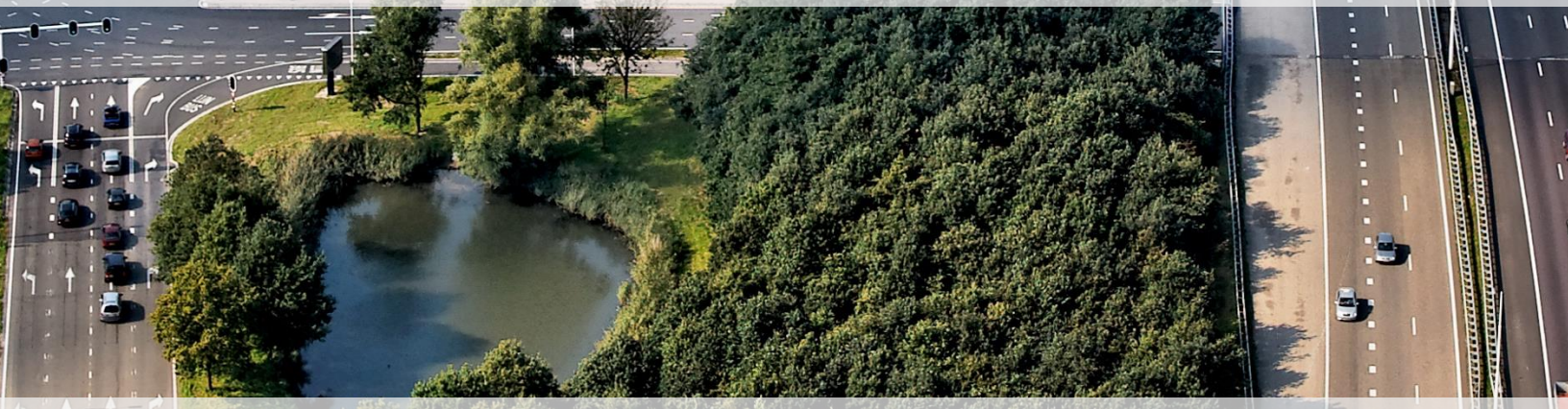
Infrastructural & spatial integration of freight and logistics within the Metropole Region Utrecht (MRU)

Lessons from applying the EU Horizon 2020 Vital Nodes approach to the Metropole Region Utrecht (MRU)



Master Thesis Environmental & Infrastructure Planning
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Date: 17 August 2020

VITAL NODES

Colophon

Title:	Infrastructural & spatial integration of freight and logistics within the Metropole Region Utrecht (MRU)
Subtitle:	Lessons from applying the EU Horizon 2020 Vital Nodes approach to the Metropole Region Utrecht (MRU)
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Date:	August 2020
Version:	Final
Cover:	Beeldbank RWS (*https://beeldbank.rws.nl, Rijkswaterstaat/ Joop van Houdt)*

Preface

Seven months of Master thesis writing has flown by. It has been an educational and tough ride at the same time. I would like to use this page to thank a few people who made this thesis possible.

First, I would like to thank Rijkswaterstaat, Water, Verkeer & Leefomgeving (section Spatial Planning) and Kevin van der Linden in particular for their support and enthusiasm. I appreciated the open and 'just ask 'environment within the department. Next to that, I want to thank supervisor prof. dr. Jos Arts for his enthusiasm, ideas and, above all, feedback which kept me structured during the process.

Furthermore, I want to thank the participant of this study. Their contribution made this study possible. Last but not least, I want to thank my family for their patience and support.

Henri Batterink

Meppel, 16 august 2020

Abstract

The impacts of freight and logistics on urban areas is often considered an underexposed theme among planners. This study aims to address the impacts of freight and logistics by applying the 'Vital Nodes approach' in the Metropole Region Utrecht (MRU). The Vital Nodes approach is based on infrastructural & spatial integration of freight and logistics in urban areas while connecting different geographical scales of transportation. To this end, a document analysis, interviews, a case study and a focus group have been conducted to reveal insights and policy directions for sustainable integration of freight and logistics in the MRU. The findings show the need for improvement of coordination and collaboration between governmental authorities and the private (logistics) sector on regional scale. Furthermore, an alternative transportation 'chain' by means of clustered functions, multimodal solutions and hubs may be a necessity for future sustainable logistics. To this end, appointing a 'logistics agency' for U-Ned and the need for a, so-called, 'hub provider' may be concrete examples of implementation strategies. In essence, application of the Vital Nodes approach within the MRU shows that the realisation of an effective transport chain is only possible if the effects of different scale levels are taken into account. Acknowledgement of each other's roles and responsibilities in the transportation chain appeared to be important as well. Moreover, identification of one common objective, creates opportunities for a long-lasting collaboration and added value for actors involved. In this sense, perspective will be created for actors involved even if added value will not pay-off immediately. Building a coalition within U-Ned with the focus on integration of logistics may be a suggestion for further research.

Key words: freight, logistics, spatial and infrastructural integration, urban nodes, sustainable mobility, multimodality

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Abbreviations

Abbreviation	Dutch	Meaning
BO	Bestuurlijk overleg	Governmental consultation
BRU	Bestuur Regio Utrecht	Regional board Utrecht
CRA	College van Rijksadviseurs	Board of Government Advisors
DUS		Daily Urban System
EC		European Commission
FUA		Functional Urban Area
I&W	Ministerie van Infrastructuur en Waterstaat	Ministry of Infrastructure and Water Management
KTA	Korte Termijn Aanpak	Short-term approach
LEV		Light Electric Vehicle
LOD		Logistics Oriented-Development
LUTI		Land-use and Transport Interaction
MAAS		Mobility as a Service
MIRT	Meerjarenprogramma Infrastructuur, Ruimte en Transport	Long-range Infrastructure, Space and Transport Programme (MIRT)
MoVe-RDH	Mobiliteit en Verstedelijking (Rotterdam- The Hague)	Mobility and Urbanization programme Rotterdam – Den Haag
MRDH	Metropoolregio Rotterdam- Den Haag	Metropole Region Rotterdam- The Hague
MWKZ	Merwedekanaalzone	Merwedekanaal zone
MRU	Metropoolregio Utrecht	Metropole Region Utrecht
NMCA	Nationale Markt- en Capaciteitsanalyse	National Market- and Capacity analysis
NUVit		Networking for Urban Vitality
OECD		Organisation for Economic Co-operation and Development
RWS		Rijkswaterstaat
RWS- MN	Rijkswaterstaat, Midden Nederland	Rijkswaterstaat, Central Netherlands
SUMP		Sustainable Urban Mobility Plan
TEN-T		Trans-European Transport Network
TOD		Transit Oriented-Development
UCC		Urban Consolidation Centres
VN		Horizon 2020 project Vital Nodes

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1. Introduction and background

1.1 Background

In the year 2050 around 70% of the world population will live, move and work in highly urbanized areas. Consequently, both opportunities and challenges will be created, as decisions taken today will affect the life of people for a long time to come (OECD, 2015). Transportation of people and goods provide a crucial role by enabling accessibility and vitality within these urbanized areas (van der Linden et al, 2019). Flows of freight and logistics strengthen the economic position of the region. However, such spatial-economic developments may simultaneously affect mobility and inducing negative effects for liveability and vitality such as noise, disturbance, poor air quality and transport safety (Province of Utrecht, 2019; van der Linden et al., 2019; van der Werf et al., 2019).

Currently, several challenges and trends emerge from urban accessibility, urban development and logistics. First, several authors argued that due to ongoing urbanization and densification of already highly populated areas, pressure on metropolitan areas is increasing which results in conflicting urban functions. The concentration of activities in the same urban area create tensions between transportation and other spatial functions such as housing, working, recreation, and between freight and passenger flows, which are competing for the same physical space and infrastructure (Heeres et al., 2012; Broesi et al., 2017; 2018; van der Linden et al., 2019). Second, a growing demand for more flexibility in logistics and freight transport can be seen as consequence of the desired just in time principle by consumers (van der Linden et al., 2019). This so-called 'synchromodality' tries to use various transport modes and distribution locations in order to utilize transport and freight delivery systems in an efficient way focusing on service and reliability for end-users (van der Werf et al., 2019; Faith Ell et al., 2020). Thirdly, innovations in technology are changing the way logistics and transport is organized (Broesi et al., 2017). Developments such as E-commerce and 'just in time delivery' fundamentally change the spatial configuration of logistics functions in relation to urban areas causing XXL-warehousing along infrastructure corridors (Broesi et al., 2018; van der Linden et al., 2019). Since 2013, almost a hundred XXL-warehouses were developed mostly located in urban areas. The ongoing development of 'boxes' within the landscape and its impact is increasingly debated on local, regional and national scale. Therefore, a national taskforce is suggested to coordinate brownfield developments and (BCI, 2020). Moreover, the CRA (college van Rijksadviseurs) (2019) argued for more steering and possibilities for restructuring and concentrating these areas to prevent uncontrollable sprawl while considering other challenges (e.g. energy transition).

Simultaneously, a 'logistics sprawl' and development of micro hubs on local (neighbourhood) scale is observed (van der Linden et al., 2019). However, little awareness is recognized among authorities to coordinate such activities in an integrated manner. Generally, approaches towards logistics are often approached from a sectoral point of view. Therefore, Broesi et al. (2018) argued that a new spatial typology should be investigated. Fourth, increasing environmental and societal awareness concerning sustainable transport, zero-emission policies (SUMP) are changing the way of organizing last-mile delivery (Heeres et al., 2019; Broesi et al., 2017; 2018; van der Linden et al., 2019). Another trend is the enormous increase of food, grocery, clothing and other goods delivered by vans and trucks which causing disturbance and pollution while crossing neighbourhoods (van der Werf et al, 2019). Consequently, an increasing number of cities are introducing zero-emission zones, regulation and stimulating other means of transport within their urban areas. Lastly, stricter environmental standards regarding health and liveability quality require different approaches to planning of infrastructure, mobility and spatial development and especially their linkages (van der Werf et al., 2019; Broesi et al., 2017). Such a perspective does not only strengthen the

robustness of transport network on local (inter-urban), regional (daily urban systems) or national (corridor) level, but social economic developments of urban region as well (Heeres, 2017).

The various trends and challenges illustrate the complexity of urban regions – or more specifically called 'urban nodes' in EC TEN-T policies (EC1315, 2013). Urban nodes are defined as 'the touching points where the transport infrastructure of the TEN-T network, such as ports, including passenger terminals, airports, railway stations, logistic platforms and freight terminals located in and around an urban area, is connected with other parts of that infrastructure and with the infrastructure for regional and local traffic' (EC 1315, 2013). Urban Nodes host and connect multimodal transport modes and different scales of logistics transport (e.g. corridors and intra-urban) (Heeres, 2019). In this light, every urban node has its own specific characteristics which is why a one-size-fits-all solution in dealing with these challenges would be short-sighted (Van der Linden et al. (2019). Since urban nodes can be viewed from different angles it would be worth to unravel this fundamental multiplicity. Arts (2014) and Faith-Ell et al. (2020) argue that this fundamental multiplicity is resulting from diverse spatial scales, modalities, sectors and stakeholders.

To make it more complex, the rise of (urban) logistics in and around these urbanized areas is causing friction between functions, scales and scarcity of space (Heeres et al., 2012). The planning for these developments should integrate different scale levels on which society operates in space (Sýkora, 2009). Bohler et al. (2019) and Heeres (2012) argue that early collaboration in planning- and decision-making process is needed to identify fitting solutions for urban node development. To this end, deeper insight into context of specific qualities that surroundings of road infrastructures acquire from different spatial functions (e.g. residential areas, economic functions and nature) would give more insight (Heeres et al., 2012). Thereby, the role funding is important. In freight logistics financing is mainly privately driven, whereas investments in passengers transport (roads, public transport, bicycle routes, etc.) is driven by public funding, which causes a silo-ed environment (Vital Nodes, 2019). To overcome such silo-ed and fragmented practice, multi-level governance, holistic planning approach across various scales and sectors is needed in order to provide a tailor-made collaboration, which is in line with area-oriented aims and objectives (Heeres et al., 2019).

In a country such as the Netherlands, the population is expected to grow to 18.5 million people in 2050 (PBL/CBS, 2019). According to the prognoses around 75% of this growth will be accommodated within the Dutch major cities, the so-called 'Randstad', and its surrounding municipalities. The city of Utrecht will experience the fastest growth of roughly 20% due to many construction plans and the realization of Vinex Leidsche Rijn which is attractive for young families that want to move towards the city (PBL, 2019). Simultaneously, freight and logistics flows over land are projected to increase with 80% in 2050 compared to 2005 (EEA, 2010). Each year, over 200 million tons of freight crosses the province of Utrecht consisting of 58% via road, 40% via waterways and the remaining 2% via railways (Province of Utrecht, 2019). The MRU is one of the most attractable and dynamic urban areas of the Netherlands in terms of demographic and economic growth (U-Ned, 2018). Pressure on the housing market and, thereby, mobility and related infrastructures is creating friction in the urban space. The U-Ned programme (collaboration between governmental authorities within and around the city of Utrecht) tends to address these problems by means of a programmatic and integrating approach towards housing and mobility and its interaction. This is done in order to guide and accommodate expected economic and demographic growth within the metropole region Utrecht (U-Ned, 2018). Thereby, the U- Ned programme tries to integrate and align these challenges and interests on short, mid- and the long term (U-Ned, 2018).

It might be interesting to compare the policy objectives of U-ned with the recently completed EU Horizon 2020 Vital Nodes project. Both policies seem to have remarkable similarities between each other in terms of goals and approaches. The Vital Nodes (VN) project is part of the Horizon 2020 programme which is EUs

research and innovation programme aiming for smart and sustainable economic growth and job creation (Horizon 2020, 2020). The VN project is aimed to strengthen the interconnection between urban nodes while simultaneously develop sustainable mobility within urban nodes of the trans-European Transport Network (TEN-T). In particular, the multimodal connectivity between these long-distant corridors and last-mile and its interaction with passenger transport is addressed (Vital Nodes, 2020). It may be worthwhile to compare both approaches in order to identify implications for U-Ned. To this end, this study aims to identify Vital Nodes implications by using U-Ned as representative test case for applying the VN approach to Dutch practice and more specifically to planning practice within Rijkswaterstaat. First, a brief introduction of the Dutch spatial-infrastructural planning's context will be given in order to understand the U-Ned programme. Thereafter, Vital Nodes will be introduced.

1.2 Long-range Infrastructure, Space and Transport Programme (MIRT)

In order to understand the foundation of a programme like the U-Ned, it is relevant to discuss the MIRT-programme which stands for national programming and budgeting system for infrastructure and spatial development. MIRT is the Dutch integrated investment programme which aims to ensure (urban) transport & accessibility, safety and well incorporated infrastructure within spatial planning in the long run (I&W, 2020). The MIRT-process is characterized by an integrated planning, both horizontally (spatial planning, economy, mobility, and liveability) and vertically (national government, provinces, and municipalities) (Arts, 2010; Klagegg, 2016). Thereby, the MIRT-programme is based on an intensive and early collaboration between the Dutch national government and stakeholders before, during and after development of projects (Klagegg, 2016; I&W, 2020). One of the focus points of the current MIRT programme is the area-oriented programmatic approach towards accessible urban regions. One of these programmes is the U-Ned programme for the Utrecht region which acknowledges the interconnection between urbanization and accessibility and its inherent relationship on local, regional and (inter-) national scale which is, therefore, rooted in multi- level governance (I&W, 2020).

Currently, Various MIRT projects in and around Utrecht are to be considered or explored with regard to refurbishment or addition of infrastructure. For example, the expansion of the A27/ A12 Ring road, A27 Houten-Hooipolder, A28/A1 motorway intersection Hoevelaken and the 'Ring road' North Utrecht. Simultaneously, the new 'Uithof' tram line will generate more travel capacity between Utrecht central station and Utrecht Science park. However, these developments are likely to be not enough to accommodate the expected growth in mobility flows (U-Ned). Simultaneously, the 'housing deals' initiated to address the housing shortage by de Ministry of Interior Affairs put additional pressure on the MIRT-projects. For example, development and transformation of the A12 Oudenrijn-Lunnetten zone, Beurskwartier and completion of Vinex Leidsche Rijn (U-Ned). In particular, transformation of the 'Merwedekanaalzone' is creating opportunities for accommodating urban growth and urban accessibility in relation with the U- Ned programme (I&W, 2020). The Ministries of Interior Affairs and Infrastructure & Water Management are both together investing in the housing deals and the MIRT-exploration in order to create coherence between developments (MIRT, 2019).

1.3 Introduction to the U-Ned Programme

The metropole region Utrecht (MRU) is facing a tremendous growth in terms of population and transport flows (U-Ned, 2018; I&W, 2020). This results in spatial challenges with regard to housing and infrastructure to ensure economic vitality and attractivity. In the period until 2040 the accommodation of 104.000 additional houses within the MRU is required in order to solve the housing shortage in the Netherlands (I&W, 2020). Obviously, these developments will influence the mobility and accessibility around Utrecht which is already quite congested (U-Ned, 2018; MIRT, 2019). Moreover, U-Ned focusses on a broader scope by considering besides the city and the Metropole region, national scales as well (I&W, 2020). The metropole region Utrecht has a node-function on regional, national as well as international scale which will continue to growth in terms of transport flows (U-Ned, 2018). Aim of the U-Ned programme is to develop innovative measures regarding housing, employability, mobility, liveability and the complex interrelation between them (U-Ned, 2018; MIRT, 2019). In this manner, Utrecht's economic needs and its 'hub' function ('draaischijf functie'), on road and rail, in short and the long term will be maintained (figure 1) (I&W, 2020). To that end, the U-Ned Programme was established by the Ministries of Infrastructure & Water Management (previously Ministry of Infrastructure and the Environment), Economic Affairs and Interior Affairs, the Province of Utrecht and City of Utrecht, Rijkswaterstaat, Prorail and NS (the Dutch railway operator) in order to instigate such ambitious multi- scale and multi-disciplinary objective. In addition, the U10 municipalities: Bunnik, De Bilt, Houten, IJsselstein, Nieuwegein, Stichtse Vecht, Utrecht, Utrechtse Heuvelrug, Vijfheerenlanden, Wijk bij Duurstede, Woerden en Zeist are involved (U-Ned, 2020).

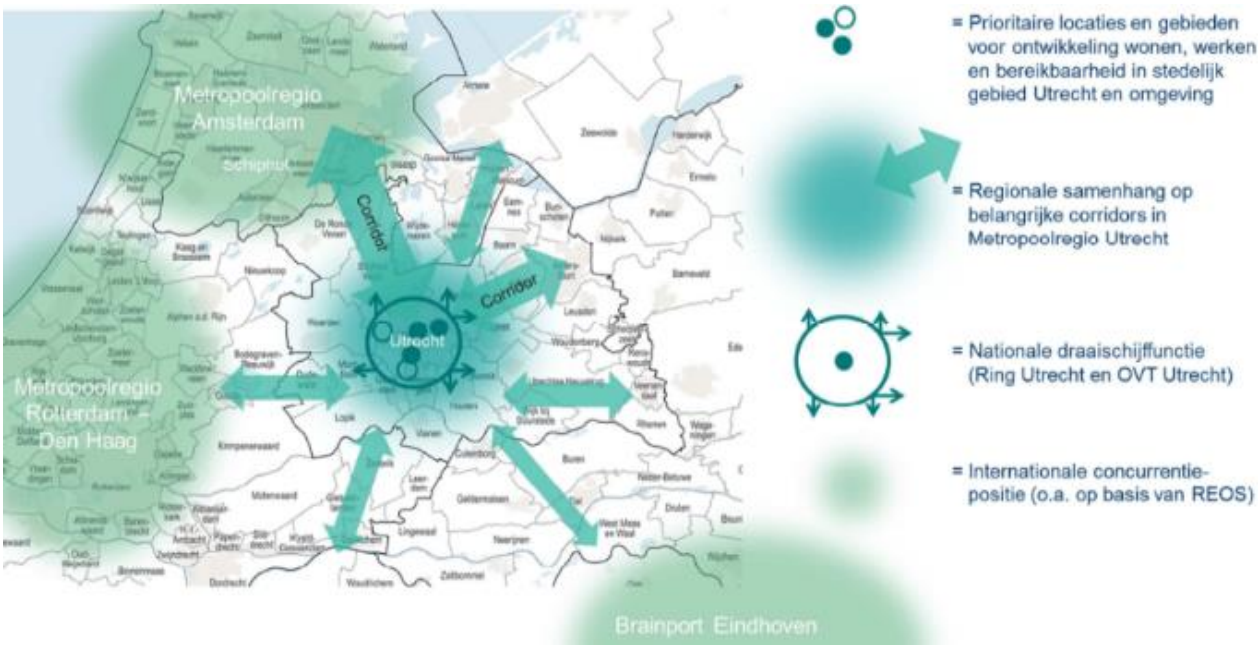

Figure 1: Geographical scope U-Ned: Coherence on different scales (Source: U-Ned, 2018).

Within the MRU, four core challenges and priorities need to be addressed towards 2040 (U-Ned, 2018; BO MIRT, 2019 & I& W, 2020).

- Creation of conditions for development of circa 84.000 to 100.000 houses and attractive settlement locations for 80.000 potential jobs;
- Simultaneously realization of fitting infrastructure & network choices with regard to mobility and multi-modality in solving bottlenecks on road & rail on local, regional and (inter) national scale;
- Simultaneously, improvement of liveability and sustainably, and;

- Previous key challenges will be addressed in an integral, adaptive and feasible way with a short-, mid- and long-term focus.

In this sense, a programmatic approach is considered a suitable framework since it is not just a scaled-up version of project-management but becomes more a strategic programme oriented on aligning interdependent projects with requirements, goals and drivers for the wider context (Busscher, 2014). Not only different scales, sectors and multi-level governance approaches are considered but also different timeframes (short and long term) are distinguished (U-Ned, 2018).

U-Ned is based on three focal points which are developed for the short- mid and long-term (see U-Ned, 2018; 2020; I&W, 2020 and figure 2).
1) Better utilization of the existing hubs, infrastructure and networks in the city and its surroundings;
2) Preparation to a new level of urbanization and mobility; and,
3) ongoing development of Utrecht as multimodal transport hub on (inter) national scale in relation to attractive and competitive business locations.

Figure 2: Programme focus U-Ned (Source: U-Ned, 2018).

To this end, U-Ned developed four programme tracks with different timespans.
1) *MIRT-examination*: preparation to a new level of urbanization and mobility by development from one central node to a radial structure. Thereby, further development of main hubs and large-scale infrastructural measures are considered valuable for the entire region (Period 2030-2040). (See BO MIRT, 2019);
2) *MIRT- Exploration*: Improvement and better utilization of the existing hubs, infrastructure and networks in the city in combination of new residential areas, for example, the Merwedekanaalzone and Nieuwegein. Thereby, accessibility of residential areas, NMCA-bottlenecks (National Market- and Capacity analysis) and addition of (high-quality) public transport lines are considered (before 2030) (See BO MIRT, 2019);
3) *No regret measures*: ongoing development of Utrecht as multimodal transport hub while flatten the pressure on central hubs and infrastructure and ensuring accessibility of residential areas (before 2025);
4) *Short term measures* (in Dutch: Korte termijn aanpak, KTA): Projects which influence traffic behaviour, sustainably, liveability, congestion, public transport measures (see KTA, BO MIRT, 2019) (within 5 years).

1.4 Introduction to the EU Vital Nodes (VN) project

As discussed in section 1.1, European cities increasingly need to cope with major challenges as result of increasing freight and logistics traffic. The EU Horizon2020 project Vital Nodes tried to improve European interconnection, and to develop sustainable mobility solutions for the last mile delivery within urban Nodes (Vital Nodes, 2020a). Therefore, it addresses specifically the multi- and intermodal connection between long distance and last-mile freight logistics. The interaction with passenger transport is considered as well since multimodality is often found in dense urban regions (Vital Nodes, 2019). The Vital Nodes project is

part of the EU Horizon 2020 programme which is a research and innovation programme with the goal to remove barriers for innovation within the EU (European Commission, 2020). The project is based on two main objectives (van der Werf et al., 2019):

1) Delivering validated recommendations for effective and sustainable integration of European urban nodes with the TEN-T corridors with the focus on freight and logistics;
2) Establishment of long-lasting knowledge networks for safeguarding continuity of implementation and knowhow (van der Werf et al., 2019).

In addition, network issues of logistics transportation, in relation to other spatial issues such as urban vitality and liveability, are addressed (Vital Nodes, 2020). The Vital Nodes approach is based upon the Networking for Urban Vitality (NUVit) strategy which focuses on spatial design as both strategic and technical tool in order to achieve integrative spatial concepts. Likewise, multimodal optimization of a transport network in relation to spatial functions and spatial density are considered (NUVit, 2015). In other words, addressing transport challenges by connecting and integrating the 'silo-ed' worlds of the spatial and infrastructural dimension (Faith-Ell et al., 2020) - see also Figure 3 and 4. Furthermore, Vital Nodes tends to put freight and logistics on the agenda since these have been underexposed among policymakers and planners (Vital Nodes, 2019).

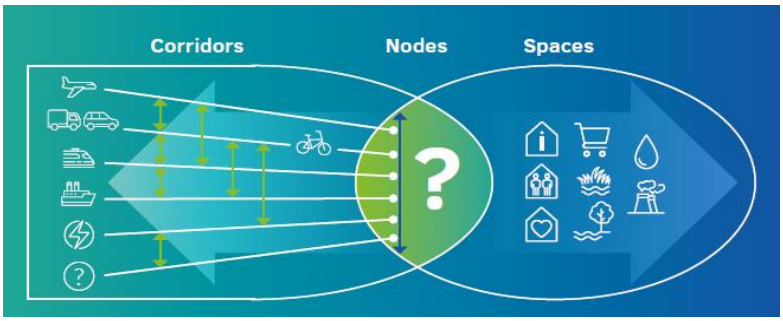

Figure 3: The Vital Nodes principle (Source: Vital Nodes, 2020)

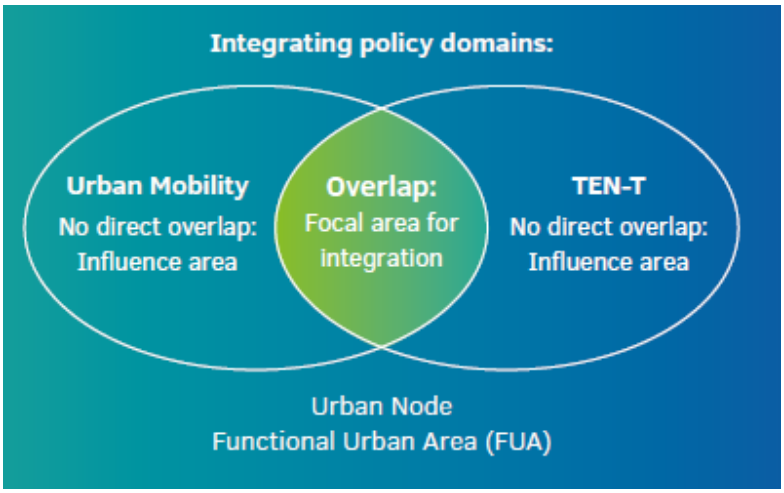

Figure 4: Integration of TEN-T and Sustainable Urban Mobility Policies (Source: Vital Nodes, 2020).

The following four results were developed during the Vital Nodes project (Vital Nodes, 2020). First, a *toolbox containing of proven methods* applicable to analyse. Second, *development plans* for urban nodes. Third, the *validated recommendations* for integration of Urban Nodes within (TEN-T) corridors. Also, an '*Nodes book' of 'good' practices and solutions* has been made. This 'Nodes Book' provide information of urban nodes which have implemented measures for the integration of involved policy fields (see figure 4).

These results are used as basis for the discussion regarding integration of urban Nodes within the wider network (Vital Nodes, 2020). A first inventory of cross-over points between the VN approach and U-ned could be the call for a more integral approach towards the wider city, the connectivity between various scales, the possibilities for multimodality and the lack of an approach towards logistics (RWS-MN, 2020).

1.5 Problem definition

Three main dilemmas can be determined while defining an overall problem definition. Combining the observed trends as stated in the background, with the context of the Metropole region Utrecht (MRU), results in the following problem statements:

1) There is a need to accommodate and integrate mobility growth, both in terms of person and freight transport flows, and in relation to spatial and infrastructural interventions in many urban areas in Europe and the Netherlands, this is certainly true for the Metropole Region Utrecht (MRU);
2) The configuration of (city) logistics & freight on different scales is underexposed in relation to the U-ned programme; and,
3) The impacts of freight and logistics on urban areas is growing which is also the case in the MRU.

Application of the Vital Nodes (VN) toolbox which integrates spatial and network dimensions can be relevant to get a grasp of possible tailor-made solutions. Applying the validated tools and recommendations to the context of Utrecht may generate interesting insights and possible directions for U-Ned (policy) interventions. Combining both approaches of Vital Nodes and U-Ned together can therefore be seen as a synergy in itself. The primary research question is of the study is stated as follows:

How can lessons from the European Vital Nodes (VN) project regarding logistics & freight transport be translated into the U-Ned programme within the Metropolitan Region Utrecht (MRU)?

In order to draw useful lessons and applicable tools for integration three questions arise. The why-question: why should one act? (value). The what question: what are potential synergies? (integration network & spatial development). The how-question? How to implement? (time/ institutional/ financial issues) (van der Werf et al., 2019). Following the Vital Nodes (VN) approach the following secondary questions are formulated:

1. *Which theoretical concepts regarding infrastructure and spatial integration are relevant building blocks for Vital Nodes (VN) and how are these related to the nature of urban nodes?*
2. *What are the key challenges regarding freight and logistics within the U-Ned programme?*
3. *Which possible 'good' practices are applicable from the VN toolbox to the U-Ned programme within the metropole region Utrecht?*
4. *How can Vital Nodes tools effectively be implemented within the U-Ned programme?*

1.6 Scientific relevance

Many authors (E.g. Arts (2007), Heeres (2017), Arts et al. (2016), van der Linden et al. (2019)) noted the dilemma of competing space: Growing transport and passenger flows created a real challenge for space. Therefore, a shift towards mixed use of functions is somehow needed (van der Linden et al., 2019). Freight and logistics networks should become part of an integrated planning approach (Broesi et al., 2018). There is still little awareness observed by authorities about the impact of logistics activities such as XXL warehouse which are demanding a lot of urban space. Thus, there is a need for new strategies that incorporates the impact of logistic while integrating infrastructural and spatial developments into one. The search for innovative spatial typologies as answer to upcoming trends should be fostered (Broesi et al., 2018).

Second, the issue of scaling. According to Arts (2016) there is a lack of understanding integration of different scales, and their interactions, in relation to urban nodes which levels of scale can be identified as: the (TEN-

T) corridors, the Daily urban system (DUS) and the local level. The 'intermediate' scale of the Daily Urban System (DUS) is usually poorly discussed in the planning process (Arts, 2014). Currently, passengers' flows are mostly understood according to its underlying Daily Urban System (DUS) – focus is on commuting distances, travel to facilities. Focus is less on freight and logistics, consequently the notion of DUS does not fully match with these transport flows. Therefore, the notion of Functional Urban Area (FUA) is relevant. FUA is understood as functional territorial units that represent areas of strong integration between urban cores and their immediate hinterland (ESPON, 2005). The population is usually well served within FUAs by jobs and services concentrated in urban cores (Sýkora, 2009). This leaves potential for creating added value of infrastructure investments untouched since this is the scale where most added value (in terms mobility, economically, accessibility) can be found (Arts, 2016; NUVit, 2015). Lastly, guiding the need for integration of multi-scale, multi-sector, multi-actor, multi-modality in order to achieve a fruitful spatial and infrastructural merge requires more insights in multi-level governance approaches gained from experiences (Philips, 2016; Linssen et al., 2019: Faith Ell et al., 2020).

1.7 Societal relevance and results for planning practice

In general, the study will contribute to knowledge building about coordination and integration of freight and logistics within the Dutch context as underexposed theme among planners. Thereby, applying and testing the toolbox on the concrete case of the MRU will, on the one hand, generate insights in the application of the toolbox in the Dutch context. On the other hand, testing the toolbox itself will enrich the toolbox with additional recommendations and lessons. Results can be further compared and translated to other urban areas and in the Netherlands by exchanging new approaches, instruments, experiences, skills and competences (van der Werf et al., 2019). Moreover, applying the relatively new spatial-infrastructural integrating concepts such as logistics-oriented development (LOD) may foster knowledge building surrounding these concepts in relation to the Dutch context.

The same challenges are observed while zooming in to the Metropole region Utrecht. The MRU is one of the most competitive regions of the EU with relatively young, high educated inhabitants, strong knowledge and service sector and close ties between government, private sector, knowledge and educational institutions (U-Ned, 2018). These characteristics allow for dynamic, diverse and highly urbanised areas where possible knowledge spill-overs and innovation take place (U-Ned, 2018). Therefore, solving infrastructural bottlenecks, housing shortage and liveability issues within Utrecht are crucial for urban vitality and economic prosperity. However, inclusion of logistics & freight and its related externalities within U-Ned is still underexposed. Unawareness about inclusion of freight & logistics as a multiplicit task among municipalities, provinces, public and private sectors in practice will, in the end, result in an unintended surprise of a jammed urban engine. Therefore, insights and lessons given by the Vital Nodes approach in coordinating influence of freight flows on last mile and FUA level and on spatial integration within cities may be valuable to counteract negative impacts in and around the city of Utrecht.

For planning practice, the study can be relevant because different contexts are asking for different approaches. 'Good' practices found in this study might function as inspiring examples in addressing problems in other situations (Flyvbjerg, 2006). A one-size-fits-all solution is not an option since urban nodes are complex due to a wide range of unique characteristics. Therefore, insights in the match between tailor-made tools with an 'compatible' context are beneficial in search for an appropriate 'fit' (van der Linden et al., 2019). In this sense, the 'force of example' should not be underestimated (Flyvbjerg, 2006). Attention to pragmatic 'soft' measures and methods addressing the multiplicity of challenges should be part of the approach (Faith Ell et al., 2020). In practice, the study will give insights in 'good' practices that may be

relevant for the U-Ned programme. In addition, 'fitting' strategies and tools will be applied to concrete local and functional urban area (FUA) scales of transport by means of a case study in order to examine the applicably in practice.

1.8 Research design

The logic of the research design is based on comparing and applying general (EU) Vital Nodes policy recommendations and lessons from the Vital Nodes toolbox into the U-Ned programme. First, the underlying spatial-infrastructural concepts of the Vital Nodes (VN) approach will be discussed in a theorical review. Thereafter, a literature and document research will be conducted in order to identify stakeholders and objectives of the U-Ned programme. The second phase of the study will comprise an empirical research by the means of semi-structured interviews with various authorities, experts and stakeholders with different backgrounds. Third, the 'exemplar' case studies will be discussed during these interviews. Furthermore, a (online) focus group will be held to validate possible approaches, strategies and solutions. Results of the data collection will be shown in chapter findings followed by answering the research question in the concluding chapter.

1.9 Outline of the thesis

This thesis will consist of six chapters of which this is the first one. Chapter one has introduced the knowledge gap regarding integration of freight and logistics within urban areas. Moreover, the U-ned programme and the Vital Nodes have been introduced. Chapter two will contain the theoretical framework in which the relevant building blocks of the Vital Nodes approach will be discussed. Chapter three will discuss the used research methods and ethics. Chapter four will present the findings of the document analysis, interviews, focus group and exemplar case study following the Vital Nodes approach. In addition, chapter five will present the conclusions and discussion of this thesis. Also, a reflection on the research process will be provided. Furthermore, recommendations for further research and for Rijkswaterstaat will be given. Lastly, chapter six will contain the references mentioned in this thesis.

2. Theoretical framework: Background of the Vital Nodes concept

2.1 The need for spatial and infrastructural integration

This chapter consists of an overview of concepts and theories which are closely related to the Vital Nodes thinking. First, the concepts considered in this chapter are based on spatial and infrastructural integration on various scales; local (intra-urban), regional (city-hinterland) and (inter) national (inter-urban), building towards the ingredients of the Vital Nodes approach. According to the EU regulation urban node means an urban area where the transport infrastructure of the trans-European transport network, such as ports including passenger terminals, airports, railway stations, logistic platforms and freight terminals located in and around an urban area, is connected with other parts of that infrastructure and with the infrastructure for regional and local traffic (European Union, 2013). Yet, this conceptualization of urban nodes is quite narrow and focussed on infrastructure.

Many others have addressed the separate and 'silo-ed' paradigms of spatial and infrastructure planning (Arts et al, 2016; Heeres, 2017; Straatemeier, 2019; Faith-Ell et al., 2020). While agreement seems to dominate among authors about the 'logic' necessity of integration between these policy fields, practice tells us another story (Kelly, 1994). The integration of transport and land-use domains is widely seen as direction towards sustainable and efficient cities and mobility (Wegener & Fürst, 1999; Faith-Ell et al., 2020). In other words: spatial and infrastructural development are seen as 'two sides of the same coin (Scholl, 2012). However, both policy fields remain separate rather than coordinated ones with limited scope (Kelly, 1994; van Geet et al., 2019). Infrastructure planning is often concerned with solving bottlenecks using narrow strategies according authority guidelines while spatial planning is occupied with development of profitable land-use ignoring mobility and accessibility (Arts et al., 2016; Faith Ell et al. 2020). In arguing for better coordination, recognition of institutional barriers of legislation, public-private sectors, levels of governance are essential (Kelly, 1994; Faith-Ell et al., 2020).

The relationship between land-use and transportation is considered a complex and cyclical one. Kelly (1994) argues, therefore, that simplistic measures will only worsen the problem than make it better. Nevertheless, many authors (e.g. Mitchell & Rapkin, 1954; Wegener & Fürst, 1999) tried to conceptualize the relationship between (network) infrastructure and (spatial) land-use.

2.2 Land-use transport interaction (LUTI)

Diving into the nature of urban nodes brings us back to the basics of the reciprocal relationship between land-use and transport which is better known as land-Use Transport Interaction (LUTI) (Mitchell & Rapkin, 1954; Wegener & Fürst, 1999; Cervero, 2001). Many studies show that urban form, whether it is compact, multimodal, or sprawling, has impact on the type, location and costs of transportation systems needed to serve metropolitan areas (Kelly, 1994). Due to the fact that spatial activities are distributed over earth's surface fosters the need for transport from one place to the other. Nevertheless, the other way around, from transport to land-use, is less recognized but equally important (Wegener & Fürst, 1999). In order to explain the relationship between land-use and transport, Mitchell & Rapkin (1954) came up with the notion of the land-use transport feedback cycle which can be explained as follows (see figure 6).

1) Distribution of *land-uses*, for instance, residential and commercial determine the location of daily activity of humans;
2) Consequently, distribution of human *activity* demands the need for interaction to overcome distance by means of a transport system;

3) Distribution of transport system provides opportunities for spatial interaction or, so-called *accessibility;*
4) Resulting from *accessibility* a change in land-use will occur and trigger start of a new cycle.

However, Kelly (1994) points out the chicken and egg nature of the problem which argues for better coordination in addressing institutional barriers. Development of public funded transport, both on city and local level, will be only desirable together with high-density development. Private funded (residential) developments will only be viable if accessibility is guaranteed (Kelly, 1994). Owen, p.224 (1966) described the relation as follows: 'the relationship should be both functional and geographical comprehensive and comprehensible from a planning standpoint by assuring that the transport is used to promote community goals, and that community plans make satisfactory transportation possible'. Thereby, the transport land-use feedback cycle is a highly simplified representation of reality which ignores a lot of external and internal complexities (Straatemeier, 2019).

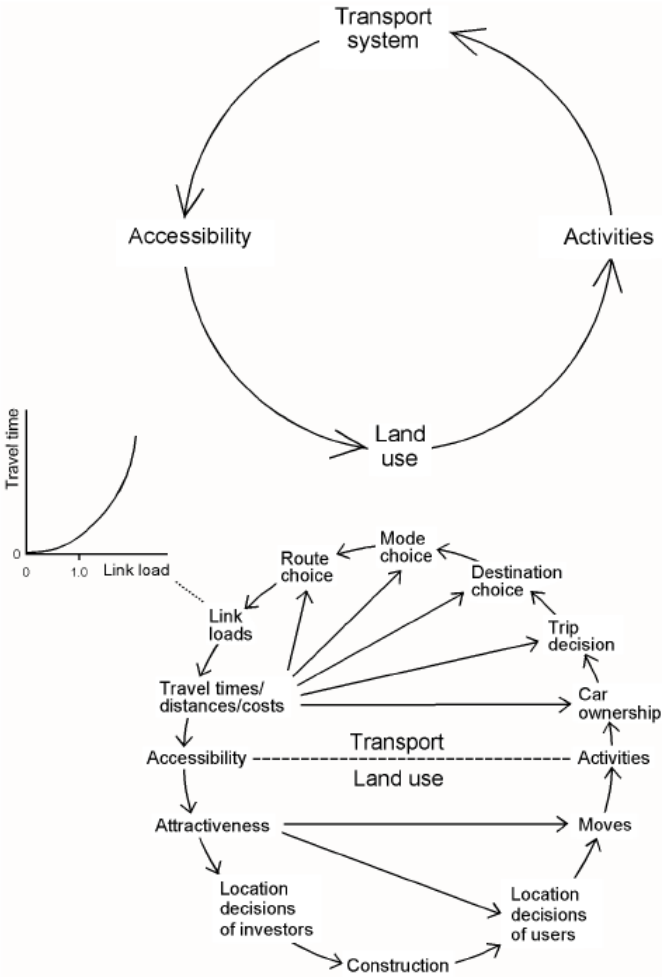

Figure 5: Land-use feedback Cycle (Source: Wegener & Fürst, 1999).

While zooming in to the feedback cycle a few factors seem to establish the relationship according to Wegener &Fürst (1999). Land-use is likely to be influenced by transport factors such as accessibility, travel cost and travel time. This are the so-called, 'push' factors. Transport is expected to be influenced by land-use factors such as urban density, employment density, neighbourhood design, location and city size. These can be seen as the 'pull' factors (Wegener & Fürst, 1999). Concluding from their research, impacts of transport policies on transport patterns tend to be larger than the interplay of land-use on transport and the other way around (Wegener & Fürst, 1999). This is partly caused by the fact that different urban processes are subject to different timespans, especially relevant to freight and logistics transport, Infrastructural networks and spatial patterns are very slow processes. Housing and commercial locations are subject to slow change while the complementing population and employment processes are much faster. In accordance, transport and travel are instantly modified to urban development (Wegener & Fürst, 1999). Therefore, influence of transport patterns tends to be larger than the land-use activities.

This changing *accessibility* as mediating factor seems to function as 'catalyst' for urban development and for connectivity within and between urban nodes. *Accessibility* is defined as the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations (perspective of persons), and 'the extent to which land use and transport systems enable companies, facilities and other activity places to receive people, goods and information at various times of the day' (perspective of locations of activities) (van Wee et al., 2013). Especially, the last part of this definition concerning freight is relevant

to this study due to the focus on freight and logistics. Accessibility can be directly related to both the qualities of the transport system (e.g. travel speed) and the qualities of the land use system (e.g. functional densities and mixes) (Bertolini, 2005). To be specific, accessibility concepts could give better insights on pressure of transportation networks towards locations where development would be undesirable or have potential to facilitate such a desired development. The other way around, insights in limited potential of development locations resulting from low accessibility or the opportunity of specific locations due to their good accessibility would, obviously, have more development potential (Straatemeier, 2019).

The following assumptions could be done while considering freight and logistics. From a land-use point of view, locations that are better accessible to motorways and railway (freight) terminals will, obviously, be more attractive for development of industrial areas including warehouses. On local level, a well-established accessibility of retail or, for instance, pick-up points and other daily destinations will be more attractive for residential development and the other way around (Wegener & Fürst, 1999). From a transport point of view, concentration and mixture of employment and residential activities will, in general, result in shorter trips. However, Wegener & Fürst (1999) state that residential density alone is not enough to reduce trip length whereas concentration of employment and commercial density causes average trip lengths. However, this agglomeration of activities may also result in a shift from car-use to efficient public transport and other modes of (shared) transport in relation to, for example, freight. Although, a not too dispersed spatial organisation is required (Wegener & Fürst, 1999). On local scale, walking and cycling will become more attractive if the destination of the trip, for instance a pick-up point, will be nearby.

Also, Bertolini (1999) shed a light on *accessibility* as important factor in the connection between the infrastructural and spatial dimension within nodes as part of a network of competing and complementary nodes and places (see figure 7). In general, all the nodes provide accessibility to a transportation network. This leads to a hierarchy of nodes since not all nodes are connected equally (Bertolini, 1999). The y-axis represents the transport or node- content of an area. In other words, the accessibility (potential interaction with people). The more accessible, the more interaction. The X-axis represent the spatial content or place- content. In other words, the intensity of activities (degree of realisation of a potential interaction). More activity means more interaction. Bertolini (1999) extracts four stages where both indicators are equally strong. First, stress is explained as a maximum of intensity and diversity of transport and activities. Here is the potential interaction the strongest which can lead to bottlenecks and conflicts between space and infrastructure competing for space. Second, on the left bottom the 'dependency area' is found where both transportation and activity demands are minimal that provision can be accommodated in place without enhancing accessibility. Lastly, unsustained nodes entail facilitation of relatively large degree of transportation compared to activities whereas unsustained places lack activity. The nodes and places in the middle enhance a good accessibility.

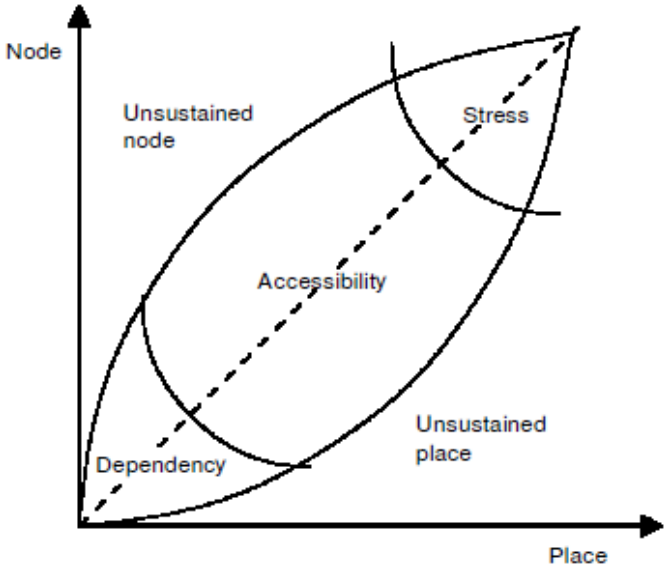

Figure 6: The Node- place Model (Source: Bertolini, 1999).

2.3 Towards area-oriented development

The silo-ed and fragmented worlds of infrastructure and land-use are observed also with regard to motorway development. Road infrastructure has also been subject to neglection of interaction with its surroundings (Heeres et al., 2012; Heeres, 2017). Traditionally, a line-oriented approach consisting of specific legislation, sectoral frameworks and own funding mechanisms resulting in a technocratic and hierarchal focus (de Roo et al., 2001). Heeres et al. (2012) observed a paradigm shift towards an integrated area-oriented approach seeking for innovative combinations between other spatial sectors in order to address in the increased complexity in highly dynamic planning approaches (See figure 7). From routing (Minimise environmental effects of road infra), context sensitive design (mitigating and broader view regarding liveability and environment) to total design (mutual relation spatial and infrastructural planning). Aims of area-oriented approaches to broaden the functional time and scope of infrastructural dilemma's in more flexible way by considering specific characteristics or demands from the surrounding area (Heeres et al., 2012). This open focus may lead to more synergetic solutions which are often seen as more resilient with relatively uncertain developments. To instigate such an approach, top down sustainable policy agenda is combined with bottom up collaborative approaches. The shift is characterized by cross-sectoral approaches which include multiple stakeholders, area-oriented public and private interests and both functional spatial plans as well as the underlying institutional processes (Heeres et al., 2012).

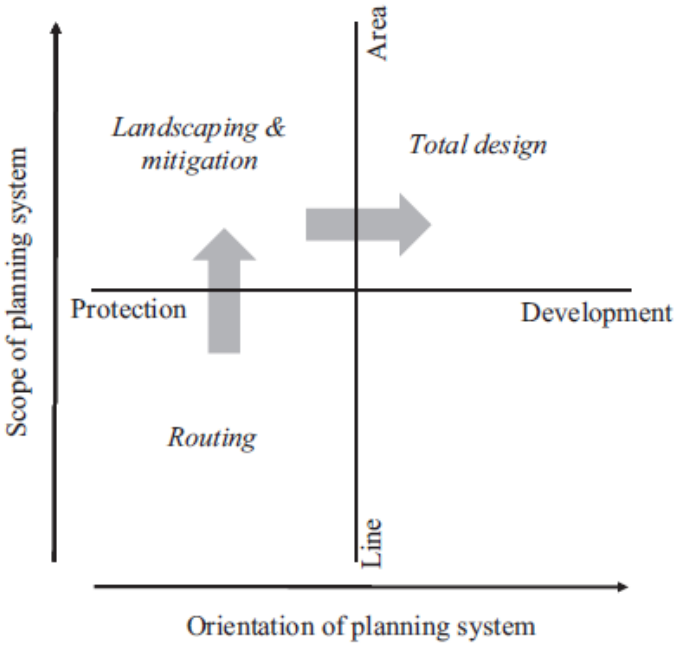

Figure 7: Trends towards area-oriented infrastructure planning (Source Struiksma et al., 2008).

However, not only infrastructure paid little attention towards integrative approaches in the past. Likewise, the spatial planning side of the coin ignored its additional pressure on infrastructure by emergence of mobility due to residential areas (Struiksma et al., 2008). In attempt to overcome this sectoral barrier a shift was made towards total design (figure 8). Total design is based on believe that infrastructure should sensitive to its surroundings and the other way around (RVW, 2008). This relationship is established on the thinking from infrastructural components towards the specific areas (inside-out) and from specific area components towards infrastructure in order to create a more integrated vision (Arts, 2007). This requires deeper insight in the context specific qualities that are acquired from spatial functions around infrastructure on different scales. Still, within area-oriented approaches infrastructure remains central. A step further will be area-development which is a more collaborative approach which is a

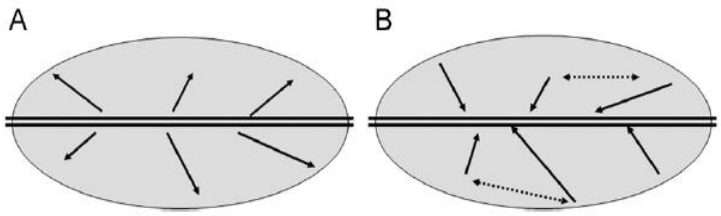

Figure 8: Area-oriented approaches in road infrastructure combine two perspectives (A) inside-out and (B) outside-in (source: Arts, 2007).

derivation of mobility needs of surrounding functions based on the total design principle (Arts & Vaan, 2010). This inclusive process includes a synergic and mutual relationship between economic, environmental and social aspects which will lead to a higher spatial quality of the area (Janssen-Jansen, 2007). Consequently, such an approach requires a governance approach which entails coalition building and multilevel governance networks in early stages of the planning process (Heeres et al., 2012; Salet & Woltjer, 2009).

According to Heeres (2017) these developments will dependent on modified organisational and institutional adjustments allowing for a broader integrate spatial and infrastructural coherence without losing sight of control and direction. In other words, it is depending on the given value or trade-offs of such an integrated approach for other functions within the area. This is depending on the internal (transport and traffic related) as well as external (land-user related) interrelatedness of infrastructure with its surroundings (see figure 9). For instance, both high internal and external interdependence demands an area-oriented approach while low interdependence makes such a strategy less attractive since the benefits of the trade-offs will be less than the coordinating efforts needed for coalition building (Heeres, 2017). Examples of these area-oriented development can be found in the concepts such as transit-oriented development and mixed-use developments which tend to combine spatial planning and infrastructural networks allowing for compact and multimodal urban nodes enabling economic, environmental and societal benefits (Heeres et al., 2012).

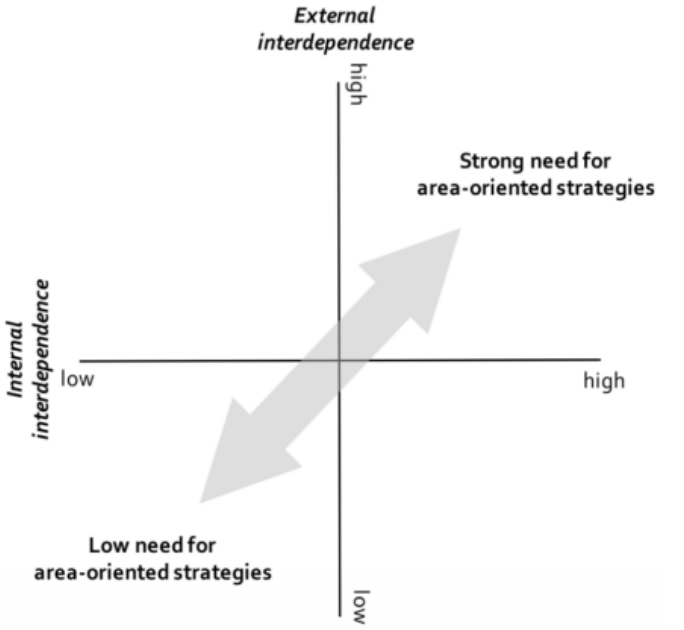

Figure 9: Need for area-oriented approach is dependent on interrelatedness of internal and external factors determined by the aim of the development (Heeres, 2017).

2.4 Corridors

At a higher geographical scale, corridors are relevant. In the pathway towards urban nodes the understanding of their inter-urban connecting 'necklace' is essential. These 'line-oriented' infrastructures connect urban nodes to each other. According to the EU Trans-European Transport Network (TEN-T) corridors are urban nodes defined as the touching points where the transport infrastructure of the TENT network, such as ports, including passenger terminals, airports, railway stations, logistic platforms and freight terminals located in and around an urban area, is connected with other parts of that infrastructure

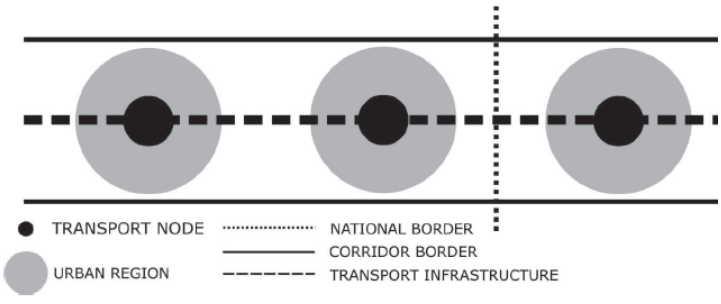

Figure 10: Transport corridor conceptualization (Source: Witte, 2014).

and with the infrastructure for regional and local traffic (EC 1315, 2013). Van der Werf et al. (2019) points out the importance of integrating urban nodes with corridors in enabling connections and sustainable mobility which makes consideration of corridors crucial for insight in urban nodes. Corridors can be defined as narrow bundles of infrastructure which are connecting two or more urban regions over a certain physical space consisting of both persons and freight transport (Figure 10). In particular, the function of a corridor is its connecting character which must enable the free and easy flow or transmission of people, goods or information (Chapman, 2003). Thereby, various scales and transport modes can be considered as multi-layered and multi-dimensional zones (Chapman, 2003; Witte 2014). Connecting these 'armatures' of important modes of infrastructure with other corridors and within urban nodes is essential to the interface of efficient, consecutive and, above all, sustainable freight transport chain (Faith Ell et al., 2020). In essence, urban nodes are centres of economic development whereas corridors facilitating their interaction which makes them dependent on each other (Witte, 2014).

2.5 Transit-Oriented development (TOD)

In the past, several concrete concepts have been developed in attempt to 'unite' the, on first sight intertwined but fundamentally different, concepts of land-use and infrastructure. A well-known concept for urban development is Transit-oriented development or in short: TOD (Curtis et al., 2009). TOD is a relevant concept to consider because of its attempt to connect the infrastructural a spatial domain. TOD refers to mixed used residential and commercial developments with sufficient density, preferably graduated, oriented towards and in proximity (walkable) distance to a public transportation node (train, metro, tram or bus) in opposition to a car-dominated and 'sprawlish' urban form (Tan, 2013). The concept is based on various indicators such as walkability, density and the location-efficiency trying to encourage urban accessibility, sustainability, vitality and diversity (Cervero, 2009; Renne, 2008). The concept made its entrance under influence of rapid urbanisation of urban areas which encountered increasingly disturbance within their cities. In particular, the awareness of shifting towards sustainable mobility, ineffective policies regarding emission reduction and prevention of urban sprawl as spatial and infrastructural integrating concept has led to increasing attention to TOD development (Banister, 2008; Tan, 2013). Besides close located railway stations, other TOD aspects, for instance, on- and off-street parking, housing type and tenure and other near services are important (Renne & Wells, 2002).

TODs are often visualized as nodes or a bunch of nodes connected through corridors. A radius represents the core development area surrounding the actual source of (transit) infrastructure, for instance a metro or railway station. (Local) functions and density of the potential development are captured in this circle (Tan, 2013). Regional scales are reached by the 'line-oriented' corridor infrastructure connecting various nodes and the so-called 'backdrop '(Cervero, 1998) (figure: 11). The idea behind TODs includes spatial polices by encouraging the concentration of urban developments around stations in order to develop a synergic relationship in connecting dense urban areas with reinforcement of

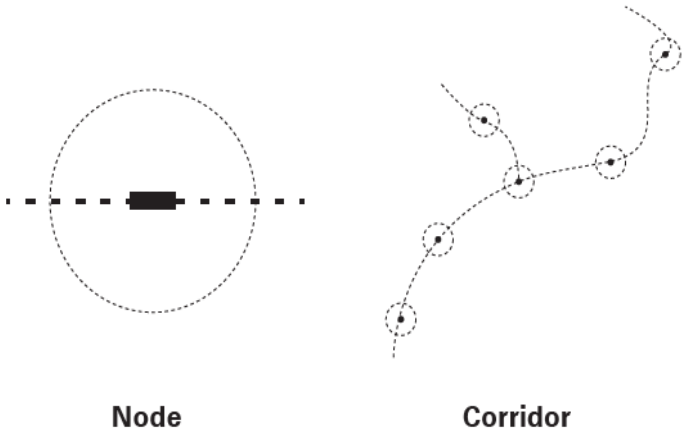

Figure 11: Common visual representations of TOD as node in a corridor (Source: Tan, 2013).

transport systems (Curtis et al., 2009). Yet, according to Tan (2013), most urban nodes within the Netherlands are rather qualified as transit Adjacent Developments (TADs) than as TODs. TADs are defined as functions enjoying proximity to transit nodes but lack the mutual relationship with commercial and residential functions as described in the LUTI concept (Renne, 2009). In other words, the areas lack accessibility between the transport and land-use function due to barriers or distances (Tan, 2013). Bertolini (2015) identified the relationship between accessibility within TODs. In particular, his findings concluded that policies targeting spatial distribution (e.g. populations and related job densities) and connectivity of TODs (accessibility) together reinforce each other. However, urging just density isn't effective whereas connectivity is. This supports the LUTI claims as stated by Wegener & Fürst (1999).

TODs strongly influence daily urban systems (DUS) such as work and live style which are seen as complex patterns. The daily urban systems (DUS) of people are influenced by, for instance, the mixed-use densification and accessibility factors used by TODs. Therefore, TOD as concept can be determined as context-specific by nature. Not only urban structures and regulation are changed but the interrelated individual choices and socio- cultural atmosphere within urban areas as well (Tan, 2013). Such environments require political and decision-making processes depending on essential consensus building between normative beliefs and social constructions. Moreover, the overload of fragmented regulations, instruments and responsibilities don't match the integral and coordinating nature of TODs (Tan, 2013). Accordingly, the lack of political and academic consensus and regional governance institutions are mentioned as major obstacles for successful implementation (Bertolini & Thomas, 2014; Thomas et al., 2015). This considered, Institutional innovation seems needed to smoothen the implementation processes (Tan, 2013). Therefore, according to Thomas et al. (2018) the following criteria are important by implementing TODs. 1) Collaborative and cooperative attitude between stakeholders with regard to policy with a multidisciplinary view. 2) Specific area-oriented focus and tools sustained by public and private partnerships; and 3) focused on small scale, holistic design which is embedded in existing spatial and infrastructural patterns and architecture. A shift from 'best practices' to using experiences and lessons in understanding barriers and opportunities in given contexts should be leading (Bertolini, 2012).

2.6 Towards Logistics-oriented development (LOD)

So far, most of the discussed concepts and theories are assuming people and passenger as the main subject to transport flows within urban nodes. As said earlier, the EU Tent-T guidelines (2013) define urban nodes as urban area where the transport infrastructure of the TENT network, such as ports, including passenger terminals, airports, railway stations, logistic platforms and freight terminals located in and around an urban area, is connected with other parts of that infrastructure and with the infrastructure for regional and local traffic". In order words, according to Faith Ell et al. (2020) they are, thus, origin and destination of freight and ensuring connectivity between various transport modes and scales (Heeres, 2019). Urban nodes are the connecting dots in facilitation of the interface between long-distance transport between urban nodes and last mile delivery within urban nodes (van der Linden, 2019; Heeres, 2019). However, none of the concepts discussed are addressing urban nodes specifically as connecting places for freight and logistics (Linssen et al., 2018). In analogy of the TOD concept, which is integrating passengers' modes of transport with land use, a call for a concept which integrates freight and logistics transport with land-use is needed (Broesi et al, 2018). There seems to be a

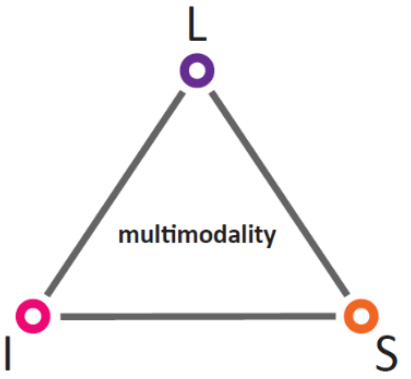

Figure 12: The basis of the FLUXNET Toolbox: multimodality can be influenced by considering Logistics (L), Infrastructure planning (I) and Spatial planning (S) in an integral perspective. (Source: Fluxnet, 2018)

lack of 'Logistics -oriented development' (LOD) in facilitating and coordinating freight and logistics transport, next to, and together with passenger transport within the urban nodes (Linssen et al. 2018; van der Linden et al., 2019).

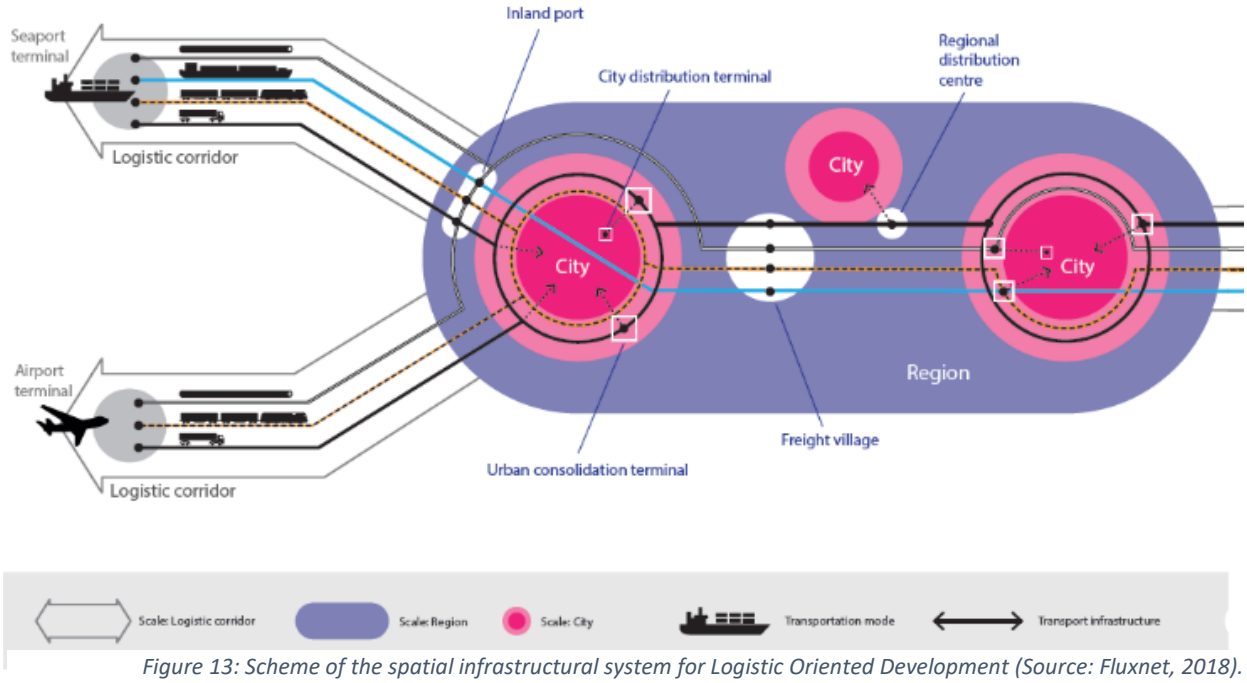

Figure 13: Scheme of the spatial infrastructural system for Logistic Oriented Development (Source: Fluxnet, 2018).

Logistics oriented development (LOD) aims to improve and optimize the multi-modality of the spatial infrastructural system by the transport and logistics sector. Logistics is the science of physical distribution systems (Rodrigue, 2012). Logistics is close related to transportability. The *transportability i*s defined as the ease of movement of passengers, freight or information. It is related to transport costs as well as to the attributes of what is being transported. An effective planning of logistics activities is an important way to get both cost and efficiency advantages for urban regions (Rodrigue, 2012). Logistics requires an efficient structure which is accessible via various modalities and enables innovation (Fluxnet, 2018). 24/ 7 delivery, technology, sustainable awareness, urbanization and globalisation have great influence on the configuration of spatial organization (location, transhipment hub and consolidation centres) and infrastructural organization (networks, modalities, (local) hubs and terminals. Logistics oriented development tries to integrate and interlink spatial planning, logistics and infrastructure (Figure 12) (Fluxnet, 2018). Currently, the spatial and infrastructural configuration for freight and logistics does not match with multi-modality.

LOD is based on the following multi-dimensional approach (See figure 13). 1) logistics and freight are addressed in relation to spatial and infrastructural integration. 2) Multi-scaler (corridor, regional local). 3) various kind of freight is addressed. 4) Both passenger and freight are considered simultaneously. 5) creation of common strategies and facilitating collaborative

		local scale	regional scale	corridor scale
	Optimize a terminal	o	o	o
	Add a terminal	o	o	o
	Optimize infrastructure	o	o	o
	Add infrastructure	o	o	o
	Optimize a mode	o	o	o
	Add a mode	o	o	o

Figure 14: Principles for multimodal optimisation can be organized in a scheme that contains three dimensions (Source: Broesi et al., 2018; Fluxnet, 2018).

discussions (Fluxnet, 2018). To encourage such an integration, optimization or addition of terminals, transport modes and infrastructure (elements) on the different scales is required. Thereby, adding or optimizing an element may strengthen other fields and levels as well since they are connected via these elements (See figure 14) (Broesi et al., 2018; Fluxnet, 2018). Application to other cases may give interesting insights towards new spatial typologies considering network position, relation to urban areas, and spatial appearance.

2.7 last-mile delivery

Earlier in this chapter the connection between urban nodes (the inter-urban scale) have been addressed in the form of corridors. Simultaneously, on a local intra-urban scale last- mile delivery plays a role within urban nodes. De Souza (2014) defines 'Last mile delivery' as the last leg in a supply chain whereby the consignment is delivered to the (final) Recipient. The 'last mile' (or 'first mile') is a common logistics distribution problem in built-up (urban) environments (de Souza, 2014). Examples are concepts such as urban consolidation centres (UCCs) which entail central location where packages are assembled and arranged efficiently in order to optimize the delivery plan and keep disturbance of logistics low within urban areas (de Souza, 2014). Especially, the coordination of the interface between (national) corridors, regional and (local) last mile transportation hosted by urban nodes is underexposed and to interest of this study. In order to do so, Broesi et al. (2018); Fluxnet (2018) identified four dimensions of the 'chain' consisting of infrastructure (links), hubs & terminals (connecting network dots), mobility (transportation needs) and the spatial context (how the network is used. Effective last mile strategies combine the multiple dimensions in the approach (Heeres et al., 2019). Infrastructure, spatial context and in less extent hub & terminals seem to be more strategic long-term projects enhancing connectivity and robustness whereas mobility seems to focus on short term improvement of connectivity.

The interrelation between last mile and corridor transportation entail substantial parties across the transportation 'chain' which have become dependent on each other in order to improve the transportation system as a whole (Heeres et al., 2012; 2019). Last mile logistics is fragmented and uncoordinated (de Souza, 2014; Arts et al.,2016). Various stakeholders often have their own funding, interests and perspectives on transportation (Arts et al., 2016; Heeres et al., 2019). For this reason, Heeres et al. (2012; 2019) and de Souza (2014) mention the importance of a collaborative and coordinating approach on multi-scaler, multi-disciplinary and considering spatial functions. For instance, the last mile part requires involvement of different (public) authorities as well as private parties and a market mechanism which both respects delivery constrains of carriers and governmental requirements (de Souza, 2014, Heeres et al., 2019). Multi-level governance, tailormade collaborative approaches and instruments which provide structure and solidity (e.g. contracts) seem to address these challenges.

2.8 Importance of scaling

Efficient integration of logistics along a consecutive chain of infrastructure is complex (Van der Linden et al., 2017). These interrelated complexities originate from various transport services along the chain (long-distance vs. last mile city logistics) which relating components such as infrastructure and environmental regulations and policies are operated by different stakeholders. Moreover, along the chain different spatial scales play a role containing of fine-mazed local, city regional networks and corridors linking urban nodes (van der Linden et al., 2017). Often scales are addressed along linear patterns. From urban node connecting corridors, Daily urban system or Functional urban Areas towards (local) last or first mile measures (Arts et al., 2016). Especially, the Daily urban system (DUS) level is poorly understood in literature. The Daily urban

system (DUS) is used as framework for daily activities of individuals (see figure 15) (Arts et al., 2016). However, the daily urban system (DUS) does not seem to match logistics purposes since it is mainly person oriented (Linssen et al., 2018; Van der Werf et al., 2019). Deviated from the DUS is the Functional Urban Area or FUA which seem the direction towards defining the influence area of core urban nodes regarding logistics (van der Linden, 2017; Linssen et al., 2018). The definition of FUA is seen as complex (Linssen et al., 2018). The FUA is understood as urban-regional interaction of the city's connections with its hinterland (Sýkora, 2009). The OECD defines the FUA as densely inhabited city and of a surrounding area (commuting zone) whose labour market is highly integrated with the city (OECD, 2013). The population is usually well served within FUAs by jobs and services concentrated in urban cores (Sýkora, 2009). Usually, the FUA is bigger than the DUS and are both considered as highly dynamic and fundamentally differ in terms of time and theme of an activity (Arts, 2014; NUVit, 2015). In addition, linking and optimizing these different levels may be solving bottlenecks while serving corridor and local spatial-infrastructural issues resulting in synergic planning (Arts et al., 2016; NUVit, 2015).

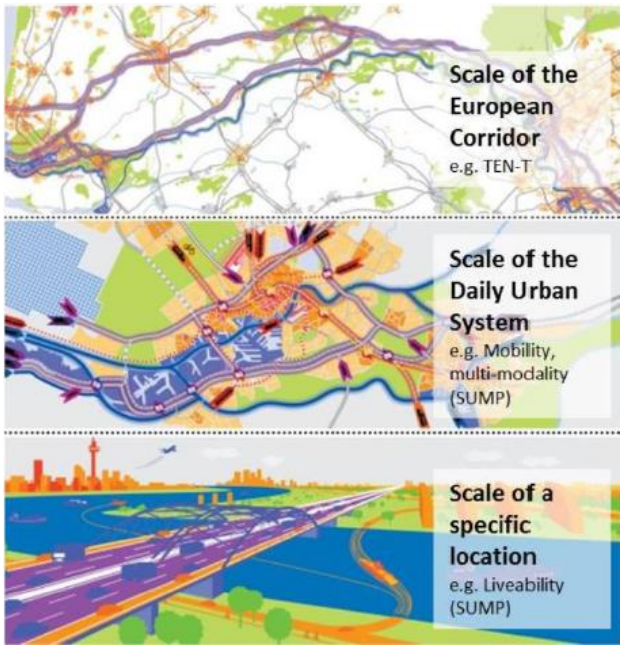

Figure 15: Linking different levels (Source: Arts et al., 2016)

2.9 Addressing multiplicity: Vital Nodes Toolbox

When merging all the 'ingredients' which are discussed before, a comprehensive and defined approach towards urban nodes is arising (Vital Nodes, 2019). Combining spatial scales, sectors, modalities, and multi-level governance and various stakeholders in order to integrate logistics within common spatial-infrastructural procedures seems required since a one-size-fits-all solution isn't capable of addressing multiplicity (Broesi et al., 2018; van der Werf et al., 2018). Vital Nodes approach is based on the NUVit project which defined six main dimensions (see figure 16) resulting in successful integrated land-use and infrastructure planning (Arts et al. 2015; NUVit, 2015). First, the network dimension is about multi-modal optimization, various spatial scales regarding logistics. Second, the spatial dimension which include spatial concepts and accessibility which creates, together with the network dimension, synergies. Third, network and spatial are related to timing (short-term and long-term) strategies and the captured value creation of the combined development. Lastly, in order to instigate effective integrated spatial infrastructural planning, a fitting institutional governance framework and coordinated implementation including communication and identification of barriers would be recommended (arts et al., 2015).

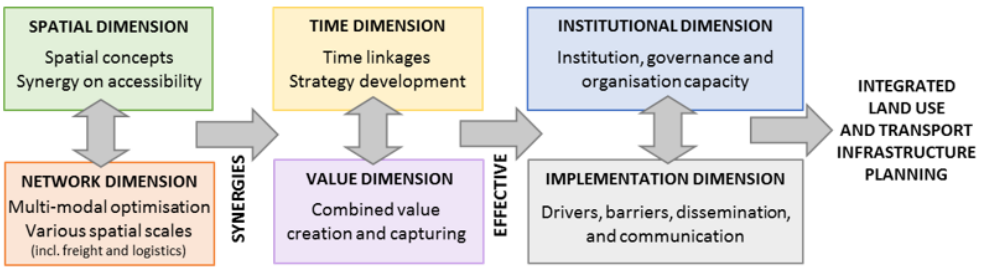

Figure 16: linkages between different dimensions (Source: Arts et al., 2015)

The toolbox includes methods and 'good 'practices which may give direction towards integrated approaches regarding multimodal infrastructure, freight & logistics and spatial planning interventions. Often a combination of tools with different perspectives act upon different dimensions might be necessary to address the complexity of urban nodes (Arts et al., 2015; Vital Nodes, 2018). Thereby, the 'what' is the added value of spatial-infrastructural integration is essential for synergy creation on various levels (horizontal arrow). Thereafter, the 'How should this be addressed be answered by addressing timing, finance and institutions (figure 17) (Vital Nodes, 2020). To address spatial-infrastructural context-related nature of urban nodes, the local knowledge may be essential which requires stakeholder involvement. Furthermore, time and value elements require strategic thinkers. The last phase requires the decision-making process of fitting solutions addressing complexity, starting off with a new cycle (van der Werf et al., 2018).

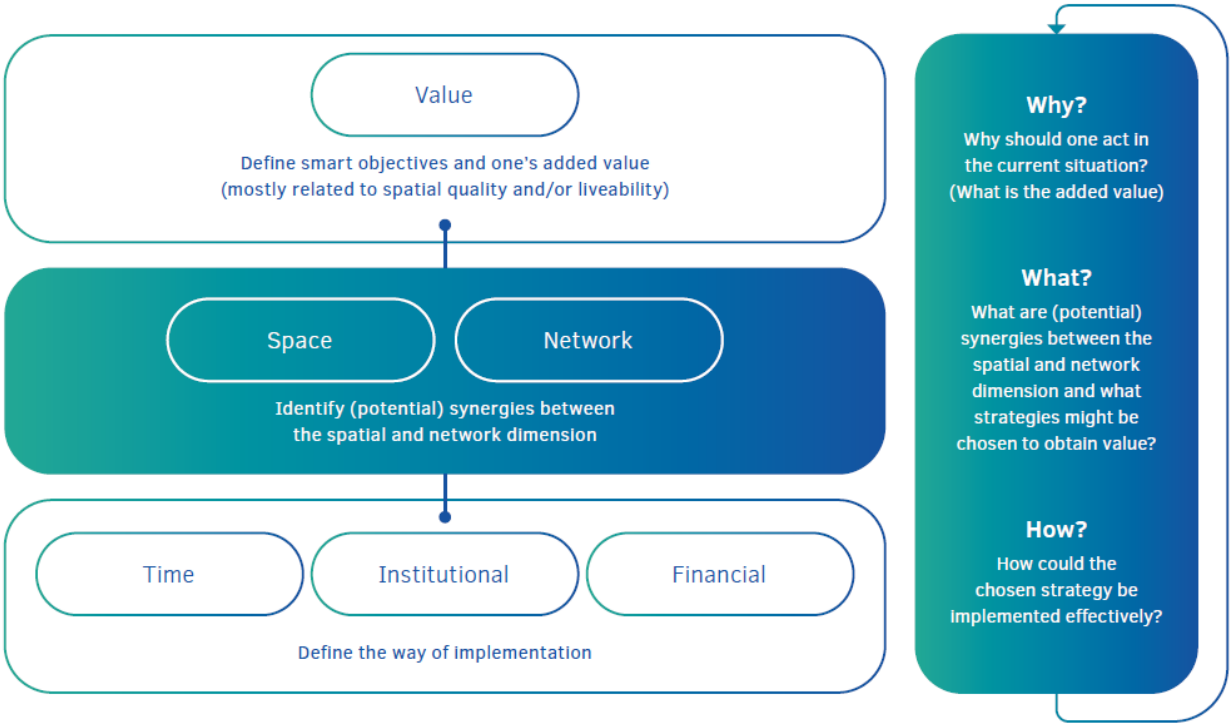

Figure 17: Configuration of the dimensions after application in Vital Nodes for integration of urban nodes and TEN-T (Source: Vital Nodes, 2020)

2.10 Towards a conceptual model

This chapter discussed the relevant theories and concepts relating to the integration of the spatial and infrastructural domain. To conclude this chapter, a conceptual model which is based on the Vital Nodes approach is composed (see figure 18). The Vital Nodes approach addresses the **'integration of land-use and transport planning (LUTI)'** by answering the '**why'**, '**what'** and **'how'** question.

According to van der Werf et al. (2019), the basis of an comprehensive strategy is the '**added value'** that integration of the spatial and network dimensions has. '***Why'*** *is action needed in the current situation?* In particular, the '**added value'** for each actor individuality is important. To this end, creation of a common understanding of each other's perspectives and insights may strengthen shared goals even if one's own objectives are not influenced directly. Such collaborations may strengthen the trust between actors and may, therefore, lead to removal of barriers and alignment of policy objectives. Subsequently, potential synergies between the two policy fields need to be identified. '***What'*** *synergies between the '**spatial and network'** dimension may be serving a complementary approach to obtain this '**added value'**?* Lastly, it is important to consider '**how'** these strategies can be implemented effectively. The '**financial'**, **'governance'** and '**timing'** elements define the way of implementation. The outcomes of the Vital Nodes approach will improve the integration of land-use and transport planning.

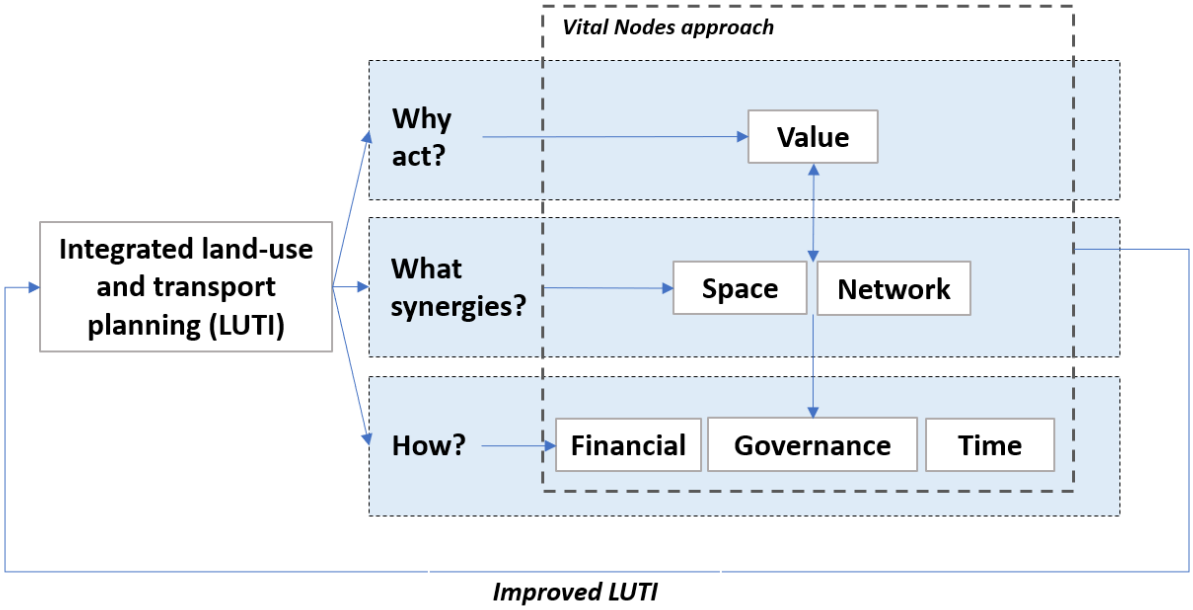

Figure 18: Conceptual model based on van der Werf et al. (2019) (Source: Author, 2020)

3. Research methods

3.1 Research approach

This chapter will elaborate on the methods for data collection, choices for certain stakeholders and the data collection. The logic of the research design is based on application of the Vital Nodes approach into the U-Ned programme. As discussed earlier, the complexity and multiplicity of urban nodes show that a one-size-fits-all solution may not work in addressing problems (van der Linden et al., 2019; van der Werf et al., 2019). In other words, there cannot be one universal solution be identified which allows for tailormade and adapted solutions. Heeres et al. (2012) argue, therefore, that due to the context-dependent and inter-related nature of spatial-infrastructural integration and its related concepts, a qualitative approach is recommended (Heeres et al., 2012). As shown in the previous chapter, the Vital Nodes approach acknowledges this as well by considering different scales, multiple modalities, multiple sector (freight & logistics), stakeholder (and their motives) and multiple governance approaches (van der Werf et al., 2019). Thereby, fact-based planning including action-oriented planning, strategic visioning, monitoring and implementation by means of tools and data is used to unravel these complex multiplicity (van der Werf et al., 2019).

Four methods have been used in order to apply the Vital Nodes approach to U-ned: a *literature study* on U-Ned documentation, *semi-structured interviews, a 'exemplar' case study* on U-Ned and, a *focus group* between U-Ned stakeholders to validate the findings. Using various sources and perspectives of information is known as triangulation which is described as 'using different aspects to give a correct position to gain better understanding of the issue' (Clifford et al., 2010, p.106). In particular, the use of triangulation in a (single) case study could strengthen validity of the research (Yin, 2013). In addition, a focus group consisting of experts validated the findings (e.g. identified challenges and proposed solutions).

The research process consisted of the following stages:

1) A document study has been conducted in order to identify objectives of the U-Ned programme. Furthermore, the policy plans of involved governmental authorities (e.g. municipality, province and Rijkswaterstaat) have been analysed in order to determine specific stakeholder objectives. Simultaneously, a document analysis of the Vital Nodes literature has been conducted in order to define 'good' practices' relevant for the U-Ned case. Documents have been analysed according the following question: What is already done with regard to freight and logistics within U-Ned?

2) Semi-structured interviews have been conducted with various stakeholders with different backgrounds (see appendix 1). These interviews shed a light on challenges, barriers and potential solutions regarding freight and logistics within the MRU (see interview guide, appendix 2). The input of the document analysis and the semi-structured interviews revealed potential synergies between network and space for the U-Ned programme and the way in which these synergies could be implemented effectively.

3) During the semi-structured interviews, two 'exemplar' cases are discussed to illustrate implications of freight and logistics on different scale levels: the 'Merwedekanaalzone' on local level (city) and 'Jumbo Nieuwegein' on regional level (functional urban area). Aim of the 'exemplar' cases was to determine challenges and possible solutions for U-Ned. In general, the case study is a holistic and in-depth research approach which can be used to identify and explore processes in specific situations.

4) The last part of the exploratory research consisted of a (online) discussion group among experts of Rijkswaterstaat, Water, Verkeer and Leefomgeving (Department of Water, Traffic and Environment). In addition, an (online) focus group has been conducted between U-Ned stakeholders to validate the findings. In this discussion, experts have reflected on challenges, potential solutions and implementation strategies within U-Ned. Reflection of the findings among experts will strengthen the final lessons and recommendation for U-Ned usage.

In short, as shown figure 19, policy plans of stakeholders and the U-ned programme have been examined in a (theoretical) document analysis **(stage 1 - examine).** Interviews with U-Ned stakeholders have been conducted to get familiar with the U-Ned context and to gather challenges **(stage 2 - gather)**. The 'exemplar' case studies are discussed during the semi-structured interviews to define implications of freight and logistics on different scale levels **(stage 3 - illustrate)**. Lastly, an (online) discussion group with U-Ned stakeholders has been organized to reflect on solutions, recommendations and (possible) applicable 'good' practices to the U-Ned policy **(stage 4 – evaluate).** Since urban nodes are dynamic and subject to change, a feedback loop is introduced to empathize the ongoing process of adaptation of policies. Nevertheless, in this study the process, as showed in figure 19, is only run though ones.

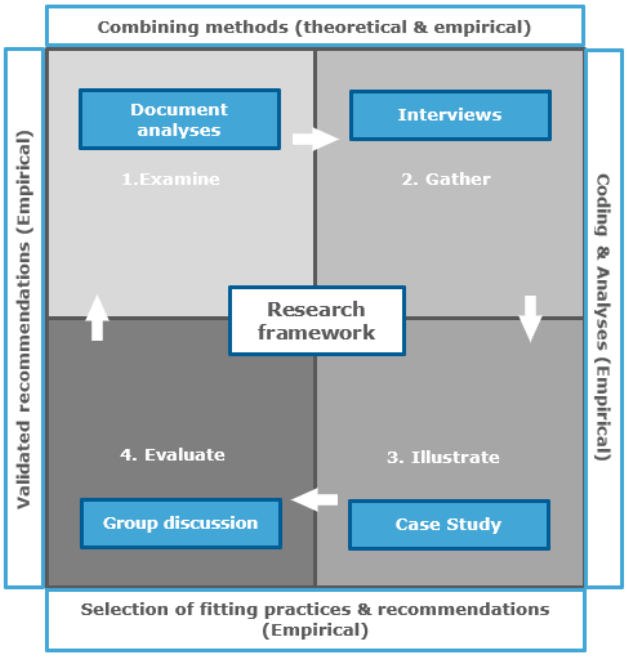

Figure 19: Research approach (Source: author, 2020)

3.2 Data collection

According to der Linden & Linssen, 2017a, a group of potential stakeholders which are relevant for engaging in an interview could cover multilevel and multi-actor communities; national, regional and local actors and experts. These stakeholders include, for instance, representatives of multimodal hubs, infrastructure providers and spatial and urban planners. As shown in appendix 1, stakeholders are selected along the spectrum from different *multi-level governance* authorities (municipality, province and Rijkswaterstaat as executive agency of the Ministry of Infrastructure and Water Management). These organizations affect and operate on different *scale levels* (national, Regional (DUS and FUA) and local last mile) and in different *sectors* (passengers & logistics). Furthermore, these three governmental authorities are responsible for the infrastructure network on the different scale levels. The contacts are mainly provided via the Rijkswaterstaat networks (see appendix 1). The contacts are mainly reached by mail or phone. The municipally of Utrecht has been contacted as major city within the MRU (Interviewee 2). Furthermore, the municipality of Utrecht is closely involved in the development of the Merwedekanaalzone and its implications for logistics on local level. The province of Utrecht has been contacted because of their regional (or Functional Urban Area) viewpoint. Moreover, the province is involved by revising the 'kwaliteitsnet goederenvervoer Utrecht'

('Quality network freight and logistics Utrecht') which is the regional policy for freight and logistics transportation within the MRU (interviewee 5). Participants from Rijkswaterstaat have been approached for an interview to obtain insights in the national road network crossing the MRU (Interviewees 6 and 8), the freight and logistics corridor (interviewee 7) and the Merwedekanaal (interviewee 1). In addition, 'a board member of the Dutch Governmental Advisors' which is an expert on the cutting edge of mobility and spatial planning has been approached (interviewee 3). In this sense, a perspective broader than those of the different single governmental authorities is guaranteed. Lastly, an expert on urban logistics and smart mobility which is involved in development of the Merwedekanaalzone has been contacted to obtain insight in the concrete challenges of freight and logistics in urban areas (interviewee 4).

If an interview candidate was not able to participate in an interview the 'snowball method' is used. This meant that the potential interviewee was asked to recommend other potential participants which may be interesting for conducting an interview. In other words, one person leads to another (Myers & Newman, 2007). Snowballing helps the researcher to obtain a critical mass of interview data (Myers & Newman, 2007). However, this may also lead to unexpected surprises (e.g. interesting or instead irrelevant research lines). According to Myers & Newman (2007) the researcher should always be prepared for such unexpected situations which requires a certain flexibility. An interview guide (see appendix 2) is made as preparation of the interviews to identify challenges, possible solutions and implementation strategies. The structure of the interview guide ensured the answering of the sub-questions as stated in 1.5. Furthermore, the content of the interview guide showed differences between the interviewees because of their various backgrounds and knowledge.

3.3 Semi- structured interviews

This study is based on a qualitative research approach which aims to determine motives, arguments and motives of stakeholders. In this way, underlying complex processes can be identified (Clifford et al., 2010). The participants which have been interviewed can be found in appendix 1. The selection of interviewees has been done on basis of two criteria. First, participants (or their organization) needed to be involved in U-Ned. Or, the participant needed to be involved in issues regarding freight and logistics. In general, participants are representing the three governmental levels namely the municipality (R2), the province (R5) and Rijkswaterstaat (as executive agency of the Ministry of Infrastructure and Water Management) (R1, R6, R7). Approaching these governmental levels has been important since policies for the infrastructure networks, used by freight and logistics transportation, is developed by them. Therefore, the linkage between the different scales can only be identified if all the three governmental levels are considered. In addition, an expert has been interviewed which is specialized in the combination between spatial planning and mobility (R3). This expert has been chosen to obtain a perspective different from the three involved governmental levels. Another expert has been interviewed which is specialized in smart mobility and urban logistics (R4). Moreover, this expert has been involved in development of the mobility concept of the Merwedekanaalzone. This interview obtained insights regarding the practical challenges of freight and logistics within dense urban areas. The interview guide which is used during the semi- interviews can be found in appendix 2.

This form of interviewing has, in contradiction to structured interviews, 'some degree of order but is still allowing for flexibility in addressing the subject' (Clifford et al., 2010, P. 103). 'This type allows participants to use its own words in addressing discussions about subjectivity, meaning and politics' (Clifford et al., 2010, P. 103). Using semi-structured interviews may unravel parts of the context-dependent and inter-related nature of spatial-infrastructural integration (Heeres et al., 2012). This method allows participants to

elaborate further on relevant issues beyond the researcher questionnaire. This may be relevant and effective since every stakeholder has its own perspective and insights (Clifford et al., 2010). Nevertheless, this method allows the researcher to guide the questionnaire back towards the concrete question structure if it is going to much off the subject (Clifford et al., 2013; Yin, 2013).

Transcription and coding

The interviews have been recorded and transcribed which allows the researcher to focus fully on the interview content instead of the noting every word spoken (see appendix 4). Thereafter, the interviews are analysed by means of coding (see appendix 3). Coding is understood as evaluating and structuring data in order to understand its meaning (Clifford et al., 2010). Thereby, the sub-questions are corresponding with the interview guide headings to ensure answering the research question. The semi- interviews are with permission recorded, transcribed and coded by means of Atlas. Ti. The codes are derived from the theoretical background (deductive coding) and by means of inductive coding. The deductive codes (see appendix 3) are mainly based on the Vital Nodes literature. Inductive coding has been used if a particular code was considered meaningful for answering the research questions but was not included in the theoretical framework. These inductive codes are mainly relating to potential synergies and implementation strategies. Initially, inductive codes have been derived from the document analysis or the range of interviews. Thereafter, analytically coding has been executed which means that the codes have been changed to theoretical codes from literature after reflection (Clifford et al., 2010).

3.4 Exemplar case studies

The Merwedekanaalzone (MWKZ) and Jumbo Nieuwegein have been selected as 'exemplar cases' to determine challenges and solutions on different scales within the MRU. According to Flyvbjerg (2006), a case study is defined as detailed examination of a single example of a class of phenomena, a case study cannot provide reliable information about the broader class, but it may be useful in the preliminary stages of an investigation since it provides hypotheses, which might be tested systematically with a larger number of cases. A case includes a unit of observation on a certain time and space with a logical connection to the research question (Flyvbjerg, 2006). The Merwedekanaalzone case and Jumbo Nieuwegein are selected as illustrating cases in order to 'test' the general VN approach in a deductive manner. Is the VN approach valid (or not valid) for this case, then it applies to all (no) cases (Flyvbjerg, 2006). It is often argued by authors that one cannot generalize from a single case alone (Clifford et al., 2010; Yin, 2013).

Nevertheless, most powerful empirical foundation for generalizations derives from an in-depth study of a specific situations in a real-life context (Yin, 2013). In addition, Flyvbjerg (2006) argues that case study insights cannot be generalized does not mean that it will contribute to the collective process of knowledge accumulation in combination or addition with other methods. Therefore, the force of example shouldn't be underestimated (Flyvbjerg, 2006). To this end, these 'exemplar' cases might be seen as illustration for issues regarding freight and logistics on different scales. To strengthen validation of case studies it could be valuable to combine different methods (triangulation) and embed it within existing literature (Yin, 2013). Moreover, constantly evaluation considering what works for whom, when where and why is required (Woolcock, 2013. P.245; Yin, 2013). In Vital Nodes terms: what, why and how determines the value and usefulness of an intervention (van der Werf et al., 2019).

3.5 (Online) focus group

In the last stage, a (online) focus group has been established to reflect on possible practices and recommendations derived from the semi-structured interviews and insight gathered in the exemplar case study. Due to the corona crisis this discussion has been held online in a small group of experts to keep it online workable. Participants of the first focus group (round 1) have been recruited from the Rijkswaterstaat department of Water, Verkeer & Leefomgeving (WVL) (Water, Traffic and Environment), section 'Spatial Planning' (R9, R10, R11, R12, R13, R14 and R15) (see appendix 1). Aim of this round was to deepen the knowledge found in the semi-structured interviews together with experts from Rijkswaterstaat. Furthermore, an online focus group has been organized between U-ned stakeholders (e.g. Province of Utrecht (R5), municipality of Utrecht (R2) and Rijkwaterstaat (R15) (see appendix 1). As discussed in section 3.2, these participants (and their organization) have been selected on basis of their responsibility for the infrastructure provision used by freight and logistics transportation. Furthermore, the expert specialized in the combination between spatial planning and mobility (R3) has taken part to ensure a perspective different from those of the governmental participants. During the focus group discussion, challenges, possible solutions and implementation strategies have been validated by the participants. The questions discussed in the focus group can be found in appendix 5.

According to Clifford et al. (2010) a focus group, has usually 6 to 12 participants which together discuss a particular topic. The aim of such a discussion is the interaction between participants to come up with ideas grounded by various inputs and to give expert reflection (Clifford et al., 2010). Following Stebbins (2001), exploratory research with its open character and emphasises on flexibility, pragmatism is a more inviting and accurate way of representing research than treating it as narrowing, quasi rule-bound and discipline-based process that settles and confirms rather than unsettles and questions what one knows. Exploratory research is perhaps better thought of a perspective, a way of approaching and carrying out a study including reporting what has been learned (Stebbins, 2001). The approach moves the debate beyond oversimplified either-or choices since no single study can be definitive which can be considered as long, open, choice-laden, interest-governed process (Stebbins, 2001). These characteristics match the 'synergizing' tools of Vital nodes in the following way.

Continuous interaction with a diverse group of stakeholders in urban nodes is important for mutual understanding of each other issues and the underexposed awareness of the role of urban nodes by integrating spatial and network components (van der Linden et al., 2017a). According to van der Linden et al. (2019), the challenges of integrating freight and logistics into area-oriented approaches is a 'new kid on the block' for urban nodes which makes exploratory research needed.

3.6 Ethical considerations

If interviews are used as input for research, it is recommended that, the participants are able to speak up in confidential way and know what has happened to his or her data (Clifford et al., 2010). This has been mentioned before the interviews in order create awareness by the participant of his or her rights (Clifford et al., 2010, P.111). The interviews have been held one-to-one which ensures that the participant can express themselves freely. This is aside from a focus group discussion, where interaction between participants is, especially, required. To ensure transparency the research data has been handled only by the researcher and his Rijkswaterstaat and Rijksuniversiteit Groningen supervisors. In addition, a final version has been sent to the participants to act transparent and show what has happened with their input (Clifford

et al. 2010, P. 111). Participants have been interviewed, online, from (most likely) their own home since this study has been conducted during the corona crisis.

Furthermore, the positionality as intern at Rijkwaterstaat need to be mentioned. According to Clifford et al. 2010, it is important to consider, as researcher, consequences of actions for the research context and between actors involved. This is important to consider since actors are affected by the research conducted. In addition, behaving ethical is important to build trust between the researcher and the actors to ensure reliability of the research (Clifford et al. 2010). This demands sensitivity to, and acknowledgment of the expectations, interests and possible tensions of participants within and outside Rijkswaterstaat. For instance, sometimes a strategic choice has been made to approach participants via university communication or, especially, via the Rijkswaterstaat networks. Purpose of this was to enhance the trust building between the participant and the researcher.

In particular, the awareness of affecting the relationships of Rijkswaterstaat with other the organizations and actors involved has been carried out carefully. In fact, an intern is still representing the point of view of Rijkswaterstaat for other actors involved. Conducting research without harming these relationships and collaboration such as U-Ned has been of great importance. If necessary, the transcription of sensitive subjects which are discussed during the interviews are checked to ensure integrity towards the participant. Moreover, an explicit distinction has been communicated between statements and observations made by the researcher and statements of Rijkswaterstaat during the data collection. The independence of the researcher has always been communicated to the participants, although the research request has been initiated by Rijkswaterstaat. To this end, the research is conducted with an open point of view on responsibilities and interests of U-Ned stakeholders. However, recommendations are also given for Rijkswaterstaat in particular.

Data quality

Another important factor should be mentioned with regard to the data collection. The interviews have been conducted via online platforms (e.g. Skype for business and Zoom) due to the outburst of the corona crisis. The interviews have often been conducted on a place where participants felt comfortable. However, this could have resulted in disturbing external factors during the interviews due to the distant communication (Clifford et al., 2010). It is possible that the (online) way of collecting data has influenced the data quality in negative way. Moreover, explanations of the interviewees could have been interpreted and understood in different ways which could have influenced the outcomes (Clifford et al., 2010). In addition, it might be assumed that collected data is valid and reliable in this specific context since all interviewees are considered expert in the field.

3.7 U-Ned as representative test case

So far, the application of the Vital Nodes approach in Dutch context has only be executed in the city of Rotterdam. However, the city of Rotterdam has an exceptional position within the Netherlands due to its large port and increasing large volumes of freight and logistics (Vital Nodes, 2018). The Metropole Region Utrecht (MRU), and more specifically the U-Ned programme, may be a more representative case with regard to Dutch planning practice. The Metropole region Utrecht can be considered as one of the major metropolitan urban regions (G4 cities) within the Netherlands. The MRU consists of a functional urban area (FUA) which serves 880.000 inhabitants (OECD, 2019). This means that Utrecht can be considered as the smallest G4 city while being one of the larger metropolitan urban areas in the Netherlands (OECD, 2019).

In addition, the MRU is designated as a facilitator of an (inter) national 'hub' function within the Dutch infrastructure network (U-Ned, 2018; MIRT, 2019). Furthermore, the existence of an integral accessibility and mobility strategy (U-Ned) underlines the necessity for guiding urbanization and its related issues within the MRU. These issues (including the notion of freight and logistics) play a role in other metropolitan areas as well. The fact that the MRU is designated as one of the larger (above-average) metropolitan urban regions in combination with its important 'hub' function makes it an interesting 'test case' for other metropolitan urban regions in within the Netherlands.

For planning practice, the application of the Vital Nodes approach within the MRU may serve as valuable example for considering the notion of freight and logistics in accessibility and urbanization programmes such as U-Ned. These insights may function as representative example for other accessibility and urbanization programmes, as well. For planning practice within Rijkswaterstaat, the implications for the major road infrastructure and linkage with different scales and networks may give interesting insights. In particular, the role of Rijkswaterstaat, as major road network operator, in these developments may be an important lesson to learn from.

4. Findings: the value of Vital Nodes for the MRU

The results obtained during the document analysis and the interviews will be presented in the following sections by means of the Vital Nodes approach as shown in figure 17. First, in 4.1 the metropole region Utrecht will be considered as urban node according the Vital Nodes approach. Section 4.2 will discuss current developments and policies within the MRU on the three scale levels (local, regional or functional urban area and (inter) national level) because authorities involved on these scales having their own policies, action plans and agendas regarding freight, logistics and mobility. The two 'exemplar' cases Merwedekanaalzone and Jumbo Nieuwegein will be discussed here. Section 4.3 will present the possible synergies between space and network followed by section 4.4 which will discuss possible implementation strategies regarding governance, time and finance. Lastly, 4.5 will enrich the Vital Nodes toolbox by introducing possible good practices identified within the MRU.

4.1 Characteristics of the MRU as an urban node

To compare the MRU with other Vital (urban) nodes in the network a few characteristics as defined by Böhler et al. (2019) provide tools for typology. Characteristics of urban nodes are depending on the specific place and context in which they are connected to other nodes (van der Werf et al., 2019). Table 1 shows the concretization of the MRU as urban node in comparison to other urban nodes. The MRU can be characterized as relatively small regional hub which is mainly driven by inbound consumption. Production and transit are not a major typology although a continuous growth in the logistics sector is creating an increasing polycentric function within the Netherlands (Municipality of Utrecht, 2015; RWS-MN, 2019). The MRU is designated as metropolitan region which contains a FUA between 250000 and 1,5 million inhabitants. The FUA includes roughly the whole province of Utrecht (OECD, 2019).

Urban Nodes typology	Cross border: multi or unimodal	Sea: Gateway/ regional hub	inland: size: small / big (1 mln or more)	Relation of the node and the Corridor: consumption or production and transit)	Developed / cohesion region	Centric versus poly centric
Metropole Region Utrecht (MRU)	-	regional hub	Inland, small	inbound / consumption	Developed	Polycentric (borrowed size)

Table 1: Urban nodes typology (Source: Vital Nodes, Deliverable 2.3, 2019)

Current developments regarding freight and logistics in the MRU

To determine valuable synergies between space and network and implementation strategies it may be valuable to consider current policies regarding freight and logistics. To this end, various policy documents have been analysed on the three governmental scales: local level (city of Utrecht), regional level (province of Utrecht and the U16) and on national level (Rijkswaterstaat). Consideration of these three levels is important to uncover the interrelationship between these networks and to find solutions accordingly.

Local Level (city)

The municipality of Utrecht is currently working on a revision of their freight and mobility plan: 'Slimme Routes, Slim Regelen, Slim Bestemmen' (smart routes, smart regulation and smart zoning). Aim of the policy is improvement of liveability, spatial quality, economic vitality, accessibility, reduction of energy and sustainable logistics (Municipality of Utrecht, 2015; R2, 2020). The municipality acknowledges the fact that the focus should be on infrastructure which facilitates upcoming trends of logistics, for instance, terminals

and consolidation centres. Therefore, infrastructure, as theme, is integrated with developments and rise of new logistics concepts because of their interrelation (Municipality of Utrecht, 2015). However, the policy states that implementation of logistics concepts in a top down manner may be difficult because the region does not involve a strong logistics or industrial cluster. In this sense, facilitating and simulating initiatives would be more appropriate (Municipality of Utrecht, 2015). Within the action plan 'smart routes, smart regulation and smart zoning' five themes are identified with regard to freight and logistics on city level. The following measures are important (see figure 20):

1) Focus on safer and smart logistics by creation of more efficient loading locations and routes;
2) Zero emission city logistics which reduce the number of trips and improve spatial quality of public spaces as trigger for change. Aim is zero-emission provision of the inner-city in 2020 and in 2025 the whole city (first stimulated, later regulated) (Municipality of Utrecht, 2015; MIRT, 2019, R2). Initiatives such as hubs, (flexible) loading locations including charging stations are stimulated and facilitated. Furthermore, a city exemption scheme including bundling criteria is maintained to decrease the number of vehicles (Municipality of Utrecht, 2015; R2, 2020).
3) Development of logistics construction hubs which supply construction sides in an efficient way to reduce disturbing construction traffic within the city itself (e.g construction Merwedekanaalzone).
4) Upgrading consolidation possibilities on Lage Weide (port of Utrecht): cooperation between city and industry with the intention to connect last-mile with long-distant transport since it is the major industrial area which is connected via rail, road and water. Part of this is the realisation of a distribution centre to link scales. Investments in deepening the port, renewal of barges and access with the A2 have been realised;
5) Reducing the number of last- mile logistics movements in neighbourhoods. Cooperation between carriers and retailers by using the same hubs are stimulated. Development of MWKZ is seen as starting point (Municipality of Utrecht, 2015).

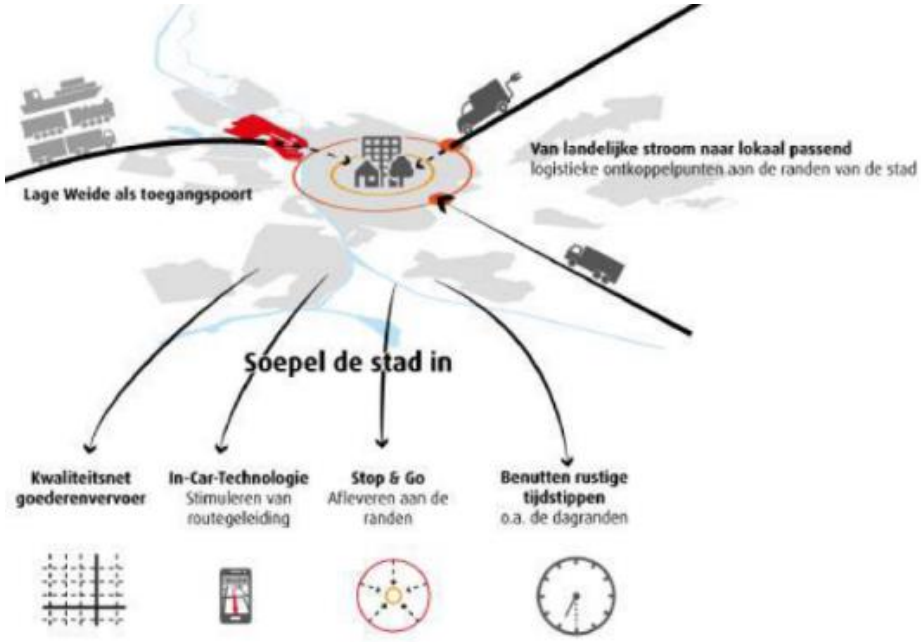

Figure 20: Logistics in Utrecht 2025 (Source: Municipality of Utrecht, 2016).

Exemplar case: Merwedekanaalzone (MKWZ)

To achieve the ambition to accommodate residential areas and zero-emission standards within the its city boundaries, the city of Utrecht has decided to develop the former brownfields along the Merwedekanaal. The highly urbanized development contains of a high number of housing on relatively small piece of land. The development will host a maximum of 10.000 houses and will have a parking standard of 0,3 or lower. Such a concept requires an alternative approach with regard to mobility and logistics (Stedenbouwkundig

Plan Merwede, 2020; R2; R4, 2020). Pedestrians and bikes will be the major way of transportation within the neighbourhood. Mobility services are provided by so-called 'mobility hubs' which provide 'Mobility as a Service' (MAAS) such as car-sharing and E-bikes, E-scooters which are 24/7 available (Stedenbouwkundig Plan Merwede, 2020; Goudappel Coffeng, 2018; R4, 2020). In addition, bus lines and a (potential) tramrail which connect the neighbourhood with the inner-city, the central station, P+R Westraven, railway station Lunnetten-Koningsweg and Utrecht Science Park will be provided as alternative for car usage.

Logistics related transportation will also provide by these mobility hubs will also function as consolidation hubs for goods and packages for delivery within the neighbourhood and will be situated and clustered on the edge of the neighbourhood together with other facilities (figure 21 & 22) A distinction is made between four kinds of transport flows.

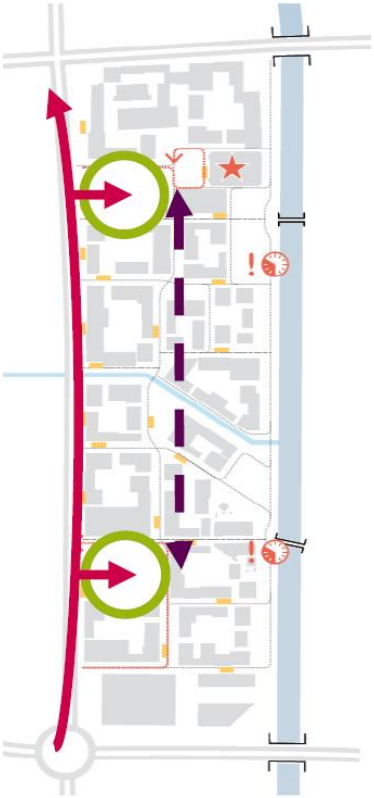

Figure 21: Logistics principle of MWKZ (Source: Goudappel Coffeng, 2019)

1) Consolidation on the edges: Clustering on the edges of MWKZ ensures an efficient stocking of facilities (retail, catering and offices supplies) without entering the actual residential area. Loading locations need to be reserved to ensure optimal use and distribution during the day will be realised;
2) (Indoor) bundling of goods by means of hubs: Smaller service logistics and parcels are consolidated indoor in the mobility hub. Possibilities are offered to make a model shift from delivery vans towards light zero-emission vehicles indoor nearby the mobility hub. To minimize the length and number of trips parcel lockers at the corner of the apartment buildings and a parcel pickup point at the mobility hub will be realised (Stedenbouwkundig Plan Merwede, 2020, R2; R4, 2020);
3) Admission of (small!) light electric vehicles (LEV's) owned by companies such as PostNL and DHL which are currently making a shift to zero-emission delivery (R4, 2020)
4) Usages of dynamic permits: for a few logistics flows is made an exception in case they comply to the requirements such as type, size, time and fuel (Goudappel Coffeng, 2019). Dynamic permits will be given to food suppliers, movers and retail and catering within the area (Goudappel Coffeng, 2019; R4, 2020).

Aan de rand van het gebied	Logistieke hub (nabij mobiliteitshub)	Dynamische ontheffing in het gebied
Retail	Serviceloqistiek	Retail en horeca in het qebied
Horeca	Pakketten	Boodschappen naar consumenten
Kantoor/rest		Maaltijden
		Verhuizen

Figure 22: Flow characterization MWKZ (Source: Goudappel, 2019)

Usage of the Merwedekanaal as way of transportation

Rijkswaterstaat has researched the added value of the Merwedekanaal with an eye on dense city developments as MKWZ. The usage and value of the Merwede canal regarding circular economy, efficient land-use, sustainable mobility and energy (Posad Spatial Strategies, 2018). The canal is strategic located in the heart of Utrecht and is connected with the Amsterdam-Rijn canal, which is one of the busied waterways of Europe (R1, R6, 2020). The Merwede canal can be seen as literally the green- blue long of the city (Posad Spatial Strategies, 2018; R1, 2020). Currently, the canal is seen as a barrier in the city but can gain added

value with regard to alternative modalities for city logistics considering development of the Merwedekanaalzone and other dense urban area developments around the canal (Posad Spatial Strategies, 2018). One scenario that has been envisioned is the possibility of transportation along the canal by building loading wharfs for sustainable shipping to reduce pressure of logistics on the city network (See figure 23) An important concern are the bridges which needed to be designed in such way that they allow passage of (cargo) ships and have the required height and width (Posad Spatial Strategies, 2018; R1, R2, 2020). Alignment of developments and using momentum seems to be important now the opportunities arise (Posad Spatial Strategies, 2018; R1, 2020).

Regional level (functional Urban Area)

On Regional level the so-called 'kwaliteitsnet goederenvervoer' ('quality network freight and logistics') is introduced in 2008 which is a cooperation between Rijkswaterstaat, Midden-Nederland, the province of Utrecht, municipality of Utrecht, the U16 (the former 'Bestuur Regio Utrecht', BRU) and transport and logistiek Nederland. The 'kwaliteitsnet goederenvervoer' is defined as *a coherent network consisting of connections between economic centres which consolidate freight and logistics (BRU, 2006*).

To this end, the policy provides concrete guidelines towards common choices for alignment and invests in keeping the network up to date together with involved municipalities and the province (BRU, 2006). The term 'economic centres' indicates the inner cities, industrial areas and solitary companies which generate relatively much freight and passenger flows. The economic centres are connected by indicated infrastructure which together constitute the broader network 'linkages (see figure 23) (BRU, 2006).

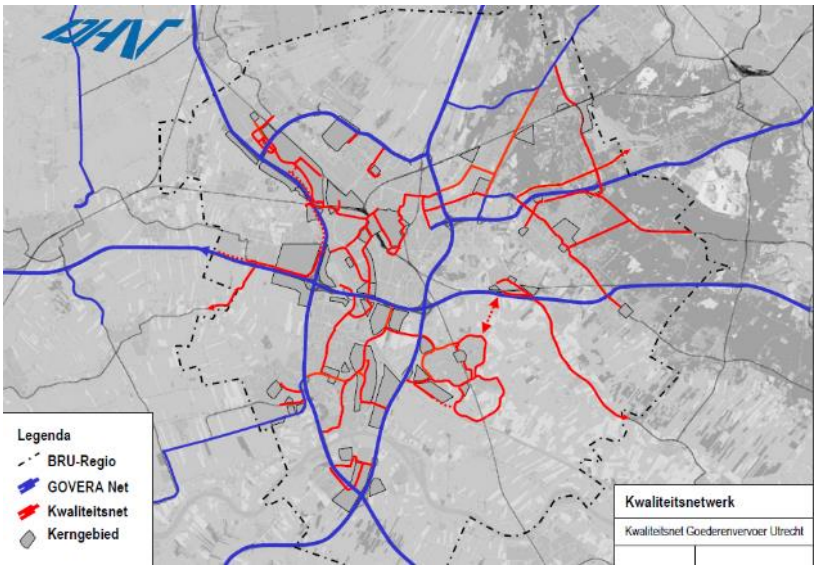

Figure 23: Quality network Utrecht (Source: BRU, 2006)

However, qualitative relations of these economic centres with each other and in the broader network are not much considered. Standards for this infrastructure are, thus, mainly based on concrete criteria such as the physical qualtity of the network, accessibility and safety (BRU, 2006). The function of the province is mainly seen as facilitating and stimulating authority with regard to investments in zero-emission logistics, cleaner freight transport, synchro-modality and bundling initiatives (Province of Utrecht, 2019; R5; MIRT, 2019). The province of Utrecht is planning to actualise the old 'kwaliteitsnet goederenvervoer' with an additional focus on noise pollution, (linkage of) multi-modality via water and road and consolidation locations (Province of Utrecht, 2019; R5, 2020). Furthermore, the province is planning to broaden its focus to the area of spatial planning and provision of clean energy facilities for freight transport and inland shipping at, for instance, Lage Weide (Province of Utrecht, 2019; MIRT, 2019). To this end, initiation of knowledge-sharing and cooperation between municipalities and industry is seen as crucial in further development of this ambitions (R5, 2020). In addition, in programme U-Ned the redevelopment of the A12

zone is mentioned as potential brownfield redevelopment but is considered quite complex (U-Ned, 2018, MIRT, 2019).

Exemplar case: Jumbo Nieuwegein

Supermarket concern Jumbo opened last year a new sustainable and fully automatic warehouse with the size of 45000 square meters along the A12 corridor on industrial park 'the Liesbosch in Nieuwegein (figure 24) (Jumbo,2020). Features such as charging stations for electric cars and bikes, solar panels and greening of the terrain have been implemented (Jumbo, 2020). Aim to the construction is a more efficient supply of a range of 12000 non-perishable products to all jumbo supermarkets in the Netherlands (Logistiek.nl, 2020). The central location, future expansion possibilities and boost for 'the Liesbosch' supported the choice for this location (Municipality of Nieuwegein, 2018). *'It underlines the attractiveness of this municipality as important national distribution hotspot'* (Municipality of Nieuwegein, 2018). In this sense, this terminal can be characterized as terminal which operates mainly at national scale larger than Utrecht' Functional urban area. In this sense, the location is well connected to the major road network and the other parts of the Netherlands (R7, 2020). However, locations around the A12-zone nearby the residential areas of Utrecht are becoming more scares which raises the possibilities for zoning (R2; R5, 2020).

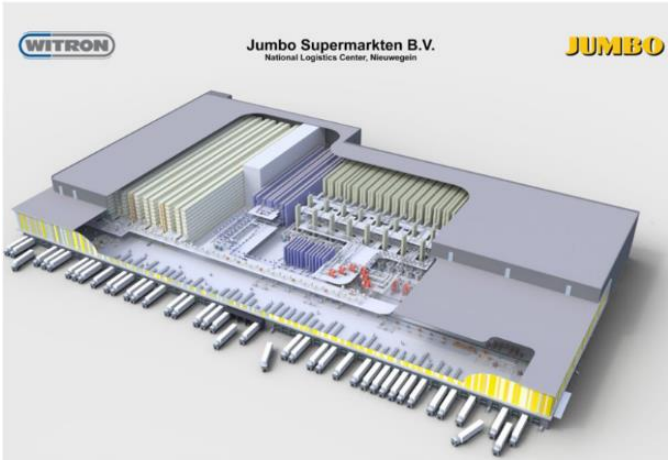

Figure 24: Fully automatic warehouse Nieuwegein (Source: Logisitiek.nl, 2020).

> *~ 'It may be a logical place to situate such warehouse with a national function along the A12. Undoubtedly, there will go a few flows of city logistics into the city of Utrecht. However, it may be questionable if a valuable location along the A12 could have had more added value for Utrecht (and surrounding municipalities) oriented city logistics instead the national functions which it has now (R3; R7, 2020).*

Besides, the warehouse is made automatic which lacks the opportunity for additional jobs in the region which makes it less attractable for municipalities to host such developments (R2, 2020).

(Inter) national Level (corridor)

The MRU has a major 'hub' function ('draaischijf functie') with regard to the transportation network of the Netherlands (especially regarding the highway and railway networks); It plays a crucial function in facilitation of (peri-urban) flows between major urban metropole regions, main ports and hinterlands (U-Ned, 2018; RWS-MN, 2019; MIRT, 2019). The ongoing urbanization and its additional (intra-urban) traffic as consequence create tensions between these flows (MIRT, 2019). Therefore, this tension has a great influence on all scales of the network including the ring road which is already quite congested. An adequate and vigorously approach regarding the bottlenecks on the ring road is desired while considering expression of the 'Noordelijke Randweg Utrecht (NRU) (MIRT, 2019). Therefore, a strategic planning by adjustment between various scales is needed to guide developments in the MRU (RWS-MN, 2019). Furthermore, as part of the mobility and urbanization strategy, the subject of freight and logistics is still underexposed within RWS-MN and U-Ned (R6, 2020). Current, Rijkswaterstaat-Midden Nederland is developing a strategic action

perspective in which freight and logistics is seen as an element of Rijkswaterstaat' area-oriented approach towards mobility and other actors involved. Thereby, short-term, midterm and long-term actions regarding logistics are identified and turned into an (possible) action or measures (R6, 2020). Also, this vision is still searching for actions regarding freight and logistics on the major Rijkswaterstaat networks which underlines the blind spot of accommodation of logistics within the MRU.

Synthesis

The desk research shows that the matter of freight and logistics is underexposed on regional level within the MRU. The number of documents which are still in the revising or updating phase underline the necessity of the blind spot of freight and logistics as part of a broader urbanization strategy. The need for a common vision on accommodation of freight and logistics may be desired. On local level, it may be relatively easier to implement measures compared to larger levels because of the number actors involved and (governmental) boundaries faced. Given the fact that freight and logistics cut through multiple governmental layers, private and public sectors, scales and physical boundaries results in uncoordinated blind spot since actors involved are all responsible for a different piece of the link or the chain.

4.2 Key challenges within the MRU

In the following sections, the major challenges regarding freight and logistics (4.2) will be linked to possible synergies between network and space (4.3) and its implementation (4.4). During the interviews and document analysis, four major challenges have been found. The challenges are supported by the identified knowledge gaps regarding freight and logistics as discussed in chapter 2 of this study. The challenges comprise:

A. the underexposed role of freight and logistics within U-Ned in general;
B. the improvement of coordination and collaboration on functional urban area level;
C. the vulnerably of the (infrastructure) network;
D. the need for an alternative transportation 'chain' towards dense urban areas.

The challenges are closely related to each other but discuss different aspects faced within the MRU. Acknowledging these challenges is essential to determine the added value of possible solutions by involved stakeholders related to one's own specific objectives. Seeing the value of addressing challenges might be easier if the urgency is endorsed even though the added value will pay-off later.

A. Lack of Logistics-Oriented Development goals within U-Ned next housing and mobility

> *~ 'The weird thing about the new environmental & planning act as well as U-Ned is that it has a narrow focus on accommodation of housing and the need for accessibility, while nobody thinks about the fact that those people need to be supplied by logistics as well' (R5, 2020).*

U-Ned, as urbanization and mobility platform, mainly has its focus on accommodation of urbanization and mobility strategies within the metropole region Utrecht (R5; R6, 2020). Thereby, the importance and impacts on freight and logistics as part of the broader urban strategy is ignored (R5; R6, 2020). First, accommodation of freight and logistics functions competing with the accommodation of housing may be a challenge in, for example, the A12 zone (R3, 2020). The A12 zone seems to be a valuable consolidation

location for city logistics of Utrecht and Nieuwegein (R2; R3; R4, R5, 2020). In particular, with an eye on the upcoming zero-emission zones it may be strategic valuable to regulate and reserve areas around the A12-zone in order facilitate the space for (city) logistics consolidation and linking last mile and long-distance logistics (R3; R5; 2020). However, U-Ned described developments in the A12 zone as an opportunity but is also considered as quite complex due to scarcity of space and additional pressure on the infrastructural networks (U-ned, 2018; MIRT, 2019). In this sense, (regional) consolidation centres which not necessarily supply the cities of Utrecht or Nieuwegein such as the Jumbo distribution centre may compete with (city) logistics functions in the area (R2; R3; R5; R6, 2020). The same goes for waterfronts along the Merwedekanaal and nearby the A12 to facilitate multimodality and transhipment to the water (R3; R5, 2020).

Currently, Logistics-Oriented Developments in agreement with future developments of mobility and urbanization are not included in the U-ned goals which makes it fragmented and incomplete (R6; R8, 2020). Besides, the competition between logistics and mobility and urbanization goals the combination may be a challenge (R3, R4; 2020). Currently, U-Ned focusses mainly on the further development of current hubs and development of new hubs around Utrecht. There seems to be ad-hoc urban sprawl of logistics instead of coordinated polycentric urban development and multi-modal solutions (R3, 2020). The combination and connection with logistics is not made (R4, 2020). The challenge of mixing functions around the ring roads may be a necessary step in the integration of logistics in the urban with an eye on zero-emission zones in cities (R3; R4; R5, R7, 2020). The challenge is to consider if and how U-ned can be a (potential) platform for coordination of freight and logistics in balance and combination with urbanization and mobility issues towards realisation of common measures and scenarios.

B. Improvement of coordination and cooperation of spatial planning and infrastructure regarding freight and logistics at regional or Functional Urban Area level

The overall picture derived from the interviews and document analysis shows a lack on (coordinated) Logistics-Oriented Development within the MRU. Each actor (e.g. municipality, province and Rijkswaterstaat) acknowledge the rising challenges of freight and logistics within the MRU and develop their own strategies, policies and action plans within their boundaries and responsibilities (R1; R2; R5, 2020). The focus is often laid on specific projects while ignoring their relation to the broader (spatial) area, network or other developments within the network. As consequence, potential synergies are missed, noticed too late or do not complement each other (R5, 2020). Obviously, this fragmentation is logical since funding streams and agendas are different (R1; R2; 2020). The municipality focusses predominantly on zero-emission logistics whereas the province is concerned with development of clean energy hubs and sustainable inland shipping (R2; R5, 2020). Thereby, the regional focus is often on zero-emission person mobility and not much on cleaner fuel for freight transport (R5, 2020). Also, alignment of policies between municipalities is often lacking (R2; R3, 2020). Furthermore, implementation of a zero-emission zone has the tendency to 'push' traffic towards the ring road which causes even more pressure which should be accommodated (R15, 2020). In contrast, Rijkswaterstaat- Midden Nederland focusses mainly on the keeping the highway network around Utrecht going and tries to 'shave off' the local network (R15, 2020). Moreover, they aren't activity involved in clean energy initiatives and strategic clustering of consolidation centres (R3; R6; R7 2020).

The 'Kwaliteitsnet Goederenvervoer' ('quality network freight and logistics') focusses predominantly on physical, network infrastructure but not much on the coordination of logistics development, spatial and infrastructural integration and synchromodality (R2; R5, 2020; BRU, 2006). However, the province is intending to focus more on spatial planning considering logistics (province of Utrecht, 2019). In this sense, there is a lack of common understanding of what Logistics-Oriented Development is and which (positive)

influence it can have on local, regional (FUA) and national scale (R3, 2020). For instance, in linking last mile and long-distance transport. Moreover, a coordinated and strategic policy and action plan with anchored goals seems to be missing. Such a common vision integrating local, regional (FUA) and national responsibilities on freight and logistics in the MRU may ensure a better coordination and understanding of impacts on different scales.

C. Vulnerability of the network conflicting (transport) flows of local on the one hand and regional and (inter) national on the other

As stated by Rijkswaterstaat, Midden Nederland, the fragile network around Utrecht has to deal with capacity problems between national regional and local traffic and competing flows of passenger and freight and logistics (Rijkswaterstaat, MN, 2019; R6, 2020). In particular, the A12 (Gouda- Oudenrijn-Lunnetten) and Ring road Utrecht (A2, Papendorp between Maarssen and Nieuwegein) are competing with the underlying network (e.g. Europalaan) which results in creation of bottlenecks on both networks (MIRT, 2019; RWS-MN, 2019). Moreover, it is uncertain which influence developments such as the Merwedekanaalzone (Rijkswaterstaat-MN, 2019) and, for instance, developments of mobility or logistics hubs along the ring road will have on traffic flows and creation of bottlenecks (R3; R6, 2020).

However, multimodal hubs and 'parkeren op afstand' (long-distant parking) as consequence of development of the Merwedekanaalzone may create an accumulation of traffic nearby the A12-zone (Rijkswaterstaat-MN, 2019; R3; R4; R8, 2020). Regularly, traffic is dispensed and divided across the city when heading to the major ring road (R4, 2020). In this sense, commuting traffic towards the ring road is clustered and concentred at the ramps of the A12 (R4; R8, 2020). At least another road configuration is required other than expansion and simply adding capacity (R3; R4, 2020).

D. Connecting last mile and long-distance transport in towards an efficient 'chain'

The development of zero-emission zones and earlier mentioned trends in (city) logistics allow for the a more efficient and different linkage between (inter-urban) last-mile and (intra-urban) long-distance transport. Regular transport modes and consolidation locations have increasingly impact on urban regions and, therefore, seen as unsustainable (R2; R3; R4; R7, 2020). Connecting these scales is complex since multiple modalities, private and public stakeholders and different scales of operation are involved (R2; R3; R4, 2020). These challenges apply both to passenger hubs and logistics hubs as well as for a possible combination between the two (R3; R4, 2020). In addition, goods can be transhipped at locations along the ring road (R2; R3; R4; R7, 2020), at the edge of the zero-emission zones (R1; R2; R3, R4, 2020) and between urban nodes (R6; R7, 2020). Location of the consumer is an important criterium (See case Jumbo Nieuwegein) and is dependent on the space, infrastructure and modalities available (R5; R7, 2020). Thereby, other modes of modalities suitable for the passenger or specific logistics should be available any minute, at all time to create a smooth modal shift towards the destination (R2; R4, R7, 2020). For instance, developments of hubs require different forms of cooperation such as multi-level governance approaches between multiple municipalities, (Utrecht and Nieuwegein), province of Utrecht and Rijkswaterstaat (R3; R6, 2020).

4.3 Towards synergies between space and infrastructure

In this section, concrete synergies between network and space, relating to the four challenges, are discussed. The possible added value these synergies obtain, for the MRU is discussed. The challenges are indicated in this chapter by capital letters (A, B, C, D) and linked to the ideas, concepts and strategies by indication with a number (1,2,3,4).

Network + Space

A1: Lack of Logistics-Oriented Development goals & B1. Integrating Logistics-Oriented Development: strategic clustering of clean energy hubs, (secured) truck parkings and consolidation centres on Functional Urban Area level

To strengthen the MRU's network on freight and logistics on regional and functional urban area level a broader focus on location, clustering and strategic situating within the broader (FUA) network is needed. The current MRU comprehensive strategy on freight and logistics (kwaliteitsnet) is mainly focused on the physical (road) network and bottlenecks while ignoring spatial planning and various transport scales and modes, for instance, the combination with inland shipping along the Amsterdam-Rijn kanaal (Province of Utrecht, 2019; R2; R5, R7, H8, 2020). In addition, strategic clustering of (re) developments of logistics functions such as 'clean energy hubs, (secured) truck parkings and de- coupling hub in order to reduce additional trips, emission and disturbance within urban areas is often uncoordinated (R7, 2020).

> *~ 'Clean energy hubs, truck parkings and de-coupling hubs, all beautiful concepts. Clustering of these logistics functions are essential in prevention of individual logistics sprawl across the city regions. […] Naturally we search for sustainable solutions in clean fuels but bundling and clustering of this activities may be perhaps even more valuable to achieve sustainable benefits' (R7,2020).*

Developments are mainly based on stand-alone initiatives which are facilitated and stimulated by bringing parties together but aren't part of a boarder coherent network of facilities and policy (R5, 2020). Strategic clustering within the boarder network may be perhaps from more importance than the sustainably of the vehicles itself which will becoming increasingly cleaner with an eye on the future (R7, 2020). Moreover, spatial clustering results in relatively less use of space, less unnecessary trips and less spatial fragmentation and sprawl (R7, 2020).

> *~ 'My role as governmental party is the facilitation and stimulation of initiatives and bring parties together as long as we think that it fits in our network and policy. At a given moment, parties need to close their own business case' (R5, 2020).*

Another point which should be made is the synergy between clustering clean energy hubs with other facilities and functions. For example, a shared, up to date infrastructure network which is well connected (R3, 2020). This is needed because it is impossible to make a sustainable shift on basis of the freight and logistics sector alone (R5; R7, 2020). For instance, synergies can be found in the combination with zero-emission public transport situated on 'the Liesbosch', facilitation of a charging and fuel station meant for road and water modalities on Lage Weide (R5, 2020) or combination of a (secured) truck parkings, clean energy hub and other facilities along the A12 corridor on 'AC de Meern' (R2; R5; R6, 2020). Also, for Rijkswaterstaat, Midden Nederland it may be good to look at the facilitation and cooperation of such synergizing developments along its roads, waterways and corridors in meeting the needs of the logistics sector (R6; R7, 2020). In particular, (Secured) truck parkings are a valuable addition nearby de- coupling hubs since there is a chronic lack of logistics facilities within urban areas and in the Netherlands in general

which causes unsafe situations (R7, 2020). Cooperation and understanding between actors are, therefore, essential although they will have still their own agendas, funding and focal points (R2; R3; R5, 2020).

> *~ 'Finding strategic and smart location and connections along the, already fragile, major infrastructure is crucial in avoiding bottlenecks, resistance on the network created by for this kind of hubs and facilities' (R6, 2020).*

Good practice: Coordination on regional level in the Metropole Region Rotterdam- The Hague (MRDH)

Logistics is seen as programme objective within the accessibility and urbanisation strategy (Mobiliteit en verstedelijking Rotterdam- The Hague, MoVe-RDH) of Metropole Region Rotterdam- The Hague (MRDH). Especially, regional coordination of logistics regarding linking multimodalities on strategic locations has their focus (MoVe, 2020). The Rotterdam- The Hague region has a larger freight and logistics cluster than the metropole region Utrecht (MRU) has due to the port of Rotterdam. However, it may be valuable to compare the clustering and location strategies on regional level done by MoVe. Furthermore, integration of the programme objective logistics as part of the broader urbanization and accessibility strategy could have added value for a possible manner of integration of logistics within the U-Ned programme.

B2: Integrating Logistics-Oriented Development: Lage Weide' and the 'Liesbosch' as major multimodal logistics node for (city) logistics

The first step of integrating 'a logistics pillar' in U-Ned besides mobility and urbanization may be the focus to the two major industrial areas: A2. Lage Weide and A12, Liesbosch as mentioned by the respondents (R2; R3; R4; R5; R6; R7,2020). These two areas are strategically located along the corridors, are relativity close the inner cities of Utrecht, Merwedekanaalzone, the city centres of the surrounding municipalities and offer possibilities for modal shift towards water, rail and road (R2; R3, R4, 2020). Although, adding quality to these places may be a necessity (R5, 2020). Functions as de-coupling points, storage and consolidation centres may be crucial with an eye on the implementation of the zero-emission zones (Municipality of Utrecht, 2015; R2; R3; R4, 2020). An ongoing trend of huge 'bundled' freight flows are transported to the city and 'broken apart' and distributed in zero-emission 'Light electric vehicles' (LEV's) towards the city (R2; R4; R7, 2020).

> *~ 'Urban densification results in less space for transport movements. Transport is pushed out to the highway zones which becoming more and more an 'interaction and linkage area' which will function as a kind of 'terminal' for transhipment and consolidation of goods and persons which shift to another modality. To facilitate such consolidation an alternative way of spatial configuration is needed' (R3, 2020).*

How these hubs are connected with each other and with the inner city is dependent on the (appropriate) infrastructure and modes available (R2, 2020). To this end, updating the 'kwaliteitsnet' according the FUA of the MRU might be recommended (R3, 2020). Simultaneously, shifting the focus integration of spatial planning such as de-coupling hubs and consolidation centres within the broader (road) network may be a following step (Municipality of Utrecht, 2015; Province of Utrecht, 2019; R3; R4, 2020). In particular, the A12-zone (Liesbosch) is from highly importance in facilitating the connection between the local (last-mile) and national (long-distance) scale towards an efficient logistics flow (R3, 2020). It may be, therefore, not convenient to use the valuable space for a linkage between regional-regional or corridor- regional logistics flows (R3, 2020). Cooperation between multiple authorities is needed because the 'Liesbosch' is situated in the municipality of Nieuwegein which makes steering difficult (R2; R5, 2020).

> *~'I can imagine that the highway exit is closed, and the capacity used to connect and develop a consolidation hub which 'captures' the last-mile supply for a particular part of the city. […] Such design innovations are far more interesting than road expansion and, above all, needed for involved parties to address future challenges which are faced' (R3, 2020).*

Redesigning the A12-zone and connecting logistics functions directly to it may address the vulnerability of the network. For example, one layer or exit gives merely access to several regional functions such as a distribution centre or a mall but does not provide access to the wider city (R3, 2020). On these hubs are alternative modes of transport provided to ensure zero-emission logistics towards the city as well as to the Merwedekanaalzone (R3; R4, 2020). Precondition for success of these kinds of hubs may be the addition of different practical services which ease the usage, functionality and value of the place considered by users (R3; R4; R7,2020). The connection with passenger transportation could be made on the hubs where both passenger and logistics flows meet to reduce additional trips (See multipurpose use of space) (R2; R3; R4, 2020).

'Good' practices: freight and logistics transport strategy, Budapest

As stated above a kind of 'circle' of (logistics) hubs should be created around the city. In Budapest the same idea was introduced in Budapest which dealt as well with a lot of freight traffic within their city (van der Werf et al., 2019). Solution may be found in strategical location of distribution and consolidation centres along major infrastructure which link national, regional on the one hand and local traffic on the other. Simultaneously, the municipally of Budapest implemented restrictions for inner city parts to facilitate only desired traffic (van der Werf et al., 2019). In this sense, the city is relieved from these freight flows crossing the city. A similar 'circle of hubs' along the A12 and A2 may help reducing traffic as well in Utrecht.

B3. Integrating Logistics-Oriented Development: Area-oriented approach

To overcome fragmented governmental and financial boundaries in multilevel governance situations which contain spatial-infrastructural synergies area-oriented developments come into play (R9; R15, 2020). If an area-oriented approach is taken beforehand financial and sectoral issues will be tackled in advance (R9; R11, 2020). To this end, an open focus is used in the search for synergic solutions while including private and public interest (Heeres et al., 2012). Consequently, coalition building in an early stage of the governance process is needed (Heeres et al., 2012; Salet & Woltjer, 2009). In this way, actors are forced to take a more integral perspective and consider the shared interests (R9; R11, 2020). Thereby, the scale of the intervention (e.g. hubs or modal shift) should fit the governance model to make it work (R15, 2020). For instance, concepts as transit-oriented development (TOD) may be valuable for (mobility) hubs (Tan,2013) whereas the 'relatively' new introduced concept of LOD may more relevant for logistics hubs (Broesi et al. 2019). These LOD and TOD concepts connecting scales and create multifunctional usage of scares space in, for example, the A12-zone.

Good practice: the Antwerp ring road

The city of Antwerp approved a multimodal masterplan including a ring road. However, the implications for the broader area were not considered during the planning process which resulted in resistance among affected citizens (van der Werf et al. 2019). This forced the municipality to launch a participation and co-creation process to take into account the broader surroundings of the project. As result, actors were involved beforehand in an open process which gained trust. Furthermore, synergies (e.g. space for housing) were developed which obtained added value for the local area (van der Werf et al., 2019). Engagement of

actors involved early in the process while taking into account the area-specific circumstances can be considered as important. With regard to the integration of LODs along the ring road, it may help to involve logistics related companies and affected actors (e.g. citizen) early in the process. The chances of a planning process which is successful will be much higher.

C1. Addressing vulnerability of the network: Modal shift to the Merwedekanaal

The value of the Merwedekanaal is often underestimated and seen as barrier for city development and no longer from importance for inland shipping with advent of the Amsterdam-Rijn Kanaal (R1; R6; R7, 2020). In this sense, it seems a logical step to change the ownership of the canal to the municipality of Utrecht (R1; R2, 2020). The Merwedekanaal is situated straight through Utrecht along major developments such as the Merwedekanaal zone, Beurskwartier and developments around the 'Jaarbeurs' which create opportunities for transport along the canal (R1; R2; R2; R5, R7, 2020).

> *~ 'The canal has far more potential for the city such as ecology, recreation and transport modes as we think as Rijkswaterstaat. It is often seen as barrier for the city while if it is made part of spatial development it may have great potential' (R1, 2020).*

With the sight on the network of potential hubs, two (regional and local connected) locations are mentioned as potential consolidation locations for (city) logistics (R2; R5; R6, 2020). Thereby, industrial park 'the Liesbosch' nearby the A12 has more potential as consolidation location than, for example, industrial park Lage Weide. Due to the water level passage of the locks is a necessity which makes it time consuming (R2; R5, 2020). Especially, the 'Liesbosch' can be considered as potential location for (city) logistics because of the clustering of logistics related companies, food suppliers and the great connection with the A12 (R2; R3; R5, 2020). Another synergy can be found in development of a clean energy hub at the 'Liesbosch' which makes it possible to fuel the vessels with hydrogen (R5, 2020).

> *~ 'Using the water is dependent on the goods and its urgency that are transported. Saying: just make use of the water as transport mode is short-sighted. The only thing that matters is: Is it save and sustainable in the end, that is the case. The reason for using the water, apart from sustainably in general, are bottlenecks in the city. If the whole city is congested…that's also not sustainable either. Also, do not underestimate the steps that are made in clean road transportation' (R7, 2020).*

However, a shift towards the water transport is also considered complex and expensive (R2, R4, 2020). The necessity for spatial integration of barges, loading facilities and an additional hub both at destination and departure location is required (R2; R4, R5, 2020). Functions which are dependent on a location along the water should be prioritized by means of zoning (R5, 2020). Moreover, the kind of freight is important which results in the fact that volume products are more likely to be shipped by vessels (see logistics construction hub) (R7, 2020). Efficient bundling of high volumes vica versa is needed to ensure its profitability and development of a proper business case (R2; R4, 2020). Furthermore, additional modalities are needed to bridge the gap between the water and the front door or a retail function which constraints directness of the 'chain' (R2, 2020). Aside from this, the planned bridges are too low to pass such vessels (R1; R2; R5, 2020). Therefore, it may be smart to consider the possibility of shipping and dredging the canal with an eye on future transport potential (R2; R5, 2020). At least, the potential should be researched if it obtains enough added value (R1, R2, R4, R5, R7, 2020).

Good practices: Water transportation in Gothenburg

In Gothenburg, DHL did a pilot to determine how water can be utilized for (city) logistics and freight transportation (for instance to reach the construction hub). Aim was to overcome jammed local traffic in the city of Gothenburg (DHL, 2020). Special containers (1 cubic metre) which can also be transported by cargo bikes were used. The DHL terminal is closely located near the barges and the distance between the terminal and the barges is being linked by a small truck. In the city, two locations are used to unload the containers to electric vehicles and the bikes (DHL, 2020). This could obtain value for multi-modality transportation of the Merwedekanaal zone, Beurskwartier, the inner-city and Jaarbeurs.

C2. Addressing vulnerability of the Network: Logistics construction hub

A lot of upcoming projects are initiated in the city of Utrecht in order to accommodate the expected growth. This trend may also occur an increasing number of construction traffic such as cranes, construction materials, vans and heavy loaded trucks. With the upcoming (dense) urban developments (see modal shift to Merwedekanaal) which will have a fundamental impact on the liveability in the city it may be interesting to look at the possibilities for development of a construction hub (R3, R5, H8, 2020).

> ~ '*But the Liesbosch has more potential to function as and become a multi-purpose and multifunctional hub [….] there are various construction companies and food suppliers which may have the opportunity to make use of the Liesboschhaven as transhipment location' (R5, 2020).*

Such construction hub is avoiding the additional pressure on the local and regional road network caused by these flows since transhipment will take place along the Merwedekanaal (R3; R5, 2020). A construction hub can be defined as a location at the edge of the city from where the logistics process is coordinated and monitored by means of open data facilities. Construction materials are consolidated and bundled in day packages which are delivered without delay (Volker Wessels, 2020). The province brought together involved parties at the 'Liesbosch harbour' situated along the Merwedekanaal and nearby the A12 which may be a strategic location for consolidation of construction materials towards a modal shift towards the water (R5, R6 2020). The Liesbosch has much potential as multipurpose and multifunctional hub also for further future developments (R5, 2020). A precondition for initiating a logistics construction hub is the required depth of the Merwedekanaal and the absence of fixed bridges modal shift to water (R5; 2020).

Good practices: Collaboration on reducing construction traffic

As part of the logistics programme objective of 'mobiliteit en verstedelijking' (MoVe) in the province of Zuid-Holland development of construction hubs is one of the major targets to reduce pressure on urban areas (MoVe, 2020). A cooperation between the cities of Delft, The Hague, the province of Zuid-Holland and the Metropole Region Rotterdam and the Hague (MRDH are actively supporting and stimulating initiatives for construction hubs. Thereby, usage of regulation and permits for construction traffic and digital platforms are reseached to increase efficiency (MoVe, 2020). An interesting practice for U-Ned may be the specific focus on connecting contruction hubs to major (rail) road and water ways on regional level.

D1. Connecting scales: Towards an efficient transport chain.

To achieve cleaner city logistics by zero-emission zones, dynamic permitting and hubs usage (municipality of Utrecht, 2015) allow for an adaptation in the transport 'chain' (R2; R3; R4; R6; R7, 2020). Consolidation will not only take place at consolidation centres along the ring road but as well in micro hubs within the city (e.g. mobility hub at the Merwedekanaal zone).

> *~ 'It is questionable if it is a smart idea to build car-free neighbourhood in the current situation. It is a bit like saying to a liquor store that is isn't allowed to drink alcohol there…in other words, there is a contextual change needed to make it work properly' (R3, 2020).*

Important is to consider is that such last- mile delivery solution need to substitute the immediacy and directness of a regular delivery system (e.g. delivery vans) (R2; R4, 2020). Therefore, such solutions of a mobility hub (for Merwedekanaalzone) are only adding quality in case they provide the same service level which need to be as efficient as possible (R3; R4, 2020). Precondition for such mobility hubs are the need for a sufficient catchment area and enough logistics volume (R2; R4, 2020). In addition, cooperation between carriers and pickup points should be constituted but (private) 'white label' hub providers are an upcoming trend as well (R2; R4, 2020). However, these hubs create individual additional movements as well while one delivery vehicle may consolidate all parcels into one efficient trip. This raises the question what will be more efficient and optimal in the end and dependents on the contextual situation (R2, 2020).

Thus, there is not a one size fit all solutions, but is should be seen per transport chain, type of goods and related infrastructure (R2; R4; R7,2020). With an eye on synchro-modality it is always recommended to invest in more modalities and transhipment locations to strengthen the network (R7, 2020).

> *~ 'It doesn't matter who's the carrier, in the end it is important that it is carried' […] Maybe it is needed to tranship products ten times to another modality. If that is, in the end, beneficial to an economically efficient transportation chain, not really a problem' (R2, 2020).*

An ongoing trend of huge 'bundled' freight flows are transported to the edges of the city and further distributed in zero-emission 'Light electric vehicles' (LEV's) going into the city (R1, R2; R4; R7, 2020). Long-distance freight is increasingly made bigger since trucks are becoming cleaner and one shipment is by definition more sustainable (R7, 2020). The distinction between fully loaded and partly loaded vehicles is made (R2; 2020). Only fully loaded vehicles are allowed to enter the city and partly loaded vehicles need to make a modal shift at a consolidation hub to merge goods together in LEV's and avoid unnecessary trips (R2; R7, 2020). Therefore, data sharing (e.g. mobility as a service products) and cooperation between carriers can be seen as an essential criterium to achieve this but is still not much done (R2; R4; R7, 2020). Question which raises may be if various (zero-emission) vehicles during the day are better than one on a particular time (R4, 2020).

> *~ 'The prevailing idea often is to divide huge volume of a truck in 27 LEV's which enter the city. However, in this situation 27 times more movements are made, and 27 drivers are needed. Sometimes, dividing goods doesn't always have the desired effects' (R4, 2020).*

Good practice: City hub, result of agile team Vienna

In the city of Vienna, an agile team was appointed to address the issues regarding the large amount of logistics flows within the city. The team came up with the idea of a hub which functioned as central storage facility for goods (van der Werf et al., 2019). Thereafter, the goods are bundled and delivered by zero-emission vehicles. This way of working has two benefits. The number of trips is reduced and the 'last mile'

delivery is done in a sustainable way (van der Werf et al., 2019). The concept is quite similar to the Utrecht city hub concept (See section 4.5). Moreover, the lessons of the Vienna city hub concept may be interesting for 'last mile' delivery in the Merwedekanaal zone.

D2. Connecting scales: Multimodal hubs

To address the scarcity of space in, for example, the A12 zone the combination between other functions and facilities may be a valuable synergy to focus on (R2; R3; R4, 2020). The trend of urbanization and dense inner-city developments as result such as the Merwedekanaal zone may be as well have potential on industrial areas to accommodate additional square meters (R2, 2020).

> *~ 'In fact, one plot per company is an outdated concept as well as for (city) logistics. I'm much more interested in combining different functions by 'layering'. Consolidation of Logistics on the ground floor, stores on the first floor and office space on top of that. Much more functions can be accommodated, and the land prices will drop' (R2, 2020).*

Moreover, combining functions will enhance vitality of these areas (R2, 2020). An upcoming trend of (city) logistics carriers combining transport with storage and offices space is ongoing. An example is City hub Utrecht along the A2 which facilitate zero- emission consolidation towards the city (R2; R4, 2020). Another synergy can be found in the linkage with passenger transport hubs (R3; R4, 2020). These multimodal hubs including a P+R are par excellence the location where flows of logistics and persons meet and exchange of goods could take place (R4, 2020). Especially, identification of strategic places in the broader network where various modalities meet is, therefore, interesting (R2, R4 2020). Normally, both flows are transported to the same location in the city and returning to the same location along the ring road afterwards. In this sense, one of both flows can be eliminated (R4, 2020). Another method is to 'shave off' local traffic by closing the exits and develop multimodal and multifunctional hubs which facilitate bikes and public transport instead in order to reach, for example, Merwedekanaalzone (R3; R4, 2020) (see figure 25). The remaining capacity can be used for regional flows (R3, 2020).

> *~ 'In particular P+Rs Westraven and the Uithof, with today's knowledge dimensioning P+Rs would have been logistics consolidation on the lowest floor and parking and public transport on top of that. Public transport, parking and logistics are brought together, add solar panels on the roof and your policy has been created for the coming ten years' (R4, 2020).*

To designate an integrated multimodal and multifunctional place as 'hub', four dimensions need to be considered: the physical space, the modalities, the services and the additional facilities. In this sense, the 'hub' does not exist but is always a tailor-made remedy in its functionality (R4, 2020). Therefore, the value and goal should always be considered (R3; R4, 2020). Moreover, quality should be added by means of services to make it a place to transfer, to stay and to serve as linkage (R3; R4, 2020). The reason why 'hubs' don't work often is caused by a well thought through design in order create an attractive place (R3, 2020).

> *~ 'The term 'hub' is often misused, there does not exist a 'standard' hub. A circle is drawn including a function programme and designated as 'hub'. It is important to always consider its functionality instead of labelling everything as 'hub' all of a sudden (R4, 2020).*

However, there are a few complexities to consider. It is questionable how desired multilevel land-use of logistics with other functions is (R5, 2020). Which functions are suitable to mingle and which effects does that have on the highway zone? Furthermore, is it desired to situate such multimodal hubs on the most fragile parts of the network close to a dense urban area or should logistics and passenger transport be captured before entering the urban region? (R1, R8, 2020).

Good practice: The Dutch 'Good Hubs' initiative

The 'good hub' initiative supports and facilitates the development of multimodal hubs and urban consolidation centres (UCCs) within Europe by exchanging knowledge. Aim is to avoid disturbance within European city-centres (Eco2city, 2020). In essence, the initiative tries to develop guidelines which can be transferred and used by public and private actors within other cities. Moreover, the initiative is also supporting organizations which invest in alternative fuel (e.g. hydrogen) locations for inland shipping and road transportation (Eco2city, 2020). This may be interesting as well for clustering of Logistics-Oriented Developments such as truck parkings and clean energy hubs (see A1).

4.4 Effective implementation

Institutional, financial and time

The section will discuss the way in which the proposed strategies as discussed in the previous section could be implemented effectively within the metropole region Utrecht. Here, the institutional, implementation and time dimensions come into play. In this section, innovations and possible linked 'good' practices are mentioned to address (physical and institutional) barriers and drivers for implementation.

Institutional

Multi governance approach as glue between parties involved

Integrating logistics-thinking within the MRU allows for multi-level governance perspectives to integrate and coordinate logistics on a regional scale. The barriers of development of innovation in freight and logistics transportation includes different (private and public) sectors and (administrative) boundaries resulting in various funding sources (R1; R2; R3; R4; R5; R6; R8, 2020). In contradiction to passenger transportation, it is for governmental parties much more difficult to steer the logistics sector because of market disruption (R3; R4, 2020). Another factor which allows for (multi-level) collaboration is building capacity (See building capacity). Efficient alignment and connection between (spatial and infrastructural) components of the transport chain interfere and overlap with many responsibilities, interests and ownership which creates dependency (R1; R2; R6, 2020). For example, highway zones are often seen as blind spot for municipalities which cannot be seen as part of a broader (city) development while It may be the most important place for coordination of mobility (R3, 2020). Therefore, shifting from fragmented and one core responsibly towards cooperation and collaboration is desired in integration of logistics which is fundamentally different from crossing paths or simply talk to each other (R1; R3, 2020).

> *~ 'It is going to be much more diffuse. It takes a more vulnerable role which is characterized by uncertainty because you are 'one' of the partners and not always in the lead' (R3, 2020).*

Especially, understanding each other agenda, transparency and the willingness to create a give-and-take attitude seem to be a necessity (R1; R5; R7, 2020). Thereby, the various compromise should be made visible for all parties to consider a reasonable and broad supported consideration (R1, 2020). The province may be a suitable governmental authority to bring parties surrounding logistics in the MRU together on regional level (R9; R15, 2020). This may also relevant considering the FUA.

> *~ 'An innovate solution will simply be expensive and who is the one paying? It is all about the money. Everyone embraced the concepts of hubs, water transportation, indoor loading and usage of light electric*

vehicles. The visions and objectives are skyhigh. But…the question is: what is left whenever the bill needs to be paid?' (R2, 2020).

The governmental agencies mainly regulate, stimulate and facilitate towards transformation. However, the market should move along with these changes. Moreover, the market should be prepared and informed to develop a reasonable perspective on the steps that need be taken (R1; R2; R5; R11, 2020). Thereby, the importance of respecting the current business models of the logistics sector should be precondition for collaboration (R4; R7; R13, 2020). However, initiatives should be mainly be facilitated and stimulated but purchasing should be avoided (R5; R6, 2020). The shift should be made by market parties and carriers by changing their fleet in light electric vehicles. This will not be a problem for the larger (delivery) companies. (R2; R4, 2020). However, for freelancers it still may be an issue which is not really addressed yet (R2; R4, 2020).

> *~ 'Governmental authorities urgently need to cooperate with the logistics sector. If not, steering and regulating is useless. The logistics sector has her own business models and competitiveness which are major steering forces […]. Considering the scarcity of space and liveability issues demand for strong regulations. However, the past has shown that steering without relying on the sector itself it is doomed to fail' (R13, 2020).*

The way in which developments are governed is depending on the specific objectives and local context (R4, 2020). For instance, public (by means of concessions and covenants) and public-private partnerships and public-public partnerships (to share the risks) are potential options (R4, 2020). With a lot of actors involved it is likely to deploy a public-private partnership modal to divide responsibly and steer together (R4, 2020). Furthermore, engagement by means of a regional covenant could gain value in stimulation of clean energy hubs and hydrogen facilities development (R5, 2020).

Role of governmental agencies

Traditionally is the role of governmental agencies defined as regulator, stimulator, facilitator and communicator (R2, 2020). Initially, stimulation and facilitation are needed to 'pull' the logistics sector to an alternative transportation chain. Later, regulations will act as 'push factor' and stick behind the door to make a shift (R2; R4, 2020). Especially, regulations are an important factor to force a change and maintain a clear standard (R4, 2020). Regulation need to be strictly maintained to avoid misuse and ineffectiveness of stimulation policies mainly in the initiation phase (R4, 2020). Another important issue is (zoning) regulation of reserving space to enable logistics integration within the MRU (R3; R5, 2020). This can be done via zoning plans and area-oriented environmental visions (R2, 2020). To this end, valuable space which acquire potential characteristics for (city) logistics could be reserved for future developments (e.g. good connection to major infrastructure and water or clustered near synergizing functions) (R7, 2020). Thereby, the role of the province and region is seen as important considering their overview on space and infrastructure while consider the Functional urban area scale (R9; R10; R15, 2020). Again, collaboration and involvement within U-ned and together with the logistics sector is crucial to since responsibility is divided (R7, 2020).

Logistics 'agency' for U-Ned

Appointing a 'logistics agency' as start of exploring a potential integration of logistics next to passenger mobility and urbanization within and together with U-Ned may be an opportunity to look at. Currently, the idea of the logistics agent is proposed within policy documents of the city of Utrecht and Goedopweg (a project organisation the Municipalities of Utrecht & Amersfoort, Province of Utrecht and RWS). Policy states that top down measures do not work because of the absence of a strong industrial and logistics cluster in

the region (Municipality of Utrecht, 2015; Goedopweg, 2020). However, coordination of logistics functions may be an issue when looking at the whole MRU (R5, 2020). Therefore, the need for a more coordinating role in the form of an 'logistics agency' on the level of the entire MRU may be a solution. Aim of the logistics agency is to stimulate the private sector to unfold innovation regard clean, light and smart freight and logistics (Goedopweg, 2020). To this end, the logistics agency functions as intermediary between public and private sector. This includes an intermediating role of connecting, knowledge building and keeping in contact with the logistics sector within the MRU. The efforts of the logistics agency are aimed to result in project- based improvements and initiation of public-private partnerships or public-public partnerships to bridge the fragmented logistics chain (Goedopweg, 2020).

Good practices: Fluxnet study and 'Cargo terminal Vienna Sud'

'Good' practices can be found in, for instance, the Fluxnet study which calls for integration of the concept of Logistics-Oriented Development in urban nodes (Broesi et al, 2018). Strategic coordination, cooperation and clustering of logistics activities (e.g. clean energy hubs, truck parkings and consolidation centres) with the fitting infrastructures along the A2 (Lage Weide) en A12 (The 'Liesbosch') should be arranged. Thereby, the LOD concept should be balanced with the urbanization and mobility strategy of U-Ned. Point of departure could be the renewal of 'Kwaliteitsnet Goederenvervoer' (Quality network freight and logistics) while considering spatial, logistics and infrastructural integration (Fluxnet, 2018). Optimizing and adding terminals, infrastructure and modalities on' scale connecting' locations Liesbosch en Lage Weide may be a direction for the logistics agency. Another good practice can be found in the Vienna which faced 'logistics sprawl' in the region because logistics was not coordinated on regional or FUA level (van der Werf et al., 2019). To tackle this logistics activities were clustered in a terminal 'Wien Sud'. Although, Vienna is a lot bigger than Utrecht, the idea of clustering (multimodal) logistics activities on 'Lage Weide' and the 'Liesbosch' may have a potential when coordinated by a logistics agent as is done in Vienna (van der Werf et al., 2019).

Aligning the transport chain: data-sharing

Organizing last-mile and long-distance transport different as consequence of regulations regarding zero-emission zones is needed (R2; R4; R7, 2020). Various carriers, vehicles and companies all use different systems, networks and platforms to organize their transport chain efficiently (R2, 2020). In addition, different segments of goods and products call for different transport modes and moments of delivery (R2; R7; R16, 2020). Market involvement is essential in the search for alignment of those chains. However, data sharing by (private) logistics carriers is often seen as complicated and tricky because of confidential company information (R2; R7, 2020). Building trust and a financial agreement between companies within the transport chain is, therefore, crucial (R2; R5; R7, 2020). Nevertheless, a growing number of digital platforms is developing in which carriers provide insight in their shipment information, services and routes in attempt to combine and bundle goods (R7, 2020). Other examples of good practices can be found in collaborations between storages centres and carriers which share their data and software together to complement each other's business (R2, 2020). Development of shared ICT solutions is seen as the path towards efficiency of transport chains in and between cities although major steps need to be made (R2; R7, 2020)

> *~ 'To succeed in a transformation of the logistics chain te need for data sharing, vehicle sharing, and bundling are essential. However, there is a long way ahead of us (R2, 2020).*

Good practice: stadshub Amersfoort (cityhub Amersfoort)

A mover's company and PostNL have initiated a collaboration to decrease the number of polluting vehicles in the inner city of Amersfoort (Goedopweg, 2020a) (See stadshub Amersfoort, section 4.5). A hub is created At the movers' company in which goods are stored, bundled and delivered in one shipment (Goedopweg, 2020a). To this end, a data platform has been launched which allow retailers and restaurants to manage their storage by means of order picking. Therefore, PostNL and the movers company needed to develop a shared and comprehensible data platform. The process of fulfilment will be monitored the entire transportation chain (Goedopweg, 2020a).

Financial

Role of the market: the need for a hub provider

A specific problem occurs by developing a new logistics system by means of logistics and passenger hubs both on local (neighbourhood) scale and regional scale (highways). The transportation system changes although responsibilities of providing mobility and logistics services need to be replaced (R2; R4, 2020). To this end, a new 'role' of a so-called 'hub provider' is required. After all, there is no responsible actor (e.g. Rijkswaterstaat, municipality or real estate agency) which core business includes the provision of mobility or logistics services (R2; R4, 2020).

> *~ 'How to shape such a role? Which governance mode to use since it's not a two-month pilot? In fact, it should be provided for the coming 10 to 15 years. […] From the day that the first residents are living there, transportation services should be guaranteed (R4, 2020).*

For development of neighbourhood or 'mobility' hubs it may be worth to look into a public-private model since various actors, major interests and much uncertainty are involved. The problem of a public-private model may be the gap between exploitation and revenues that at start (R4, 2020). To this end, the risks and potential uncertain costs are divided by various actors to ensure required logistics and mobility services at all time from the first day (R3; R4, 2020). Another trend is development of (private) 'white label' hubs which provide logistics services and collaborate with carriers (R2, 2020). The level of services should be relativity high to replace the convenience and comfort, availability and affordability of present transportation modes (R3; R4, 2020). Thereby, functions which contribute to a pleasant experience should be added and combined to a logical place to be, to use and to transfer (R2, 2020). A provider could ensure those services and experiences (R2; R4, 2020).

> *~ 'The same is applicable to (city) logistics hubs and consolidation centres. These developments do not function everywhere and that is mainly due to hubs which are providing from day one an efficient transportation alternative for regular fashioned transportation towards to the city by, for instance, a heavy truck which is driven by a company itself (R4, 2020).*

A hub provider may have an important role in the linking, regulating and coordinating (city) logistics in an efficient way (R2; R4, 2020). To this end, for neighbourhood hubs as planned in the Merwedekanaal zone the need for flexible configuration of space may be an important criterium to adjust and tailor to logistics demands of the day (R4, 2020). For example, if it is expected that during the day a lot of delivery vans will drop by space can be reserved. However, this has consequences for the business case of a hub in terms of reserved square meters for logistics consolidation by real estate developers. Negotiation of this space is

essential for the functionality of logistics within urban developments as Merwedekanaal zone (R2; R4, 2020).

Good practice: Hely hub, Utrecht

An example of a 'white label' hub which offers mobility services is the 'Hely Hub'. 'Hely hub' is a start-up which aims to make multimodal solutions more accessible in urban areas such as the city of Utrecht. To this end, an app is developed in which bikes, scooters and electric cars can be reserved and picked up at the Hely hub. The start-up tries to keep the financial costs as low as possible in order to offer an alternative for the current modes of transportation (Hely hub, 2020). The concept appears to be frequently used by mainly local residents (Amsterdam smart city, 2020). The concept is quite similar as the proposed mobility hub concept of the Merwedekanaal zone (see section 4.1). However, integration of logistics services (e.g consolidation at the hub in zero-emission vehicles) may be an interesting addition for the MRU.

Timing

Importance of building capacity

A precondition for development and implementation of hubs or a shift to other modalities should be found in building capacity (R2; R4, R5, 2020). A solid business case concerning a system of hubs and modalities is needed to create an efficient and long-lasting network (R2; R4, 2020). This can be seen as an essential criterium since such developments are an alternative for the usual embedded transport modes and should be, therefore, as effective as possible (R2; R4, 2020). Next to development of a new logistics system for the Merwedekanaalzone, also other neighbourhoods should be connected to ensure sufficient volumes and the efficiency of hubs (R2; R4, 2020). Looking beyond administrative borders to search for synergies might be recommended (R5; R6, 2020). The same applies to usage of a modal shift towards the water which are merely profitable in case larger volumes are 'bundled' transported towards a destination and vice versa (R2; R7, 2020). In addition, inclusion of additional sectors next to the logistics sector including freight transport and inland shipping is needed to make an impactful shift towards clean and sustainable transportation (R5; R7, 2020). Clean energy hub initiatives should be stimulated to search for clustering and cooperation in order to ensure a profitable business case (R5; R7, 2020). For example, searching for cooperation with clean public transport by developing a clean energy hub on the 'Liesbosch' could gain added value (R5, 2020).

Good practices: Clustering clean energy hubs and logistics facilities

'Good practices can be found in, for instance, the province of Gelderland which launched 'the clean energy hub' initiative. Aim of the project is to provide alternative fuels on strategic locations along major water and road (corridor) infrastructure (van der Werf et al., 2019). Clustering these initiatives on Lage Weide and the Liesbosch along the A2, A12 and Amsterdam Rijn kanaal and Merwedekanaal (for city logistics) may obtain value when clustered with other logistics functions.

4.5 Enriching the toolbox

Through research, several 'good' practices were mentioned by interviewees as illustrations of possible solutions which are currently initiated or developed within the MRU. These 'good' practices could play a valuable role as inspiring cases. On the one hand they could be helpful to improve future initiatives within the MRU, on the other hand it could be an enrichment to the Vital Nodes toolbox.

Construction Hub 'VolkerWessels'

Construction company 'VolkerWessels' developed a construction hub the edge of Utrecht as stating area for construction materials. Materials where transported further by means of cleaner vehicles to reduce trips across the city of Utrecht (see figure 26). The building process monitored for 28 weeks and turned out to be much more efficient in terms of emissions, pollution, time of disturbance within the city. Co_2 -Emission caused by person and construction waste traffic was reduced with 68% (Goedopweg, 2017). According the results almost 70% of construction traffic was reduced. Both construction materials and construction workers were transported along this hub (Goedopweg, 2017).

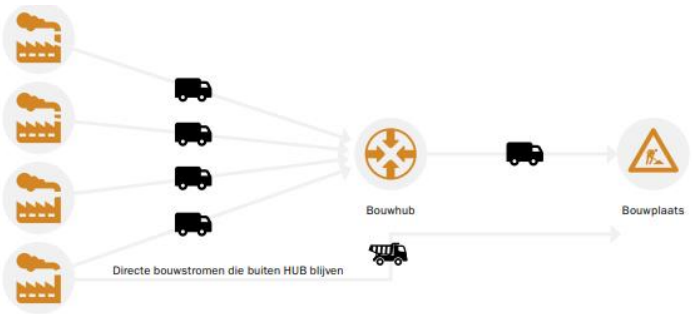

Figure 25: The concept of a construction hub (Source: TNO, 2020)

Stadshub Amersfoort (cityhub Amersfoort)

Within the city of Amersfoort, a mover's company and PostNL have initiated a collaboration in order to decrease the number of polluting vehicles in the inner city of Amersfoort (Goedopweg, 2020a). To this end, a hub is established at the movers' company in which goods, food and facilities are stored, bundled and delivered in one shipment instead of a range of vehicles which enter the inner-city (Goedopweg, 2020a). Simultaneously, the municipality of Amersfoort want to ban polluting and heavy trucks before 2025. The municipality of Amersfoort is not an actor but stimulated and facilitated the collaboration between (private) parties (Goedopweg, 2020a). Next to the various logistics services, a data platform will be launched which allow retailers and restaurants to manage their storage by means of order picking. Furthermore, the process of fulfilment will be used, which monitors the entire transportation chain (Goedopweg, 2020a).

'City hub' Utrecht: the zero-emission last mile connection

City hub is an (private) initiative in the city of Utrecht which provide zero-emission (city) logistics. Logic of concept is based on bundling of goods at the edge of the city which are, subsequently, towards the city transported and delivered in zero-emission vehicles such as E-cars, electric transport bikes and electric boats (see figure 27) (Cityhub, 2020). In this sense, disturbance and emission on the last mile are avoided because heavy trucks do not have to enter the city anymore. In addition, the delivery is not dependent on time windows anymore. Cityhub is strategically located along the A2 on Lage Weide and relatively close to inner-city parts. Besides, the consolidation centre does included storage facilitates as well to create an efficient transport chain (Cityhub, 2020).

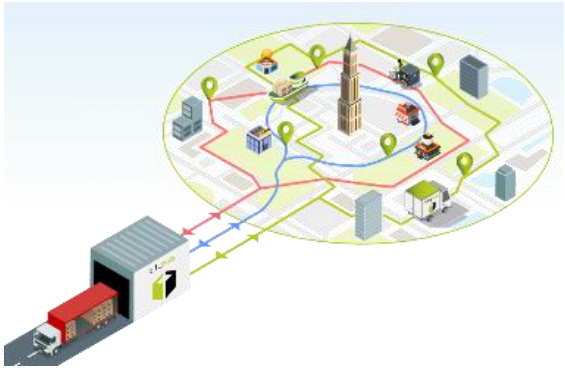

Figure 26: The concept of cityhub (Source: Cityhub, 2020)

Logistics hub Utrecht East

The Utrecht university, University of applied sciences Utrecht, the province of Utrecht and university medical centre Utrecht initiated a collaboration with regard to a jointly procurement and consolidation of facility resources and parcel deliveries (R5, 2020). To this end, they developed a plan for a shared hub (logistics hub east) which functions as linkage between regional and local logistics flows (R5, 2020).

Currently, a small logistics hub is established which is run by various employees of the involved parties (R5, 2020).

'Beer boat' Utrecht

Various interviewees touched upon the (electric) 'beer boat' which supplies on a daily basis beer and frozen products the inner-city of Utrecht. Usage of the water as way of transportation relieves the inner-city from trucks in the small alleys. Moreover, the boat is not affected by a time window and the boat can also be hired for movements to the inner-city. Space is made for trucks at the barges from where containers can be loaded on the boat (municipality of Utrecht, 2020). Business model of the boat is based on relatively large volumes of liquor towards the city and waste in the opposite direction.

Synthesis.

These 'good' practices as discussed above might have also implications for future developments within the MRU. These initiatives as discussed above are mainly initiated as stand-alone developments. The main lesson drawn from these 'good' practices might be that building capacity is crucial to ensure a long-term solution. Furthermore, integration of these stand-alone initiatives within a broader, regional vision may strengthen the search for synergies and the possibility to learn from these initiatives. To this end, building a coalition within U-Ned with the focus on integration of logistics may be a suggestion for further development of these initiatives. In addition, the initiatives as presented above are mainly facilitated by governmental authorities. A more steering role of governmental authorities within a programme may accomplish capacity building and an improved integration of these initiatives.

The following elements important for enrichment of the Vital Nodes approach. First, the appointment of the 'logistics agency' may be a valuable addition to the toolbox. It may be effective to make such an agency responsible for encountering the underexposed position of freight and logistics within metropolitan areas. Second, the need for a 'hub provider' may be a solution for ensuring a certain service level for (logistics) hubs within metropolitan areas. These hubs will only be a potential alternative for current (logistics) transportation modes if it offers the same or a better transportation chain. In addition, introduction may obtain opportunities for sustainable and zero-emission transportation services and functions within European cities which are maintained by such a 'hub provider.

5. conclusion & discussion

This chapter will answer the main question of this study. First, the underlying sub-questions will be discussed. Thereafter, the strengths and weaknesses of the study will be discussed. At the end of this chapter recommendations for further research will be given as well as for the role of Rijkswaterstaat.

5.1 Key findings regarding the research questions

Aim of this research is to apply the Horizon 2020 Vital Nodes approach to the context of the Metropole Region Utrecht. The results identified the main challenges in spatial and infrastructural integration of freight and logistics answering the question: why spatial and infrastructural integration may obtain value for the MRU? Accordingly, spatial and infrastructural synergies are introduced answering the question: what potential synergies are possible within the MRU? Lastly, implementation strategies and 'good 'practices are discussed answering the question: how strategies could be implemented effectively? The central research question is:

How can lessons from the European Vital Nodes (VN) project regarding logistics & freight transport be translated into the U-Ned programme within the Metropolitan Region Utrecht (MRU)?

To answer main question, four sub-questions are formulated. First, the secondary questions will be discussed and thereafter directions and recommendations will be given.

1. *Which theoretical concepts regarding infrastructure and spatial integration are the building blocks for Vital Nodes (VN) and how are these related to the complex nature of urban nodes?*

Integration of network and space is often explained in relation to the transport land-use feedback cycle. Distribution of land-use occurs human activity which, subsequently, demands for a transport system which positively influences accessibility of a place. Thereafter, a new cycle is started since accessibility of land use is improved. This accessibility seems to be a major factor in connecting nodes within a broader network. Ideally, a connecting node contains a balance between interaction (node function) and activities (place function) in order to keep nodes accessible. Too much diversity of activities and interactions cause bottlenecks whereas little activities and interaction can be accommodated in place without intervening.

This node and place function create complexities and underline the necessity for broadening the scope beyond accessibility and narrow focus on improvement of networks towards an area-oriented approach. To this end, combination and collaboration between other (spatial) sectors are founded to address the increased complexity and to develop potential synergies, added value and trade-offs. Therefore, acquired relations between infrastructure and spatial functions might be required to identify while considering different scales. This shift is characterized by cross-sectoral public and private interests with the underlying instructional governance. The concrete synergies of uniting land use and infrastructure can be found in the concept of Transit-Oriented Development (TOD) which contains the clustering of mixed used dense commercial and residential developments oriented to transport facilities. Avoiding urban sprawl, reducing emissions and emergence of sustainable urban mobility are important drivers. To this end, synergic relationship is built by connecting a reinforced transport system to a concentration of urban activities.

In analogy, to the Transit-Oriented Development (TOD), the new concept Logistics-oriented Development (LOD) comes into play. Logistics-oriented development refers to the integration of freight and logistics transport with land-use and infrastructure in urban nodes. So far, the matter of freight and logistics and its influence on urbanization and accessible has been underexposed. LOD is aiming for optimization and addition of multimodality of the infrastructural and spatial system while connecting different freight and logistics scales as well. The concrete elements of LOD are configuration of spatial organization (location, transhipment hub and consolidation centres) and infrastructural organization (networks, modalities, (local) hubs and terminals. In analogy to area-oriented approaches and TODs, a cross sectoral collaboration is required. An important function of TODs and LODs is the connection of various scales containing of (inter) national, regional (FUA) and the local, 'last' or 'first mile'. Especially, the FUA scale, which refers to urban-regional interaction of the city's connections with its (commuting) hinterland, is important in the integration of freight and logistics.

The nature of urban nodes calls for a tailormade mix of ingredients which cannot be reduced to a one-size-fits-all solution due to its multiplicity. Combining spatial scales, sectors, modalities, and multi-level governance in order to integrate logistics within common spatial-infrastructural procedures may be, therefore, a challenging task. Therefore, the added value for the specific actor should be clarified.

2. What are the key challenges regarding freight and logistics within the U-Ned programme?

Four main challenges regarding freight and logistics are identified as result of desk research and interviews. The first challenge is described as a *lack of 'Logistics-Oriented Development'* within the U-Ned programme. In general, the programme U-Ned is mainly focussed on accommodation of residential housing and its expected growth which has consequences for accessibility of the region. However, the influence of freight and logistics next to accessibility, mobility and urbanization appears to be a blind spot. On the one hand, this is caused by the sectoral, institutionally fragmented transport chain which is no one's complete responsibly. On the other hand, is steering on the (private) freight and logistics sector often seen as a 'no go area' because of issues of market disruption. The document analysis and the interviews show that the different authorities are mainly focussed on solving problems within their own responsibilities instead of searching for cooperation to address the multi-scaler challenges. Governmental authorities (e.g. the city of Utrecht, the province of Utrecht and Rijkswaterstaat) are mainly acting separately from each other regarding freight and logistics. Therefore, searching for alignment, collaboration and coordination between different levels of government based on a common objective might be key (vertical integration). Simultaneously, integration with the other U-Ned objectives (e.g. urbanization) may be an issue (horizontal integration).

The second challenge contains the *Improvement of coordination of spatial planning and infrastructure regarding freight and logistics on regional (FUA) scale.* In general, the involved actors are developing their own policies mainly within their own responsibly. Coordination on regional level might be needed to gain synergic and complementing Logistics-Oriented Developments. Currently, the cooperation on regional (FUA) level is mainly focussed on network optimization while neglecting spatial planning, clustering and relation to the broader network. Guiding the increasing impacts of freight and logistics is important to avoid disturbance and competition for space.

The third challenge is described as *vulnerably of the network*. Competing local, regional and (inter) national traffic flows are observed. Moreover, it is uncertain which influence development as, for instance, the Merwedekanaalzone and (multimodal) hubs will have on the pressure of the already congested road

network. Freight and logistics transportation, as part of broader traffic system, will be influenced as well. Therefore, measures and innovations other than simply adding network capacity are needed.

The fourth challenge encompasses a different way of *organizing the connection between last-mile and long-distance transport*. Development of zero-emission regulation demands for a different way of organizing passenger and logistics transportation towards an efficient modality chain. The current transport modes and growing consolidation locations have increasingly impact on the MRU. This stresses the need for awareness and the urgency for a transition towards another transportation system.

3. Which possible 'good' practices are applicable from the VN toolbox to the U-Ned programme within the metropole region Utrecht?

The next step is application of 'good' practices in order to address the observed challenges. Solutions which address the integration of Logistics-Oriented Development (LOD) can be found in the strategic clustering of clean energy hubs, truck parkings and consolidation centres while considering the broader network. Coordination will reduce unnecessary trips, create synergies and developments will benefit from the shared infrastructure and facilities. Situating of these logistics-oriented developments will probably be along the A2 (on industrial area Lage Weide) and the A12 (on industrial area Liesbosch) considering their connection to the ring road and opportunities for modal shift. Furthermore, those locations are the main industrial areas close to the urban areas within the MRU. Therefore, development of multimodal hubs for (city) logistics, whether or not combined with passenger hubs, have potential on these locations.

Solutions addressing the vulnerability of the network might be found in water transportation along the Merwedekanaal. Pressure of the local network will be reduced by shifting transportation of, for instance, city logistics and construction materials towards usage of water modalities. It is important to mention that such a shift is considered complex and expensive but worth further research. Another innovation which is in line with water transportation, is development of a construction hub nearby the Liesbosch harbour. A construction hub refers to a location where logistics process regarding construction materials are coordinated in order to reduce emission and disturbance on the local network within the MRU.

Addressing the need for an alternative approach towards organization of an efficient transportation chain can be found in the alignment of (multimodal) hub developments, provision of multimodality and the related 'fitting' infrastructure. To this end, it is essential to provide a comparable or better service level as alternative option for regular (single) modes of transportation. Optimization and addition of missing infrastructure, connecting dots (e.g. terminals) and modes need to be identified. Therefore, cooperation and collaboration are seen as crucial element for creation of a well-functioning transportation system as replacement for regular transportation modes (e.g a polluting delivery truck). It should be considered that the effectiveness of solutions is depending on the match between type of goods, volumes, modalities and infrastructure available. Furthermore, multifunctional use of space (e.g. multimodal hubs) may be an answer to linking different scales of the transport chain. To this end, combining and connecting functions along major infrastructure will create a synergizing effect and further sprawl will be avoided (e.g TODs in combination with LODs). Especially, for the U-Ned programme this may gain added value because of their focus on (passenger) hub development.

4. How can Vital Nodes tools effectively be implemented within the U-Ned programme?

Regarding the institutional elements of implementation, a multilevel governance perspective might be desired to overcome financial and administrative boundaries. Creation of an effective transportation chain consisting of hubs and different transportation modes is depending on different (public and private) responsibilities. Consequently, the multi-scale and multi-actor 'nature' of proposed spatial and infrastructural synergies requires a cross-sectoral procedure. Such a collaboration needs to be arranged beforehand to create trust, willingness and the added value on the long-term. Initially, the role of governmental authorities should be focussed on facilitation and stimulation. Simultaneously, increasingly stricter regulations should come into place to push the transition in the right direction which includes reserving space for logistics activities. Furthermore, respecting the business models of the private logistics companies is crucial in arranging a collaboration. It may be worthwhile to appoint a *'Logistics agency'* for the entire MRU which is responsible for committing and mediating the logistics sector and authorities together for the integration of freight and logistics. Aim of the '*logistics agency'* is to stimulate the private sector to unfold innovation regard clean, light and smart freight and logistics. The efforts should result in project-based improvements which are aligned with other U-Ned objectives (e.g. accessibility). Another institutional aspect which can be introduced is a '*hub provider'* which is made responsible for maintaining an efficient transport chain by means of a concession or contract. Moreover, the service level of developments will be ensured from the very beginning.

With regard to financial implementation elements, public private or public-public partnerships may be useful to divide the risks and responsibly. The role of a *'Hub provider'* may ensure the quality of mobility and logistics services while keeping the costs as efficient and affordable as possible. This is essential to provide a competitive alternative for unsustainable and often cheaper transportation modes. The importance of capacity building should be mentioned in relation to timing elements of implementation. Upscaling of the network of hubs and multimodal solutions are crucial for the creation of solid business case. This is needed to ensure a reliable and multi-modal transportation 'chain' as replacement for the current 'single' modes of transportation. Activity searching for synergies regarding bundling of volumes and clustering of activities which make use of the same facilities might be recommended. Lastly, steps need to be made in data-sharing between logistics services. Alignment of systems, data, platforms and processes is essential to link different components of the transport chain efficiently. Therefore, building trust between actors is seen as precondition.

In essence, the findings of this study make clear that the Vital Nodes approach application within the MRU may have added value in creation of awareness of integrating logistics as important process within urban areas. The accommodation of freight and logistics next to, and consistent with the urbanization and accessibility strategy may be the main lesson of this study. Bringing the often-fragmented worlds of spatial planning and infrastructure considering logistics together is the main challenge which is also observed in the MRU. Furthermore, alignment and clustering of logistics activities considering the broader FUA should be considered by creation of strategic (U-Ned) policy goals such as urbanization, mobility and accessibility. The study showed that integrating spatial and infrastructural developments (e.g. multimodal hubs and consolidation centres along the ring road) may provide an alternative for the current A-to-B logistics, which is often characterized by, less sustainable, single transportation modes. Provision of an effective transport chain with regard to logistics is only possible while considering the interrelation with other scales and the responsibilities of actors involved. Therefore, implementation of the Vital Nodes approach within the MRU

is informed by overcoming financial and administrative boundaries by building trust and willingness between public and private sector. Creation of a common purpose which provides sight on long-term added value may create perspective for actors involved. Although, freight and logistics are not seen as substantial sector in the region, development of a shared vision followed by an action perspective may be necessary for effective accommodation of future trends in logistics within the MRU.

5.2 Discussion

This section provides a discussion, of the findings of this study and the contribution for planning theory and practice. The scientific relevance of this study is based on the applicability of the Vital nodes thinking in the Dutch context. Previous Vital Nodes studies were (except for Rotterdam) mostly carried out outside the Netherlands which made its application valuable for both the metropole Region Utrecht as well for enrichment of the Vital Nodes approach itself. The study made clear that the subject of freight and logistics is underexposed in the MRU, as in many European cities, as explained by Van der Werf et al. (2019). The claims made in this study provide a point departure for acknowledging the lack of coordination and potential collaboration between actors involved. With regard to generalization several remarks should be made. As stated by van der Linden (2019) solutions cannot be reduced to a one-size-fits all solution since contextual factors play an important role in intervening in urban nodes. Therefore, statements and recommendations made in this study and valid for the MRU must be seen as example. Outcomes could be used as direction, considerations for creating awareness for integration of freight logistics and supported by possible 'good' practices.

Implications for planning theory and planning practices

The contribution for planning theory and planning practices of this study can be found in four main lessons. First, the subject of freight and logistics need to be addressed as one of the integral urban functions and is therefore relevant to integrated urban planning. This implies the consideration of impacts on urban areas and possible solutions for accommodation next to urbanization strategies. This is important for integral policy development. Second, the study revealed the need for awareness of a transition towards an alternative organization of the transportation chain. This has implications for the way in which urban areas and infrastructure are organized and connected to each other (e.g. usages of hub and multimodal solutions). Third, such multimodal solutions may have a positive effect on reducing bottlenecks in and around urban areas. Four, this study shed a light on the clustering and synergizing of logistics activities to gain added value on regional (FUA) level which can be activity steered by authorities. Building collaborations of both private and public actors which all acknowledge the same goal on the long term are recommended.

Applying the findings to practice

To integrate the findings of this study into the U-Ned, it may be valuable to consider policy transfer elements as specified by Dolowitz and Marsh (1996). Regarding addition of policy goals, the integration and accommodation of freight and logistics as part of the broader urbanization and accessibility strategy would be the important lesson. Important policy instruments derived from the study are the importance of coalition building between the logistics sector and various public authorities by the logistics agency. Furthermore, public-private partnerships should be created to ensure services levels by, for example, hub providers. The need for data-sharing is another policy instrument to overcome the problem of a fragmented transportation chain. Strategic clustering of LODs considering the broader functional urban area may be another transferable instrument towards the MRU. Moreover, the regulations regarding mobility in the

Merwedekanaalzone are seen as test case for further development of carefree neighbourhoods within Utrecht and therefore an interesting case to draw transferable regulations from. An important aspect of this study is the provision of 'good' practices applicable to the MRU. These good practices can be described as transferable ideology, ideas and concepts which can be potential successful. Transferable concepts drawn from this this study refer to multimodal hubs along the ring road, a modal shift towards the Merwedekanaal or development of a construction hub.

Following Dolowitz and Marsh (1996) transferability of these aspects can be divided in four degrees of transfer; Copying (without change), emulation (selecting general standards), hybridization (combining elements) and inspiration (expanding ideas). Copying policies without any changes will rarely happen due to contextual factors of urban nodes (van der Linden, 2019). To this end, policy interventions as presented in the study are more likely to be subject to emulation, hybridization or function as inspiration. A system of hubs can be transferred as emulation by keeping the main idea but leave room contextual factors. In fact, every hub entails specific area-oriented characteristics to make them useful (R4, 2020). An example of hybridization could be found in transferring programme elements of the MoVe programme towards the U-Ned programme. To this end, good practices are mixed towards a new effective policy adjusted to the new context. Inspiration of transferable aspects may work as catalysator for expanding ideas. For instance, outcomes of this study provided possible innovate ideas regarding alternative road configurations of the A12 as solution for traffic competing flows.

Regarding constraining factors for policy transfer as discussed by Dolowitz and Marsh (1996), within the MRU the following aspects need to be considered. Integrating freight and logistics within U-Ned will result in additional difficulties in terms of realization of U-Ned goals itself. Programmes with multiple goals are harder to reach than programmes with single goals (Dolowitz & Marsh, 1996). Moreover, the fewer side-effects a transfer will have, the greater possibilities of transfer (Dolowitz & Marsh, 1996) Integration of freight and logistics and an alternative transportation chain will have great influence on the way urban areas are organized. Therefore, transferability will probably be a process of years. In addition, the more 'information agents' are involved, the easier transferability will happen (Dolowitz & Marsh, 1996). Therefore, building coalitions which share the same long-term goals regarding logistics may be helpful in transferability of policy.

5.3 Recommendations for planning practice in general and for planning within Rijkswaterstaat

In this section, recommendations for planning practice in general and planning within Rijkswaterstaat are discussed.

Recommendations for planning practice

In general, the issues regarding freight and logistics within urban areas should be seen as part of mobility and accessibility policies because of their interrelation. A broader perspective might be, therefore, recommended beyond the narrow focus of passenger transportation. It might be recommended to conduct a design-based-research regarding potential multimodal solutions of the future. For example, LODs which are connected to major infrastructure, (logistics) hubs and innovate road configurations as solution for an alternative and more sustainable transportation chain. Another recommendation may be to bring public and private actors together aiming for strategic clustering of various logistics activities on regional level.

Opportunities for synergies are more likely to appear if different responsibilities and roles regarding freight and logistics are brought together. To this end, development of a common understanding of roles and responsibilities of actors involved should be required. Therefore, an active role of governmental authorities in steering LODs within metropolitan urban areas might be recommended to avoid disturbance caused by freight and logistics in the future. this end, building a coalition within U-Ned with the focus on integration of logistics may be a suggestion for further research.

Recommendations for Rijkswaterstaat

As stated in this study, building a coalition might be required to divide and align responsibilities between various actors along the transportation chain. Rijkswaterstaat, as operator of the major road and water infrastructure, should be seen as important relevant component of this collation. Using the term 'relevant' is intended as important actor which involvement is recommended. Rijkswaterstaat should be seen as participating actor within this broader U-Ned coalition. Developments as proposed in this study do affect Rijkswaterstaat assets which is why Rijkswaterstaat involvement might be necessary (e.g. road configuration or hub development on or above land owned by Rijkswaterstaat. With regard to accessibility and mobility of the MRU it is crucial to be, as Rijkswaterstaat, continuously involved within these programmes. Various participants of this study argued that Rijkswaterstaat should not be initiator of such alternative accessibility solutions. Instead, the province, together with the major municipalities, were often mentioned as stimulating actors. Nevertheless, it has become clear during this study that implementation and integration of, for instance, hubs and LODs, are only possible in consultation of a broader coalition. A coalition such as U-Ned seems to be a suitable platform, in terms of the crucial actors involved, to put the challenges regarding freight and logistics on the agenda. This study revealed the underexposed position of logistics is acknowledged by various governmental agencies. The main recommendation for Rijkswaterstaat may be to keep insisting on development of a shared policy regarding freight and logistics which is supported by the involved U-Ned actors. Moreover, the discussion regarding the way in which logistics should be integrated within the U-Ned programme might be encouraged by Rijkswaterstaat. To this end, proving the importance of collaboration between actors including Rijkwaterstaat might be key.

Several recommendations could be made regarding the responsibilities of Rijkwaterstaat as part of the U-Ned coalition. This study discussed the possibility of multimodal hubs and consolidation centres nearby the A2 and A12. The influence which such developments will have in terms of bottlenecks and pressure on the ring road requires further research. During the study it was suggested that it would be more logical to situate multimodal developments 'before' the metropolitan area of Utrecht. As result, logistics and passenger flows will be 'captured' before entering the urban area and disturbance will be avoided. However, this may lead to further sprawl of logistics activities in the region. Moreover, the range of alternative (e.g. electric and hydrogen) fuelled transportation modes are not always capable of reaching the city edges and vice versa. Therefore, a balance should be found between the city edges, the destination within the city and the transhipment hub to arrange a transportation chain.

Second, additional research is required for the connection of multimodal hubs and consolidation centre to the ring road. To this end, innovative road configurations along the A12 and A2 which do not create bottlenecks should be researched. Moreover, such hubs and consolidation centres along the road infrastructure are demanding space which need to be integrated within an already dense urban area. The connection between both the ring road as well as to the alternative transportation mode (s) may be a challenge within the often-narrow space along the ring road.

Third, to better connect the LODs to the major road infrastructure within the MRU it may be worthwhile to have a look at the freight corridors programmes (East corridor: Rotterdam - Arnhem/Nijmegen - Germany (along the A15) and Corridor South east: Rotterdam - Noord-Brabant/Limburg - Germany (along the A16, A58 and A67)). Although the MRU does not include a major logistics sector it may be valuable to consider measures and policy instruments as example for logistics integration. For instance, insights of these programmes may be valuable for the connection of proposed LODs on Lage Weide and the Liesbosch to the ring road.

Apart from the integration of LODs within the road network, it may be worthwhile to determine the policy regarding truck parkings, clean energy hubs within these LODs. Additional steps need to be taken to align these developments to each other and within the Rijkswaterstaat policies. Determining the connection between the road network and these logistics developments within the Rijkswaterstaat policies may be, therefore, a recommendation for the integration of logistics within the MRU.

5.4 Reflection on research and recommendations for further research

Several remarks regarding reliability of this study should be made. First, the conclusion is based upon a limited number of interviews which has as consequence that statements are based on a small foundation of expert-knowledge. Therefore, claims made in this study should be interpreted as a general basis for awareness raising of the impacts caused by freight and logistics and as inspiring example. In addition, interviewees are mainly originating from the public sector while involvement of the (private) logistics sector is neglected. Therefore, this study shows only one side of the coin with regard to freight and logistics which may have different perspectives on the claims made. The important insight of involving the logistics sector emerged relatively late during the interviews and couldn't be realized within the research demarcation. Also, only U-Ned 'partners' (e.g. municipality and province) were approached instead of the U-Ned project team itself. Therefore, the question in which the subject of freight and logistics needs to be integrated within the U-Ned programme remained underexposed in this study. During the process, an unintended shift was made from the two cases to U-Ned as a whole. This is due to the fact that interviewees were not always familiar with the cases which resulted in general judgments and speculation. Furthermore, the entire data collection of this study is done via online platforms due to the corona pandemic. The chances in which biases could have played a role in the data collection phase in comparison to a face-to-face interview are significant. In addition, the focus group to validate the findings was held online as well which could have been a barrier for participants to react and to participate in an interactive way.

The outcomes of this study show a lack of shared policies and collaboration between responsible actors regarding logistics in the MRU. An alternative transportation chain should be provided with an eye on future trends. It is, therefore, recommended to dive deeper in the following issues. Further research should be conducted regarding the coalition building between the provinces, municipalities and Rijkswaterstaat addressing the need for an alternative transportation chain consisting of hubs and modalities. Which role should the various governmental authorities take to divide and share responsibility? How to overcome financial barriers prompted by different funding streams? Furthermore, how to prepare and maintain such a coalition given the many uncertainties involved?

Moreover, the (private) logistics sector was not included in this research which presents, therefore, one side of the coin. Further research should focus on participation of the logistics sector within innovative

initiatives addressing the subject of logistics within urbanized regions. Therefore, appointing a 'logistics agency for the entire MRU could be a solution. Further research is needed to map and identify the needs of the logistics sector, the way in which the sector should be actively involved and how the role of the logistics agency should be fulfilled. Diving deeper in the various contract forms aiming for bounded cooperation might be recommended (e.g. concessions, covenants and public-private partnerships).

Another more concrete issues that requires additional research is the need for data sharing. How can different services, modes, goods and volumes be aligned towards an effective transportation chain? Additional research in technology (e.g. MaaS) and smart solutions for collaboration between carriers and hub providers is recommended. In addition, research can be conducted regarding the need for hub providers. Which governance should be used (e.g. public- private partnerships or white label hubs) and which implications does that have for an effective transportation chain?

5.5 Personal Reflection

This paragraph contains a reflection on the own process. The number of Vital Nodes documents at start of the process created a bit of confusion in formulation of the research objectives. Making sense of the large amount of information took some time. During the data collection and data- analyses I found it rather difficult to distinguish primary and secondary issues. Talking to people with interesting expertise I did like but this proved to be a pitfall as well, because of a tendency to getting of topic. During data analyses it became challenging to select the appropriate data for answering the research questions. The search for a fitting logical structure, therefore, caused some time constraints which resulted in a tight schedule. Moreover, sometimes I had the tendency to connect everything to everything while analysing the data and formulating conclusions. The difficulty of using qualitative data is that the interpretation of the researcher will always influence and bias the outcomes. During the study I caught myself sometimes in that situation.

Another aspect which was difficult during this research was the outbreak of the Corona crisis which resulted in (online) data collection and writing from home. Initially, this might be positive in terms of focus and less distraction during the process. However, going to an office or the university to structure your day is worth a lot in that respect. Furthermore, doing an internship from your own home isn't that inspiring as going to the office. Nevertheless, I have become increasingly interested in the cutting edge between spatial and infrastructural issues regarding logistics which is a personal spin-off of this study. If I would write a master thesis again the focus will be more on the primary research objectives instead of the focussing on everything discussed. In this sense, it will be avoided to relate everything to everything.

This study is conducted during an internship at the Rijkswaterstaat department, Water, Verkeer & Leefomgeving (WVL) (Water, Traffic and Environment). During this internship I gained more insight in the working field and in ongoing developments regarding mobility and logistics within urban areas. In general, it is often assumed that Rijkswaterstaat is occupied with network improvement of water and road infrastructure. However, during my internship I encountered various broader themes such as area-oriented developments, archaeology, the connection with public transportation and chain modality. Obviously, this might be attributed to the focus of the specific department. Nevertheless, I was surprised by the broad focus of Rijkswaterstaat regarding the connection with, for example, sustainable mobility and public transportation. Furthermore, I was surprised by the diversity of themes, issues and projects that were addressed within the department. The choice and focus of themes which are addressed are, in my opinion, more flexible than thought beforehand. The choices not always imposed from above but seen as: 'is it

important to for Rijkwaterstaat to be involved'. I appreciated the open and 'just ask 'environment within the department. This enhanced the feeling that I could attend most all of the meetings and sessions if I wanted to. In particular, I want to thank cluster Ruimte (section Spatial Planning) for their enthusiasm and support!

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7. Appendix

Appendix 1: Interviewees

Appendix 2: Interview guide

Interview Guide	(Dutch)
Part 1. General (interviews)	*Introductie* *Ethiek* *Uitleg Vital Nodes en doel onderzoek* *Expertise respondent*
	A. Kunt u uzelf (en de projecten) introduceren? (Verantwoordelijkheid en rol?)
	B. Wat is uw rol bij U- Ned? *(Merwedekanaalzone of Jumbo Nieuwegein?)*
Part 2. Interests	*Het gaat hier om **belangen van de stakeholder***
	A. Wat zijn de belangen van de stakeholder?
Part 3. Challenges	*Het gaat hier om de identificatie van **challenges** omtrent integratie van **goederenvervoer** met **infra en ruimte** op verschillende **schaalniveaus** en **modaliteiten.***
	A. Welke challenges ziet de stakeholder met betrekking tot U-Ned *(MWKZ of Jumbo Nieuwegein).*
**Stakeholders en case specifiek*	B. Kunt u dat toelichten? *- Challenges omtrent integratie van goederen? ** *- Challenges omtrent integratie infra en ruimte? ** *- Challenges omtrent schaalniveaus en connectie daartussen? ** *- Challenges omtrent modaliteiten? **
Part 4. Solutions, drivers and barriers	*Het gaat hier om identificatie van **oplossingen, bewegingsredenen en barrières** rondom U-Ned (MZKZ of Jumbo Nieuwegein).*
	A. Wat zijn mogelijke drivers and barrières? A1. Kunt u dit toelichten?
	B. Wat zijn mogelijk aan te dragen oplossingen? B1. Kunt u dat toelichten?
**Stakeholders en case specifiek*	C. Hebt u hier voorbeelden van? *- Oplossingen/ barrières omtrent integratie van goederen? ** *- Oplossingen/ barrières omtrent integratie infra en ruimte? ** *- Oplossingen/ barrières omtrent schaalniveaus en connectie daartussen? ** *- Oplossingen/ barrières omtrent modaliteiten? **
Part 5. Added value (Discussion Group!)	*Het gaat hier om de (potentiele) **toegevoegde waarde** van de **integrale** manier van denken volgens de Vital Nodes gedachte.*
	*A. **Heeft** deze (VN), integrale manier van denken toegevoegde waarde voor U-Ned en zijn gerelateerde ontwikkelingen?* *A1. Waarom wel/ niet?*
**Stakeholders en case specifiek*	*B. **Welke** toegevoegde waarde heeft de integrale manier van denken voor U-Ned en zijn gerelateerde ontwikkelingen?* *- Met betrekking tot integratie van goederen? ** *- Met betrekking tot integratie infra en ruimte? ** *- Met betrekking tot schaalniveaus en connectie daartussen? ** *- Met betrekking tot modaliteiten? **
	B1. Waarom? Kunt u dit toelichten?
Part 5. Conclusie en aanbeveling (Discussion Group)	*Toepasbaarheid van Vital Nodes benadering op de case*
	A. Welke aanbevelingen zijn eraan te dragen voor de toepasbaarheid van Vital Nodes *B. Heeft u verdere toevoegingen aan dit interview? (Feedback?)*
Part 6. Afronding	*Bedanken, ethiek benadrukken*
	Bent u geïnteresseerd in de eindversie Suggesties voor andere kandidaten voor een interview? Ethiek herhalen, contactgegevens doorgeven en bedanken.

Appendix 3: Code scheme

Code scheme	Sub-question	Inductive/ deductive
Spatial- structural integration	1; 3	Deductive
Space	1; 2	Deductive
Network	1; 2	Deductive
Financial	1; 4	Deductive
Governance	1; 4	Deductive
Time	1; 4	Deductive
Challenges	2	Deductive
Consolidation hub	3	Inductive
Mobility hub	3	Inductive
Construction hub	3	Inductive
Truck parkings	3	Inductive
Mixed functions	3	Inductive
Zoning	3	Inductive
Modal shift	3	Deductive
Modal shift (Merwedekanaal)	3	Inductive
Clean energy hubs	3	Inductive
'Stadsrandhubs' (passenger hub)	3	Inductive
Role market	4	Inductive
Role government	4	Inductive
Merwedekanaal zone (in general)	2	Deductive
Data-sharing	4	Inductive
(Multi-level) governance	4	Deductive
Building capacity	4	Inductive
Bundling	3;4	Inductive
Corridor	1	Deductive
Last- mile	1	Deductive
Functional Urban Area (FUA)	1	Deductive
Zero emission zones	2;3	Inductive
Jumbo (in general)	2	Inductive

Appendix 4: Transcription

Appendix 5: Focus group questions

Focus Group questions	
Challenges Waarom actie ondernemen? (Wat is de toegevoegde waarde?)	1) Het ontbreken van 'logistics-oriented development' in U-Ned 2) Fragiel netwerk: conflicterend nationaal, regionale en lokale stromen 3) Efficiënt linken van last mile and long-distance logistiek transport 4) Ontbreken van een coördinatie en samenwerking op het gebied van ruimtelijke en netwerk integratie van logistiek op regionaal niveau (FUA)
Per challenges*	
Value	a) Herkenning? b) Aanvullingen?
Network + spatial	c) Welke potentiele synergiën tussen infra en ruimte zijn er?
Implementation	d) Hoe past het binnen Utrechtse context? e) Wat is er volgens nodig voor implementatie?
Discussie	1) Als U-Ned opnieuw ontworpen zou kunnen worden wat zou er anders moeten? 2) Wat is er nodig om de Vital Nodes concept te implementeren?