principle in combination with rail could work, but only for shopping entities outside the city centre (figure 6.31)** | - most waste treatment facilities well located along highways<br>- tram network of Delft is not fine grained, just one line along the city centre<br>- waste treatment facilities are located in the north and the south<br>- distance of waste treatment facilities and end points is too big<br>**--> principle in combination with rail will not work (figure 6.37)** |
| | Cargo boat [water] | - waste treatment facilities well-located along highways and some at the river<br>- no proper connections between facilities, highway entrances and water infrastructures to cover the city<br>**--> principle in combination with water will not work (optimally) (figure 6.26)** | - most waste treatment facilities are well-located along highways<br>- water network around city centre is valuable asset, but further not fine-grained<br>- two well-located waste treatment facilities at the edge of the low emission zone and are close situated to water<br>**--> principle in combination with water could work, but needs consideration of post transport (figure 6.32)** | - most waste treatment facilities are well located along highways<br>- water network in the city centre is fine-grained<br>- waste treatment facilities are located in the north and the south in the proximity of water and eventually to share with The Hague<br>**--> principle in combination with water could work (figure 6.38)** |
| | Cargo bike / electric vehicle [road] | - waste treatment facilities well-located along highways around the city<br>- whole city can be covered and synergy with waste can be reached<br>- not engaging multi modal transport, while dependent on vehicle technology<br>- variant could work on its own, but could be complementary to other modes<br>**--> principle in combination with road could work, but without multimodality (figure 6.27)** | - most waste treatment facilities well-located along highways<br>- whole city can be covered and synergy with waste can be reached<br>- two valuable waste treatment facilities at the edge of the low emission zone<br>- variant could work on its own, but could be complementary to other modes<br>**--> principle in combination with water could work, but without multimodality (figure 6.33)** | - most waste treatment facilities are well located along highways<br>- whole city can be covered and synergy with waste can be reached<br>- waste treatment facilities are located at the proximity of water<br>- variant could work on its own, but could be complementary to other modes<br>**--> principle in combination with water could work, but without multimodality (figure 6.39)** |
| [2]<br>UCC situated along a waterway corridor | Cargo tram [rail] | - high potential in Rotterdam for this strategy due to the river Maas corridor<br>- tram network of Rotterdam is fine grained with end points close to the river<br>- for the southern side, another mode or strategy will be required<br>- post transport from tram stops to final destination needs to be considered<br>**--> principle in combination with rail could work, but a hybrid system is necessary (figure 6.28)** | - one water corridor (Haagse Vliet) towards city centre which offer possibilities to transfer from truck to boat and one city ring around the city centre<br>- tram network of The Hague is fine grained, but without end points along water<br>**--> principle in combination with rail will not work (figure 6.34)** | - the Schie is considered as the main water corridor embracing the city centre<br>- due to the size of the city, it doesn't make sense to propose an extra transfer from water modes to rail modes<br>**--> principle in combination with rail will not work (figure 6.40)** |
| | Cargo boat [water] | - high potential in Rotterdam for this strategy due to the river Maas corridor<br>- canal structure of Rotterdam is not fine grained to cover every retail area<br>- potential solution for Schiedam<br>**--> principle in combination with water will not work for Rotterdam, but could work for Schiedam (figure 6.29)** | - one water corridor (Haagse Vliet) towards city centre which offer possibilities to transfer from truck to boat and one city ring around the city centre<br>- canal structure of The Hague is not fine grained to cover every retail area<br>- due to the limited degree of fine grainess, it does not make sense to transfer<br>**--> principle in combination with water will not work (figure 6.35)** | - the Schie is considered as the main water corridor embracing the city centre<br>- fine-grained water structure around the city centre allows smaller boats to be used for post transport, while the Schie can be used for bigger freight ships<br>- some water to water transferpoints and final drop-off points will be needed<br>**--> principle in combination with water could work, if there is enough space(figure 6.41)** |
| | Cargo bike / electric vehicle [road] | - high potential in Rotterdam for this strategy due to the river Maas corridor<br>- road infrastructure can cover the whole city, several dropping points required<br>- variant could work on its own, but could be complementary to other modes<br>**--> principle in combination with road could work for Rotterdam and it could complement other variants (figure 6.30)** | - one water corridor (Haagse Vliet) towards city centre which offer possibilities to transfer from truck to boat and one city ring around the city centre<br>- road infrastructure can cover the whole city, several dropping points required<br>- for outskirt commercial zones, other strategies could complement the system<br>**--> principle in combination with road could work, but a hybrid system is necessary (figure 6.36)** | - the Schie is considered as the main water corridor embracing the city centre<br>- road infrastructure can cover the whole city, several dropping points required<br>- variant could work on its own, but could be complementary to other modes (for instance with reaching De Hoven)<br>**--> principle in combination with road could work and it could complement other variants (figure 6.42)** |
| A possible strategy: | | Hybrid strategy | Combined strategy | Combined strategy |
| A possible application of strategy: | | - UCC combined with waste treatment facilities [node] in combination with transport over road [mode; links]<br>- UCC along the Maas river [node] in combination with (post) transport over rail (tram) and road [mode; links]<br>- hybrid system of both strategies can be applied in Rotterdam | - UCC combined with waste treatment facilities [node] in combination with (post) transport over water (to the city ring) and road [mode; links]<br>- UCC along De Haagse Vliet [node] in combination with (post) transport over the road [mode; links]<br>- combination of both is strategies due to the fact that the waste treatment facilities are situated along water can be applied in The Hague | - UCC combined with waste treatment facilities [node] in combination with (post) transport over water and road [mode; links]<br>- UCC along the Schie [node] in combination with (post) transport over water (canals in the city centre) and road [mode; links]<br>- combination of both is strategies due to the fact that the waste treatment facilities are situated along water can be applied in Delft |

**FIGURE IV.19:**
Overview of findings and conclusions of the variants
*(author's drawing)*

*Author*
M.L. (Marcel) de Groot

*Mentors*
Dipl.-Ing. U.D. (Ulf) Hackauf
Dr.ir J.H. (John) Baggen

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*Institute*
Delft University of Technology
Faculty of Architecture and the Built Environment
MSc Architecture, Urbanism and Building Sciences
Track Urbanism