Report on improved transhipment technologies for cost-optimised cargo collection/delivery

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Involved partners

Following project partners have been involved in the elaboration of this document:

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ca.	circa
CT	combined transport
FIBC	Flexible Intermediate Bulk Container
GLZ	Grafschafter Logistikzentrum
IBC	Intermediate Bulk Containers
kg	kilogramme
km	kilometre
LIFO	last in-first out
m	metre
mm	millimetre
max.	maximum
min.	minute
RLC	Rail Logistics Centre
SWL	single wagonload
ViWaS	Viable Wagonload Production Schemes

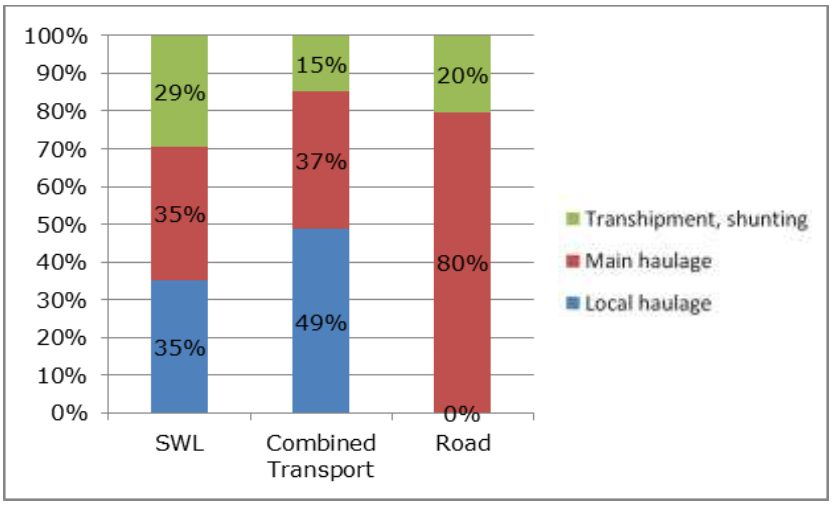
1 Introduction

Single wagonload (SWL) transport is still a major component in numerous European states' transport systems and in the logistics of different economic sectors such as steel, chemical industry and automotive. However, changing framework conditions and increasingly demanding market requirements have led to dramatic market losses and even to a complete shutdown of SWL business in some countries.

As this business segment has been evaluated as important for specific transports in a European co-modal transport system, significant improvements need to be achieved.

One major challenge in SWL transport is the optimisation of the "last-mile". Depending on the main haulage transport distance, the last-mile part (transhipment, shunting, local haulage) of the transport chain can have a share of more than 60% on the total costs. An example is shown in Figure 1 for an exemplary transport chain of retail goods in two swap bodies, transported by rail in single wagonload on a distance of 139 km.

Figure 1: Cost distribution for different transport chains: SWL, CT, Road



Source: TU Berlin based on data of SBB Cargo and Bentheimer Eisenbahn[1]

Beside the development of new concepts and the introduction of advanced technologies for the last-mile rail operation, also the transhipment of freight in the customers' sidings offers potential for increasing the efficiency of single wagonload services. In particular, palletised dry goods or unit loads require extensive handling activities. These handling operations have significant effects on the transport time (quality) and transport costs (price competitiveness).

[1] ViWaS Deliverable N°: D4.1 "Report on target markets and KPIs related to ViWaS project developments"

2 Evaluation methodology for transhipment technologies

Bentheimer Eisenbahn AG has developed a methodology for the analysis and assessment of operation costs and potential benefits of different transhipment technologies. This methodology has been developed on the basis of real SWL transport chains and applied for the optimisation of the handling activities at the Rail Logistics Centre in Nordhorn.

This report contains a description of the evaluation methodology and the specific application case. The main goal of this exercise was the selection of the most efficient forklift type for loading and unloading of SWL freight wagons in the Rail Logistics Centre in Nordhorn considering internal handling processes.

The evaluation with the main analysis steps carried out is shown in Table 1:

Table 1: Methodology for analysis of transhipment technologies (forklifts)

Analysis step		Main aspects/results
1	Analysis of structural parameters of the building (hall, ramp)	Bearing capacities of floors and ramps, width of doors, height of racks, size of handling area
2	Analysis of freight characteristics	Freight weight, packing type/size
3	Pre-selection of appropriate forklift types (based on step 1 and 2)	Propulsion (diesel, electric, fuel gas), dimensions, turn radius, load capacity, lift height, investment
4	Selection of assessment parameters and gathering of specific values	Depreciation/renting costs, maintenance costs, consumption (power demand)and related energy costs
5	Comparison of processes/costs	Loading / unloading of wagons, internal transfer operations from/to storage
6	Field tests	Proof of theoretical values (e.g. consumption), gathering of practical experience
7	Final evaluation results	Summary/evaluation of results; Identification of most suitable transhipment technology (forklift); Purchase decision

Source: Bentheimer Eisenbahn

This report focusses on the analysis steps 3 to 7. As a main result the most appropriate transhipment technology has been identified and a purchase decision has been taken.

3 Optimisation of SWL transhipment operations

In the Rail Logistics Centre "Grafschafter Logistikzentrum (GLZ)" of Bentheimer Eisenbahn in Nordhorn, about 70 single wagons per month are loaded/unloaded, serving multiple customers. Last-mile services to these customers are carried out by truck. In correspondence to specific requirements of customers' logistics, freight is partly stored in the Rail Logistics Centre (RLC). The logistics chain is separated into several working steps starting with the preparation of transhipment up to the invoicing.

As mentioned before, Bentheimer Eisenbahn developed a methodology to analyse and optimise related transhipment processes and technologies. This methodology has been applied for specific SWL transports of Bentheimer Eisenbahn to identify the most efficient forklifts with respect to these transports and the specific spatial conditions within the Rail Logistics Centre. For the optimisation of transhipment processes the following goods have been analysed: (1) steel panels, (2) intermediate bulk containers[2] (IBC) and (3) big bags with salt products.

As a result of a market analysis on potential forklift types the "Kalmar Forklift GCE 70" has been pre-selected for further analyses (cp. evaluation methodology, analysis step 3). In the following steps this machine has been compared with the forklift, currently used at the RLC Nordhorn for above operations: "Toyota 7FG45". Figure 2 provides an overview on the main technical parameters of both types.

Figure 2: Tested forklifts

Toyota 7FG45	**Kalmar Forklift GCE 70**
	
Max capacity: 4,500kg Length: 3,130mm Width: 1,450mm Height: 2,350mm	Max capacity: 7,000kg Length: 3,550mm Width: 1,620mm Height: 2,870mm

Source: Bentheimer Eisenbahn

[2] An Intermediate Bulk Container (IBC) is a tank for the storage and transportation of organic and inorganic chemical liquids. IBCs are applicable to a wide range of industries such as chemical, pharmaceutical, paper-making, metallurgical, rare earth, electroplating, electrical power, food and environment protection.

3.1 Logistics and transhipment chain: Steel panels

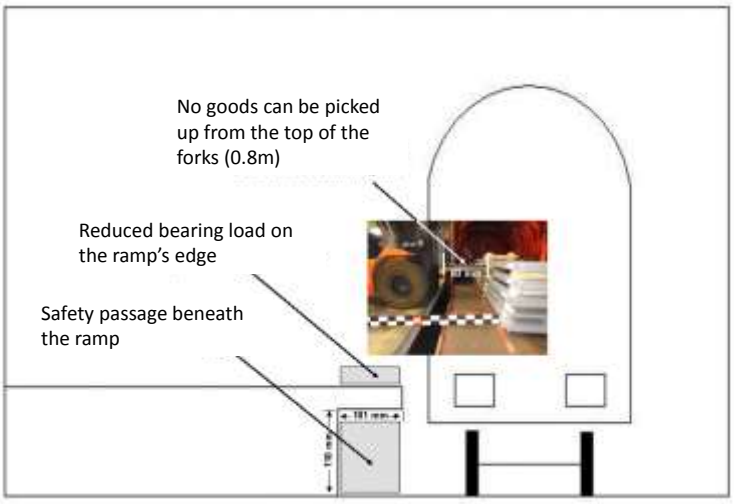
The RLC Nordhorn is (amongst others) an external storage point for a large German steel producer. Every week, four wagons with each 50 tonnes of steel plate bundles are handled. The steel plate bundles are stored intermediately and distributed by truck to customers in the Nordhorn region in a 100 km radius.

Figure 3: Steel plate bundles on rail wagon in the RLC Nordhorn

Source: Bentheimer Eisenbahn

Each wagon is loaded with 18 to 20 bundles of steel plates in six-fold stacking. The wagons are shunted into the hall and unloaded by a forklift. Due to its payload of maximum 4.5 tonnes, the previously used forklift could only pick one bundle of steel plates at a time. Therefore, it is not possible to pick goods from the top of the forks (on a length of 0.8 m). When carrying a bundle of steel plates the load centre is at the end of the fork ("critical" situation).

Figure 4: Cross-section "transhipment wagon-ramp" in RLC



Source: Bentheimer Eisenbahn

Due to static characteristics, it is not possible to pick up 2 bundles simultaneously, as the ramp cannot bear the load (point loads). Parallel to the track, there is a safety passage beneath the ramp with a width of 1.0 m.

3.2 Logistics and transhipment chains: Intermediate Bulk Containers

Bentheimer Eisenbahn handles roughly 20 wagons per week in the RLC Nordhorn. Each wagon is loaded with 21 IBCs, which are (1) stored intermediately and (2) distributed to customers in the Nordhorn region.

3.3 Logistics and transhipment chain: Salt products

Currently, six trucks of salt products are weekly delivered from The Netherlands. These products are packed either on palettes or in "big bags" (FIBC[3]), transhipped by forklifts and stored intermediately, before being transported to Northern Europe by rail.

[3] Flexible Intermediate Bulk Container (FIBC) or big bag is an industrial container made of flexible fabric that is designed for storing and transporting dry and flowable products, such as sand, fertilizer, and granules of plastic.

4 Cost analysis

Table 2 to Table 19 – presented on the following pages - summarize the results of the transhipment analysis and related cost assessment which have been carried out for the goods described before:

- Steel panels (Table 2 to Table 7);
- Intermediate bulk containers (Table 8 to Table 13);
- Big bags with salt products (Table 14 to Table 19).

The final results are shown in Table 20 to Table 22.

Based on the elaborated results a purchase decision was taken. Bentheimer Eisenbahn bought the Kalmar GCE 70 in order to optimise the SWL transhipment processes in the Rail Logistics Centre in Nordhorn.

Currently, the methodology is applied in connection with another potential SWL logistics and transhipment chain within the RLC Nordhorn. Due to limited capacity in the current hall it is considered to open-up an external storage area next to the currently used facilities. This means that on the one hand, distances between wagon loading/unloading, storage and truck loading/unloading increase. On the other hand, the new forklift with an increased capacity might be able to eliminate potential disadvantages. Detailed calculations are currently done to evaluate the economic viability of the considered extension. The developed evaluation methodology thereby proofs to be an important tool for strategic development planning of the Rail Logistic Centre.

4.1 Cost comparison: Steel panels

Table 2: Steel panel working area - unloading

	1 steel panel bundle – ca. 2.7 tonnes	2 steel panel bundles - ca. 5 – 5.5 tonnes
TOYOTA 7FG45		Not possible: • Excess of the forklift's bearing load • Load centre exceeded
	✓	
KALMAR GCE 70		Validation: not possible • Load centre • Static verification of the ramp's bearing load
	✓	

Table 3: Steel panel working area – storage and removal (LIFO)

	1 steel panel bundle - 3 tonnes	2 steel panel bundles - 6 tonnes
TOYOTA 7FG45		Not possible: load centre exceeded
	✓	
KALMAR GCE 70		
	✓	✓

Table 4: Steel panel working area – internal run to transhipment point

	1 steel panel bundle - ca. 2.7 tonnes	2 steel panel bundles - ca. 5-5.5 tonnes
TOYOTA 7FG45		not possible: • excess of the forklift's bearing load • load centre exceeded
	✓	
KALMAR GCE 70		
	✓	✓

Table 5: Steel panel working area – loading of goods (sideways loading)

	1 steel panel bundle - ca. 2.7 tonnes	2 steel panel bundles - ca. 5-5.5 tonnes
TOYOTA 7FG45		not possible: • excess of the forklift's bearing load • load centre exceeded
	✓	
KALMAR GCE 70		
	✓	✓

Table 6: Steel panel operational intermediate result

Operational intermediate result "Steel panels"	 Toyota 7FG45	 Kalmar GCE 70
Working area - unloading		
1 steel panel bundle of ca. 2.7 tonnes	✓	✓
2 steel panel bundles of ca. 5.5 tonnes	**no**	**no**
Working area - storage (LIFO)		
1 steel panel bundle of ca. 2.7 tonnes	✓	✓
2 steel panel bundles of ca. 5.5 tonnes	**no**	✓
Working area – removal (LIFO)		
1 steel panel bundle of ca. 2.7 tonnes	✓	✓
2 steel panel bundles of ca. 5.5 tonnes	**no**	✓

Operational intermediate result "Steel panels"	 Toyota 7FG45	 Kalmar GCE 70
Working area – internal run to transhipment point		
1 steel panel bundle of ca. 2.7 tonnes	✓	✓
2 steel panel bundles of ca. 5.5 tonnes	**no**	✓
Working area – loading of goods (sideways loading)		
1 steel panel bundle of ca. 2.7 tonnes	✓	✓
2 steel panel bundles of ca. 5.5 tonnes	**no**	✓

Table 7: Steel panel forklift movement costs

Calculation basis: receipt of 1 wagon with 50 tonnes steel panels

Working area – goods receipt	time in min.	hourly rate	total
Toyota-forklift	60	30.00 €	30.00 €
Kalmar-forklift	60	30.00 €	30.00 €
time/cost savings	***0***		***0 €***
Working area – LIFO storage			
Toyota-forklift	60	30.00 €	30.00 €
Kalmar-forklift	30	30.00 €	15.00 €
time/cost savings	***30***		***15.00 €***
Working area – LIFO removal			
Toyota-forklift	45	30.00 €	22.50 €
Kalmar-forklift	30	30.00 €	15.00 €
time/cost savings	***15***		***7.50 €***
Working area – internal run to transhipment place			
Toyota-forklift	45	30.00 €	22.50 €
Kalmar-forklift	30	30.00 €	15.00 €
time/cost savings	***15***		***7.50 €***
Working area – loading of goods (2 trucks with each 25 tonnes)			
Toyota-forklift	120	30.00 €	60.00 €
Kalmar-forklift	60	30.00 €	30.00 €
time/cost savings	***60***		***30.00 €***

Result 1 wagon	time in min.	hourly rate	total
Toyota-forklift	330	30.00 €	165.00 €
Kalmar-forklift	210	30.00 €	105.00 €
time/cost savings	***120***		***60.00 €***

4.2 Cost comparison: Intermediate Bulk Containers

Table 8: IBC working area - unloading

	1 IBC - ca. 1 tonne	2 IBCs - ca. 2 tonnes
TOYOTA 7FG45		not possible: load centre exceeded
	✓	
KALMAR GCE 70		
	✓	✓

Table 9: IBC working area - storage and removal (block storage)

	1 IBC - ca. 1 tonne	2 IBCs - ca. 2 tonnes
TOYOTA 7FG45		not possible: load centre exceeded
	✓	
KALMAR GCE 70		
	✓	✓

Table 10: IBC working area - internal run to transhipment place

	1 IBC - ca. 1 tonne	2 IBCs - ca. 2 tonnes
TOYOTA 7FG45		not possible: load centre exceeded
	✓	
KALMAR GCE 70		
	✓	✓

Table 11: IBC working area – transhipment

	1 IBC - ca. 1 tonne	2 IBCs - ca. 2 tonnes
TOYOTA 7FG45	not possible: forklift is too large for the trailer **Loading done by e-hub wagon**	
KALMAR GCE 70		

Table 12: IBC operational intermediate result

Operational intermediate result IBCs	 Toyota 7FG45	 Kalmar GCE 70
Working area - unloading		
1 IBC of ca. 1 tonne	✓	✓
2 IBCs of ca. 2 tonnes	**no**	✓
Working area - storage (block storage)		
1 IBC of ca. 1 tonne	✓	✓
2 IBCs of ca. 2 tonnes	**no**	✓
Working area - removal (block storage)		
1 IBC of ca. 1 tonne	✓	✓
2 IBCs of ca. 2 tonnes	**no**	✓

Operational intermediate result IBCs	 Toyota 7FG45	 Kalmar GCE 70
Working area - internal run to transhipment place		
1 IBC of ca. 1 tonne	✓	✓
2 IBCs of ca. 2 tonnes	**no**	✓
Working area - transhipment		
1 IBC of ca. 1 tonne	**no**	**no**
2 IBCs of ca. 2 tonnes	**no**	**no**

Table 13: IBC forklift movement costs

Calculation basis: receipt of 1 wagon IBCs

Working area - unloading	time in min.	hourly rate	total
Toyota-forklift	30	30.00 €	15.00 €
Kalmar-forklift	15	30.00 €	7.50 €
time/cost savings	***10***		***7.50 €***
Working area - storage			
Toyota-forklift	30	30.00 €	15.00 €
Kalmar-forklift	20	30.00 €	10.00 €
time/cost savings	***10***		***5.00 €***
Working area - removal			
Toyota-forklift	30	30.00 €	15.00 €
Kalmar-forklift	20	30.00 €	10.00 €
time/cost savings	***10***		***5.00 €***
Working area - internal run to transhipment place			
Toyota-forklift	30	30.00 €	15.00 €
Kalmar-forklift	15	30.00 €	7.50 €
time/cost savings	***15***		***7.50 €***
Working area - transhipment			
Toyota-forklift	-	-	-
Kalmar-forklift	-	-	-
time/cost savings	***-***		***-***

Result 1 wagon	time in min.	hourly rate	total
Toyota-forklift	120	30.00 €	60.00 €
Kalmar-forklift	70	30.00 €	35.00 €
time/cost savings	***50***		***25.00 €***

4.3 Cost comparison: Salt products

Table 14: Big bag working area – unloading

	1 big bag/palette - ca. 1 tonne	2 big bags/palettes - ca. 2 tonnes
TOYOTA 7FG45	not possible: forklift too large for the trailer **Loading done by E-hub wagon**	
KALMAR GCE 70		

Table 15: Big bag working area – storage and removal (block storage)

	1 big bag/palette - ca. 1 tonne	2 big bags/palettes - ca. 2 tonnes
TOYOTA 7FG45		not possible: load centre exceeded
	✓	
KALMAR GCE 70		
	✓	✓

Table 16: Big bag working area – internal run to transhipment place

	1 big bag/palette - ca. 1 tonne	2 big bags/palettes - ca. 2 tonnes
TOYOTA 7FG45		not possible: load centre exceeded
	✓	
KALMAR GCE 70		
	✓	✓

Table 17: Big bag working area – transhipment

	1 big bag/palette - ca. 1 tonne	2 big bags/palettes - ca. 2 tonnes
TOYOTA 7FG45		not possible: load centre exceeded
	✓	
KALMAR GCE 70		
	✓	✓

Table 18: Big bag operational intermediate result

Operational intermediate result "Big bag"	 Toyota 7FG45	 Kalmar GCE 70
Working area - unloading		
1 big bag/palette of ca. 1 tonne	**no**	**no**
2 big bags/palettes of ca. 2 tonnes	**no**	**no**
Working area - storage (block storage)		
1 big bag/palette of ca. 1 tonne	✓	✓
2 big bags/palettes of ca. 2 tonnes	**no**	✓
Working area - removal (block storage)		
1 big bag/palette of ca. 1 tonne	✓	✓
2 big bag's/palettes of ca. 2 tonnes	**no**	✓

Operational intermediate result "Big bag"	 Toyota 7FG45	 Kalmar GCE 70
Working area - internal run to transhipment place		
1 big bag/palette of ca. 1 tonne	✓	✓
2 big bags/palettes of ca. 2 tonnes	**no**	✓
Working area - transhipment		
1 big bag/palette of ca. 1 tonne	✓	✓
2 big bags/palettes of ca. 2 tonnes	**no**	✓

Table 19: Big bag forklift movement costs

Calculation basis: Exit of 1 wagon salt products

Working area - unloading	time in min.	hourly rate	total
Toyota-forklift	-	-	-
Kalmar-forklift	-	-	-
time/cost savings	**-**		**-**
Working area - storage			
Toyota-forklift	35	30.00 €	17.50 €
Kalmar-forklift	20	30.00 €	10.00 €
time/cost savings	***15***		***7.50 €***
Working area - removal			
Toyota-forklift	35	30.00 €	15.00 €
Kalmar-forklift	20	30.00 €	10.00 €
time/cost savings	***15***		***5.00 €***
Working area - internal run to transhipment place			
Toyota-forklift	30	30.00 €	15.00 €
Kalmar-forklift	15	30.00 €	7.50 €
time/cost savings	***15***		***7.50 €***
Working area - transhipment			
Toyota-forklift	75	30.00 €	37.50 €
Kalmar-forklift	50	30.00 €	25.00 €
time/cost savings	***25***		***12.50 €***

Result: **1 wagon**	time in min.	hourly rate	total
Toyota-forklift	175	30.00 €	87.50 €
Kalmar-forklift	105	30.00 €	52.50 €
time/cost savings	***70***		***35.00 €***

4.4 Cost comparison: Summary of results

Table 20: Summary of the operative work processes

Summary of the operative work processes (movement costs)			
	Cost saving per wagon	**Wagons per month**	**Cost savings per month**
Salt products	35 €	12	420 €
Steel panels	60 €	16	960 €
IBCs	25 €	20	500 €
Total			**1,880 €**

Table 21: Forklift fixed costs

Forklift fixed costs		
	 Toyota 7FG45	 Kalmar GCE 70
Monthly write-off	300.00 €	460.00 €
Monthly maintenance costs	75.00 €	75.00 €
Power demand (forklift gas)	260.00 €	260.00 €
Total	**635.00 €**	**708.00 €**
Additional costs	**-**	**160.00 €**

Table 22: Final results

Result			
Kalmar GCE 70		Additional costs	Savings
Operative working processes (movement costs)		-	1,880.00 €
Fixed costs		160.00 €	-
Monthly savings			**1,720.00 €**
<u>Purchase decision</u> **The Kalmar GCE 70 was bought, and hence the working processes optimised.**			