

AlpInnoCT

Description of the state of the art of the European transport system with focus on CT

Output O.T2.1 including Deliverable D.T2.5.1

Review of key activities and
optimization potentials from origin to
destination along the pilot corridors

September 2018



Document Title: Review of key activities and optimization potentials from origin to destination along the pilot corridors			Sub Title: -	
Document History	Version	Comments	Date	Done by
1) Elaboration of draft version	Draft Report		15/06/2017	Florian Kopschinski
1) PPs comments (PPs) 2) Finalization according to PPs contributions	Final Report		11/09/18	Florian Kopschinski
Published final deliverable	O.T2.1(D.T2.5.1)		11/09/18	Florian Kopschinski
Number of pages:				47
Number of annexes:				2

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Approval for delivery	AlpInnoCT Coordinator		Date
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List of Abbreviations

Abbreviation	Meaning
ACT	Accompanied Combined Transport
ADR	Accord européen relatif au transport international des marchandises Dangereuses par Route
CIM	Convention International concernant le transport des marchandises par chemin de fer
CIP	Check-In-Protocol
CMR	Convention relative au contrat de transport international de marchandises par route
CT	Combined Transport
DB	Deutsche Bahn
DIN	Deutsches Institut für Normung e. V.
ELISCH	Eingangsliste Schiene
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
FS	Ferrovie dello Stato Italiane
GPS	Global Positioning System
ISO	International Organization for Standardization
MRN	master reference number
N/S	north/south
ÖBB	Österreichische Bundesbahnen
RID	Regulations Concerning the International Carriage of Dangerous Goods by Rail
RoLa	Rolling Highway
RU	railway undertaking
SME	small and medium-sized enterprises
TEU	twenty-foot equivalent unit
UCT	Unaccompanied Combined Transport
VAT	value added tax

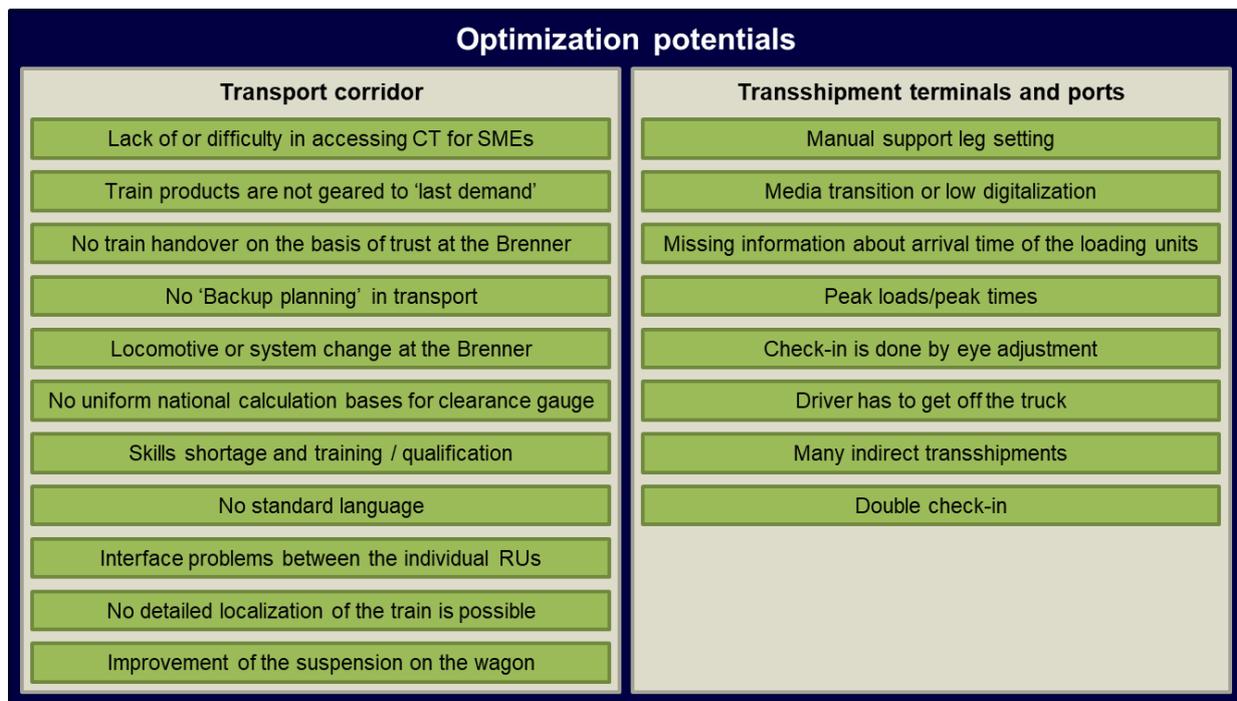
Executive summary

The present study was conducted by Eberl - Internationale Spedition GmbH und Co. KG as part of the AlpInnoCT (Alpine Innovation for Combined Transport) project. Its aim was to analyze selected CT transport relations from origin to destination as well as transshipment terminals and ports.

For this purpose, all operational processes were examined – from the shipper at the point of departure to the handover to the recipient at the place of receipt. In addition to the relation Verona – Rostock, essential characteristics of the relation Trieste – Bettembourg are part of the considerations too. In order to be able to provide a detailed analysis, also a locomotive ride was accompanied along a chosen section of the route and the procedures at important interfaces were examined in practice.

On the basis of the process descriptions of the combined transport as well as further expert interviews with ports and transshipment terminals, it was possible to identify key activities and uncover optimization potential within both the material flow and the information flow (see Figure 1).

Figure 1: Overview about the derived optimization potentials



Source: LKZ Prien GmbH

The results (especially the optimization potentials) of the study provide the basis for work package T3 'CT model concept' and T4 'Development of CT in the future – Implementation and pilot activities' and emphasize the need for innovative CT solutions.

Foreword and introduction

Continued growth in traffic volumes leads to environmental problems. Especially the Alps as a sensitive ecosystem have to be protected from pollutant emissions. In this case, Combined Transport (CT) is an ideal approach to counteract these developments and shift goods from road to rail.

To foster this environmentally friendly transport method, it is crucial to increase the efficiency as well as the productivity of CT. Therefore, an association of public and private partners initiated the AlpInnoCT project to develop measures for improving CT. To this end, the innovative approach of transferring production know-how to CT will be used. Production knowledge has been used for years for the optimization and efficient design of processes.

In order to achieve the project objective and to realize a reliable and economic Combined Transport of the future in the Alpine region, among others the following questions must be answered:

1. Which optimization potentials exist in the European freight transport concerning the flows of material and information?
2. Which optimization potentials exist in transshipment centres and ports concerning the flows of material and information?

Based on these questions the main objective of this study is to analyze selected CT transport relations from origin to destination in order to develop optimization potentials and key activities with all actors of the transport chain. The analysis includes the examination and visualization of the material and information flow of the transport corridor as well as of the processes in transshipment centres and harbours as important nodes in the transport chain.

The results (especially the optimization potentials) of the study provide the basis for Work package T4 'Development of CT in the future – Implementation and pilot activities' and emphasize the need for innovative CT solutions.

In order to ensure a systematic and target-oriented approach, relevant theoretical basics about the Combined Transport process chain as well as transshipment centres are presented at the beginning of this study. After providing general information that highlights the importance of the topic, the transport relations Verona – Rostock and Trieste – Bettembourg (see Figure 2) as well as transshipment centres and ports are analyzed. Particular attention is paid to the description of the process flows and the derivation of optimization potentials.

The following approach is used for analyzing activities:

1. Expert interviews and workshops
2. On-site inspections of the processes
3. Consideration of recent developments in the field via specialist journals, expert forums, etc.

In addition, the authors' many years of practical experience (inter alia in the form of the Combined Transport research project 'Munich-Verona in six hours') contributed to the analysis. Thus, the author's general expertise from the implicit foundation of the analysis without this kind of information being explicitly stated in this report.

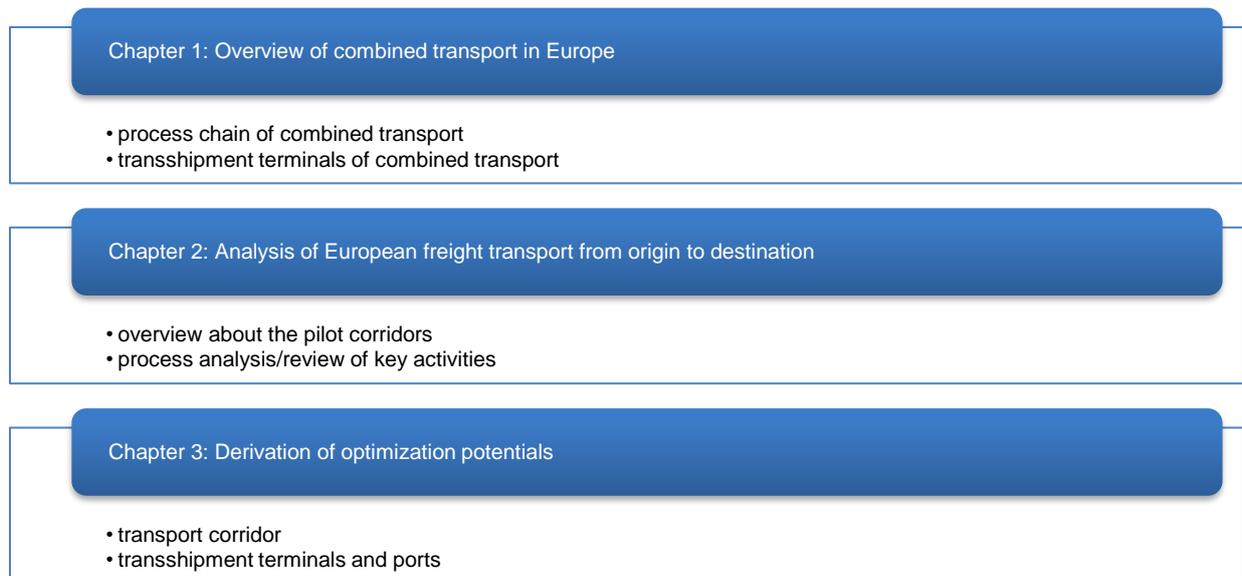
Figure 2: Transport corridors within AlpInnoCT



Source: LKZ Prien GmbH

Figure 3 shows the main contents as well as the used methods of the individual chapters.

Figure 3: Methodology and approach of the study



Source: Spedition Eberl

1 Combined Transport in Europe: Overview

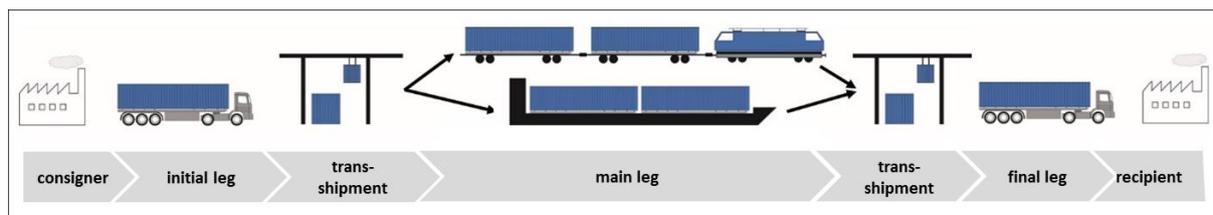
After giving an overview of the study including a description of the thematic background as well as its objective and methodological structure, chapter 1 focuses on the relevant theoretical foundations. Therefore, relevant theoretical basics about the Combined Transport process chain as well as transshipment centres are presented. This intends to create a fundamental sensitivity for the topic and generate a cross-partner knowledge base.

1.1 Process chain of the Combined Transport

➤ General information

The transport operations in Combined Transport consist of a multi-link transport chain. According to DIN 30781 a transport chain is a "series of technical and organizational interconnected processes, where persons or goods are moved from a source to a destination."¹ The consigner is the source and the recipient is the destination.

Figure 4: Transport chain of the Combined Transport



Source: LKZ Prien GmbH

Combined Transport is intermodal transport where the major part of the European journey is by rail, inland waterways or sea and any initial and/or final legs carried out by road are as short as possible.² This transport of goods in loading units is carried out by at least two modes of transport without changing the loading unit. A loading unit is the physical transport unit, which is composed of the product itself, the loading aids (box pallets, etc.) and the load securing equipment (e.g. lashings). Unit swap bodies, containers and semi-trailers are used to transport the loading goods. The main distance covered track (main run) is carried out by rail or waterway with the aim to keep the trailing on the road as short as possible.³

This combination allows the use of the system benefits of at least two different modes of transport. In Europe, Combined Transport road/rail is with the two transport modes 'road' and 'railway' of crucial importance.

➤ Unaccompanied CT (UCT)

In UCT only the loading unit is transshipped from one transport mode to the other – towing vehicle and driver do not accompany the transport (load). Therefore, trucks are needed at the destination terminal in order to haul the loading units to their final destination. This final leg by truck is typically done by a subsidiary of the transport company or a network partner. For the transshipment process the loading

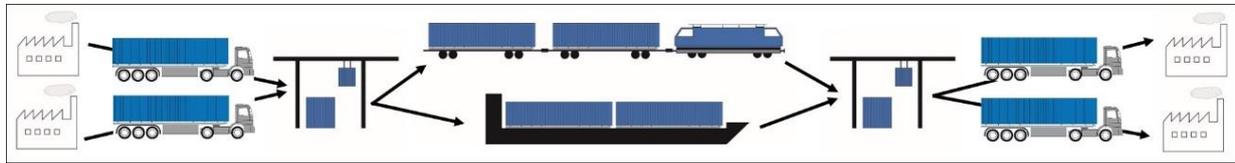
¹ (Deutsches Institut für Normung e.V. (DIN), 1989, p. 3)

² (UNITED NATIONS, 2001, p. 18)

³ Cf. (Deutsches Institut für Normung e.V. (DIN), 1989, p. 3)

units must be standardized, and in most of the cases they have to be craneable.⁴ The most important transport units in UCT are containers, swap bodies and semi-trailers.

Figure 5: Unaccompanied CT



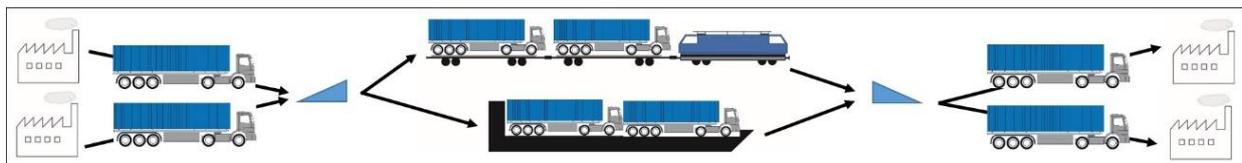
Source: LKZ Prien GmbH

➤ Accompanied CT (ACT)

In ACT the truck or lorry plus the semi-trailer are mainly transshipped on a low loading wagon with continuous loading platform/area.⁵ This happens in special terminals via a 'Roll-on-Roll-off' technique over a ramp. For safety reasons the driver is accommodated in a couchette during the journey. At the destination drivers can continue their journey to the recipient directly.⁶ This type of Combined Transport is well-known under the name 'Rolling Highway' (short: RoLa).

In general, more units are transported by unaccompanied CT than by accompanied CT.⁷

Figure 6: Accompanied CT



Source: LKZ Prien GmbH

➤ Loading units

Combined Transport is subdivided into maritime and continental transport. While maritime transport includes classic overseas transport chains in import and export traffic with standardized ISO containers, international transport chains can be subsumed under continental transport with swap bodies or (craneable) semi-trailers whose dispatch and receiving terminals are located in Europe.⁸

⁴ Cf. (Gronalt, et al., 2011, p. 20)

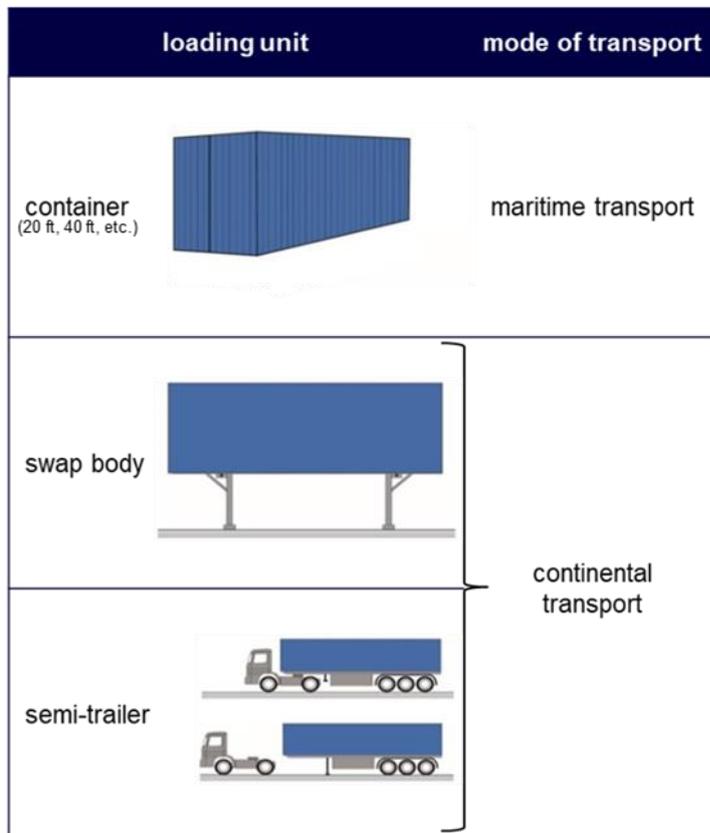
⁵ Cf. (Berndt, 2001, p. 32)

⁶ Cf. (Lampe, 2006, p. 10)

⁷ Cf. (Arndt, Büscher, & Gohlke, 2013, p. 195)

⁸ Cf. (Posset, et al., 2014, p. 41)

Figure 7: Loading units in maritime and continental transport



Source: LKZ Prien GmbH

➤ Stakeholders in the CT chain

The transport chain of Combined Transport is a complex construct which, due to the numerous players, has a multitude of interfaces. The stakeholders presented in Table 1 organize, design and ensure a smooth transport process.

Table 1: CT stakeholders

Stakeholder	Description
Consignor	Puts goods in the care of others (shipping agency or carrier) to deliver to the recipient
Terminal operator	Responsible for the handling and storage of loading units
Shipping agencies	Acting as intermediary on behalf of the consignor organizing the transport of goods and/or providing related services
Freight carrier	Responsible for the transport of the goods - either done by them or sub-contracted to another company
Multimodal freight carrier (combi-operator)	Completes a multimodal freight contract and assumes responsibility for its performance as a carrier

Stakeholder	Description
Railway undertaking (RU)	Carries out the transport of the goods from the transshipment terminal to the destination terminal
Recipient	Authorized to accept the goods

Source: LKZ Prien GmbH adapted from (UNITED NATIONS, 2001)

1.2 Transshipment terminals of Combined Transport

➤ Structure of a terminal

Onshore connection

The term 'onshore connection' refers to both the access to the terminal by road and rail. On the street side the truck passage occurs by gates with counters. Marked areas are available for loading and unloading as well as for the entry and exit of trucks. To perform the cargo-handling operation to and from the truck, the trucks park in loading lanes or in other transfer positions.

Storage areas

As noted above, distinct areas (sidings) are necessary for indirect transshipment operations for the interim storage of loading units. This bridges the time gap that arises due to asynchronous deliveries and pick-ups of loading units. Storage areas are therefore seen as buffer areas, which provide a balancing distribution of loading units over time.

Water-side connection

Transshipment terminals need a quay or a quay wall with berths for the loading and unloading of ships. The transshipment operations are carried out with the help of quay cranes, which are arranged at the quay wall. The transport of loading units to the quay cranes can be carried out indirectly with the help of reach stackers, forklifts or directly with trucks and trains.

➤ Terminal process

With the help of transshipment terminals, loading units can be handled between modes of land transport (trucks or freight train) and mode of water transport, or only between land transport.⁹ Terminals serving all three modes of transport (rail, road, ship) qualify as trimodal terminals. If loading units are merely transshipped between two modes of transport it is called a bimodal terminal.

The most widely used technology for the transshipment of loading units are gantry cranes or mobile handling equipment like reach stackers. A mobile rail bridge is under a gantry crane which spans several tracks, truck lanes and parking lanes due to its size. The spreader, which is mounted on the gantry crane, can be adjusted to the respective turn-up end load units and engages the container into the top corner fittings. Swap bodies and semi-trailers are grasped at the bottom with the gripper in order to handle them.¹⁰

⁹ Cf. (Posset, et al., 2014, p. 191f.)

¹⁰ Cf. (Arndt, Büscher, & Gohlke, 2013, p. 200)

Figure 8: Transshipment of a craneable semi-trailer with help of a gantry crane



Source: LKZ Prien GmbH

Mobile transshipment modules, which are also equipped with a combined spreader grapppler, are usually used to support the gantry crane. Due to their flexibility they also reach areas beyond the reach of the gantry crane.¹¹

Figure 9: Transshipment of a container with a reach stacker



Source: LKZ Prien GmbH

For internal terminal handlings terminal tractors are frequently used. In comparison to containers and swap bodies, which are transported by the terminal tractor on chassis, semi-trailers can be coupled directly to the terminal tractors.¹²

¹¹ Cf. (Arndt, Büscher, & Gohlke, 2013, p. 200)

¹² Cf. (Posset, et al., 2014, p. 222)

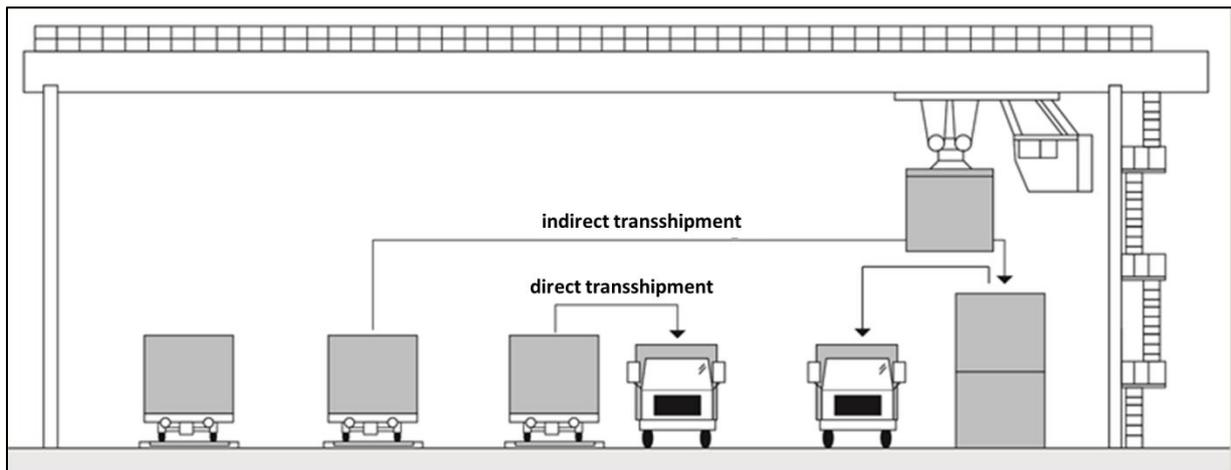
Figure 10: Terminal tractor with coupled semi-trailer



Source: LKZ Prien GmbH

The transshipment process itself can be carried out with (*indirect*) or without (*direct*) intermediate storage.¹³ Within direct transshipment between rail and road, the loading unit is transshipped directly from rail wagon to the truck and vice versa.¹⁴ In contrast to this, with indirect transshipment the loading unit is transshipped indirectly into an intermediate parking area in a first step, before it is transshipped to another mode of transport in a second step.¹⁵

Figure 11: Direct and indirect transshipment between rail and road



Source: LKZ Prien GmbH

¹³ Cf. (Posset, et al., 2014, p. 192)

¹⁴ Cf. (Seidelmann, 2010, p. 50)

¹⁵ Cf. (Lampe, 2006, p. 23)

2 Analysis of European freight transport from origin to destination

An important part of this task is the analysis of European freight transport. The investigation of the material flow, as well as in the information flow, considered the entire logistic chain. For this purpose, all operational processes were examined – from the shipper at the point of departure to the handover to the recipient at the place of receipt. In addition to the relation Verona – Rostock, essential characteristics of the relation Trieste – Bettembourg are part of the considerations too.

Due to its great importance for increasing the efficiency of transalpine freight traffic, the primary focus along the Verona – Rostock route is on the analysis of the section Verona – Munich. In order to be able to provide a detailed analysis, a locomotive ride was accompanied along this section of the route and the procedures at important interfaces were examined in practice. Moreover, knowledge gained within the research project ‘Munich-Verona in six hours’ and practical experience of the project partners were integrated into the analysis as well.

Based on this detailed analysis and further workshops or working discussions, key activities as well as relevant optimization potentials could be identified in the process flow.

2.1 The pilot corridors: Overview

a) Transport corridor Verona – Nuremberg – Rostock

The logistical chain can be divided into the following subsequences¹⁶. The analysis of the transport chain starts at the entrance of the loading unit in the terminal Verona.

1. Entrance of the loading unit in the terminal Verona (first leg by road or rail)
2. Handover of the loading unit to the terminal operator company
3. Administrative and physical processes in the terminal Verona (moving the loading unit to the carrying wagons)
4. Administrative and physical processes for the train dispatch (security check cargo and wagons)
5. Rail transport (section Verona – Nuremberg)
6. Handover of the loading unit to the terminal operator company
7. Administrative and physical processes in the TriCon Container-Terminal Nuremberg (moving the loading unit to the carrying wagons)
8. Administrative and physical processes for the train dispatch
9. Rail transport (section Nuremberg - Rostock)
10. Handover of the loading unit to the terminal operator company

The route Verona – Rostock runs from Verona via Brenner, Hall in Tyrol and Kufstein to Munich. From Munich it continues via Pressig, Steinbach am Wald to Merseburg, Birkenwerder to Rostock.

It should be noted at this point that although the course of the route includes Nuremberg, currently there is no stop at this junction.

¹⁶ See here example for the south-north direction, those for the N/S direction are reversed accordingly.

Figure 12: Transport corridor Verona - Rostock



Source: LKZ Prien GmbH

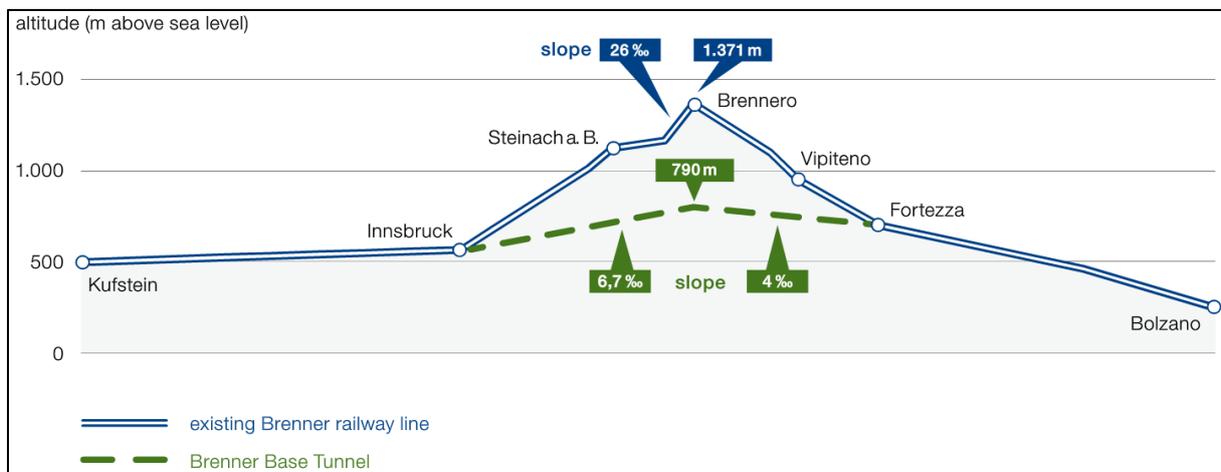
Of particular importance for the increase in efficiency of transalpine freight transport is the section Verona – Munich. Due to the many (transnational) interfaces and the increased potential for optimization, this section of the route is considered in detail as part of the analysis. A locomotive ride was also carried out for this purpose (the image documentation can be found in the appendix).

The 432 km long railway line from Munich to Verona via the Brenner Pass is one of the most important Alpine crossings between central and southern Europe. The locomotives can also be used nonstop north of the Brenner in the networks of DB and ÖBB. However, significant technical differences exist between North and South in the traction current system and in the signalling system including train control as well as in the national language (communication between train driver and route dispatcher), which is why so far in the station Brenner both a locomotive- and a locomotive personnel change is required.

Built in 1867, the existing Brenner railway line has a capacity of 260 trains per day and runs over the mountain pass on a route with slopes as steep as 27 ‰. To meet the transportation needs of the 21st century the expansion and development of the existing stretch of the rail is planned¹⁷.

¹⁷ Cf. (Brenner Basistunnel BBT SE, 2017, p. 7)

Figure 13: Altitude profile Brenner railway line / Brenner Base Tunnel



Source: (Brenner Basistunnel BBT SE, 2017, p. 8)

The CT shuttle trains between Munich and Verona consist of up to 540 m (3 locomotives) and 560 m (2 locomotives) long carriages of up to 32 four-to-eight-axle wagons of various types for the transport of containers, swap bodies and semi-trailers.

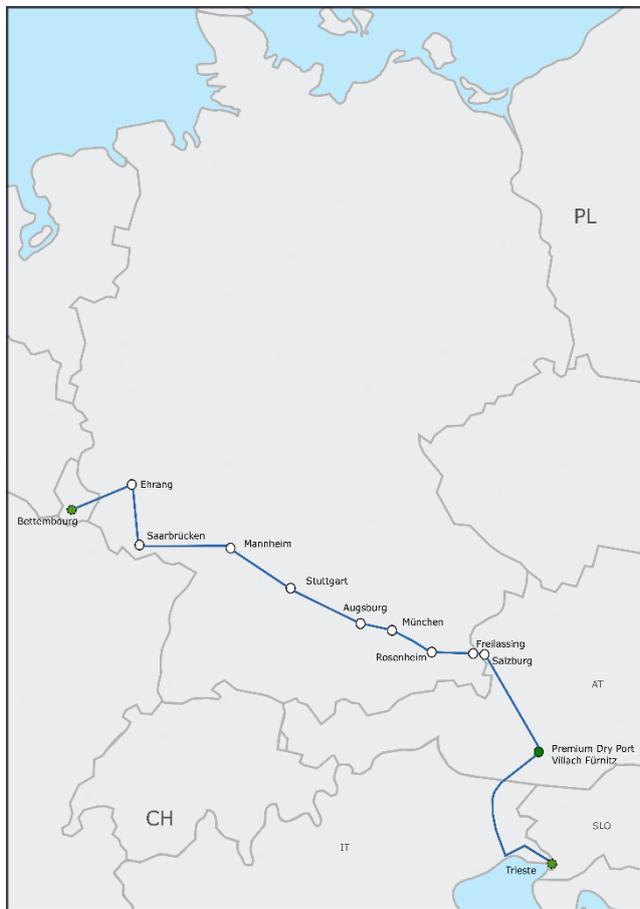
b) Transport corridor Trieste – Villach – Bettembourg

Similarly, the transport chain between Trieste and Bettembourg can be subdivided into different subsequences (example for the south-north direction, those for the north-south direction are reversed accordingly). The inspection of the transport chain starts with the entrance of the loading unit in the port of Trieste.

1. Entrance of the loading unit in the port of Trieste
2. Handover of the loading unit to the terminal operator company
3. Administrative and physical processes in the port of Trieste (moving the loading unit to the carrying wagons)
4. Administrative and physical processes for the train dispatch (security check cargo and wagons)
5. Rail transport (section Trieste – Villach)
6. Handover of the loading unit to the terminal operator company
7. Administrative and physical processes in the terminal Villach
8. Administrative and physical processes for the train dispatch
9. Rail transport (section Villach - Bettembourg)
10. Handover of the loading unit to the terminal operator company

The route Trieste – Bettembourg runs from Trieste via Tarvisio, Villach, Bischofshofen and Salzburg to Munich, and continues via Saarbrücken to Bettembourg.

Figure 14: Transport corridor Trieste - Bettembourg



Source: LKZ Prien GmbH

2.2 Process analysis and review of key activities

2.2.1 Initial leg

After the shipper has prepared the loading unit to be transported, they commission a forwarding agent to handle the transport of the loading unit and send a transport order by email or fax. The sender can either be the forwarder, the manufacturer or the recipient (self-collector). The sender is responsible for the preparation of the delivery note, which in addition to the general delivery note information such as number, packages and quantity of packages also includes details of the transported (potentially hazardous) good.

The selected forwarder receives the transport order from the shipper by e-mail as a pdf file and/or by fax (see Figure 15 und Figure 16). If the forwarding agent accepts the order, a forwarding contract is concluded between the client or consignor and the forwarding agent. Frequently, the commissioning by the customer also takes place by telephone. In practice, it is also conceivable that the placing of an order by the customer precedes a binding offer by the freight forwarder and delivers the first legally binding declaration of intent. The contract is concluded when the customer accepts the offer of the freight forwarder and places an order.

Figure 15: Configurator for the shipment request

Origin	<input type="text" value="Location"/>	<input type="text" value="Postal Code"/>	<input type="text" value="Country"/>
Destination	<input type="text" value="Location"/>	<input type="text" value="Postal Code"/>	<input type="text" value="Country"/>
Shipment Details			
Amount	<input type="text" value="1"/> St.	Type of Packaging	<input type="text" value="Euro Pallet"/> <input type="text" value="KG"/>
Package Dimensions:	<input type="text"/> x <input type="text"/> x <input type="text"/> cm	Value of Goods:	<input type="text"/> EUR
Transit Insurance	Delivery Deadline		
<input checked="" type="radio"/> Yes <input type="radio"/> No	<input checked="" type="radio"/> 1-3 working days <input type="radio"/> Delivery Before		
	<input type="text" value="tt.mm."/>		
Sender's Details			
<input type="text" value="Company"/>	<input type="text" value="Family Name or Equivalent"/>	<input type="text" value="Given Name"/>	
<input type="text" value="Street"/>	<input type="text" value="Postal Code"/>	<input type="text" value="Location"/>	
<input type="text" value="Telephone"/>	<input type="text" value="Fax"/>	<input type="text" value="E-mail"/>	
<input type="text" value="Country"/>	<input type="text" value="Industry"/>		
<input type="checkbox"/> Click here to indicate that you have read and agree to the terms presented in the Privacy Policy			
<input type="button" value="Submit Request"/>			

Source: Spedition Eberl

Based on this information the freight forwarder arranges the transport chain. For this the forwarder selects an agency in the transshipment terminal, which carries out the subsequent handling of the loading unit and commissions a transport company to transport the cargo to the transshipment terminal on the road. The forwarder also transfers the information which is necessary for the involved parties via email and/or fax. For the last mile of the load, the forwarder commissioned by the sender organizes a carrier. The flow of information takes place via email and/or fax. Between the forwarding agency and the carrier a so-called transport contract or freight contract is concluded.

The dispatcher of the transport company receives the transport order by fax and/or email. Based on this information the dispatcher creates a driving order (delivery note with general delivery information and ADR transport information) and assign it to a driver of the transport company.

The driver of the transport company receives from the dispatcher all necessary information for the transport order (delivery note with general delivery information and ADR transport document information) and carries out the road transport.

The bill of lading is usually completed by the consignor. If the freight forwarder commissions a foreign freight carrier, the forwarding agent of the shipper is legally responsible to the commissioned freight carrier. In the case of complete loads, the customer, and not the freight forwarder, is occasionally indicated as the consignor. For groupage consignments, the forwarder is always the consignor. The bill of lading is not only signed by the consignor but also by the carrier.

The freight contract in international freight traffic, as well as in national transport, comes about through two consensual declarations of intent. The legal basis for the international road freight transport contract is the CMR (Convention relative au contrat de transport international de marchandises par route). While the bill of lading is not obligatory in national freight traffic, the creation of a bill of lading (CMR bill of lading) is obligatory in international freight traffic. The bill of lading is prepared in three original copies and signed by the consignor and the carrier. The consignor receives the first copy, the second one accompanies the goods to the consignee, the third one remains with the carrier.

Figure 17: CMR consignment note

1 Absender (Name, Anschrift, Land) Expéditeur (nom, adresse, pays)		Internationaler Frachtbrief Lettre de Voiture International <small>Diese Beförderung unterliegt trotz einer gegenseitigen Abrechnung den Bestimmungen des Übereinkommens über den Beförderungsvertrag im internationalen Straßengüterverkehr (CMR). Ce transport est soumis, notwithstanding toute clause contraire, à la Convention relative au contrat de transport international de marchandises par route (CMR).</small>					
2 Empfänger (Name, Anschrift, Land) Destinataire (nom, adresse, pays)		16 Frachtführer (Name, Anschrift, Land) Transporteur (nom, adresse, pays)					
3 Auslieferungsort des Gutes Lieu prévu pour la livraison de la marchandise Ort/Lieu Land/Pays Datum/Date		17 Nachfolgende Frachtführer (Name, Anschrift, Land) Transporteur successifs (nom, adresse, pays)					
4 Ort und Tag der Übernahme des Gutes Lieu e date de la prise en charge de la marchandise Ort/Lieu Land/Pays Datum/Date		18 Vorbehalte und Bemerkungen der Frachtführer Reserves et observations des transporteurs					
5 Beigefügte Dokumente Documents annexés							
6 Kennzeichen u. Nr. Marques et numéros	7 Anz. der Packst. Nombre des Coils	8 Art der Verpck. Mode d'emballage	9 Bezeichnung des Gutes* Nature de la marchandise*	10 Statistik-Nr. No statistique	11 Bruttogew. l. kg Poids brut, kg	12 Umfang m³ Cubage m³	
							
Klasse Classe	Ziffer Chiffre	Buchstabe Lettre	(ADR) (ADR)				
13 Anweisungen des Absenders (Zoll- und sonstige amtliche Behandlung) Instructions de l'expéditeur (formalités douanières et autres)							
15 Frachtzahlungsanweisungen Prescription d'affranchissement Frei Franco Unfrei Non franco			20 Besondere Vereinbarungen Conventions particulières				
21 Ausgefertigt in Etablie à			am le				
22 Unterschrift und Stempel des Absenders (Signature et timbre de l'expéditeur)			23 Unterschrift und Stempel des Frachtführers (Signature et timbre du transporteur)				
Amtl. Kennzeichen		Nutzfertig in kg		24 Gut empfangen Réception des marchandises			
Ktz				Date.....			
Anhänger				Unterschrift und Stempel des Empfängers (Signature et timbre du destinataire)			
Benutze Gen.-Nr. <input type="checkbox"/> National <input type="checkbox"/> Bilateral <input type="checkbox"/> EG <input type="checkbox"/> CEMT							

*Bei gefährlichen Gütern ist, außer der eventuellen Beschriftung, auf der letzten Seite der Rückseite anzugeben die Klasse, die Ziffer sowie gegebenenfalls die Buchstabe des der in Anhang 1 des Übereinkommens festgelegten Gefahrstoffes.

Source: cmronline.de

Equivalent to road transport, for rail transport a freight contract between the freight forwarder and the railway undertaking is concluded as well. If the freight forwarder wants to commission an RU to carry out the transport, a service contract must already be in place between the freight forwarder and the RU, in which basic performance data such as goods, types of wagon, prices, etc. have been agreed upon. This service contract covers all possible shipments that the freight company intends to ship by rail within 12 months. If the freight forwarder issues the transport order to the RU, a separate contract will be concluded which is legally a freight contract.

The freight contract must be recorded in the CIM bill of lading, which is a prescribed form. It is a consignment note obligation. The bill of lading form is printed in two or three languages, one of which must be in German, French or Italian. The entries must also be made in one of these languages. The freight contract is concluded with the shipping track and applies throughout to the receiving station.

2.2.2 Transshipment

Transshipment terminals and ports play a crucial role in Combined Transport due to their interface function between the different modes of transport. Against the background of a predicted increase in the volume of transport in CT, transshipment terminals and ports will have to handle ever larger quantities of goods and adapt their processes to the changed volumes. In the entire consideration of the infrastructure in CT, transshipment facilities are the point where the most serious bottlenecks occur already today. The rail infrastructure also represents a bottleneck in the overall system. Missing routes, construction sites, etc., imply that some terminals cannot fully utilize their capacities because the inflow and outflow are not guaranteed.

New areas are difficult to find because of their size, road, rail and water connections. In order to be able to successfully counteract these developments, options for a more efficient structuring of process flows are necessary.

For this purpose, the process flows of the TriCon Container Terminal Nuremberg are analyzed as an example in the context of this chapter and optimization potentials within the material and information flow are derived.

In order to be able to present general optimization potential, the optimization potentials generated in the analysis are supplemented with the help of expert discussions and special characteristics of other transshipment terminals or ports (including Verona, Trieste and Bettembourg) are also integrated into the derivation of the optimization potentials.

a) TriCon Container-Terminal Nuremberg

The TriCon Container-Terminal Nuremberg is a trimodal terminal, which is connected to the three modes of transport rail, road and water.

Figure 18: TriCon Container-Terminal Nuremberg



Source: Spedition Eberl

Within the terminal, containers, swap bodies and craneable semi-trailers can be handled. The total throughput capacity is around 350.000 loading units per year.

The 17-hectare company site has ten full-length loading tracks (each 700 m), four rail portal cranes and a 116-meter-long port basin with a mobile reachstacker. Furthermore, two railway sidings with 700 meters each, two bypass tracks (one of them is electrified) and a brake test facility for both terminal modules are available.

After a description of the transshipment terminal, the process sequences of the process steps of a loading unit are considered in this chapter. In the two scenarios,

- Scenario A: Transshipment from road to rail
- Scenario B: Transshipment from rail to road

the flow of information is taken into account for each sub-process. As a result, potential breaks become visible in the process and can be considered during the process optimization phase. The cargo handling rail/rail is not considered in the context of this work, since these peculiarities are already included in the two other transshipment variations.

The data obtained during the analysis are based in particular on interviews and workshops with experts in the field of transport logistics as well as on-site inspections. The authors are aware that the data obtained within the analysis may vary according to the period and day considered. Nevertheless, it is possible to uncover optimization potential and special features in the process flow.

It should be noted at this point that all processes in the TriCon Container Terminal Nuremberg are electronically recorded and documented – from the entrance to the site via the dispatching to loading. For this purpose, the electronic operations control system ICMS of Modality is used. In addition, with the customer portal LogOn a real-time information platform exists for all those involved in the CT chain. It enables communication for all involved parties at all times. The real-time query of ships, trains and trucks allows a detailed planning process of the transport chains.

➤ **Road to Rail**

1. Entry into the transshipment terminal

The actual consideration of the goods handling road/rail begins with the arrival of the truck at the transshipment terminal.

Upon entering, the lorry with the loading unit parks in front of the terminal control centre in one of the marked storage areas. Before the street-side entrance of the loading unit, the terminal already receives some basic information about the incoming loading unit such as the planned date of receipt and the type of loading unit.

Figure 19: Parking trucks in front of the terminal control centre



Source: Spedition Eberl

2. Terminal Check-In

After the truck has been parked, the checker, an employee of the terminal operator, uses a handheld computer to record all visually identifiable data of the arriving truck. In addition to checking the completeness of the delivered loading unit and checking whether the loading unit can be accepted for transshipment and rail transport, an external inspection of the loading unit is also carried out with the aim of detecting obvious discernible damage. The result of this visual inspection is stored as Check-In Protocol (CIP) in the database of the terminal operator. Data such as the licence plate, the dangerous goods class, the load unit number, the load unit size or the loading unit number are also included.

Figure 20: Check-In by an employee



Source: Spedition Eberl

3. Handling in the terminal control centre

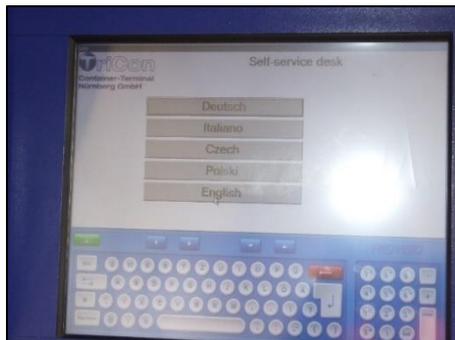
After completing the check-in, the truck driver goes to the self-service station, enters his registration data and signature, and automatically receives the documents required for registration, such as the stored CIP.

Figure 21: Truck driver at a self service station



Source: bayernhafen Gruppe

Figure 22: Self-service desk



Source: LKZ Prien GmbH

The driver then goes to the control centre or administration building of the terminal operator, where the personal registration with an employee is carried out.

Figure 23: Personal registration in the administration building



Source: bayernhafen Gruppe

In the control centre the target/actual comparison of all data, information and descriptions used up to that point in time takes place. This data is derived from the details of the transport order, the delivery note and ADR transport document details of the truck driver and the check-in protocol, which are transferred by the forwarder and stored on database of the agency. Based on this information, the employee

in the control centre and the truck driver fill out a dispatch note, which remains at the terminal operator as a receipt. In addition, a delivery note is drawn up at the control centre showing the parking space number in the crane track for the truck driver.

If the previously performed check-in is not correct and the loading unit cannot be loaded or the dangerous goods label is not in order, this must be rectified. The terminal can also get commissioned. If the activities are not carried out, the registration is refused and feedback is given to the operator or client.

Subsequently, crane and bypass orders for the loading units are automatically generated and transmitted to the crane drivers digitally on their display in the crane. The crane orders contain the loading unit signs and number, size, dangerous goods information, the official number plate of the truck and the destination information of the loading unit. Operators and shipping companies receive status, inventory and movement reports via the loading unit or information about dangerous goods movements or the loading and unloading reports. The documentation of accompanying documents such as customs or dangerous goods and the corresponding messages to the operators are also automated.

The crane driver can call up the individual loading orders on a screen in the driver's cab and thus be informed which loading unit must be loaded on which train. If the train is not ready for a loading unit, it is possible to store it in short-term storage.

If the loading unit cannot be transhipped directly from road to rail, for example because the truck has arrived at the terminal before the arrival of the train, there will be temporary transport-related intermediate stops.

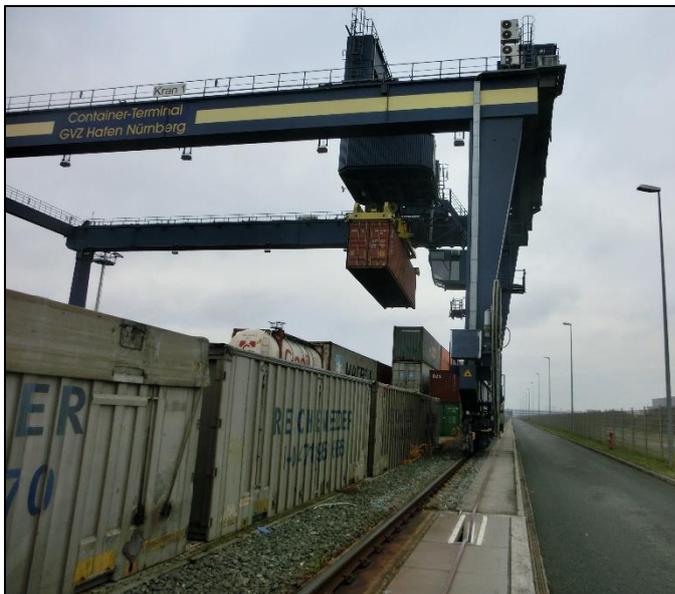
With completed clearance in the control centre, the truck driver receives a document and/or a pick-up ticket, on which the loading point number(s) for the unloading and possibly also for the reloading are noted. With this information, the truck drives to its assigned loading space in the cargo handling area.

4. Transshipment

By a modern license plate recognition software, the driver automatically gains access to the terminal at the barrier and is directed to the corresponding module. After parking in the prescribed parking area in the crane track, the driver waits for the handling by the crane driver next to his vehicle.

After the truck has arrived at the correct loading place, the loading unit (container or swap body) is unlocked. Before the transshipment is carried out, the crane driver compares the data transmitted with the crane order with the loading unit number as well as the parking space number of the loading unit provided and then carries out the transshipment.

Figure 24: Container handling



Source: Spedition Eberl

Every movement of the loading units is detected electronically in the operations control system. When setting down the loading units, an admissibility check is carried out with regard to loading scheme and dangerous goods regulations. After the transshipment has been carried out, the crane driver confirms the order in the system and thereby gives feedback to the terminal control centre.

The reachstacker is primarily used for reloading and creating capacity on the premises. It carries out orders received according to production specifications and priorities. Every movement of the loading unit is registered automatically.

Figure 25: Reachstacker



Source: bayernhafen Gruppe

Semi-trailers can be handled in the analyzed terminal in modules 1 and 2. Before the semi-trailer can be disconnected, it is positioned on the loading place. Then the semi-trailer is secured of the parking brake. In a next step, the support legs are adjusted to the specified support foot height by manually cranking of the driver. In addition, the analysis identified that, based on internal safety information provided by various railway undertakings, the support leg had to be adjusted to the dimension indicated on the number plate minus two centimetres.

After compressed air and electrical lines have been separated between the terminal tractors or truck and semi-trailer, the fifth wheel coupling can be opened. The truck drives forward and the semi-trailer can be handled.

After reaching the final position of the semi-trailer in the wagon, a slow setting down and locking of the kingpin takes place on the trestle of the wagon. After setting down the semi-trailer, it may be that the support leg must be readjusted by re-cranking, if the support legs do not have enough space and the function of the crash elements is hindered. For re-cranking the semi-trailer must be lifted again due to a blockage of the crank after loading the semi-trailer (see Figure 26).

Figure 26: Blockage of the crank after loading the semi-trailer



Source: LKZ Prien GmbH

With about four minutes, the transshipment time of semi-trailers is comparable to the times for swap-body transshipments, but can only be achieved if no additional cranks are necessary.

5. Train departure

From all loading orders, the wagon list is created. It corresponds to the installation of the individual wagons with information on the transport content in accordance with the RID guidelines and will be handed over to the wagon technician at the end of the compilation of the train. In addition to the wagon number, the wagon list also contains the train number and the load unit number.

6. Output comparison

After all transshipment operations have been carried out on the freight wagon, a target-actual comparison is made on the train by the wagon technician and the result is documented in the loading list before the exit of the train. Moreover, the wagon technician checks the loading of the loading units. This includes checking the proper loading of the loading units and checking the functionality of the brakes and the wagon technology. After these tests, the brake docket created by the wagon technician as well as the wagon list with the recorded data are given to the driver.

If the check is not passed readjustments of the loading units on the wagon must be carried out. Subsequently, the status information is sent to the operator and a plausibility check by the customer is carried out.

If released by the customer, the train documents are completed and forwarded to the RU. The train is now ready to leave.

After handling, the truck driver drives his truck either to pick up a loading unit on the designated parking area or leaves the premises.

Preparation for the outgoing trains begins with the technical wagon inspection, that means the carrying wagons of the wagon composition intended for the exit train are checked for damage. If defects are found, the corresponding wagons are immediately sorted out and replaced. Once the final wagon set is on the track, it can be connected to a stationary brake test facility. With the help of a firmly anchored air compressor at the end of the track systems, the train's brake system is filled with air so that the brake

pads release. After that the wagon technician checks whether they can be put on and released at each train axis. The train preparer then records the sequence of loaded wagons in the train composition.

Loading units for the intended train can still be placed until the end of loading time. After completion of loading and last crane, the control centre determines that everything is loaded. The CIM consignment note and the associated shipping document will be printed out, checked for correctness together with the shipping orders and the accident data sheets and handed over to the train preparer. At the same time, the last loading unit and its reliable loading are checked by the load master.

If there are no objections by the wagon technician, the train preparer will carry out the exit control. He checks whether the train is allowed to drive based on the brake weight and the total weight. If this is the case, the wagon list (list of the wagon and load order) and the brake note will be printed. The entire documents (wagon list, brake docket, CIM bill of lading, proof of dispatch, shipping orders and accident data sheets) are delivered to the locomotive, which is provided at the top of the train in the crane track. After attaching the locomotive, the wagon technician takes over the simplified brake test. Here, only the brakes of the last wagon are checked, since it is a closed system in which it can be assumed that at full functionality of the last brake and the upstream brakes are flawless.

If all loading units are on the train, the rail transport to the destination terminal takes place. The wagon list, the customs documents and the delivery notes of the individual loading units with RID transport document data accompany the train and, depending on the RU, are sent by e-mail to the control centre of the destination terminal on a case-by-case basis.

➤ **Rail to Road**

1) Entry

After the rail transport, the train arrives at the destination terminal.

2) Input comparison

Before the train arrives at the terminal, the system will print out the wagon list and the ELISCH. With the arrival of the train at the transshipment terminal, the physical transfer and thus the transfer of liability takes place. In the case of a personal handover, the reconciliation between the ELISCH and the actual wagon series takes place. As part of the incoming goods inspection, the consignments are checked for completeness and condition. Then the ELISCH will be forwarded to the control centre together with the documents (CIM consignment note, proof of dispatch, dispatch orders and accident data sheets) which were carried on the train; the train is shunted into the crane track.

After the train has entered the terminal, the input comparison is carried out. Similar to the terminal check-in on the road side, this includes an inspection of the completeness of the transferred intermodal loading units as well as an external check of the loading units (including damage and correct dangerous goods regulations). In addition, the wagon technician transfers the carried-along wagon list as well as the customs documents and the delivery notes of the individual loading units with RID transport document information to the control centre of the terminal operator.

If this quantitative and qualitative train adjustment is correct, the existing loading units are released in the ICMS and the recorded data are entered in the ELISCH. If the adjustment is not correct, this will also be documented in the ELISCH and the information will be passed to the customer.

If a repair or adaptation of the labelling is desired by the customer, this gets done and the loading unit then is released in the ICMS.

3) Handling in the control centre

After the entrance adjustment for the train it must be clarified whether customs clearance is necessary. If so, customs will be informed by fax, if necessary a customs inspection and the clearance by customs is documented in ICMS. Subsequently, crane jobs are automatically generated analogously to the road/rail transshipment process and transmitted digitally to the crane driver.

For the data transmitted to the crane driver reference is made here to the transshipment process road/rail, since these are identical.

In addition, the control centre reports the arrival of the train to the agencies. Afterwards the wagon list, the customs documents and the delivery notes of the individual loading units with RID transport information are forwarded to the responsible agencies.

The handler of the respective agency informs the dispatcher of the forwarder, who is responsible for the organization of the final leg, about the arrival of the train. Based on the wagon list, which he receives from the dispatcher by email, the forwarder checks his transport orders and notifies the intended transport company.

The dispatcher of the assigned transport company receives the transport order of the forwarder by email and/or fax. From this he creates a driving order for a truck driver of the transport company.

The truck driver receives the driving order from his dispatcher. The transmission takes place by phone or by personal delivery.

The truck driver gets in touch with the operator in the agency with his transport order. In return, he receives the ADR transport documents which remain in the agency after the arrival of the train at the destination terminal. In addition, the truck driver receives the number of the train on which the loading unit that is to be picked up is located and the associated parking space number in the crane track.

With this information the truck driver drives into the crane track.

4) Transshipment

Transshipment of rail/road or the transshipment times are comparable to the previously described road/rail transshipment. The loading unit to be unloaded is either transferred to already available trucks that have been unloaded or to the intermediate storage area. After placing the loading unit on the truck, it is secured by the driver.

Again, transshipment of semi-trailers is a special case. For coupling the semi-trailer, it is secured by means of the parking brake in the same way as for the uncoupling operation. The tractor is moved up to the semi-trailer and released the fifth wheel. The tractor now drives under the semi-trailer and connects the kingpin with the fifth-wheel coupling. Before the loading unit can leave, the connecting cables are hooked up, the support foot is cranked and the parking brake of the semi-trailer released.

Using a screen in the driver's cab, a software displays to the crane driver the crane orders to be processed. After transshipment of the loading unit to the truck, he deletes the crane order from the system.

5) Check-Out

After completion of the transshipment, the adjustment is automatically carried out at the exit barrier using cameras. These record both load unit number and license plate number of the truck. If they match, the barrier opens.

If the loading unit contains of dangerous goods, the terminal also checks whether a dangerous goods label has been applied to all four side walls. As the process sequences for dangerous goods are basically identical, this aspect will not be considered further.

6) Departure of the loading unit

The exit of the terminal is secured by a barrier again, which opens only when the driver has acknowledged the pick-up note. Depending on the time of day, waiting times may occur.

The truck driver leaves the crane track and carries the load to the receiver. At the consignee he deletes the consignment and hands him the delivery note.

b) Port of Trieste

In the following, the specifications concerning the customs transit procedures for import and export cycle as well as the operations from a vessel point of view are discussed.

Table 2: Total volume of container throughput (Port of Trieste)

Total volume of container throughput moved by rail (in TEUs)		Total volume of container throughput moved by road (in TEUs)	
from 01/01/2017 to 30/11/2017		from 01/01/2017 to 30/11/2017	
Rail		Road	
IN	71.360	IN	92.417
OUT	72.784	OUT	82.727
TOTAL	144.144	TOTAL	175.144

Source, Sinformar, 2017

➤ Specifications regarding the customs transit procedures for import and export cycle

▪ Import traffic

There are three different options to get the cargo into EU Countries maintaining the potential benefits of the special Free Port Zone rules and regulations:

- 1) Vessels/Trucks/Rail:
Customs clear the goods at Trieste Port. In this case an Italian VAT number must be available or thanks to a direct fiscal representation or with a so-called direct VAT identification.
- 2) Vessels/Trucks/Rail:
Use a T1 transit document (*common transit procedure – T1) to immediately receive the goods at destination and customs clear the goods after receiving them.
- 3) Rail only:
Use the CIM document (CIM - consignment note for rail transport) which allows the cargo to be transferred from Trieste to the final destination rail terminal without additional transit documents or requirements.

▪ Export traffic

The EU exporter should customs clear the goods at the place of origin. To load them via Trieste, a copy of the export document (normally MRN bar code – ‘Master Reference Number’) is needed only via mail to close it at the Trieste Customs office.

➤ Operations from a vessel point of view

▪ Main stakeholders involved

- Port Authority

- Public Legal Regulatory Authorities: Bureau of Customs, Port Masters Office, Sanitary Inspection Authority – for crew members, passengers and goods, Fiscal Police
- Ship Owner
- Shipping Line Agent
- Terminal Operator
- Inland Intermodal Terminal

▪ **Sequence of container ship vessel arriving at the port and leaving the port (water side)**

- 0) Port of origin. Security declaration ready to be submitted attached to the vessel arrival pre-announcement.
- 1) Vessel arrival pre-announcement.
- 2) Request for berth.
- 3) Manifest report sent to Bureau of Customs.
- 4) Customs and Public Legal Regulatory validation procedures.
- 5) Customs and maritime rights related taxes payment initialization.
- 6) Admittance report notification (loading/unloading detailed plan and time schedule report).
- 7) Customs procedures and maritime rights related taxes payment finalization.
- 8) Hailing services assignment.
- 9) Mooring and piloting services acceptance notification.
- 10) Vessel arrival (anchoring within port areas).
- 11) Loading and unloading from/to vessel operations (->land side)

Prior departing/at departure (no vessel is allowed to leave the port without security control and a valid port clearance documentation)

- 12) Vessel status formal declaration submitted to Public Legal Regulatory Authorities.
- 13) Accepted and verified compliance of the vessel status (validated security, customs rules, ship sanitation control, port and hailing services fee payment validation).
- 14) Request mooring and piloting services for departure procedures.
- 15) General departure application submitted (permission for departure with detailed plan and time schedule for vessel manoeuvre during the departure procedures).
- 16) Authorization to leave the port notification (permission for departure report with detailed plan and time schedule).
- 17) Mooring and piloting services assignment notification for departure procedures.
- 18) Vessel departure.

▪ **Sequence of truck and train arrival & departure events (land side)**

- 1) Storage of containers awaiting to be loaded/unloaded in the terminal yard.
- 2) Truck/train assigned to the vessel loading/unloading arrival at the Port entry gate.
- 3) 1st level acceptance – entry in the Port area.
- 4) Inspection conducted by the legal regulatory authorities to ensure the correct correspondence of the arrived truck/train data to the pre-announcement notice information.
- 5) Truck/train 2nd level acceptance – entry in the terminal area of destination.
- 6) Truck/train load-unload procedures.

7) Checkout of truck/train leaving the port area.

2.2.3 Main leg

The following descriptions mostly refer to processes during a locomotive or system change. Further information on the daily process flow (disposition of the trains, etc.) can be found in the process visualization or previous process steps.

The topographical boundary conditions of the Alpine crossing affect the railway operation. For technical, economic and political-administrative reasons, trains on the trans-Alpine route between Munich and Verona require various stops for changes of locomotive, attachment and disconnection of double traction and helper engines as well as for locomotive driver changes. On the flat sections between Munich and Kufstein and between Verona and Bolzano, the CT trains are usually transported with only one locomotive. Double traction is also used along the route via Tarvisio.

For technical and safety reasons, a second (and possibly third) locomotive must be used at the top on the south ramp between Bolzano and Brenner to cope with the gradient of the Brenner. Similar conditions also apply north of the Alps, where between Innsbruck and Brenner double traction is necessary.

As a rule, a maximum of 2 drawing locomotives are used here for economic reasons

- North-South a total of 2 locomotives up to 1,439 t
- North-South a total of 3 locomotives up to 1,600 t
- South-North a total of 2 locomotives up to 1,500 t

On the relation maximum line speeds are 100 km/h for trains (unloaded and loaded) and for locomotives of 120km/h. Maximum speed is adjusted to weather conditions. In addition, the permitted maximum speed of the car fleet must be observed.

At the Brenner station a change of power is necessary as the railway networks north and south have different power/overhead systems as well as signal and train protection systems. Suitable multi-system locomotives are already used (e.g. ÖBB Taurus) in the freight transport of the participating railways but the change still takes a lot of time (shutdown and booting of the system). Due to this form of organization, up to seven different train drivers are involved in the transport process in the case of heavy trains. This is not only due to the technical conditions mentioned (for example, double/triple traction); but also the technical and administrative regulations and safety regulations in Italy, such as the requirement that every locomotive or locomotive pair in Italy must be manned twice, or the geographical and temporal limitation of locomotive deployment. The presence of a second traction unit driver on the locomotive in Italy will no longer be required as soon as the installation of the automatic block system with codified circuits and signal repetition at the driver's cab has been completed on the entire section Verona – Munich and the entire staff will be equipped with radio equipment.

The European Train Control System (ETCS) is a replacement for legacy train protection systems and designed to replace the many incompatible safety systems currently used by European railways. It is the signalling and control component of the European Rail Traffic Management System (ERTMS).

Below, the processes during a locomotive or system change will be presented.

A. Arrival of the trains at Brenner

Due to the different power systems in Austria and Italy, just before passing the system limit (route separation: currentless section of the overhead line in the station centre), approaching trains shut down the pantograph of the train and the train rolls currentless with momentum to stop the locomotive before the exit signal. Then the first locomotive (and possibly last) is uncoupled by the shunting staff at the Brenner

station; the train locomotives will be pushed back to Austria (or Italy) at a reduced speed by another locomotive (namely the receiving locomotive of the outbound train towards Verona or Innsbruck or a diesel shunting locomotive) at reduced speed. Before and sometimes after the repulsion of the locomotive this is temporarily turned on a siding.

The locomotive change is a very extensive (route intersection, driving license, time combination of incoming and outgoing trains) as well as expensive (inter alia train driver, dispatcher) operation. The ejected locomotive thus returns to the area of its own power system and is ready for the train to continue its journey.

B. Handover of the trains direction N-S ÖBB/FS

Before the train is handed over, the train preparer checks the number of wagons connected to the train according to the wagon list and checks the last wagon of the train. At the same time the train wagon signals are exchanged, they are marking the end of the train and are different due to legal requirements in Austria and Italy.

With a rough control (approximately 15 minutes), an analytical test (approximately 50 minutes) can be avoided, with the proviso that the analytical test (wagon for wagon) is carried out at the destination station of the train.

The documents of the arrival train are brought from the locomotive to the wagon office, where a copy of the CIM consignment and proof of shipment is made. The printing and delivery of the documents accompanying the journey varies according to the location (for example, fax machine in shunting yards, shipping of papers to the hotel where the train drivers are housed).

Other documents: Carriage lists, customs documents, CIM consignment, dangerous goods annex, waste annex. The documents differ in both directions (Rostock – Verona). In addition, original waste papers must accompany the train (dangerous goods analogously).

The RU carries out various checks of the documents (RID goods, gross weight, destination station, etc.) and, if necessary, corrects the data to be entered in their system and in the wagon list. The head of the train control will eventually receive a copy of the wagon list as a document or instructions to the train crew regarding brake regulations, maximum speed, speed restrictions, etc.

For safety reasons, not only one but both directions are blocked at construction sites in Italy.

A change of locomotives at the Brenner is less expensive than a system change. For example, if the system changes, the locomotive will be switched from the Italian to the Austrian system. The locomotive comes for example with an Italian system and then it (in the case of Brenner even several locomotives) must be 'resetted'.

C. Handover in the south-north direction

In the south-north direction, analogous or similar processes take place as in the north-south direction. Variations occur primarily at the information flow level. An important difference here is that, unlike in the north-south direction, all data is provided in the south-north direction before the train arrives at Brenner.

Comparing the transport and process flows of the two considered transport relations, it can be stated that they do not differ substantially due to similar actors and interfaces as well as the topographical events. For this reason, the relation Trieste – Bettembourg is not described in detail again in this section.

It should be noted at this point that the railway company TX Logistik carries out the transport from Trieste to Munich. For the transport from Munich to Bettembourg the RU CFL is responsible. However, CFL uses locomotives of TX Logistik.

In addition to the process times (in order to make the effects of the measures developed in WP T4 measurable), however, the integration of optimization potentials in order to derive general optimization potentials and success factors that are significant for the Alpine region is of interest for this study and the further project activities.

➤ Determination of the lead time

section	RU	departure (planned)	arrival (planned)	time (planned)
Verona Quadrante Europa - Brennero/Brenner	TX Logistik	8.11.17 / 11:39	8.11.17 / 15:11	03:32
Brennero/Brenner - Kufstein	TX Logistik	8.11.17 / 15:40	8.11.17 / 17:08	01:28
Kufstein - München-Laim Rbf	TX Logistik	8.11.17 / 17:35	8.11.17 / 18:48	01:13
München-Laim Rbf - Pressig-Rothenkirchen	TX Logistik	8.11.17 / 18:55	9.11.17 / 0:10	05:15
Pressig-Rothenkirchen - Steinbach am Wald	TX Logistik	9.11.17 / 0:15	9.11.17 / 0:29	00:14
Steinbach am Wald - Großkorbetha	TX Logistik	9.11.17 / 0:29	9.11.17 / 2:30	02:01
Großkorbetha - Birkenwerder (b Berlin)	TX Logistik	9.11.17 / 2:42	9.11.17 / 6:28	03:46
Birkenwerder (b Berlin) - Rostock Seehafen	TX Logistik	9.11.17 / 6:38	9.11.17 / 9:34	02:56

The planned lead time is 21:55 h, the planned driving time 18:57 h.

section	RU	departure (planned)	arrival (planned)	time (planned)
Trieste Aquilinia - Tarvisio Boscoverde	TX Logistik	6.11.17 / 21:15	6.11.17 / 23:45	02:30
Villach Hbf (in Vb) - Tarvisio Boscoverde	TX Logistik	6.11.17 / 23:03	6.11.17 / 23:27	00:24
Tarvisio Boscoverde - Villach Westbf (in Vb)	TX Logistik	7.11.17 / 0:14	7.11.17 / 0:37	00:23
Villach Westbf (in Vb) - Bischofshofen (in Bo)	TX Logistik	7.11.17 / 1:55	7.11.17 / 4:26	02:31
Bischofshofen (in Bo) - Salzburg Hbf (in Sb)	TX Logistik	7.11.17 / 5:03	7.11.17 / 6:30	01:27
Salzburg Hbf (in Sb) - München Laim Rbf	TX Logistik	7.11.17 / 6:30	7.11.17 / 8:47	02:17
München Laim Rbf - München Hbf Vorstellgruppe Süd	TX Logistik	7.11.17 / 9:00	7.11.17 / 9:15	00:15
München Laim Rbf - Saarbrücken Rbf	CFL	7.11.17 / 10:00	7.11.17 / 20:15	10:15
Saarbrücken Rbf - Saarbrücken Hbf So	CFL	7.11.17 / 20:30	7.11.17 / 20:45	00:15
Saarbrücken Rbf - Bettembourg	CFL	7.11.17 / 21:00	7.11.17 / 23:15	02:15

The planned lead time is 26:00 h, the planned driving time 22:08 h.

2.2.4 Final leg

The truck driver leaves the terminal and carries the cargo to the recipient. At the recipient he discharges the cargo and issues the delivery note.

3 Derivation of optimization potentials

3.1 Transport corridor

On the basis of the process descriptions described above, as well as further expert interviews with ports and transshipment terminals, it was possible to uncover optimization potential within both the material flow and the flow of information. A selection of the optimization potentials will now be assigned to the categories 'Organization & Process', 'Know-how & Skills', 'IT' and 'Technology' and then explained. The numbering of the selected optimization potentials serves only for structuring, and do not indicate a priority ranking of the individual points.

➤ Organisation & Process

1. Lack of or difficulty in accessing CT for SMEs

Description: For small and medium-sized enterprises (in particular freight forwarders and transport companies) access to Combined Transport is associated with major barriers to entry and therefore only possible with great effort.

Cause: The difficult access for SMEs to CT is on the one hand caused by missing business models for the last mile (esp. disposition and organization of initial and final leg), as well as lack of know-how and a not CT-oriented business organization (including disposition concept) on the other hand.

Consequences for the processes in CT: Due to the difficult access, this environmentally friendly method of transport is difficult to realize for freight forwarders and the potential for transferring road freight traffic to railway is limited.

2. Train products are not geared to 'last demand'

Description: The train products are currently not based on 'last-demand', i.e. the goods must be at the terminal at a fixed time (regardless of when the goods are actually needed by the consignee).

Cause: Suppliers etc. plan with too much buffer and shift the warehouse to the street or the terminal.

Consequences for the processes in CT: The train products are usually not focused on the 'last demand' at the moment, whereby no optimal planning of the time window can be defined for each participant in the transport chain. In addition, this bullwhip effect leads to load peaks in terminal terminals (along with overcrowded parking spaces for trailers due to fluctuating capacity utilization).

3. No train handover on the basis of trust at the Brenner

Description: When the train is handed over at the Brenner, the wagon technician checks the complete set once again. Therefore, there is no "handover of trust". North-South 700 km regulation in Italy, South-North normally not necessary after trust agreement between RUs (after three months of testing).

Cause: 1. 700 km regulatory in Italy (political framework) 2. Need of wagon inspection without damaged wagons/trailer for 3 consecutive months to receive status "handover of trust" fails.

Consequences for the processes in CT: 2nd Wagon inspection on north-south trains which result in extra waiting times and inefficient slot utilization at Brenner.

4. No 'Backup planning' in transport

Description: In the transport sector, unlike the production sector, an alternative workflow concept is missing.

Cause: The rail freight traffic is operated by many railways; a continuous cooperation is not given yet.

Consequences for the processes in CT: As an example, reference should be made to the construction work on the railway tunnel in Rastatt: In August 2017 no rail transport could be realized on the Rhine Valley Railway, the railway line between Karlsruhe and Basel. The reason was that during construction work on the railway tunnel in Rastatt, the tracks lowered above the construction site. Since alternative workflow concepts (i.e. a 'backup concept') did not exist at the time of the incident and had to be developed, the capacity for European rail freight transport was reduced by a certain extent for a quite long time.

5. Locomotive or system change at the Brenner

Description: At Brenner currently still costly and time-consuming locomotive or system change must be carried out.

Cause: In addition to different power and signal systems, the differing draft control systems require a locomotive or system change at the Brenner.

Consequences for the processes in CT:

If this locomotive or system change could be avoided, the following added value could be achieved:

- No interruption of the logistic chain
- Optimal locomotive application: Reduction of scheduling processes to prevent interruption of the operating sequence, which allows for better utilization of the resources north or south of the Brenner (the same applies to the scheduling of train drivers (service plans))
- At the Brenner, time, personnel and material-intensive maneuvering can be eliminated.

Summarized, a waiver of the locomotive or system change at the Brenner would require a continuous double traction on the entire route. The necessity of the train stop for personnel changes (due to duration of use, language barrier, different operating regulations) as well as for the brake test before driving down the slope is not canceled out by the use of multi-system locomotives. Nevertheless, multi-system locomotives would make the re-handling unnecessary.

6. No uniform national calculation bases for clearance gauge (Future Trailer)

Description: The calculation methods and fundamentals of the clearance gauge heights in the rail infrastructure differ between European countries.

Cause: Since these are very complex calculations (up to 23 calculation assumptions), there is currently no uniform European calculation basis.

Consequences for the processes in CT: Due to the different calculation methods, no smooth inter-modal transport can be guaranteed.

➤ **Know-how & Skills**

7. Skills shortage and training / qualification

Description: There is no lack of train capacity, but missing train drivers with route knowledge (prerequisite for driving on the route).

Cause: The lack of skilled workers (especially in rail transport) can be attributed, among other things, to old-established and deadlocked structures in the promotion of young talent.

Consequences for the processes in CT: Professionals are getting older and cannot pass on their expertise, thus losing know-how. But this availability sets the 'limits' for the railway offers (example Rastatt).

8. No standard language

Description: Train drivers have to speak the local language when traveling on foreign networks (in the air and sea transport, English has long been the operating language).

Cause: Strict language requirements for foreign train drivers by network operators.

Consequences for the processes in CT: The train routes which can be driven by the locomotive drivers depend not only on his or her course knowledge but also on the language which he/she is able to speak (that means in the worst case a train passing Germany, Italy and Switzerland must change its locomotive driver at every border).

➤ **IT**

9. Interface problems between the individual RUs

Description: In rail transport, the documentation of other RUs is often not accepted and the documents are recreated instead.

Cause: Due to the many participants and transnational interfaces, the central responsibilities are not regulated.

Consequences for the processes in CT: The many individual systems, elaborate interface creation and some necessary legal basics increase the documentation effort.

➤ **Technology**

10. No detailed localization of the train is possible

Description: The location of the train is not always clear and not every RU informs about the location in the same way.

Cause: The trains are not equipped with a continuous GPS yet (benchmark: road).

Consequences for the processes in CT: The transparency towards the customer (real-time tracking of the parcel) as well as to partners in the logistics chain (e.g. terminals) is not given.

11. Improvement of the suspension on the wagon (for example air suspension)

Description: Semi-trailers are built for the requirements of road transport. During road transport, the semi-trailers are driven by air suspension, whereas the rail transport imposes a burden on the inter-modal transport units (especially semi-trailers).

Cause: During rail transport, the semi-trailers are unsprung in the wagon because the only suspension that acts is the suspension of the wagon.

Consequences for the processes in CT: Heavy burden and abrasion of the semi-trailer.

3.2 Transshipment terminals and ports

On the basis of the process descriptions described above, as well as further expert interviews with ports and transshipment terminals, it was possible to uncover optimization potential both within the material flow and the flow of information. It is quite conceivable that the described optimization potentials do not apply equally to all transshipment terminals or ports. The numbering of the selected optimization potentials serves only for structuring, whereby no conclusions can be drawn on the priority of the individual points.

1) Manual support leg setting

Description: The transshipment times of semi-trailers are higher than those of the other loading units.

Cause: Before semi-trailers can be transshipped, the support legs must be adjusted to the correct loading position by manual cranks. Since the support leg in the wagon must be two centimeters from the ground, in order not to hinder the function of the crash elements of the wagon, it can lead to readjustments.

Consequence: The manual setting of the support leg with possible cranking leads to waiting times of the loading unit and cranes and consequently also to higher throughput times of the loading unit.

2) Media transition or low digitalization

Description: The data recorded within the various tests are entered on paper and then transferred to the system.

Cause: So far there is no overall terminal-internal software solution which exists for the admission of the data. Partial terminal solutions are already available, but – especially in the hinterland – so far not aligned. Above all, the problem is the interaction of the actors and legal regulations.

Consequence: Media transition can result in incorrect transfer of data from paper to the system.

3) Missing information about exact arrival time of the loading units

Description: Dispositive use of resources for peak coverage.

Cause: Currently, information on the exact time of arrival of the loading units is missing, in particular about the roadside entrance. About the railside location information is transmitted to the terminal after passing the last intermediate station. Even less transparency prevails over the causes of possible delays and the current status of the loading unit.

Consequence: The lack of information can cause a too high or too low number of employees in terminal operation. This in turn requires under- or overworking of the individual employees and has a negative effect on the quality of the work. Also technical capacities (key word: plant availability (crane, storage area)) are affected by peak loads. As a result, smoothing should be the optimization goal.

4) Peak loads/peak times

Description: On the roadside, the delivery of the loading unit is not distributed throughout the day despite continuous opening hours, but concentrated at certain peak times. Especially in the late morning or midday and in the late afternoon it comes to peak loads, while in the rest of the day less trucks arrive at the terminal.

Cause: The peak loads result in particular from the fixed customer appointments, that is to say given loading and unloading times. In addition, the roadside delivery and collection is often based on the loading times of the trains.

Consequence: The peak loads caused by a lack of balance lead to waiting times before the individual process steps in certain time windows. In contrast, business is low at terminals especially at night and on weekends.

5) Check-in is done by eye adjustment

Description: At peak times, damage to the loading unit may not be detected due to limited time resources. Furthermore, it is conceivable that different tolerance values for the individual employees regarding the relevance of the damage are present.

Cause: The check-in of the loading units is carried out by visual inspection of the employees.

Consequence: Damage to the loading unit will be detected only after the transfer of liability to the terminal, which causes it to be responsible for the damage.

6) Driver has to get off the truck

Description: When entering the terminal, the material flow is delayed by the fact that the driver must leave his vehicle and go to the counter building to submit the pick-up order, to legitimize the collection of the shipment and to carry out the check-in. This circumstance can lead to the accumulation of several vehicles in the exit area.

Cause: Due to the terminal construction, at the moment there is no possibility for the driver to perform both operations from the vehicle.

Consequence: Because the driver has to get out of the truck, the continuous flow as well as the lead time of the loading unit is hindered and the lead time of the loading unit increased.

7) Many indirect transshipments

Description: The majority of the load units cannot be loaded directly, whereby it comes to many indirect transshipments with transport related intermediate storages.

Cause: The main cause of indirect transshipments are the asynchronous delivery times of the loading units.

Consequence: Since the majority of the load units must be exposed again after the intermediate storage, an additional loading process occurs. These are not paid by the customer and therefore should be avoided.

8) Double check-in

Description: The check-in or control of the charging unit is usually done twice. The first check-in is carried out at the arrival of the truck at the terminal, the second check-in takes place in the empty container depot.

Cause: Check of the loading unit e.g. in the train entrance. Then bypassing the empty container depot by truck. Then there is one more check in the depot before storage.

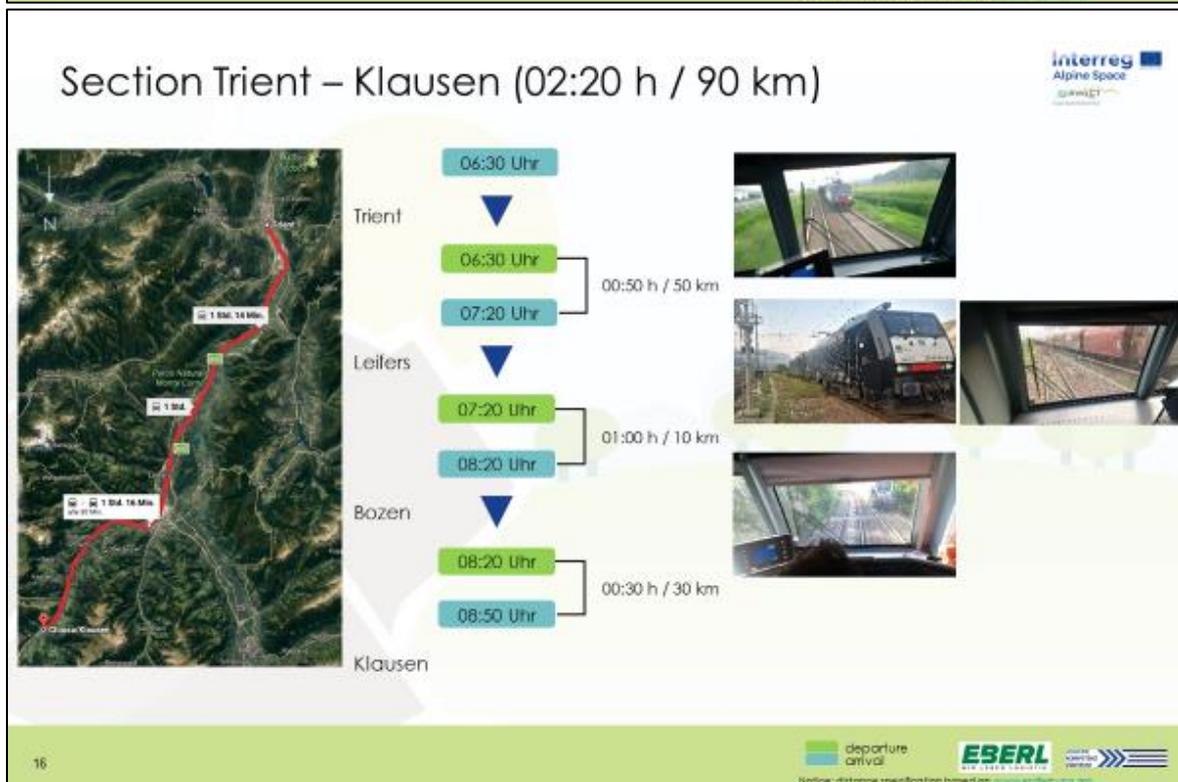
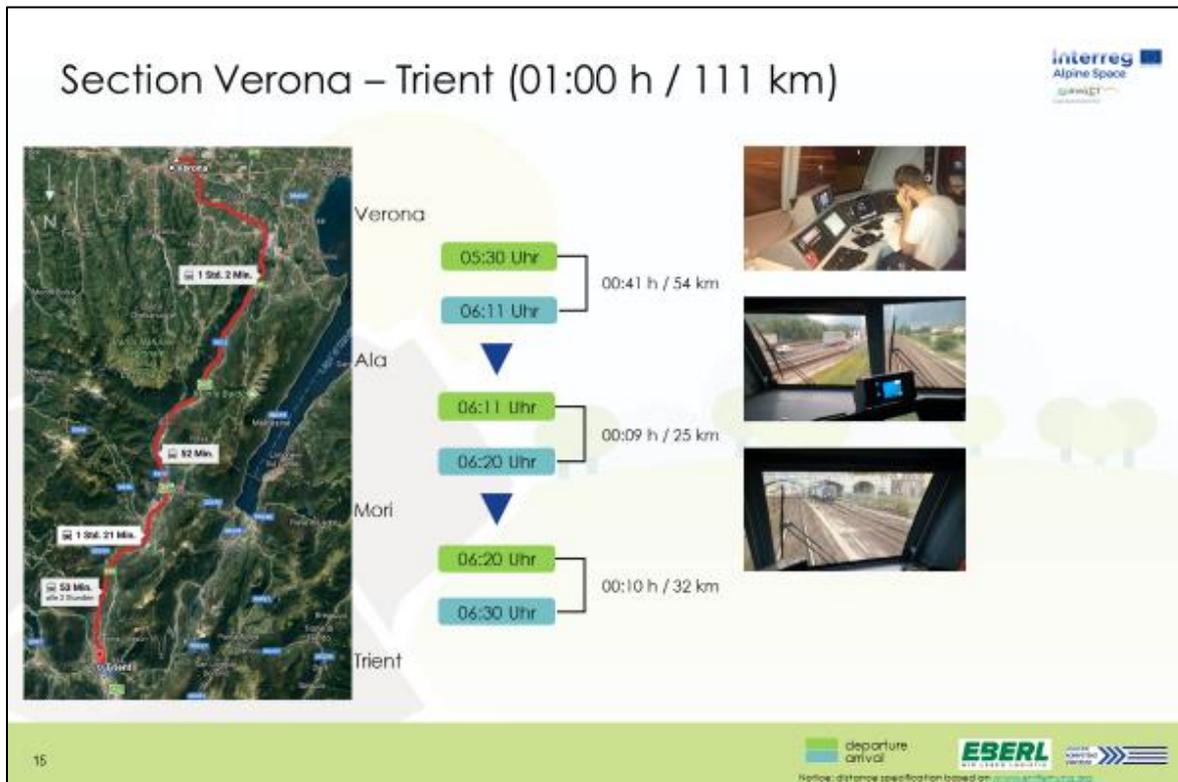
Consequence: Handling bottlenecks in the depot.

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Annex

Impressions of the locomotive ride (02.08.2017)



Section Klausen – Steinach am Brenner (02:40 h / 77 km)



Klausen	08:50 Uhr	▼	
	08:50 Uhr	▶	00:20 h / 22 km
	09:10 Uhr	▶	
Franzensfeste	09:10 Uhr	▼	
	09:10 Uhr	▶	00:40 h / 40 km
	09:50 Uhr	▶	
Brenner	11:15 Uhr	▼	
	11:15 Uhr	▶	01:40 h / 15 km
	11:30 Uhr	▶	
Steinach			



17

Section Steinach am Brenner – Wörgl (01:15 h / 107 km)



Steinach	11:30 Uhr	▼	
	11:30 Uhr	▶	00:30 h / 35 km
	12:00 Uhr	▶	
Tullens	12:00 Uhr	▼	
	12:00 Uhr	▶	00:45 h / 72 km
	12:45 Uhr	▶	
Wörgl			

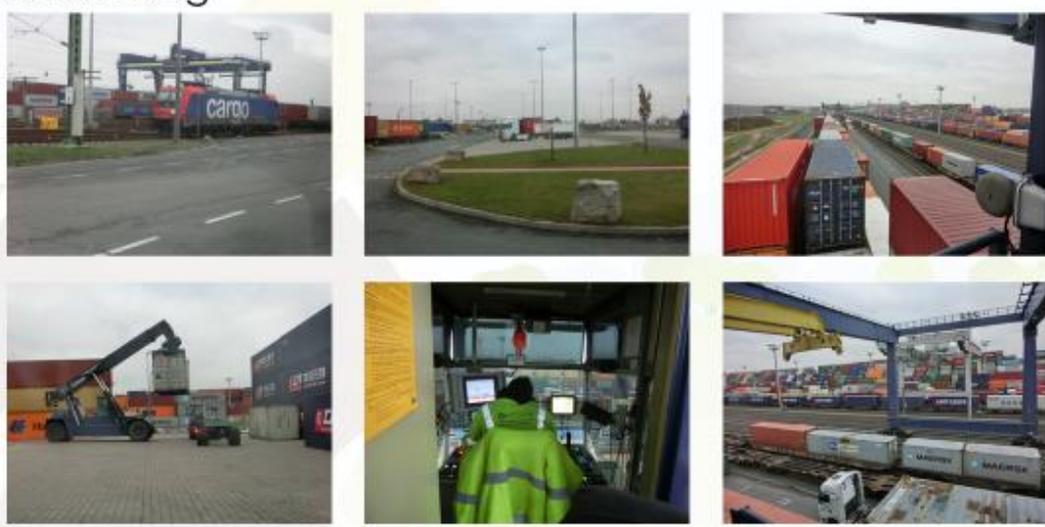


20 trains passed in total

18

On-site inspections

On-site inspection TriCon Container Terminal Nuremberg

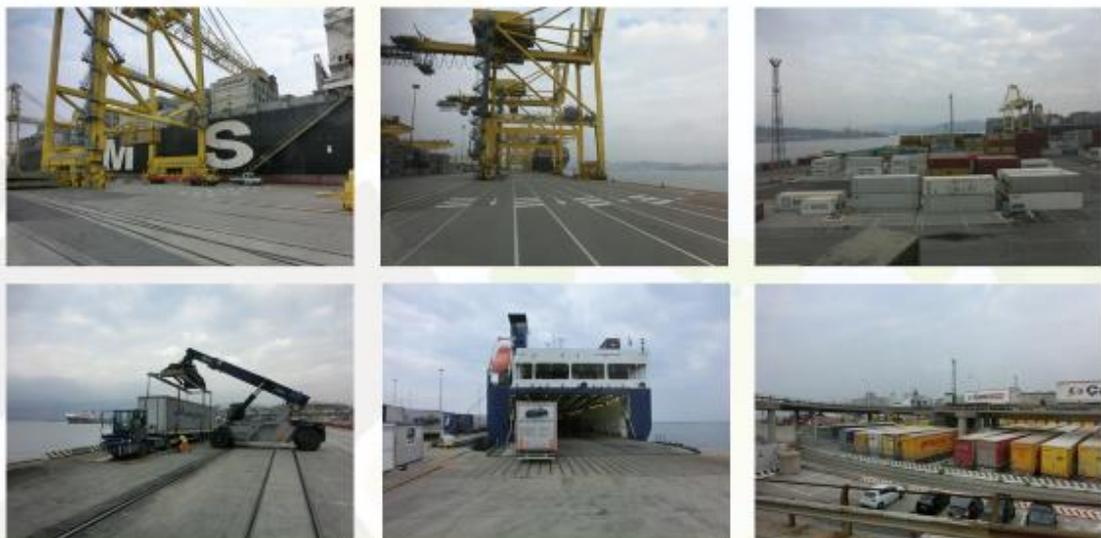



Source: Ispahon Beer

32



On-site inspection port of Trieste

Source: Ispahon Beer

33





On-site inspection terminal Bettembourg



Source: UZPlan GmbH