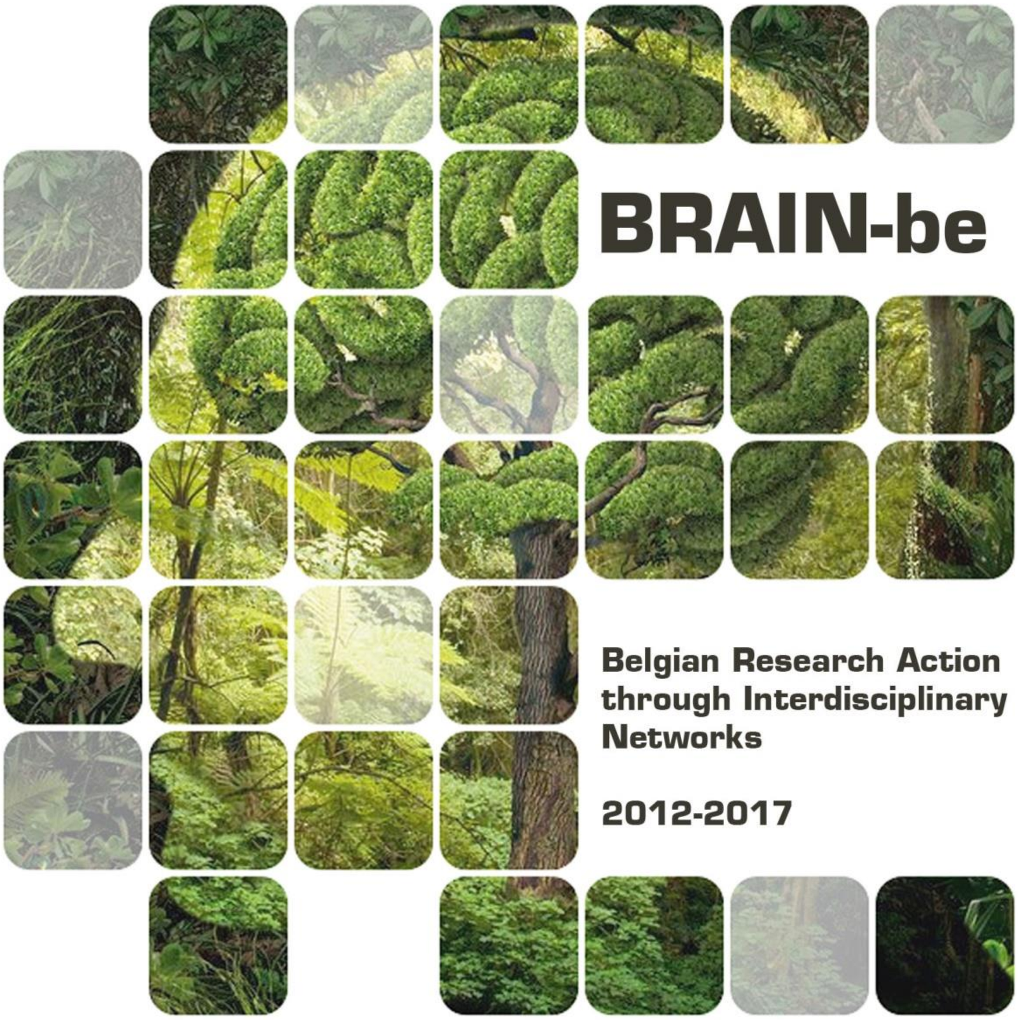

BRAIN-TRAINS

BRAIN-TRansversal Assessment of Intermodal New Strategies

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BRAIN-TRAINS

BRAIN-TRansversal Assessment of Intermodal New Strategies

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EXECUTIVE SUMMARY

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ABSTRACT

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Transport is critical for Europe's economic competitiveness and commercial exchange. The Common Transport Policy, set out in the European Commission's White Papers on Transport, with the last version dating back only to 2011, establishes ambitious objectives, seeking to achieve an efficient and sustainable balance between the various transport modes, to the benefit of commercial transport users and society at large.

In contrast to this policy objective, the dominant freight transport mode by far is road transport, with a market share of 76.4% in Europe in 2010) (as compared to 73.7% in 2000), and 69.5% in Belgium (as compared to 77.4% in 2000). Even though there is an improvement to be observed in Belgium, there is still ample spare capacity for the so-called alternative transport modes, being rail, inland navigation and pipelines as far as freight is concerned.

Effectively integrating the alternative modes of transport into today's highly international logistics supply chains will be key to reaching a better balance between the modes. Such intermodality requires that the different modes (rail, inland navigation, pipelines, road and maritime transport) be easily inter-operable, physically in the first place. At the same time, sufficient competition needs to be safeguarded within these alternatives modes. There is a clear risk in rail freight transport for instance of getting dominated by a limited number of powerful, integrated international groups (Gevaers et al., 2012).

Objectives

BRAIN-TRAINS' main goal is to develop a blue print establishing the detailed criteria and conditions for developing an innovative intermodal network in and through Belgium as part of the Trans-European Transport Network (TEN-T). More concretely, the project will develop an operational framework (incorporating the required criteria and conditions) within which effective intermodal transport can be successfully established and within which all stakeholders can have beneficial participation and commitment. Focus will be on rail intermodality, hence taking rail developments at the focus. The project also tackles the interaction of both interurban and urban contexts. BRAIN-TRAINS also focuses on freight transport, but the interaction with passenger transport is evident, as they mostly use the same network, and many policy instruments (e.g. infrastructure construction, road pricing,…) impact on both transport segments.

Conclusions

25 conclusions and recommendations are derived from the BRAIN-TRAINS research:

1: A minimum load factor has to be ensured, if a rail freight service is to be provided, in order to fully exploit the economies of scale.

2: Rail subsidies are indispensable and a framework is needed to optimize their offering.

3: Tackling the long transit and terminal handling times of intermodal transport by increasing the freight traffic priority and optimizing the terminals' operations (e.g. developing a pool of containers).

4: Focus on environmental objectives to increase the market share of intermodal rail transport

5: Increase the load factor of trucks for drayage operations to improve the efficiency and market share of intermodal rail transport and to reduce the high drayage costs.

6: In the context of flow consolidation, favor the collaboration, cooperation and sharing of transport resources through innovative commercial strategies and technical tools to increase the intermodal market share.

7: Adapt the policy decisions in future road taxes on motorways so as to reflect the real level of externalities of each mode to favor intermodal rail transport.

8: Increase the energy efficiency of freight transport.

9: Increase load factors in freight transport.

10: Improve the emission technology of the vehicles used in freight transport.

11: Use alternative fuels like biodiesel.

12: Use low-sulphur fuels.

13: Increase the share of electric trains in the Belgian traction mix.

14: Enhance the electricity supply mix used by electric trains.

15: Consider the regulatory body as a key lever to manage the IM and the market.

16: Make the network better performing from an economic and technical point of view by a better monitoring from the Federal State (increase capacity, reduce access charges).

17: Make a European Agency for Economic Regulation.

18: Set-up a competition authority.

19: Continue to invest, but in the right things.

20: Collaborative business development should be the next trend.

21: Data collection and analysis as fuel for improved rail freight operations and innovations.

22: Integrate federal and regional intermodal freight transport policies into an interfederal long term vision and plan.

23: Make the co-creation of (interfederal) intermodal freight transport policies more effective and innovation-oriented by applying the steps for policy integration.

24: Make the jointly agreed policies for intermodal freight transport into reality by fostering administrative coordination and implementation within and between governments.

25: Consider institutional changes to increase the performance of the system

Keywords
Rail freight intermodality, operations and networks, economic impact, environmental impact, regulation and competition, policy-making and administration

1. INTRODUCTION

BRAIN-TRAINS deals with rail freight intermodality, and the extent to which it can be made successful, under market, society and policy-making challenges, and analyzing how intermodality contributes to answering these challenges. Starting point is the relatively weak usage of this type of transport. The research builds on existing knowledge, integrating, and approaching the problem from an interdisciplinary perspective. It tackles five issues which both scientifically, for the sector and for policy-makers are still unresolved. Scientifically, because till present, most research deals with the individual modes of transport, but hardly ever is the chain perspective taken and translated into measurement, calculation and indicator analysis. For the sector, as the individual modes are still very much fragmented and working in isolated ways, also geographically: country borders are real obstacles to the well-functioning of international transport, especially by rail. Finally, also for policy-makers, as competences and responsibilities are spread over a multitude of ministries, departments and agencies, not only at the same level, but also at different levels (EU, national, regional, municipal). The latter is of key importance to the Belgian Federal government and hence also to BELSPO in providing supportive research: that government is in charge of rail transport, and also of its still national rail freight operator, but at the same depends on the policies from governments at international (EU) and regional level. Integrating and co-ordinating that is they key challenge to be dealt with. It is also the only way to reach the objectives which the Federal government has put itself, as the ones imposed by for instance the EU but also the ambitions of for instance the Belgian regions.

The research starts by analyzing the current status of intermodality, including success factors and barriers. Main inputs to that are scientific and sector literature, and time series on the use of intermodal transport. Equally, the research assesses the major future related initiatives and challenges. This is executed for each issue's strengths and competences, so that a more complete picture of future development is achieved. Both the success factors/barriers and initiatives/challenges inputs are used to build scenarios of future market, policy and intra-sector rail freight transport development. This gives an overview of the most likely scenarios of future development, which are used for the further analysis. Subsequently, five work packages model and quantify outcomes and impacts for each of the scenarios.

A first quantification track involves simulating the optimal setup of national and international intermodal rail freight corridors, taking into account government roles and incentives. Use is made in that analysis of cost functions that deal simultaneously with the modes of transport as such, but also with transfer points. As part of the analysis, cost differences between the different intermodal solutions and also a comparison with road-only solutions are calculated.

Second, the economic track estimates the direct and indirect impact on the national economy that establishing optimized rail freight transport can have, through job creation and value added. Depending on the setup, the direct and indirect impact on the economy may be larger or smaller. A micro-level analysis is applied to the rail freight operators in Belgium for the direct impact. A more advanced type of input-output analysis is applied to approximate the indirect impact on sector level.

Third, it is tested how each of the scenarios contributes to environmental and social sustainability. To do that, a Life Cycle Approach is used. For each of the scenarios, the scope of the life cycle is determined, and the impacts are quantified. Environmental impacts are crucial in the analysis, as transport remains one of the big sources of air pollution, and the improvement targets that among other the European Commission imposes are drastic.

Fourth, the need for and options of regulation are assessed. Regulation can be crucial, especially as the rail market turns more and more into an oligopolistic or even near-monopolistic one, at least for certain product types. Allocating the available capacity in an equitable way is important for the price and service offered to the users. The level of economies of scale, the optimal number of operators, and the required type and level of regulation are analysed for each scenario.

Finally, the fifth track models how public administration and policy making should be organized and coordinated to optimally implement rail freight development and intermodality in each scenario. A transition problem requires good interaction and co-ordination between the relevant ministries and departments at different levels. This track searches for the optimal level of interaction for different contexts and environments.

The five tracks compose a truly interdisciplinary approach, with interlinkages and mutual inputs, and with feedback scenario loops among them. This provides governments realistic approaches to future developments. The output is useful not only in a Belgian context, but has scientific merits which are also applicable in other contexts, both as to the methods and techniques developed, as to the types of scenario applications made. The lessons learned and methods developed can for instance be applied also to measure economic and environmental impact for other economic activity sectors, to optimize regulatory setups, and to create a suitable government interaction and co-ordination framework.

BRAIN-TRAINS also develops indicators. These should support users in an easy way to measure developments for each of the domains involved in the research, and get a view on where action is required. The scientific methods applied result for each of the identified domains in existing, adapted or newly created types of indicators.

The data and sources that BRAIN-TRAINS taps from, are essentially existing sources which are available free of charge. Furthermore, maximum interaction is sought with stakeholders in governments at various levels, but also with transport sector members, shippers, associations, etc. BRAIN-TRAINS used a Delphi-technique approach, with a panel of experts, interviews, workshops, round tables, and involvement in the follow-up committee that guided the project. The follow-up committee judged on key processes and deliverables throughout the project duration.

In this way, BRAIN-TRAINS is able to answer the transition involved in transportation, linked to economic, social and environmental challenges, which among others the Belgian Federal government is explicitly encouterig. Authorities should get insight into what role they should take and how best, so that the challenges can be met, ambition targets achieved, and the full economic and social benefits of transportation can materialize.

2. STATE OF THE ART AND OBJECTIVES

Transport is critical for Europe's economic competitiveness and commercial exchange. The Common Transport Policy, set out in the European Commission's White Papers on Transport, with the last version dating back only to 2011, establishes ambitious objectives, seeking to achieve an efficient and sustainable balance between the various transport modes, to the benefit of commercial transport users and society at large. In contrast to this policy objective, the dominant freight transport mode by far is road transport, with a market share of 76.4% in Europe in 2010 (as compared to 73.7% in 2000), and 69.5% in Belgium (as compared to 77.4% in 2000). Even though there is an improvement to be observed in Belgium, there is still ample spare capacity for the so-called alternative transport modes, being rail, inland navigation and pipelines as far as freight is concerned. The issue is how to increase their market share significantly so that the objectives of the Commission's latest White Paper can be achieved and Belgium can fully insert itself within and comply with this European policy.

Reaching the above can be considered a real societal transition as it requires fundamental innovations both at the production (technological) side and the consumption side. A central question is how to govern cross-cutting policies between different ministries, agencies within and between government levels in order to yield an efficient and effective achievement of the set policy goals. In this project, the transition towards more intermodal freight transport, both in terms of needed operational policy changes, changes in regulation and changes in governance are studied. In addition, it is taking into account social and environmental challenges. Such transitions do not only need new choices and actions in transport policies across the different subsectors, but also need to be backed-up by accompanied policy measures and choices in fiscal policies, environmental policies, economic policies as well as spatial planning policies.

BRAIN-TRAINS' main goal is to develop a blue print establishing the detailed criteria and conditions for developing an innovative intermodal network in and through Belgium as part of the Trans-European Transport Network (TEN-T). More concretely, the project develops an operational framework (incorporating the required criteria and conditions) within which effective intermodal transport can be successfully established and within which all stakeholders can have beneficial participation and commitment. Focus is put on rail freight transport, within an intermodal context, hence taking rail developments at the focus. The proposal also tackles the interaction of both interurban and urban contexts. BRAIN-TRAINS also focuses on freight transport, but the interaction with passenger transport is evident, as they mostly use the same network, and many policy instruments (e.g. infrastructure construction, road pricing,…) impact on both transport segments.

In this section of the report, the choices for each work package (WP) will be explained and how this led to the definition of the scientific objective for each WP separately. The state of the art for each issue at international level is linked to its social and political problems within the scope of federal competences.

In **WP2**, we drew insights about the influence of the costs, the externalities and other relevant operational parameters of transport on the repartition of the flows and modal split over a freight transport network. A strategic and a tactical planning horizon are considered as the outline of this study. The research analyzes a number of parameters that have been identified as significant managerial and policy levers – according to the conducted SWOT analysis – and come up with recommendations that could contribute to enhancing the market position of intermodal transport and achieve more balanced modal splits across the EU.

The first developed multi-modal network models that were able to handle intermodal flows appeared in the early 1990s (Caris et al., 2013). Since then, the terminal design and infrastructure network configuration have particularly received increased attention (Caris et al., 2008). Geographic information system (GIS)-based decision support models have also been developed to test the impact of different policy measures on the stimulation of intermodal transport (e.g., introducing new terminals and subsidies in Macharis and Pekin (2009) and increasing fuel prices and internalising external costs in Macharis et al. (2010).

Among the decisions to make related to intermodal transport, the correct location of intermodal terminals is of is of strategic importance in terms of intermodal competitiveness in relation to road (Mostert and Limbourg, 2016). Indeed, the location of intermodal terminals leads to specific flow distributions between modes of transport. GIS-based models (Macharis and Pekin, 2009, Macharis et al., 2010, Meers and Macharis, 2014) or tools of the operations research domain can be used to identify the effect of different freight transportation policies on the flow distribution between several modes of transport. In optimization, network design models are used at the strategic level to determine the flow distribution between road and intermodal transport, as well as the location of intermodal terminals. Most studies focus on the minimization of operational costs on the network (for instance Arnold et al. 2004, Racunica and Wynter, 2005, Limbourg and Jourquin, 2009, Limbourg and Jourquin, 2010, Ishfaq and Sox, 2011, Sörensen et al., 2012, Sörensen and Vanovermeire, 2013, Ghane-Ezabadi and Vergara, 2016); however, some models also concentrate on CO_2 emissions (Mostert et al., 2017a) or on generalized costs of transport, including transport externalities (Iannone, 2012, Zhang et al., 2013, Santos et al., 2015, Zhang et al., 2015, Mostert et al., 2017b).

More recently, SteadieSeifi et al. (2014) noted that tactical-level issues have been accorded an increasing importance; these problems typically involve an optimal utilization of the given infrastructure by choosing services and associated transport modes, allocating their capacities to orders, and planning their itineraries and frequency. The issue of freight consolidation becomes particularly relevant for tactical service network planning, as demands of multiple customers simultaneously share the same 'vehicle'. Crainic (2000) presents a generic framework for service network design in freight transport. A more recent review of service network design formulations, incorporating different decisions, such as service frequency, mode and routing, is considered by Wieberneit, 2008.

Several assets (alternatively, resources) are involved in operating services, e.g., tractors, locomotives, trailers, loading/unloading units and crews. They are available at costs and with limited quantities, which requires, in most cases, an optimal management. Design balance constraints are typically used to balance the number of asset units entering and leaving each terminal/node. They are applied in most design models addressing air and maritime transport issues (e.g., Barnhart and Schneur, 1996; Lai and Lo, 2004) and, in a more limited presence for land-based transport carriers (e.g., Perennes, 2014; Andersen et al., 2009b). Arc- and cycle-based formulations are usually considered, within a time-dependent service network design problem. Andersen et al., 2009a show, by a computational study, that the formulations based on cycle design variables may be solved faster than the formulations based on arc design variables.

In **WP3**, the aim is to draw insights about the influence of rail freight transport, its development and the usage within an intermodal context, on the evaluation and evolution of job creation, national output creation and value added. Direct and indirect economic effects are considered as the outline of this study.

Freight transport and related sectors achieve competitive advantage through high productivity, flexible and customer-oriented approach. Measures directed to freight transport affect/influence to a greater or lesser extent the rest of the economy. This direct and indirect strategic value does not always come in the direct economic value of the transportation, but is for many businesses and sectors also a reason to be and to remain active in a particular region or country. To determine and quantify this influence it is not enough to know direct and indirect effects of freight transport: also a quantification of the strategic significance of the sector is necessary.

As a state of the art, a useful cost comparison, both to operations and to society, of using intermodal transfer points in port hinterland connections is made by Lannone (2012), be it limited to the region immediately surrounding the port.

To quantify the strategic direct and indirect effects, the methodology that TNO developed for road freight transport at the request of AVV and DGV of Rijkswaterstaat (Kuipers et al., 2005) is often used. Hereby, a theoretical model is designed that reproduces the most important relationships responsible for freight transport growth. The model can relate physical performances in freight traffic, for instance traffic performances and transported tonnage, with the development of value added in the sector in monetary units. The method distinguishes between two parts. Direct strategic value of freight transport: the strategic value that is experienced by the customer (shipper/producer, merchant or retail chain), but not always possible to be expressed in economic value (in EURO's). Indirect strategic value of intermodal freight transport: the radiations effects that a strong intermodal transport sector has on the economy and society as whole.

Economic value is expressed by the physical and monetary effects of policy measures. Direct effects of transport decisions and investments are often calculated by a classical cost-benefit analysis approach. However, Mouter et al. (2012) and Beukers et al. (2012) indicate the weakness of such approach due to the absence or underestimation of the indirect economic effects. In addition to the social costs and benefits, also indirect effects should be taken into account, which exist because the economic sectors are interrelated due to which changes in demand and supply in one sector ignite a ripple effect throughout the rest of the economy (Coppens et al. 2005).

Therefore, input-output analysis is sometimes used to approximate indirect effects at sectoral level within a national economy. Such input-output analysis is performed on port activities by Coppens et al. (2007), who made an application to ports and their hinterland linkage.

In terms of indicators for direct impact, Vennix (2017) uses added value, employment and investments to estimate the economic importance of air transport and airport activities in Belgium over the period 2013 – 2015. For road freight transport, Kuipers et al. (2005) focus solely on the added value of the sector to analyse its economic importance. Looking at maritime and port-related studies, Peeters et al. (2002) and Coppens et al. (2007) are addressing the importance of an economic consideration when making development decisions for port expansion or port improvement. This consideration needs to be supported by the use of economic parameters such as 'added value' and 'employment', in order to analyse the impact on the economy as a whole. SERV (2009) uses the parameters 'added value' and 'employment' to assess the impact of the financial and economic crisis on the Belgian economy. Finally, also Meersman et al. (2012) focus on employment and added value within their Indicator Book to assess the importance of the different freight sectors within the Flemish economy.

The research carried out within the framework of **WP 4** implies several stages.

In a first stage, we analyse the environmental impacts of rail freight transport (distinguishing between electric and diesel traction), inland waterways transport and road freight transport independently. Moreover, a comparison between the environmental impacts of these inland freight transport modes is to performed. It should be noted that as the study of the different scenarios progresses and new data are collected, the method used improves and therefore the results can be updated.First, the results in energy consumption, direct emissions and impact assessment are explained (Merchan et al., 2017a). Afterwards, the results in rail freight transport and road freight transport can be updated (Merchan et al., 2017b). This is because the information collected on railway infrastructure are fully modelled and the values of energy consumption in road transport are revised as a results of enhanced load factors. Finally, the results in impact assessment of road freight transport are updated again (Merchan et al., 2018) as a result of the improvement in the method of calculating road infrastructure demand.

In a second stage we carry out a study of the environmental impacts related to intermodal rail freight transport. For this, we study three consolidated intermodal rail-road routes in Belgium (Merchan et al., 2017b). The objective of this analysis is to compare the environmental impacts of these intermodal routes depending on the freight transport mode chosen (rail or road transport) for the major part of the intermodal route.

In a third stage, we analyse how the increase of rail freight transport as a result of the possible development of the intermodal rail freight transport affects the environmental impacts of the modal split of inland freight transport in Belgium. For this, we study an increase of rail demand by 133%, 64% or 10% for a best, medium and worst case scenarios (Merchan et al., 2018).

WP5 provides a new framework and tools to assess the competition in the Belgian rail freight market. It is based on a disaggregate analysis to improve knowledge about the players and their strategies. To give a comprehensive overview of the market and its dynamics, the market scope is extended from the Belgian market to the Western European market considering that more than 70% of the rail freight traffic are crossing the boundary (Eurostat, 2016).

Until the railway liberalization, the academic literature was usually considering the EU rail freight market as segmented and concentrated with strong national incumbents. The most popular approach is to measure and compare the efficiency of each national operator on its respective network.

A large body of literature has been developed in the United States to measure the efficiency of each operator on its network (Caves et al, 1980 and 1981; Oum and Yu, 1994; Sloboda, 2004) and to assess the effects of diverse external/internal shocks like deregulation (Baumol and Willig, 1983), mergers (Berndt et al., 1993; Schmidt, 2001) or economies of scale (Caves et al., 1987; Wheat and Smith, 2010). Different methods are used to measure efficiency, from a simple approach like Data Envelopment Analysis (Oum et al., 1999) to a more complex analysis, like a translog cost function. In Europe, the literature is more recent, from the 1990s and the beginning of the liberalization by the European commission (91/440/EEC). A lot of research has been produced and based on a similar analytical framework than for the USA, using the assumption that each incumbent operates on its market as a monopolist (De Borger, 1992; Cantos and Maudos, 2001; Friebel et al., 2010). The difference is that the European analysis is most of the time mixed between passenger and freight according to the structure of the incumbents, whereas the US analysis is generally specific to the freight market because of a strong specialization of the operators in this sector.

As opposed to this, few market analyses have been produced in the USA or the EU to assess competition on the rail freight market in open access, and most of them are recent. In the USA, McCullough (2007) uses a concentration indicator (Herfindahl–Hirschman index), but this is done to assess the general efficiency of the market and not to go in depth through a competition analysis. In Europe, studies try to assess the EU competition for rail freight, but all of them are either at a very aggregated level (Beck et al., 2013; Crozet et al., 2014; ECA, 2016) or when there is a disaggregated analysis (firm level), it is limited to a specific national market (Deville and Verduyn, 2012; Laisi et al., 2012; Van de Voorde and Vanelslander, 2014; Woodburn, 2014) or at the single firm level (Gasparic et al., 2009, Vierth, 2011).

There is no comprehensive competition analyses in the academic literature for the European rail freight industry. This is most likely because of the recent evolution of the market but also the difficulties to get data from operators. The WP 5 proposes a first application of such firm-level approach to the European rail freight market. This approach is well-known and has been tested in several sectors like banking (Bikker and Haaf, 2002; Bos and Schmiedel, 2007) or the maritime industry (Sys, 2010).

WP6 is focusing on governance and organization for the development of rail freight strategies and intermodality. Intermodal freight transport policies are cross-cutting and complex in nature, as designing and developing such policies demand the involvement and actions from different levels of government (EU, federal and regional) and from different policy sectors (mobility, public works, fiscal policies, economic policies, environmental policies…). Central in the governance of cross-cutting policies is the issue of coordination or integration (Head 2008). Studies on coordination of government policy have for long remained limited. However, governments increasingly face complex, cross-cutting and wicked policy issues, while traditional departmentalism and administrative reforms like agencification have made their administrative apparatus increasingly fragmented and because of Europeanization and decentralization multiple levels of government became involved.

As governments increasingly focus on the coordination of policies across policy sector and organizational boundaries, the academic literature have expanded accordingly in the recent years, using different labels as policy and administrative coordination (Bouckaert et al., 2010; Cejudo & Michel, 2017; Egeberg & Trondal, 2016; Lægreid, Sarapuu, Rykkja, & Randma-Liiv, 2014; Peters, 2018); horizontal management (Peters, 2015); policy integration (Candel & Biesbroek, 2016; Tosun & Lang, 2017); cross-agency or intragovernmental collaboration (O'Flynn, 2008; Wilkins, Phillimore, & Gilchrist, 2017); boundary spanning policy regimes (May, Jochim, & Sapotichne, 2011; Trein, 2017) and more practitioner-based concepts like holistic government, joined-up government (Bogdanor, 2005; Carey, Mcloughlin, et al., 2015; Karré et al., 2013) and whole-of-government (Carayannopoulos, 2017; Christensen, Lægreid, 2007; Trein, Meyer & Maggetti, forthcoming). Furthermore, there is an emerging literature on how governments deal with current cross-cutting challenges like the financial crisis, the related budgetary austerity, risks like global epidemia (e.g. bird flu), terrorism and internal security, and climate change (Czarniawska 2009; Boin and 't Hart 2010), but also persistent cross-cutting challenges like poverty reduction or minority integration.

The expanding body of literature on coordination and policy/administrative integration (see Bouckaert et al., 2010; Candel & Biesbroek, 2016; Tosun & Lang, 2017; Trein, Meyer, & Maggetti, forthcoming) studies how actors at the center of government try to ensure this by designing coordination arrangements that intervene on two levels: the institutional level (e.g. culture, rules of the game, and interdependencies) and the instrumental level of structure and processes (Carey, Mcloughlin, & Crammond, 2015; Christensen, Danielsen, Laegreid, & Rykkja, 2016; Klijn & Koppenjan, 2016).

However, studies remain limited in several aspects. First, the impact of specific coordination arrangements on the creation and realization of integrated and innovative policies is understudied. The limited evaluation studies, however, show an often modest impact upon the policy processes and outcomes (Candel & Biesbroek, 2016; Tosun & Lang, 2017). Moreover, although more studies nowadays move beyond the structural aspects of coordination arrangements and the literature on collaborative governance, network management and collaborative innovation deals with how one can foster policy integration and administrative integration through the use of collaborative processes and network management instruments[1], there is a lack of in-depth studies on the functionality of these processes and managerial instruments and how they results in better integrated and innovative policies which are jointly developed by the involved actors (e.g. Agger and Sørensen, 2016; Termeer and Nooteboom, 2014; Doberstein, 2015) (see for a full argumentation: Stevens 2018a). Overall, knowledge about how the processes and design of collaboration has a impact is relatively underdeveloped (Ansell and Torfing, 2014: 238-239; see Stevens 2018a: 15). Moreover the use of inferential social network analysis in such studies is hereto very limited, despite the relevance of this innovative method. Third, such studies on policy and administrative integration in the field of intermodal freight transport are largely absent.

This study adds to these limitations in the literature by studying in-depth cases of policy and administrative integration, with attention for the processes, instruments and structures used and their functionality. Moreover multiple methods are used, like interviews, questionnaires and inferential social network analysis. Lastly, the study results in relevant insights and recommendations and toolboxes regarding processes, instruments and institutional changes for more optimal intermodal freight transport policies.

Please note that in the study the term 'integration' is used which is linked to the coordination of policies and administrative actions. With the term 'integration', we mean 'the (stable) relationships and interdependencies that exist among a multitude of organizations within a particular policy subsystem ' (Stead and Meijers , 2009). An important distinction that has to be made for this study is the difference between 'policy-level integration' and 'administrative integration'.

Policy-level integration refers to the extent to which policy-makers try to create greater coherence in decision-making for issues that transcend the boundaries of established policy fields, and which do not correspond to the institutional responsibilities of individual departments (Stead and Meijers , 2009. Administrative integration, then, denotes the extent to which involved administrative actors (together with private or privatized companies, civil society organizations, etc.) streamline practices and activities in the policy implementation phase (Mulford and Rogers, 1982).

3. METHODOLOGY

In this section the implementation of the chosen, adapted or developed methodologies for each of the five issues will be summarized. Special attention is given to data implications.

WP 2 created two models. For the first model, the developed methodology is based on an intermodal network design model. The considered research problem belongs to the strategic decision horizon, tacking long-term planning issues from the economic and environmental perspective. The model allows optimizing two main kinds of objectives. The first one relates to economic aspects, trying to generate the minimum total operational transportation costs on the road and intermodal networks. The second objective that can be optimized relates to environmental concerns. The objective is then to find the solution that minimizes the total amount of specific emitted air pollutants or external costs.

Using the developed mathematical model, the impact on the modal split of several policies translated into scenarios can be evaluated. Scenarios are constructed based on the elements of the

[1] . Such a view on the use of management in collaborative policy innovation networks is understood by certain scholars as metagovernance (Meuleman, 2008: 70; Voets et al., 2015: 3). Sørensen and Torfing (2005: 202), for example, define metagovernance as, "the endeavour to regulate self-steering policy networks (or collaborative networks) by shaping the conditions under which they operate." (Stevens 2018a: 15).

SWOT analysis that have been identified as the most relevant issues to tackle by experts in the field (Troch et al., 2017).

The main input parameters of the formulation are the location of the existing intermodal terminals on the Belgian case study, the distances (in km) between two nodes (each node representing a NUTS3 region) using a specific mode of transport (road, rail or IWW), the cargo aggregated demand for one year between the nodes of the origin/destination matrix (in t), the costs/emissions/external costs values (in € or t of pollutants) for the transportation and transhipment of goods between modes, as well as the potential subsidies/taxes (in €/tkm) imposed on certain modes by public authorities. The output values consist of the flow repartition (in tkm) between road, intermodal with rail, and intermodal with IWW transport.

For the second model, the developed methodology is based on a service network design model. The considered research problem belongs to the tactical decision horizon, tackling medium-term planning issues from the economic perspective of a typical transport operator. The market is assumed to be composed of shippers with demands to be delivered over the network. The decisions are two-fold: the operating frequencies of the services during the planning period - typically, a week - and the optimal routing of the demands over service-based itineraries. The objective is to deliver the demands in a cost-minimization manner, where the costs are divided into a fixed and a variable component to run the services and transport the goods over them, respectively. The model is designed to suit a general multi-modal framework; a service is defined by a transport mode, in addition to its origin-destination node pair, and thus corresponds to a physical arc in the network.

Mathematically, the proposed mixed-integer program extends the classical static path-based multicommodity formulation, originally introduced in Crainic (200)0 in the general freight transport context, and later re-considered in Crainic and Kim (2007) for intermodal transport. A static case is assumed throughout the decision process, in terms of the shipping demands, as well as the underlying physical network, including the terminals' locations. The model is further developed to incorporate scheduled services and basic resource-balancing constraints at the terminals: design aspects that are relevant for long-corridor freight transport.

Based on the realized SWOT analysis in Troch et al., 2015, an exhaustive list of elements has been identified, analyzed and, lastly, translated into a number of quantifiable scenarios. They comprise the most plausible future events affecting the development of intermodal transport. The design is performed according to three levels: best-, worst- and middle-case scenario Troch et al., 2017, in a direct linkage to the goals set by the White Paper of the European Commission (2011). A point of reference is taken to be the present day. The scenarios are examined by the methodological means of the developed service network design models, essentially from a costs' perspective. The models are invoked on real-world data instances, with a strong emphasis on freight transport in and through Belgium. The potential correlations between the foreseen changes in the transport modes' operating costs, market demands and road taxes, on one side, and the competitiveness of intermodal transport, on the other, are thoroughly investigated.

Nevertheless, a set of basic assumptions will remain constant in all scenarios. In particular, we consider an underlying physical network that comprises three modes of transportation: road, rail and inland waterways. A service, in our notion, is defined by its origin, destination, transport mode and departure day of the week, while an intermodal itinerary is formed of at most three service legs. The network is assumed to be fully connected in terms of all-road/trucking services, making it feasible to accommodate the whole set of shippers' demands.

Among the scenario parameters, we distinctly consider the following inputs:

- Infrastructure and maintenance costs of the operating services, in terms of a fixed and variable component.
- Road taxes.
- Origin-Destination matrix of flows over the network.

The model computes in return the following outputs:
- Modal split, in terms of tkm.
- Consequent intermodal market share.

WP 3 performed a direct and indirect analysis on economic impact. For the direct impact analysis, a micro-level analysis methodology was used to develop three economic indicators based on Vanstraelen (2005).

A first indicator (1) to evaluate the direct economic contribution of a company is the added value per full-time equivalent employee (FTE):

$$Added\ value\ per\ FTE = \frac{Added\ value\ (EUR)}{Average\ workforce\ (FTE)} \quad (1)$$

A second indicator (2) to assess the productivity of a company is the added value per production unit. For the rail freight sector, production units can be expressed in tonkilometers (tkm) or trainkilometers (trainkm). Within the research the main production value is expressed in tkm:

$$Added\ value\ per\ production\ unit = \frac{Added\ value\ (EUR)}{Total\ production\ (tkm)} \quad (2)$$

A last indicator (3) is the added value range of a company. This indicator calculates the contribution of added value to the production value expressed in revenue. This is reflecting the level of vertical integration of a company, or the level of ownership over the established production.

$$Added\ value\ range = \frac{Added\ value}{production\ value\ (revenue\ in\ EUR)} \quad (3)$$

Van de Voorde and Sys (2017) define added value as the sum of labour costs, depreciations, other costs and operating results and exploitation subsidies. This approach is taking into account the compensation values for production factors such as labour and capital, in order to obtain the estimated added value as a reward for taking part in the company's production process. Alternatively, Peeters et al. (2002) define added value as the difference between the value of the produced outputs and the value of the required inputs for this production. These definitions indicate that added value at a company level estimates the monetary amount that is added to purchased services and goods by adding production factors such as labour and capital. Therefore, employment is also an integral part of added value. Both approaches are followed and compared in this research.

To calculate these economic indicators, the added value of a company needs to be estimated. In the research four different approaches are explored. Two main methods are the bottom-up approach and the top-down approach, following the definitions of Van de Voorde and Sys (2017) and Peeters et al. (2002). The bottom-up approach is accumulating the retribution values for the different production factors to obtain the added value. The operational profit is an integral part of the created added value by the company. However this does not mean that a positive added value goes hand in hand with a positive operational profit, as also the gross wages, rent and interest are taken into account (Welten, 1996). Depreciation values for replacing capital factors such as buildings and machines should be added to obtain the gross added value. When the added value is corrected for price increasing taxes and price lowering subsidies, the net added value is obtained in factor costs or market prices (Bloemen, 2017). Contrary to the bottom-up approach, the top-down approach is not summing the different components of added value, but starts from the total operating income and subtracts all elements that are not a part of the added value creation (NBB, 2007). In addition, two alternative top-down approaches are evaluated: a simplified top-down calculation presented by Van Dijk (2017) and an adapted top-down calculation.

In order to calculate the added value and the corresponding economic indicators, data collection is necessary. Before liberalization in 2010, Rail freight services were part of the public NMBS group. This national main organization captured also all passenger services and infrastructure maintenance on the Belgian rail network. Only general estimations exist for operational freight costs and freight revenues. After liberalization, rail freight services were split from the national group and started to publish their own annual accounts. As of this year, detailed information can be collected from the annual accounts of the incumbent rail freight operator.

For the indirect impact analysis, the input-output methodology is used. This methodology has been developed by the Russian economist Wissily Leontief (Miller & Blair, 2009). The study of indirect economic impact of rail freight transport on the national economy requires using the national input-output tables. The Federal Planning Office (2015) is publishing these national input-output tables every five years. The last version takes into account the input-output tables of 2010 and was published in December 2015. For the analysis, the methodology is adapted to split the rail freight sector from the national land transport sector including all passenger and freight transport activities on land, such as taxi services, metro, rail freight, rail transport, bus transportation, road freight, etc. In a national input-output model, the economy is split into n industries. In this research, the methodology is adapted to convert the existing national input-output model into n+1 industries, based on customer and supplier data of the n+1th industry, in this case the rail freight sector represented by the incumbent rail freight operator in Belgium.

The output of the methodology are multipliers that can be interpreted as indicators on the indirect economic impact of a sector on the national economy. A first indicator is the Leontief multiplier, or a final demand to output multiplier approximating the total effect on the national output created for each increase of final demand of the observed sector by one unit. A second indicator is the Net multiplier, indicating the same effect on the economy for each additional unit of output of the observed sector. The analysis can also be linked to employment figures, resulting in the effect on the total employment of the national economy, for each increase by one unit of output or one additional full-time equivalent employee within the observed sector.

These multipliers should be interpreted with caution, as assumptions are necessary to perform these calculations on the approximated indicators. A first limitation is the difference in activities that are part of the nature of an organization. Within this research, only the primary activity of an organization is taken into consideration. A second limitation is bound to the obtained data, as this data reflects different years compared to the used national input-output framework. This limitation has been checked for its validity by a sensitivity analysis using raw supply and demand data for the corresponding years to the obtained data. Results from this sensitivity analysis cannot be interpreted as such, but evolutions can be taken into account. A third limitation is the absence of data on subsidies and handling margins, resulting in an overestimation of the final output. And a final limitation is the assumption that no final consumption is taking place for rail freight transport services.

The Life Cycle Assessment (LCA) methodology has been chosen in **WP 4** to analyse the environmental impacts of the intermodal freight transport in Belgium, which includes the LCA of rail freight transport (distinguishing between electric and diesel traction), inland waterways transport and road freight transport.

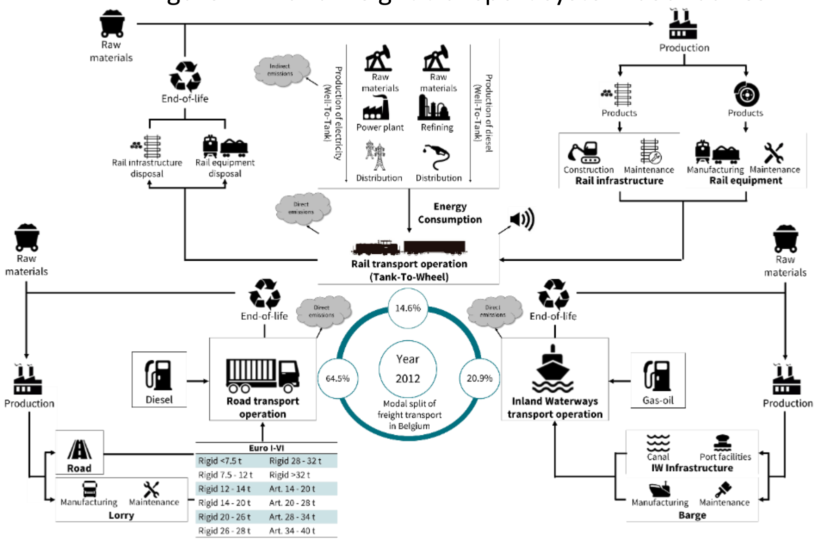
The LCA methodology allows studying complex systems like freight transport, providing a system perspective analysis that allows assessing environmental impacts through all the stages of the intermodal freight transport system (transport operation, vehicle and infrastructure), from raw material extraction, through materials use, and finally disposal.

Furthermore, the LCA approach allows analysing the overall life cycle of the energy carrier. Thereby, we consider the environmental impacts related to the use of energy (e.g. diesel or electricity) starting from the raw materials extraction (e.g. oil or uranium), continuing with energy generation (e.g. diesel refining or electricity production) and ending with the energy distribution to the traction unit (locomotive, barge or lorry). Besides the assessment of the environmental impacts related to the energy consumption during the transport operation, our LCA study includes the emissions and energy and raw material consumptions from the construction and maintenance of transport infrastructure and the manufacturing and maintenance of transport vehicles. An LCA study comprises four stages.

First, the goal and scope definition. The LCA study carried out within the framework of the WP 4 aims to analyse the environmental impacts of intermodal freight transport in Belgium and the different scenarios developed for the year 2030. The functional unit chosen has been “one tonne-kilometre of freight transported” in the different modes of transport.

The second stage of an LCA is the inventory analysis. Figure 1 presents the stages considered in our study for the rail freight transport, inland waterways transport and road freight transport.

Figure 1. Inland freight transport system boundaries

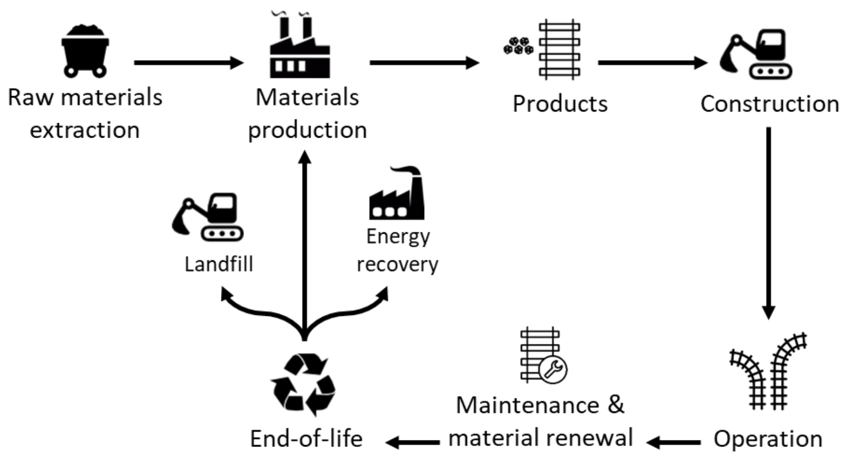


A detailed study of the rail freight transport has been conducted, collecting data directly from Infrabel (the Belgian railway infrastructure manager) and B-Logistics (rebranded to Lineas, April 2017), which is the main rail freight operator in Belgium. The rail freight system has been divided in three sub-systems: rail transport operation, rail infrastructure and rail equipment (locomotives and wagons).

For the rail transport operation sub-system, the specific energy consumption of electric and diesel trains has been determined separately. Upstream emissions related to the production and distribution of the energy to the traction unit and the direct emissions during the rail transport activity have been determined. In the case of indirect emissions from electric trains, in order to adjust as closely as possible the environmental impact related to the yearly electricity consumption, and since the electricity supply mix varies widely over the years, our LCA study uses the electricity supply mix in Belgium corresponding to the appropriate year. Three types of direct emissions produced during the rail transport operation have be distinguished: the exhaust emissions to air related to the diesel combustion in locomotives, the direct emissions to soil from abrasion of brake linings, wheels and rails and the sulphur hexafluoride (SF6) emissions to air during conversion of electricity at traction substations.

As shown in Figure 2, the subsystem rail infrastructure includes the processes that are connected with the construction, maintenance and disposal of the railway infrastructure. We have collected data from Infrabel and literature sources relative to the Belgian railway infrastructure. This comprises information on the materials and energy used in the construction of the railway network (including track, tunnels and bridges) such as rails, sleepers, fastening systems, switches and crossings, track bedding or overhead contact system for example. The maintenance of the Belgian railway infrastructure has been analysed as well. Therefore, the maintenance works such as rail grinding, rail renewal, sleeper and fastening system renewal, switches and crossing renewal, ballast tamping, ballast renewal, ballast cleaning and weed control are taken into account. We have considered in the maintenance of railway infrastructure both the fuel consumption and exhaust emissions from the machinery used in the maintenance and the new materials used in the track renewal. We have also included in our study the end-of-life of the railway infrastructure and the land use in the Belgian railway network. Most of the elements are recycled such as the ballast that is reused as material for backfill and the wooden sleepers that are incinerated with energy recovery. The life cycle phases of manufacturing, maintenance and disposal of rail equipment (locomotives and wagons) are taken into account in our study as well.

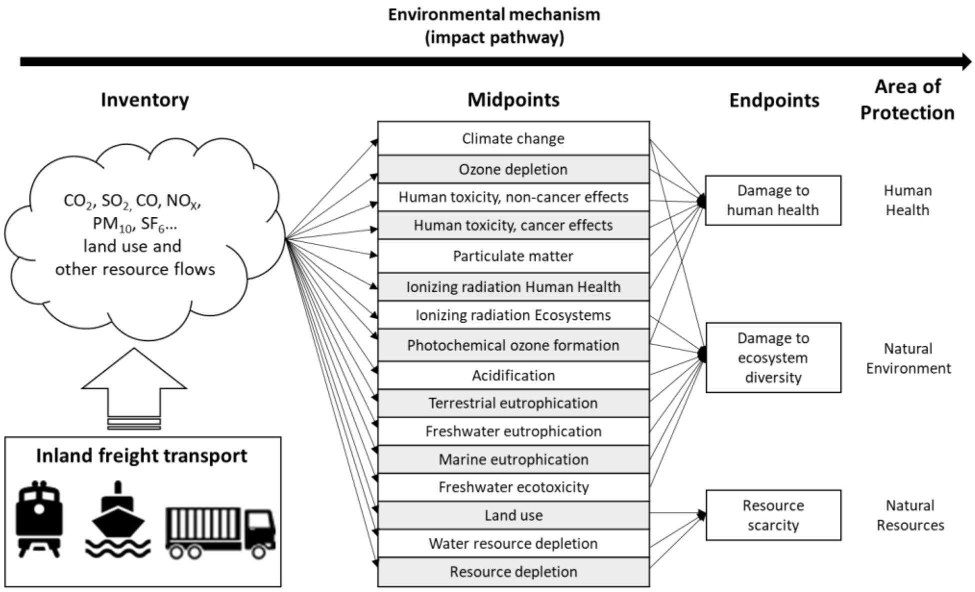
Figure 1. Life Cycle Assessment of the railway infrastructure



In the case of both inland waterways transport and road transport in Belgium, the Ecoinvent V3.1 database has been used as a model (Weidema et al., 2013). Analogously to the rail transport system, for the LCA of inland waterways transport, all life cycle phases of inland waterways transport operation, inland waterways infrastructures (including canals and the Port of Antwerp), and manufacturing and maintenance of the barge are included. Information relative to the total annual freight moved by inland waterways transport in Belgium by barge type, fuel consumption in the vessel transport operation and waterways infrastructure characteristics for several years have been collected. For the LCA of road transport, all life cycle phases of road transport operation, road infrastructure, and manufacturing and maintenance of the lorry are included. Information relative to the total annual freight moved by road transport in Belgium by weight classification and heavy duty vehicle technology type, fuel consumption in the road transport operation and road infrastructure characteristics for several years have been collected.

The third stage is the impact assessment. The LCA methodology allows modelling in a quantitative and multi-criteria way the environmental impacts of all relevant pollutant emissions and energy and material consumptions in numerous midpoint environmental impact categories, such as climate change, particulate matter emissions, photochemical ozone depletion or human toxicity for example. Then, as can be seen in Figure 3, the influence of these midpoint categories to endpoint categories such as damage to human health, damage to ecosystem diversity and resource scarcity can be evaluated. These endpoint categories are related to the areas of protection of human health, natural environment and natural resources, respectively (European Commission, 2010). All calculations in our study have been made with the SimaPro 8.0.5 software using the Life Cycle Impact Assessment (LCIA) method "ILCD 2011 Midpoint+" (version V1.06 / EU27 2010), which is the method recommended by the European Commission (European Commission, 2010). "ILCD 2011 Midpoint+" is a midpoint method including 16 environmental impact indicators.

Figure 3. Diagram of the LCA methodology applied on inland freight transport



The fourth stage is the assessment of the results obtained in the previous stages.

The methodology for **WP5** is based on two classical approaches used to analyse the market structure (Lipczynski *et al.*, 2013): the static and the dynamic approaches. Each approach is characterized by a large panel of indicators. The selection of the following indicators has been done according to the available data.

The static approach is useful to give a picture of the level of concentration on the market. Traditional measures are the number of firms and the distribution of the size of firms on the market (Sys, 2010). Indicators used to measure the level of concentration are traditionally split in two kinds of measures: absolute and relative concentration. Unfortunately, because of an imperfect information on the market, only the absolute concentration can be measured.

The absolute concentration is usually measured by four indicators: the n-firm concentration ratio (CR), the Herfindahl-Hirschman index (HHI), the Hannah and Kay index (HKI) and the entropy coefficient. In this study, only the two first are used because of data availability. Indeed, the last two require data for all firms in an industry, while CR and HHI only need data for the biggest firms. The n-firm concentration ratio is a simple indicator to identify the existence of an oligopoly.

$$CRn = \sum_{i=1}^{n} s_i \tag{4}$$

It does not need extended data and is calculated based on the market share (s_i) of the n biggest firms (CR2, CR4 and CR8). CR4 is most often used and considers only the first four companies in the top ranking. When CR4 > 25% of market share, the literature shows the existence of a loose oligopoly (Shepherd, 1999; Martin, 2002). When CR4 > 60%, there is a tight oligopoly with a high risk of over-concentration and collusion between the biggest firms.

The HHI is the usual indicator to have an overview of the level of concentration on the market according to the weight of each firm (squared market share, s_i).

$$\text{HHI} = \sum_{i=1}^{n} s_i^2 \times 10{,}000 \tag{5}$$

There is a monopoly when HHI = 10,000 and a high concentration on the market when HHI > 1,800. (i.e. Shepherd, 1999) Hence, concentration is low when HHI < 1,000.

The dynamic approach gives a time perspective of the market. It is composed by two indicators: the Persistence Of Profit (POP) to assess the degree of competition on short-run and long-run, and the Capital cost/Labor cost ratio (C/L ratio) is used to measure the economies of scale and to give an overview of the market structure of the European rail freight market.

The POP-method has been developed to give a dynamic approach of the firm behaviour on the market (Cable and Mueller, 2008). The indicator measures the firm's standardized profit rate ($\pi_{i,t}^{s}$) according to firm's profit rate ($\pi_{i,t}$) minus the average industry profit rate ($\overline{\pi}_t$). The standardization (average profit rate of all firms) excludes the macroeconomic effects in so far all firms are affected by the same economic environment.

$$\pi_{i,t}^{s} = \pi_{i,t} - \overline{\pi}_t \tag{6}$$

On this base, a first-order autoregressive model is formulated and commonly used for each firm as follows:

$$\pi_{i,t}^{s} = \alpha_i + \lambda_i \pi_{i,t-1}^{s} + \varepsilon_{i,t} \tag{7}$$

The main interest from this indicator is to test the correlation between the profit rate of one year comparing to the previous year on short-run (λ_i) and long-run ($\pi_{i,t-1}^{s}$). In the short run, a persistence of profits rate (λ_i > 0) is a sign of barriers or dominant position driver of abnormal profit (above the norm). But, when λ_i = 0, there is no persistence of profits (quick erosion), which is a sign of high competition and low barriers in so far as all firms compete on a same and homogeneous market.

In the long run, a positive (negative) α_i can be the sign of a competitive (non-competitive) position for certain firms when their profit rate is above (below) the norm. However, it can be also the sign of a niche market with less competition and high barriers or a strategy from a dominant player to keep market shares (Sys, 2010). The interpretation of $\pi^s_{i,t-1}$ is clearer in the long run according to the degree of convergence between the firm's profit rates. When $\pi^s_{i,t-1}$ = 0, firms are limited in their strategy to get abnormal profits because of a high competition and low barriers. Consequently, a convergence between different firm's profit rate is observed. Conversely, when $\pi^s_{i,t-1}$ ≠ 0, there is lower or no convergence. This is the sign of heterogeneity into the market with high barriers and a niche market where abnormal profits persist.

To resume, the conditions of a perfect competition are found when λ_i = 0, α_i = 0 and $\pi^s_{i,t-1}$ = 0 (Lipczynski *et al*, 2013). For other results, values will be discussed according to the existing literature in the next step.

Finally, the capital-labour ratio is computed to assess the level of economies of scale in the ground handling industry (Meersman *et al.*, 2011). This indicator, derived from industrial economics, has the advantage of being a good substitute to the calculation of the curve of the long run average costs when data are limited and to give some clues about sunk costs or barriers on the market.

$$R = \frac{C}{L} \tag{8}$$

The capital cost (C) is related to the amortization cost of the material and infrastructures used for production, while the labour cost (L) is related to the cost of employees at full time. The relationship between them can be interpreted as follows. There are economies of scale when R > 0 and no existence when R = 0. Meersman *et al.* (2011) show that an industry with a high intensity of capital has larger economies of scale than an industry with a low intensity. Hence, the capital intensity can be associated to the sunk costs necessaries to enter and operate on the market (cost of material, advertising, research & development, etc.). These costs can differ from one market to another according to the type of goods and services. In the case of the rail freight industry, the main costs are usually those of rolling stock and interoperability (especially for locomotives) or authorization to start a service as license and safety certificate (Laisi *et al.*, 2012).

For the study of the governance and organization of intermodal freight transport policies in **WP6**, the methodological approach that was applied, combined multiple case studies, encompassing extensive document analysis, semi-structured interviews (36 in total), questionnaires as follow-up of interviews, and (inferential) social network analysis techniques.

As a first step, we aimed to get more in-depth knowledge about the current level of policy-level and administrative integration between actors for intermodal freight transport in the federal state of Belgium. The findings resulting from this research step, together with an extensive review of the literature on policy coordination and implementation were used as input for the SWOT in WP1 (see D1.1 - 1.2, part G), as well as in WP6 (WP6.2). Therefore we conducted two case studies, studying initiatives in which the relevant policy-level and administrative actors at both the Federal and regional level of government were involved and needed to work together. First of all, we analyzed the attempt of the Federal Department of Transport and Mobility to establish a holistic government strategy encompassing the different levels of government and policy sectors for sustainable and intermodal mobility and (freight) transport. This policy process already started in 1997 and finished around 2010;

however, without a successful result. On the basis of a document analysis and seven interviews with high-ranked policy officials and validated through a BRAIN TRAINS stakeholders' meeting with 25 end users of transport policies, we mapped the actors as well as the development of the case and deduced a list of inhibiting factors in developing this particular holistic government strategy across the different levels of government in the Belgian dualistic federal state (e.g. the competence division, influence from European Union, inclusive communication, etc.) (see also Stevens and Verhoest 2016a).

The first case served as a pilot case. However, because the studied process in the first case ended in 2010, the decision was made to look at a second, more contemporary case to see whether similar research findings come up. Specifically, we studied for this second case the transposal of the EU directive on Intelligent Transport Systems (ITS) of 2010 (2010/40/EC directive) into the dualistic federal system of the Belgian state. ITS-systems are advanced applications which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated and 'smarter' use of transport networks (European Union, 2010:L207/1). Insights on the degree of policy-level integration were acquired through a document analysis of relevant policy documents (policy plans, position papers, review reports, progress report, meeting reports, etc.) and interviews. With regard to the level of 'administrative integration' among the actors involved in the implementation of the policy actions of the EU ITS-directive, we use Social Network Analysis (SNA) on the implementation projects as reported in the Progress report of 2014, in order to uncover to what extent administrative actors from different governmental levels and policy domains cooperate. SNA is a method designed for investigating social structures through the use of network and graph theories (Scott, 1991). SNA is a method designed for investigating interaction networks, both the actors and their mutual relations, through the use of network and graph theories (Scott, 1991). For the analysis, we used the UCINET software program.

The findings of these two case studies showed that in order to achieve the best case scenario (and – albeit to a lesser extent the medium case scenario) actors at both levels of governments need to strive for a high extent of policy-level and administrative integration. In order to come to recommendations of how such high levels of policy and administrative integration can be achieved jointly by the involved governments, we conducted three clusters of research activities as part of WP6 and its sub activities.

First, as achieving the best case scenario necessitates that actors at the involved different governmental levels design new and integrative policy strategies for intermodal freight transport jointly, we decided to develop a toolbox for such policy integration, which elaborates the relevant process steps and managerial techniques (see for this toolbox: D6.4, section 4.1). Therefore, we combined a review of the academic literature on how coordinators or network managers can optimally facilitate collaborative policy design networks (see e.g. Milward and Provan, 2006; Klijn and Koppenjan, 2004; Agranoff, 2006; Sørensen and Torfing, 2012; Torfing, 2017), with two in-depth case studies of more successful network initiatives designing innovative and integrative policies across policy domains and governmental levels in a collaborative way. These case studies combined extensive document analysis, as well as semi-structured interview followed by a pretested survey with standardized questions and with each of the representatives in both networks (in total 25 interviews and surveys). The data analysis included, besides the analysis of the process, the actors and their resources they brought into the process, the meta-governance by the coordination also an analysis of the (cooperative and learning) interactions between the representatives in these networks, by the use of social network analysis. The observed interaction patterns between the representatives and the organisations involved in both networks were explained by the use of Exponential Random Graph Modelling (ERGM) which is an innovative way to study collaborative policy design networks (see for the methodological argumentation, Stevens and Verhoest 2016b). Both case studies were selected based on the successfulness of the collaborative policy design process and the number and kind of involved actors. Due to a lack of successful cases within transport policy, both cases were selected on adjacent policy fields which face similar complex constellation of involved actors and similar levels of political salience (spatial planning/environment) (see for extensive case study analyses and findings: Stevens 2017a; Stevens and Agger 2017b; Stevens 2017c; Stevens 2018b; Stevens and Dorren 2017).

Second, achieving the best case scenario additionally necessitates a strong coordination between the involved administrative actors from the different policy domains and governmental levels, or, stated differently, a high level of administrative integration. In order to develop a toolbox and recommendations regarding administrative integration (see for this toolbox, D 6.4 section 4.2), we combined insights from the previously mentioned case studies, with insights arising from an extensive review on the literature of administrative coordination/integration and previous and other empirical research by the involved researchers on coordination between public and private organisations in service provision, regulation, and policy implementation (see e.g. Six and Verhoest 2017; Mathieu, Verhoest and Matthys 2017; Voets, Verhoest and Molenveld 2015; Molenveld 2016; Aubin and Verhoest 2014; Bouckaert, Peters, and Verhoest 2010; Verhoest and Bouckaert 2005).

Third, achieving the best case scenario and in order to optimise performance of intermodal policies, requires also the reconsideration of the institutional set-up and organization of such policies at both national and EU-level. In order to come to recommendations related to institutional changes, we used insights from the abovementioned case analyses and interviews, and insight from a BRAIN TRAINS workshop in Ghent (8/09/2017), and combined and validated these with an analysis of position statements by societal interest groups, parliamentary debates and initiatives, as well as four additional interviews with key public and private actors involved in intermodal railway freight transport. Moreover, we took into account the policy recommendations done by other WPs and the institutional changes they refer to (mainly WP5 on regulation). These additional research activities were performed during WP 7.

4. SCIENTIFIC RESULTS AND RECOMMENDATIONS

In this section the main results of the described methodologies are summarized and some final recommendations are stated.

The main results and recommendations of **WP2** can be summarized in the following points:

- It has been noticed that the train load factor has been kept at high levels: 97-99%. In order for a rail service to be profitable and make up for its high fixed costs, the load factor should not fall below the above mentioned levels. Otherwise, freight consolidation should be sought in order to fill the containers, and the experiments conducted on the market formed around the European rail corridors show that this is indeed a possible endeavor, under a suitable optimization framework.

- Experiments have shown that subsidies are crucial for the business' survival and to make up for the high initial fixed costs. However, determining the optimal height at which these subsidies should be provided requires a mathematical framework that combines optimization techniques along with the knowledge of the incurred costs and market prices. A more generic logistics view is also necessary as subsidies are typically given to both rail and IWWs transport. Most studied cases share a certain recommended figure of the required subsidies (i.e. no more than 70-75% of the fixed costs).

- According to our conducted survey among shipping firms in Belgium, the average reported increase in transit time of intermodal with respect to all-road transport is 98-185.7%. Additionally, the average number of days equipment remain unavailable in all-road and intermodal transport is 3 and 6 days, respectively. We expect that giving higher priority to freight over passengers trains – provided that currently the opposite is being applied in Europe – would result in shorter transit times, hence an enhanced service quality of intermodal transport overall. The long transshipment times at the terminals also suggest a possible room for improvement in the terminal handling operations in order to reduce congestion and waiting times.

- Reduced costs and externalities, as well as increased sustainability over long distances have been identified as strength points of intermodal transport. The predominant market share of intermodal rail transport highlights the efficiency of this mode in terms of environmental objectives. The focus on environmental policies is therefore one solution to achieve the modal transfer from road to more environmentally friendly modes, as expected by the European Commission. On the contrary, results show that road transport is favoured when the focus is on policies which optimize economic objectives (minimization of operational costs).

- When the focus is on economic objectives (i.e. when operational costs are optimized), road transport has the highest market share. The lower representation of intermodal rail and IWW transport is explained by the high pre- and post-haulage costs (i.e. drayage operational costs). These costs can be reduced by improving the load factors of the trucks. This improvement could be achieved by a better bundling of flows, with an increased collaboration between freight carriers, so as to maximize the load factor of the trucks reaching or leaving the intermodal terminals. Such favorable results could also be attained by trying to increase the potential backhauling and consequently reduce the need for empty truck journeys.

- Intermodal transport is characterized by the possibility to carry large flows of goods. The bundling of flows allows an optimal loading of the long-haul modes like train or barge. The high fixed costs of the travel by rail or IWW can therefore be divided into more units, allowing economies of scale. Consolidation might also be improved in the pre- and post-haulage travels by truck. This could be achieved by the development of more cooperation and sharing of transport resources between the transport operators. A potential implication would be the development of new commercial strategies and technical tools to ensure the smooth collaboration between stakeholders.

- The introduction of a road tax leads to a more favorable market share for intermodal rail transport than in the case in which no tax is imposed. However, the resulted intermodal market share is still lower than the one obtained in the configuration which focuses only on the externalities of transport. These results highlight the environment-friendliness of intermodal rail transport and the necessity to take political measures through taxes, so as to reestablish the optimal social modal split which takes into account externalities and their related costs. This could also be obtained by including externalities in the economic system through the monetization and internalization of externalities (=external costs), e.g. by applying the polluter pays principle.

The main results and recommendations of **WP3** can be summarized in the following points:

- The direct analysis shows that rail freight operators in Belgium have undergone major transitions since the liberalization in 2007. Before the liberalization, rail freight activities were an integral part of the national rail operator, and no joint cost allocation, neither joint revenue nor employee allocation was taking place. As such, only limited conclusions can be drawn for this period. After privatization of the rail freight services, a positive trend in added value generation and employment creation is indicated by the observed indicators.

- The methodology application has learned that the simplified top-down approach is a good estimator of the actual added value when no transition is taking place. This method is easily executable due to the low amount of data required. For transition periods, the adapted top-down approach is a good estimator of the added value generation, which allows avoiding the data-intensive bottom-up approach.

- Competition has pushed the rail freight sector in Belgium forward. Although competitors have captured some high added value niche markets from the incumbent rail freight operator, both the added value generation as well as the added value per FTE are increasing within the incumbent rail freight operator and its competitors.

- Comparing the rail freight sector to road and inland waterways, it can be concluded that the latter is heavily depending on profit margins to generate added value, whereas the road and rail freight sector are generating added value due to job creation.

- Road freight and rail freight activities show a lot of similarities in terms of added value and employment generation. Nevertheless, the amount of revenue generated is lower in the road freight sector compared to the rail freight sector, indicating the high operating costs for the latter. It will be the challenge for the rail freight sector to maintain its positive added value and job creation while transitioning a higher share of revenue into profit margins. This will in its turn increase added value creation and can stimulate further job creation to surpass road transport.

- The indirect analysis confirms the finding that the rail freight sector has a considerable positive impact on the national economy compared to other land transport modes. For the observed data, an approximation multiplier of 2.423 was observed, resulting in an increase of economic output by 2.423 EUR for each additional EUR of final demand in 2011. This can be intuitively explained by the inputs required for rail freight services, often delivered from within the national economy. When taking into account data of 2015 this multiplier drops to 1.883, due to the cost cutting that was performed in the transition towards a more profitable sector after liberalization. Nevertheless, for the remaining land transport activities, this multiplier fluctuates around 1.645 and for IWW the multiplier stabilizes around 1.571, both considerably lower compared to the approximation of the economic impact by rail freight services.

- Linking the indirect analysis to the employment figures of the national economy, also the job creation effect of rail freight services is reconfirmed. For each additional million EUR of output, 10 additional FTE are hired in both the rail freight sector as well as the remaining land transportation sector. When taking into account seconded employees, this multiplier rises for the rail freight sector to 13.7 FTE for each additional million EUR of output. For the IWW, this job creation is considerably lower with an estimated value of 3.6 FTE per million EUR off additional output.

- These results show that collaborative business development should be the next trend. This evolution should not be one-sized, but find its source in both the rail freight operators, the shippers as well as the supporting stakeholders such as governments, terminals, port authorities, etc. The analysis has shown that the economic benefit as such is not the main issue blocking the development of a strong rail freight usage in Belgium. With collaborative business development, bottlenecks such as a lack of flexibility and a lack of economies of scale can be taken away, and a mental barrier can be broken down by increasing the image of rail freight transport as a trustworthy and valid alternative to road freight services.

- To do this, it is crucial to continue investment, however in the right things. Rail freight can only become flexible and attractive when standardization and operability with other modes of land transport are increasing. As such, smart investments need to be made to take away these bottlenecks and create a nutritious environment for rail freight transport development within an intermodal context. The role of the infrastructure manager, INFRABEL, and as such by extension the responsible governmental parties, are crucial within this setting. It is also recommended that Belgium, with Lineas as a growing international rail freight operator and INFRABEL as the infrastructure manager, takes the lead to effectuate this standardization and interoperability implementation on a European level. As distances within Belgium are small, longer cross-border routes will be key to the future survival of rail freight transport business in Belgium. By taking an active role in this, the Belgian rail freight sector will be one step ahead.

- A final recommendation lies in the tracking and publishment of data. Collaboration should not only take place at operational level, but also at strategic levels in order to combine data to form a strong case for all plausible stakeholders to be more involved in rail freight transport development. In this respect, data can be seen as the fuel for improved rail freight operations and innovations.

The main results and recommendations of **WP4** can be summarized in the following points:

- In view of the results obtained in the LCA study carried out within the framework of the WP 4, the electricity supply mix plays a fundamental role in the environmental impacts of rail freight transport when using electric traction. Moreover, the load factor and emission engine technology are shown as determining factors in the environmental impacts of road transport.

- A better environmental performance of intermodal freight transport can be achieved by improving the characteristics of the inland freight transports modes such as energy efficiency, load factor, emission technology, use of alternative fuels and the electricity used in electric trains.

- Increase of the energy efficiency of freight transport. Transport is the sector with the highest energy consumption in the EU-28 and the second in Belgium with a 31.7% and 28.3% of the final energy consumption in the year 2012, respectively. Within the transport sector, road transport constitutes 81.6% in the EU-28 and 82.4% in Belgium of the transport final energy consumption (Eurostat statistics, 2017). Therefore, the search for a more energy-efficient transport system becomes necessary. Inland waterways transport is the most energy-efficient mode of inland freight transport in our study, but also in both the EcoTransIT (2008) and Ecoinvent databases. Within rail freight transport, electric traction has the lowest energy consumption, while diesel traction has the highest. Focusing on road transport, our study shows that the energy consumption is highly dependent on the load factor. Thereby, an articulated lorry of 34-40 t with a load factor of 50% presents the highest energy consumption among the inland freight transport modes studied. However, with a load factor of 85%, it can achieve a lower energy consumption than diesel trains. The energy efficiency in the railway sector, and therefore its competiveness, will improve in the future. Some points to improve the efficiency of the rail freight transport will be the weight reduction through new materials of locomotives and wagons (Helms and Lambrecht, 2006). This would allow the saving of the energy consumed during the transport activity, but also energy consumed in the manufacture and disposal of rail vehicles. Moreover, the development of new engines for more energy-efficient locomotives, the energy recovery systems from braking, the energy-efficient driving through the control of speed and improved aerodynamics in rolling stock, will lead to a reduction in the energy consumption (IEA/UIC, 2015). Furthermore, a greater energy efficiency could be achieved by optimizing the management systems in the intermodal terminals, which would allow lower waiting times for transport vehicles such as barges or lorries and more efficiency in the transhipment processes using cargo handling equipment for example.

- Increase of load factors in freight transport. As mentioned above, the energy consumption is highly dependent on the load factor. Higher load factors in freight transport can be achieved through the shifting of road freight transport in long distances to rail freight transport. Thereby, the higher payload capacity of trains promotes their shared use by several companies, which would improve the load factor and reduce the transport intensity. Furthermore, the higher operating costs of rail freight transport entail the optimization of the load factor to make it profitable. Moreover, the longer the train and the heavier the cargo, rail freight transport becomes more energy-efficient (Messagie et al., 2014). In the Belgian network, the length of freight trains is limited to 750 m and the maximum permitted load is 3600 t, although the average load of freight trains in Belgium were 569 t, 575 t and 584 t in the years 2006, 2007 and 2008, respectively (SNCB, 2009). Furthermore, the use of electric locomotives rather than diesel locomotives enables to transport heavier loads.

- Improvement of the emission technology of the vehicles used in freight transport. The emission technology of a vehicle (e.g. diesel locomotive, barge or lorry) is a determining factor in the environmental impacts of freight transport. The air pollutant emissions from road transport have decreased over the years as a result of the implementation of the Euro emission standards, which have promoted enhancements of the emission control technologies. For diesel locomotives, the lower rate of replacement of the locomotives due to their longer life span causes a slow implementation of new engines with better emission technologies. It should be noted that the higher rate of renewal of the lorry fleet produces a faster improvement in road transport emissions.

- Use of alternatives fuels as biodiesel. Replacing diesel by other sources of cleaner energy as biodiesel, will lead to the reduction of environmental impacts. The use of biodiesel produces advantages in terms of CO_2 emissions, but analysing the life cycle of the biodiesel, the pollution could be transferred from air when combusting to soil and water during crop production. Therefore, the environmental advantages of the use of biodiesel depend on the specific type and source of the biodiesel. It should be noted that the use of biodiesel does not affect exhaust emissions dependent on engine technology such as NOx or particles for example.

- Use of low-sulphur fuels. The exhaust emissions of SO_2 are dependent on the sulphur content in fuels. Therefore, the higher the sulphur content in the fuel, the greater the SO_2 emissions. The fuel quality legislation has been shown as an effective measure to reduce the exhaust SO_2 emissions. In Belgium, the amount of sulphur by mass permissible for diesel used by diesel locomotives and lorries is 10 ppm from 2009. However, diesel in Belgium has an average sulphur content of 8 ppm since 2008. Similarly, the gas-oil used in barges has a limit of sulphur content of 10 ppm from 2011.

- Increase of the share of electric trains in the Belgian traction mix. In view of the results obtained in our study, electric trains show a better life-cycle environmental performance than diesel trains. Thereby, electric trains are more energy-efficient than diesel trains and the use of electric locomotives rather than diesel locomotives enables to transport heavier loads. It should be noted that even though the use of diesel is present in rail freight transport in Belgium, the use of electric traction is much greater. Moreover, the use of diesel traction is decreasing in Belgium, which means that only a small part of the rail freight produces exhaust emissions. Therefore, the increased use of electric trains in intermodal transport represents an opportunity to attain a more environment- and health-friendly, and energy-efficient transport system.

- Enhancement of the electricity supply mix used by electric trains. The electricity supply mix plays a fundamental role in the environmental impacts of rail freight transport when using electric traction. Thus, as the use of electric trains will increase in the future and have a higher share of the total inland freight transport, the energy split for the electricity generation will be more important in the environmental impacts of goods transport. The use of electric trains becomes especially interesting when they are powered by sustainable electricity. The liberalization of the energy supplier market for the rail freight transport companies could be seen as an opportunity to improve the electricity supply mix of electric trains. Rail freight transport operators could commit to clean electricity as a competitive factor. However, this could also have a negative effect, since companies could opt for cheaper energies such as nuclear energy or coal. Nuclear fission does not produce direct air emissions such as greenhouse gases for example, but instead nuclear wastes with a high potential impact on human health and ecosystems are produced.

According to the **WP5**, some recommendations can be drawn for the Belgian policy:

- The research shows an active competition between firms on the Western European rail freight market. Those give positive signs of increasing competition and attractiveness on the market in spite of the non-evident impact of liberalization at an aggregate level. Operators develop strategies of differentiation and new business models based on new services such as leasing, outsourced maintenance or drivers, etc. This is an important lever to reduce sunk costs and increase the attractiveness of the market. In this way, the strong increase of the number of newcomers after the European liberalization shows that there is a market for rail freight where it is possible to make business in spite of intra-modal competition, road competition or the imperfect European single market.

- Nevertheless, the indicators cannot conceal the persistence of barriers and drawbacks for the rail freight market. First of all, the ratio of capital cost on labour cost confirms the existence of barriers, which increase the price for newcomers to enter the market in spite of efforts from the European Commission and the European Railway Agency (ERA) to harmonize rules and support technical interoperability. Consequences are over-costs for operators and barriers to entry between different national networks. In this way, the corridor policy (TEN-T) is a first step, but the control of the performance of network managers at European level and the harmonization of practices between them seems to be a long way with strong cultural and organizational barriers. Secondly, the POP analysis shows imperfect competition on the market due to an imperfect single market (barriers and segmented market). Finally, the discussion highlights a risk of concentration around a tight oligopoly and a dominant operator at the head. Hence, the future for the rail freight market seems dark and the narrow size of the European market (€15 billion) compared to the needs in financial and political investments to complete the single market does not call for optimism.

- Considering the Belgian network as a key element for hinterland competition. The performance indicators with targets and corresponding financial penalties to push the infrastructure manager towards a better productivity, like in Switzerland and The

Netherlands, can be a good signal towards the market in the long term to ensure a stability of the access charges.

- Drawing a transport policy on the long term and keep the consensus like in Switzerland. This is maybe the most difficult lever to implement in a policy but also the most efficient to give a vision on the long term and drive investments. Beyond the political changes, a stable Federal agency for transport policy can be a first step towards the long term. The stability of the funds in the long term can be a second step.

- Drawing an exhaustive transport policy taking account not only the infrastructure investment but also the performance of the infrastructure manager, the market conditions and the incentive schemes for the other modes. The analysis of the Swiss case shows that this exhaustiveness has been developed progressively from the first performance contract in 1980 to the infrastructure plan in 1986, the rail freight liberalization in 1999 and the incentive scheme in the years 2000. Today, each of these levers are cumulated.

- Considering the infrastructure manager as a privileged way to implement a transport policy by a strong monitoring. In Austria, the monitoring considers mainly the implementation of the infrastructure plan, while in The Netherlands and Switzerland, it concerns the implementation of the rail transport policy and the network manager performance. In any case, in each country, the performance contract is clearly a lever for the State and the monitoring is annual.

- Considering the pricing of access charges as an incentive lever to drive the market. In The Netherlands, the price per train-km is decreasing for trains above 600 tons and for the dedicated line from Rotterdam to the German border compared to the rest of the network. The highest number of incentives are in Switzerland where several discounts are offered for trains with a good environmental performance, anti-noise equipment or ERTMS equipment. This type of incentive scheme seems to be more and more preferred over the classic system of subsidies, costly and borderline with the European law.

- Considering the regulatory body as a key lever to manage the infrastructure manager and the market. A major change in the regulatory body would be an extension of its skills to the definition of the contract of performance. This approach does not exist in Europe but the advantages could be high according to the independence of this institution. First, it is a perfect intermediate between the political vision and the reality of the market. Second, such organization would be a small revolution for a rail sector used to be drive by the government with the risks of public capture (Laffont & Tirole, 1991; Crozet et al., 2014). Third, it will be a guarantee in the stability of the infrastructure manager monitoring on the long term. Concrete skills would be:
  - A regular and deep market analysis similar to Austria.
  - The definition and the monitoring of the contract of performance according to the political orientations.
  - A restrictive power on the pricing of access charges.
  - An extension of the juridical fields to the consumer's complaints similar to The Netherlands.
  - An extension of the field of the regulatory agency to the other modes of transport similar to Sweden[2].
- Implementing a European transport agency for regulation. The benchmark shows a high heterogeneity in the missions of the different regulatory bodies while the basics are similar.

[2] This case has not been detailed in the benchmark but since 2009, the Swedish regulatory body (Transportstyrelsen) is the only in Europe to be intermodal.

The European Commission kept the competencies for regulation and market monitoring. Then, it transferred its competencies for technical harmonization to the European Rail Agency. A similar transfer to the ERA or another agency would have beneficial impact in terms of coordination and harmonization for a better regulation of the rail single market. This last point cannot be neglected to improve knowledge about the market and its economic efficiency.

As to the governance and organization of intermodal freight transport policies in **WP6**, the different research activities resulted in the following scientific results.

- First, the two case studies (the failed 1997-2010 interfederal initiative to formulate a joined-up strategy for sustainable and intermodal mobility and transport, and the policy and administrative coordination in the transposition of the ITS EU-directive) gave evidence that while competences regarding freight transport and related policy domains in Belgium are indeed scattered across the federal and the regional level, the level of current policy-level and administrative integration is very limited and initiatives to increase such integration fail or yield only limited progress, especially when considering such integration across levels of governments. The evidence of the first case resulted in a list of enablers and impediments for policy level integration across policy domains and governmental levels (see figure 1, D1.1-1.2 G; Stevens and Verhoest 2016a), while the second case showed on the one hand policy makers to work rather autonomously with limited concertation and on the other hand clusters of cooperating administrative actors mainly located within the different governments and with very limited cross-governmental linkages (see D6.4. section 2). This policy fragmentation found in these cases proved during the research to be a major issue in intermodal freight transport policy more generally.

Figure 1. List of enablers and impediments

1. The willingness of the involved actors to work across organizational and governmental boundaries and the role of the coordinating actor in the constellation;
2. The inclusiveness of actors in procedures and communication;
3. Impatience, strict deadlines and the demand for quick wins;
4. The compatibility of policy orientations among involved actors;
5. The fit with operational policy plans;
6. Regionalization of transport competences;
7. The growing influence of the European Union and transnational institutions;
8. Sectorial changes and demands that have to be taken into account;
9. Political proliferation (after elections);
10. Budgetary cuts and austerity measures.

- The second set of case studies conducted in WP6 of two more successful initiatives of policy integration across policy domains and governmental levels, together with the other research activities done (see methodology) and findings of the first case study, resulted in extensive insights of under what conditions policy makers and administrative actors actively engage in collaborative policy design networks and which metagovernance strategies or network management strategies coordinators of such networks can apply to come to innovative, integrative policies. These insights (reported in Stevens 2017a; Stevens and Agger 2017b ; Stevens 2017c; and Stevens 2018b; Stevens and Dorren 2017) makes valuable contributions to the literature on policy integration and collaborative policy innovation networks, which has been so far limited in terms of contextualized analyses of the success of such strategies or which lacks knowledge on relevant factors based on inferential social network analyses (see e.g. Sørensen and Torfing, 2012; Torfing, 2017). A full account of the contribution towards the literature in terms of theory, methodology, and future research is given in the dissertation of Vidar Stevens (2018a: 196-2010).

- This empirical evidence in combination with extensive review of academic literature and former research resulted in the development of two toolboxes which detail processes, instruments and managerial techniques to increase policy integration, respectively administrative integration. First, as there is need of a well-considered reflexive management of the process to jointly co-create and frame innovative integrative freight transport policies, a detailed step-wise approach for successful policy integration was developed by BRAIN-TRAINS (see for detailed guidelines, D.6.4 section 4.1: toolbox for policy level integration pp.15-42). This toolbox extensively describes the following steps, referring to relevant approaches and tactics: (1) analysing the political and policy context; (2) identifying and involving the relevant stakeholders (political, administrative and societal); (3) setting up a strong groundwork from where the collaboration can unfold; (4) different approaches in which the coordinator can manage the collaborative process by using different 10 network management strategies; (5) different approaches in order to policy learning activities in collaborative decision-making processes; and (6) developing and agreeing on an strategic plan for implementation. This toolbox is directly relevant for federal and regional policy makers aiming to design jointly an innovative and integrative strategy for intermodal freight transport policies. Beyond its practical use in this specific domain, the toolbox approach to policy integration is also relevant to other policy issues in which governments need to coordinate with each other and internally.

- Similarly, a toolbox for administrative integration was designed which formulates coordination instruments in order to secure implementation of the jointly agreed policy measures as well as the necessary conditions at (inter)organizational level (see for detailed guidelines, D.6.4 section 4.2: steps towards administrative level integration pp.43-61). The toolbox shows the relevance of deploying network instruments (like systems for sharing data and information as well as platforms for coordination), transport chain coordination and a better coordinated regulation of the different markets (like rail, road, IWW) as well as the need for hierarchical instruments to get the jointly agreed policy measures implemented through the ministerial hierarchies and related agencies. The toolbox also highlights the conditions for effective implementation of joint strategies and collaboration within and between governments: (1) a clear mandate (including organizational leadership commitment, ministers' and stakeholders' buy-in, and clearly defined and agreed joint outcomes); (2) well-functioning performance management systems (including appropriate accountability frameworks, sufficient resources, and performance measurement process), and (3) collaborative behaviour, by having the right skills and competencies, coordination-supporting organizational cultures and shared values. Again, the toolbox is also applicable for cross-cutting policy issues, other than intermodal (railway) freight transport.

- The study shows that, in order to achieve the best case scenario, high levels of policy and administrative integration regarding intermodal (railway) freight transport prove to be necessary. Hence using the abovementioned developed toolboxes, the following recommendations in terms of process-related and instrumental approaches were formulated (see for full details on the recommendations: D7.2, concluding section):

- ✓ Integrate federal and regional intermodal freight transport policies into an interfederal long term vision and plan
- ✓ Make the co-creation of (interfederal) intermodal freight transport policies more effective and innovation-oriented by applying the steps as outlined in the toolbox for policy integration (D.6.4 section 4.1)
- ✓ Make the jointly agreed policies for intermodal freight transport into reality by fostering administrative coordination and implementation within and between governments (taking into account the conditions and instruments as described in the toolbox for administrative integration, see D6.4, section 4.2)

- However, also recommendations about institutional changes within Belgium and at the EU-level to be considered have been formulated:
  - ✓ Increase the expertise on (intermodal) freight transport policies within the core-administration (ministries/departments) and ministerial cabinets both at federal and regional level.
  - ✓ Rationalise and streamline the landscape of coordination bodies in which federal and regional actors aim to concert their policies and actions regarding (public/freight) transport policy, or mobility more broadly and make them more well-performing
  - ✓ Assign a joint interfederal body (like the ECMM) encompassing the ministers of mobility (assisted by their top administrators) which not only develops and renews the interfederal intermodal freight transport policy, but which also monitors and discusses the implementation of intermodal policy measures by the different governments
  - ✓ Create or upgrade to a full-fledged market regulator, with an independent status, resources and expertise and a strong and broad regulatory mandate (as recommended in WP5), with a good collaboration and intense interactions with the competition authority
  - ✓ Advocate towards the EU for institutional changes at the EU-level by the creation of an European agency for economic regulation and a competition authority in order to make an economic single market for the rail sector and to avoid dominant positions on that European market

5. DISSEMINATION AND VALORISATION

The results of this research have been disseminated through their presentation in several scientific conferences of operations research (ORBEL, EURO, IFORS, OR) and transport (BIVEC-GIBET, NECTAR, WCTR, TRA, ETC). Results of the project are also used for academic purposes such as presentations during courses such as the Antwerp Rail School edition 2015 and 2017. Research results have also been presented and discussed at the annual BRAIN-TRAINS workshops organized during the project lifecycle. Results have been valorized through their publication in scientific journals and proceedings of conferences. A list of publications is provided in the next section. Results are also publicly published on the website (http://www.brain-trains.be) and have been frequently made visible by publishment in the academic newsletters.

The academic research done by the UA research group 'Public Administration and Management' (PAM) within BRAIN-TRAINS was presented at eight different conferences (including IPSA – International Political Science Association conference, IRSPM International Research Symposium on Public Management, ICPP conference of the International Public Policy Association, EGPA European Group of Public Administration, WIPCAD), next to the joint papers with the other research teams be presented at other conferences. Also one practitioner-oriented book chapter was published, besides one PhD dissertation and seven scientific articles and book chapters (see next section 'publications'). The interim results were also discussed with practitioners at the BRAIN-TRAINS workshops and at the BRAIN-TRAINS final conference. The results also inspired the content of an executive training program in 2017-2018 and in 2019, called ‘Masterclass network organisation and network leadership’ to which public managers from the federal, Flemish and local level participate in order to increase their skills for policy and administrative integration. Moreover, the publications and PhD dissertation are openly accessible. A valorisation of another kind is that the research and resulting theoretical and methodological insights on policy and administrative integration within BRAIN TRAINS helped in acquiring additional H2020 research funding, as the research group on Public Administration and Management of UAntwerp became partner and work package leader in the H2020 research and innovation project TROPICO ‘Transforming into Open, Innovative and Collaborative Governments’ (2017-2021), which consists of 12 European universities.

6. PUBLICATIONS

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