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METRO.FREIGHT.2020 – strategies for strengthening rail infrastructure for freight transport in urban regions

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Abstract

In most European congested urban areas the rail tracks of the 19th and 20th century serving locations of industry and goods stations were removed, transformed for public passenger transport, closed down or used for other purposes. The main reasons might be the de-industrialisation of the inner cities and the centralisation of the supply-sector (wholesale markets, shopping centres). Simultaneous the urban areas got an excellent road network on the surface and an efficient public transport system in the underground or on dedicated tracks. Nevertheless the amount of goods delivered to urban areas increased due to material prosperity. In this context "METRO.FREIGHT.2020" analysed the possibilities of a reinforced utilisation of railway infrastructure for freight transport on the first and the last miles within the urban regions in Austria as exemplified in case studies for the metropolitan Region of Vienna, the agglomerations of Graz and Linz and for the urbanised Rhine-Valley in Vorarlberg. In this context the focus point of consideration was the interface of transport and urban development, to a lesser extent the theoretical approach behind. As a fundamental milestone a cadastre of existing or recoverable sidings or other rail shipping points has been surveyed. They were evaluated in respect of serviceability concerning tracking freight trains in the rail network and extensibility in the service area which was complemented with propositions for further developing.

The recommendations focus measures intending technically and economically operable access points to rail net on one hand and potentially appropriate access points for the future. But, to reach this goal more strengthened integration of commercial location policy and of shippers' transport demands with a coordinated land use planning and an infrastructure development policy is required. Finally the methodical approach elaborated comprises following components to push more rail freight shipping:

- Traffic zoning is a hierarchical spatial approach subdividing an urban region in sectors, zones and 'agglomerates' as spheres of activity for political and private actors involved in freight traffic generation and infrastructure affaires.

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- Surveying a multimodal topology of infrastructure network which integrates all transport modes in its layout of freight infrastructure propped up on a public platform of a multimodal network graph in future.
- Characterizing an 'agglomerate' typology of shipping sites with affinity to rail which describes the typical initial position and development trends of the freight transport inducing traffic zones.
- Shaping spatial structures which consist of super structures of shipping industrial sites as traffic generators, the infrastructure with its capacity for freight movements and the 'metastructure' as external affected settlements and land uses are prime targets and intervention objects, the coordinated measures have to be allocated to.

The railway operators are called on to offer more flexible train and operation forms tailored to the logistics of shippers if the rail infrastructure within the serving area from the consolidation node to the sidings enables it.
In the end three scenarios have been identified, namely a scenario of ultimate displacement of rail freight service in towns, a retarding scenario which brakes the retreat of rail connected with a change of paradigm in transport and traffic planning leading into an offensive scenario of 'clean freight mobility' to revitalize and extend rail freight operations into areas of high consumption.

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Keywords: Urban logistics; rail freight; agglomeration; city logistic; rail infrastructure

1. Introduction

During the last decades urban railway infrastructure to develop industrial and commercial locations in European agglomerations had been abandoned or opened up respectively reconstructed for public transport or converted to other land-use purposes. These developments had been intensified by de-industrialisation of cities and centralisation of local supply structures, while at the same time due to mass motorization road infrastructure and rail tracks for public transport were extended. Nevertheless, extensive rail infrastructure still exists across European city-regions, whether it meets the main functions of public transport and freight transportation or it just outlasted the urban development process.

Hence, the study "METRO.FREIGHT.2020" (Hörl/Dörr/Wanjek et al., 2011) examined the function of (still) existing urban rail infrastructure in four selected Austrian city-regions to meet the needs of private sidings of especially mid-sized companies. Therefor the study authors concentrated on the performance of urban origin respectively destination transportation on the first and last mile, particularly on transportations into the urban core. In this context the focus point of consideration was the interface of transport and urban development, to a lesser extent the theoretical approach behind.

2. Urban railways are the poor relation of freight transport

Regional and local transportation concepts are usually not considering urban railway infrastructure on behalf of freight transportation aspects. Generally those infrastructures shall be used to reach aims and implement measures in the field of public transport. In the case of freight transport regional and local transport policies concentrate on requirements to prevent through-going traffic (on both roads and railways), to extend freight terminals (in periurban areas) and to implement smart city logistic concepts. Due to the European Climate and Energy Fund private sidings are of great interest in the Austrian transport policy, although they are mostly mentioned related with major shippers. Indeed detailed concepts designate industrial and commercial sites in combination with existing or planned railway tracks as functional areas, but specific statements are lacking. Even if some Austrian regions (e.g. Upper Austria) are trying to set additional impulses by promoting private sidings (Höfler et al., 2008, p. 125), political appreciation and implementation in the planning process due to reserving railway connections is still lacking.

Generally all regional and local transport policies agree that it is necessary to ensure the accessibility of existing and planned commercial and industrial sites. Despite that, most of elaborated master plans do not include statements about how to ensure these requirements and give no detailed statements for modality or all kinds of infrastructure and network designing issues. Particularly private sidings as well as the possibility of freight transport on light railways are not considered in master plans for urban development, although all of them are components of urban traffic infrastructure. Siding transports are of great importance, since they generate a 2/3 share of the total transport volume on the Austrian rail network and they also relieve traffic on the road.

Even though major shippers induce the majority of the siding transports at the moment, there is a big potential for mid-sized companies who mainly use trucks. The main reasons why mid-sized companies are using trucks instead of even existing private sidings is that:

(1) the organisational effort is too high,
(2) the availability of the tracks for siding operations is at certain times limited due to public transport services,
(3) the availability of external sources (e.g. freight wagons) is quite often difficult and
(4) the period of pre-ordering is too long.

Initiated by customer expectations there is a current trend towards sustainable logistic, which means, that logistics providers should offer more CO_2-neutral transport services. To implement green logistic concepts railways could be used on one hand, but on the other hand operating restrictions and shutdowns of existing infrastructure preclude the application of this transport option. At the same time producing industries are characterised by a structural transformation. Old industrial sites, which were perfectly connected to the railway infrastructure had been abandoned, divided or re-used for other purposes. In these cases the existing railway infrastructure often lost its initial function and was neglected bit by bit. Over time the infrastructural preliminary work will break apart and gradually disappear until it will be lost forever.

This development reveals that an integrated and coordinated approach across transportation and infrastructure policy, urban planning, business location policy and shipping agents is indispensable to guarantee an efficient utilization of urban railway infrastructure in the future. Whereas the current promotion of combined transport is able to increase the transport volume on railways, this does not apply for urban transportation on the first and last mile. Trucks still remain the main pillar of freight transportation in the city, especially for local deliveries and the fine distribution to urban freight terminals, which seems to be problematic in view of sustainable transportation system planning.

3. Tasks and methodological approach

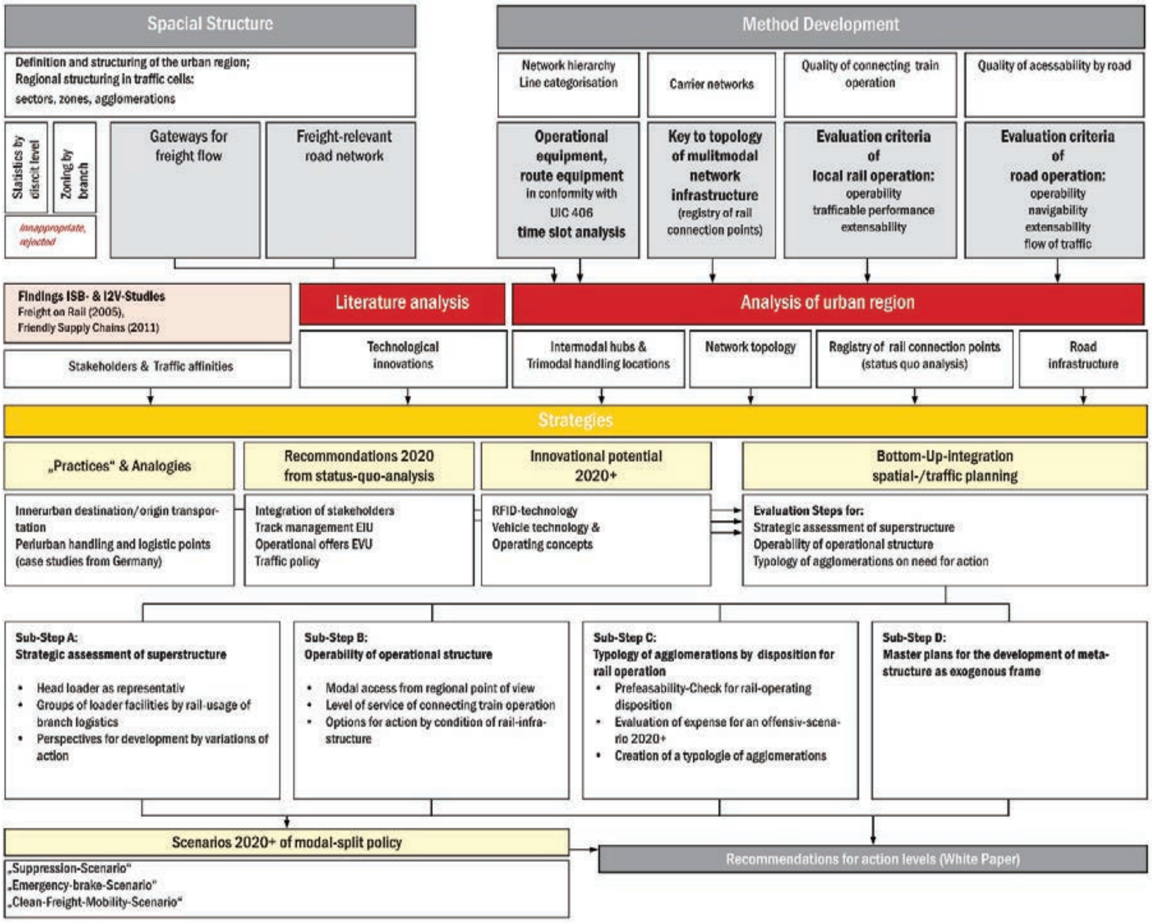
To enhance the integration of existing railway infrastructure in regional and local master plans for urban development the study "METRO.FREIGHT.2020" identified inhibiting factors as well as enabling factors. Thereby strategies and recommendations for a responsible and sustainable use of urban railway infrastructure, in particular private sidings for future master plans could be deduced.

In short, the study took into account:

- freight transport related networks with regard to service functions for fine distribution, collection and distribution of industrial and commercial sites
- freight transport generating commercial sites with regard to their operability (transport quality), their industry affiliation, the resulting transportation affinity of their logistic and the actual as well as the potential options for a multimodal transport
- action fields for relevant stakeholders
- range of options deduced from urban and functional related situations ('metastructure' of external effects generated by freight transport) and infrastructural conditions

Figure 1 demonstrates the methodical approach and the way from analysing aspects of spatial structures (e.g. gateways for freight flows) as well as aspects of operation (e.g. route utilization, network hierarchies, quality of siding conditions) and accessibility (e.g. share of heavy-load vehicles) to deduce suitable scenarios in order to draw up strategies and recommendations for future planning.

Within the study the authors concentrated on four selected city-regions: Vienna, Linz, Graz and the Rhine-Valley-Corridor in Vorarlberg (surrounding of Bludenz – Bregenz). This ensured a large range of different economical, infrastructural, spatial and logistical conditions, which have to be considered to enhance siding transportation.



Source: Hörl/Dörr/Wanjek et al., 2011, p. 4

Fig. 1. Methodical approach of METRO.FREIGHT.2020.

First of all, due to the analysis, **cluster of mid-sized shippers** were identified. In order to range these mid-sized shippers in a geo-system of spatial and transport network related information, a hierarchical classification system based on three levels of presentation and action levels (sectors, zones and agglomerations) needed to be developed. This was used as an important input for the selection of the four different city-regions.

Besides these identified clusters of mid-sized shippers, **operating options** of urban transportation networks had to be screened during the analysis. Therefore a valuation method for railway and road infrastructure was needed. For the railway infrastructure network units for freight transport, operating facilities, their qualitative and capacitive characteristics as well as their conditions were taken into account. For the competitor ‚road' general operation possibilities by truck were considered, because they add considerable value to the modes overall appeal. These characteristics of railway and road infrastructure which are relevant for urban freight transport result in a "register of multimodal infrastructure network and connecting nodes". This register covers all analysed information according to sidings and their multimodal infrastructure network.

In addition locations of shippers which could be successively served one after another are summarised as operation areas. Based on various criteria these operation areas are valued with regard to their future **options for freight transport on railway** as table 1 demonstrates exemplarily. Therefore a valuation tool ("methodology toolbox") was developed to provide a basis to deduce recommendations for both the superstructure (general shipper, groups of shippers and their economic development) and the operation infrastructure (modal connectivity, transportation quality of sidings).

Table 1. Evaluation of operability and facilities of sidings in the city-region of Vorarlberg (small excerpt for exemplification).

Shunting hub	**Station**	**Connecting rail operator**	**Sector/Zone-Code**	**Connection to Network**	**Configuration of connecting rail**	**Operability**	**Trafficable performance**	**Extensibility**
Sector Walgau (V1) = Zone Bludenz (V11) *Agglomerations Bludenz-Lorüns (111), Nüziders-Ludesch (112), Nenzing-Frastanz (113)*								
Bludenz (km 67,7 from Lindau and km 136,3 from Innsbruck)	Bludenz (km 67,7)	Cement plant Lorüns	111-1	C2 (MBS)	Factory shunting facility ⚡		MBS	
		Transformer station Illwerke	111-2	Station A1/B1	Factory shunting facility		10105	
		Terminal container service Hämmerle	111-3		2-track uKV		see above	
	Ludesch (km 63,3)	Rauch-terminal	112-1	Station A1	2-track H		see above	extensible
		Spedition Logwin	112-2		Single track		see above	
		Red Bull Logistic Service	112-3		Single track under construction		see above	under construction
		Loading track (construction company)	112-4		Single track			

Legend (small excerpt for exemplification)					
Operability		Trafficable performance		Extensibility	
	Grade A		Siding fully operable and obviously used		No specific extensibility
	Grade B		Siding probably not used by shippers		Extensibility along the siding and its surrounding
	Grade C				
Further details for colour coding can be found in: Hörl/Dörr/Wanjek et al., 2011,					
p. 27.		p. 33.		p. 34.	

Source: Hörl/Dörr/Wanjek et al., 2011, p. 52

Within the study in the four selected city-regions and due to the analysis of urban railway infrastructure and shippers who are operating on sidings it turned out, that prospective shippers should initially be summarised into 'agglomerates'. This helps to valuate siding infrastructure with regard to future needs of reserving railway connections. These 'agglomerates' were defined through both observed and by railway companies operated freight transport. The reason therefore is that existing and efficiently useable railway infrastructures could be considered. Locations for loading and unloading do not necessarily have to be a spatial connected entity. In fact they also can be formed like a branch (operating network to connection nodes) with its twings (sidings). Besides it is also advisable to consider road connections and their operation quality for different 'agglomerates' (access roads, collecting road or access point to the next main road or interstate) and to ensure that the overall appeal of roads as competitor of railways and their environmental conditions are taken into account as well.

4. Frame conditions for freight transport on urban railways

Requirements of both involved actors, such as rail transport providers and shippers, as well as technical requirements of infrastructure and transport equipment (rolling stock) determine frame conditions for freight transport on urban railways as shown in figure 2. These requirements define to some degree whether or not transport on rail is practicable and operated.

Source: Authors' figure.

Fig. 2. Requirements of different influence groups that determine frame conditions for freight transport on urban railways.

Therefore the following aspects of **rail transport providers** are necessary to take into consideration:

- a predictable **regularity of transports** over the year,
- a **reasonable volume** (e.g. determined through the number of wagon loads) and
- an **operable transport range** (distance between origin and destination of available routes)

It is particularly important that the relation of these parameters is substitutive. This means that for instance a transport range considered sufficient can be reduced because of a high level of regularity and relevance. Conversely this applies not if a low level of relevance has to be compensated by a long transport range.

For **shippers** both product- and process-specific aspects as well as aspects with regard to markets of procurement and sales are important to take into account. Due to a complex decision making process on route and vehicle choice it is not accurate to define just a few key facts. Instead, upstream logistical settings are crucial and can only be sketched out here:

- Good-specific **transport properties** (e.g. self-loading goods, dangerous goods, heavy load, cold chain)
- **Transport requirements** which are defined by the production process (e.g. just-in-time, just-in-frequence, palettisable or containerisable goods)
- **Production depth** of transport goods (raw-, semi-finished-, finished-products) and its position in the supply chain (Procurement or distribution logistics)
- **Scarcity in the market** of conveyed goods or their volatility of market prices

In addition interactions between traffic generating actors and their **affinity to a specific system** of transport mode had not been systematically investigated up to now. The following three analytical fields results therefore:

- Affinity of **transport substrates** (not just type of statistical defined goods) to specific transport modes and vehicles which correlates strongly with the company size or product output.
- Affinity of **customary logistic processes** (influenced strongly by customer satisfaction) to specific transport modes and vehicles (Hörl/Dörr/Pöchtrager et al., 2010). In this context relevant aspects are: shift of site-related modal splits in favour of road infrastructure, increasing outsourcing of production steps as well as reserving of (private) sidings.

- Affinity of **operating sites** to networks of transportation infrastructure (these are much more differentiated than usually mentioned by spatial and transportation planners). Infrastructural conditions like entry situation of business sites and handling of loading procedures vary a lot, both because of industry-specific and individual reasons. Often this results out of a site development over a long period. For retrofitting operations especially at private sidings often no resources were left because expansion of production facilities had priority (Dörr/Hörl/Pöchtrager et al., 2011, p. 29). At the same time the growing number of settlements in the surrounding of industrial used areas results in an increased sensitivity against emissions (both noise and waste gas).

Furthermore indirect synergies created by a casual pooling of frequent loading shippers along a route or at a siding should not be underestimated. Even without an official cooperation model between the shippers advantages can be opened up by both the rail transport supplier and the shipper. Of course the biggest advantages can be developed by a coordinated business settlement of companies with rail affine load products or goods and similar transport relations (main transport routes) where a reliable time table can be established.

Last but not least aspects of **transportation infrastructure** have to be taken into account. The evaluation of the conditions for operating on sidings along a route or a route section depends on both operating equipment (could be covered in a route list) and the track load of the railway network (could be shown in a graphic schedule).

5. Scenarios 2020+ for an integrated spatial and transportation planning

On the basis of the study analysis three conceivable scenarios were developed due to deduce strategies and recommendations for different approaches to reserve urban railway networks and (private) sidings as an opportunity of mid-sized companies within their decision making processes for transport mode and vehicle choice. Special attention was paid on the different economical, infrastructural, spatial, operation-related and logistical conditions for (private) sidings (Hörl/Wanjek, 2013, p. 121-126). This makes sure that strategies to ensure the technical and economical operability of existing rail connection points as well as potentially appropriate connection points for can be worked out for the future. It is important to know that the success of reserving an urban railway network depends on the political willingness and social acceptance to a certain degree. This is a great uncertainty which can hardly be predicted.

As follows, the three developed scenarios are shortly described and possible effects on infrastructure, superstructure as well as ‘metastructure’ are outlined.

5.1. Scenario A ‘Displacement-Scenario’

This scenario describes a situation in which freight transport on urban railways were irreversible displaced and switched into periurban areas. At the same time public transport is given priority, so that freight transport on railways is seen as a source of irritation and a disruptive factor for both the rail operation and the ‘metastructure’. This is the reason why rail transport providers remain passive and undertake no activities to expand their services or operation offers. In this scenario two problems arise parallel: the unwillingness of rail transport providers and the incomprehension of spatial and transportation planners.

Effects on infrastructure, superstructure and ‘metastructure’:

- With increasing proximity to the urban core existing railway infrastructure is displaced. Thus shippers have to shift their freight transport onto the road and road infrastructure has to be extended to handle the additional traffic volume.
- The attractiveness of the city locations for the producing economic sector decreases and company sites are replaced in periurban areas. Thereby the economic structural accelerates the change forwards to a de-industrialisation (migration of the product producing sector) of the urban core.
- Caused by the thinning of urban railway infrastructure a suitable and economically representable operation in urban areas will be more difficult or even impossible. Mid-sized companies will lose their transportation alternative on

rail. This consequently affects, that for example recycling goods, dangerous goods and building materials will be shifted from rail to road. Thus, an undesired situation with a high transportation volume on road will arise.
- The supply of goods within the urban core is usually arranged through distribution centres, which are located in periurban areas and served by main transport routes. Besides the increasing transport volume on the road this also causes that the largest possible good vehicles will be used within the urban core. Thus negative effects on the metastructrue along busy sections of the urban road network and corridors with high emissions occur.
- Furthermore the lack of urban railway infrastructure also causes decreasing possibilities for transportation regulations.

5.2. Scenario B 'Emergency-break-Scenario'

This scenario uses strategies to reserve the few remaining urban railways and to prepare for trend reversal. Besides two actions are going to be implemented: a master plan for modernization of urban railway infrastructure and a feasibility study for both possibilities of keeping freight transports transferred to rail and attracting new freight transportation on rail.

Effects on infrastructure, superstructure and 'metastructure':

- Initiatives are formed to keep freight transportation transferred to rail and to enhance the value of the few remaining public terminals with new transportation offers.
- Spatial and transportation planners ensure that the few remaining railways, sidings and loading sites stay at a high level of quality and are available all time. Therefore the political appreciation of urban railway infrastructure as a possibility for 'clean mobility' increases and both hot spots as well as measurements find their way into urban master plans.
- In addition shippers and logistical interest pools start to counter the loss of transport mode and vehicle choice and identify benefits for their business ('green logistics', 'peak oil').

5.3. Scenario C 'Clean-Freight-Mobility-Scenario'

This is an offensive scenario to combine the political aim of 'clean mobility' with an entrepreneurial concept of 'green logistics' by a strategy of public-private-partnership. The requirement for this is a concentrated approach which includes measurements to regulate the freight transport, strengthening the latest (drive) technology and both arrange new decentralised high-tech loading sites and enhance the value of existing ones. Therefore several steps are important:

- The midterm changeover to a low-emission supply of goods and waste management starts by securing the remaining railway infrastructure (as described above) through both a review of possibilities for loading and shipping and an accelerated use of innovative technologies.
- Therefore just the almost fully electrified transport mode rail is appropriate. This means that goods should be transported on electrified railways at least as far as possible into the urban core. Beside urban decentralised end points of rail electric vehicles for carriage of goods are necessary as well.
- To make this possible both are essential, to keep (private) sidings alive and attractive and to reinvigorate already closed sidings.

Effects on infrastructure, superstructure and 'metastructure':

- This helps to reduce transport volume on road and defuses the level of emissions along urban main roads (corridors of emissions).
- For a long-term perspective this could help for an example to implement green zones (environmental zones) in the urban core which could be enclosed by main roads like a belt. Within these green zones low-emission or emission-free vehicles have to be used.

- Existing urban railway infrastructure for public transport opens up the city centre. Additional network elements are available for freight transport. Therefore loading points could be easily established especially within urban areas with high density.

For a successful strategy aiming at a ‘clean freight mobility’ it is important that freight transport and other types of transport are equally treated. This means that future expansions in the field of freight transportation have to include both road and railway infrastructure.

In addition it is necessary that beside innovative technologies for vehicles or motors innovative supporting organisations are integrated. For an example a public-private-partnership could help to combine private business know-how (e.g. sector knowledge, route planning tools for freight distribution) and possible actions of public administration (e.g. accompanying transportation regulations, adaption of infrastructure). This model of supply for a city, which could be also called a ‘**smart city supply**’, should be operating subsidy-free and optimised from an economical point of view.

6. Implementation and Outlook

On the basis of the study “METRO.FREIGHT.2020” it is possible to provide methodical modules for different application possibilities (depending on data situation and interested clients). This methodical set of modules includes:

- evaluation of superstructure (business class and organisation)
- operability of served infrastructure (quality of the siding, the road connections and the modal effects)
- typology of ‘agglomerates’ depending on rail operation and dispatch modes

Due to the developed evaluation tool typologies of shipper ‘agglomerates’ can be identified and thus operation zones can be valued with regard to both their existing amount of sustainable transportation on urban railways and their future ability of handling transportation on rail with reasonable relevance. Thereby, transport alternatives on the road are an important input factor. Each specific perspective is enabled to give an indication, whether the rail siding is enabled to be preserved and to be ensured for the future. The more specific perspectives indicate the need of rail connections within an ‘agglomerate’ the greater is the need of integrating spatial and transportation planning strategies. Conversely, this also enables to evaluate, whether from a long-term point of view an ‘agglomerate’ still needs the existing railway infrastructure at all.

These findings should be considered in interdisciplinary master plans which ensure both spaces in a city-region for shipping companies to secure their existence and infrastructural requirements for exchanging goods on a long-term perspective. Both processes are going hand in hand, so they have to be coordinated to provide shippers an appropriate choice of transport mode and vehicle. Furthermore this helps to reduce negative environmental effects of freight transport on road by shifting it on rail.

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