

Increasing Rail Cargo Transport Performance

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ESSEN



1. Introduction
2. Specifics Rail Cargo
3. Model Structure
4. Practical Example
5. Outlook

1. Introduction: Trends

Globalisation

→ Complex & volatile SC

Sustainability

→ Energy & Pollution

Trends for Logistics and Rail Cargo (RC)

Innovation

→ Technology / Integration

Security

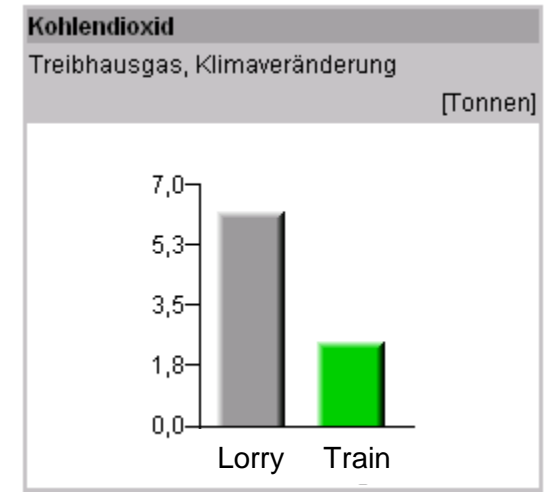
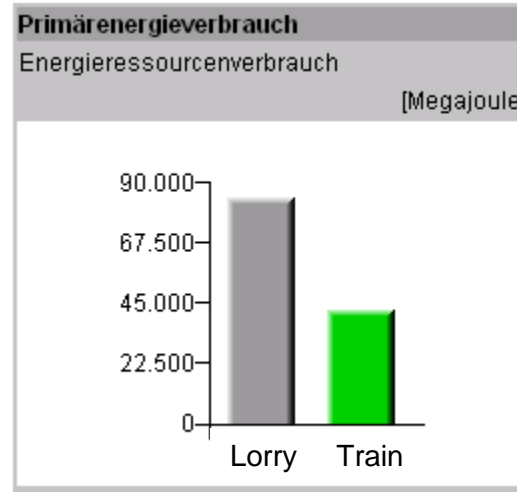
→ Physical & Information

Source: Straube, F., Pfohl, H. (2008), Bundesvereinigung Logistik (BVL) Berlin.

2. Specifics: Strengths RC

Example Sustainability

Transport of 100 tons of bananas from Bremerhaven (D) to Gossau (CH)



- ➡ 50% less energy consumption, 60% less CO₂ emission compared to lorry
- ➡ With increasing road pricing and also increasing congestion rail cargo may be the strategic alternative

Source: www.ecotransit.org.

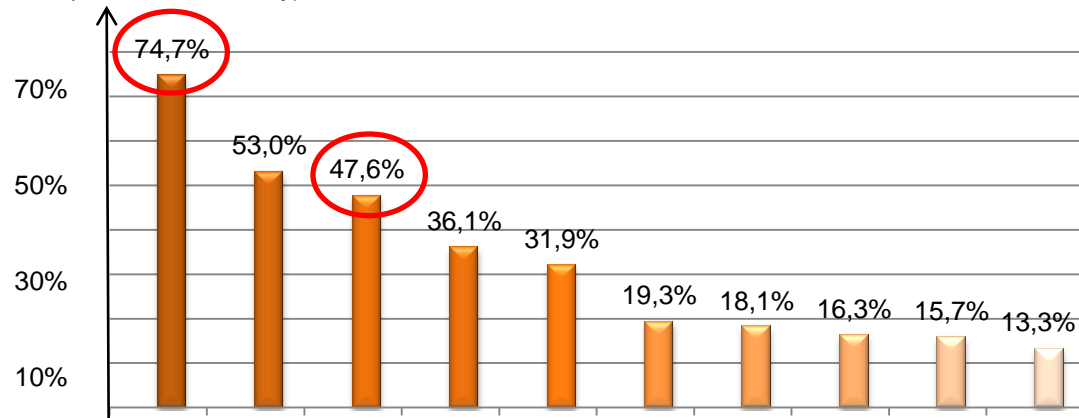
2. Specifics: Weaknesses RC

Example Quality:

2 out of top 3 hindering reasons for rail transports

(Questionnaire with 170 IHK companies in Germany)

in per cent, multiple namings possible



1. slow transport speed/low flexibility
2. no direct rail track access
3. very low customer service

Source: BME/Wittenbrink 2007.

2. Specifics: Chances RC

Co-operation of RCO (MAEKAS)

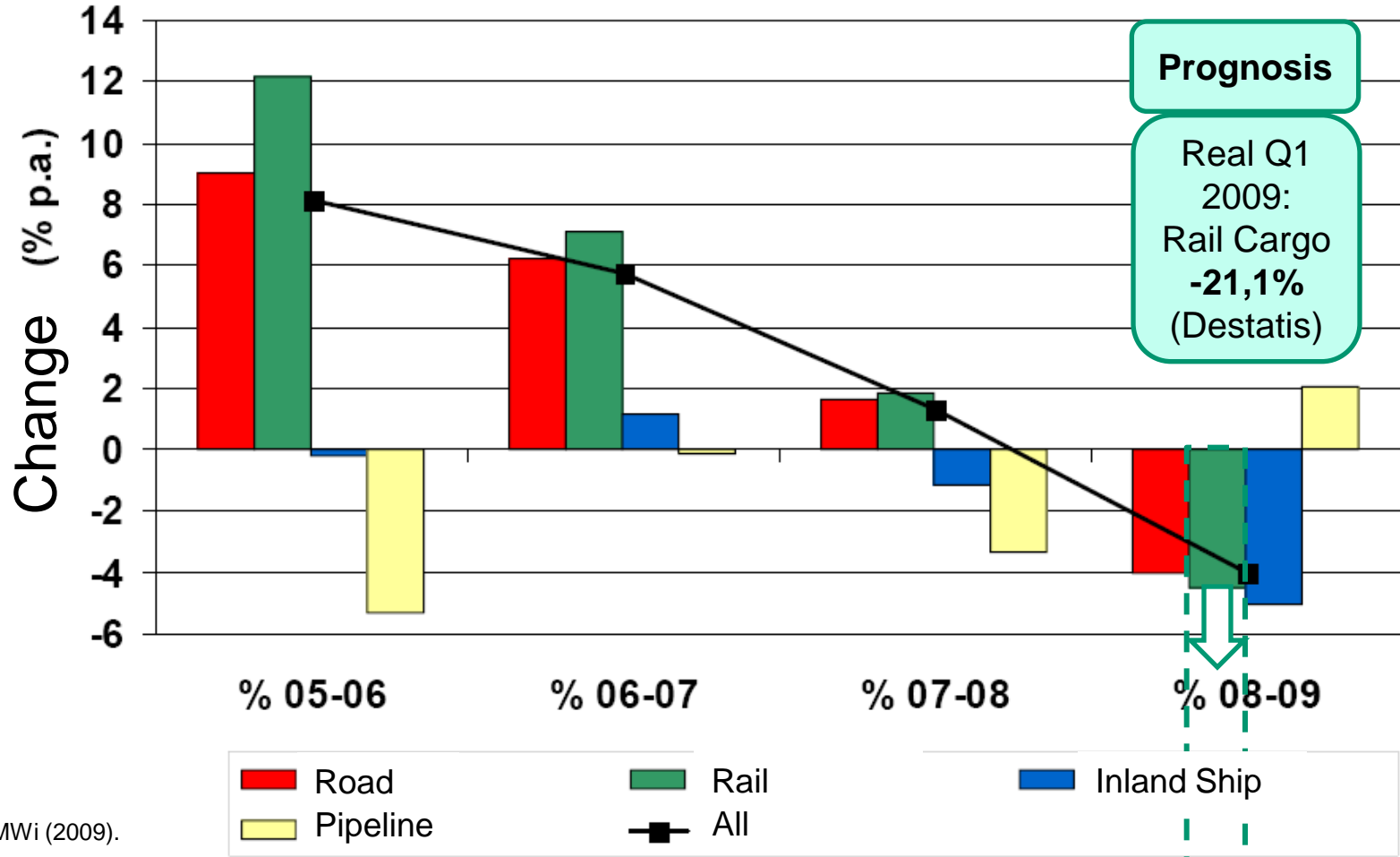
- One virtual company through co-operation of regional & international rail operators (1-stop-shop)
- Intelligent bundling of transport requests among co-operation partners within a strategic overall concept
- Easy communication through a web portal
- Coaching with re-activating passive rail tracks (last mile)



Source: www.maekas.wiwi.uni-due.de

2. Specifics: Risks RC

□ **Dependent** of business cycles and therefore skaling problem



Source: BMWi (2009).

2. Specifics: SWOT Rail Cargo

Strengths:
Sustainability,
System Quality,
Price Advantage

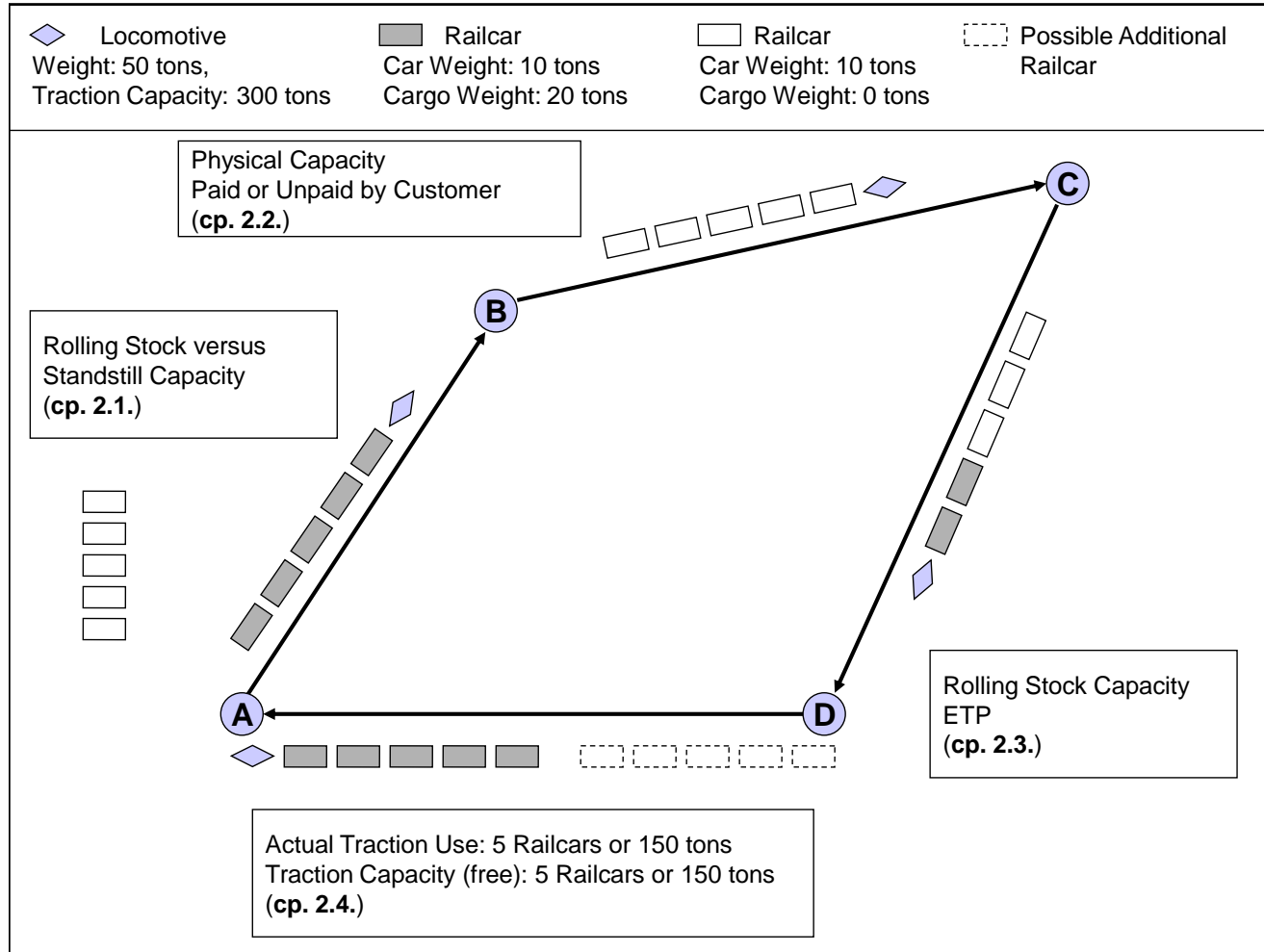
Weaknesses:
High Fix Costs,
Disadvantages in Flexibility
and Service,
Interoperability and Track
Connection Problem (Last Mile)

RAIL CARGO

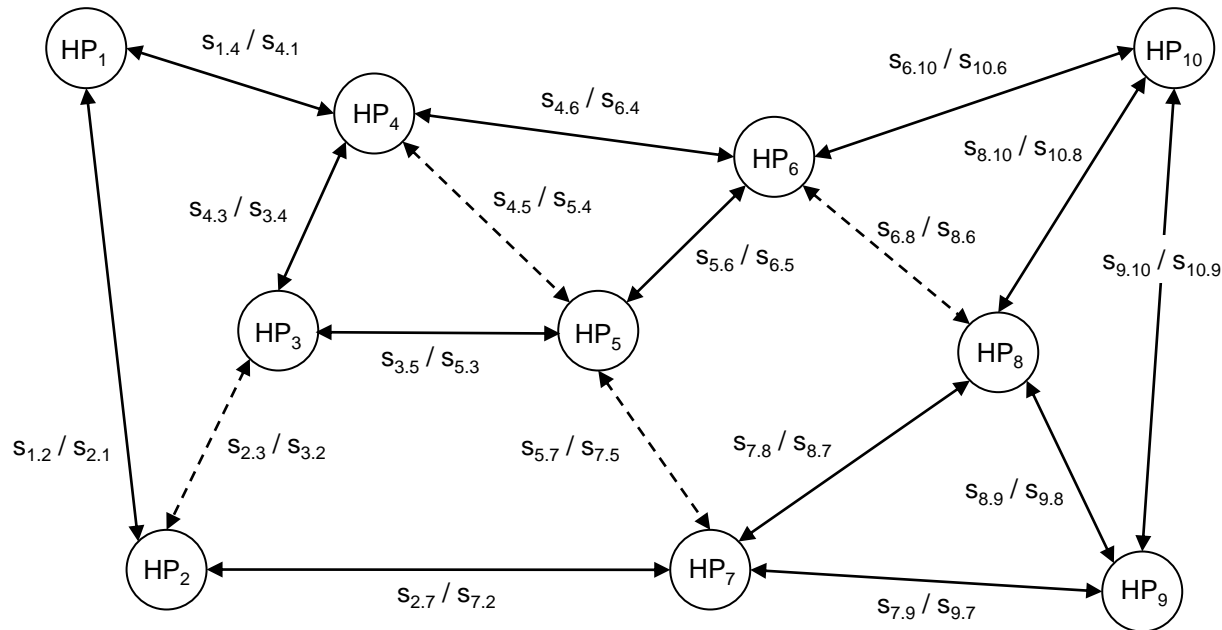
Chances:
Co-operation for Increasing
Cargo Loads (Scaling),
Co-operation in order to
Enhance Quality,
Systems / SC Steering (4PL)

Risks:
Business Cycle and
Scaling Risks,
Technology Implementation,
Competition and Price Decrease,
Insourcing Lorry

Empty Transport Definition Variations



Example for a Rail Cargo Network



electrified rail connection HP_i: Stop Point non-electrified rail connection

Model Structure

- **Objective:** Minimizing Empty Ton Kilometers / Empty Transports (*Alternative: CO₂*)

$$LTKG = \sum_{e=1}^E \sum_{q=1}^{Q_e} LTK_{e,q} \rightarrow \min!$$

- **Examples for Restrictions:**

(a) Capacity Restrictions:

$$\forall e = 1, \dots, E \quad \forall q = 1, \dots, Q_e \quad \forall c = 1, \dots, C \quad \forall p = 1, \dots, P: \quad l_{g_{\text{sta.c.e.q.p}}} \leq y_{\text{sta.c.e.q}} \cdot l_{k_{\text{sta.c}}}$$

(b) Stop and Load Restrictions:

$$\forall e = 1, \dots, E \quad \forall q = 1, \dots, Q_e \quad \forall c = 1, \dots, C \quad \forall i = 1, \dots, N \quad \forall p = 1, \dots, P:$$

$$z_{b_{\text{sta.c.i.e.q.p}}} \leq x_{e,q,p,i}$$

□ Example Integrity Restriction:

All in on stop point loaded cargo loads have to be the same size as the deloaded cargo loads in the destination stop point.

$$\forall c = 1, \dots, C \quad \forall i = 1, \dots, N:$$

$$gmb_{sta.c.i} > 0 \rightarrow \exists j \in 1, \dots, N : gme_{sta.c.i.j} = gmb_{sta.c.i} \quad \wedge \quad \dots$$

$$gmb_{sta.c.i} = 0 \rightarrow \forall j = 1, \dots, N : gme_{sta.c.i.j} = 0$$

□ Example Decision Variable:

The link of locomotives and tours is implemented by a binary decision variable with the accepted values of 0 and 1.

$$\forall a = 1, \dots, A \quad \forall e = 1, \dots, E \quad \forall q = 1, \dots, Q_e:$$

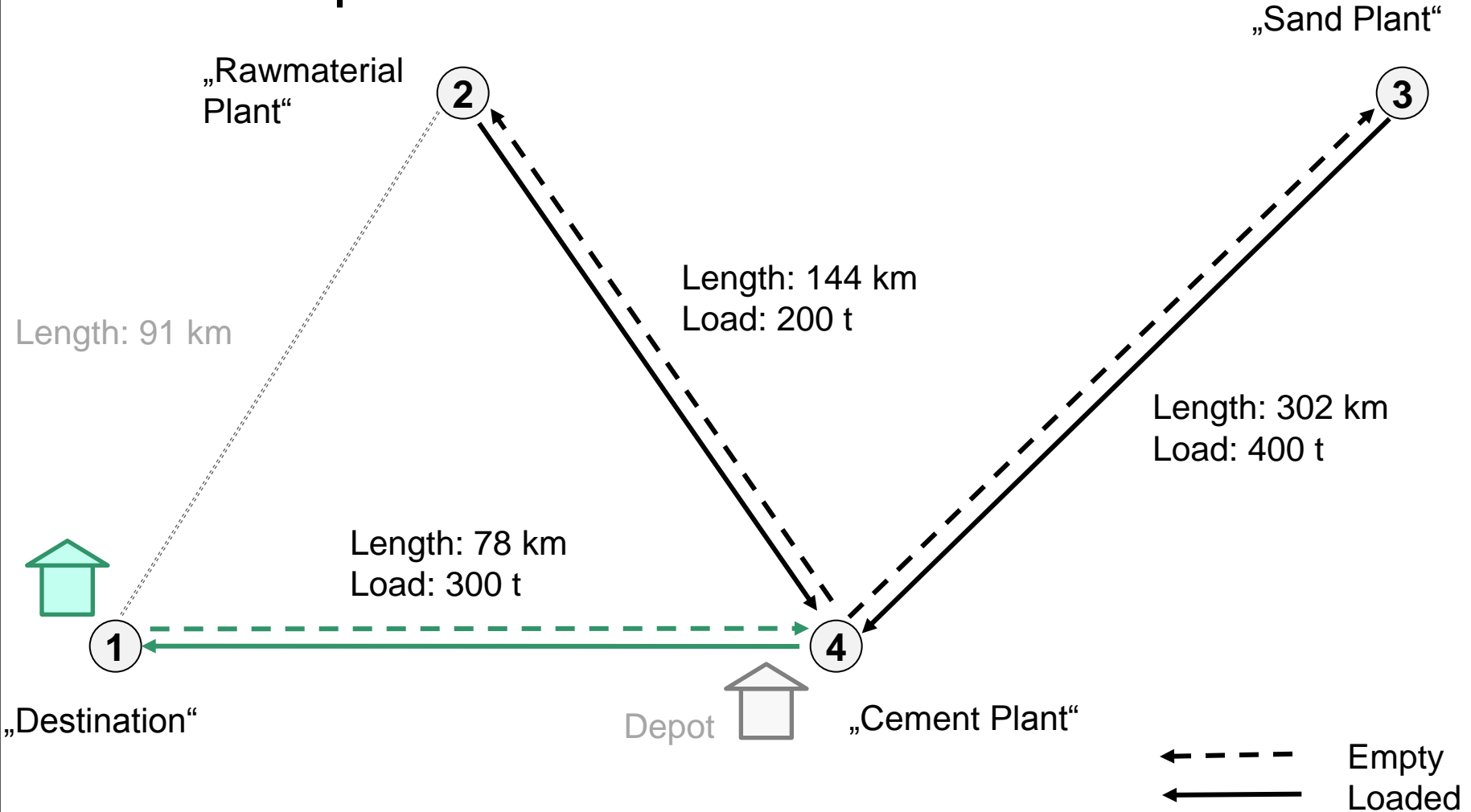
$$y_{die.a.e.q} \in 0, 1$$

mit :

$$y_{die.a.e.q} = \begin{cases} 1, & \text{wenn eine Lokomotive des Typs } LT_{die.a} \text{ der Tour } T_{e,q} \text{ zugeordnet wird} \\ 0, & \text{wenn keine Lokomotive des Typs } LT_{die.a} \text{ der Tour } T_{e,q} \text{ zugeordnet wird} \end{cases}$$

4. Practical Example*

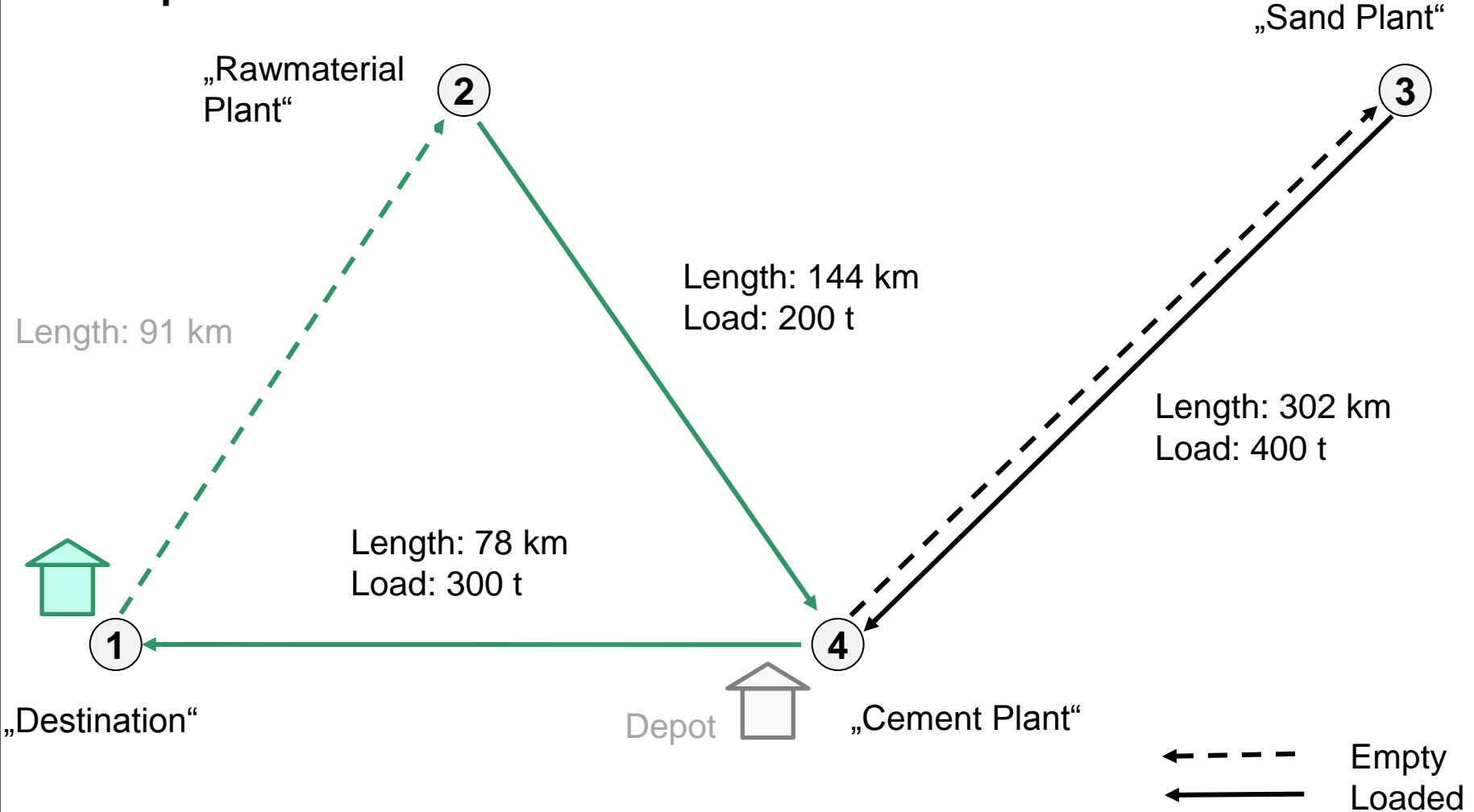
Real Transport Problem



* Real Business Date exchanged.

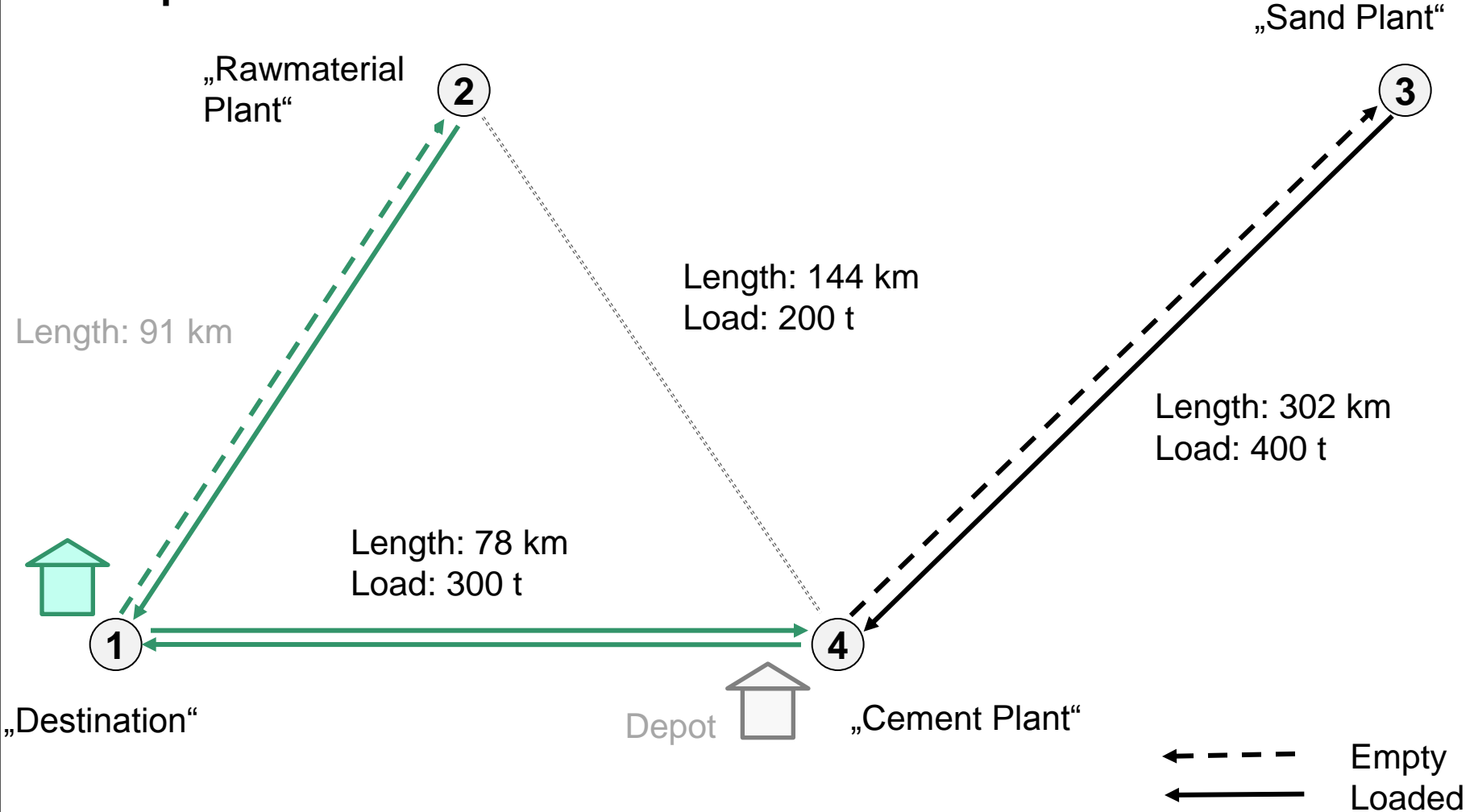
4. Practical Example

□ Optimization I



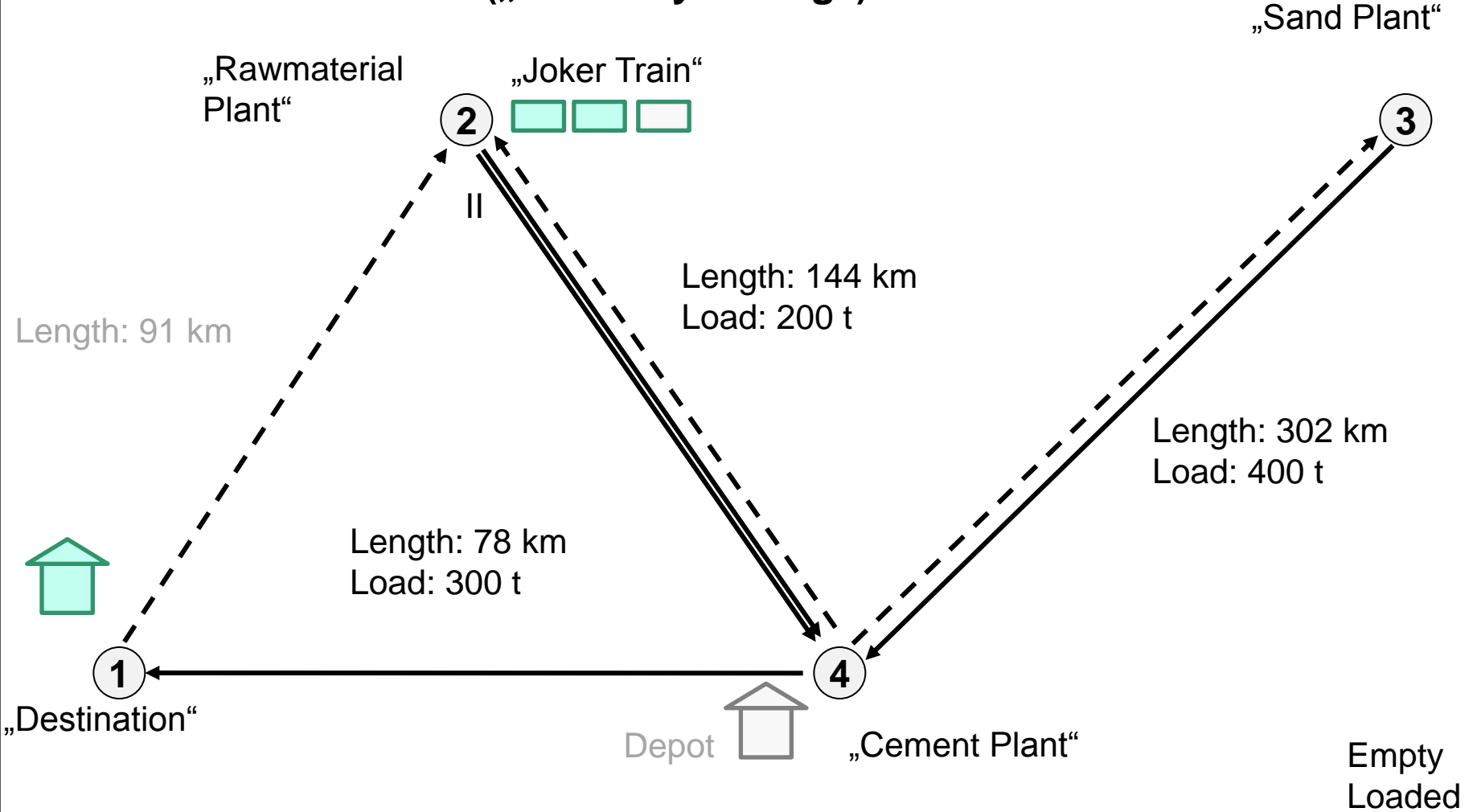
4. Practical Example

Optimization II



4. Practical Example

□ Practical Solution („flexibility is king“)



Annotations

- Ongoing theoretical research work for rail cargo modelling necessary e.g. with the optimization direction total emissions by RCO

$$\text{TGE}_{\text{CO}_2} = \sum_{e=1}^E \sum_{q=1}^{Q_e} \text{TE}_{e,q,\text{CO}_2} \rightarrow \text{min!}$$

and also optimization of total tour length of RCO:

$$\text{TGL} = \sum_{e=1}^E \sum_{q=1}^{Q_e} \text{TL}_{e,q} \rightarrow \text{min!}$$

- Testing and operative piloting with rail cargo operators (RCO).
- Further extension and implementation in logistics planning („supply chain design“), also by LSP.
- The question who is initializing a co-operation in order to optimize tour planning is not relevant (but maybe in terms of incentives for innovators).

- I. **Co-operation** is a necessary improvement and optimization strategy for rail cargo operators.
- II. **Co-operation and optimization models** have to be enlarged and extended in order to support operational tour planning decisions.
- III. Modelling will have a **practical and positive impact** for rail cargo operators in terms of tour planning, strategic decision making (which new customers to take on) and also project evaluation.

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Thank you for
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