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Business Models for Freight and Logistics Services

Working Paper 4 of the study LowCarb-RFC - European Rail Freight Corridors going Carbon Neutral

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1 Introduction

1.1 Context: The LowCarb-RFC project

This publication is one of three summary reports of work performed within the study “Low Carbon Rail Freight Corridors for Europe” (LowCarb-RFC). This study is co-funded by Stiftung Mercator (an independent private foundation) and the European Climate Foundation (ECF) over a three-year period from September 2015 to November 2018 and is being 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. This sector is one of the most steadily growing sources of greenhouse gas emissions in Europe, and is very difficult to address using renewable energies and other standard climate mitigation measures in transport. Starting from the traditional Avoid-Shift-Improve approaches, the LowCarb-RFC methodology concentrates on the modal shift to rail and mitigation measures in all freight modes along the two major transport corridors crossing Germany: the Rhine-Alpine (RALP) corridor from the Benelux countries to Northern Italy and the North Sea-Baltic (NSB) corridor from Benelux to the Baltic States via Poland. Besides major European strategies, the project concentrates on the implications for transport policy at the intersection of these two corridors in 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 thematic area 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 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 working paper

This working paper provides input to Stream 1 of the LowCarb-RFC project by exploring business models which can help the railway sector maintain and even expand its share in European and regional freight transport markets in the coming decades.

The majority of studies dealing with the rail transport sector and its declining role in the modal split focus on the sector's investment and modernisation deficit. Most studies examine the role of infrastructure and physical assets or legal and regulatory barriers (Höft, 2016; Kim & van Wee, 2011; Macharis & Pekin, 2009; Meyer, 2013; Rich, Kveiborg, & Hansen, 2011; Woodburn, 2003). The role of business models is only slowly finding its way into the literature (Flodén & Williamsson, 2016; Flodén & Woxenius, 2017). Business models, however, have the potential to revolutionize the transport sector and revive rail transport. Business model innovations are thus critical to realizing the full environmental potential of the rail transport sector, which is considered to have a much greater chance at achieving carbon neutrality than the road transport sector, for example.

Instead of focusing solely on the rail transport sector, however, the paper adopts a systemic perspective. The rail transport sector is integrated into the larger transport system and, in most cases, rail transport services are combined with other modes. Therefore, a systemic perspective is essential. All modes of transport and all participants in the transportation value chain are included in the analysis, with the exception of the infrastructure providers. The role of infrastructure and infrastructure providers is investigated in more detail in the paper on policy and regulatory interventions.

This paper discusses a range of business model innovations taking place outside the rail transport sector with a direct impact on rail transport. The paper also discusses business model innovations that may have been developed elsewhere but could be transferred to the rail transport sector. The paper's main research question is whether business model innovations have the potential to strengthen the rail transport sector.

While the focus is on how to increase the market share of rail transport in the modal split, it is not exclusively on business model innovations within the rail transport sector. It will also look at business model innovations outside the rail transport sector with the potential to increase the modal market share of rail transport. This paper is based on a survey of all business model innovations within the rail transport sector and relevant innovations outside the sector. The focus of the paper is illustrated in Figure 1.

Figure 1: Defining the unit of analysis: Business models inside and outside the rail transport sector

Business models in the rail transport sector	
Traditional business models	New business models
Business models of the infrastructure providers (not part of the paper)	

New business models in the rail transport sector				
Structural business models		**Digital** business models		
Horizontal corporations	Vertical cor-porations	Process-oriented	Analytics-based	Platform-based

Business models outside the rail transport sector		
Business models that could be adopted in the rail sector	Business models with an impact on the rail transport sector	Business models with no relevance to the rail transport sector (not covered by the paper)

The paper is structured as follows. Section 2 describes traditional business models in the rail transport sector. Section 3 then turns to business model innovations. It distinguishes between structural (Section 3.1) and digital business models (Section 3.2). This section also addresses how business model innovations, particularly in the road haulage business, could undermine the revitalisation of rail transport (Section 3.3). Finally, Section 4 concludes with recommendations to business leaders and policy-makers.

2 Classic business models

There have been few business model innovations since the liberalisation of the rail transport market. A study by Waibel (2008) shows that eight main business models have emerged in the liberalised market. He distinguishes business models by relation type (short distance, regional long-distance and international transport) and production type (individual car, whole train, and intermodal). Based on these distinctions, he groups traditional business models into four basic categories:

1. Relation type specialists
2. Production type specialists
3. Minimalists
4. All-rounders.

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 categorized into eight basic types:

1. Short distance minimalists: short train for single or a limited number of businesses, typically planned railways;
2. Short distance specialist: focused on short distances and the last mile with a few attractive units and wagons;
3. Regional relationship specialist;
4. Production type specialist - whole train: providing long-distance and international transport services, often specialising in limited bulk (chemicals, cars etc.) types;
5. Corporation all-rounder: all relation and production types; provides most services in cooperation with business partners;
6. Own capacities all-rounder: all relation and production types; provides most services using own capacities;
7. Long-distance minimalist: providing long-distance and international whole train service;
8. Incumbent rail transport businesses: the previous monopolists.

These eight business models are still prevalent today. There has been only limited business model innovation from within the rail transport sector, which appears to be constrained by a significant degree of inertia. The incumbent rail companies often seem too big to bring about the organisational and cultural transformations that are necessary to explore the potential of digital business models (Semmann, 2016). Other commonly mentioned constraints include lack of know-how, insufficient support from management and employees (Semmann, 2016). And although many businesses understand the importance of digitalisation in principle, many shy away from taking the necessary practical steps to introduce digital technologies. For small and medium-sized enterprises, a lack of resources is considered to be the main factor (Semmann, 2016; van Markyk & Treppte, 2016).

According to a study by Roland Berger, one third of transport businesses believe that the digital revolution could render their current business models obsolete (van Markyk & Treppte, 2016). The majority of business model innovations can therefore be expected to take place in new businesses or come from outside the rail transport sector. Innovations in the retail sector, such as the introduction of cyber-physical systems, are considered to be one of the main drivers of modernisation and digitalisation in the transport sector (Kersten, Seiter, See, Hackius, & Maurer, 2017). As retailers continue to digitalise their production and business processes with the help of cyber-physical systems, they will seek to expand this approach down the value chain into the transport sector, forcing transport service providers to adopt such innovations. Therefore, this study considers all types of business models with relevance for the rail transport sector, regardless of whether they originate from inside or outside the rail transport sector.

3 New business models

New business models have emerged due to the liberalisation and European integration of the rail transport sector in the 1990s as well as the digital revolution in the 2010s. This paper distinguishes between structural and digital business model innovations (see Figure 1). Eight examples were selected to illustrate the current dynamics in business model innovation. Needless to say, the authors do not claim that the selected business models are in any way representative of the current transport sector. Instead the selection was based on the main dimensions of business model innovation as described in the literature. According to the literature, the main sources of business model innovation are the servitization of previously product-based business models (Tukker, 2004), the emergence of use-based instead of ownership-based models (Eckartz, Frank, Meyer, & Gandenberger, 2017; Lerch, Gandenberger, Meyer N., & Gotsch, 2016), and the digitalisation of the economy (Lerch, Schnabl, Meyer, & Jäger, 2017).

In order to categorize and compare the business models discussed in this paper, a business morphological box is used (see Figure 2) as first described in (Lay, Meier, Schramm, & Werding, 2003). 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 variations of these dimensions. The dimensions of the first four rows mainly describe the business rather than the model. These categories include the modes of transport, the location where the product or service is performed (mobile, stationary or virtual), the stage of the transportation process (planning and administration, the transport and loading stage, and monitoring of the process), and finally the type of customers or users targeted by the business model.

The remaining dimensions relate more strongly to the core of the discussed business model. The dimensions will be introduced and explained in the following sections.

Figure 2: Morphological box: Variations of business model innovations

Dimensions	Characteristics				
Mode	rail	road	intermodal	canal	sea
Location	mobile	virtual	stationary		
Stage	planning and administration	transport	loading	monitoring	

<table>
<tr><th>Dimen-sions</th><th colspan="15">Characteristics</th></tr>
<tr><td>User</td><td colspan="2">logistics services provider</td><td colspan="4">forwarder</td><td colspan="3">terminal manager</td><td colspan="4">infrastructure provider</td><td colspan="2">shipper</td></tr>
<tr><td>Main value proposition</td><td colspan="3">bundling</td><td colspan="4">matching</td><td colspan="5">information management</td><td colspan="3">process management</td></tr>
<tr><td>Sustaina-bility</td><td colspan="5">integral to the value proposition</td><td colspan="5">communication</td><td colspan="5">not part of the value proposition</td></tr>
<tr><td>Value chain</td><td colspan="7">horizontal</td><td colspan="8">vertical</td></tr>
<tr><td>Degree of digitalisa-tion</td><td colspan="5">information management</td><td colspan="5">simple optimizations</td><td colspan="5">advanced analytics</td></tr>
<tr><td>Scalability</td><td colspan="7">high</td><td colspan="8">low</td></tr>
<tr><td>Timing</td><td colspan="7">predictive</td><td colspan="8">reactive</td></tr>
<tr><td rowspan="2">Product service systems</td><td rowspan="2">pure product</td><td colspan="3" rowspan="2">product-oriented PSS</td><td colspan="7">use-oriented PSS</td><td colspan="3" rowspan="2">results-oriented PSS</td><td rowspan="2">pure service</td></tr>
<tr><td colspan="2">leasing</td><td colspan="2">pooling</td><td colspan="3">sharing</td></tr>
</table>

3.1 Structural business model innovations

There are a number of business model innovations that focus on the structural organisation of businesses. It is possible to distinguish between horizontal and vertical cooperation between businesses, and vertical integration of businesses.

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. There appears to be substantial optimization potential here. In the European Union, 24% of vehicles are transported empty, while the average loading of the rest is 57% (World Economic Forum, 2011). Capacity optimization is particularly important for rail transport. Rail transport is most cost-effective when cargo is bundled and transportation can be organised in point-to-point whole trains (Mertel, 2015). Conversely, it is often prohibitively expensive to transport cargo that cannot be transported by whole trains. By bundling cargo, either with other rail transport businesses or by coordinating with their partners along the value chain, transport providers can optimize the use of transportation capacities.

Carpooling for Cargo, for instance, is a pilot project that capitalizes on bundling transportation by horizontal collaboration between different shippers. It was started in 2010 by the University of Antwerp's spin-off company Tri-Vizor, which detected significant bundling and synergy potentials for temperature-controlled transportation services (UCB Pharma GmbH, 2011, p. 13). Tri-Vizor then partnered with the pharmaceutical companies UCB and Baxter to create a framework for consolidating and synchronising their freight flows. By providing horizontal collaboration between multiple independent shippers and logistics service providers, Carpooling for Cargo is able to realize double-digit net savings and reduce the carbon footprint per freight movement by up to 20-40% (UCB Pharma GmbH, 2011, p. 13).

Figure 3: Example: Carpooling for Cargo

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 optimizations	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		

This example introduces three additional dimensions of the methodology (shown in dark grey); the first is the main value proposition of the business model. Based on the review of the literature and the survey of relevant business models, it is possible to classify new business models into four types: matching platforms, information management systems, process management systems, and services focusing on the optimization of load capacities through bundling, as in the case of Carpooling for Cargo. Second, the paper distinguishes between business models that address transaction costs and the conflicts of interests of actors who interact horizontally or vertically along the value chain. In the case of Carpooling for Cargo, the new business model facilitates vertical cooperation. Third, there is the sustainability dimension. Sustainability appears to be an integral part of several business models' value proposition.

Vertical integration, which is the integration of previously separate businesses through mergers or acquisitions, is used to reduce or internalise transaction costs. For instance, while a road hauler and a rail transport company can be expected to favour the mode of transport they provide, even where this might not be the most cost-effective one, an integrated business that has both road and rail capabilities is free to choose the most cost-effective mode in every given situation.

3.2 Digital business models

Digital business models are based on the use of digital technologies to generate value. Digitalisation has the potential to increase the reliability, flexibility and speed of rail transport. Such quality improvements can increase the competitiveness of rail transport versus the road haulage business. Digitalisation also has the potential to improve the integration of rail transport into the modal mix. To exploit this potential, however, new business models are required.

This chapter introduces three additional dimensions of the morphological box. First, the degree of digitalisation. Along this dimension it is possible to distinguish basic information management, simple optimizations and advanced analytics. Information management could, in principle, still be done in paper form, but is a lot less efficient. Simple optimizations and advanced analytics, on the other hand, depend on modern computing powers. The second new dimension deals with the scalability of the business model. Digitalisation often greatly enhances scalability and allows companies like AirBnB or Uber to grow very quickly. Thirdly, there is the timing dimension, which is also related to digitalisation. The use of digital technologies and cyber-physical systems promises huge advances in predictive logistics, where transportation needs are anticipated, and could unleash further optimization potential.

Figure 4: Digital business models in the morphological box

Degree of digitalisation	information management		simple optimizations		advanced analytics
Scalability	high			low	
Timing	predictive			reactive	

3.2.1 Process-oriented business models

Against this background, it is possible to distinguish three types of process-oriented business models. First, there are the business models, which optimise processes by introducing digital automation and processing technologies. Cyber-physical systems, which create a digital twin of the physical infrastructure, harbour enormous potential for synchronising transport processes and shortening production cycles. The digital twins can exist at the level of manufacturing plants but also at the level of the transportation system. As soon as such digital twins are established and it is possible to exchange data between cyber-physical systems, production systems can be synchronised. Both manufacturers, and transport service providers can use this data to optimise their own business processes. Analytics- and platform-based business models are discussed below.

Full-scale cyber-physical systems are not yet a reality. The technological precursors for such systems, however, such as RFID chips and various sensors and actuators, can already be found in various applications. During the research for this paper, the authors came across numerous examples of business models exploiting these technological potentials. Most examples fall into three domains: shipping information, terminal management and supply chain management.

In the context of active marketing, predictive logistics is becoming more and more important. Predictive logistics uses data that the company already has to predict likely future developments. For instance, logistics providers are able to predict the time and quantity of the next order based on the customer's past orders. The timing dimension of the morphological box captures this. While the majority of transport services are provided reactively, predictive logistics appears to hold huge potential for the future (Autier & Haisermann, 2017). At present, however, no business model could be found that leverages this technological opportunity.

3.2.1.1 Shipping information management

Business models that deal with the management of shipping information use digital technologies to detect the location of cargo. In this context, GPS sensors are used for geo-tracking and optical scanners as well as RFID chips are used to monitor the movements of cargo past predefined locations. These technologies provide numerous business opportunities. One application, for instance, is geofencing, where business processes are triggered autonomously when cargo passes a specific location. When a shipment arrives at the final customer's plant, for instance, billing processes are triggered autonomously. The wagon rental company VTG Rail Europe, for instance, provides such services to optimise cash flows. According to the company, dispatchers receive their payments two days earlier with the help of its geofencing services (Heinrici, 2017).

Goodpack, for instance, is the world's largest provider of intermediate bulk containers. The Vilant Asset Tracking system was created to enable full visibility of its containers in real-time and to automate its internal and customer processes in order to improve administrative efficiency. The tracking system consists of RFID tags mounted on containers and RFID readers that track the movement of the containers. The benefits of the system include the availability of real-time tracking information, increased administrative efficiency and a reduced risk of loss and theft (Bestfact, 2015c). The generated information can also be used to optimize the use of loading capacities.

In this context, blockchain technology might harbour great potential. It could be employed to trace the condition and quality of cargo, for instance, with regards to the origin of products, their quality and freshness (Wöhrle, 2017). Related business model innovations have not yet found their way onto the market.

Figure 5: Example: Goodpack

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	

Dimensions	Characteristics						
Sustainability	Integral to the value proposition		communication		not part of the value proposition		
Value chain	horizontal			vertical			
Degree of digitalisation	information management		simple optimizations		advanced analytics		
Scalability	high			low			
Timing	predictive			reactive			
Product service systems	pure product	product-oriented PSS	use-oriented PSS: leasing	use-oriented PSS: pooling	use-oriented PSS: sharing	results-oriented PSS	pure service

The Goodpack case is also interesting from the perspective of product service systems, which proves to be a source of many business model innovations. Goodpack does not sell its RFID-fitted containers, but leases them to customers. For Goodpack, this has the advantage of creating new revenue sources beyond pure product sales. For instance, it offers a digital tracking platform to complement its services. This also has great potential for customers. Goodpack's customers can reduce the cost and risks related to the purchase, maintenance and financing of containers. It also becomes easier to optimize the use of the containers' loading capacities. If the containers were used by a single company, they would always have to be returned after the contents had been delivered to the customer. The leased containers, in contrast, can be relayed more easily to another shipper or forwarder.

3.2.1.2 Terminal management

Terminal management is of critical importance for road transport, as rail rarely serves the first or last mile. Therefore, new technologies with the potential to reduce handling costs when the cargo is moved to and from trains and across other modes of transport are crucial.

One example of a digital terminal management system is the BLU control system for container-loading stations in intermodal transport developed by Berghof Automation GmbH in Mühlhausen. The system provides assistance with all operative procedures at rail-road terminals resulting in a better use of resources, increased efficiency of logistics processes and faster processing of trucks at the terminal (Bestfact, 2015a). Besides its implementation at the intermodal terminals of the German terminal operator DUSS, Berghof Automation GmbH received the order to equip twelve Norwegian rail-road terminals with the BLU control system (Berghof GmbH, 2016).

Figure 6: Example: BLU control system

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 optimizations	advanced analytics				
Scalability	high	low					
Timing	predictive	reactive					
Product service systems	pure product	product-oriented PSS	use-oriented PSS: leasing	use-oriented PSS: pooling	use-oriented PSS: sharing	results-oriented PSS	pure service

3.2.1.3 Supply chain management

Another business case consists of the use and analysis of production data to optimise transportation processes, e.g. by bundling cargo. Cyber-physical systems show great potential in this context. Where such systems allow manufacturers and transport service providers to share production data, this data can be used to anticipate transportation needs and optimize the use of transportation capacities. One example is bundling cargo for whole train operations.

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 in managing their mobile resources, such as staff, loading units and transport units (Vogel, 2015). The system's customers participate via an 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).

Figure 7: Example: Catkin

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 optimizations	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		

In this context, the digitalisation of transport equipment and the creation of digital twins also create multiple opportunities for new business models that are based on condition monitoring. Condition monitoring can be applied at multiple levels. At the level of 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 cargo, condition monitoring can provide other opportunities for optimisation, particularly in the context of perishable foods or hazardous cargo. This could be an interesting field for insurance companies to optimize the type of contracts they provide.

3.2.2 Analytics-based business models

Analytics-based business models use the potential offered by advanced computer analytics, such as big data and artificial intelligence. Similar to the previous category of process-oriented business models, analytics-based models also depend on the introduction of technologies that create a digital image of the transportation process. Such business models can often be found in the context of route optimization, such as the Intermodal Links Planner. It identifies the best intermodal connections in Europe by analysing the schedules of more than 90 intermodal rail, barge and short sea operators. The search engine provides information about transport duration, frequency, departure dates and the contact data of all the available intermodal logistics transport suppliers. The increased visibility of intermodal options leads to more intermodal transport, resulting in time savings, and reduced emissions and costs (Bestfact, 2015d).

Figure 8: Example: Intermodal Links Planner

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 optimizations	advanced analytics				
Scalability	high	low					
Timing	predictive	reactive					
Product service systems	pure product	product-oriented PSS	use-oriented PSS leasing	pooling	sharing	results-oriented PSS	pure service

Finally, there are decision-support systems that provide simulations as a service. SimConT, for instance, is a decision-support tool developed in 2005 by the department of production management and logistics at the University of Vienna.

This tool helps to plan the use of inland container terminals and facilitates efficient resource-planning and effective capacity utilization. It is based on modern simulation techniques, and can analyse the maximum storage locations as well as modelling the inbound and outbound flows, which allows the dynamic evolution of planned changes at the terminal. Consequently, SimConT provides support on the strategic and tactical level and minimizes the risk of investments and stranded costs (Bestfact, 2015e).

Figure 9: Example: SimConT

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 optimizations	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		

3.2.3 Platform-based business models

Platform-based business models use digital technologies to reduce transaction costs between all the participants of the value chain. Their main function is to reduce search and matching costs. Similar to a dating platform, they bring together all of the participants in the transportation value chain and make matches between users and providers. Critically, and unlike the previous two categories of business models, platform-based business models do not require the digitalisation of the physical rail transport infrastructure and the introduction of cyber-physical systems. They merely require businesses along the transport value chain to be willing to share information on the type (i.e. route and the type of cargo that can be transported) and cost of the transport service provided. Technologically, platform-based business models represent a lower hanging fruit. At the same time, it is infinitely more difficult to mobilise a critical mass of transport service providers to make such platforms a reality. Due to network effects, the value of such platforms depends on and increases with the number of participants. Therefore, the mobilization of a critical mass of users is the first major challenge for any such platform.

Freight Arranger, for instance, 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 intermodal 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 a modal shift towards rail. Besides strengthening intermodal transport, it reduces administration costs and processing time and increases the load factor of trains (Bestfact, 2015b).

Figure 10: Example: Freight Arranger

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 optimizations	advanced analytics				
Scalability	high	low					
Timing	predictive	reactive					
Product service systems	pure product	product-oriented PSS	use-oriented PSS: leasing	use-oriented PSS: pooling	use-oriented PSS: sharing	results-oriented PSS	pure service

In 2017, after several months of testing, another digital marketplace was launched by the start-up CILLOX, which is part of DHL. Cillox has now been renamed Saloodo! and brings together customers and transport service providers on a Digital Freight Platform. Besides the matching process, the platform monitors and optimizes transport processing. Following a test phase with approximately 100 transport and logistics partners of DHL, the platform is now available in 17 countries, and integrates more than 4,900 carriers and 200,000 trucks (Bollig, 2016; Lutz Lauenroth, 2017).

Figure 11: Example: Saloodo!

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 optimizations	advanced analytics				
Scalability	high	low					
Timing	predictive	reactive					
Product service systems	pure product	product-oriented PSS	use-oriented PSS: leasing	use-oriented PSS: pooling	use-oriented PSS: sharing	results-oriented PSS	pure service

While the introduction of cyber-physical systems is not considered essential for platform-based business models, they can reap significant potential benefits from such systems. First, fully interconnected cyber-physical systems could use such platforms to book and sell transport services autonomously. Second, cyber-physical systems could allow such platforms to provide additional services, such as route optimizations.

3.3 Innovations outside the rail sector

While business model innovations can work in favour of the road transport sector, they can also work against it. The digital revolution not only has great potential for the rail transport sector, but for other sectors, too. In road haulage, for instance, digital innovations like autonomous driving have huge market potential. Platooning, for example, is a technology that allows multiple trucks to follow one another autonomously. Only the first truck would be steered by a human driver. Autonomous driving, of course, has the same potential in the rail sector. However, it is expected to be introduced much quicker in the road haulage business. The platooning technology, which is expected to be ready within the next 10 to 20 years (Jahncke, 2017), is estimated to increase the cost effectiveness of road transport by 28% (Bieker, 2017). Such an efficiency increase for road haulage would certainly put rail transport under significant additional pressure.

In addition to the cultural differences between the two sectors, which are often cited to explain the higher innovation capacities of the road haulage sector, a major reason why new innovations, such as platooning, can be expected to arrive much faster on roads than on railway tracks is that trucks are produced in much larger batch sizes than locomotives, providing greater opportunities for scale economies. Road trucks are also replaced much more frequently than locomotives (Höft, 2016).

4 Conclusions and recommendations

The rail transport sector harbours great potentials for business model innovations. The digital transformation, in particular, can be expected to open the door to various innovations, most of which have not yet seen the light of day. This paper has limited itself to business models that have already been introduced in the transport sector, and business models that have been developed elsewhere but might be transferable to the transport sector. However, the future may well bring many more business model innovations that are still unimaginable today.

With the help of the morphological box, which was used to compare individual business models, it is also possible to identify areas that are still less commonly exploited in new business models. This is achieved by overlaying the various business models in a heat map. These less frequently used dimensions of business model innovations can indicate still untapped potential or barriers that prevent business from exploiting these opportunities, in which case further research is recommended.

Figure 12: Heat map

<table>
<tr><th>Dimen-sions</th><th colspan="7">Characteristics</th></tr>
<tr><td>Mode</td><td>rail</td><td colspan="2">road</td><td>intermodal (9)</td><td colspan="2">canal</td><td>sea</td></tr>
<tr><td>Location</td><td colspan="2">mobile (1)</td><td colspan="3">virtual (7)</td><td colspan="2">stationary (1)</td></tr>
<tr><td>Stage</td><td>planning and administration (6)</td><td colspan="2">transport (1)</td><td colspan="2">loading (3)</td><td colspan="2">monitoring (3)</td></tr>
<tr><td>User</td><td>logistics services prov. (5)</td><td colspan="2">forwarder (5)</td><td>terminal manager (3)</td><td colspan="2">infrastructure provider</td><td>shipper (5)</td></tr>
<tr><td>Main value proposition</td><td>bundling (1)</td><td colspan="2">matching (2)</td><td colspan="2">information management (1)</td><td colspan="2">process management (5)</td></tr>
<tr><td>Sustaina-bility</td><td colspan="2">integral to the value proposition (1)</td><td colspan="3">communication (4)</td><td colspan="2">not part of the value proposition (3)</td></tr>
<tr><td>Value chain</td><td colspan="3">horizontal (1)</td><td colspan="4">vertical (4)</td></tr>
<tr><td>Degree of digitalisa-tion</td><td colspan="2">information management (4)</td><td colspan="3">simple optimizations (3)</td><td colspan="2">advanced analytics (2)</td></tr>
<tr><td>Scalability</td><td colspan="3">high (5)</td><td colspan="4">low (4)</td></tr>
<tr><td>Timing</td><td colspan="3">predictive (1)</td><td colspan="4">reactive (8)</td></tr>
<tr><td rowspan="2">Product service systems</td><td rowspan="2">pure product (3)</td><td rowspan="2">product-oriented PSS (3)</td><td colspan="3">use-oriented PSS (1)</td><td rowspan="2">results-oriented PSS</td><td rowspan="2">pure service (1)</td></tr>
<tr><td>leasing (1)</td><td>pooling</td><td>sharing</td></tr>
</table>

Legend:	1	2-3	4-5	6-7	8-9

Figure 12 suggests potential for as yet unexploited business model innovations in the area of predictive logistics, use-oriented and results-oriented product service systems, and the facilitation of horizontal cooperation and bundling. Predictive logistics could start to play a bigger role as soon as cyber-physical systems become more widespread. 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. We are not able to state that such business models do not exist. The heat map in Figure 12 is also not representative of the total population. However, although we searched specifically for business models in each of these categories, we found only isolated or no examples.

The heat map also appears to suggest that there is a bias toward purely digital business models. Such business models promise unlimited scalability and may therefore be more attractive to investors. However, conventional business models can also be upgraded by implementing digital technologies. This is particularly important for incumbents and SMEs. If they fail to respond and adapt to the digital revolution, they might eventually be forced out of business. Moreover, it needs to be recognized 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 utilize transport-related data might grow at the expense of incumbent businesses.

To develop a better understanding of the innovation potential of the rail transport sector, this paper has argued that 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 further emphasize 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 relationships 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 these relationships is also key to exploiting the (environmental and safety) potential of rail transport and, ultimately, to increasing its market share in the model split.

Platform-based business models harbour a huge market potential. Such business models have the potential to save 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 antitrust challenges. Therefore, further research is needed in terms of evaluating regulatory and other policy measures to address such antitrust challenges ahead of time.

Business leaders need to recognize that they do not necessarily have to revolutionize their entire business or abandon their main business model. Research shows that the most successful businesses start out by experimenting with complementary models that are introduced in parallel to their main model (Lerch et al., 2017).

Policymakers are also recommended to intensify their efforts in solving the legal and technical challenges surrounding the digital waybill, which has huge potential for intermodal transport.

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6 LowCarb-RFC Project Publications

The below list of 9 working papers and 3 summary report is in parts preliminary as some of the material is in preparation by the time of releasing this report. A current list of publications is at:

- Fraunhofer ISI: LowCarb-RFC project website: https://www.isi.fraunhofer.de/en/competence-center/nachhaltigkeit-infrastruktursysteme/projekte/lowcarb_rfc.html
- Stiftung Mercator, Climate-Friendly Freight Transport in Europe: https://www.stiftung-mercator.de/en/project/climate-friendly-freight-transport-in-europe/
- Transport & Environment, Low Carbon Freight: http://lowcarbonfreight.eu/

Working Papers

Doll, C., Köhler, J., Maibach, M., Schade, W. and Mader, S. (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 Maibach, M. (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.

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Summary Reports

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