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MYTH OR POSSIBILITY – INSTITUTIONAL REFORMS AND CHANGE MANAGEMENT FOR MODE SHIFT IN FREIGHT TRANSPORT

SUMMARY REPORT 1 OF THE STUDY
LowCarb-RFC – EUROPEAN RAIL FREIGHT CORRIDORS GOING CARBON NEUTRAL

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Zurich, Karlsruhe, 30 June 2018

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ABSTARCT

This summary report combines the regulation and other policies supporting innovation with concepts of change management and the creation of new markets for rail transport and climate mitigation on European freight corridors. Improved competitiveness of the railways requires solving the double challenge of earlier and more extensive liberalisation of road haulage and the dominant role of the incumbents in rail freight.

Rail freight growth requires the reform of complex internal structures, long decision pathways and overcast expectations towards rail. This requires changes in the organisation and institutional setting of rail freight together with infrastructure expansion, digitalisation and modernisation. We find that current institutional design and adaptation efforts of incumbents, while introducing major change, remain distant from their final customers. Deeper institutional reform processes, as planned for DB, would require more political pressure in order to materialise.

In the longer term new operators could improve rail's competitiveness with respect to road. Success factors include equivalent working conditions, across modes, standardisation of rail systems and innovation support. A survey of business models in other sectors finds common developments including predictive logistics, use- and results-oriented product service systems, horizontal cooperation and bundling. These may well complement traditional company strategies.

ZUSAMMENFASSUNG

Der vorliegende Bericht führt makroökonomische Politikwerkzeuge wie Regulierung und Interventionen mit Unternehmensstrategien wie Change Management und Marktdesign für mehr Bahnverkehr und Klimaschutz zusammen. Bessere Marktbedingungen für die Güterbahnen bedürfen der Auflösung eines doppelten Ungleichgewichts durch die frühere und entschiedenere Liberalisierung der Straße und die strukturbildende Rolle der Staatsbahnen.

Neben externen Faktoren benötigt ein Wachstum der Schiene die Auseinandersetzung mit komplexen Organisationsstrukturen, langen Entscheidungswegen und ideologischen Erwartungen an den Sektor. Dies braucht Veränderung der Organisationsstrukturen und Institutionen der Bahnen zusätzlich zu Kapazitätserweiterung, Digitalisierung und Modernisierung. Jedoch bleiben selbst weitgehende institutionelle Reformprozesse meist marktfern. Dringend benötigte, tiefere institutionelle Design- und Anpassungsprozesse wie von DB Cargo anvisiert finden jedoch nur unter massivem externen Druck statt.

Mittelfristig können neue Akteure die Wettbewerbsfähigkeit der Bahn gegenüber der Straße befördern. Erfolgsfaktoren beinhalten gleiche Arbeitsbedingungen und Innovationsförderung. Über verschiedene Sektoren zeigen sich prädiktive Logistik, anwendungs- und ergebnisorientierte Produkt-Service-Systeme, horizontale Kooperation und Bündelung als geeignete Geschäftsmodelle. Diese können zusätzlich zum traditionellen Geschäftsmodell von Unternehmen Anwendung finden.

1 CONTEXT

1.1 THE LOWCARB-RFC STUDY

This publication is one of three summary reports of work performed within the study "Low Carbon Rail Freight Corridors for Europe" (LowCarb-RFC). The study has been co-funded by Stiftung Mercator Foundation and the European Climate Foundation over a three-year period from September 2015 to November 2018 and is carried out by the Fraunhofer Institutes for Systems and Innovation Research ISI (Karlsruhe) and for Logistics and Material Flows IML (Dortmund), INFRAS (Zurich), TPR at the University of Antwerp and M-FIVE GmbH (Karlsruhe).

The LowCarb-RFC study concentrates on long-distance freight transport along major European corridors as this sector is among the most steadily growing sources of greenhouse gas emissions in Europe. It is the most difficult to address by renewable energies and other standard climate mitigation measures in transport. Starting from the classical suite of strategies such as "avoid", "shift" and "improve", the LowCarb-RFC methodology concentrates on mode shift to rail and mitigation measures in all freight modes along the two major transport corridors crossing Germany: Rhine Alpine (RALP) from the Benelux countries to Northern Italy and North-Sea-Baltic (NSB) from Benelux via Poland to the Baltic States. Besides major European strategies, the project concentrates on the implications for transport policy at the intersection of these two corridors, which is the German Federal State of North-Rhine Westphalia (NRW). The project focuses on rail as a readily available alternative to carry large quantities of goods along busy routes by electric power, and thus potentially in a carbon neutral way. Within this setting, the project pursues three streams of investigation:

- **Stream 1: Railway Reforms**. This section of the LowCarb-RFC project responds to the idea of rail freight as a strong pillar of climate mitigation policy. It considers the slow pace of climate mitigation in the freight transport sector and asks the question how regulatory frameworks, company change management processes or new business models can accelerate them.
- **Stream 2: European Scenarios and Impacts**. For rail, road and waterway transport along the two corridors, cost and quality scenarios are established and their impact on modal split, investment needs and sustainability are modelled. This stream is the analytical core of the study and shall provide the basis for the subsequent analysis of pathways of interventions.
- **Stream 3: Case Study NRW**. This step eventually breaks down the transport scenarios and intervention pathways to the local conditions in NRW and looks at the implications for investments or de-investments in certain infrastructures, jobs, economic prosperity and the environment.

1.2 PURPOSE OF THIS REPORT

This report summarises the results of Stream 1 of the LowCarb-RFC project. It aims at bringing together the macro-economic policy tools of regulation and interventions (EU and national railway reform packages) with business strategies of change management (reactions of railway companies and new entrants) and the creation of new markets and services, considering future challenges and potentials with regard to digitalisation and automation. Regulation strategies and new business models are picked from successful projects and in particular from innovative new market entrants into the classical railway business based on market observations and expert interviews from within and from outside the railway sector. In contrast, change management processes are derived from economic literature and sector publications.

In the past, industrial adaptation processes have taken decades to evolve from first prototypes to full market entry. For instance from the development of steam engines, electric light and the automobile to their large scale use in factories, private homes and on public roads around 50 years passed. This corresponds to a complete professional life, giving companies and institutions sufficient time to digest these new opportunities. Current speeds of innovations are considerably faster. From the opening of the world wide web for commercial use in the early 1990s to its first bubble only 10 years passed. Mobile communication entered consumer markets within a few years and real world tests with automated vehicles would not have been conceivable so quickly in the early 2010s.

New technologies, in particular in the IT sector, bring about new ways of making business and influence the expectations of customers. On top of that, political and social changes, e.g. through the formation of the European Union, and the rising urgency of climate change put additional pressure on organisations and companies to modernise. In particular for an infrastructure-heavy sector like the railways with partly 200-year-old legal and technology roots a quick adaptation to new business cultures and market demands appears difficult. This publication shall shed some light on options and barriers for this endeavour.

This summary report paves the road for detailed scenarios in the railway sector towards 2050. The lessons learned from the theory or regulation and organisations and from the assessment of emerging business models set speed and magnitude of conceivable changes in high volume freight markets as a contribution to deep greenhouse gas mitigation strategies.

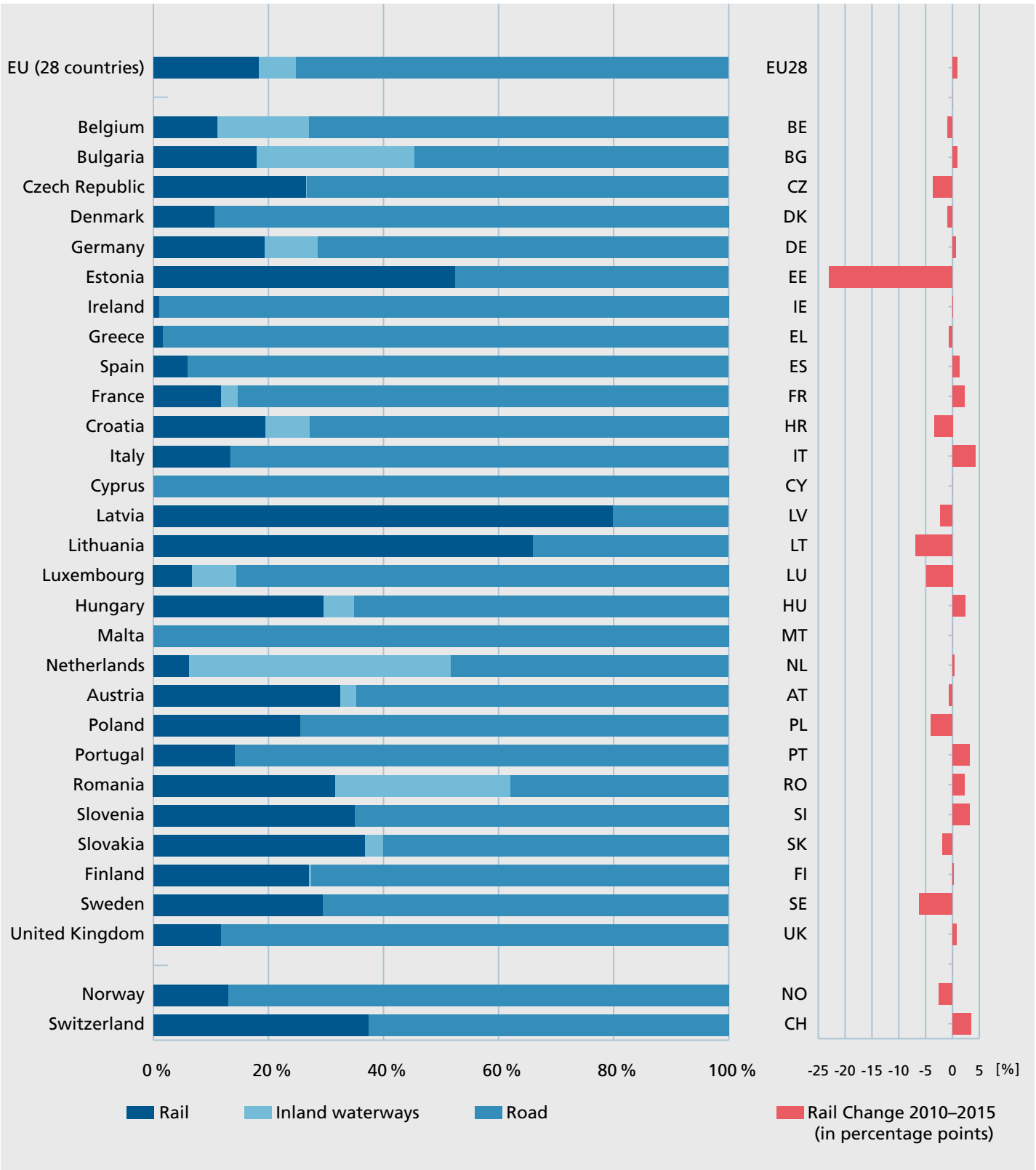


FIGURE 1: Modal split of inland freight transport 2015 (% of total tkm) and change in railway transport since 2010 (in percentage points)

EU28 includes rail transport estimates for Belgium (2015), inland waterways transport estimates for Finland and does not include freight transport for Malta (negligible); BE (estimated values for 2015), FI (estimated values for 2010) (Eurostat 2017).

Graphic INFRAS. ***Source****: Eurostat 2017.*

2 CHALLENGES FOR THE RAILWAYS IN A DYNAMIC MARKET

2.1 EUROPEAN INITIATIVES TO BOOST RAIL FREIGHT

Carrying cargo by rail or ship is considerably safer, cleaner, less energy consuming and more climate friendly than shipping by road haulage. Studies computing the external costs of transport reveal the external costs of rail freight and barge transport are four to five times lower than the external costs of trucking across the EU (van Essen et al. 2011). Moreover, the railways can be very cost-efficient when transporting large quantities of goods over longer distances. This is for example the case in port hinterland transport or in the access to and from large production facilities. Even in smaller and more local production environments like food and retail markets railways can be used successfully, given the cooperation of forwarders and rail undertakings.

An approach to boost innovation and market success in the railway sector by the European Commission is to enforce competition, mainly through improving access conditions for new entrants, improving interoperability and transnational infrastructure and supporting innovation programmes especially for combined transport. In the recent past, the European Commission has set itself an ambitious goal: Revitalising rail transport in the EU by boosting competition. However, the liberalisation of the rail market in Europe turns out to be a challenge: "A more competitive and efficient rail industry is a prerequisite for achieving the targets of reducing emissions […]" (European Commission 2018).

With regard to the railways' sustainability benefits, transport strategies and master plans on the European level like the 2011 White Paper (European Commission 2011) and the Connecting Europe Facility (CEF) regulating 2013 to 2020 investments into the Trans-European Networks for Transport (TEN-T) pay special attention to the railways and to multimodal facilities. According to the 2nd Work Plan of the Rhine-Alpine Core Network Corridor (CNC), the EC reports 76 % of investment costs going to these categories. In addition: through the Marco Polo programmes the EC has invested considerable funds in intermodal freight facilities in order to combine the strengths of road and rail and thus to compensate for the system disadvantages of the railways. Similar priorities can also be found in national investment programmes.

2.2 PERFORMANCE SO FAR

Modal split: In most countries today's transport market is dominated by road transport

Overall, the modal split of freight transport in the EU has been stagnating since 2010. On average, about 18.3% of the modal split of freight transport can be assigned to railways (2015) (Eurostat 2017).

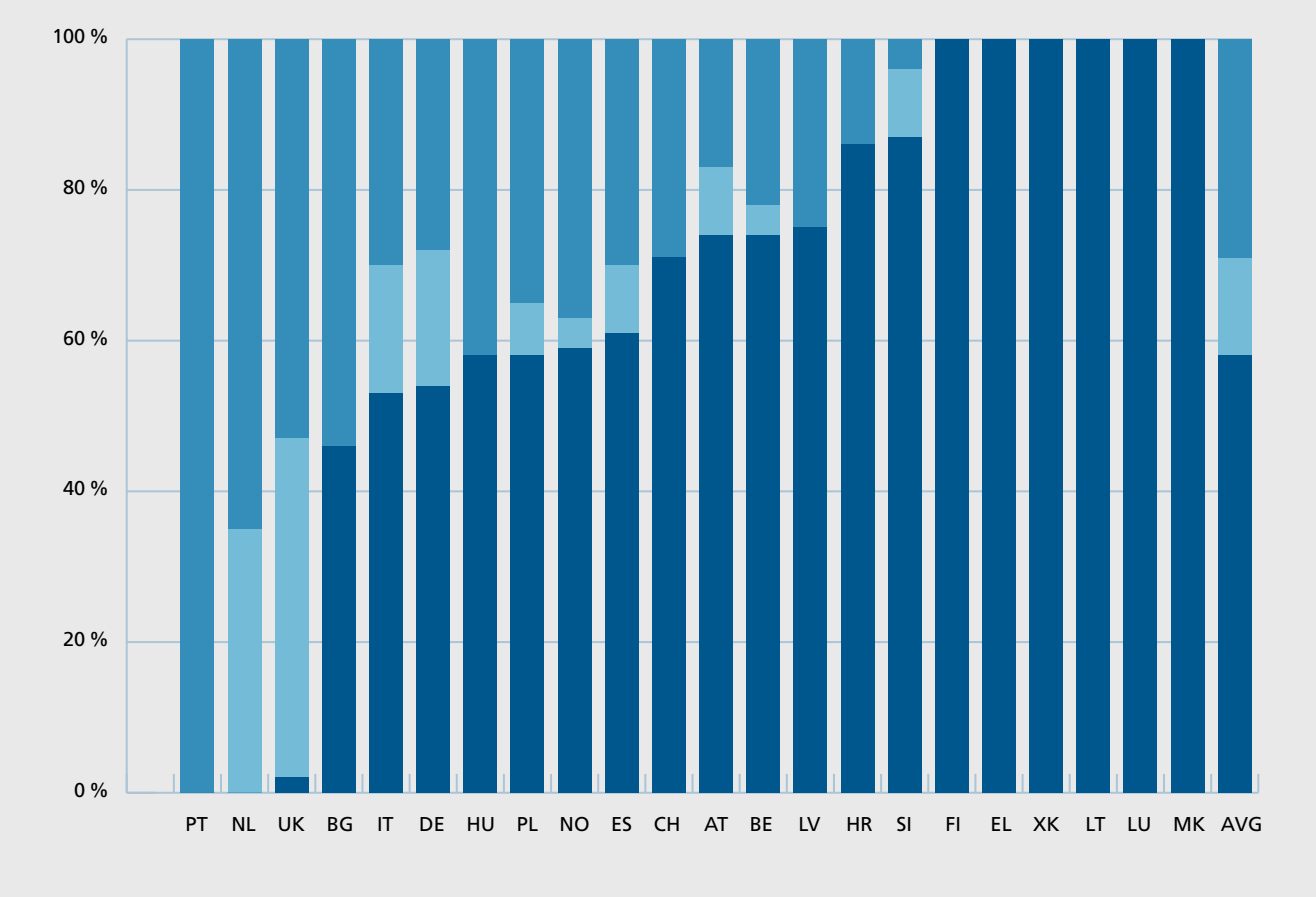
With respect to the current situation in most countries, Crozet et al. (2014) argue, that "rail freight is still facing a doubly-imperfect competition". According to the authors, the identified mismatch is characterised by two main aspects. On the one hand, Crozet et al. address intermodal competition: the competition between road and rail is, from their perspective, "off balance". The authors emphasise the "extensive deregulation" in the road sector. They put this down to the fact that, compared to the rail sector, the liberalisation of the road sector happened at an earlier stage. On the other hand, they describe the intra-modal competition – namely the competition between railway operators – as "imperfect". There, major companies "play a structuring role" (Crozet et al. 2014).

Market shares and importance of incumbents: A heterogeneous picture across Europe

The Second Railway Package (2004) demanded that access to the entire EU rail network must be granted for all types of rail freight services and service providers by 2007. Since this point in time, freight services have been fully open to competition (European Parliamentary Research Service 2016, Grenfell et al. 2013).

In a nutshell, it can be stated that the liberalisation of the rail markets is still "insufficient" – as argued in a report by the European Parliamentary Research Service (2016) for instance. In most countries, incumbent operators dominate the freight market (European Parliamentary Research Service 2016, Crozet 2016).

FIGURE 2: Market shares of freight railway undertakings 2016 (based on net tonne km)



***AVG** = Average for all countries which provided data.* ***Sources:** IRG-rail 2018a, IRG-rail 2018b.*

In theory, this coincides with the European Court of Auditors' definition of new entrants, according to which these are rail freight operators, which are operating in a "competitive market" (European Court of Auditors 2016). On the one hand, the number of companies or the share of non-incumbent players might serve as an indicator to assess the openness of a market for new entrants. On the other hand, however, the market share of new entrants alone cannot explain the intensity of competition, as the authors of the IRG market monitoring report point out (IRG-rail 2017).

2.3 REGULATORY FRAMEWORKS IN SELECTED COUNTRIES

Different national political situations, different strategies in selected countries

Making the railway sector more competitive is one of the key objectives of the European railway reforms to boost liberalisation processes. By starting with Directive 1990/440/EG in 1990 the reform policy now consists of four railway packages (Doll et al. 2017). However, the extent of rail freight liberalisation in Europe varies from one country to another. Crozet et al. describe the processes "as a slow movement that is gradually taking place throughout Europe" (Crozet et al. 2016).

Western European Countries, such as the Netherlands, the United Kingdom or Germany, were among the first to liberalise their rail freight markets, starting in the mid-1990s. In contrast to that, Eastern and Central European Countries, such as Hungary, Slovakia or Slovenia, started their reforms in the early years of the 2000s (Crozet 2016).

The following tables sketch the extent to which the liberalisation approaches vary from one country to another. Against the backdrop of the general focus of the LowCarb-RFC research project, we specifically consider the following six countries: Belgium, Germany, Italy, Poland, Switzerland and the Netherlands.

BELGIUM

	Key measures	Scientific classification
1991	SNCB (Société nationale des chemins de fer belges) turned from a state company to a "public limited company with an independent management" (Van Voorde & Vanelslander 2014).	Van de Voorde and Vanelslander (2014) claim, that – in comparison to other European countries – rail freight transport does not have "a prominent position" in Belgium.
2005	Transformation into a holding company (SNCB Holding and the two daughter companies Infrabel and SNCB).	
2013	Initiative to transform the holding structure; consisting of Infrabel as infrastructure manager and N-SNCB as train operator.	

***Source:** INFRAS with data from Van de Voorde and Vanelslander (2014).*

Van de Voorde and Vanelslander (2014) are very critical of the results of the liberalisation processes in Belgium. Even though the minimum requirements of the EU directive 91/440 – demanding a separation between network and operations – were met, the authors question whether this really served the underlying objectives: to gain an efficient and competitive market.

Despite this critical perspective, the authors consider that the reform resulted in three essential outcomes: the separation of rail infrastructure and services, the fact that rail facilities were easier to access and that the independence of regulators was guaranteed. Van de Voorde and Vanelslander conclude that this "far-reaching liberalisation process" resulted from pressure on a European level.

GERMANY

	Key measures	Scientific classification
1994	Transformation of the two state enterprises "Deutsche Bundesbahn" and "Deutsche Reichsbahn" into the Deutsche Bahn AG. By implementing Directive 91/440/EC transportation markets were opened for entrant firms.	The railway sector reform ("Bahnreform") initiated the liberalisation process of the German railway sector. The Fall of the Berlin Wall represents a historical turning point. Several factors – such as an unsatisfactory performance with respect to rail transport of passengers as well as of goods – increased the pressure on policy actors to reform the rail sector (Schwilling & Bunge 2014).
1994	Separation of Deutsche Bahn AG into five subsidiaries.	
2008	Plans to partially privatise Deutsche Bahn AG failed.	
2013	Proposal for a new railway regulatory law was blocked in the second chamber (Bundesrat). Its aim was to enhance competition in the railway sector.	

***Source:** INFRAS with data from Haucap & Pagel 2014, Kirchner 2011, Schwilling & Bunge 2014.*

In their analysis of the development of rail freight in Europe, Haucap and Pagel (2014) argue, that in Germany "intra-modal competition has developed well, especially in comparison to markets in other EU member states" (Haucap & Pagel 2014). Regarding current developments, however, the authors criticize the following two aspects: On the one hand, despite the liberalisation process, the ownership of rail infrastructure and operating services has not been separated. Due to its vertically integrated structure, Deutsche Bahn AG owns subsidiaries such as DB Schenker Rail AG (transport services) and DB Netz AG (infrastructure manager). On the other hand, the European Commission as well as the German Monopolies Commission have suggested "to vertically separate the infrastructure and transport services more clearly" in order to guarantee non-discriminatory access (Haucap & Pagel 2014).

ITALY

	Key measures	Scientific classification
1992	Conversion of Ferrovie dello Stato (FS) (today: Ferrovie dello Stato Italiane, FSI) to a joint stock (state-owned) company.	On the one hand, the opening of the Italian railway sector came into force "well ahead of the deadlines set by the European Union", according to Lanfranco Senn and Tatiana Cini (2011). On the other hand, the authors underline that the market share of rail did not considerably increase due to the reforms.
1999–2001	Law 388/2000 granted open access to the railway infrastructure; the former monopoly FS "became a licensed railway undertaking". In the aftermath of EU directive 91/440 Trenitalia was created (Senn & Cini 2011).	
2003	2003: Full liberalisation of freight international services (OECD 2013); Law 188/2003 allowed international freight undertakings to access the railway.	
2007	Full liberalisation of freight domestic services (OECD 2013).	

***Source:** INFRAS with data from Desmaris 2016, OECD 2013, Senn & Cini 2011.*

According to Lanfranco Senn and Tatiana Cini, the railway sector in Italy "remains full of barriers to competition" (Senn & Cini 2011). In their analysis, the authors underline, on the one hand, the reform processes and efforts to liberalise the sector within the past two decades. On the other hand, they underline the existing hurdles. Among these barriers are "non-availability of rolling stock, lack of secondary markets and of interoperability".

POLAND

	Key measures	Scientific classification
1990–2003	The state-owned company "Polskie Koleje Państwowe" (Polish State Railways) was restructured, reformed and privatised.	According to Engelhardt (2011) recent developments in the Polish rail sector are two-fold. On the one hand, it has progressed a lot, especially since Poland became a member of the European Union. On the other hand, however, the author argues that the achievement of reforms is "still not satisfactory".
2004–2009	Implementation of most EU legislative acts.	

***Source:** INFRAS with data from Engelhardt 2011, Pieriegud 2014.*

In his analysis, Engelhardt argues that Poland's regulatory model "is fully adjusted to the European law" (Engelhardt 2011). The author states that companies of the PKP Group play a "dominant" – however declining – role on the comparatively "new" rail market in Poland. The fact that private operators are gaining in relevance, is assessed as "indicative of increasing liberalisation". Despite this progress, Engelhardt expects an oligopolistic market structure in the future where a few undertakings might dominate the market. Similarly, Jana Pieriegud (2014) concludes that a difference to other European markets is, that "a small group of companies deliver more than 90% of transport performance in the rail freight market in Poland".

SWITZERLAND

	Key measures	Scientific classification
1996/1999	Railway Act and Railway Reform 1: Modification of the legislative conditions for railway operation, i. e. separation of operation and infrastructure, more competition in particular on the rail freight network and liberalisation of the rail freight sector (Swiss Federal Office of Transport 2012, 2018).	In comparison to EU member states, the rail freight sector in Switzerland stands out: There, its modal share is – according to the European Court of Auditors – about 170 percent higher than the average in the European Union (European Court of Auditors 2016). In a report, published by the Swiss Federal Office of Transport in 2012, it is argued that the railway reforms in the recent past have set the baseline for "good framework conditions for the railways" in Switzerland (Swiss Federal Office of Transport 2012).
from 2005 (2007/2010)	Railway Reform 2: subdivided into three packages; i.e. equal treatment of all transport companies; improvement of interoperability with actors from the EU and improvement of the organisation of public transport infrastructure Swiss Federal Office of Transport 2012, 2018).	

***Source:** INFRAS with data from Swiss Federal Office of Transport 2012, European Court of Auditors 2017, Swiss Federal Office of Transport 2018.*

In general, it can be stated that the Swiss railway sector often serves as a role model for other countries and actors from abroad (cf. European Court of Auditors 2016). Desmaris (2014), who analyses the reforms of passenger rail, highlights two positive outcomes resulting from the reforms of passenger transport: a "more efficient use of public funds" on the one hand as well as a "significant improvement in the quality of services for passenger rail". With respect to rail freight transport, the Swiss "road-to-rail policy" (Swissinfo.ch 2011) plays a decisive role: On the one hand, Switzerland increased the weight limit of trucks up to 40 tonnes. On the other hand, however, a heavy vehicle tax was introduced in 2001. The objective of this policy is to significantly reduce the number of trucks (max. 650,000 in 2018) that cross the Alps every year. This policy was strengthened by popular votes as well as by huge investments into the infrastructure and rail expansion as in the Gotthard Base tunnel for instance (Swiss Federal Office of Transport 2016, Gottardo 2016).

THE NETHERLANDS

	Key measures	Scientific classification
1995	The rail way operator NS (Nederlandse Spoorwegen) was split up into various daughter companies.	By comparing the market structure of the Netherlands and Belgium, Van de Voorde and Vanelslander (2014) argue with respect to the Dutch rail market that it has "truly transformed since the liberalisation, much more than the Belgium market".
2000	The freight division NS cargo was sold to Raillon (subsidiary of DB Logistics).	
2002	The infrastructure management and the main operator were fully separated.	
2005	Railways Act came into force (Ministry of Transport Public Works and Water Management 2010).	

***Source:** INFRAS with data from Deville & Verduyn 2012; Dionori et al. 2011, Ministry of Transport, Public Works and Water Management 2010; ECMT 2005.*

According to a report published by the OECD, the Dutch Railway Act has led to partial liberalisation of the railway market. While there are still restrictions with respect to passenger transport, rail freight transport is "fully open for competition" (OECD 2013). However, the OECD report criticises the fact that there "have been few developments in the Dutch railway market following liberalisation of the international rail tracks". The report states that there are capacity constraints and entry barriers for international actors (OECD 2013).

Comparison: The role of market openness

The following table provides a brief overview of the modal split and the market openness of the six countries of interest in this report. Regarding the modal split, it compares the share of railways in the inland freight transport, regarding the market openness it sheds light on the market share of non-domestic incumbents, namely foreign incumbents and non-incumbents.

TABLE 1: Modal split (railways, 2015) and market openness (foreign incumbents + non-incumbents in %, 2016)

Country	**Railways-Modal split** of inland freight transport 2015 (% of total tkm)	**Market openness** (Market share of foreign incumbent + market share of non-incumbent, based on net tonne-km, in %, 2016)
Belgium	11.1%	26%
Germany	19.3%	46%
Italy	13.4%	47%
Netherlands	6.1%	100%
Poland	25.5%	42%
Switzerland	37.4%	29%

***Source:** INFRAS with data from IRG-rail 2018b, Eurostat 2017.*

Based on this data, the table does not indicate a correlation between the share of foreign incumbents and non-incumbents and the share of railways in inland freight transport.

2.4 MAIN CHALLENGES OF THE RAIL FREIGHT SECTOR

National variety of strategies as a key barrier

In general, it can be concluded that the rail freight sector is struggling with the fact that national strategies are still very different. According to the European Parliamentary Research Service (2016), new entrants often face barriers and discrimination, especially due to the strong position of incumbents. In order to find pathways towards climate neutral freight corridors, it is of key interest to further discuss and question these barriers (European Parliamentary Research Service 2016).

Market and institutional barriers

The rail freight sector has to deal with numerous institutional barriers, disparities and competitive challenges, which can only in part be influenced by the railway sector. Challenges can be attributed to technology and market trends, policy and regulatory settings and to the structure of the railways themselves. While many reports and policy communications have elaborated on the factors hindering real market growth of the railways, in the following we list a selection of barriers to rail freight success.

- **Challenges imposed by the road sector:** Declining costs for trucks, drivers and fuels through larger trucks, autonomous driving, platooning and electrification will improve the competitiveness of road haulage in the future. Since the truck vehicle industry is globally organised, economies of scale are supposed to be much bigger than in the railways sector (with weak competition in the European rolling stock market).
- **Decreasing mass product markets:** The railways are traditionally strong in bulk markets with currently low or even negative growth potential, whereas unitised freight markets triggered by e-commerce with stronger growth rates are particularly suitable for road logistics.
- **Complex and rigid institutional settings across Europe:** Interoperability deficits, low inter-sectoral competition and the complex stakeholder structure in combined transport slow down innovation and market adaptation processes in rail transport considerably.
- **Internal organisation:** Based on their business models and production concepts, rail actors often have complex internal organisations and long decision pathways, which hinder railway companies from reacting flexibly to the dynamic market challenges. Thus, the timeline for the diffusion of new investments is critical.
- **Vulnerability and external shocks:** Disruptions of services like the Rhine Valley rail tunnel collapse in summer 2017,

large construction sites or strikes hit the railways way harder than the road sector due to complex and partly outdated routing and path allocation procedures.

Barriers from the customer's perspective

Within the LowCarb-RFC project, Transport & Environment has organised a rail stakeholder platform. In a protected environment shippers and operators were discussing options to support rail freight transport across Europe. Among many good concepts and initiatives, the platform meetings also listed the key barriers to more rail freight from the perspective of shippers, technology providers and new market entrants.

- **Limited growth potential for rail freight.** Relatively ambitious scenarios of modal shift for the railways still only project a maximum market share of 24% against 18% today. The main reasons restricting the theoretical growth of rail transport beyond this limit are cost advantages of the road sector, infrastructure capacity and quality shortages, flexibility deficits of rail due to lower densities of rail networks compared to road, priority of passenger over freight trains and complex and non-transparent booking systems.
- **Hard market entry conditions for disruptive companies.** The emergence of innovative players with new ideas to move rail freight towards the 21st century is often considered the only option to reform the sector from within. New market entrants, be it technology or service providers, mostly face protected markets with high upfront costs. These ideas and concepts are then hard to adopt on a large scale unless the incumbent companies are investing in them, which makes innovation reliant on support from established companies.
- **Rail freight suffers from ideological burden.** Carrying freight by rail is a business just like other elements of the production chain. Considered in that way, pragmatic and market-oriented structures could possibly make good use of the bundling and efficiency advantages of the system and establish stable markets. However, rail freight is considered a public sector obligation, in particular outside Germany. This political and ideological dimension slows down reform and innovation processes in the sector. Also, due to the low number of companies compared to road, shippers often need just one bad experience with rail before switching to road as other options on rail are scarce.
- **Competition in the rail freight market has positive as well as negative implications.** Shippers desire competition because it makes more options available, drives down shipment costs and potentially fosters innovation in the sector. However, this comes at a cost: incumbent railway undertakings earn less revenue on highly profitable markets to cross-subsidise unprofitable services. Competition in the market thus fuels the concentration of both, new market entrants and incumbents, on profitable market segments and consequently reduces the presence of the railways across the country. This manifests the system disadvantages of rail transport compared to trucking which exist anyway.
- **More flexible, reliable and cheaper services are the key to a modal shift.** Freight transport is a business with controlling and managing units in companies deciding on the best way to run it. In this environment costs play the most decisive role. For forwarders, costs are not only monetary expenses, but also the impact of certain supply characteristics on subsequent production steps. Therefore, reliability and safety, flexibility, etc. can be transformed into cost saving potentials or cost increasing risks. Mode choice decisions in freight are driven by these categories. Sustainability goals and the image of alternatives may play a role too for some companies, but the measurable impact of these factors for the majority of firms is at best marginal.

Despite these many obstacles and barriers to rail use, the platform meetings have unveiled a number of success stories. These include companies with a traditionally high value for social responsibility, as well as companies who have entered this track later. The practice cases show that if a company managed to get shipments by rail or with inter-modal transport chains running, the advantages for their supply chain became obvious. So the spread of good examples within the production and rail sectors is key to turn managers' views from truck to train. More info is available at the T&E Rail Freight website: www.lowcarbonfreight.eu

Considering these challenges, new and flexible business strategies and change management are decisive for a successful market penetration:

- How to react to institutional frameworks and how to improve internal organisation?
- How to enter new markets?
- How to adapt business models in digitalised markets?

The following chapters analyse the strategies from the German railways on the one hand and new entrants on the other hand, in order to develop a stringent business model framework and conclusions to improve institutions and business strategies.


DB
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3 INSTITUTIONAL CHANGES IN LARGE RAILWAY COMPANIES

This section analyses how institutional and organisational changes, which have taken place in the rail transport sector during the last 25 years, have influenced the railway sector's intermodal competitiveness in a positive or negative direction. We focus on the case of Germany as it is the largest country crossed by the LowCarb-RFC corridors Rhine-Alpine and North-Sea-Baltic.

The combination of radical technological change and a major market challenge suggest that a large scale transformation or transition of rail freight is needed. This then suggests that an appropriate analytical framework for such a radical innovation is the Multi-Level Perspective on transitions (MLP), introduced in Grin et al. (2010) and Köhler et al. (2018). The dominant firms in an industry – the regime – are usually resistant to such change. If the regime responds to the changes by changing some of its practices and institutions, possibly replacing some actors, it may successfully adapt to the new circumstances. If a regime is unable to adapt, it collapses or is overthrown, and is (eventually) replaced by a new regime better suited to the new conditions, a transition to a new regime.

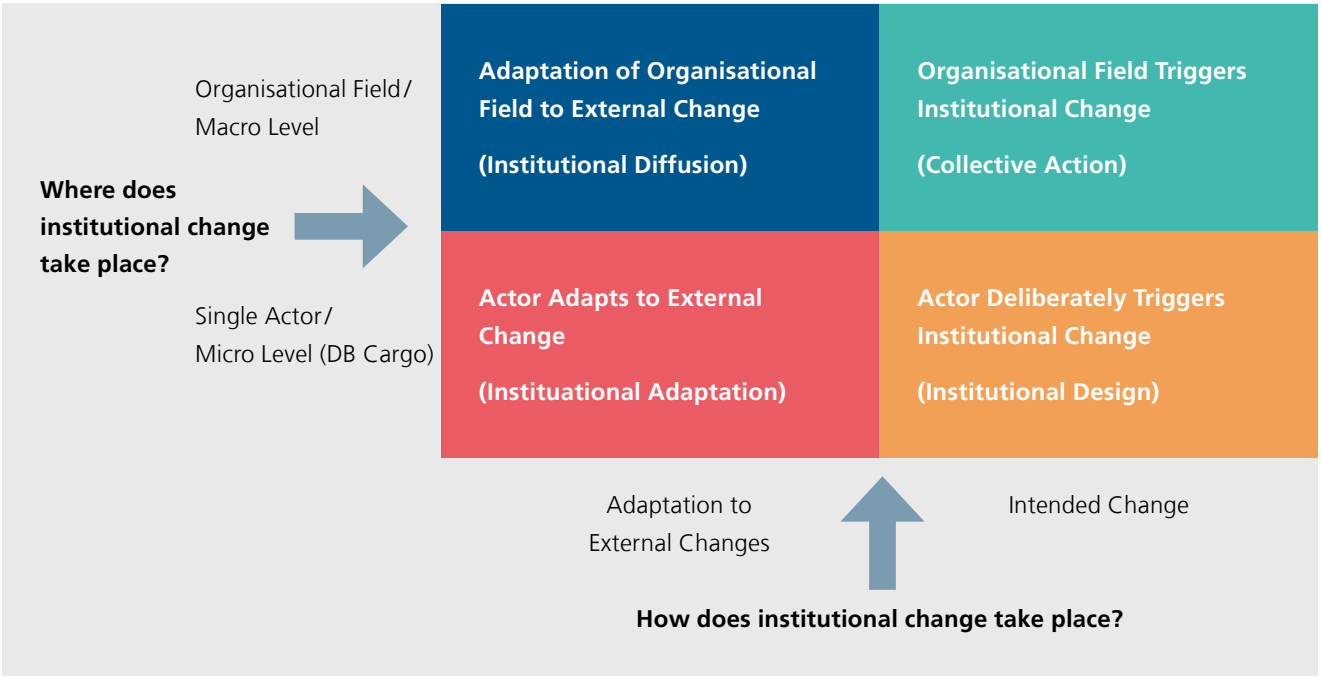
The MLP is linked to the literature on institutional change in which four different perspectives on institutional change are discerned: institutional design, collective action, institutional adaptation, and institutional diffusion. Each of these perspectives examines the situation in the German rail freight sector from a different angle. Based on this analysis, processes of institutional change and their potential impact on modal shift are discussed.

3.1 FOUR PERSPECTIVES ON INSTITUTIONAL CHANGE

First of all, it is important to provide definitions of the terms institution and institutional change. One of the most frequently cited definitions of the term institution is the one proposed by North (1990), who states that institutions are "the rules of the game in a society, or more formally, … the humanly devised constraints that shape human interaction." Institutional change can then be defined as "the difference in form, quality, or state over time in an institution" (Van de Ven & Hargrave 2004).

Our analysis of institutional change in the German rail transport market refers to a theoretical framework that provides a systematic overview of four different perspectives on institutional change. With regard to the current situation of the railway sector and the difficulties associated with achieving a modal shift, the aspired changes of the institutional framework should show a high amplitude, high speed, and high scope. Scope, i.e. the sectors reforms are targeting at, is a very relevant aspect here due to the fact, that an increasing demand for rail transport can also be induced by disincentives for road transport. Van de Ven and Hargrave (2004) have conducted a literature review of theories of institutional change, which revealed four distinct perspectives. Before these different perspectives are applied to the situation in the rail transport sector, Figure 3 provides a systematic overview based on the following two-dimensional framework.

FIGURE 3: Four Perspectives on Institutional Change in the German Railway Sector



***Source:** Fraunhofer ISI based on Van de Ven & Hargrave (2004).*

The dimension mode of change on the horizontal axis refers to the causal relationship between actors and institutional change. The two perspectives on the right, collective action and institutional design, share the perception that institutional actors are actively engaged in the change of institutional arrangements and able to construct new institutional realities. The two theories on the left, institutional diffusion and institutional adaptation, in contrast, have in common that institutional actors are regarded as being constrained in their ability to bring about institutional change and only able to reproduce existing institutional arrangements and adapt to external changes. Due to these constraints, these perspectives focus on the question how institutional arrangements can change the structure and behaviour of actors (Van de Ven & Hargrave 2004).

On the vertical axis, the dimension focus of analysis refers to the perspectives' level of analysis. On the micro-level, institutional adaptation and institutional design both address behaviour of single actors who design or adopt new institutional arrangements. On the macro-level, the institutional diffusion and collective action perspectives focus on the diffusion or construction of institutions at the industry level or within the relevant organisational field (Van de Ven & Hargrave 2004).

In the following subsections, the four perspectives are described in a more comprehensive fashion, before they are applied to the situation in the German railway sector.

3.2 INSTITUTIONAL DESIGN PERSPECTIVE: DB CARGO

Institutional Diffusion	Collective Action
Instituational Adaptation	Institutional Design

THEORETICAL APPROACH:

Institutional change as a gradual, incremental and deliberate process

The institutional design perspective builds on the premise that „through choice and action, individuals and organisation's can deliberately modify, and even eliminate institutions" (Barley & Tolbert 1997). Hence, today's institutional arrangements can be regarded as the results of decisions and actions taken by actors in the past. In general, due to the complexity and interrelatedness of institutional arrangements, institutional change is incremental (North 1990). However, a crisis can offer opportunities for discontinuous change. Bringing about change in large and complex organisations can be conceived as a specific form of intended institutional change. Organisational change management programs are usually triggered by changes in the organisation's environment. Environmental changes can have a negative impact on the organisation's performance when the organisation's structures do not fit the requirements of the new environmental situation anymore.

PRACTICAL APPLICATION:

Large scale change management program "Zukunft Bahn" initiated in 2016 as an example for intended institutional change at DB Cargo

As a response to operative losses and declining competitiveness, DB Cargo has started a large-scale change management program ("Zukunft Bahn"). Objectives include:

- Concentration on European railway corridors
- Increased standardisation of services and operations
- Reduced regional fragmentation
- Higher flexibility of personnel
- Practical application:

EXPECTED EFFECTS ON INTERMODAL COMPETITIVENESS:

Potentially positive

DB Cargo, as the focal actor in the German rail transport sector, is actively engaged in a large-scale transformation of its business model triggered by ongoing operative losses. This transformation aims at further growth of the DB's rail transport business by enhancing efficiency of operations. However, implementing these changes will probably be faced with strong resistance from employees and trade unions. From the change management literature it becomes evident that "…many of the most troublesome problems of changing organisations occur not in the strategic/task shift, but in the implementation of the organisational transition to support the change in the nature of the strategy and the work" (Nadler 1993). Hence, it remains to be seen whether the DB management's initiative to trigger discontinuous institutional change can be successfully implemented and if competitiveness of DB Cargo not only vis-á-vis other railway companies, but also compared to road transport might be increased. Another limitation of DB Cargo's change management activities is that they are very much supply-side driven and that no attempts are made to fundamentally change the relationship to customers and other actors in the market.

3.3 COLLECTIVE ACTION PERSPECTIVE: INSTITUTIONAL CHANGE AT THE SECTOR LEVEL

Institutional Diffusion	**Collective Action**
Instituational Adaptation	Institutional Design

THEORETICAL APPROACH:

Focus on groups of actors that try to trigger institutional change

The collective action perspective views institutional changes as being intentionally pursued by social actors. However, the collective action perspective does not focus not on single individuals or organisations but on groups of actors that try to trigger institutional change. Hence, from the collective action perspective, the appropriate unit of analysis is the inter-organisational field or industry. The collective action perspective builds on contributions from social movements theory as well as on insights from the literature on technological innovation and industrial change (Van de Ven & Hargrave 2004). Building on insights from social movements theory, collective action requires mobilising structures, framing processes, and political opportunities to trigger institutional changes (McAdam 2008).

PRACTICAL APPLICATION:

Various actors from the railway sector have taken collective action to demand changes of the regulatory framework in favour of rail transport

Successful collective action requires:

- Mobilizing structures, e.g. networks such as "Allianz pro Schiene"
- Framing processes, e.g. shared understanding of problems and potential solutions
- Political windows of opportunity: Master Plan Rail Transport

EXPECTED EFFECTS ON INTERMODAL COMPETITIVENESS:

Positive

Building on insights from social movements theory, collective action requires mobilising structures, framing processes, and political opportunities to trigger institutional changes (McAdam 2008). One important example for mobilising structures in the rail transport sector is the network "Allianz pro Schiene" (Pro-Rail Alliance), founded in the year 2000, which today represents 23 members, non-profit organisations from civil-society, and 123 supporting members, which are mainly companies from different areas of the railway sector. The objective of the Pro-Rail Alliance is to promote safe and environmentally friendly rail transport. Based on the Alliance's public announcements and publications, the members' shared understanding of the sector's problems seems to be that the regulative environment in Germany one-sidedly favours road transport over rail transport. Consequently, the alliance has repeatedly demanded a reduction or abolition of regulative and financial benefits of road transport and has called for greater political support for and public investments in rail infrastructure. The Pro-Rail Alliance's vision for 2020 is to reach a market share of 25% for rail freight in Germany (Allianz pro Schiene 2017). Among the Pro-Rail Alliance's currently most important political targets is the reduction of track access charges. In recent years, these charges have been steadily increasing, whereas the road toll for trucks

has remained stable and even decreased slightly. Moreover, the network demands greater financial contributions from the federal government to finance the maintenance and extension of the railway network. Next to these political activities, the Pro-Rail Alliance calls for more innovation in the sector and the implementation of measures that strengthen the environmental performance and social acceptance of railways in Germany.

Building on social movements theory, political opportunity is another necessary condition for successful institutional change. Such opportunities can arise from unstable political coalitions or alliances between politicians and members of the social movement. For example, the Pro-Rail Alliance has successfully supported the introduction of a road toll for trucks in Germany, which came into force in 2005, and which had faced fierce opposition of forwarding agents and their customers at that time. In view of upcoming major technological changes in the road transport sector, such as electrification of trucks and autonomous driving, and due to the rising political pressure on the transport sector to reduce its GHG emissions, the political situation of the transport sector at this stage can be considered as unstable. It is likely to offer the opportunity to trigger changes of the institutional framework in favour of more sustainable modes of transport. Such an opportunity developed with the installation of the round table for rail transport in September 2016, headed by the State Secretary of the German Federal Ministry of Transport and Digital Infrastructure (BMVI). The round table's work culminated in a master plan for rail transport, published by the BMVI in June 2017. The master plan's objective is to strengthen the competitive position of rail versus road transport by enhancing the efficiency of rail infrastructure, using available potentials for innovation, and creating a more favourable political framework (BMVI 2017).

3.4 INSTITUTIONAL ADAPTATION PERSPECTIVES: COMPLIANCE OF DB CARGO TO EXTERNAL CHANGES

Institutional Diffusion	Collective Action
Instituational Adaptation	Institutional Design

THEORETICAL APPROACH:

Change originates in the institutional environment and affects the organisation

The institutional adaptation perspective examines how and why organisations conform to forces in the institutional environment. In contrast to the institutional design and collective action perspectives, change originates in the institutional environment and affects the organisation. Institutional adaptation processes have been analysed by researchers interested in the question why modern organisations resemble each other so much in their structures and processes (DiMaggio & Powell 1983). The answer of researchers addressing this issue is that organisations have to conform to similar environmental norms, rules and beliefs in order to achieve social legitimacy.

PRACTICAL APPLICATION:

Railway reform of 1994 as a critical event to which DB Cargo is still struggling to adapt

The German Railway Reform of 1994 was an intervention of policy makers with the objective of creating a liberalised, market-oriented railway sector. These disruptive policies, however, seem not to have fundamentally changed the organisational culture and operations of DB Cargo towards greater flexibility and attention to customer needs.

EXPECTED EFFECTS ON INTERMODAL COMPETITIVENESS:

Potentially positive

The railway reform aimed at substantial changes in the nature and character of the German railway, which was then supposed to operate like a private, market-oriented company in a liberalised market environment. However, compared to the situation in other countries, such as the UK, the separation of infrastructure and operations was not strictly established, but resulted in the infrastructure manager (DB Netz) and the railway undertakings (DB Cargo, DB Regio and DB Fernverkehr) being part of the DB holding (Nash et al. 2013).

The railway reform has changed the DB's institutional framework according to the principles of a market-oriented and liberalised economy, even though these principles were not applied as consistently as in other countries and the emphasis was more on reducing financial burdens and enhancing the efficiency of railway operations than on fostering competition (Lodge 2003). Instead of profound organisational changes that would have resulted in greater efficiency and competitiveness in the long term, the management seems to have prioritised cost reductions. For example, after the Railway reform resulted in the attempt to place DB AG on the German stock market, DB Netz dramatically reduced the number of private companies' sidings. It is obvious that these abandoned or deconstructed parts of the railway network would have been crucial assets to incentivise companies to shift freight back from road to rail.

The shortcomings of DB Cargo's business model were strikingly revealed when the global economic and financial crisis

hit Germany in 2009 and resulted in dramatic reductions of sales and operative losses, whereas at the same time the negative impacts on competitors were much weaker. In conclusion, analysis from the perspective of institutional adaptation suggests that, in the 20 years following the railway reform, the DB has been primarily concerned with maintaining its legitimacy through enhancing its profitability as a holding company. This was achieved through cost reductions at the operational level as well as through the acquisition of profitable businesses in the transport sector (Stinnes/Schenker, Arriva) and their integration in DB Holding. The railway reform has so far been less successful in triggering fundamental changes of DB Cargo's business model.

3.5 INSTITUTIONAL DIFFUSION PERSPECTIVE: CHANGES AT THE SECTOR LEVEL DUE TO DIFFUSION OF NEW INSTITUTIONS

Institutional Diffusion	Collective Action
Instituational Adaptation	Institutional Design

THEORETICAL APPROACH:

How do institutions diffuse among a population of organisations?

The institutional diffusion perspective analyses how institutions diffuse among a population of organisations. In contrast to the institutional adaptation perspective, institutional change is examined at the industry level or at the level of the inter-organisational field. Institutional change is frequently explained with the help of evolutionary theory, based on processes of variation, selection or retention. A major objective of studies on institutional diffusion is to examine the conditions under which institutions are being reproduced within the organisational field, as well as the speed and coverage of this process.

PRACTICAL APPLICATION:

Emergence and diffusion of new competitors and business models in the rail transport market

The institutional diffusion perspective points to institutional changes resulting from the market entry of new competitors in the German rail transport market, which pursue very specialised business models. The combined forces of market liberalisation and changing customer demands have resulted in the emergence and diffusion of new business models in the rail transport markets. Among them are for instance business models which are more narrowly focused on promising niches of the rail freight market (e. g. combined transport of containerized goods). The diffusion of these specialised business models and the strong equity links between private rail transport businesses and port operators seems to leave little scope for DB Cargo to adapt to the changing situation, which is characterised by strong growth in maritime trade of containerised goods. Alliances with the SBB, BLS and Cargo Tren Italia may be necessary, if these companies are also willing to open up their business.

EXPECTED EFFECTS ON INTERMODAL COMPETITIVENESS:

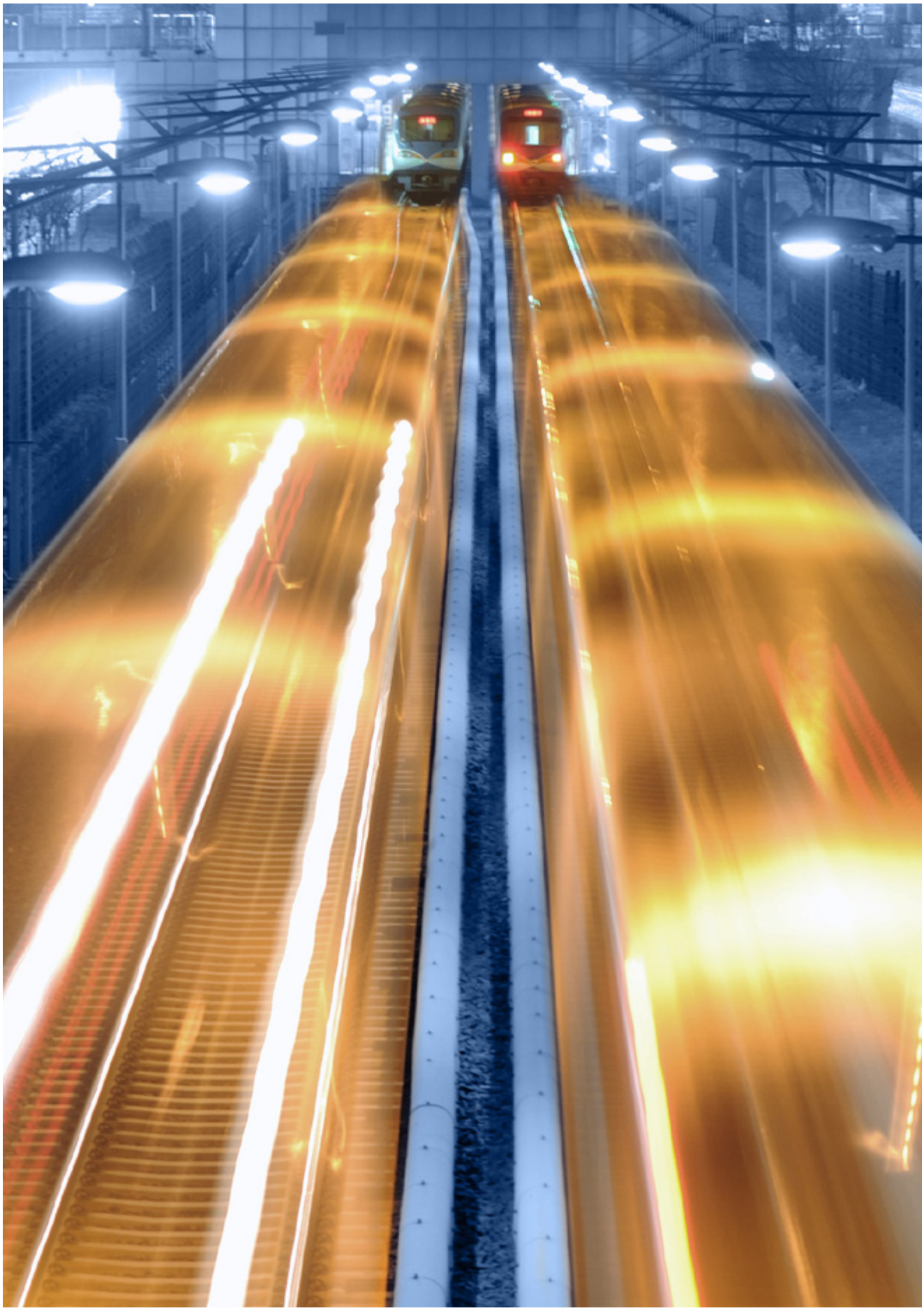
Positive

Market entry of new competitors to DB Cargo will have positive effects on intra – and intermodal competitiveness, at least in the long term.

3.6 CONCLUSIONS

The four perspectives suggest that the current processes and rates of change may not be strong enough to cause the far-reaching changes necessary for a large scale transformation of the modal split of freight transport. The analysis for the German railways sector shows, that intramodal competition has increased as a consequence of the German railway reform, which can be described as a disruptive form of institutional change. New domestic and foreign competitors have entered the rail freight market with business models tailored to promising segments of the market and have rapidly gained market share. At the same time, the increasing pressure from intramodal competitors has triggered an attempt at a transformative organisational change initiative at DB Cargo, which is currently in the process of implementation. Even though the success of this initiatives is highly uncertain, in total, these changes are likely to result in a higher competitiveness of the sector and a stronger orientation to customer needs. On the other hand, the road freight sector has increasingly come under political pressure due to its rising GHG emissions and rail transport is seen as a viable alternative.

The master plan for rail transport issued by the German government in 2017 acts on many requirements of the railway sector and foresees a reduction of financial burdens, capacity extensions, and technological innovation in the railway sector. However, these political initiatives will probably not result in significant changes of the current modal split as long as the external costs of road freight are not taken into account. Another important driver of institutional change in the transport sector is technological progress brought about by the digitalisation of the railway freight sector and its customers.



4 BUSINESS MODELS OF NEW ENTRANTS

Enforcing market openness and favourable access conditions for new entrants are among the key pillars of EU railway policy and of many national railway reforms. The policy initiatives constitute an intended change to major parts of the European freight sector and thus fall under the "Collective Action" perspective according to the systematic introduced in Section 3.

Following the not-for-profit organisation "Independent Regulators' Group" (IRG) "new entrants" are, on the European scale, railway undertakings "that are not related to an incumbent" (IRG-Rail 2017). The European Court of auditors defines new entrants in the rail freight market as "a rail freight operator (other than the incumbent freight operator) licensed to the applicable EU and national rules, operating in the competitive market" (European Court of Auditors 2016). In other words, new entrants are not necessarily non-incumbent railway undertakings. The definition provided by the Independent Regulator's Group also includes, from a more national perspective, companies which are incumbents in other countries – such as Deutsche Bahn or SNCF for instance – and enter a foreign market as a "new entrant" (IRG-Rail 2017). Subsidiaries of national railways in third countries are in most cases independent of their mother company and therefore act in the same way as legally private railway undertakings. In the following elaborations the two types of non-incumbent carriers are treated equally.

4.1 PRACTICAL ANALYSIS OF NEW ENTRANTS

In the rail freight sector, incumbents are often blamed for having a comparatively low level of innovation capability. In their analysis of the development of rail freight in Europe for instance, Crozet et al. (2014) highlight the necessity of new competitors to avoid stagnation in the sector and to break old habits especially due to natural monopolies. The authors characterise new entrants as the "source of innovations capable of changing the costs and content of rail freight's offer" (Crozet et al. 2014). In its "Rail Freight Masterplan" the German Federal Ministry and Digital Infrastructures (BMVI) highlights its willingness to further support the rail freight sector. According to the masterplan, "making extensive use of the potential for innovation" is a key focus of the envisaged measures in Germany (BMVI 2017).The following subchapter sheds light on three selected "new entrants". Among other things, it discusses their innovative approach as well as potential opportunities and barriers they might face.

BLS Cargo: Network and platform oriented

Business model	BLS Cargo is a corridor haulage provider based in Bern, Switzerland, and was founded in 2001, as a subsidiary of the BLS AG, which is primarily owned by the canton of Berne and the Swiss federation (BLS Cargo 2018a, BLS 2018a, BLS 2018b). A key factor of the company's business model is its transnational network with partners from all over Europe. Apart from operating itself in Switzerland as a traction provider, BLS Cargo cooperates with haulage providers from various countries. Thanks to this transnational network, the company is able to provide services for products that come from the North Sea for transport to the Mediterranean (BLS Cargo 2018b). In contrast to many other haulage providers, BLS Cargo has a competitive advantage with respect to the functioning of their locomotives. These so-called multi-system locomotives can be used for transnational and cross-border transport, removing the necessity changing locomotives at borders (BLS Cargo 2016).

Actor constellation/ market focus	According to its own statement, the market share of BLS cargo in Swiss transit rail traffic is about 25 percent (BLS Cargo 2018a). By calling itself "the Alpinists", the company points out its transnational market focus and its railway network that runs across the Alps from the Netherlands and Germany to Italy (BLS Cargo 2018b). In Switzerland, BLS Cargo's main competitor is SBB Cargo. Until 2014, Deutsche Bahn held a 45 percent stake in BLS Cargo. The initial reason for Deutsche Bahn to invest in BLS Cargo was, to not leave the transport market across the Alps to the Swiss incumbent (NZZ 2014). Since 2017 the French company SNCF Logistics has held 45 percent of BLS Cargo (NZZ 2017).
Innovative approach	Thanks to its international network with haulage transport providers from all over Europe, BLS Cargo is able to offer transnational transport solutions to its clients. This network and the use of multi-system locomotives enables the company to provide transportation across borders without wasting time in changing locomotives for instance. It underlines its ability to "excel along the entire Alpine corridor" (BLS Cargo 2018b). Apart from that, BLS Cargo also provides numerous additional services such as train inspections, operational services or the opportunity to cover locomotives with advertisements (BLS Cargo 2018b).
Institutional development and key factors	BLS Cargo has always been connected to international partners, having broad experience in the rail freight market in neighbouring countries. With respect to its international network, BLS Cargo explicitly points out its competences in establishing "linguistic and cultural links between northern and southern Europe" (BLS Cargo 2018b). In this respect, the multi-system locomotive can also be declared as an innovation that is enabled by an institutional framework that is shaped by a large network of international partners.
Potential barriers	Even though BLS Cargo stands out with its multi-system locomotive, the need for such a product also symbolises the barriers, traction providers are confronted with. Varying electricity and safety systems across Europe were and are still obstacles for rail freight service providers, especially in comparison to road transport. In addition, one can assume that cooperation with partners from several countries requires a lot of resources.
Potential opportunities	Through international cooperation and multi-system locomotives, the corridor haulage provider BLS cargo is able to compete with road transport services. After having received 15 multi-system locomotives, the company expects further 13 locomotives by 2018 (BLS Cargo 2016). Due to such investments, there is a chance for the company to further expand the network and establish itself as a competitor of SBB Cargo within Switzerland.
Assessment	At the "Transport Logistic" exhibition 2017 in Munich, BLS Cargo placed themselves next to DB Schenker. This position might be interpreted as a symbol for the company's ambitions with respect to the international rail transport market. Thanks to its experience, it can be assumed that BLS Cargo will be able to further strengthen its transnational institutional framework. However, these connections also strongly depend on further developments of the rail freight market in other countries. While the share of rail freight transport in Switzerland is comparatively high, the share of road transport in neighbouring countries might further increase. Therefore, by investing in multi-system locomotives, BLS Cargo sets an example for the rail freight sector.

CargoBeamer AG: Technical innovation

Business model	As a logistics service provider, CargoBeamer's business model relies on a system designed to improve the work steps of unaccompanied combined transport. The company, which was founded in 2003 and is based in Leipzig, Germany, argues that due to technical restrictions today "only 15 percent of the road freight traffic" are suitable for a combination of road and rail transport (CargoBeamer 2018b). Its innovative answer to this imbalance is an intermodal, fully automated transport system that enables to load semi-trailers horizontally without any specific technical requirements. The company is based on a private initiative. In 1998, two engineers, Hans-Jürgen Weidemann and Michael Baier, started to develop the idea. In the course of the following years, the idea "CargoBeamer" was patented. In 2004, it gained financial funding from a "R&D-association project funding" technology programme and started to cooperate with companies in the rail freight market (CargoBeamer 2018a)
Actor constellation/market focus	CargoBeamer mainly competes with existing crane container terminals. In order to get semi-trailers from the road on the rail, using cranes is the most conventional way nowadays. However, this procedure is not only time-consuming but also expensive, as the semi-trailers need be modified (by example with special biting edges). Therefore, many haulage providers avoid combined transport. According to CargoBeamer AG more than 90 percent of semi-trailers are not suitable for crane terminals as they are not equipped in an appropriate manner (CargoBeamer 2014).
Innovative approach	CargoBeamer promises to load any type of trailer on its terminals from the motorways to the railways within little time. The horizontal loading process can be compared to interchange procedures in public transport (CargoBeamer 2018b, CargoBeamer 2018c).
Institutional development and key factors	Even though the business model and concept of CargoBeamer was already developed in the late nineties, it took about one decade until the first prototype terminal in Leipzig was developed and constructed. Institutionally, the opening of this terminal can be declared as a milestone in the company's history as it visualises the potentials of this loading technique (CargoBeamer 2018a). The company not only tries to expand its idea on the German market but also underlines its transnational vision "throughout Europe" (CargoBeamer 2018d). On its website, the company lists about five employees (CargoBeamer 2018e). Thus, it can be assumed that the individual competences of the team members are of key importance with respect to the institutional development and approaches. In July 2016, Cargo Beamer announced to have signed an agreement with "Atop Beijing" and the "Zhongche Group" that aim at producing and selling CargoBeamer wagons and terminal technology in China and at operating in the Chinese market (CargoBeamer 2016).
Potential barriers	Since many haulage providers fully focus on road transport, it can be assumed that they have reservations with respect to combined transport. As a consequence, Cargo Beamer might need to invest a lot of resources in order to convince these ventures to switch to railway. In addition, the implementation of the technique highly depends on the availability of areas that meet the necessary requirements (such as enough space, access to roads and railway infrastructure). In addition, their geographical position is of key importance. The implementation of the technique requires a solid financial basis as well as the endurance for time-consuming bureaucratic procedures. These factors are strong determinants with respect to the competitiveness of the company in general and the CargoBeamer technology in specific.

Potential opportunities	Due to the fact that most types of trailers are eligible for this system, CargoBeamer has the capacity to provide numerous haulage providers with access to the rail freight market. Being present at exhibitions such as the Transport Logistic fair in Munich in May 2017 boosts the company's level of awareness on the market. There is a chance to expand the national and international network.
Assessment	Recent agreements with partners from China that were signed in 2016 (CargoBeamer 2016), symbolise a certain degree of sustainability with respect to future developments and increasing transnational cooperation. Against the backdrop of the fact that nowadays most haulage providers only focus on motorways, CargoBeamer also has to convince these actors of the advantages of combined transport. For a new entrant, this is indeed a challenging starting point. Simultaneously, the company also should point out the qualities of their innovative system. One can assume that CargoBeamer could be a catalyser in getting more goods from the motorway onto the railway. In the end, however, it is also necessary to concede that CargoBeamer is an important but comparatively little piece of the transport chain. Large disruptive events, such as the closedown of services on Rail Freight Corridor 1 between Karlsruhe and Basel in summer 2017, might encourage testing new technologies for road-rail transhipment with wider potential benefits for Transalpine freight transport, such as CargoBeamer.

railCare: Technical and network oriented

Business model	railCare is a Swiss transport service provider with a focus on unaccompanied combined transport. It operates exclusively in Switzerland and concentrates on the transport of fresh and daily goods. As a subsidiary company of the Swiss retail group "Coop", it especially transports consumer goods for the supermarket chain within Switzerland. In addition, railCare also transports goods for companies such as "Emmi", "Heineken" or "McDonalds" (SRF 2016, railCare 2018a).
Actor constellation/market focus	The company is a wholly-owned subsidiary of the Coop Group, which is one of largest retail and wholesale providers in Switzerland. In total, the Coop universe encompasses about 2,200 sales outlets in retail (Coop 2017). railCare was founded as "tradecare AG" in Baden, Switzerland. In 2009, it was renamed and got its contemporary label. In 2010, Coop acquired 100 percent of "railCare". The retail company justified this takeover by underlining its aim to further intensify the transport of goods on railways (Moneyhouse 2017; Coop 2010, Swissinfo.ch 2010).

Innovative approach	railCare explicitly points out the advantages of transporting goods on railways: According to the company, it is often claimed that Switzerland is too small for rail freight transport. On its website, railCare disapproves this claim by underlining the assets of unaccompanied combined transport ("single point of contact") even within comparatively small distances (railCare 2018b). Against the backdrop of the fact that railCare especially focuses on rail freight, its main focus appears to be comparatively unusual: the transport of fresh and daily goods such as vegetables and fruits. The company's fleet comprises of trains and wagons as well as of lorries (railCare 2018b, railCare 2018c). Containers, of which numerous are equipped with refrigeration plants, are loaded from the roadways on the railways – and vice versa (railCare 2018d). The company compares its trains to local trains ("S-Bahn"), as they are comparatively fast and reliable (railCare 2018b). According to its own statement, railCare aims at reducing the traffic volume on the Gotthard motorway. Regarding this, it might also profit from the Gotthard Base Tunnel, which opened in 2016 (AlpTransit 2018).
Institutional development and key factors	Thanks to the takeover by the Coop Group in 2010, railCare intensively cooperates with one of the biggest retail players in Switzerland. Since its foundation in 2007, the order quantity has increased. In 2016, the company had about 300 employees (railCare & Coop 2016). In total about five locomotives and 20 to 25 trains are in service every day. This amounts to about 250 semitrailers (SRF 2016).
Potential barriers	It is striking that railCare already highlights potential barriers on its website. On the start page the company raises questions such as "Why should I switch to rail even though I am satisfied with the road?" or "Are trains suitable for the transport of consumer goods?" (railCare 2018a). Such statements symbolise barriers railCare's barriers to day-to-day business. It can be assumed that many companies are not thinking about switching to rail transportation as the distances within Switzerland are comparatively small or as rail freight is perceived as not flexible enough. Therefore, it is of great importance for companies such as railCare to prove the opposite.
Potential opportunities	Against the backdrop of the fact that the number of inhabitants as well as traffic jams might in-crease, rail freight transport in Switzerland might gain in importance. By offering unaccompanied combined transport, railCare can provide a "single point of contact" (cf. railCare 2018b) which can be seen as an asset. Due to its partnership with the Coop group, railCare is able to rely on a guaranteed volume of goods.
Assessment	railCare puts forward convincing arguments for transporting consumer goods on rail instead of on the road. On its website, it directly deals with arguments that question rail freight transport in Switzerland. Thanks to its cooperation with the Coop group, railCare has a broad network with further companies that might be interested in environmental transport. The Swiss milk processor Emmi AG for instance, explicitly highlights its cooperation with railCare – and the avoidance of truck transportation (Emmi 2017). However, in the end, railCare can not only rely on the fact that rail freight transport is less harmful to the environment. To further convince future clients, the company has to steadily invest into flexibility measures and its efficiency, in order to being able to compete with the comparatively low prices in road transportation (cf. Railway Gazette 2017).

Table: INFRAS.

4.2 SPECIFIC BARRIERS AND OPPORTUNITIES FOR NEW ENTRANTS

Section 2 of this report has listed general barriers to more rail freight transport in Europe from the perspectives of operators, which are largely incumbent rail carriers, and forwarders. The main barriers at national level include the slow implementation of EU directives, the inconsistent separation of rail infrastructure and operations, underfinancing of rail infrastructure, inefficiencies in the use of public funds, unclear policy strategies and the dependence of the railways on political decisions. In this chapter we discuss additional barriers and opportunities that are of relevance for new entrants to national railway markets. The statements derived from a set of informal interviews with market entrants and sector associations between May 2017 and June 2018.

In countries with integrated railway companies in place, incumbent carriers may have propriety access to infrastructure capacity and can influence national infrastructure investment plans much better than new entrants can do. On the other hand, non-incumbent railway operators, be it subsidiaries of foreign national railways or fully private undertakings, are less dependent on policy preferences. These differences with respect to market conditions suggest that other strategies, opportunities and barriers are of relevance for new entrants.

Some of these issues, however, hold true for established rail undertakings as well. Besides, a report on rail freight transport in the EU, that was published by the European Court of Auditors (2016) served as an important input for the following discussion. There, the authors describe what they observed within the framework of an audit that was carried out between 2014 and 2015 in five EU member states, namely the Czech Republic, Germany, Spain, France and Poland (European Court of Auditors 2016).

Lack of qualified personnel in the rail freight sector

In the railway sector, several actors underline the high level of skills that engine drivers have to meet. In comparison to lorry drivers for instance, a certain level of language skills is indispensable, in order to be entitled to transport goods across borders (cf. European Court of Auditors 2016). Skilled workforce is required not only for the driving task, which could be carried out autonomously in the future, but for communication, supervision and dealing with unexpected situations. Thus, new technologies may not help solving the problem in the medium term. The question is, to what extent such varying requirements lead to unfair competition? This might be an additional reason, why many actors in the rail freight market are confronted with a lack of qualified personnel.

Comparatively low working conditions for lorry drivers

Apart from a lack of qualified personnel, several logistics service providers in the rail freight market complain about an imbalance with respect to the working conditions. According to the sector interviews, there are logistic service providers who keep working conditions in road transport at a comparatively poor level. Especially with respect to salaries, there seem to be large differences across Europe. Consequently, however, logistic service providers in the rail freight market not only have to cope with a lack of qualified personnel as it is mentioned above, but also with an imbalance in salary conditions compared to road transportation. On top of that, road tests with autonomous trucks and platoons open the door for an even deeper decline in trucking costs compared to rail. Although the announcement of the automotive industry to bring fully autonomous road vehicles onto the market by 2040 might be questionable, partial automation of the driving task on motorways is already sufficient to considerably shift the level playing field between road and rail even along busy rail corridors considerably.

Varying electricity and safety systems

In Europe, rail carriers have to deal with numerous electricity and safety systems, gauges and other network requirements, which challenge cross-border services (cf. European Court of Auditors 2016). While for lorries it does not make a difference whether they go cross-border or not, international rail services often require changing locomotives or drivers, break tests or other time-consuming activities. Consequently, rail haulage providers cannot transport goods from one country to another without specific measures (i. e. changing the locomotives). Even though multi-system locomotives exist, purchasing them is very cost-intensive. In contrast to incumbents, many new entrants often do not have enough capital to afford such machines. On the other hand, in contrast to incumbents, new entrants possess less equipment themselves, but in many cases rent locos and waggons on demand. Strengthening the locomotive rental market could give all rail operators more flexibility in running services under the prevailing plurality of technical systems.

Sustainability of rail freight and combined transport often does not outweigh the lower costs of trucking

The environmental benefits of rail freight transport, such as lower emissions and higher safety appears to have advertising appeal for forwarding industries in terms of company sustain-

ability strategies. In this respect, railways are unquestionably more attractive than roads. However, improved marketing of the sustainability progress of the railways does not promise additional commercial success as most big companies have already exploited the opportunities of green transport today. In the end, however, the costs are decisive. Often, actors that focus on road transportation have competitive advantages with respect to the prices they are able to offer.

Dependency on infrastructure availability

Disruption of services such as on the railway line between Karlsruhe and Basel in summer 2017, where existing tracks sank because of construction works, symbolise the dependency of the rail freight sector on the available infrastructure. Rail networks are way more vulnerable to infrastructure failures than the dense road networks due to the limited availability, technical parameters and operational specificities of alternative routes. These factors quickly lead to the drop out of services and long detours and finally the loss of traffic to rail or shipping as it was observed in the three months closure of the Rhine-Alpine link in 2017 (Deutsche Welle 2017, Railfreight.com 2017).

High level of flexibility thanks to small company sizes

Due to their small size, it can be assumed that new entrants in the rail freight sector are able to react to individual consumer needs in a flexible manner. Several companies highlight their ambitions to provide individual solutions. As many small companies have comparatively flat hierarchies, changing standardised working methods in an unbureaucratic way might be easier for them than the large, established firms. In that respect, many companies underline their individual services and customer-oriented thinking. However, also some new entrants developed the habit to react on customer requests rather than to actively approach them. While this strategy worked perfectly well in the past years with growing markets gained at the expense of the incumbents, more active customer strategies will most likely be needed when also the currently new entrants get mature and are forced to compete in non-expanding markets.

Innovative solutions challenge incumbents

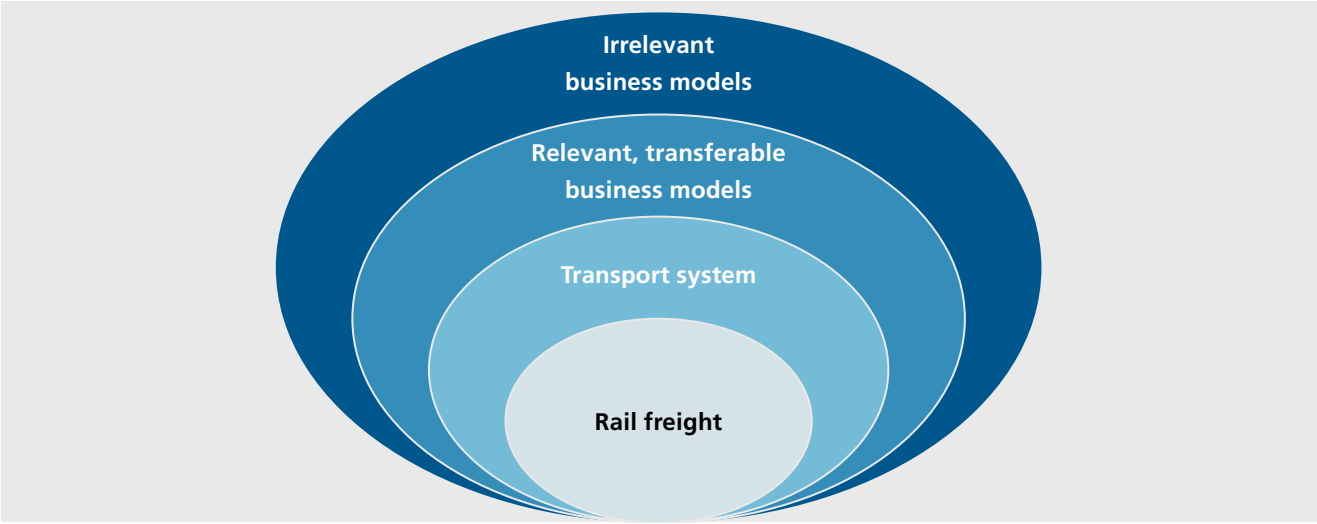
Several new entrants stand out with innovative solutions in logistic services. Even though it is difficult to assess the potential for success, there are some promising examples. CargoBeamer for instance, aims at improving combined transport by providing the opportunity to load semi-trailers horizontally. By the end of July, the intermodal operator "RailRunner" has entered the European market. Instead of hauling wagons, the company provides a system that enables locomotives to haul freight trucks and load units (CargoBeamer 2017a-e, RailRunner 2017). These systems could co-exist next to each other and can be a good supplement to traditional terminal technologies. The latter will most likely still be required throughout the coming decades as traditional containers are used ubiquitously in many industries. To limit the number of parallel systems, however, a neutral scientific assessment of their advantages, costs, risks and scalability is needed.

5 NEW BUSINESS MODELS AND DIGITAL TRANSFORMATION

This section turns the perspective from anecdotal towards a systematic review of business models in the railway sector. According to the literature, the main sources of business model innovation are the servitisation of previously product-based business models, the emergence of use-based instead of ownership-based models and the digitalisation of the economy (Lerch, Schnabl, Meyer, & Jäger, 2017; Eckartz, Frank, Meyer, & Gandenberger 2017; Lerch, Gandenberger, Meyer N., & Gotsch 2016; Tukker 2004).

To develop a better understanding of the innovation potential of the rail transport sector, it is necessary to look at the transport system as a whole. Such a systemic perspective should include the entire transportation value chain. Moreover, the digital revolution and the introduction of cyber physical systems in terms of Industry 4.0 emphasise further the importance of the systemic perspective. As Industry 4.0 and the Internet of Things promise to connect everything with everything, it would be a mistake to look at individual modes of transport, such as rail, in isolation. The digital revolution will restructure the relationship between the various modes of transport and all participants in the transport value chains. Future research is recommended to focus on these relationships. Developing a better understanding of the relationship is also the key to exploiting the (environmental and safety) potential of rail transport and ultimately increasing its market shares in the model split.

FIGURE 4: Systemic perspective



***Graphic:** Fraunhofer ISI.*

Reasons for a systemic perspective

- The rail transport sector is integrated into the larger transport system. In most cases, rail transport services are combined with other modes.
- Developing a better understanding of the relationship between rail and the other modes is often the key to exploiting the (environmental and safety) potential of rail transport and ultimately increasing its market shares in the model split.
- Many business model innovations are likely to come from outside the rail transport sector.

The following section is based on a survey of all business model innovations within the rail transport sector and relevant innovations outside the sector. The analytical focus is described in the figure below.

5.1 CLASSIC BUSINESS MODELS

The incumbent rail companies often seem to be too big to implement the organisational and cultural transformations that are necessary to explore the potential from digital business models (Semmann 2016). A survey of the rail transport sector led Waibel (2008) to differentiating these four basic categories even further. He concludes that the existing business models in the sector can be categorised into eight basic types:

TABLE 2: Categorisation of existing business models

Type	Description
Short distance minimalists	Short train for single or a limited number of businesses, typically planned rail-ways
Short distance relationship specialist	Focused on short distance and the last mile with few attractive units and wagons
Regional relationship specialist	Serving medium distances and collection / distribution of products from / to outside metropolitan regions or main transport corridors.
Production type specialist	Providing long-distance and international transport services, often specializing in limited bulk (chemicals, cars etc.) types
Corporation all-rounder	All relation types and production types, provides most services in cooperation with business partners
Own capacities all-rounder	All relation types and production types, providing most services using own capacities
Long-distance minimalist	Providing long-distance and international whole train service
Incumbent rail transport businesses	The previous monopolists

***Source:** Waibel 2008*

These eight business models are still prevalent today. There has been little business model innovation from within the rail transport sector, which appears to be constrained by a significant degree of inertia. The new entrants analysed in the previous chapter apply mostly classical business models. There are, however, some elements of new approaches as the following sections will specify.

5.2 NEW BUSINESS MODELS

Both the liberalisation and European integration of the rail transport sector in the 1990s as well as the digital revolution in the 2010s have given rise to new business models. We distinguish between structural business model innovations and digital business model innovations. In order to categorise different business models for freight and logistics services, a morphological box approach is used. In the left hand column, the morphological box lists the main drivers and dimensions of business model innovations. The remaining columns to the right represent the possible variations of these dimensions. By highlighting relevant variations that characterise a business model, this approach is used to compare and identify limitations and potentials.

The dimensions of the first four rows of the morphological box are mainly descriptive of the business rather than the business model. These categories include the involved modes of transport, the location where the product or service is performed (mobile, stationary or virtual), the concerned stage of the transportation process (planning and administration, the transport and the loading stage, and the monitoring of the process), and finally the type of customers or users targeted by the business models. The remaining dimensions relate more strongly to the core of the discussed business models.

Horizontal and vertical cooperation either between rail transport providers or between rail transport providers and other businesses along the value chain, are employed to optimise the usage of transportation capacities:

Three reasons that underline the relevance of business model innovation:

- In the EU, 24% of vehicles run empty, while the average loading space utilisation of loaded rail cars is 57% (World Economic Forum 2011).
- For rail transport capacity optimisation is particularly

important. Rail transport is most cost effective when cargo is bundled and transportation can be organized in point-to-point whole trains (Mertel 2015). The example of BLS Cargo and CargoBeamer (see previous chapter) can be mentioned here.

- By bundling cargo, either with other rail transport businesses or by coordinating with their partners along the value chain, they can optimise the use of transportation capacities. The example of railCare (see previous chapter) can be mentioned here.

EXAMPLE OF A STRUCTURAL BUSINESS MODEL

Type (Business model)
Structural
Practical example (Name and description)
Carpooling for Cargo is a pilot project that capitalises on bundling transportation by horizontal collaboration between different shippers. By providing horizontal collaboration between multiple independent shippers and logistics service providers, Carpooling for Cargo is able to realise double-digit net savings and to reduce the carbon footprint per freight movement up to 20 – 40% (UCB Pharma GmbH, 2011).

TABLE 3: Morphological box for a structural new business model

***Source:** Fraunhofer ISI*

5.3 DIGITAL BUSINESS MODELS AIM AT INCREASING RELIABILITY, SPEED AND FLEXIBILITY OF RAIL TRANSPORT BY USING DIGITAL TECHNOLOGIES

Digital business models are business models that are based on the use of digital technologies to generate value. Digitalisation has the potential to:

- improve information and exchange basis (internal, external)
- improve access for third parties (data platforms, interoperability)
- increase customer needs and relations
- increase process efficiency in the vertical
- increase the reliability, flexibility and speed of rail transport.
- increase the competitiveness of rail transport against the road haulage business.
- improve the integration of rail transport into the modal mix.

TABLE 4: Types of digital business models

Business model	Process-oriented	Analytics-based	Platform-based
Description	Aims at optimizing the process through the introduction of digital automation and processing technologies (e.g. synchronizing transport processes and shortening production cycles).	Is based on the potential of advanced computer analytics such as big data and artificial intelligence	Uses digital technologies to reduce transaction costs between all participants of the value chain. Its main function is the reduction of search and matching costs.
Subcategories	*Shipping information management:* digital technologies to attract the location of cargo *Terminal management:* technologies with the potential to reduce handling costs for moving cargo from and to rails *Supply chain management:* usage and analysis of production data to optimise transportation processes		*Simple matching* *Matching plus additional services*, such as contracting and the management of monitoring and enforcement *Matching plus analytics-based services*, such as route optimisation
Practical examples *(Extract)*	Goodpack (provider of intermediate bulk containers) BLU control systems (provides assistance with operative procedures at rail-road terminals) Catkin (connection of the various participants of the supply chain)	Intermodal Links Planner (Identification of intermodal connections in Europe) SimConT (planning of operations of inland-container terminals)	Freight Arranger (online booking and tracking service) Saloodo (matches customers and transport service providers)

EXAMPLES OF DIGITAL BUSINESS MODELS

Type (Business model)

Process-oriented (Supply chain management)

Practical example (Name and description)

The software company **Catkin** provides a supply chain management system to connect the various participants of the supply chain. The system is platform independent and supports businesses to manage their mobile resources, such as staff, loading units and transport units (Vogel, 2015). The systems customers participate via app or website. In many cases it replaces systems based on Excel, E-mail and phone communications to document and update consignment related information (Catkin, 2017).

Table 5: Morphological box for a process-oriented digital business model

Dimensions	Characteristics				
Mode	Rail	Road	intermodal	canal	Sea
Location	Mobile	virtual	Stationary		
Stage	Planning and administration	transport	loading	Monitoring	
User	Logistics services provider	Forwarder	Terminal manager	Infrastructure provider	Shipper
Main value proposition	bundling	matching	information management	process management	
Sustainability	Integral to the value proposition	communication	Not part of the value proposition		
Value chain	Horizontal	Vertical			
Degree of Digitalisation	Information management	Simple optimisations	Advanced Analytics		
Scalability	High	Low			
Timing	Predictive	Reactive			
Product service systems	Pure product	Product oriented PSS	Use oriented PSS		Results oriented PSS	Pure service
			leasing	pooling	sharing		

***Source**: Fraunhofer ISI*

EXAMPLES OF DIGITAL BUSINESS MODELS

Type (Business model)

Analytics-based

Practical example (Name and description)

SimConT is a decision-support tool developed in 2005 by the department of production management and logistics of the University of Vienna. It helps in planning of operations of inland container terminals supporting efficient resource-planning and effective capacity utilisation. It is based on modern simulation techniques, being able to analyze the maximum storing positions as well as modeling the inbound and outbound flows, which allows for a dynamic evolution of planned changes of the terminal. Consequently, SimConT provides support on the strategic and tactical level and minimises the risk of investments and stranded costs (Bestfact, 2015a).

Table 6: Morphological box for an analytics-based digital business model

Dimensions	Characteristics				
Mode	Rail	Road	intermodal	canal	Sea
Location	Mobile		virtual	Stationary	
Stage	Planning and administration	transport	loading	Monitoring	
User	Logistics services provider	Forwarder	Terminal manager	Infrastructure provider	Shipper
Main value proposition	bundling	matching	information management	process management	
Sustainability	Integral to the value proposition	communication	Not part of the value proposition		
Value chain	Horizontal	Vertical			
Degree of Digitalisation	Information management	Simple optimisations	Advanced Analytics		
Scalability	High	Low			
Timing	Predictive	Reactive			
Product service systems	Pure product	Product oriented PSS	Use oriented PSS		Results oriented PSS	Pure service
			leasing	pooling	sharing		

***Source**: Fraunhofer ISI*

EXAMPLES OF DIGITAL BUSINESS MODELS

Type (Business model)

Platform-based

Practical example (Name and description)

Freight Arranger is a platform-based business model, providing access to intermodal rail freight transits. It is a free online booking and tracking service, which finds solutions to inter-modal freight transits and provides a list of the cheapest options. Freight Arranger was designed in order to improve rail freight's visibility and to secure modal shift. Besides strengthening inter-modal transport, it reduces administration costs and processing time and increases load factor of trains (Bestfact, 2015b).

Table 7: Morphological box for a platform-based digital business model

Dimensions	Characteristics				
Mode	Rail	Road	intermodal	canal	Sea
Location	Mobile	virtual	Stationary		
Stage	Planning and administration	transport	loading	Monitoring	
User	Logistics services provider	Forwarder	Terminal manager	Infrastructure provider	Shipper
Main value proposition	bundling	matching	information management	process management	
Sustainability	Integral to the value proposition	communication	Not part of the value proposition		
Value chain	Horizontal	Vertical			
Degree of Digitalisation	Information management	Simple optimisations	Advanced Analytics		
Scalability	High	Low			
Timing	Predictive	Reactive			
Product service systems	Pure product	Product oriented PSS	Use oriented PSS		Results oriented PSS	Pure service
			leasing	pooling	sharing		

***Source:** Fraunhofer ISI*

In the context of process-oriented digital business models, the digitalisation of transport equipment and the creation of digital twins also creates multiple opportunities for new business models that are based on condition monitoring. Condition monitoring can be applied at multiple levels. At the level of the transport equipment, condition monitoring provides the opportunity for predictive maintenance offering vast opportunities for optimisation and improving cost effectiveness vis-à-vis road haulage. At the level of the cargo, condition monitoring may provide other opportunities for optimisation, particularly in the context of perishable foods or hazardous cargo. This could be a field for insurance companies to optimise the type of contracts that they provide. Further categories of digital business models are analytics – and platform-based business models.

6 CONCLUSIONS: INSTITUTIONAL CONDITIONS TO LET RAIL FREIGHT INNOVATIONS HAPPEN

6.1 DRIVERS OF INSTITUTIONAL CHANGE

The four perspectives on institutional analysis suggest that the current processes and rates of change may not be strong enough to cause the far-reaching changes necessary for a large scale transformation of the modal split of freight transport. The theory of Multi-Level Perspectives (MLP) suggests that the inertia of the rail freight regime could be overcome by the development of new organisations and institutions, which can utilise new technologies in internet-based business models and railway operations to drastically improve the competitiveness of rail freight as a part of intermodal supply chains. The MLP suggests further that such new organisations and institutions may need to be implemented by a range of actors in rail freight and not just DB. Van Mossel et al. (2018) review organisation theories and their application to the behaviour of regime incumbents. They suggest that if an incumbent does adopt the new technologies and organisation of a niche, its chances of survival are greater.

The conclusion here is that incumbent railway undertakings, such as DB Cargo, may be able to take advantage of the large opportunity provided by the supportive political environment through the sustainability debate. However, this means that they will need to change their organisation to develop new business models and institutions that lead the internet-based logistics industry of the 21st century. Other actors, whether new rail operators or entrants from the logistics sector, may provide the competitive pressure to DB Cargo and deliver the necessary innovations. They may also grow to become major actors in the sector. A new structure of the industry with a changed business model for DB will be necessary.

The example of the German railway reform shows a strong increase in intramodal competition by domestic and foreign competitors, following business models tailored to promising market segments. This can be described as a disruptive form of institutional change, putting the incumbent freight carrier under pressure and most likely resulting in a higher competitiveness of the sector and a stronger orientation towards customer needs. These developments and the currently issued rail transport master plan alone will however hardly drive rail mode share upwards unless road haulage covers its full social costs. Another important driver of institutional change in the transport sector is technological progress brought about by the digitalisation of the railway freight sector and its customers.

6.2 INNOVATIONS IN THE RAIL FREIGHT SECTOR: SUCCESS FACTORS

Digital transformation and automation have enormous potential in the rail sector

Technological progress will lead to fundamental changes facing the rail sector as a whole and its competitive performance compared to the road sector. It also requires institutional changes and flexibility. Thus, digitalisation cannot be fully introduced by new train operators alone, because it requires fundamental changes in the train control systems, currently still run by DB Netz as a monopoly.

The following innovations are of major importance:

TECHNICAL:

- Automation in operation: Marshalling, train coupling, train disposition
- Autonomous driving
- Energy efficiency improvements

ORGANISATIONAL/INSTITUTIONAL:

- Automated planning and disposition and integrated customer-oriented freight information
- Efficiency improvement of administrative functions
- New intermodal underground systems, such as cargo sous terrain / cargo tube

Access conditions (infrastructure and markets), standardisation and global money

Having access to the rail infrastructure and markets of different countries seems to be a decisive factor for new entrants to be successful in the (international) rail freight transport sector. However, this often requires the use of multi-system-locomotives with automotive devices. Therefore, access to the international rolling stock industry and global capital is necessary.

Lessons from other sectors show that niche markets and global markets require completely different conditions to introduce innovations. Rail freight and especially long distance combined transport need access to large scale solutions with a high level of standardisation, such as fleet modernisation packages (e.g. autonomous and intelligent wagons) or standardised trailer long distance transport.

Client orientation instead of systems orientation
Cooperating with actors from other countries and investing in a network of personal contacts appears to be of great importance for new entrants to be successful in the (international) rail freight market. Direct links to their customers should provide the railways an advantage over freight trading platforms, which can push them into a carryer-only role. However, this not only requires network-oriented business models but also flexible – and transparent – access conditions for various actors across the European transport market.

In order to enhance the interaction with customers and to fully use given capacities, actors in the transport market have to further invest in the digital transformation. This not only enables a more efficient organisation of cargo transportation but also facilitates the cross-linking with other transport modes and carriers.

Taking advantage of combined transport
An intelligent combination of various means of transport can boost rail freight traffic: To strengthen rail freight transport in general, we therefore strongly recommend taking full advantage of the possibilities of combined transport. Regarding this, further investments into the standardisation of services and products are required. In order to facilitate combined transport and to accelerate cargo handling for instance we propose standardised trailers and automatic terminals.

Carbon neutral rail freight corridors requires Interoperability 2.0
Cargo handling does not stop at borders. The creation of carbon neutral rail freight corridors requires increased efforts into the connection of cross-border traffic – a kind of "Interoperability 2.0". Different languages should not imply barriers. This is why an agreement on one single language (e.g. English) in international transportation is an important success factor. Engine drivers should be able to express themselves at least on a basic level in this language. The same applies with respect to the rolling stock: To further facilitate international operations, neighbouring countries should continue to standardise power supply and safety systems.

The following policy areas are of major importance:

- improving access conditions for new actors in combined transport (e.g. infrastructure, innovative approaches, new business models)
- planning and finance conditions for combined transport
- launching an investment package for the Rail Digitalisation offensive (infrastructure, rolling stock)
- enabling a "push and pull approach" from modal shifts from road to rail to guarantee a level playing field.

6.3 NEW BUSINESS MODELS NEEDED

New business models and digital transformation
The rail transport sector harbours great potential for business model innovations. Digital transformation in particular can be expected to open the door to various innovations, most of which probably have not yet seen the light of day. This may be possible through including digitalisation into national transport investment plans.

Therefore, a more systematic approach to identify successful business models is needed to unveil potentials for making sustainable freight transport more efficient or attractive. The report introduced the concept of morphological boxes to compare individual business models and to identify less commonly used areas in new business models where companies or regulators may get active.

Based on the survey of business models and the comparison with business model developments in other sectors, it was possible to identify areas that are still less commonly used in new business models, such as predictive logistics, use-oriented and results-oriented product service systems, the facilitation of horizontal cooperation and bundling. Typical examples of new services are customer-oriented logistics planning and forecasting tools (linking of individual production and logistics processes), and big data based location and capacity optimisation tools (for example platform services such as Uber Freight).

In these areas there appears to be the biggest unexploited potential for business model innovations in the freight transport sector. Predictive logistics might start to play a bigger role as soon as cyber physical systems, i.e. the Internet of Things, start to become more prevalent throughout industry. Use-oriented and results-oriented product service systems can be expected to have great potential in the case of high-cost assets such as infrastructure, terminals and transport and loading equipment.

Purely digital business models and digitally upgraded conventional business models side by side
There is a bias toward purely digital business models. Such business models promise an unlimited scalability and may therefore be more attractive among investors. However, conventional business models may be also enhanced through the imple-

mentation of digital technologies. This is particularly important for incumbents. If they fail to respond and adapt to the digital revolution they might eventually be forced out of business. Moreover, it needs to be recognised that the transportation process will always involve physical assets. Digitalisation will never replace the physical movement of goods. However, value chains might change and the businesses that are best able to gather and utilise the transport related data might grow at the expense of the incumbent businesses.

Further investments in platform models needed

Digitalisation opens new potentials for platform-oriented business models to improve multimodal access to transport chains. Besides new entrants in the transport sector, new digital business models are required to improve the interface between rail transport companies (RTC) and the client.

Platform-based business models harbour a huge market potential. Such business models have the potential to solve a series of transaction costs. At the same time, however, there is the risk that proprietary platforms that are controlled by a single or a limited number of companies will lead to considerable anti-trust challenges. Therefore, further research is needed in terms of evaluating legal, regulatory and other policy measures to address such anti-trust challenges in advance.

Business leaders need to recognise that they do not necessarily have to revolutionise the entire business and give up their main business model. Research shows that the most successful businesses start out by experimenting with complementary business models that are introduced in parallel to the main business model (Lerch et al. 2017).

6.4 OUTLOOK

This report departs from the thesis, that rail freight transport is a decisive pillar of climate mitigation policy in transport and thus needs strengthening. Second, the report constitutes that, despite much efforts and funds devoted to mode shift policies, rail freight remains on a declining pathway in most European countries, and – facing the potentials of automotive driving and platooning for trucks – this path might even accelerate. Starting from these observations, the report looked at several options besides classical infrastructure investment programmes to strengthen the railways' market position.

In the further course of the Low Carb-RFC project, these options, including change management, company structure and business model innovations, are acknowledged in the definition of rail freight scenarios. In particular the proposed switch towards the flexible use of capacities and the dismantling of legal and organisational barriers are attributed a considerable potential for reducing the users' generalised cost of using rail instead of road.

This report has opened the door for further elaborations and discussions. The need for rapid digitalisation in the railway sector constitutes a key requisite for the sector's competitiveness with regard to road haulage. While this is common knowledge, the railways are lagging behind innovation rates in other sectors. National governments who are controlling most of the large rail companies and who are responsible for issuing transport master plans on their territory could more strongly and decisively push the sector towards the uptake of new technologies and business concepts.

The analyses of literature on institutional change management strongly suggests that external pressure is needed to start and maintain reform processes. External drivers for change can be market forces or policy interventions. Policy-inflicted change processes need to persist over a longer time span and need to be clear in their targets. This study did not go further into detail on the role of policy institutions. Further research should thus shed more light on the levers policy institutions have at hand to drive organisational change processes in transport and associated industries like energy and telecommunication.

This research on institutional change and further reforms and policies have to take into account different speeds of change. On the one hand hardware oriented infrastructure such as freight rails, freight bypasses, access tracks and terminals, on the other hand software oriented topics like infrastructure and logistics management tools, depending indispensably on access to freight data and related traffic data.

An agile rail freight sector has to combine the intelligence and related core competences of customised services, market size and integration of several levels of the logistics value chain. The role of the railways (and their owners) in this dynamic multilevel field might to be defined in a new manner: Future research also has to open up the institutional perspective: Not separative (road or rail, infrastructure or services), but new combining and integrative approaches have to be developed and challenged compared to the traditional understanding. Such approaches should focus on new institutional approaches in combined transport road-rail and even dare to raise the question, if the future freight infrastructure needs a differentiation between these two traffic modes.

Subsequent publications in the LowCarb-RFC project then provide model calculations on mode shift effects and climate gas reduction potentials of these scenarios. In return, these market growth and sustainability benefits may be an important driver for implementing the structural and operational reforms indicted by this study.

7 LOWCARB-RFC PROJECT PUBLICATIONS

The below list of 9 working papers and 3 summary reports is in parts preliminary as some of the material is not published by the time of releasing this report. A current list of publications at:

Fraunhofer ISI providing all working papers and summary report: https://www.isi.fraunhofer.de/en/competence-center/nachhaltigkeit-infrastruktursysteme/projekte/lowcarb_rfc.html

Stiftung Mercator issuing the summary reports:

WORKING PAPERS

Doll, C., J. Köhler, M. Maibach, W. Schade, S. Mader (2017): The Grand Challenge: Pathways Towards Climate Neutral Freight Corridors. Working Paper 1 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Fraunhofer ISI and IML, INFRAS, TPR and M-Five. Karlsruhe.

Petry, C. and M. Maibach (2018): Rail Reforms, Learnings from Other Sectors and New Entrants. Working Paper 2 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Infras. Zurich.

Gandenberger, C., Köhler, J. and Doll, C. (2018): Institutional and Organisational Change in the German Rail Transport Sector. Working Paper 3 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Fraunhofer ISI. Karlsruhe.

Meyer, N., D. Horvat, M. Hitzler (2018): Business Models for Freight and Logistics Services. Working Paper 4 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Fraunhofer ISI. Karlsruhe.

Doll, C., J. Köhler (2018): Reference and Pro Rail Scenarios for Low Carbon Freight Transport on Major European Corridors towards 2050. Working Paper 5 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Fraunhofer ISI. Karlsruhe.

Mader, S. and W. Schade (2018): Pro Road Scenario for Climate-Neutral Road Freight Transport on Major European Corridors towards 2050. Working Paper 6 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. M-Five GmbH. Karlsruhe.

Van Hassel, E., Vanelslander, T and Doll, C. (2018): The Assessment of Different Future Freight Transport Scenarios for Europe and the North Rhine Westphalia region. Working Paper 7 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. TRR, University of Antwerp and Fraunhofer ISI. Antwerp.

Sieber, N., C. Doll, E. van Hassel, T. Vanelslander (2018): Sustainability Impact Methods and Application to Freight Corridors. Working Paper 8 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Fraunhofer ISI TPR/ University of Antwerp, Karlsruhe.

Eiband, A., A. Klukas, M. Remmer, C. Doll (2018): Local Impacts and Policy Options for Northrhine-Westphalia. Working Paper 9 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Fraunhofer IML, Fraunhofer ISI. Karlsruhe.

SUMMARY REPORTS

Petry, C., M. Maibach, C. Gandenberger, D. Horvat, C. Doll, S. Kenny (2018): Myth or Possibility – Institutional Reforms and Change Management for Mode Shift in Freight Transport. Summary Report 1 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Infras, Fraunhofer ISI, T&E. Karlsruhe.

Doll, C., J. Köhler, A. Eiband, E. van Hassel, S. Mader (2018): The Contribution of Mode Shift and New Technologies to Climate Mitigation in Freight Transport. Summary Report 2 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Fraunhofer ISI, Fraunhofer IML, TPR/UNiv. of Antwerp, M-Five. Karlsruhe.

Doll, C. et al. (2018): Policy and business–how rail can contribute to meet transport climate targets in the freight sector. Summary Report 3 of the study LowCarb-RFC–European Rail Freight Corridors going Carbon Neutral, supported by Stiftung Mercator and the European Climate Foundation. Fraunhofer ISI, Fraunhofer IML, TPR/UNiv. of Antwerp, M-Five. Karlsruhe.

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