

Customer Agreements within the Rail Freight Industry

-A review of Service Network Design models

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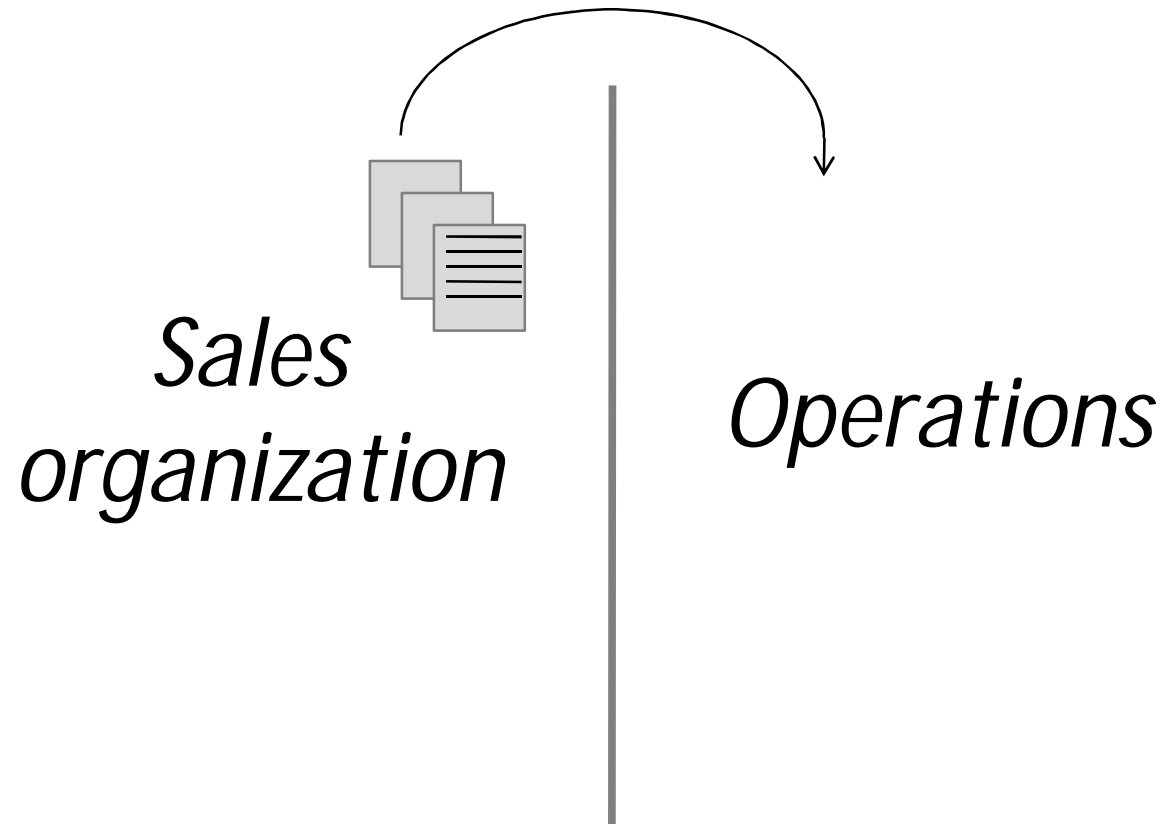
Research Focus

(Research focus | Customer agreements | Literature review)

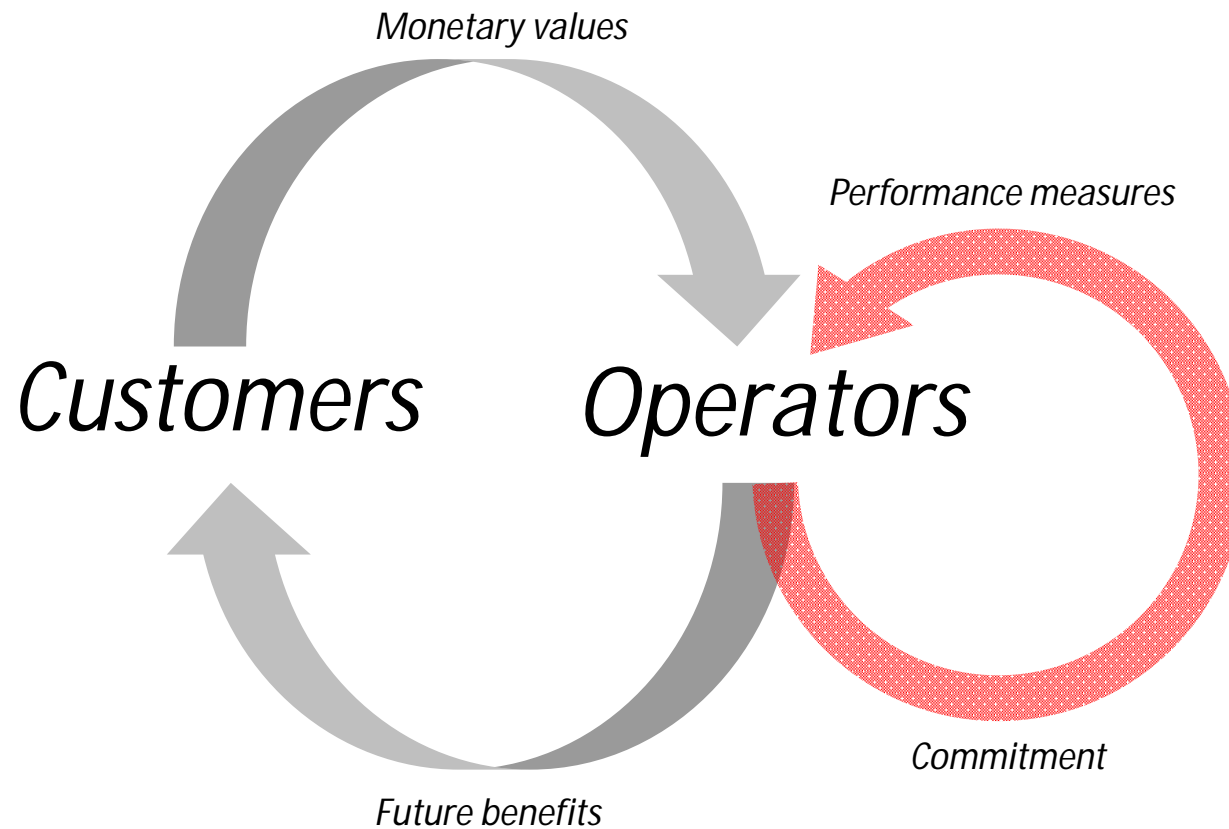
Main purpose

“Investigate how customer agreement characteristics affect key rail freight performance measures”

Incentive



Need for further research?



Overall methodology

- The research project takes on a quantitative approach
 - Phase 1 – Simulation (MultiRail)
 - Phase 2 – Optimization (SND-models)
 - Phase 3 – Additional quantifications

Customer agreements

(Research focus | Customer agreements | Literature review)

Customer Value Creation

- Logistic categories
 - Where? (Location aspects)
 - When? (Time aspects)
 - What? (Product aspects)
 - How much? (Quantity aspects)
- Entails how customers are to be served

Customer agreements

- Identified key agreements
 - Transportation relations
 - Departure day (s) of the week
 - Departure frequencies
 - Pick-up times
 - Delivery timeframes
 - Car specifications
 - Average shipped freight volumes
 - Freight volume variation allowance

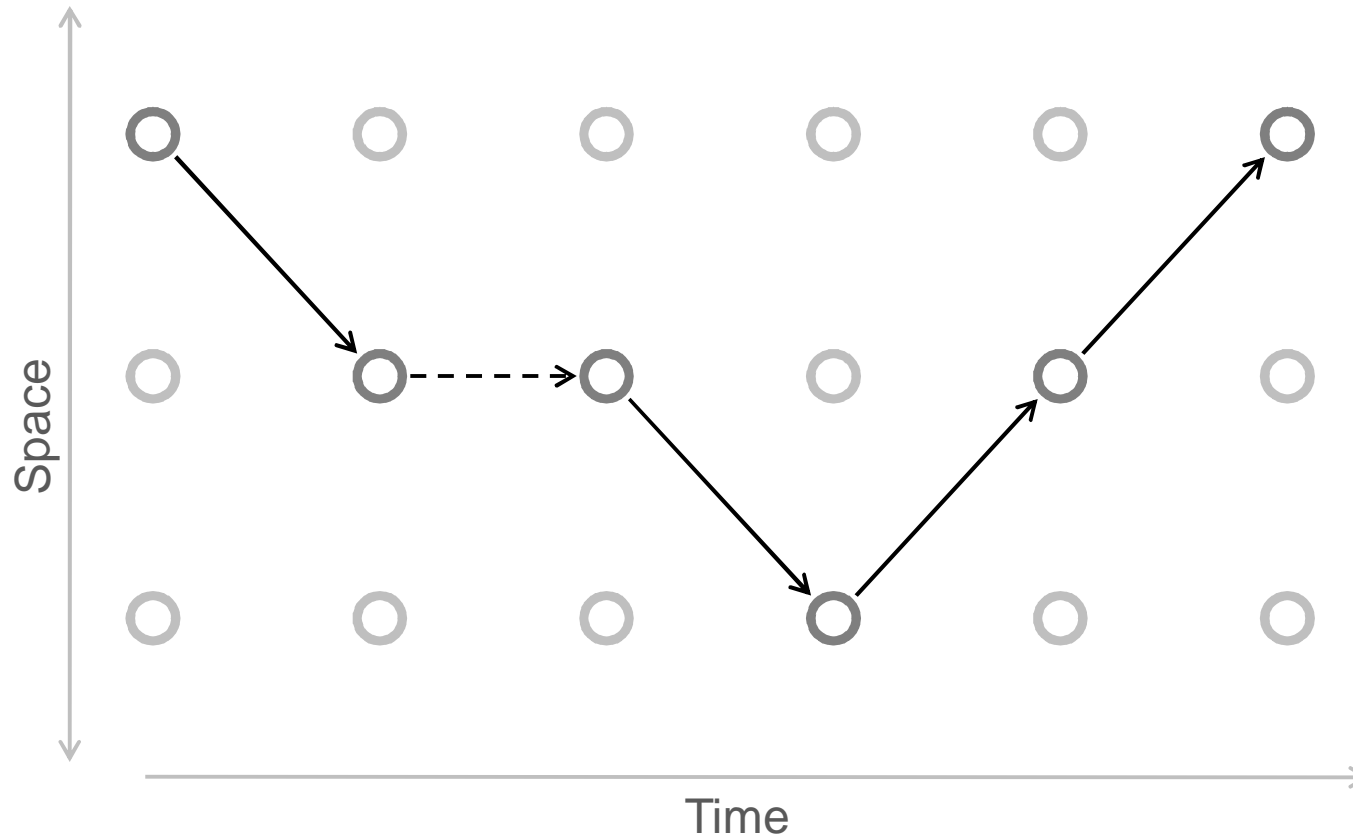
Literature review

(Research focus | Customer agreements | Literature review)

Review approach

- **Aim to** assess model development requirements
- **Focus on** customer agreements
- **Limit to** Service Network Design models
- **Include diversity of** transportation modes

Service Network Design Models



Service Network Design Models

- E.g. Model formulation

$$z(x, y) = \sum_{(i,j) \in \mathcal{A}} f_{ij} y_{ij} + \sum_{p \in \mathcal{P}} \sum_{(i,j) \in \mathcal{A}} c_{ij}^p x_{ij}^p$$

↓
Commodity flow conservation relations
Design balance constraints
Capacity restrictions

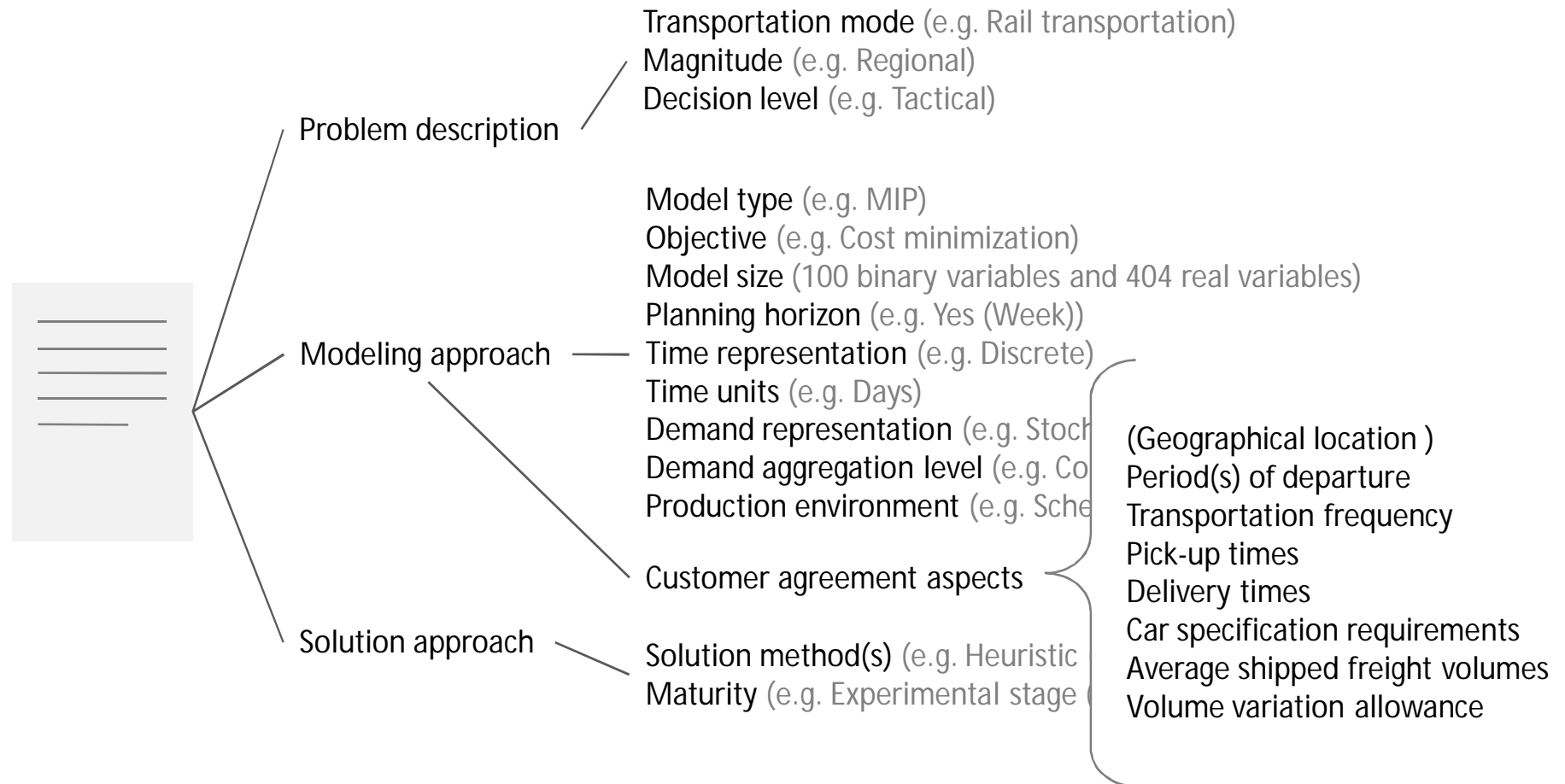
**Adopted from Pedersen, Crainic and Madsen, 2009*

Reviewed papers

<i>Author(s)</i>	<i>Publication title</i>	<i>Year</i>	<i>Type</i>	<i>Mode</i>	↓
Andersen et al.	Service Network Design with Asset Management: Formulations and Comparative Analysis	2009	SND	Generic	
Crainic and Rousseau	Multicommodity, Multimode Freight Transportation: A General Modelling and Algorithmic Framework for the Service Network Design Problem	1986	SND	Generic	
Kim et al.	Multimodal Express Package Delivery: A Service Network Design Application	1999	SND	Generic	
Lium et al.	A Study of Demand Stochasticity in Service Network Design	2009	SND	Generic	
Pedersen et al.	Models and Tabu Search Metaheuristics for Service Network Design with Asset-Balance Requirements	2009	SND	Generic	
Teypez et al.	A Decomposition Scheme for Large-scale Service Network Design with Asset management	2010	SND	Generic	
Jarrah et al.	Large-Scale Less-than-Truckload Service Network Design	2009	SND	LTL* (Road)	
Dall'Orto et al.	The Single-node Dynamic Service Scheduling and Dispatching Problem	2006	D-SND	LTL* (Road)	
Lai and Lo	Ferry Service Network Design: Optimal Fleet Size, Routing and Scheduling	2004	SND	Maritime	
Andersen and Christiansen	Designing New European Rail Freight Services	2009	SND	Rail	
Andersen et al.	Service Network Design with Management and Coordination of Multiple Fleets	2009	D-SND	Rail	

*LTL = *Less-than Truckload*

Classification framework



Classification results

- Geographical location
 - **Represented in** all (11/11) surveyed papers
 - **Modeled in terms of** OD-pair based demand and network topology
 - **Impacts model output** since costs are associated with the routing of freight and the services employed to perform operations

Classification results

- Period(s) of departure
 - **Represented in** all (11/11) surveyed papers
 - **Modeled in terms of** service employment at specific time periods during the planning horizon
 - **Impacts model output** since costs are associated with employed services and high freight flows are aligned with higher variable costs

Classification results

- Transportation frequency
 - **Represented in** all (11/11) surveyed papers either as decision variables or derived output
 - **Modeled in terms of** specific service employment during the planning horizon
 - **Impacts model output** since costs are associated with employed services

Classification results

- Pick-up times
 - **Represented in** eight (8/11) surveyed papers
 - **Modeled in terms of** time of commodity availability or earliest pick-up time (EPT)
 - **Impacts model output** since pick-up time restricts service employment possibilities

Classification results

- Delivery times
 - **Represented in** six (6/11) surveyed papers
 - **Modeled in terms of** due dates, latest delivery time (LTD) or value of time (VOT)
 - **Impacts model output** since e.g. optimal route selection and service employment not always possible and punish costs are associated with late deliveries

Classification results

- Vehicle specification
 - **Represented in** four (4/11) surveyed papers
 - **Modeled in terms of** heterogeneous vehicle fleets
 - **(Impacts model output** in terms of service employment possibilities)

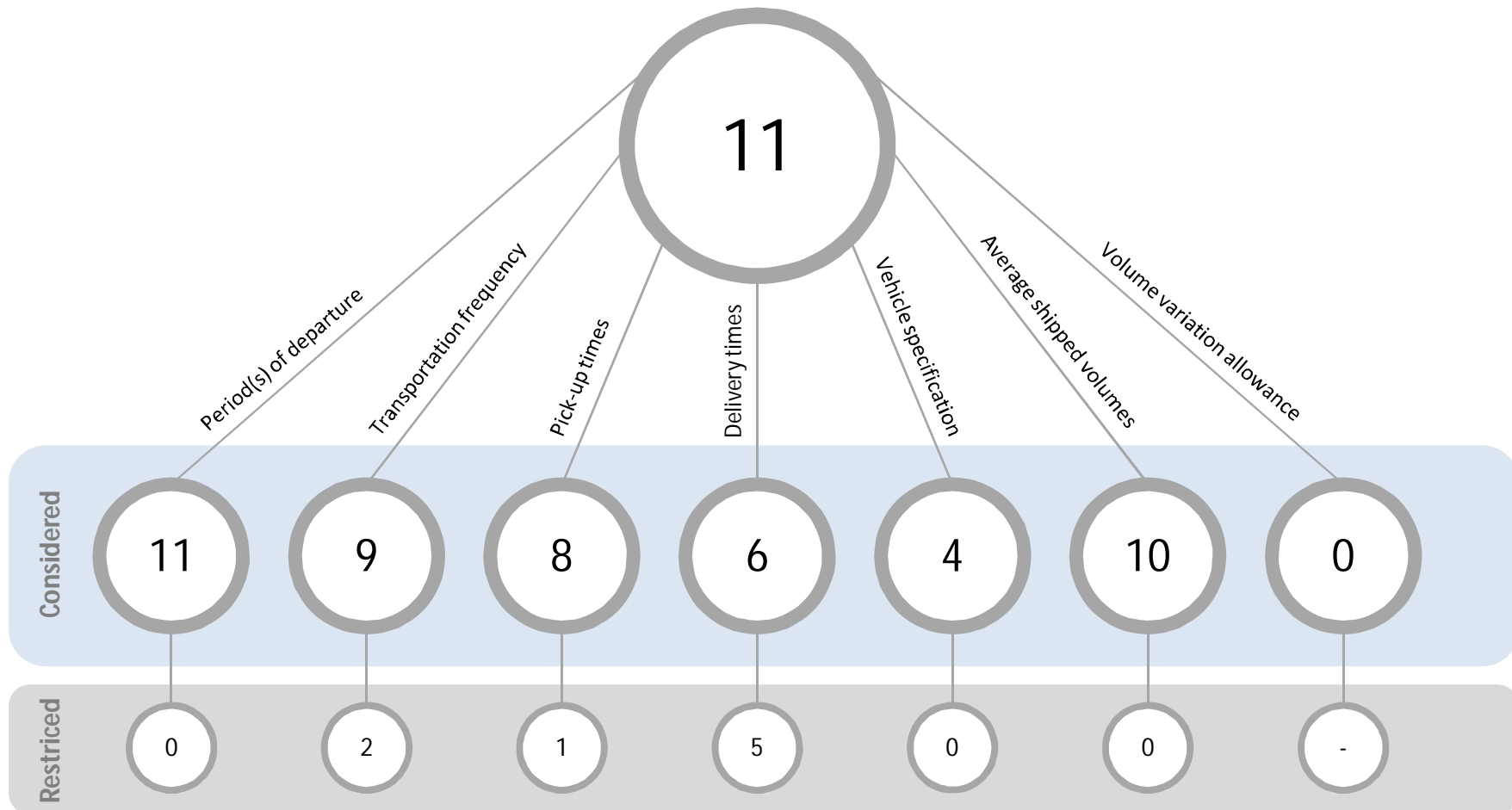
Classification results

- Average shipped freight volumes
 - **Represented in** ten (10/11) surveyed papers
 - **Modeled in terms of** freight flow on employed services (service legs)
 - **Impacts model output** since freight flow influence variable costs and revenue

Classification results

- Freight volume variation allowance
 - **Represented in** none (0/11) surveyed papers
 - **(Modeled in terms of)**
 - **(Impacts model output)**

Customer agreement classification



Intermediate conclusions

- **Wide variety** of modeling approaches
 - Motivates the classification and the need to establish a clear picture of current state-of-the-art models
- **Aspects of agreements** are well represented in Service Network Design models
 - Concludes a high model applicability for current problem and confirms the model selection

Intermediate conclusions

- Though, few agreements are modeled **explicitly as constraints**
 - Certain model development required
 - Increased complexity (already NP-hard) as more aspects and restrictions are included