Sustainable Topcorridors

Institutional arrangements for sustainable corridor development

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Colophon

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Abstract

Developing a sustainable freight transport system remains a big challenge for the Dutch Topcorridors programme. However, a sustainable and integrated transport system is crucial for a well-functioning society, environment and economy. This process is further complicated by the multi-dimensional characteristics of corridors as they are multi-scalar as corridors cross multiple administrative borders; multi modal as multiple modes of transport are included; multi-sectoral as infrastructure development and spatial planning are inherently linked; and lastly, multi-governance as multiple governance levels are involved in corridor development. Sustainable corridor development requires an integrated approach which includes the functional interrelations and institutional interdependencies of corridor development, which remains challenging. The national government applied a governmental approach to align and coordinate the development of the Topcorridors and its nodes. Therefore, this research has carried out a multi-scalar case study with semi-structured interviews and a document analysis to find which institutional arrangements can support sustainable development of the Topcorridors and its nodes. The findings indicate that attention must be paid to formulating measurable goals, providing monitoring and evaluation to adjust when necessary and to political influences as these affect the capacity and funds that are available at the nodes. Furthermore, it is important to operate in a coherent manner to ensure that the programme does not become too loosely coupled. Finally, the Topcorridors are part of the European TEN-T and freight transport is international, requiring the consideration of the European scale in the development of a sustainable transport system.

Key words: corridor development, nodes, freight transport, sustainable infrastructure, programmatic approach.

List of tables and figures

List of abbreviations

Abbreviation	Meaning
CEH	Clean Energy Hubs
EGTC	European Grouping of Territorial Cooperation
EU	European Union
FUA	Functional Urban Area
I&W	Ministerie van Infrastructuur en Milieu EN: Ministry of Infrastructure and Environment
MIRT	Meerjarenprogramma Infrastructuur, Ruimte en Transport EN: Multi-Year Programme for Infrastructure, Spatial Planning and Transport
MLG	Multi-level governance
RTG	Rail Terminal Gelderland
TEN-T	Trans-European Transport Network

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1. Introduction

1.1. Topcorridors programme

Infrastructure is considered a requirement for spatial-economic development as infrastructure increases accessibility and connectivity between individual places and regions (Faith-Ell et al., 2020; Arts et al., 2021). Therefore, it is no surprise that the logistics and freight transport in the Netherlands is of added value for the economic value of the Netherlands (Ministry of Infrastructure and Environment, 2017). It is expected that this trend proceeds to continue in the upcoming years. However, to ensure this trend the existing infrastructure remains important (Topcorridors, 2021b). For a large part, logistics and freight transport in the Netherlands is facilitated by the east and south-east freight corridor, which contains multiple modes of transport (Topcorridors, 2021b). The Dutch share of this corridor is organised in the so-called Topcorridors programme. The Topcorridors programme has been established since 2017 and cooperates in order to optimise the east and south-east axes. In the programme, attention is paid to ensure *"a joined, integrated, multi-modal, cross-regional and international approach"* (Topcorridors, 2021b). The goal of the programme is to strengthen the corridors and improve sustainability, whilst contributing to the economic vitality of the regions (Topcorridors, 2021b). The strength of the freight corridor lies mostly in well-functioning nodes (Topcorridors, 2021b). Therefore, six nodes are identified along the Topcorridor (Figure 1) in the Netherlands based on strategic locations, economic significance and importance for freight transport (Topcorridors, 2021b). The nodes are connected cities through the Topcorridor.

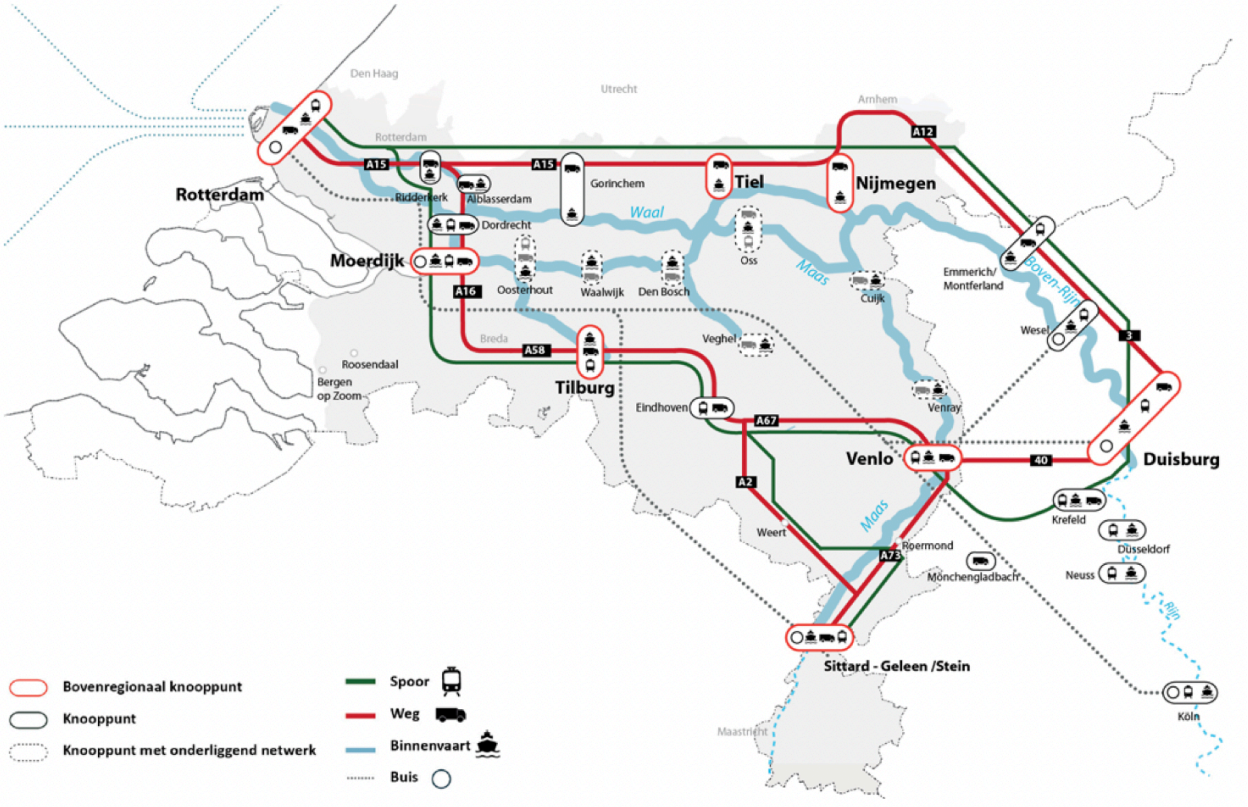

Figure 1: Identified nodes (Defacto Urbanism, 2019).

The Dutch Topcorridor is part of the European Rhine-Alpine corridor. The Rhine-Alpine corridor connects the main North-Sea Ports of the Netherlands and Belgium (Rotterdam and Antwerp) with the port of Genoa (European Commission, 2013). This corridor is multi-modal and connected to several European east-west axes (Faith-Ell et al., 2020), as can be seen on Figure 2 below. It crosses through some of the main economic centres and most densely populated regions of western Europe. Furthermore, the Rhine-Alpine corridor is one of the busiest freight routes of Europe (European Commission, 2013). The Rhine-Alpine corridor is one of the nine corridors which together form the Trans-European Network for Transport (hereafter TEN-T).

In the late 1990s, the European Union (hereafter EU) launched the TEN-T (European Commission, 2013). The purpose of this network development is to enhance European objectives: *"The trans-European transport network shall strengthen the social, economic and territorial cohesion of the Union and contribute to the creation of a single European transport area which is efficient and sustainable, increases the benefits for its users and supports inclusive growth"* (EU Regulation no. 1315/2013, p.8, cited by Öberg et al., 2016 p. 3701). In contribution to this, the objective of the TEN-T is to improve infrastructure usage, decrease environmental impact of transport, reinforce energy efficiency and enhanced safety (European Commission, 2022; Kotzebue, 2022). This is in line with the fundamental objectives of the EU, one of which is sustainable development. Within the EU, sustainable development is considered a horizontal responsibility, implying that it should be considered in all objectives of the EU (Öberg et al., 2017).

The concept of sustainable development is widely discussed and its definition varies between individuals and organisations. There currently is no final definition of the concept (Jordan, 2008; Öberg et al., 2017). In the context of sustainable transport systems, sustainability is related to climate change and to more environmental aspects e.g., biodiversity, environmental pollution and non-renewable resources (Arts et al., 2021). A more holistic view towards sustainability, including the environmental, ecological and economic dimension, is needed (Öberg et al., 2017). This avoids perceiving sustainable development as only addressing one dimension (Öberg et al., 2017; 2018). Balancing the different dimensions, the environmental, ecological and economical dimension, can result in sustainable infrastructure development and usage (Arts et al., 2021). Related to corridor development, sustainability is explained as a development to ensure sustainable and economically efficient transport. It is viewed mostly from an environmental point of view, although cohesion, efficiency and benefits for users of the transport corridor remain important (Öberg et al., 2017).

One of the key challenges for sustainable development is the transport sector (Marsden & Rye, 2010). Hence, the interest of the EU in developing sustainable transport systems is increasing (Guasco, 2013). Furthermore, the scope of the TEN-T policy includes the objective of closing gaps, removing technical barriers and bottlenecks, and to strengthen economic, social and territorial cohesion within the EU (European Commission, 2022). A sustainable, and integrated, transport system is crucial for a well-functioning society, environment and economy (Arts et al., 2016; CEDR, 2021). This requires a more integrated and strategy driven planning approach (Arts et al., 2016). The development of such a sustainable freight transport systems remains one of the big challenges for the Dutch Topcorridor and its nodes.

1.2. Multi-dimensional characteristics

As mentioned, the Topcorridors are part of the Rhine-Alpine corridor which is part of the TEN-T. The core network of TEN-T consists of nine corridors, displayed in Figure 2 (European Commission, 2013). The transnational freight transport that takes place within Europe along these corridors is essential for the functioning of the single market within Europe (European Commission 2013; Guasco, 2013). Corridors are bundles of infrastructure connecting at least two urban areas (Priemus & Zonneveld, 2003; Witte, 2014). Due to these connections, the development of transport systems such as corridors affects multiple spatial scales, multiple modes of transport, multiple sectors and multiple levels of governance (Witte et al., 2013; CEDR, 2021).

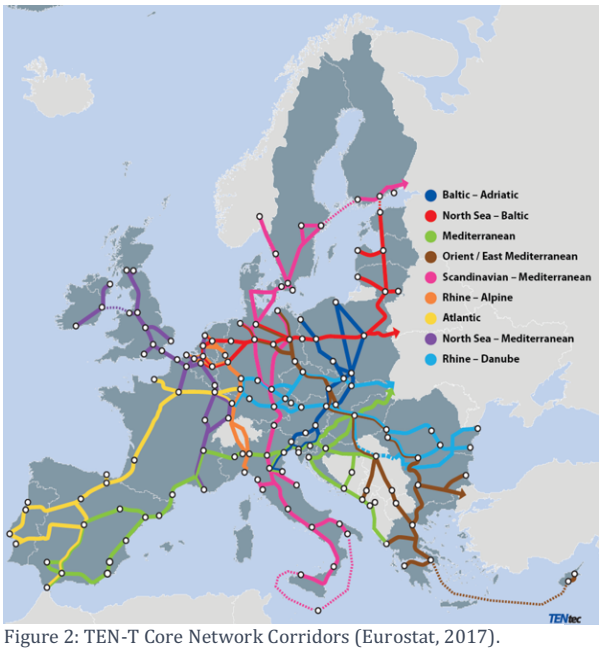

Figure 2: TEN-T Core Network Corridors (Eurostat, 2017).

1.2.1. Multi-scalar dimension

The TEN-T functions as a European transport network, connecting and crossing through different countries, regions and cities. The connected cities are at the core of the TEN-T, these are the urban nodes. These urban nodes, and their surrounding urban regions, are in need of sustainable freight transport systems to mitigate the negative consequences of traffic to benefit from the TEN-T (Vital Nodes, 2020). Negative consequences of traffic entail e.g., poor air quality, noise, emissions and congestion. It is important to consider these nodes as significant elements of corridor development as the meaning of a corridor differs per scale and is related to the scale at which corridor development is addressed (De Vries & Priemus, 2003). Therefore, the challenge to develop sustainable freight transport systems has to be addressed on both the level of the corridor itself and on the level of the urban nodes, the so-called functional urban area (hereafter FUA) (Vital Nodes, 2020). Corridors thus have a multi-scalar character. Integration is crucial as local issues, e.g. congestion, might have solutions on the corridor level, and issues on a corridor level also need to be taken into account in local infrastructure (Vital Nodes, 2019; Panteia, 2021). The success of the node thus is related to the success of the corridor. Therefore, besides the need for integrated policies due to the multi-sectoral character, this integration needs to be structured on the levels of both the corridor and the FUA (Guasco, 2013; CEDR, 2021). Considering the multiple scales involved, this is necessary as the enhanced vitality of a region has a positive impact on the functioning of transport corridors (Arts et al., 2016). However, this regional scale is often poorly discussed throughout the planning process (Arts et al., 2014).

1.2.2. Multi-modal dimension

Corridors generally consist of multiple modes of transport and thus infrastructure e.g., roads, railways, waterways, pipelines (Priemus & Zonneveld, 2003; Romein et al., 2003; Witte, 2014). Infrastructure can serve both passenger and freight transportation (Witte, 2014). The different modalities can interact at the FUA. Last-mile transport logistics and long-distance freight transport can be linked here (Panteia, 2021). These connections can also be beneficiary for modal shift (Witte, 2014). Therefore, multi-modal mobility of corridor development needs to be included in corridor development (CEDR, 2021). That different modalities can be linked is one of the strengths of the FUA (Vital Nodes, 2019).

1.2.3. Multi-sectoral dimension

As new infrastructure commonly is connected and build upon existing infrastructure, corridor development is considered to be path-dependent (Priemus & Zonneveld, 2003). Due to this path-dependency and the density of western-Europe, the localisation of bundles of infrastructure has a strong influence on economic development and patterns of urbanisation (Priemus, 2001; Witte, 2014; CEDR, 2021). Thus, the corridor concept is broader than the transport infrastructure component (Priemus, 2001). Infrastructure shapes the spatial environment at the local scale, and is part of the FUA on a regional scale (Heeres, 2017). This is understandable as infrastructure networks are embedded in a larger system (Arts et al., 2016; CEDR, 2021). The corridor concept therefore seeks to integrate policies on infrastructure, economic development and urbanisation (Priemus & Zonneveld, 2003; Chapman et al., 2003; Witte, 2014; Öberg et al., 2016). Today's corridor development is concerned with the interrelatedness between transportation capacity, economic benefits and spatial aspects (Witte, 2014). This integration aims to strengthen the connection between infrastructure planning across multiple levels and sectors (Öberg et al., 2016). Integration of transport and land-use planning is essential for sustainable planning outcomes in the future due to interaction between transport and land-use planning (Perić & Scholl, 2017). However, this integration is rarely visible in practice (Chapman et al., 2003; Arts et al., 2016). Corridor development thus has a multi-sectoral character that must be addressed as focusing solely on the transport infrastructure system itself would not be sufficient (CEDR, 2021).

1.2.4. Multi-governance dimension

Due to the multi-scalar character the success of the corridor itself and that of the nodes are interrelated. The corridor crosses through administrative borders and is less tied to a single governance level or a single public administrative area (Romein et al., 2003). Furthermore, other sectoral spatial dimensions i.e., residential or facilities, are affected by infrastructure development as infrastructure development is inherently interrelated with other land uses. This relationship is both functional, as present infrastructure has an influence on the quality of other land uses, and spatial as the different land-uses are close-by or even overlapping (Heeres, 2017). The interrelationship can be both positive, infrastructure increases the accessibility which may result in socio-economic development, and negative due to negative environmental impacts. Therefore, navigation between the different involved scales, governance levels and spatial sectors is needed for corridor development (Romein et al., 2003; Heeres, 2017; Faith-Ell et al., 2020). The ability to navigate between levels also offers the opportunity to focus on specific nodes in the corridor, and to zoom out and consider the corridor as a whole (Faith-Ell et al., 2020).

1.3. A need for integration

Challenges in corridor development, as sustainable development, are often related to the multi-dimensional characteristics of corridor development (Witte, 2014). In the Netherlands, such challenges are often addressed by the province or municipality. These governmental institutions have their own organisations for management and maintenance of land-use interests and project implementation (Heeres et al., 2016). However, challenges as sustainable development are insufficiently addressed through these commonly applied governance levels (De Vries & Priemus, 2003; Witte, 2014). In order to address the issue of developing a sustainable freight transport system, sustainable development should be assessed on the corridor and FUA level (Vital Nodes, 2020). Policies developed on different institutional levels along a corridor need to be integrated (Guasco, 2013; Vital Nodes, 2019; Panteia, 2021). This integration must be structured on both levels (Guasco, 2013; CEDR, 2021). Hence, the challenge should be approached on different levels. Numerous governance systems must align and coordinate to achieve a sustainable freight transport system (Priemus, 2001; Guasco, 2013). Besides different governance levels, these systems include multiple sectors. In practice this implies that e.g. the goals of economic development and transport

infrastructure development on local and regional scales, must be balanced with sustainability goals (Witte, 2014). Due to the multi-dimensional characteristics an integrated approach, taking both the functional interrelatedness and the institutional interdependencies into account, is suggested. The need for an integrated approach is also stressed by the Vital Nodes project (Vital Nodes, 2019).

An integrated approach towards corridor development thus takes the multi-dimensional characteristics of corridor development into account (De Vries & Priemus, 2003; Arts et al., 2021). Such an approach can be applied as it integrates the importance of the larger networks with the interests of the FUA. The approach actively strives to integrate the different interests from different sectors and scales in a specific area (De Vries & Priemus, 2003; Heeres et al., 2016; Heeres, 2017; Arts et al., 2021). Besides the transport system, the region in which the infrastructure is embedded is taken into consideration. The integration of infrastructure with other spatial sectors involved is expected to result in improved sustainable infrastructure development due to improved coordination as it allows for a broader scope, including more than just the physical infrastructure that is being realised (Heeres et al., 2012; Heeres, 2017). It allows the inclusion of e.g., housing, nature development and other spatial functions. Such an approach remains challenging as it does not only require cooperation between different governmental scales, but also with market parties, interest groups and private actors (Öberg et al., 2016; Heeres, 2017; Vital Nodes, 2020). This implies horizontal and vertical governance. A larger insight in the interaction between the responsible actors, both governmental and non-governmental, and on different institutional levels, on behalf of corridor development is needed (Heeres et al., 2016). Especially considering that the realisation of a sustainable transport system requires an inclusive approach (Öberg et al., 2018). Non-governmental stakeholders to include in the process towards a sustainable freight transport system include i.e., freight companies (Panteia, 2021). By coordinating transport infrastructure and spatial developments, solutions can be found, enhancing the vitality of a region on the FUA scale. This has a positive impact on the functioning of (international) transport corridors (Arts et al., 2016). An approach where multi-dimensional integration can be structured and balanced is the next challenge for sustainable TEN-T planning (Guasco, 2013).

As mentioned, the challenge to develop a sustainable freight transport system needs to be addressed on the corridor and FUA level. Whilst projects contributing to this goal in the Netherlands are taking place, limited cohesion is recognized on the scale of the Topcorridor (Topcorridor, 2021b). The need for more guidance on the level of the Topcorridor is also stressed by the Topcorridors programme (Topcorridors, 2021a*)*. Keeping this in mind there is a need for a more coherent integrated approach on the level of the corridor which takes the scale of the urban nodes into account as well. Governance towards a sustainable freight transport system needs to be aligned and coordinated along both scales.

A programmatic approach can be used to improve coordination between projects whilst including both governmental and non-governmental stakeholders (Busscher, 2014). A programmatic approach offers an overarching management layer through which interdependencies between projects can be managed. It links to both project and strategic management (Busscher et al., 2013). A programmatic approach functions as a framework by which projects can be managed in a coordinated manner in order to achieve a common goal, or to gain benefits which would not be realised if the projects were only managed independent of each other (Pellegrinelli, 1997). Looking back at the case of the Dutch Topcorridor programme, the common goal is to strengthen the corridor and to make it more sustainable. The selected nodes could be considered as different projects within the programme which are dependent on each other and on the programme as a whole to succeed. The general idea is that the benefit of a programmatic approach creates an increase in value by improving the management of the individual projects, especially when project integration has an influence on success (Pellegrinelli, 1997). In the context of the Topcorridor, the success of the corridor shares an interdependency with the success of the individual nodes, whose successes are dependent on one another as well.

1.4. Problem definition and research questions

Developing a sustainable freight transport system remains a large challenge for the Dutch Topcorridors and its nodes. However, a sustainable, and integrated transport system is crucial for a well-functioning society, environment and economy. The multi-dimensional characteristics of corridor development result in a more challenging process towards sustainable corridor development. Corridors are multi-scalar as corridors cross multiple administrative borders; multi modal as multiple modes of transport are included; multi-sectoral as infrastructure development and spatial planning are inherently linked; and lastly multi-governance is necessary as multiple governance levels are involved in corridor development. Therefore, there is a need for an integrated approach which includes the different institutional levels of the corridor and of the FUA. Such an approach needs to be aligned and coordinated along both scales as the success of the Topcorridors shares an interdependency with the success of its nodes. In order to explore which institutional arrangements might contribute to making the Topcorridor operate in a more sustainable manner the following research question, and following sub-questions, has been formulated:

Which institutional arrangements can support sustainable development of the Topcorridors and its nodes?

1. How can development of corridors and nodes be conceptualised?
2. What role do functional interrelationships play in corridor development?
3. How can be dealt with the institutional interdependencies in corridor development?
4. How can a programmatic approach be applied to achieve sustainable corridor development?
5. What are barriers, factors of success and conditions for sustainable development for both the corridor and the nodes?

This research aims to gain a better understanding on how the multi-dimensional challenges can be approached in order to achieve an integrated and sustainable transport system. In this research the integration, interaction and coordination between different scales and sectors will be explored. Such research often focusses on the national, provincial and municipal level. However, due to the multi-scalar character of corridor development it is important that challenges such as sustainable development are addressed on both the level of the corridor and the level of the nodes. By focusing on the interaction between the corridor and the nodes, this research adds to current-day research on corridor development.

1.5. Thesis outline

This thesis consists of eight chapters, of which this introduction is the first one. The following chapter, Chapter 2, is focussed on the theoretical framework regarding this research and contains multiple concepts: corridor development; functional interrelatedness; institutional interdependencies; multi-level governance and the programmatic approach. This chapter will be concluded with a conceptual model, outlining the research. In Chapter 3 the applied research methods will be explained, this includes the multi-scalar case study and an introduction to the used case as well. In Chapters 4 through 6 the results will be discussed per case. Thereafter these results will be analysed and discussed in Chapter 7. Finally, conclusions and recommendations will be formulated in Chapter 8.

2. Theoretical framework

In this chapter the theoretical foundation for this research is shaped. This foundation contributes to first three sub-questions and provides input for the conducted semi-structured interviews and following analysis. Throughout the chapter, multiple concepts will be discussed and connected. First the concept of corridor development, and the interaction between a corridor and its nodes, is discussed. Followed by functional interrelatedness, discussing the relationships between different spatial land-uses and infrastructure, and institutional interdependencies, as many organisations and sectors are involved. Lastly programme management is introduced as way to coordinate the multiple dimensions of corridor development. This theoretical framework results in a conceptual model showing the relationships between the different concepts.

2.1. Corridor development

2.1.1. Corridor level

The concept of infrastructure can be defined as "*all physical assets, equipment and facilities of interrelated systems and the necessary service providers, together with the underlying structures, organisations, business models and rules and regulations, which are used to offer certain sector specific commodities and services to individual economic entities or the wider public to enable, sustain or enhance social living conditions*" (Weber and Alfen, 2011, p.9, in Arts et al., 2021). Infrastructure is a requirement for social-economic development and is an enabling layer for different activities (Arts et al., 2021). It enables e.g. communications and transport of goods and people, stimulating economic development (Chapman et al., 2003). Considering transport infrastructure and networks, the spatial scale of such networks has been increasing since the Industrial Revolution (Trip & Zonneveld, 2003). Transport infrastructure has developed into a dense, interconnected network containing multiple subnetworks operating at different scales and containing multiple modes (Arts et al., 2021). The TEN-T is one of these subnetworks, consisting of numerous corridors.

As briefly touched upon in Chapter 1, corridors are bundles of infrastructure connecting at least two urban areas (Chapman et al., 2003; Priemus & Zonneveld, 2003; Witte, 2014). The corridor area is considered a complex area, intertwined with physical infrastructure (Chapman et al., 2003). Corridors can function as a network structure for freight and passenger transportation, which can be used to structure both urban development plans and infrastructure development (Witte, 2014). Consequently, the scope of corridors entails, besides infrastructure, the spatial dynamics of urbanisation, institutional functions, transportation and economic development of the areas it crosses through. As corridors can be used for multiple objectives, competition between the different developments can occur (Chapman et al., 2003).

Corridors are multi-scalar, multi-modal, multi-sectoral and multi-governmental; they are multi-dimensional. Considering the multi-scalar dimension, there is the scale of the urban node, the FUA it operates in and the corridor as a whole. The ratio between the scales is displayed in Figure 3 below. These scales can be used to structure both infrastructure and urban development plans (Witte, 2014). When the nodes are carefully selected and well-developed, they can realise socio-economic development which would otherwise not occur (De Vries & Priemus, 2003). The corridor can than function as a socio-economic environment (Faith-Ell et al., 2020). Furthermore, technological and spatial development can take place in urban nodes. A multi-modal connection is a prerequisite for a successful corridor (De Vries & Priemus, 2003). The multi-modal dimension is a pre-requisite as it allows different nodes to function as a single region by relying on each other's functions which is only possible when the nodes are well-connected. it allows the different nodes to borrow size (Faith-Ell et al., 2020). Not only those located within the corridor benefit from these connections, stakeholders located nearby the corridor also experience externalities (Öberg et al., 2018). These externalities can

be positive and negative e.g., congestion and environmental impact (Chapman et al., 2003). Developments within the node can result in bottlenecks on the scale of the corridor, thus coordinated planning is necessary (Faith-Ell et al., 2020). It is important to take corridor development seriously, as important challenges for spatial development otherwise might be overlooked (De Vries & Priemus, 2003). The corridor concept is often used as an analytical concept to draw attention to spatial developments between large urban areas, as these areas do not always benefit from the presence of the corridor (Chapman et al., 2003).

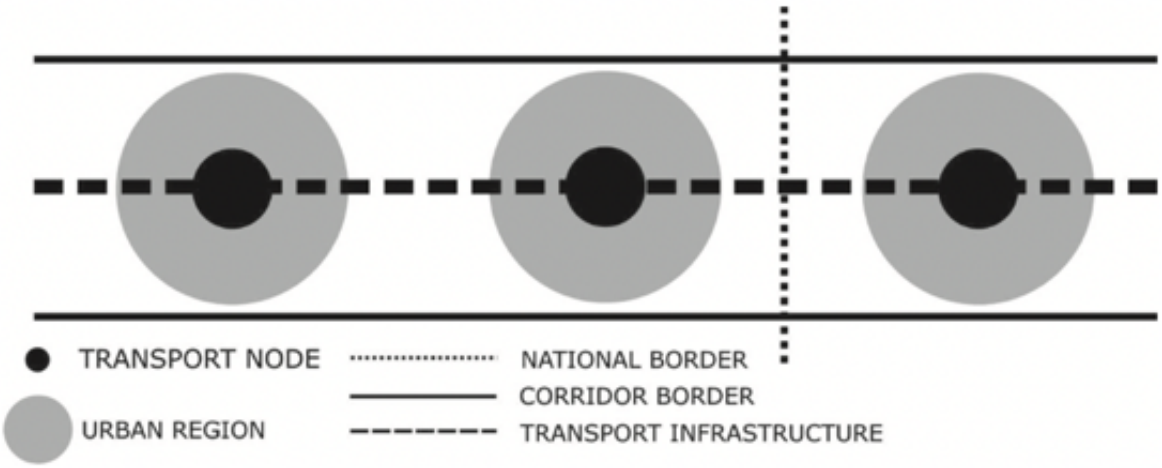

Figure 3: Transport corridor conceptualisation (Witte, 2014).

2.1.2. Node level

Based on TEN-T guidelines, an urban node is "*an area 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 infrastructure and with the infrastructure for regional and local traffic*" (Vital Nodes, 2020 p.6). Nodes thus are multi-modal hubs, connected by a corridor, where modal shift can take place between long-distance and local infrastructure. By providing this link, nodes facilitate integration of the corridor network with other spatial sectors i.e., regional economic development and regional and local spatial structures (Heeres, 2019). Besides providing connections between sectors, nodes connect different scales involved in corridor development. In this sense, nodes function as important transport hubs providing linkages between modes of transport and long-distance and last-mile transport (Heeres, 2019; Vital Nodes, 2019). The interconnections between the nodes, and corridor, are essential to provide these linkages. In practice, the nodes are key elements of both the national and TEN-T corridors (CEDR, 2021). Aside from the multi-modal interconnections between the nodes and corridor, the success of corridors interconnections between urban areas depends on intersectoral, cross-border, public-private and central-local coordination (De Vries & Priemus, 2003).

Urban nodes have a dual objective to address the TEN-T objectives for urban nodes, whilst stimulating more sustainable urban mobility (Vital Nodes, 2019). The TEN-T guidelines stress the importance of mitigating negative effects of transport on urban areas as a result of functioning as an urban node along the corridor (Vital Nodes, 2020). Issues related to transport infrastructure and logistics, such as sustainability and integration of urban nodes in TEN-T corridors, require integration beyond the level of a city (Vital Nodes, 2020; Panteia, 2021). As discussed, such issues need to be addressed on the level of the FUA and the corridor. The FUA concerns the area where the infrastructure on corridor level interacts with the infrastructure on the level of urban nodes (Vital Nodes, 2020). This is displayed as 'urban region' in Figure 3 above. Within the FUA, numerous urban and regional stakeholders operate.

In the FUA, various multi-sectoral challenges are assessed i.e., spatial development, multi-modal mobility, governance and institutional dimensions. Furthermore, the FUA is essential for integrating urban nodes within the larger TEN-T corridor (CEDR, 2021). Keeping the goal of integrated and sustainable transport infrastructure in mind, it is essential to take the whole land-use cycle along in this process (Arts et al., 2016). Hence, alignment of the corridor level and FUA is necessary. By coordinating transport infrastructure and spatial developments, area-oriented solutions can be reached, enhancing the vitality of a region on the FUA level. This has a positive impact on (international) transport corridors (Arts et al., 2016).

2.1.3. Interaction between corridors and nodes

As mentioned, the success of the corridor and nodes are interdependent. The success of both scales thus is connected to its ability to connect different scales (Heeres et al., 2016). The nodes operate as linkages between different transport modes and connect long-distance with last-mile infrastructure (CEDR, 2021). These linkages between scales are necessary to connect different infrastructure scales to enable interaction (Faith-Ell et al., 2020). This is in line with the multi-scalar dimension of corridor development and infrastructure networks (Arts et al., 2021). Benefits of a solid connection, and improved accessibility, are often experienced by the entire corridor network and nodes. Transport flows, for example, often begin and or end at urban nodes (Vital Nodes, 2019; Faith-Ell et al., 2020). Furthermore, as different scales can interact at the nodes, transport can shift between modes, aligning with the multi-modal dimension of corridor development.

The interdependent relationship between the corridor and its nodes relationship is strengthened as an intervention on one spatial scale can have consequences on other scales (Arts et al., 2021). Interventions at the FUA scale can have a positive or negative effect on the corridor scale, and the other way around. This implies that well-adjusted optimisation of the spatial development and infrastructure on the FUA scale can secure the interests of the corridor whilst tackling challenges on a local level (Heeres et al., 2016). It is important to pay attention to this (uneven) distribution of costs and benefits along transport corridors. Although accessibility of the corridor network might improve, this might lead to noise and air pollution at the nodes and along the corridor (Arts et al., 2021). Benefits on a local scale are not always clear, this can lead to resistance (Faith-Ell et al., 2020).

By selecting urban nodes, the assumption exists that corridor design can influence investment decisions and results in inequality due to the uneven distribution of benefits along the corridor. Therefore it is important to consider the interdependencies between urban nodes along the corridor to manage competition between nodes to counterproductive competition (Chapman et al., 2003). By connecting nodes, and thus regions, the spatial-economic position of the nodes is influenced. Different nodes located in each other's proximity can benefit from each other's functions and can function as a larger region, related to the concept of borrowed size (Faith-Ell et al., 2020). Due to their proximity, the nodes are able to benefit from each other's strengths instead of merely mutual competition.

In conclusion, it can be stated that transport infrastructure links operate on different spatial scales and are linked at the nodes. These connections facilitate modal shift. As a result, the selection of urban nodes can have local benefits and drawbacks, such as economic development and environmental consequences. These advantages and disadvantages can be addressed by applying a corridor approach (Chapman et al., 2003). As the effects of corridor development are felt on the node, FUA and corridor level, corridor development influences multiple spatial scales and institutional levels. Therefore, corridor development plays a role in spatial policy making of multiple levels (Witte, 2014). It is thus relevant to ensure that governmental organisations of different institutional levels are capable to deal with corridor development (De Vries & Priemus, 2003).

2.2. Functional interrelatedness

The interrelationships between different land-uses are apparent due to i.e., increasing pressure on the available space and stricter environmental regulations (Heeres, 2017). Present day, this can be seen in the Netherlands as the pressing nitrogen issues result in stricter nitrogen legislation. Consequently affecting multiple sectors such as infrastructure and agriculture (Rabbinge & Winsemius, 2021). Infrastructure thus is often related with other land uses (Heeres, 2017; Arts et al., 2021). The interrelatedness is both functional and spatial. Functional interrelatedness includes the influence infrastructure and other land uses have on each other's quality. Spatial interrelatedness implies the physical proximity, or overlap, between different land uses. Infrastructure planning and the planning for other land uses are interrelated, thus considering just the transport infrastructure when discussing corridor development is insufficient (CEDR, 2021). As it affects multiple spatial sectors, it is a multi-sectoral affair.

As numerous land-uses are involved, also considering the multi-scalar dimension, coordination to avoid conflict with each other and with infrastructure development (Heeres, 2017). As infrastructure is involved in multiple sectors and scales, the functional interrelationship between infrastructure and other spatial sectors increases (Trip & Zonneveld, 2003; Heeres, 2017). Spatial development leads to a demand for accessibility, provided by infrastructure (Heeres, 2017; Arts et al., 2021). However, accessibility to infrastructure is a requirement for spatial activities (Heeres, 2017). The accessibility connects infrastructure and spatial planning (Stanley, 2014). Infrastructure and other land uses are complementary interests (Heeres, 2017). It is thus not surprising that infrastructure is essential for local and regional socio-economic development (Heeres, 2017; Arts et al., 2021). This functional interrelationship has positive and negative outcomes on spatial scales. Considering positive and negative outcomes, the multi-scalar dimension should be considered as the positive effects of an intervention in the infrastructure network are experienced on a corridor scale. Whereas the negative externalities of said intervention have more impact on a local scale (Heeres, 2017).

The interrelationship between infrastructure and spatial planning remains a fundamental issue in planning (Heeres et al., 2016). This is related to the multi-scalar dimension of corridor development and the uneven distribution of costs and benefits of a transport system. This is especially relevant when considering the environmental impact of infrastructure, where the negative environmental consequences are mostly experienced on a local scale. Therefore, an integrated planning approach is needed where not only the different scales but also the relation between infrastructure and its environment is incorporated (Heeres et al., 2016; Heeres, 2017; Vital Nodes, 2019).

2.3. Institutional interdependencies

The previous sections showed that improved coordination is necessary due to multiple interests being linked in the interface of infrastructure development. Due to the functional interrelatedness of infrastructure and other land uses, policy makers, planners and other stakeholders from different sectors and institutional levels need to cooperate and coordinate to achieve their goals (Heeres, 2017). The different scales in which different sectors, as transport infrastructure and urbanisation, operate are connected and interdependent (Trip & Zonneveld, 2003). As different institutional contexts are involved which have to deal with institutional interdependencies, it is important to share goals and interests. Integrated planning is a strategy to deal with different interests and relations between the involved sectors and institutional levels (Heeres, 2017).

The integration of transport and land-use planning is essential for more sustainable planning outcomes in the future (Chapman et al., 2003; Arts et al., 2016). Besides different sectors, it is important that other stakeholders are involved when the interrelatedness between infrastructure and land use is strong. By applying an integrated planning approach it is acknowledged that different land-

uses do not operate in an isolated manner. The functional interrelationship between infrastructure and other land-uses requires a balance between the different involved sectors, scales and institutions. This integration can be viewed as a spatial governance process (Kotzebue, 2022). Governance implies "*the patterns that emerge from the governing activities of social, political and administrative actors*" (Jordan, 2008, p.21). The term refers to interorganisational, self-organising networks (Rhodes, 1996). Governance thus takes interaction between different spatial scales and numerous stakeholders into consideration in the decision-making process (Romein et al., 2003; Jordan, 2008). It is important to discuss governance in the context of corridor development, as infrastructure and spatial planning are involved with public and private actors on different spatial scales (Romein et al., 2003; de Vries & Priemus, 2003). Especially as there are multi-dimensional developments, not connected to a specific institutional level (Romein et al., 2003). Within the governance process of corridor development multiple levels interact with each other, due to the multi-modal dimension of corridors. Furthermore, iinteraction within horizontal levels takes place as well due to multi-sectoral dimension of corridor development (Romein et al., 2003). The levels of governance thus interact in different directions; vertical and horizontal. Therefore, a multi-level governance approach would be appropriate.

The concept of multi-level governance (hereafter MLG) is a "*system of continuous negotiation among nested governments at [supranational, national and regional] territorial tiers"* (Hooghe & Marks, 2002, p.4). Efficient MLG requires the involvement of both positive and negative externalities of a decision in the decision making process (Hooghe & Marks, 2002). Concerning corridor development, this implies that the positive and negative consequences for the corridor level, FUA and local level are taken into consideration. Vertical governance thus is necessary. Besides multiple levels, multiple sectors need to be involved due to the multi-sectoral dimension. This requires horizontal coordination in addition to vertical coordination. Considering the dimensions of corridor development that need to be addressed, MLG can be considered as a suitable approach.

2.3.1. Vertical governance

As mentioned, vertical governance is necessary due to multiple reasons e.g., because corridors cross multiple administrative borders (De Vries & Priemus; Romein et al., 2003). Furthermore, these borders can overlap (Hooghe & Marks, 2002; Marsden & Rye, 2010). As different modes and scales of infrastructure link at the nodes and because interventions on one scale can influence other scales, coordination between spatial scales must be organised. This is necessary as an intervention may solve congestion issues one the scale of the network, the intervention can have local negative effects, such as noise and air pollution (Arts et al., 2021). Therefore, the inclusion of multiple institutional levels and sectors in governance is important as costs and benefits from transport infrastructure are not evenly distributed across space and people (Arts et al., 2021).

When infrastructure planning is strictly dominated by the national level, economic and political demands are often prioritised over local issues (De Bruijne, 2005). Considering infrastructure planning, this responsibility is partially distributed to other governmental levels (Romein et al., 2003). I.e., within the Netherlands this is partially located to provinces and municipalities. Consequently, these institutional levels are involved actors in infrastructure development (Romein et al., 2003). Coordination between levels can decrease conflicts during the development process. Specifically when a local government collaborates with local actors to implement policies of a higher level, this coordination is important (Kokx & van Kempen, 2010; Marsden & Rye, 2010).

The implementation power of TENT is strengthened by involving actors from different governance levels with different positions, knowledge and responsibilities. Representative actor participation for transport policy development is important to bridge the implementation gap between policy makers and the actual projects (Öberg et al., 2016). Broad actor involvement includes different fields of

expertise and different points of view throughout the different development stages (Arts et al., 2021). To achieve the desired results, being a sustainable transport infrastructure system, integration and interaction between the different governance levels must be achieved (Öberg et al., 2016).

Vertical MLG is significant for corridor development as it enhances the ability of dealing with consequences of corridor development, which can differ depending on the scale one considers. In order to deal with this institutional capacity building is proposed (De Vries & Priemus, 2003). This implies the challenge of realising institutional conditions for collective action.

2.3.2. Horizontal governance

As discussed, governmental and non-governmental actors should be included throughout different stages of corridor development (Marsden & Rye, 2010). Besides interaction between actors from different levels (vertical), horizontal interaction between involved sectors is necessary. By its nature, transport infrastructure is embedded in a larger system, including economy, space and society, and is strongly influenced by external factors e.g., health issues and economic development (CEDR, 2021). Consequently, corridor development is intertwined with economic development, spatial planning and local impact that should be considered. It is therefore important to involve different actors on the implementation scale. Especially as governance often is the outcome of the interplay between private actors, governmental actors and other involved non-governmental organisations (De Vries & Priemus, 2003; Romein et al., 2003; Öberg et al., 2016). The interaction between actors impacts the transport infrastructure development process and governance, and thus corridor development (Öberg et al., 2016; Kotzebue, 2022). This interaction strengthens the implementation of TEN-T (Öberg et al., 2016).

How actors behave depends on individual conditions, motivations and capacities. Interaction thus is not only necessary between different scales of a corridor, but also between spatial sectors i.e., between relevant actors within the FUA. Furthermore, due to numerous involved sectors, different fields of expertise and (conflicting) interests have to be dealt with at different levels during different development stages. Therefore, in order to provide sustainable results, it is important to carefully address content and information, while taking the dimensions of place, scale, time and actors into account (Arts et al., 2021).

Based on the discussion above, it can be concluded that improved coordination between different levels and actors is necessary. This coordination can be approached as MLG and should take place in a vertical and horizontal manner. Vertical governance is relevant as corridors cross multiple administrative borders, which can overlap. Furthermore, the long-distance infrastructure corridor network is linked with local last-mile infrastructure at the nodes. Where the infrastructures are linked, modal shift can take place. The infrastructure of both scales share an interdependency for their success. However, as different scales are involved, different levels of government are involved. These levels of governance need to cooperate and coordinate to achieve a sustainable transport infrastructure system. As corridor development is intertwined with economic development and spatial planning, local effects have to be considered as well. This requires both coordination between and within governmental levels. Involving actors with different roles, knowledge and responsibilities enhances the implementation power of TEN-T. These actors are both governmental and non-governmental, requiring a more horizontal governance approach within a level.

2.4. Programmatic approach

Traditionally, road infrastructure planning was realised through individual interventions in a larger network (Busscher, 2014). These individual projects were mainly conducted in a technical-rational manner (Arts et al., 2021). Individual project management is praised for its clear scope and relative isolation from surroundings (Busscher et al., 2014). Focus is placed upon goals and criteria e.g., budget,

time, control and the final output (Arts et al., 2021). However, the clear scope and relative isolation are also vulnerabilities of this approach (van Buuren et al., 2010; Busscher et al., 2013). Projects were frequently confronted by scarcity of either time, budget or both (Flyvbjerg, 2007; Busscher, 2014). Other issues with project management for infrastructure projects are e.g., the risk of long planning horizons and that planning and decisions are often multi-actor processes with conflicting interests (Flyvbjerg, 2007). This approach often overlooks external events. Infrastructure projects frequently encounter local resistance due to the uneven distribution of costs and benefits. Consequently, individual projects often have to pay active attention to local issues instead of the network issues they are meant to address (Faith-Ell et al., 2020).

Considering corridor development, the nodes and infrastructure trajectories connecting them, are often considered individual projects. Therefore, the importance of nodes for each other and corridor as a whole gets less attention (Faith-Ell et al., 2020). Such developments should occur in the context of the corridor over its full length, instead of as individual developments (Romein et al., 2003). A more coordinated management approach might be suitable. In response to deal with these challenges, and to improve the realisation of infrastructure projects, programme management is proposed (Busscher, 2014). Through a programmatic approach the different nodes, the interrelationships between nodes, considerations, and policies can be taken into account (Romein et al., 2003).

A programmatic approach, linking project and strategic management, focusses on coordinating related projects on behalf of strategic objectives (Busscher et al., 2013). This relationship is shown on Figure 4 below. Programme management is often viewed as an extension of individual project management (Pellegrinelli et al., 2007). Programmes are considered *"a means to influence the interrelationships between strategic goals and projects, to get a grip on project on project interdependencies, and to anticipate and deal with contextual changes"* (Busscher, 2014, p.217). The programme can be working towards shared objectives whilst providing coordination between defined projects (Vuorinen & Martinsuo, 2018). Furthermore, programmes can support finding a focus for strategic frameworks, visions and plans (Busscher, 2014). A shared strategic objective would be more difficult to achieve by separately working project managers (Van Buuren et al., 2010). Programmes offer the possibility to coordinate different projects striving towards a shared goal and can be considered an answer to projects organised in a linear manner whilst they might benefit from each other (Arts et al., 2021).

Programme management provides an external focus on aligning interrelated projects and actions, together shaping the programme (Van Buuren et al., 2010; Busscher et al., 2013). A programmatic approach offers the possibility to manage interdependencies between projects within the programme, and to learn and adapt according to changing circumstances (Pellegrinelli, 1997; Busscher, 2014). Programmes can facilitate learning to operate as a learning adaptive programme, able to adjust according to uncertain contexts (Busscher, 2014). Adaptability requires room to learn and experiment to gather information and deal with uncertainties. Furthermore, it requires debate and processes of negotiation between actors involved to correctly interpret the gathered information (Busscher, 2014). To provide the programme with room to adapt, the learning capacity should not be constrained and the political and administrative environment should be open to discussing the scope, content and objectives of the programme (Busscher, 2014).

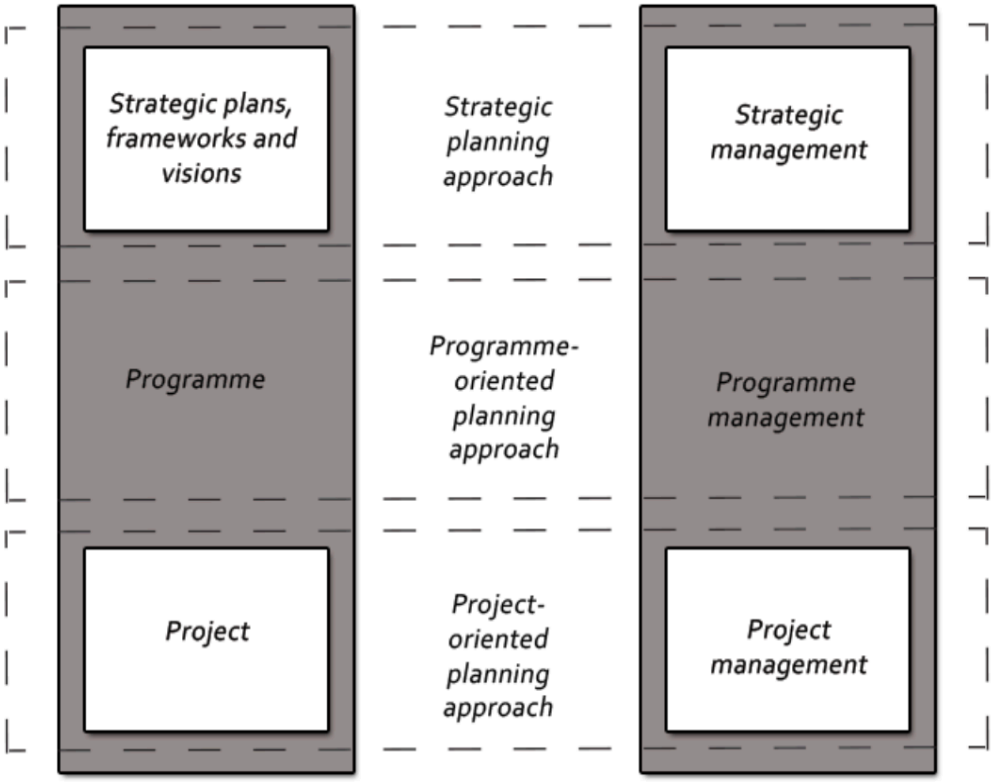

Figure 4: Programmatic approach in relation to project management and strategic management (Busscher, 2014).

By considering the corridor as a system, and the nodes as parts of the system, considerations and policies concerning the dimensions of corridor development can be included (Romein et al., 2003). The nodes can be viewed as projects within the programme and strategic objectives can be pursued on the corridor scale. By obtaining a programmatic approach to corridor development, focus can be placed upon the transport corridor as whole, as compared to individual project management (Faith-Ell et al., 2020). When applying a programmatic approach, progress should be monitored to learn and adjust to contextual changes (Busscher, 2014). Although a programmatic approach sounds suitable for corridor development, coordinated corridor development is easier said than done (Faith-Ell et al., 2020).

When using a programmatic approach for corridor development, different projects should align in a loosely coupled manner, offering room for e.g., adaptation to local environments or developing a multi-level governance framework (Faith-Ell et al., 2020). This requires planning, collaboration and coordination (Patanakul & Pinto, 2017). Aspects requiring attention within public programme management, such as infrastructure development, are as follows (Patanakul & Pinto, 2017):

1. *Managing complexity*: programmes frequently have a large scope including numerous internal and external factors, making programmes more complex. This complexity can be managed by e.g., splitting the programme in multiple projects.
2. *Navigating through political landscapes*: programmes in the public sector operate in a political environment. This influences the performance and challenges a programme has to deal with. As governmental programmes are influenced by political risks, programmes are regularly influenced by political (short-term) agendas of ministers. Programmes in the public sector are also affected by changes in policies, legislation, budgets and permits.
3. *Programme management is stakeholder management*: programmes include several stakeholders with their own objectives, all of whom may influence the progress in political, social or financial manners. In programme management it is therefore important to pay

attention to collaboration, communication and alignment between the involved stakeholders. This can be formalised through communication and collaboration channels.

4. *Managing benefits*: benefit management is fundamental in programme management. This can be challenging in the public sector as these programmes are often not driven by profit. The benefits of a public programme are generally assessed on the measurement of time, cost, and scope instead of on revenue. In order to determine whether target benefits are realised they should be defined in specific and measurable manner.
5. *Adaptive capacity:* with the expectation that the outcomes of a programme are operational for many years, it is important to incorporate some long-term flexibility for new developments. Through learning processes a programme can adapt to gained knowledge throughout the process (Busscher, 2014).
6. *Monitoring and evaluation*: government programmes, and their projects, have to follow standard processes for activities considering project management. Monitoring is an important aspect of this as it also helps to indicate the contribution of different projects to the overarching programme (Busscher, 2014). This facilitates a feedback-loop within the programme and enables the programme to adjust to contextual changes. Here lies responsibility for the programme manager (Busscher, 2014).

2.5. Towards a conceptual model

In Chapter 1 the multi-dimensional characteristics of corridor development are discussed. In Chapter 2 these different dimensions are further explained and is discussed how they are inherently interrelated to each other. These interrelations between the physical components of functional interrelatedness and the governance component of institutional interdependencies, and how these are then influenced by the different scales involved are shown on the left side of the conceptual model depicted in Figure 5 below. Together these component shape how a corridor is developed and operated. As explained this can be a relatively complex process. Therefore, a programmatic approach is proposed in Section 2.4 to tackle the challenges of corridor development in order to reach sustainable corridor development. As such programme management occurs in a public context, certain aspects need to be kept in mind. These components together shape the contextual model (Figure 5).

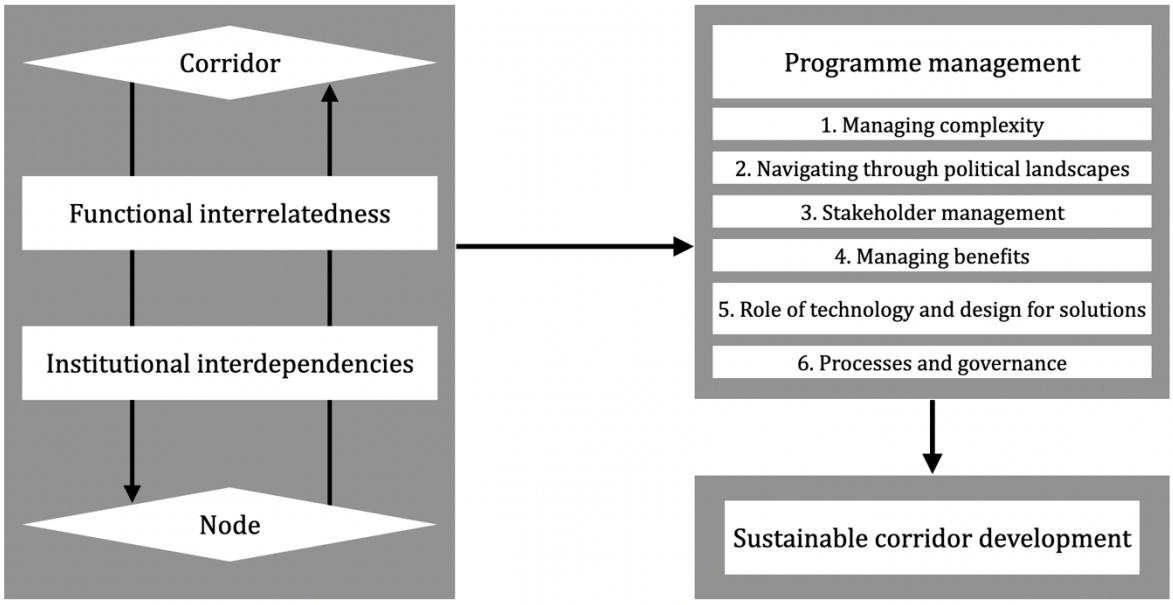

Figure 5: Conceptual model.

3. Methodology

This Chapter focusses on the research methods applied in this study. First a literature review was conducted to develop a conceptual model shaping the foundation for this research. Hereafter, the use of a multi-scalar case study is discussed and the selected cases will be introduced. Furthermore the data collection through semi-structured interviews and the accompanying analysis are elaborated upon. Additionally, a document analysis and finally the ethical considerations are discussed.

3.1. Multi-scalar case study

Conducting a case study is deemed appropriate when answering 'how' or 'why' questions (Baxter & Jack, 2008). A case study allows the researcher to gain in-depth knowledge on a specific process in practice (Flyvbjerg, 2006; Clifford et al., 2016). This research aspires to gain an understanding of how a programmatic approach can be applied to achieve sustainable corridor development and furthermore tries to indicate barriers, factors of success and conditions for sustainable corridor development. To reach this goal, a multi-scalar case study of the Dutch Topcorridors is conducted to gain such an understanding. Considering that successful corridor development depends on the functioning of the corridor and the nodes, a multi-scalar case study is applied. This offers the opportunity to not only focus on the Topcorridor programme, but also on two nodes that are part of the Topcorridor.

3.1.1. Case selection

As discussed in Chapter 1, the focus of this research is on the Dutch Topcorridors. The Topcorridors programme aims to strengthen the corridors (both the east and south-east axes) and to make them more sustainable. As mentioned the conducted case-study has a multi-scalar character to gain an understanding of both the corridor and of the selected nodes. The researched nodes were not selected in a random manner but through information-oriented selection. Through a selection of cases based on maximum variation more information can be obtained about the importance of different aspects (Flyvbjerg, 2006). This variation can be e.g., geographical, size or in terms of progress. Based on the goal of maximum variation to gain as much knowledge as possible, Nijmegen and Venlo are selected as cases in this research. These nodes differ as they are located on the two different arches of the Topcorridors and in terms of progress in development. Nijmegen is considered a more developing urban node on the Eastern corridor whereas Venlo is located on the Southeast corridor and is considered a more developed.

3.1.2. Topcorridors

The Topcorridor, located in the Netherlands, is part of the Rhine-Alpine corridor, part of the European TEN-T. The Rhine-Alpine corridor is one of the most dominant freight corridors of the European corridor network. In 2017 it was recognised that the added value of logistics and freight transport are of added value for the economic value of the Netherlands (MIRT, 2017). Especially Mainport Rotterdam and the east- and south-east corridors play an important role. Furthermore, there is a connection with Duisburg (Germany). Due to its significance, the national government and regions established agreements for a programmatic approach for the east- and south-eastern transport corridors. This programme includes both governmental parties and parties from the private sector. The sustainable economic ambitions of the corridor parties are at the core of this programme.

3.1.3. Nijmegen

Node Nijmegen is located in the Province of Gelderland in the Netherlands and has been appointed as one of the main nodes on the Dutch corridor network (MIRT, 2017). This node is located on the Eastern branch and is connected with the European coast hinterlands (Gemeente Nijmegen, 2019). Nijmegen is mainly connected via roads and water infrastructure and scores relatively low, compared to the other nodes, concerning multi-modal connections. In this sense the node is still developing.

3.1.4. Venlo

Venlo is located in the Province of Limburg along the south-east axis of the Topcorridor. In 2017 Venlo has been selected as one of the main nodes of this corridor (MIRT, 2017). Furthermore, Venlo is also part of the North Sea-Mediterranean corridor. As a node, Venlo operates above average as compared to other nodes along the corridor (Gemeente Venlo, 2018). In this sense, Venlo is considered as a more mature node within the Dutch corridor network.

3.2. Mixed methods

In a qualitative study, as this thesis, it is expected that at least two research methods are applied (Bowen, 2009). In this research, and the execution of the multi-scalar case study, three main methods have been applied. First a literature review has been conducted to answer the first sub-question. The literature review is concluded with a conceptual model and offered the foundation for the interview guide. Sub-questions two through five are answered based on the literature review combined with data collected from the semi-structured interviews and document analysis. Each of these three methods will be explained below. An overview of how each method adds to this research is provided below in Figure 6. The answers to the five sub-questions together is used to formulate a final answer to the main research question.

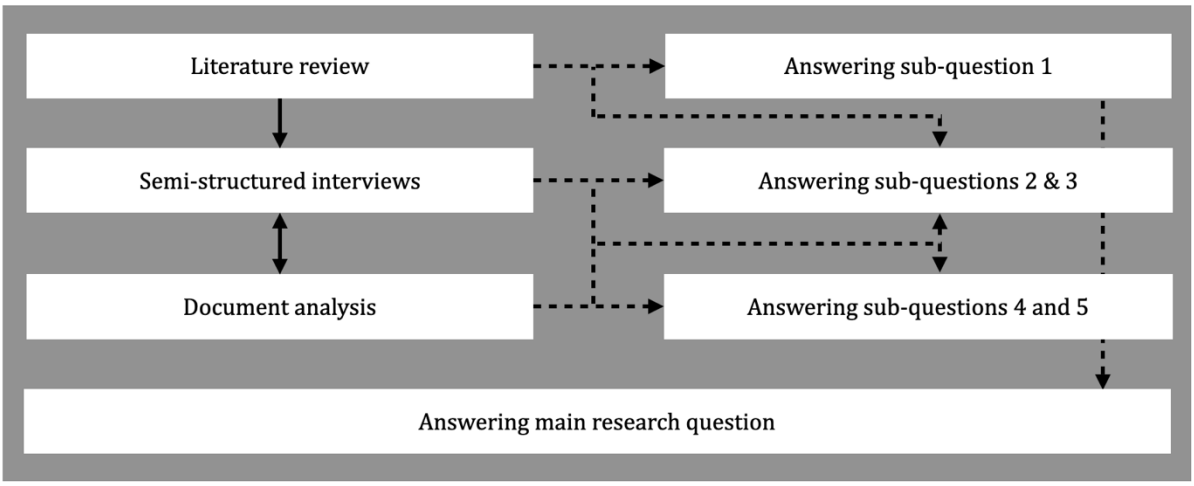

Figure 6: Overview of the used methods in relation to research questions

3.2.1. Literature review

The first step of this research is a literature review to sharpen the theoretical basis and develop a conceptual model. In the review the focus has been placed upon 'corridor development', 'nodes', 'functional interrelatedness', 'institutional interdependencies', 'multi-level governance', 'horizontal governance', 'programme management' and 'programmatic approach'. The search engines used for the literature search are Scopus, SmartCat and Google Scholar. In these search engines the terms have been combined in numerous ways. In addition, further snowballing was used when other relevant articles were suggested by one of the search engine based on other selected articles.

The literature results in a conceptual model where the different relations between the concepts of the theoretical framework are displayed. Based on the literature review an interview guide is developed to gather information in a subsequent step of this research. In addition, based on the literature review 'indicators' for the analysis of interviews and documents are identified.

3.2.2. Document analysis

An analysis of relevant organisational and institutional documents in qualitative research helps to gain a better understanding of the cases, and their accompanying contexts, that are being researched (Bowen, 2009). These documents do not have a scientific foundation but include e.g., policy documents or reports. Generally this research approach is used in combination with other research methods, as is the case in this study, as a method of triangulation. Document analysis is especially suitable for qualitative case studies (Bowen, 2009).

Numerous policy documents are analysed to gain a more in-depth understanding of the selected cases. The results of this research step are dependent on the availability of these documents. It should also be kept in mind that these documents are relevant at the time this research was conducted. This means that they are sensitive to political change, thus are dependent on the current zeitgeist.

A part of the analysed documents were gathered before the interviews were conducted. However, during the interviews, the interviewees were offered the opportunity to suggest and share other documents they deemed relevant for this research. These documents were analysed after the interviews and are included in the results as presented in Chapters 4 through 6. An overview of the analysed documents is presented in Appendix 3.

3.2.3. Semi-structured interviews

To be able to answer the final three research questions, and the main research question, semi-structured interviews have been conducted. The interviews facilitate the possibility to gather information that is not included in the analysed documents and offers the interviewees the chance to share personal experiences concerning the functioning of the Topcorridor. The interview guides, which can be seen in Appendix 1, have been used as a guideline to structure the interviews. As the interviews are conducted in a semi-structured manner each interviewee answers the same questions allowing the researcher to compare answers (Clifford et al., 2016). In addition to these questions a semi-structured interview offers room to ask follow-up questions, providing room for discussion and eventually more in-depth answers (Longhurst, 2016).

From the Topcorridors programme and both the nodes 11 interviews have taken place in total. The first interviewees are selected based on their involvement in the Topcorridors programme. From there on interviewees are selected based a referral from other interviewees, also known as snowballing (Longhurst, 2016). An overview of the interviewees can be found in Appendix 2. The interviews were conducted between May 2022 and June 2022, the answers, considerations and opinions of the interviewees are subject to their perception of the corridor or node during this period. At the beginning of the interviews all interviewees where asked permission to record the interviews, these recordings were then transcribed. Afterwards, the interviewees were offered the possibility to do a factual check of their transcript. All transcripts are assigned an identifier by which they are referenced throughout the analysis. An overview of the identifiers can be seen in Appendix 2 as well. The transcripts are analysed according to the codebook. The codebook contains multiple code groups and contains deductive and inductive codes. Deductive codes are derived from the theoretical framework as discussed in Chapter 2. The inductive codes are based on new knowledge learned from the interviews. The final codebook, including the deductive and inductive codes, can be found in Appendix 4. By applying both deductive and inductive coding, the information from the transcripts can be linked to theory and practice (Cope & Kurz, 2016).

3.3. Ethical considerations

An aspect that must be considered when conducting a case-study is the bias towards verification from the researcher. This bias implies a tendency of the researcher to confirm preconceived expectations (Flyvbjerg, 2006). It follows from the room that qualitative research offers for subjective interpretation of the results. However, a case-study does not contain a greater bias considering verification than other research methods (Flyvbjerg, 2006). Furthermore, by using multiple sources of information the researches bias is minimised (Bowen, 2009). However, the possible bias is something that deserves attention due to an affiliation of the researcher in the form of an internship with the Topcorridors Programme at the Dutch Ministry of Infrastructure and Environment. During the period that this research was set-up the overall structure of the research was discussed with the Topcorridors Programme. Being in affiliation with the Topcorridors programme offered access to numerous internal documents and insights, resulting in a more in-depth document analysis for this research. By coding these additional documents according to the codebook the transparency of the research is ensured (Cope & Kurtz, 2016).

4. Topcorridors

In this chapter, and Chapters 5 and 6, the results of the multi-scalar case study are presented. Each case is assigned an individual chapter. First a case description is provided to position the case in the context of the Topcorridors network. This is followed by a discussion of the functional interrelatedness, institutional interdependencies and programmatic approach specifically for each case. In the final section of each chapter the developments, barriers, factors of success and conditions for sustainable development are discussed.

4.1. Case description

The MIRT research resulting in the establishment of the Topcorridors programme started in 2015 (MIRT, 2017). The MIRT stands for 'Meerjarenprogramma Infrastructuur, Ruimte en Transport' (i.e. the 'Multi-Year Programme for Infrastructure, Spatial Planning and Transport') which comprises the national Planning Programming and Budgeting (PPB) system for transport, infrastructure and spatial development in the Netherlands. During a MIRT research –conducted at the start of the PPB-process of the MIRT-, the national government cooperates with local governments on processes connected to spatial developments. Throughout the MIRT research for the Topcorridors, insights concerning the scope, themes and relevant stakeholders for both the East and Southeast corridors were generated (Ministry of I&W, 2021). The MIRT research shows that the East and Southeast freight corridors are of vital importance for the Dutch economy (Topcorridors, 2021b). *"These corridors do not only connect the Port of Rotterdam with the German hinterlands (and further), but along these corridors many economic activities take place in the region that adds value* (MIRT, 2017, p.7). Approximately 70% of all freight transport through the Netherlands flows through these corridors (R4). Therefore, the national government has, together with the regions, made agreements concerning a programmatic approach for both corridor axes in the Netherlands, resulting in the Topcorridors programme (Topcorridors, 2021b). In this programme, the Ministry of I&W, the Ministry of Interior and Kingdom Relations, the Provinces of Zuid-Holland, Gelderland, Noord-Brabant and Limburg, the Port of Rotterdam and Topsector Logisitiek cooperate to achieve the goals of the Topcorridors Programme (Fransen, 2021). Furthermore, attention is paid to six strategic nodes, which play an important role concerning efficient and sustainable usage of the corridor (Gemeente Venlo, 2018). At the nodes, different modes of infrastructure are linked here and modal shift can take place (Topcorridors, 2021b). The programme functions as an link between policies and projects (Topcorridors, 2019). These goals of the programme are focused on economic, sustainability, safety and quality components (Fransen, 2021). This all fits with the vision for the Topcorridors network in 2030: *"Facilitate a smooth, reliable, robust, safe and sustainable transport system that not only contributes to sustainable economic growth and satisfies users, but that also combines this growth with an optimal quality of life and living environment along the corridors"* (MIRT, 2017, p.8). In light of this vision, the programme has formulated five pillars in which all actions are housed. The pillars are as follows (Topcorridors, 2021b):

1. Future-proof connections between Mainport Rotterdam and the European hinterlands.
2. International multi-modal accessibility of the node network.
3. Sustainable spatial-economic development of strategic nodes.
4. Increasing the sustainability of East and Southeast Topcorridors.
5. State of the art digital facilities.

A key pillar is focused on the sustainability of the Topcorridor network (Topcorridors, 2021b). Within sustainable development the focus is mainly placed upon climate and air quality (Topcorridors, 2021b). A second goal of the MIRT-programme is to realise an integrated core network of multi-modal connections and links where modal shift can take place. Through the realisation of these connections the realised network can contribute to improved national accessibility, the implementation of a multi-modal network and can strengthen the competitive position (Gemeente Venlo, 2018).

4.2. Functional interrelatedness

4.2.1. Multi-modal

Both corridors have a close-knit infrastructure network, containing roads, water, rail and pipeline infrastructure, they thus are multi-modal (Topcorridors, 2022b). The different modes are essential for a well-functioning transport system, both in national and international infrastructure networks. Pipelines currently do not play a big role, however this infrastructure could be used in the future to i.e., transport hydrogen (Topcorridors 2021b). In the interviews it is emphasized that the programme stimulates and facilitates modal shift (R1; R3; R4). The goals is to shift freight transport from road infrastructure to clean transport via water or rail to reduce emissions and lighten local impact (Topcorridors, 2021b). *"Modal shift is a tool that serves multiple purposes. Mainly sustainability, but also relieving the burden on the roads. And therefore less nuisance.*" (R5). Interviewee R2 states that this mainly done in an action-oriented manner in collaboration with the regions. Truck companies are for example developing fully electric or hydrogen trucks (R5). In addition, attention is paid to Clean Energy Hubs (hereafter CEH), where renewable energy sources are offered (R4). Interviewee R5 nuances that this contributes to a decrease in emissions however, it does not have positive influence on the pressure on road infrastructure. Furthermore, although freight transport may be shifted from roads towards transport via water, this does not guarantee that this is energy neutral transport. Whilst domestic shipping is energy-efficient, it does not guarantee less emissions (R4).

Interviewee R2 illustrates the facilitation with the examples of redeveloped port areas or improved terminals near road, rail and water infrastructure. Modal shift occurs mostly with long-distance transport (R4). Logistic brokers are deployed to connect parties to explore collaborations to realise modal shift (R2; Topcorridors, 2021d). Interviewee R2 explains that logistic brokers are deployed as it is difficult for individual entrepreneurs to organise access to cargo ships or trains. Economic attractiveness is a main motivation for modal shift (R2). Thus, subsidies are offered by the Netherlands Enterprise Agency (R1). Such measures are implemented as shifting behaviour from transport via road to transport via water or rail results in loss of flexibility and it is only feasible on longer distances (R2). The loss of flexibility is a barrier for modal shift (Topcorridors, 2021d). Furthermore, pipelines as a mode of transport currently does not play a big role. However, in the future this could be used to transport i.e., hydrogen, contributing to CEH (Topcorridors, 2021b).

4.2.2. Multi-scalar

Within the Topcorridors programme, representatives of the corridor and the nodes interact through organised meetings in the programme structure (R1). Differences between the scales are visible as the programme is quite abstract and without authority, the nodes are tangible and always present (R3). Interviewee R2 clarifies this dynamic, *"we must create something that makes people want to work together. That requires an enormous appeal to common interest and sometimes putting your own interests aside, which can be difficult".* This remains difficult as nodes focus on what benefits them, paying less attention to the bigger picture (R5). Nonetheless, cooperation between scales and entities is important as complex challenges are effectively addressed on larger scales (R4). The Topcorridors programme focusses on the Dutch Topcorridors network and nodes. However, as transport crosses national borders, the European scale should be considered. Concerning the CEH, this implies that it would be most effective to organise this along the entire Rhine-Alpine corridor (R4). Especially as Topcorridors are part of TEN-T, it is important to consider an international scale.

Although there is interaction between the Topcorridors programme and nodes, interviewee R4 stated that while there is a clear focus on individual nodes *"we have not sufficiently looked into the coherence between the individual issues and individual nodes to see what is happening with several nodes and if we can make progress"*. This statement aligns with interviewees R3 and R5, who argued that coordination

of individual nodes is insufficient. However, the programme organises interaction between the nodes, where they can exchange knowledge (R2). The focus in this interaction is slowly shifting from competition between nodes towards cooperation. Despite this shift in focus, interviewee R2 desires more complementary relations between the nodes, where each node specialises. Through specialisations the regional competitive position of the Topcorridor can be strengthened (Fransen, 2021). However, this requires cooperation and coordination between the nodes (Fransen, 2021).

4.2.3. Multi-sectoral

"The development of the freight transport and a transport network is closely related to broader mobility challenges, to issues in the physical environment and concerning sustainability, to spatial and economic development of logistics networks and to technological developments such as digitalisation" (Topcorridors, 2021). The development of sustainable integrated transport affects its physical environment, including spatial-economic developments (R3). Interviewee R5 argued that the programme therefore aspires to operate in an integrated manner by considering spatial integration. The integration of infrastructure development and spatial-economic development is important due to the scarcity of space in the Netherlands for logistic activities and some industries are less flexible as they are water bound (R2). Via spatial integration, unnecessary transport is prevented. Interviewee R4 argued that spatial integration can contribute to the economic competitiveness of the Topcorridors.

The ambition to become more sustainable therefore has an impact on spatial-economic development, as the restructuring of business parks (R2). During these redevelopments more attention is paid to the facilitation and availability of modal shift and availability of alternative fuels (R4). Attention is paid to combining functions or locating industries that are part of the same production process in each other's proximity (R4; Topcorridors 2022d).

4.3. Institutional interdependencies

MLG on the scale of the Topcorridors remains a challenge for the programme (Panteia, 2022). One of the challenges is *"How to manage as task-oriented approach in which parties can and want to step out of the shadow of their own institutional boundaries"* (Panteia, 2022, p.10). Cooperation between provinces sometimes remains challenging considering funding. However, cooperation between nodes is necessary to benefit from each other and strengthen the position of the Topcorridors (R2; Topcorridors, 2022d). Interviewee R5 also argued that *"too often we see each other as competitors and if you keep doing the same things all the time, you undermine your joint position. If you emphasize and develop this complementarity, you will be stronger together"*. This requires a coherent approach with clear directions within the Topcorridors, which is also required for sustainable corridor development (Topcorridors, 2022b). A coherent approach is needed as differences in performance between nodes Nijmegen and Venlo emphasize the importance of actively participating in the programme.

As spatial planning is often the responsibility of municipalities, the programme has no authoritative power. The municipalities and provinces in which the nodes are located thus play an important role (R4). As development of sustainable integrated transport systems touches upon multiple departments (e.g., mobility, sustainability, energy transition, spatial planning), these departments must interact. Not only within the local responsible governmental organisation, but also between the different involved governmental organisations (R5). Furthermore, coordination between provinces is needed concerning the development of business parks due to the increasing scarcity of space (Stec Groep, 2021).

However, as some issues affect multiple sectors and regions, decisions and guidance from the national government can be needed as these issues are not sufficiently addressed on a municipal or provincial level (R2; R4). Different organisations are involved on different spatial scales. Considering spatial development and sustainable corridor development this could require collaboration between

ministries (Panteia, 2022). Adding to this, interviewee R5 explained that different modes are organised by different executive bodies i.e., Rijkswaterstaat is responsible for the main road and water infrastructure whereas the responsibilities for the rail infrastructure are allocated to ProRail. The programme could take on a more intermediate role between the public, semi-public and private parties (R5). This role for the programme, bringing parties together to cooperate, formulate actions and strive towards shared goals, might be fitting as the programme itself has no legislative power or authority (R2). This lack of authority also implies that the programme is dependent on the Ministry of I&W to make certain decisions. For example, regulations concerning alternative fuels or emission standards of freight transport (R1). By promulgating such legislation the private parties are expected to adhere to the desired sustainable corridor development (R1).

4.4. Programmatic approach

The organisation of the Topcorridors programme desires efficient and effective realisation of the programme goals (Topcorridors, 2019). The programme adopted an area-oriented approach, a long-term perspective and the ability to innovate and adapt (Topcorridors, 2021b). In order to realise these goals the programme is established as follows. There is a programme team steering the programme, which actively cooperates and coordinates. This programme team is chaired by the programme manager and further consists of an advisory and implementation team. The actions and projects within the programme are executed by participating organisations themselves. Each action has a project manager, who reports to the programme manager, the programme council and annual BO MIRT (administrative consultation on the MIRT) (Topcorridors, 2019). The annual BO makes decisions and is the principal of the programme. Relations between the different bodies within the programme are displayed in the organisation chart in Figure 7 below. The appointed programme manager participates in all programmatic bodies.

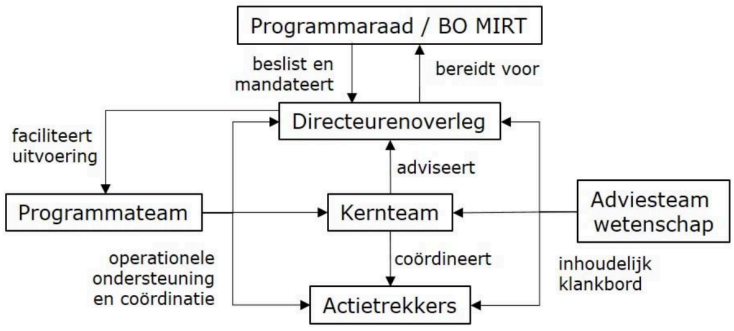

Figure 7: Organisation chart Topcorridors programme (Topcorridors, 2019).

Interviewee R1 stated that it is important as a programme to recognise that *"we can do a lot, but there is also a lot that we can't do"*. It is important to recognize which issues fall within the scope of the programme and which issues are outside of the scope. In addition, interviewee R2 argued that different aspects of the Topcorridors programme are influenced by many factors outside the control of the programme. This is the case for goals concerning the improvement of sustainability within the programme (R1; R2). For a success of the programme and the nodes, by whom many actions are realised, sufficient capacity and funding is of the utmost importance (R3). Furthermore, commitment and sense of ownership within the nodes have a big influence on the effectiveness of the programme (R2; R5). However, coordination of the nodes on the scale of the corridor is remaining somewhat behind (R3). And although there are many projects within the programme, coherency still lacks on the scale of the corridor (Topcorridors, 2021b).

A strengths of this programmatic approach is the possibility to consider freight transport and accompanying infrastructure in an integrated manner (R3). Furthermore, the programme floats between the different governmental levels involved, strengthening the integrated perspective and taking the multiple scales into account (R3; R8).

4.4.1. Managing complexity

In the Toekomstagenda 2030 it is explained that the activities and measures within the different pillars are inherently related (Topcorridors, 2021b). These activities contribute to the programme as a whole (Topcorridors, 2022b). Therefore, *"in the view of the desired corridor development it is important to ensure a coherent implementation of actions and measures"* (Topcorridors, 2021b, p.23). Therefore, attention is paid to ensure coordination between potential investments in infrastructure and spatial economic development at the nodes. Interviewee R1 explained that the programme thus consists out of actions which are accommodated to the nodes. Overall, the interviewees experience that this structure overall works, especially as actions make the programme more tangible (R1; R2; R3; R5). However, there are some nuances that must be mentioned.

First of all, the progress of a project at a node is affected by the commitment of the project manager (R4). The governmental organisations of the nodes, generally the municipality, often struggle with sufficient capacity whilst paying attention to many other local issues. *Progress requires investments and capacity* (R4), however not all nodes offer this. This relates to a second issue, sense of ownership. To realise capacity, sufficient sense of ownership at the node is required (R2). Overall a sense of ownership is present with the project managers, but this varies between projects (Topcorridors, 2022c). Thirdly, although corridor partners invest in individual projects contributing to the Topcorridors, the coherence and commonality between these investments is limited (Topcorridors, 2021b). The individual projects become, illustrated by interviewee R5, little islands operating by themselves with limited coherency. The impact of individual projects on the scale of the Topcorridors remains somewhat unclear (Panteia, 2022). Consequently, *"benefits are missed for smart, competitive and sustainable development of the Topcorridors"* (Topcorridors, 2021b, p.18). Many projects are seen as individual projects shaping, and operating as, a bottom-up organised programme (Panteia, 2022). Interviewee R1 proposed, whilst recognizing the issue of projects as islands, to consider someone who maintains an overview for each pillar. Furthermore, via the current organisational structure, the programme is able to slightly influence the projects. This is also done via funding, which can be organised via a ministry. However, an issue the nodes run into is that they can be asked 'what does this project contribute to the corridor as a whole?'. In practice it shows to be challenging to answer this question, making it more difficult to organise funding (R5). These nuances are important to be considered as the programme is *"dependent on the goodwill and priorities of the participating parties to make capacity and money available"* (R2).

4.4.2. Navigating through political landscapes

Numerous interviewees stated that on the scale of programme they notice little impact from political change as the programme operates relatively independent (R1; R2; R3; R5). Interviewee R2 added that national political change, including the establishment of a new government and new minister for at the Ministry of I&W, often goes hand in hand with a standstill concerning political decisions. Furthermore, with a new government a new government agreement is established. As the Topcorridors programme, or freight corridors in general, is not discussed in the recent government agreement this results in a loss of attention (R4). This could be related to the assumption that the system functions sufficiently and therefore gets little political attention (R4; R5). This makes the regaining of political attention more challenging and it would be beneficial if political representatives would associate themselves with this topic (R3).

From the perspective of the Topcorridors programme, consequences of change in the political municipal or provincial landscape were observed (R1; R2; R3; R4; R5). A change in the local political landscape can lead to more or less attention for corridor development, influencing the assigned capacity and priority it is given (R5). Due to elections the assigned capacity and funding can change (R2). In addition, performance is also indicated by how local governments approach corridor development and whether this occurs in an integrated or sectoral manner (R4). Interviewee R1 stated that, on the level of the provinces, if the deputy is more involved and motivated *"this results in a better starting point than when this is not the case"*. This also influences the funds provinces contribute to the programme (R4). An aspect that must be kept in mind when involving political representatives, is that sometimes a depute just *"wants a concrete project to cut a ribbon"* (R4) and thus not necessarily focusing on realising a structural connection with the Topcorridors programme (R4).

4.4.3. Stakeholder management

Representatives of the nodes and project managers participate in numerous meeting cycles where they have the opportunity to interact with the programme and with each other (R1). These representatives are mostly part of governmental organisations (national, provincial and municipal organisations). The national government is involved and has funds available to stimulate certain actions, whilst the municipalities also have funds available but their main strength concerning stakeholder management is that they can organise the involvement of relevant private parties (R2). This is perceived as a strength of the programme, that it does not only includes governmental organisations (R2; R5).

There are different initiatives where private parties, knowledge institutes and governmental organisations cooperate for research, developments and innovations for sustainable freight transport solutions (Topcorridors, 2021b). The private sector is mainly involved at the scale of the node as each node has their own connections with relevant parties (R2). Interviewee R1 argued that stakeholder involvement can be difficult as the programme maintains a long-term perspective whilst the private sector often looks no further than two years ahead. Furthermore, concerning projects, private parties and interest groups are often involved early on in the process (R1). Local citizens generally are not directly involved at the nodes or the Topcorridor (R7).

4.4.4. Managing benefits

Although ambitions concerning realising a sustainable corridor network are formulated, no concrete goals have been stated (R1; R3; R4). However, the sustainability goals of the climate agreement of the national government are translated on the scale of the corridor (Topcorridors, 2021b). These are mainly about CO2 reductions (R4). The need for measurable goals is acknowledged and currently being researched (Panteia, 2022). However, currently the ambitions are formulated in a more qualitative manner (R2). Although these ambitions result in collaborations between the national government, provinces and nodes, a remaining issue is that "*they all have sustainability high on their agenda, only in the translation of how we can take steps, that is where some difficulties arise*" (R4). Representatives agree that it is an important issue but it shows that they are still searching how to translate this (R4; R5). This lack of concrete goals also makes it more challenging to reflect on realised progress (R3). By setting concrete goals concerning, sustainability could gain more priority as "*setting goals can also force you to define more actions. Also to indicate what the concrete result should be*" (R5). However to be successful the prerequisites, capacity and funds, must be available (R5).

4.4.5. Adaptive capacity

The Topcorridors programme has an adaptive character (Topcorridors, 2021b). This means that the programme can adjust to new developments (Topcorridors, 2022a). The programme offers room for technological developments and innovations in freight transport, sustainability and digitalisation (Topcorridors, 2021b; R4). Adding to this, Interviewee R1 added that the programme is constantly

adapting. In practice, the adaptive capacity of the programme is visible as measures can be switched, stopped, added and adjusted when needed (R2). Furthermore, the flexibility is visible in the CEH project which focusses on realising access points for alternative fuels (R11). By not determining beforehand which fuels need to be offered, this can be adjusted based on developments (R3; R11). Especially as it remains uncertain which alternative fuel, for example hydrogen or electric, will be the biggest one for freight transport (R4). However, eventually decisions must be made by the national government about a framework for CEH's to guide developments and provide some reassurance (R3).

Although the room for new innovations and developments is considered positive, it can result in the programme continuing to grow while not many things are finished (R1; R9). Furthermore, certain discussions, especially concerning budgets, sometimes keep getting postponed (R1). During the first years of the programme the focus was placed upon getting the programme started and involving the right parties. During this phase the adaptive character was considered beneficial (R2). Although the adaptivity is appreciated, a balance must be found between adaptivity and decision making (R1; R2).

4.4.6. Monitoring and evaluation

The need for sufficient monitoring and evaluation is stressed in the 'Toekomstagenda 2030', especially concerning sustainability (Topcorridors, 2021b). In 2022, a qualitative evaluation of the programme was conducted where the focus was placed upon whether the programme is executing the right actions, and whether these were realised in a sufficient manner (Panteia, 2022). Although ambitions concerning sustainability are formulated in a qualitative manner, it is now attempted to attach indicators to monitor progress (Panteia, 2022; R2). These indicators could include the reduction of CO2 emissions, other emissions and targets concerning modal shift per node (R2). It would in the future also be of added value to evaluate and update the plans the nodes formulate, through an annual evaluation annual attention for these plans would be ensured (R2). This is currently not yet possible.

4.5. Sustainable corridor development

Sustainable corridor development is a key pillar of the Topcorridors programme (Topcorridors, 2021b). In practice, how sustainability is perceived differs between individuals and organisations within the programme. Although the urgency for sustainable is increasing, it was not a main priority during the first years of the programme (R3). Interviewee R5 argued that "*sustainability is propagated, but the translation into activities that contribute in a targeted way has always been poor*". The emphasis is mostly placed upon the economic function of the Topcorridors and efficient flow of goods (R3). However, when sustainable corridor development is discussed, this is generally translated into reducing CO2 emissions (R4). No active attention is paid to other emissions (R1; R2).

Within the nodes more concrete attention is paid towards to topics of sustainability and liveability (Topcorridors, 2021b). Interviewee R5 argued that this is logical as many sustainability issues, such as particle matter, are more noticeable at the node. Furthermore, negative externalities impacting liveability, such as noise nuisance, are mostly experienced on the level of the node as well (Topcorridors, 2021b). Such issues are often 'point-problems', and not as much 'line problems' (R5).

Interviewee R11 stated that the realisation of CEH is a key project contributing to sustainable corridor, not only along the corridor but also in other provinces. CEH's can be seen as "*multi-fuel stations with multiple sustainable fuels or energy carriers*" (R11). By offering multiple energy sources, one does not yet have to commit to one energy carrier and there remains room for new development (R5; R11). The alternative fuels should be accessible for transport via road and water, to stimulating modal shift (Topcorridors, 2021b; R5). Via CEH, the programme attempts to eliminate *'the chicken or the egg'* issue to stimulate a shift towards sustainable freight transport (R3). However, until now it has not been made explicit how many CEH are needed and which alternative fuels should be offered (Panteia, 2022).

The Topcorridors programme does not directly focus on the energy transition (R1; R4; R5). However, it is linked with mobility and spatial-economic developments. Considering CEH, attention is paid to generating alternative energy sources sustainably (R4). Furthermore, spatial-economic developments often are concerned with (re-) development of business parks, which can be combined with i.e., solar panels (R5). Generation of renewable energy is often related to projects at the nodes, which is currently not actively coordinated by the programme (R1). Interviewee R4 explained that many developments concerning the energy transition fall outside the scope of the programme and should be assessed by the ministry, especially concerning regulations and guiding frameworks. However, recent evaluations indicate a need for clear measurable targets on the scale of the corridor (Panteia, 2022).

4.5.1. Barriers

Interviewee R1 stated that sustainability of the Topcorridors is not frequently discussed within the programme, even though recent evaluations show that the programme is not performing well considering sustainability (R1; Topcorridors, 2022b). Although this was extensively discussed, there is room for improvement concerning the steering process. A second barrier is to behave too adaptive and postpone choices, i.e., related to the CEH. This can result in avoiding budgetary discussions (R1). Other key barriers which are frequently mentioned are the lack of sense of ownership and available capacity and funds at the nodes (R1; R2; R3; R4). This is related to a barrier mentioned by R4: *"That might be the biggest threat, that people do not recognise that this is important*" (R4). This is especially challenging due to the number of involved governmental parties (R4) and is related to priorities both on the scale of the Topcorridors and on the scale of the nodes (R3).

4.5.2. Factors of success

A factor of success is the degree to which the programme facilitates coherent directions to unify components in an integrated approach for successful corridor development (Topcorridors, 2022d). The programme can combine and adjust different developments, which can affect each other. Other factors are an active and involved project manager, as the differences in terms of progress between projects in the programme are quite big (R4). This is possibly related to the available capacity for project managers within their organisation. A different factor of success is *"by setting concrete goals"* (R5). By formulating measurable goals, with a deadline, one is obliged to formulate actions contributing to these goals. However, still the requirements of capacity and funds have to be met (R5; Panteia, 2022). Furthermore, interviewees mentioned the added value of facilitated interaction through participation in the Topcorridors programme as this stimulates the sharing of experiences, best practices and learned lessons from which other nodes or projects can benefit (R5). Lastly, a main factor of success is that the programme is not focussed on a specific goal, but rather a combination of goals concerned with economic development, sustainability and spatial-economic developments (R4).

4.5.3. Conditions

How quickly trucks and cargo ships use CEH's depends on when they are replaced and whether it is then still allowed to operate with a non-renewable energy source (R3). Guidance from the national government is needed concerning the shift towards alternative fuels. When the government does not provide this, the choice of entrepreneurs to switch to alternative fuels will get postponed (R2). This aligns with the urgency described in the Toekomstagenda 2030: *"Clear perspective for the acceleration of sustainability within the Topcorridors"* (Topcorridors, 2021b, p.33). A recent evaluation showed that the programme is not performing as desired concerning sustainable corridor development (Topcorridors, 2022b; 2022c). *"The programme council should decide what impacts this has on decisions/priorities to be taken"* (Topcorridors, 2022b, p.3). Other conditions concern room for development, innovation and cooperation between the private sector, governmental organisations and knowledge institutes (2021b). Besides these conditions, it was mentioned that to get actions going, requirements as "*capacity, funding and support from within the organisation*" must be met (R3).

5. Venlo

5.1. Case description

Venlo is a selected node located on the southeast axis of the Topcorridors in the MIRT investigation in 2017. As one of the Main-, Brain- and Greenports of the Netherlands, Venlo realises a significant contribution (387 million Euros in 2015) to the Dutch economy (Gemeente Venlo, 2018). In line with their current position in international transport networks, Venlo aspires to remain an international frontrunner concerning sustainable freight transport. This is valued by the Province of Limburg, as freight transport is an important economic sector for the province. As such, their goal is to realise safe, efficient, reliable and sustainable mobility (Gemeente Venlo, 2018).

5.2. Functional interrelatedness

5.2.1.Multi-modal

Venlo has multiple business parks and terminals, connected via road, water and rail infrastructure, as displayed in Figure 8 below. As a municipality, Venlo actively facilitates modal shift, both from the ambition to improve sustainability and to reduce congestion to reduce local (environmental) nuisance (R5). The facilitation of modal shift aligns with the ambition of Venlo to realise effective and sustainable integration of the node in the corridor network (Gemeente Venlo, 2018). Therefore, the municipality invested in improving the local port areas, especially barge terminals to assist modal shift towards transport via cargo ships (R7). Furthermore, Venlo has realised one of the largest rail terminals of the Netherlands (R6). Modal shift takes place at 'Cabooter', 'rail TCT' and 'water TCT', as depicted in Figure 8. At the terminals, transport modes are linked, both from the network infrastructure and local infrastructure, offering the possibility for modal shift between both long-distance freight transport and the last miles as local infrastructure (R6).

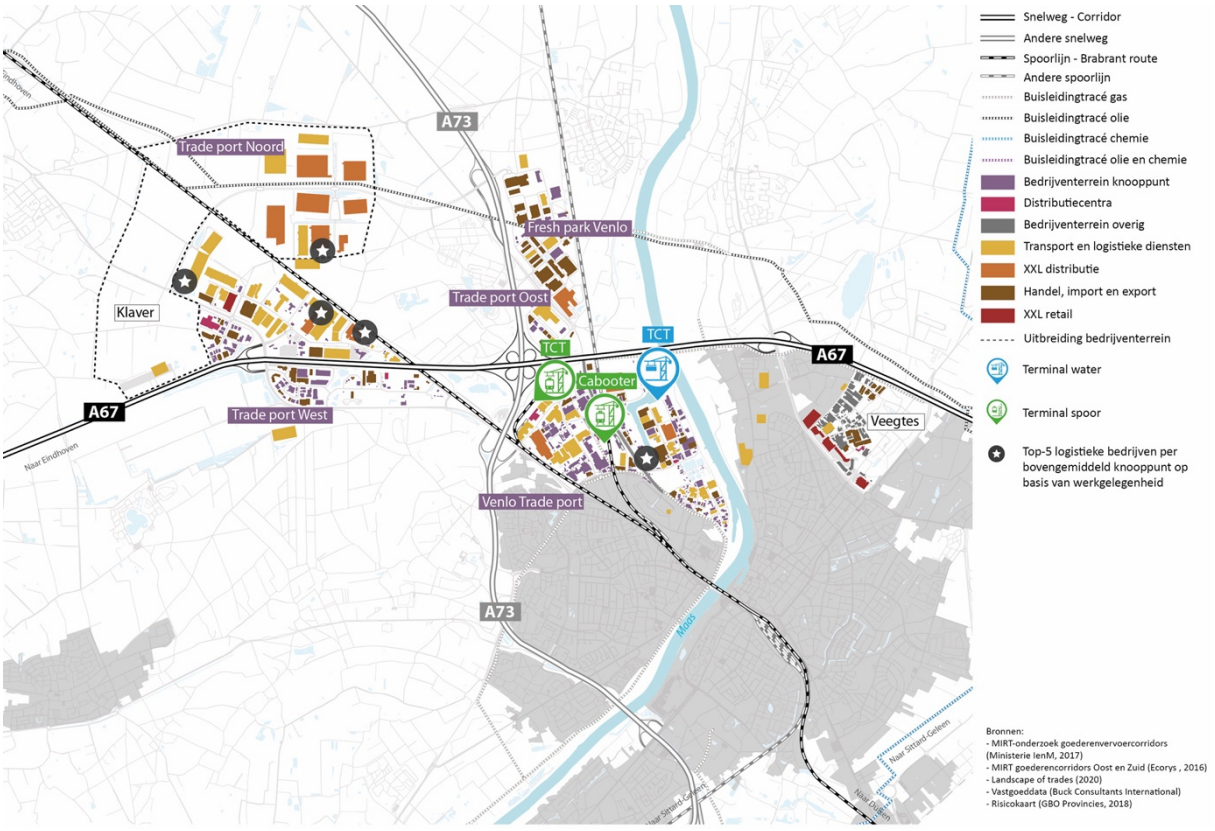

Figure 8: Overview node Venlo (R2)

Although modal shift is focussed on transferring goods from road to transport via rail or water, this remains challenging for the last-miles as the final destinations are not always accessible via rail or water infrastructure because these networks are less fine-grained (R4). This is not necessarily a problem as rail infrastructure is often not feasible on such a small scale and electric or in the future hydrogen trucks can be used.

Through the Topcorridors programme, logistic brokers are deployed to explore modal shift for entrepreneurs. They also assess possible collaborations between entrepreneurs by for example sharing a cargo ship or rail connections (R5; R6). In the region of Venlo this resulted in the 'Limburg Express', providing a connection with the port of Rotterdam through a cargo ship. This is a key example of how the different nodes, and the entrepreneurs, along the corridor can collaborate to improve connections between nodes and to strengthen the Topcorridors (R7).

5.2.2. Multi-scalar

On a European scale, node Venlo plays a role on two TEN-T corridors. Besides the Rhine-Alpine corridor, the North Sea-Mediterranean corridor crosses through Venlo. Via waterways, Venlo has a direct connection the Port of Rotterdam, Italy and Romania, further strengthening the position of the node (Gemeente Venlo, 2018; R3). On a regional scale, node Venlo develops business parks together with satellite nodes within the FUA, such as Roermond and Venray (R4). This is due to a lack of available space within Venlo, and to share different spatial functions within the FUA (R6). Despite the need to tackle complex challenges on the European corridor scale, Venlo mainly pays attention to activities that occur and that can be influenced on the scale of the node and less to a larger scale (R5).

5.2.3. Multi-sectoral

Within the municipality of Venlo, corridor and node development is given some priority. It touches upon numerous sectors within the municipal organisation i.e., mobility, economic development and spatial planning (R5). These multiple sectors come together in different cases i.e., when revitalising business parks. This development is in line with the ambition to assess different regional challenges in an integrated manner (Topcorridors, 2021f). This is done by i.e., integrating economic development with climate adaptation (R5).

Considering interactions between the different sectors, a focus shift is experienced from the economic focus towards a softer focus with more attention for the i.e., the labour market, education and surrounding environment (R6). Interviewee 6 concluded that via this focus shift the coherent idea of operating as a node as a whole is getting more shape.

5.3. Institutional interdependencies

Interviewee R5 argued that municipalities of nodes along the corridor mainly focus on the scale of the node. Venlo focusses mainly on local, more multi-sectoral and integrated issues. As discussed in Section 5.2, attention is paid to multiple sectors. Thus, different municipal departments have to cooperate. This can be difficult due to e.g., limited capacity and conflicting interests between departments due to scarcity of space (R5). Therefore, municipal departments of Venlo cooperate with municipalities of adjacent satellite nodes within the FUA.

Where the nodes focus more on multi-sectoral local issues such as housing, the Topcorridors programme mainly focusses on issues that affect the corridors as a whole, which are more infrastructure focussed (R5). This relates to a difference in priorities between the node and the corridor (R7). Interviewee R7 argued that although key points of the programme are important for node Venlo, they are not all equally relevant. For instance, a key point of the Topcorridor programme is a durable connection between the Port of Rotterdam and the European hinterlands. Venlo benefits from this connection, however it is not a main priority (R7).

In the context of the Rhine-Alpine corridor, Venlo is member of the European Grouping of Territorial Cooperation (hereafter EGTC). This organisation aspires to improve transnational collaboration between partners along the TEN-T corridor and aims to tackle complex challenges on the corridor together i.e. the realisation of charging infrastructure (Gemeente Venlo, 2018; R6). Although such collaborations remain difficult they are considered to be added value for the position of the node within the (international) corridor network (R6).

5.4. Programmatic approach

Node Venlo is actively involved in the Topcorridors programme. The municipality and province partake in different meeting cycles, such as the Programme Team (R6). Although Venlo is actively involved, the degree to which they feel directly connected to the programme varies between respondents (R7). From the perspective of Venlo, the overarching programme floats between the governmental layers (national, provincial and municipality, but also connects with the nodes and fills a certain gap (R6). A clear link is observed between the actions of node Venlo and of the Topcorridors programme (Gemeente Venlo, 2018). Interviewee R6 supported this and argued that the Topcorridors programme has little influence on i.e., increasing the sustainability of the node considering policies. However, the interviewee stressed that the programme adds value considering the influence the programme has on stimulating activities and how projects benefit from this. The programme *"opens doors and accelerates projects"* (R6).

As depicted on Figure 8, Venlo has numerous business parks for which the node cooperates with the region. These are partially located in surrounding satellite nodes as Roermond, implying regional coordination (R5). Besides regional cooperation, Venlo cooperates with different nodes along the Topcorridors. Interviewees R5 and R6 argued that coordination between nodes is quite limited. In multiple situations, these relationships are more of a competitive nature than collaborative (R5). There is some cooperation between Venlo, Nijmegen and Tiel concerning thematic projects, i.e., truckparking. However, much can be gained from a strengthened relationship between the nodes to share knowledge (R5; R6; Topcorridors, 2021f). It is suggested the Topcorridors programme could facilitate this, as municipalities tend to have insufficient capacity to organise such interactions (R6). Interviewee R5 nuanced that this should not be to steering, the programme could simply facilitate and connect different parties. A successful example is the discussed Limburg Express, where different companies along multiple nodes cooperate to be assigned a fixed window at the Deep Sea Terminal at the Port of Rotterdam (R5). Furthermore, Venlo participates in the CEH. This project is carried out by the Province of Gelderland and besides the provinces participating in the Topcorridors Programme several other Dutch provinces have joined.

5.4.1. Managing complexity

The Topcorridors programme consists of actions and projects. These are (mainly) coordinated by the overarching programme (Topcorridors, 2022b). The actions and projects are realised partially by the programme, but also by the municipalities where nodes are located and lastly also by other (non-governmental) parties. Interviewees R6 and R7 described that this manner of organisation overall is well-functioning. However, due to the large number of actions and projects within the programme it is difficult, from a node perspective, to keep track of all developments. Furthermore, interviewees R5 and R6 voiced concerns about lack of capacity at the nodes, resulting in too little time for their responsibilities. This also why it is hard to keep track of all developments. Consequently, opportunities and possibilities to cooperate for actions and projects are sometimes unnoticed.

5.4.2. Navigating through political landscapes

Interviewees indicated that political influence has a large impact on the node (R5; R6). When exploring possible expansions of business parks, Venlo cooperates with adjacent nodes due to scarcity of space. On the administrative level, these collaborations run smoothly. However, collaboration between different municipal councils shows more difficulties. These councils do not want to feel overruled by the council of an adjacent municipality. Therefore, they behave a bit more stubborn (R6).

The influence of political change is also experienced when a new representative, both at the municipal and provincial level, is appointed. It is beneficial for Venlo when the representative understands the corridor concept, its relations with freight logistics and required infrastructures (R6). Especially when a representative does not understand the urgency, necessity and does not feel a sense of ownership concerning corridor and node development, this can have a negative impact on the available capacity for this topic within the node. Politics determine which topics are emphasized (R6). Furthermore, political representatives can have different priorities and timeframes due to a focus on re-election; as interviewee R5 stated *"as long as I can make an unambiguous decision"*. This does not necessarily result in sufficient attention for this topic within the node Venlo.

5.4.3. Stakeholder management

Within node Venlo, developments are often up to the private sector. Governmental actors can facilitate this, however interviewee R5 argued that it is most efficient when a private party initiates this. Therefore, it has been attempted to include the private sector within the programme and nodes. Interviewee R5 suggested that it would be beneficial to include them in a structural manner. Furthermore, it must be analysed which stakeholders are relevant, who is already involved, and then actively keep them involved. By bringing stakeholder together to interact, new actions can arise (R5). Other stakeholders which operate on a large scale, like ProRail and Rijkswaterstaat, must also be considered as they often participate in projects and have a large influence on the realisation. Local citizens are more difficult to involve. Interviewee R7 questions whether this would be of added value, as participants are likely affected entrepreneurs. Lastly, a well-functioning broad actor network is important to realise necessary and valuable developments, including educational organisations (R6).

5.4.4. Managing benefits

Goals concerning sustainable development are set by the municipality or province. These are mainly focussed on reducing CO2 emissions (R6). The goals are linked with national and European goals. They are in line with the goals of the corridor, but not coordinated as such (R6). In Venlo these goals are linked with the Regional Energy Strategy of the northern part of the province of Limburg as well. Besides the goals, clear targets and how these targets can be operationalised, are not specified for the node (R5). This is a process that requires more time (R7).

5.4.5. Adaptive capacity

Similar to the Topcorridors programme, there is room to adapt within node Venlo. In practice this is visible in the CEH project, which focusses on realising access to alternative fuels. Currently, it is still up for debate which energy sources will become leading, therefore the CEH's are obliged to offer at least two forms of energy. By including multiple energy sources, the final choice is postponed and the market is given more time to innovate and discover what works most efficient (R7).

5.4.6. Monitoring and evaluation

Due to the lack of concrete and measurable goals concerning sustainability it is difficult to monitor progress and adjust for node Venlo. This makes it a more difficult to show how node Venlo contributes to the goals of the overarching Topcorridors programme (R5). Currently Venlo is slowly beginning with the process towards monitoring process concerning sustainability (R7).

5.5. Sustainable corridor development

As mentioned, Venlo aspires to be an efficient, reliable, safe and sustainable node, contributing to sustainable economic growth of the municipality (Gemeente Venlo, 2018). Venlo desires to function in a CO2 neutral manner (R5). Therefore, several projects, such as CEH, are formulated contributing to a sustainable freight transport system (R7; Gemeente Venlo, 2018). R7 stated that for the ambition of electric freight support, operators need to be ensured of sufficient charging points at the nodes. Besides road transport, cargo ships benefit from CEH (Gemeente Venlo, 2018). Projects as CEH are part of the added value of participating in the Topcorridors (R5). There are opportunities for Venlo to collaborate with other nodes, both within and outside the Topcorridors programme (R7). Besides the mentioned aspiration to operate CO2 neutral, no specific goals have been set concerning sustainability.

Besides sustainability, the municipality of Venlo aspires circularity (R6; R7). However, concerning the implementation it remains difficult to realise projects and make the shift from discussing how to act sustainably to actually putting words into action (R6). Interviewee R5 argued that the formulation of clear goals could stimulate the process towards sustainable development. By setting clear goals within a specific time frame, one can enforce concrete actions and projects instead of projects which are related to sustainability, but only occur incidentally (R5). However, by participating in the Topcorridors programme, node Venlo experiences additional stimulation to operationalise sustainable development at the level of the node (R6).

5.5.1. Barriers for sustainable corridor development

As mentioned, modal shift is an instrument contributing to sustainable transport within node Venlo. A barrier for modal shift is the lack of an intricate local rail-network (R5). Consequently, not all freight transport can be shifted towards rail or water infrastructure. Zero-emission trucks can be considered for the last mile (R5). Moreover, despite actions of the node, when it comes to improving sustainability of node Venlo, the municipality is partially dependent on private parties (R5). However, sustainability is not their only goal, they also strive towards efficiency, revenues and control of costs (R5).

Concerning sustainable development and the ambitions of Venlo, and inherently the ambitions of the Topcorridors programme as a whole, it must be considered that many aspects that influence sustainable development are outside the scope of the Topcorridor programme and the municipality of the node (R5). As a node one can try to influence what is discussed in these other programmes, however it cannot be controlled.

5.5.2. Factors of success for sustainable corridor development

Currently there are some collaborations concerning projects between nodes, however to increase the success of the Topcorridors more and improved collaborations between nodes would be of added value (R6). These interactions contribute to other interactions between nodes where knowledge between nodes can be shared, contributing to the success of the Topcorridors network as a whole (R5; Topcorridors, 2021f). A different factor of success within node Venlo is the amount of political attention and priority the topic of (sustainable) corridor development has gotten as mentioned.

5.5.3. Conditions for sustainable corridor development

As mentioned, Venlo is a member of the European Grouping of Territorial Cooperation focusing on transnational collaboration along the Rhine-Alpine corridor. Such organisations also offer opportunities, "*in order to bring sustainability to a higher level within the corridor, these kinds of partnerships [partnerships on a European corridor level red.] are of course essential"* (R6). For the improvement of sustainability of the Topcorridor and her nodes, one is also dependent on adjacent countries. Therefore, collaboration between nodes and along the (international) corridor is necessary.

A second condition for sustainable corridor development at node Venlo is sufficient capacity for municipal civil servants. This currently is insufficient, partially due to a shortage of civil servants and due to their other responsibilities within the municipality (R6; R7). Furthermore, whilst the available capacity is not increasing, the number of related issues is rising. The municipality i.e., also needs to pay attention to the energy transition and the nitrogen crisis. If such challenges are assessed they might disable further improvement of the node concerning freight transport (R7). Furthermore, not all required knowledge is present within the node. It remains important the these conditions are met to facilitate future developments (R5; R6).

6. Nijmegen

6.1. Case description

Node Nijmegen is located on the eastern axis of the Topcorridors network (MIRT, 2017; Gemeente Nijmegen, 2019). Compared to the other selected nodes along the Topcorridors network, Nijmegen is a relatively small logistic node (R2). Due to its position, Nijmegen forms a connection between west-European ports and European hinterlands. The node functions as an access points for consumer and producer markets of the Province of Gelderland, the Netherlands and Germany (Gemeente Nijmegen, 2019). As shown on Figure 9 below, Nijmegen is a multi-modal node as it is connected with road and water infrastructure (Gemeente Nijmegen, 2019). Although Nijmegen has attractive infrastructure connections, the municipality prefers not to present itself as a logistic municipality (R8; R9).

A key focus of the municipality of Nijmegen is sustainability, this aspect is considered in the further growth of node Nijmegen (Gemeente Nijmegen, 2019). Also, for sustainable city logistics (R8). Therefore, Nijmegen i.e., has already facilitated space to realise alternative fuels for cargo ships in order to contribute to modal shift.

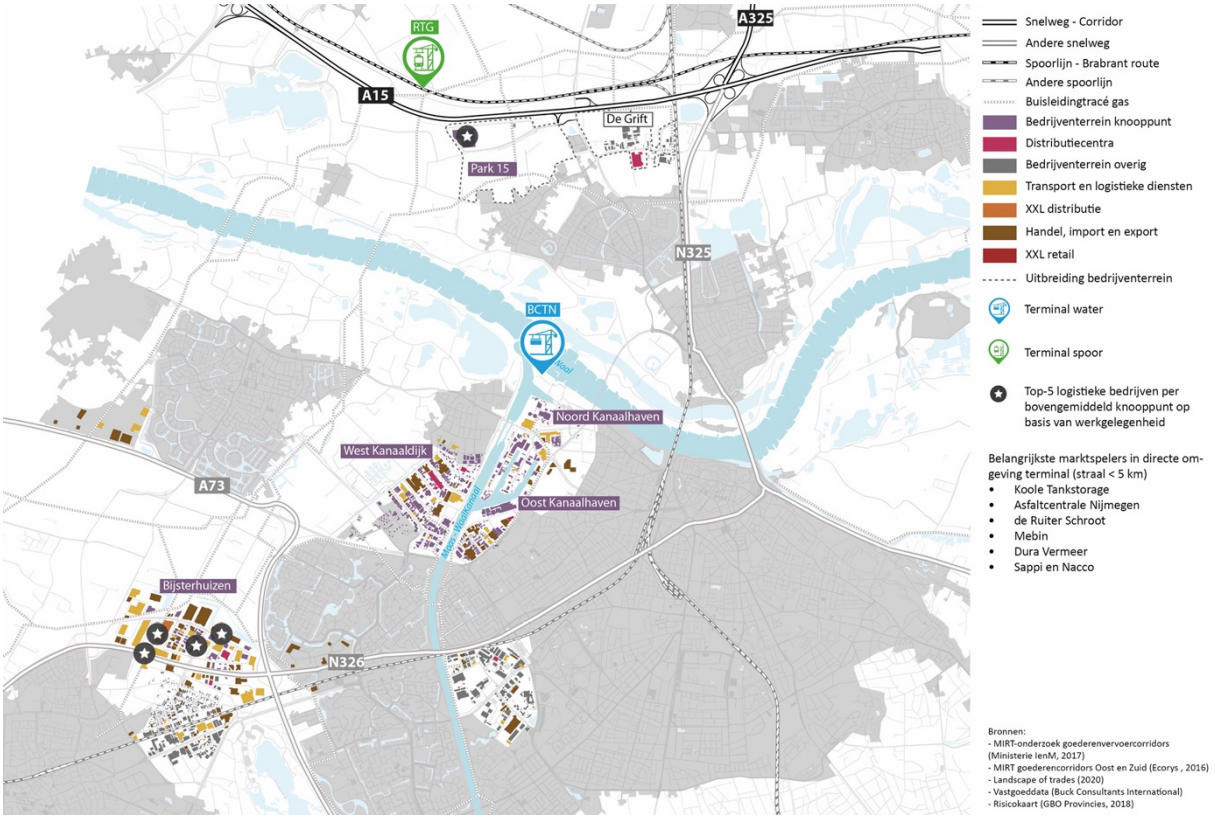

Figure 9: Overview node Nijmegen (R2)

6.2. Functional interrelatedness

6.2.1. Multi-modal

As mentioned, Nijmegen is a multi-modal node. Whilst a direct connection with rail currently is lacking, the realisation of a rail connection is in process (R9). There are concrete plans to realise Rail Terminal Gelderland (hereafter RTG), which would make Nijmegen a tri-modal node (Gemeente Nijmegen, 2019). The position of the planned RTG can be seen on Figure 9 above. The current expectations are that RTG will be realised in two to three years. However, further delays are possible as the realisation of RTG is currently up for investigation at the Council of the State (R10).

Nijmegen stimulates modal shift towards from road to water infrastructure through realisation of the BCTN terminal where modal shift can take place, as depicted on Figure 9 above (R8; R9; Gemeente Nijmegen, 2019). The modal shift ambition goes hand in hand with the desire for sustainable cargo ships. Despite the unknowns of development in freight transport, the Municipality of Nijmegen sees many opportunities in the facilitation of modal shift and multiple transport does as this contributes to efficient usage of available infrastructure (Gemeente Nijmegen, 2019). However, *"the presence of infrastructure does not automatically result in modal shift"* (Gemeente Nijmegen, 2019, p.13). Modal shift also requires behavioural change of entrepreneurs as they are not always used to collaborate with competing parties to realise modal shift.

6.2.2. Multi-scalar

Nijmegen is connected with (inter-) national freight transport infrastructure. This infrastructure is important to connect nodes on the corridor (Gemeente Nijmegen, 2019). Zooming out, this infrastructure functions as linking pin between the west-European ports and the European hinterlands (Gemeente Nijmegen, 2019). Interviewee R8 stressed the interaction and cooperation with other nodes along both axes of the Topcorridors, as certain issues as sustainability are best addressed in a coherent manner. This issue plays a role within the region and in international context as Nijmegen is located close to the German border. This is because issues as sustainability are not only an issue at the level of an individual node but also an issue concerning the connections between different nodes (R8). Here lies a role for the Topcorridors programme (Topcorridors, 2021c).

6.2.3. Multi-sectoral

Within Nijmegen, logistics and freight transport are viewed as functions facilitating other sectors (R8). Concerning the logistical function, multiple aspects are assessed, as port renewal and business parks located close to road infrastructure, displayed on Figure 9 above. Logistics and freight transport functions affect both area developments and economic aspects (R8). These functions are also influenced by multiple departments within the municipality. As departments tend to focus on own point of view, this further complicates the process towards sustainable corridor development (R10).

Although the goals of the Topcorridors programme are quite broad and the goals of nodes can usually be fitted in, node Nijmegen often has different priorities (R8; R9). Nijmegen aspires liveability in the broadest sense, including finding a balance between industrial, residential, commercial and natural areas in the entire municipality (R9). Thus, node Nijmegen has broad priorities and the related aspects are housed in different municipal departments. Interviewee R8 explained that there can be some friction between sectors concerning available capacity. Interviewee R10 argued that this does not imply that sustainability of the corridor and nodes is not considered important. However choices on assigning capacity, and which sectors get the most attention, must be made by the municipality (R10).

6.3. Institutional interdependencies

Considering horizontal governance within node Nijmegen, more close contact with relevant private parties is desired. Interviewee R8 argued that it would be beneficial if the responsible civil servant for corridor development within the municipality were to be in close contact with relevant private partners. Furthermore, as corridor development touches upon multiple sectors, coordination within the municipality is necessary (R10).

Concerning vertical governance, miscommunication between organisations can easily take place as numerous governmental organisations are involved and elaborate meeting cycles are in place. I.e., about the deployment of logistic brokers which is highly valued by the programme, whilst not all provincial representatives find this necessary (R9). Furthermore, once the national government declares that something is important but outside their scope, it is delegated to the regions. Overall, the

vertical structure is beneficial as the broad inclusion of governmental organisations enables organisations to share knowledge (R8). Furthermore, made connections in the context of Topcorridors are also useful for other projects and programmes (R9). Looking at the Topcorridors, this is of added value as not all nodes have made similar progress considering sustainable corridor development.

6.4. Programmatic approach

When the Topcorridors programme launched, node Nijmegen actively participated and facilitated interaction between governmental parties, interest groups and the private sector. Currently, node Nijmegen is less involved in the Topcorridors programme (R10). Although some civil servants prefer more involvement, the municipality and province are little involved due to political choices, sense of urgency and priorities (R8; R9). Concerning the province, management desired increased efficiency and reconsidered their objectives. They therefore reconsidered how participation in the Topcorridors programme contributed to these objectives. As these contributions were not clear or concrete the province decreased the available capacity for involvement (R9). Thus, although there is a functioning corridor community on the corridor scale, this corridor community is lacking within Nijmegen due to limited capacity of both the municipality and province (R8; R9). Interviewee R9 stressed the importance of a community within the as it shows that actions the corridor community considers to be beneficial, such as CEH, gain attention and make progress (R11). "*A corridor community adds value*" (R9). Furthermore, the node could miss future opportunities to cooperate with other organisations to stimulate a sustainable freight transport system due to its lack of active participation (R9).

Thus, for active participation of node Nijmegen in the Topcorridors programme there must be a policy or administrative ambition to make progress as this enables available capacity (R9). It is therefore important to actively involve public administrators and managers to cooperate and learn together with relevant private actors where progress can be made and benefits can be generated (R8; R9).

6.4.1. Managing complexity

Although node Nijmegen collaborates with the Topcorridors programme when it comes to modal shift through the logistic brokers and the CEH project, there is no corridor-oriented team at the level of the node due to a lack of capacity (R8). The CEH project is led by a representative from the Province of Gelderland (R11). Albeit node Nijmegen currently does not have sufficient capacity to spend on active participation in the Topcorridors programme it remains possible for the node to participate in projects within the corridor (R8). Through such projects, Nijmegen interacts with the overarching programme. Interviewee R8 desires more cooperation between projects within the programme to stimulate a more integrated approach within the corridor: *"through cooperation you can do more"*. Currently there are no other ways through which the Topcorridors programme influences realised projects at the node.

Due to the adaptive character of the Topcorridors programme, the programme and the number of projects continuous to grow. However, the increasing number of projects within the Topcorridors programme results is less focus. For managing the complexity of the programme, it could be beneficial to bring more focus within the Topcorridors programme (R9).

6.4.2. Navigating through political landscapes

It is challenging that the benefits of participating in the Topcorridors programme are relatively unknown among relevant political representatives. Interviewee R9 argued that consequently political municipal/provincial representatives often are unaware of the added value of the programme. Thus affecting their awareness and willingness to act accordingly (R10). Therefore, due to limited capacity and funds limited attention is paid to the topic. A second aspect is that *"there must also be policy or administrative ambition to take steps at the nodes and along the corridor"* (R9). Such ambitions are necessary for the topic to gain priority, and therefore attention within the node. This is where node

Nijmegen falls a bit short (R8; R9). These ambitions are necessary in Nijmegen as *"Nijmegen does not want to present itself as the logistical hotspot of the East of the Netherlands"* (R9). The impact of political influence has been experienced by the Province of Gelderland, who stated that the goals of the Topcorridors programme were not entirely aligned with the ambitions of the province. Therefore, capacity for the subject was reduced (R9). However, as mentioned in Section 6.1, the Municipality of Nijmegen aspires to be a sustainable municipality. This results in increased attention for sustainable initiatives, benefitting sustainable corridor development as much attention is paid to local reduction of emissions in freight transport and last-mile logistics (R8).

6.4.3. Stakeholder management

The first years after the Topcorridors programme launched numerous stakeholder gatherings where organised in Nijmegen. Whereas this started with mainly private parties, these currently include mainly public organisations: *"It's becoming more and more a government party"* (R9). However, capacity and motivation from local governments are required to actively involve private parties. Interviewee R8 stressed the involvement of private parties, like regional entrepreneurs, to stimulate sustainable corridor development. Through active involvement collaborations might emerge, benefitting the entire corridor (R9). The Topcorridors programme could facilitate these interactions to stimulate collaboration (R8). Interviewee 9 suggested this could be realised by building corridor communities within the node. By bringing in involved parties i.e., interest groups, the Province of Gelderland, the Municipality of Nijmegen, Ministry of I&W and regional entrepreneurs together in a community the parties become at least somewhat familiar with each other. This could result in a more active community, strengthening the benefits of participating in the programme. However, as miscommunication between governmental and private parties an easily take place a solid communication strategy towards entrepreneurs is required (R8). Considering the location selection for CEH, one could benefit from their local knowledge for suitable locations. Therefore, the project manager of the node should not only have an active network within the government, they also have to be in contact with regional entrepreneurs (R8).

6.4.4. Managing benefits

Whilst the Municipality of Nijmegen is ambitious concerning sustainability, there are no concrete goals formulated concerning sustainable freight transport related to the corridor (R9). Ideally, these goals are formulated by collaborating parties within the node. This includes private organisations, interest groups and governmental organisations. However, such cooperation is currently not present. Clear, concrete goals could stimulate the formulation of concrete actions within the node (R9). Interviewee R8 argued that as formulating concrete goals can be challenging, this could also be discussed with higher governmental levels such as the Topcorridors programme or on a European scale. This could be of added value as for node Nijmegen to stimulate sustainable corridor developments, they would benefit from similar developments at other nodes (R9).

6.4.5. Adaptive capacity

Concerning the adaptivity of the node there are various relevant aspects. First of all, as the Waal flows through Nijmegen the municipality is concerned with the rising and dropping of the water levels which have consequences for their accessibility for cargo ships. Secondly, Nijmegen plans on realising a CEH where multiple alternative fuels can be accessed (R8; R9). Furthermore, considering business parks interviewee R10 explained that many agreements concerning sustainability requirements for businesses are laid down in private agreements that are made when an entrepreneur is assigned a location. By laying these requirements down in the private agreements instead of in the zoning plans, the municipality has more flexibility to incorporate updated requirements when a new business takes over a location as compared to with a zoning plan, which is valid for 10 years (R10). Lastly, interviewee R9 argued that due to the adaptive character of the programme it only continuous to grow.

6.4.6. Monitoring and evaluation

Node Nijmegen participates in the evaluations organised by the Topcorridors programme (R9). Furthermore, no active monitoring considering the sustainability of the corridor at the node is mentioned. However, the Municipality of Nijmegen is developing a business park which has adopted a 'quality ruler'. This tool combines multiple measurements for different qualities of the businesses. Some measurements pay attention to sustainability (R10). As the business park is being developed, how the instrument is perceived and whether it has the desired effect is not evaluated yet.

6.5. Sustainable corridor development

The Municipality of Nijmegen is a politically left and green oriented municipality, paying attention to sustainability in the broadest sense (R8). This implies attention for topics as biodiversity, energy transition and reduction of emissions. Node Nijmegen aspires to contribute to sustainable corridor development through modal shift and CEH (Gemeente Nijmegen, 2019; R11). Within the node the CEH include hydrogen, charging possibilities and LPG for freight transport (R9). Concerning local emissions, node Nijmegen offers shore power (*walstroom*) for cargo ships (R8). Cargo ships can plug in when docked for electricity instead of energy from their generator, which usually uses non-renewable resources (R9). This contributes to local liveability through decreased emissions and noise nuisance (R8). Node Nijmegen aims to stimulate modal shift towards freight transport via water or rail by realising the aforementioned RTG and by improving connections with the harbour of Rotterdam. Furthermore, Nijmegen stimulates modal shift via logistic brokers. Besides modal shift, the goal is to avoid unnecessary movement of goods, and if moved to do this in a safe, clean and quiet manner to minimise local externalities (Gemeente Nijmegen; R9).

The energy transition goes hand in hand with sustainable corridor development (R9). The Province of Gelderland contributes to this through e.g., the windmills near the ENGIE area which are realised in cooperation with private parties (R9). For the involvement of private parties it is generally necessary that it is financially beneficial to partake. Due to current issues with the electricity net capacity, the municipality is looking into storage options for renewable energy (R10).

6.5.1. Barriers

Although attention is paid to realising a sustainable transport system, other pressing issues as housing or water safety demand more attention (R10). Interviewee R9 explained that local issues have priority over network challenges. Consequently, contributing to sustainable transport systems becomes less urgent on a local scale (R10). Furthermore, Nijmegen is limited involved in the Topcorridors programme due to limited assigned capacity and the distance between the node and the programme (R9; R10). Within the programme, numerous actions occur with possibilities to collaborate which pass by unnoticed as little attention is paid to this (R9). Consequently, the added value of participating in the programme becomes less clear further limiting the options and willingness to participate in projects contributing to sustainable corridor development (R9). This is also affected by political goals (R9) and the issue that Nijmegen does not want to profile itself as a logistics-oriented municipality, *"they do not consider it a core business"* (R8).

6.5.2. Factors of success

Due to limited capacity node Nijmegen could benefit from support provided by the overarching Topcorridors programme. The programme could provide information regarding questions which are relevant for numerous nodes (R10). When the nodes have the opportunity to learn from experts and other nodes, this would contribute to the added value of partaking in the programme (R8). Interaction between nodes and other relevant involved parties would also be of added value (R9).

6.5.3. Conditions

The ambitions to increase sustainability beyond CO2 emissions are indicated. However, this does not necessarily mean that sufficient capacity, energy and funds are allocated to the issue. Furthermore, concrete measurable goals that can be monitored and evaluated are needed (R9). Although the theme of sustainability usually is supported by politicians and managers, political influence can have a negative effect resulting in decreasing capacity, as is experienced in Nijmegen. However, it is important that there is sense of ownership within the node and that there are political ambitions and awareness concerning the position of Nijmegen and the opportunities offered by the programme (R8).

In order to further improve the development of a sustainable transport it is important to discuss these ambitions with entrepreneurs (R8; R10). It is important as a governmental actor to keep in touch with your environment, also to be aware of their own goals and ambitions related to sustainability and how a municipality can facilitate this (R10).

7. Analysis and reflection

In this Chapter the discussed results throughout Chapters 4, 5 and 6 are analysed and reflected upon. The main results are compared to key components from the theoretical framework in Chapter 2.

7.1. Functional interrelatedness

Nijmegen and Venlo are multi-modal nodes. The different infrastructure modes are connected with both national and international networks. The involved nodes, Topcorridors network and TEN-T are linked via these networks. Both nodes stimulate modal shift to decrease emissions and congestion. This aligns with the goals of the Topcorridors programme and mainly occurs in a project-organised manner at the nodes. Nijmegen stimulated modal shift by realising a rail terminal, whereas Venlo is further developed and focusses on revitalising port areas and terminals. Both nodes deploy, together with the programme, logistic brokers. In Venlo this has resulted in the discusses Limburg Express. A cargo ship connection with the Port of Rotterdam. Although the Topcorridors programme is excited about the logistic brokers, this differs between respondents of the nodes. They do not all share the urgency for logistic brokers as they believe modal shift will be realised without them.

In node Venlo logistics and freight transport, also related to corridor and node development, are prioritised and approached in an integrated manner. The idea of operating as a node is getting more shape, different municipal departments collaborate and functions are combined. Due to limited capacity that needs to be divided between sectors this can be challenging. To the contrary, node Nijmegen does not identify as a logistic node and views logistics and freight transport as functions, not sectors. However, in both cases there is consensus that sustainable logistics and freight transport have to be considered in a broader context whilst considering multiple sectors. Aldo due to the spatial implications of corridor development. Whilst Venlo and Nijmegen have a more integrated multi-sectoral perspective, it is experienced that the focus of the programme is mainly oriented towards the freight transport sector. However, the programme recognises that freight transport and infrastructure, especially the development of a sustainable integrated transport system, touches upon different scales and sectors. Therefore, the programme aspires to operate in an integrated manner, taking this spatial integration into account. This remains challenging as spatial planning generally falls under the jurisdiction of the municipalities and the programme has no authoritative power. It is therefore important to cooperate with different governmental organisations and departments involved.

The cases show that the different scales are linked through infrastructure. In line with Faith-Ell et al. (2020) & CEDR (2021), the different transport modes are linked at the nodes and modal shift occurs. It is important for the nodes that some value is added during modal shift to ensure benefits for the node. Otherwise the node only experiences negative externalities of modal shift, e.g. emissions. The two goals of modal shift, less emissions and less congestion, can sometimes be contradicting. To reduce congestion on roads, a shift towards cargo ships is stimulated. However, these ships generally do not operate without emissions and in the nearby future it is likely that trucks operate in a zero-emission manner before cargo ships can. However, this would not have the desired impact on road congestion. Therefore the development of zero-emission cargo ships could be enhanced. The realisation of CEH at the nodes and on an international scale could also contribute to this. As freight transport often occurs on an international scale, it is important to consider different scales when assessing these challenges.

Both nodes and the programme recognise that spatial integration of corridor and node development remains challenging as different sectors influence each other and need to be considered. Furthermore, as spatial scales are linked and interaction takes place between them the different scales need to be considered as well. The desire of the Topcorridors programme to assess these challenges in an integrated manner aligns with the described integrated planning approach by Heeres et al. (2016), Heeres (2017) and Vital Nodes (2019), arguing that both sectors and scales need to be considered.

The cases suggest to let nodes cooperate in a complementary manner where they specialise instead of being mostly similar. This opportunity aligns with the concept of *borrowed size* where nodes located in each other's proximity can make use of each other's function and together function as a larger region, and with the ambitions of the programme to function as competitive region on a European scale.

7.2. Institutional interdependencies

As the development of a sustainable freight transport system touches upon numerous land uses and sectors at the nodes, departments within municipalities have to cooperate. Although both nodes indicated that this can be difficult due to conflicting interests between departments this is a bigger issue for Nijmegen than for Venlo due to political influences. Furthermore, both nodes struggle with capacity issues. However, whereas Venlo is able to actively participate in the programme this is not an option for Nijmegen due the political choices of not wanting to be a logistics-oriented municipality or province. Consequently, Nijmegen is less able to coordinate actions with other nodes or the programme, and participates less in meeting cycles of the Topcorridors programme.

Although node Nijmegen is not actively participating, the vertical governance of the programme is still valued due to the broad inclusion of governmental organisations. This vertical structure can be challenging due to miscommunication. Moreover, provinces do not always agree with the programme e.g., the deployment of logistic brokers. However, the vertical governance structure facilitates interaction between nodes and the programme to share knowledge and experiences which is highly valued by Venlo and Nijmegen. In addition to the Topcorridors programme, node Venlo participates in the EGTC to share knowledge, experiences and to tackle corridor issues on an international scale.

Despite the programmes aspiration for spatial integration, this often falls outside the scope as this generally is the responsibility of the municipality. This enhances the need for MLG as coordination between departments and organisations is needed. Especially as challenges as sustainability affect other sectors and regions and are too big for a municipality or province. The Topcorridors programme finds itself between these governmental levels and fills the gaps between these layers by taking on an intermediate role in such situations or provide guidance. This remains challenging for the programme.

The Topcorridors programme focusses mainly on the Topcorridor scale and the nodes, the FUA's. However, the Dutch governmental layers are structured as municipalities, provinces and the national government. The spatial scales and institutional levels thus are not entirely aligned as FUA's can operate in numerous municipalities and the Topcorridors crosses through multiple provinces. Thus, cooperation between scales and entities is important as complex challenges as realising a sustainable transport system are effectively addressed on a larger scale. The need for interaction between governmental layers and spatial scales is also stressed by Heeres (2017). There are opportunities to cooperate on an international scale, e.g. via the EGTC. However, cooperation between scales and entities can be challenging as nodes then to focus on the scale of the node itself. This possibly relates to a difference in priorities between the nodes and the programme. Currently other issues such as housing projects or water safety require more urgent attention within the municipalities of the nodes.

Although the need for vertical and horizontal MLG is clear, this is not always visible in practice. Nodes tend to focus on what is important for them and the scale of the node, whereas he Topcorridors programme focusses mainly on the corridor scale and freight transport whilst recognising the need for spatial integration. As each entity focusses mainly on their own scale, a corridor approach is needed where vertical and horizontal governance are considered in addition to functional interrelations. This is an opportunity for the programme to facilitate interaction between nodes to explore possibilities for cooperation in a complementary manner, to borrow each other's size, to strengthen the Topcorridors as a whole.

7.3. Programmatic approach

When the Topcorridors programme launched in 2017, Venlo and Nijmegen actively participated in the programme. Node Venlo still actively participates and feels closely related to the programme. For Venlo the programme stimulates initiatives and projects. In contrast to node Nijmegen which is little involved due to political choices, sense of urgency and priority. Consequently, Nijmegen feels less connected to the programme. This shows the impact political influence can have on the performance and involvement of the nodes as Venlo actively profiles themselves as a logistics-oriented municipality and performs well. Whereas Nijmegen does not seem to accept that they are a logistic hub. The political influence is not really noticeable on the scale of the Topcorridors. Case Nijmegen shows that policy or administrative ambition and support is needed, as this is likely to enable sufficient capacity. This also shows the importance of ensuring that the added value of the programme is known.

Considering managing complexity, the programme consists out of different projects. A large share of these projects operate rather individual, together shaping the programme in a bottom-up manner. For node Nijmegen this means that they can still partake in certain projects, as CEH. However, there is limited coherency and less focus within the programme. This is also affected by the adaptive capacity of the programme. The adaptive capacity is highly valued by the programme and the nodes at it offers the possibility to adjust to new developments however, there is also critique that as the programme continues to grow, the focus of the programme becomes less clear. The focus within the programme is further affected by the little influence the programme has on projects at the nodes, although these projects can influence the performance of the Topcorridors as a whole.

On the scale of the Topcorridors there are collaborations with private parties, knowledge institutes and governmental organisations. From the perspective of the nodes there is room for more involvement of the private sector. However, as the private sector generally maintains a more short-term view compared to the long-term focus of the programme it could be most effective to involve private parties in projects at the nodes. Especially as the nodes have their own connections with relevant parties. Furthermore, participation in the programme facilitates interaction between nodes. This is highly valued by respondents from both Venlo and Nijmegen.

As improving sustainability of the Topcorridors is a key pillar of the programme, it is surprising that no concrete measurable goals concerning sustainable corridor development are set by the programme or researched nodes. Consequently, monitoring, evaluation of progress and adapting accordingly concerning sustainable corridor development remains difficult. Furthermore, it is challenging to determine the benefits of the programme. However, if concrete goals are set this could result in too much focus being placed upon achieving these goals. This is something that must be balanced within the programme and nodes.

By assessing the corridor freight infrastructure as a programme, freight transport and infrastructure are considered in an integrated manner, taking its multiple modes, sectors, scales and MLG into account. However, attention must be paid to coherency within the programme as several projects operate relatively independent from the programme and nodes are not always dependent on the programme for a project and collaborate outside of the programme.

Considering the six aspects of public programme management as presented by Patanakul & Pinto (2017) a few things stand out. Firstly, projects within the programme operate rather individual and with limited coherency opposed to alignment of interrelated projects being a main benefit of a programmatic approach as discussed by van Buuren et al. (2010) and Busscher et al. (2013). As projects often are independent of the programme for funding, coherency is something attention should be paid to in the future. This aligns with Faith-Ell et al. (2010), stating that coordinated corridor

development is easier said than done. Secondly, the findings indicate that monitoring and evaluating concerning sustainable corridor development is difficult due to a lack of measurable goals. Consequently, it is difficult to know when and how to adjust. This requires a feedback loop, as described by Busscher (2014). Throughout the programme, qualitative evaluations have occurred to evaluate whether the right actions were implemented and whether this occurred in a fitting manner. However, it is then up to the programme to adjust accordingly, which does not always happen. Thirdly, the findings show that the political environment of the programme influences the Topcorridors programme. The consequences of political change are most tangible and profound on the level of the nodes with the municipalities and provinces. Lastly, the adaptive capacity of the programme is viewed as positive as it offers flexibility. Furthermore, the adaptive capacity has been beneficial during the first years of the programme. However, now partners are mostly committed and the programme finds itself in a new phase with a new programme manager. This shift can be used as momentum to shift from talking and discussions about sustainability towards translating this into choices and actions. Different developments and ambitions, as zero-emission transport, require regulations and choices which should not be postponed to long. This strengthens the need for a guiding corridor approach.

7.4. Sustainable development

Both nodes actively pay attention to sustainability in different ways. Nijmegen focusses on sustainability in broad manner, stimulated by local policies. Although Nijmegen aspires a reduction in emissions, including a reduction from freight transport, there are no specific sustainability ambitions concerning their position along the Topcorridors network. However, they pay attention to local liveability by offering shore power. Contrary to Nijmegen, Venlo specifically desires to be an efficient, reliable, safe and sustainable node which contributes to local sustainable economic growth. Still, both nodes contribute to sustainable corridor development via modal shift and participation in the CEH. Through CEH, the programme desires to lower the threshold for zero-emission transport. In addition, both nodes acknowledged that projects as CEH are what adds value to participating in the programme.

Differences between nodes considering attention for sustainable corridor development align with the experiences of the Topcorridors programme which sees that how sustainability is perceived differs between individuals and organisations. However, sustainable corridor development generates more attention at the nodes than on the Topcorridors scale. Here, although sustainability is propagated, the translation of transforming ambitions into projects or actions has been poor and sustainable development has not been a main priority within the programme. When attention is paid towards the issue, the focus is mainly upon CO2 emissions, while the nodes approach sustainability in a broader sense and pay more attention to liveability. This could be because liveability is more a local challenge instead of a 'line-problem'. Furthermore, little attention is paid towards the energy transition or other emissions, this is possibly because it falls outside the scope of the Topcorridors programme.

7.4.1. Barriers

As indicated by the nodes and observed by the Topcorridors programme, the lack of available capacity and funds is a barrier for sustainable corridor development. It is often related to too little sense of ownership, influenced by local politics. Furthermore, both nodes struggle with the available rail network. Nijmegen currently has no rail terminal and Venlo struggles to connect rail infrastructure to business parks. Both aspects have a negative impact on the possible modal shift, as shifting to rail becomes less attractive. The findings indicate that is that shifting towards transport via water or rail also leads to a decrease in flexibility for regional entrepreneurs. Therefore, for modal shift to be attractive for entrepreneurs it must be an attractive option considering the costs. For entrepreneurs, sustainability is not their only goal as they also strive towards efficiency, revenues and costs control This further complicates modal shift.

An additional barrier indicated by Venlo and Topcorridors is that nodes are dependent on the private sector for several developments as sustainable corridor development depends on many developments e.g., the energy transition, which fall outside the programme's scope. Moreover, local issues often have priority within nodes over corridor challenges, as the development of a sustainable transport system.

A final barrier is that sustainable corridor development is simply not frequently discussed within the programme as other issues have priority. This is also the case in Nijmegen, where local issues are prioritised over network issues. This could be because as projects are often financed with public money, the financing municipality or province desires to see benefits within their own municipality or province. Primary attention thus is paid to local challenges over network challenges at the nodes.

7.4.2. Factors of success

The findings indicate that main factors of success are the facilitated interaction and collaborations between nodes. Venlo indicated that they would benefit from more structural collaborations between nodes as this enables the opportunity to share experiences and knowledge. Furthermore, Nijmegen indicated due to their limited capacity they from support from the programme regarding questions or issues which multiple modes struggle with. Then not all nodes would have to find a solution, and for the programme this offers the opportunity to realise more coherency.

Furthermore, the amount of political attention for (sustainable) corridor development and freight logistics is a success factor. The attention contributes to cooperation between departments and satellite nodes. Aligning with the need for sufficient capacity, a factor of success for the programme is an active and involved project manager. Such a project manager can connect involved parties with the nodes but can also cooperate within the vertical governance structure of the Topcorridors programme.

7.4.3. Conditions

The findings indicate that for a successful shift towards zero-emission transport, sufficient CEH and charging networks need to be available at the nodes and along the TEN-T. As freight transport flows through the Netherlands towards bordering countries, zero-emission transport modes need to have access to alternative fuels. This requires cooperation between nodes, on a national level but also on the international corridor network e.g., via the EGTC in which Venlo participates.

Currently, the Topcorridors programme is not performing as desired concerning sustainability. There is a need a coherent corridor-oriented approach providing guidance for sustainable corridor development. This could result in more coherency between all projects the programme consists off. Guidance is also a condition for the shift towards alternative fuels. This requires new regulations and emission norms to stimulate the transition, the programme is dependent on the national government for new regulations and norms but can take on an intermediate role.

It is stressed in the findings that concrete measurable goals are necessary as this offers the possibility to monitor progress and creates a sense of urgency. This can influence the assigned capacity for civil servants to spend on sustainable corridor network. However, one should not solely focus on achieving set goals. It is indicated that key requirements as capacity must be met by the responsible organisation.

Concerning sustainable corridor development is clear that the interpretation, urgency and priority differs between nodes and between nodes and the Topcorridors. Where nodes pay attention to achieving sustainability in an area-oriented manner, the topic is not frequently discussed within the programme despite it being a key pillar. The urgency and priority the topic is given at the nodes is influenced by local politics and influences capacity and funding, which are requirements for a well performing node. This could contribute to the performance of the overall Topcorridors network due to the interdependency for success between the corridor and nodes.

Contributing to the success of the corridor is the interaction between nodes to share experiences and knowledge. This could be further enhanced by generating knowledge within the programme from which all nodes benefit. Considering the lack of capacity at the nodes and shared challenges, this knowledge can be distributed among the nodes. Through the sharing of knowledge and connecting nodes, this could improve alignment between the nodes. Finally, the Topcorridors programme has to provide guidance for shared challenges which contribute to sustainable corridor development as CEH.

7.5. Overall reflection

The difference in involvement between nodes Venlo and Nijmegen indicates the impact of political influence at the nodes. The Topcorridors programme needs to pay attention to this aspect of programme management. Especially as the political impact is smaller for the programme as compared to the nodes. Overall, the aspects of managing complexity, benefits, adaptivity and monitoring and evaluation might need more attention than the aspect of managing stakeholders as this mainly occurs within projects at the nodes.

Considering management of complexity, the projects within the programme are operated at the nodes and not always clearly linked with the overarching programme and its goals. Although the plans of the nodes are aligned with the Topcorridors programme on paper, this is not always visible when implemented. As the nodes operate rather independent from the programme, the programme must pay attention to coherency and alignment. Although the projects should be aligned in a loosely coupled manner, as argued by Faith-Ell et al. (2020), this must not be too loose. When the programme is too loosely coupled the risk exists that projects become independent in relation to the programme. As there currently is limited coherence and commonality between investments in individual projects this risk should be considered. Here lies an opportunity to coordinate and cooperate to realise a more complementary relation between the nodes. Then the nodes can benefit from each other's functions, borrowing each other's size to strengthen the regional function of the Topcorridors programme within TEN-T. This requires coordination on the scale of the programme from the programme manager, who can interact and coordinate together with coordinators on the scale of involved nodes.

Concerning the ambitions of the programme to improve sustainability, recent evaluations (Topcorridors, 2022b) indicate that the programme is not performing as desired. However, this has not lead to more frequent discussions about the issue. Furthermore, as there are no concrete measurable goals for sustainable corridor development there is no complete monitoring and evaluation system in place. This also holds for the researched nodes. Consequently, a feedback loop, as discussed by Busscher (2014), is not operationalised making it difficult to monitor progress and adjust the programme when necessary.

Although sustainable corridor development receives more attention at the nodes and nodes are aware of their position in the network, local matters can have priority as they are generally considered more urgent. Therefore, limited capacity and funding are available, which are also prone to political influences. Despite the limited capacity both nodes stimulate modal shift and participate in the CEH project to limit emissions and improve liveability. At a CEH multiple types of energy, at least one renewable, are offered as it is currently unclear whether i.e., hydrogen or electricity will be the main energy source for zero-emission freight transport. Therefore, this decision is postponed to be able to adjust to developments and innovations. Although this leaves room for innovation, it could result in a slower transition towards zero-emission transport as operators postpone their transition as access to renewable energy resources for their vehicles remains uncertain. Nodes therefore signalled that that there is a role for the Topcorridors programme to provide guidance and for the national government to set regulations to create urgency and momentum to further enhance this development towards zero emission freight transport.

8. Conclusion

In this Chapter answers for the main research question and sub questions are formulated. First the sub questions will be discussed. Together, these answers contribute to the final conclusions concerning this research. These conclusions subsequently are followed by recommendations for further research regarding the topic of sustainable corridor development. This Chapter, and therewith this thesis, will be finalised by a reflection upon the executed research.

8.1. Research questions

Sub question 1: How can development of corridors and nodes be conceptualised?

Corridors are bundles on infrastructure connecting nodes, functioning as a network for the transport of people and freight. The findings indicate that, at the nodes, modal shift can occur as long distance and local infrastructure modes are linked. The multi-modal characteristic of nodes is essential as it allows different nodes to function as a region by relying on each other's size. The success of a corridor and its nodes is related to its ability to connect different scales of infrastructure to create interlinkages between modalities. This can enable modal shift towards sustainable transport modes. Concerning the involved spatial scales, the interdependent relationship between nodes and the corridor is strengthened as interventions at one scale impact other scales as well. Furthermore, interaction takes place between nodes. The findings indicate that this could be of added value for the nodes and the corridor as it offers opportunities for coordination between the nodes and the corridor. As indicated by interviewees, the success of a corridor and the nodes is interdependent. Therefore, attention must be paid towards aligning the different objectives, scales, sectors and stakeholders involved.

Sub question 2: What role do functional interrelationships play in corridor development?

The findings indicate that corridor development is embedded in an existing environment, and that corridor development affects and is affected by other sectors and spatial scales. As transport modes are linked, modal shift can be facilitated and spatial-development can take place. These influences are conceptualised as functional interrelatedness. Currently, the nodes are relatively similar concerning economic development, sometimes creating a competitive dynamic. However, when coordinated, this relationship can become complementary. They then can befit from each other's developments and borrow size to further strengthen the Topcorridors network as a region. The findings show that to address the functional interrelations an integrated approach is required to include the different sectors, spatial scales and governments. This requires cooperation between governmental organisations and between departments. Currently, a more integrated approach is visible at the nodes, whereas the approach from the Topcorridors programme is mainly focussed on freight transport.

Sub question 3: How can be dealt with the institutional interdependencies in corridor development?

As discussed, corridor development touches upon numerous sectors and spatial scales requiring both horizontal and vertical governance. The relationships between these sectors and scales are conceptualised as institutional interdependencies Furthermore, complex challenges as the realisation of a sustainable transport system are most effectively addressed on a larger national or international scale, such as the TEN-T. Especially as corridors travel through multiple countries developments in different countries can influence what happens on the along corridor. This can for example be done by participating in the EGTC. This organisation focusses on tackling complex issues on an international corridor scale. On the scale of a node, it is important to recognise that local 'point' issues can have priority over the 'network' issues. Therefore, through interaction attention must be paid to the cooperation between governmental departments and between governmental organisations.

Sub question 4: How can a programmatic approach be applied to achieve sustainability?

The findings show that through a programmatic approach for sustainable corridor development, the multiple modes, scales, sectors and involved governmental organisations can be considered in an integrated manner. The programme can than coordinate and align projects to contribute to sustainable corridor development. In practice the different projects operated rather individual and were not as connected to the programme as desired. This requires attention throughout the course of the programme. Furthermore, the programme should set concrete measurable goals concerning sustainability to be able to monitor progress and evaluate projects and the programme. The introduction of a new programme manager could be used as momentum to implement such goals. The adaptive capacity of the programme can be used to adjust to developments focussed on sustainable corridor development. Finally, attention must be paid to the political environment at the nodes.

Sub question 5: What are barriers, factors of success and conditions for sustainable development for both the corridor and its nodes?

The main barriers for sustainable corridor development in the Topcorridor programme are a lack of available capacity and funds. This often goes hand in hand with too little sense of ownership at the nodes and with insufficient political attention for the topic. Furthermore, the nodes and the corridor are partially dependent on private parties and other developments, as the energy transition. Which falls outside the scope of the programme but influences the programme. Lastly, although the nodes and corridor are interdependent for successful corridor development, nodes tend to focus on local issues and have a smaller sense of urgency for projects on the scale of the programme. Consequently, priorities of nodes and the programme are not always aligned.

Although a lack of political urgency can be barrier for sustainable corridor development, sufficient political awareness can be a factor of success, as suggested by node Venlo. This results in capacity and motivation to participate in the programme and its projects. Furthermore, findings suggest that the facilitation of interaction between nodes is a factor of success as this ensures familiarity between nodes so they can share experiences, knowledge and can cooperate to realise projects.

The findings show that guidance from the Topcorridors programme, and coordination between nodes, are required to achieve a coherent and aligned corridor approach for sustainable development. Furthermore, for successful modal shift towards zero-emission freight transport necessary facilities, for example CEH, must be available along the Dutch Topcorridors network and on a larger European scale as freight transport is international. The findings indicate that the realisation of CEH requires guidance from the programme concerning alternative fuels. Although the available capacity and funds are a barrier, they are also a condition for sustainable corridor development to succeed. A final condition is that concrete measurable goals concerning sustainable corridor development are set to stimulate a sense of urgency and can result in concrete actions.

8.2. Overall discussion and recommendations

The main research question of this study was: *Which institutional arrangements can support sustainable development of the Topcorridors and its nodes?* Overall the findings suggest that sustainable development of the Topcorridors and nodes can be supported by a programme in various ways. However, the functional interrelations and institutional interdependencies of corridor development need to be considered in the adopted programmatic approach. This is argued in the conducted literature research based on research by e.g., Heeres (2017), CEDR (2021), Trip & Zonneveld (2003), Öberg et al. (2016) and also supported by interviewees. The research shows that the functional interrelations impact the institutional interdependencies as the development of a sustainable freight transport system touches upon other land uses and spatial scales, therefore involving different

governmental departments and organisations. As the findings indicate, multiple of these governmental departments and organisations, mainly at the nodes, struggle to allocate sufficient capacity to this issue. The Topcorridors programme could provide nodes with support regarding the development of a sustainable freight transport system. Furthermore, to improve sustainability of the Topcorridors, attention must be paid to the applied programmatic approach.

Comparing these conclusions to the discussed planning theory (see Chapter 2) it stands out that whilst there are six points of attention described concerning public programme management (as described by Patanakul & Pinto, 2017), the findings suggest that not all these aspects are equally relevant concerning sustainable corridor development. Stakeholder management was not considered as important as local citizens are not actively involved in corridor development. Interest groups and private parties are mostly involved within projects while the programme has a more long-term horizon whereas private parties focus more on the upcoming years. Furthermore, as the programme lacks clear formulated measurable goals it is difficult to ensure monitoring, evaluation and adjustments. The aspects of monitoring, evaluating and adjusting within programme management are more related than initially presented. Taking the results, discussions and conclusions based on this research into account, the following institutional arrangements are proposed to support sustainable development of the Topcorridors and its nodes:

Provide knowledge for nodes. The findings show that governmental institutions of the nodes struggle with available capacity and are generally not able to spend sufficient time on the sustainable corridor development. Civil servants have different responsibilities and can lack the time to spend on e.g., necessary research. However, as the different nodes are likely to struggle with similar challenges it could be beneficial for nodes to have the option to the Topcorridors programme for such support. The programme could then share the gained knowledge with all nodes involved. Furthermore, this could strengthen the relationship between the Topcorridors programme and the nodes as it contributes to the added value of being part of the programme.

Formulate measurable goals. Currently, goals concerning sustainability are formulated, and evaluated, in a qualitative manner. By adopting quantitative goals, setting deadlines and adopting a monitoring framework, progress can be monitored and evaluated. Adjustments can then be made when and where necessary. This also contributes to another issue that arises in the findings, namely that sustainability is not a frequently discussed topic. Through monitoring, progress can be discussed more frequently, contributing to the awareness of the challenge and made progress.

Provide guidance. As indicated by the findings, the adaptive character of the programme results in some insecurities. This especially shows in the adoption of CEH where, although renewable energy sources are promised such as hydrogen or electricity points, transport companies are still unsure about which alternative will be most accessible. As a result, the adoption of zero-emission transport modes is sometimes postponed. By providing guidance as a programme towards which energy sources will be offered and how the network could look like some insecurities could be taken away. Furthermore, as the programme has little legal mandate it cannot prescribe regulations concerning emissions from transport along the corridor. However, the nodes are part of municipalities which can construct e.g., zero emission zones. Although the transport sector still has some years to become zero-emission, this process can be accelerated when the municipalities of the nodes announce such zero-emission zones to be established in five years. Forcing the transport sector to make an earlier transition. This however does require sufficient access to alternative fuels and charging infrastructure.

European network perspective. The Dutch Topcorridors are embedded in the TEN-T. Transport that occurs along the Topcorridors also flows towards bordering countries. Therefore, when

stimulating the transport within the Netherlands to operate in a sustainable manner, it is important that along the international route there is sufficient access to alternative fuels and charging infrastructure. Currently, this differs between countries making it less attractive to adopt sustainable transport modes. This requires coordination within Europe, as is partially via the EGTC, in which the Topcorridors programme as a whole could participate and contribute. Here lies a role for the coordinators of the TEN-T on a European scale.

8.3. Recommendations for further research

This study has focussed on the Dutch part of the Rhine-Alpine corridor and selected nodes. By including both the physical and institutional components of corridor development a broad approach was adopted. Furthermore, the inclusion of both the scale of the corridor and the nodes has resulted in a better insight in the multi-scalar character of corridor development. However, as shown in this research, the scales do not entirely align with the institutional levels adopted by the Dutch government. In addition, infrastructure for the transport of goods and people transcends the adopted institutional scales. This remains challenging in infrastructure planning and it could be further explored how this challenge could be assessed. Furthermore, as this study indicates, sustainable corridor development is a complex issue affecting different spatial scales and institutional levels. Many aspects of sustainable corridor development can be assessed on a European or national level as regulations for i.e., emissions or alternative fuels are not regulated by the corridors itself. How such aspects can be assessed in a coherent manner can be further explored.

In this research attention was paid a specific corridor and two main nodes. This research could be extended by including more nodes. Furthermore, different corridors of the TEN-T can be researched to compare different adopted approaches. Additionally, this research could be extended by adopting quantitative research methods, also contribute to the objectivity of the research.

Finally, during this research it stood out that limited attention was paid to the involvement of local citizens when it came to corridor development or projects at the nodes. As citizen involvement is an important aspect of planning practice and corridor development impacts the living environment and local liveability this is an interesting topic for further research.

8.4. Reflection

As this study was done during the COVID-19 pandemic, interviews were conducted in an online environment, limiting the possibility to observe non-verbal communication. Furthermore, during the collection of data it showed to be difficult find interviewees who focussed on improving sustainability of freight transport at the nodes as only a few people felt responsible. For one of the nodes the capacity of civil servants responsible for sustainability was too limited to partake in this research. Therefore, collected information regarding sustainability was mainly provided by other interviewees and analysed documents. In order to let the interviewees discuss the proposed institutional arrangements a focus group was considered. However, due to time constraints this eventually could not take place. Lastly, this research was combined with an internship with the researched Topcorridors programme. Despite this affiliation with Topcorridors programme, the programme did not have influence on the content or outcomes of this research. However, the affiliation provided access to internal documents and a direct connection with the interviewees.

Looking back, the development of this thesis was an educational and enjoyable process. It was challenging at times, especially at the beginning when I was struggling to create a suitable framework. The constructive input from my supervisors and enthusiastic discussions with the interviewees motivated me throughout the entire process. Overall I am happy with the final results and I look back on an interesting process which further sparked my interest in infrastructure planning.

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Appendices

Appendix 1 – Interview guide

Introductie:

- Korte introductie (interviewer en geïnterviewde)
- Introductie scriptieonderwerp en opzet interview
- Vooraf:
    - Duur van het interview en toestemming vragen om audio op te nemen
    - Mogelijkheid tot *feitelijke* controle transcript
    - De resultaten worden anoniem verwerkt in het onderzoek

Algemeen:

1. Wat is uw functie/taken/rol binnen knooppunt en daarmee ook binnen het programma?
    a. Vanuit welke partij betrokken?
    b. Wat voor verantwoordelijkheden binnen knooppunt/programma?

Duurzaamheid

1. Hoe wordt tegen duurzaamheid aangekeken binnen de corridor?
2. Hoe wordt tegen duurzaamheid aangekeken binnen het knooppunt?
    a. Hoe zie je dit terug?
    b. Logistiek, milieu?
3. Hoe is de wisselwerking tussen de corridor en het knooppunt georganiseerd? Hoe wordt dit afgestemd en/of vindt er interactie plaats?
4. Wat zijn de ambities qua duurzaamheid?
    a. Alleen CO2 reductie of breder? Per wanneer?
5. Hoe wordt duurzaamheid nu vormgegeven binnen betreffende knooppunt/programma?
    a. Ook logistiek, duurzame energie, vergroening?
6. Zijn er concrete duurzaamheidsdoelen geformuleerd? Wat zijn deze?
    a. Hoe werken deze doelen voor de corridor en de knooppunten?
    b. Zijn de duurzaamheidsdoelen meetbaar? Hoe wordt hierop gestuurd?
7. Zijn de duurzaamheidsambities gesteld vanuit het corridor-programma, een andere partij of vanuit het knooppunt zelf?
    a. Gaan de eigen ambities verder?
    b. Wat is de inbreng van de knooppunten hierin? Gaan de ambities van de knooppunten verder dan dat van het corridor-programma?
8. Wanneer zijn jullie tevreden wat betreft de verduurzaming van het knooppunt?
9. Wordt er gestuurd op multimodaliteit? Speelt dit een rol?
    a. Hoe zie je dit terug? (Faciliteiten, terminals etc)
    b. Wordt er ook gestuurd op modal shift?
    c. Vind hier ook uitwisseling plaats van logistiek op lange afstand en last-mile? Hoe en waar gebeurd dit: bij de knoop of vlakbij?
    d. Hoe speelt duurzaamheid hier een rol bij?
10. Wordt er gestuurd op een energie transitie?
    a. Gebruik, productie, opslag en welke vormen
11. Wordt er ook gelet op het beperken van milieu-emissies?
12. Hoe wordt er rekening gehouden met (lange-termijn) veranderingen?
    a. Bijvoorbeeld nieuwe ontwikkelingen op het gebied van duurzaamheid? Hoe hiervoor flexibiliteit?
13. Heeft de ambitie om te verduurzamen impact op ruimtelijk-economische ontwikkelingen qua looptijd, budget of scope?
    a. Hoe wordt het uitgewerkt op knooppuntniveau/corridor niveau?
    b. Hoe verloopt dit? Positief met nieuwe markten of kunnen andere dingen niet meer?
14. Hoe draagt het corridorprogramma hier aan bij? Of op knooppunt niveau?
    a. Zou je dit graag anders zien?

Programmatische aanpak

1. Hoe verloopt het contact met het overkoepelende programma?
2. Heeft het programma invloed op het knooppunt in relatie met duurzaamheid?
    a. Hoe wordt dit gemerkt en ervaren?
3. Werkt het om het programma op te splitsen in verschillende projecten?
4. Heeft het programma invloed op projecten? In relatie tot duurzaamheid
    a. Wat vindt u hier van? (tevreden/ontevreden) en waarom: wat is er goed aan, wat minder?
5. Hoe wordt het aangestuurd vanuit knooppunt: knooppuntplan?
    a. Hoe merk je dit?
6. Hoe wordt het aangestuurd vanuit de het corridorprogramma?
7. Merkt u verschil in prioriteiten tussen het corridorprogramma en het knooppunt?
8. Wat zijn dingen die goed gaan?
9. Waar is ruimte voor verbetering?
10. Zijn er aspecten die een verdere ontwikkeling kunnen bedreigen?
11. Hoeveel wordt er gemerkt van een politieke verandering binnen het programma?
    a. Bijvoorbeeld na aanstelling van nieuw kabinet of op knooppuntniveau van gemeenteraadsverkiezingen?
12. Ervaart u nog andere aandachtspunten?
13. Welke partijen zijn belangrijk richting duurzaamheid in relatie tot het knooppunt?
    a. Hoe worden deze partijen betrokken?
14. Wordt er ook samengewerkt met andere knooppunten? (niet alleen hoofdknooppunten, ook andere omliggende knopen)
    a. Draagt het corridorprogramma hier ook aan bij?

Barrières wat betreft verduurzaming

1. Zijn er barrières waardoor verduurzaming moeizaam verloopt?
    a. Hoe zou je dit graag anders zien?
    b. Kan het programma hier aan bijdragen? Zo ja, hoe?
2. Hoe wordt de verhouding ervaren tussen de verschillende schalen: schaal van de corridor en schaal van het knooppunt?
    a. Is het knooppunt echt onderdeel van het geheel?
3. Zijn er barrières qua realisatie van multimodaliteit?
    a. Mist er ook een modaliteit?
4. Mist er een andere ontwikkeling dan transport om het knooppunt qua duurzaamheid verder te brengen?

Afsluitend

1. Wat zijn nog goede ervaringen die u mee zou willen geven aan andere logistieke knooppunten die willen verduurzamen?
2. Wat zou je doen als je nog een keer mocht beginnen: wat zou je dan anders doen.
3. Wat heb ik niet gevraagd waarvan u nog verwacht had dat ik het had gevraagd?
4. Heeft u zelf nog opmerkingen of toevoegingen aan het gesprek?
5. Andere mensen en documenten
6. Hoe verder geïnformeerd?
7. Wilt u het onderzoek ontvangen zodra deze afgerond is?

Appendix 2 – Overview of interview participants

Case	Date	Interviewee	Identifier
Topcorridor	3rd of June, 2022	Programme Manager, Ministry of Infrastructure and Water Management	R1
Topcorridor	17th of May, 2022	Advisor Topcorridors Programme, AT Osborne	R2
Topcorridor	23rd of May, 2022	Senior advisor, Panteia	R3
Topcorridor	20th of May, 2022	Former programme Manager, Ministry of Infrastructure and Water Management	R4
Topcorridor/Venlo	16th of May, 2022	Senior policy officer at the Department of Mobility, Province of Limburg	R5
Venlo	1st of June, 2022	Policy officer mobility and logistics, Municipality of Venlo	R6
Venlo	13th of June, 2022	Strategic policy officer labour and accessibility, Municipality of Venlo	R7
Nijmegen	1st of June, 2022	Former policy advisor (self-employment), Municipality of Nijmegen	R8
Nijmegen	3rd of June, 2022	Project programme manager freight corridors and mobility, Province of Gelderland	R9
Nijmegen	16th of June, 2022	Policy officer, Municipality of Nijmegen	R10
Nijmegen	7th of June, 2022	Policy officer, Province of Gelderland	R11

Appendix 3 – Analysed documents

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Appendix 4 – Codebook

Code Group	Code	Reference
Multi-scalar dimension	Interaction between scales	Heeres et al., 2016
	Interaction between nodes	Faith-Ell et al., 2020
	Corridor scale	Chapman et al., 2003; De Vries & Priemus, 2003
	Node scale	Heeres, 2019
Functional interrelatedness	Road	
	Rail	
	Water	
	Pipelines	
	Modal shift	Heeres, 2019
	Multiple sectors	Priemus & Zonneveld, 2003; Chapman et al., 2003; Witte, 2014; Öberg et al., 2016
	Mixed use	
	Friction	
	Integration	
Institutional interdependencies	Vertical governance	De Vries & Priemus; Romein et al., 2003
	Horizontal governance	Romein et al., 2003
	National government	
	Provincial government	
	Municipal government	
	Governmental actors	Marsden & Rye, 2010
	Non-governmental actors	Marsden & Rye, 2010
	Private sector	
Programmatic approach	Programme management	Pellegrinelli et al., 2007; Patanakul & Pinto, 2017
	Managing complexity	Patanakul & Pinto, 2017
	Political influence	Patanakul & Pinto, 2017
	Stakeholder management	Öberg et al., 2016; Patanakul & Pinto, 2017
	Benefits	Patanakul & Pinto, 2017
	Flexibility	Patanakul & Pinto, 2017
	Monitoring and evaluation	Busscher, 2014; Patanakul & Pinto, 2017.
Sustainable development	Sustainability	
	Alternative fuels	
	CO2 Emissions	
	Other emissions	
	Energy transition	
	Liveability	
	Barriers	
	Conditions	
	Factors of success	