Design of a robust railway line system for sever winter conditions in The Netherlands

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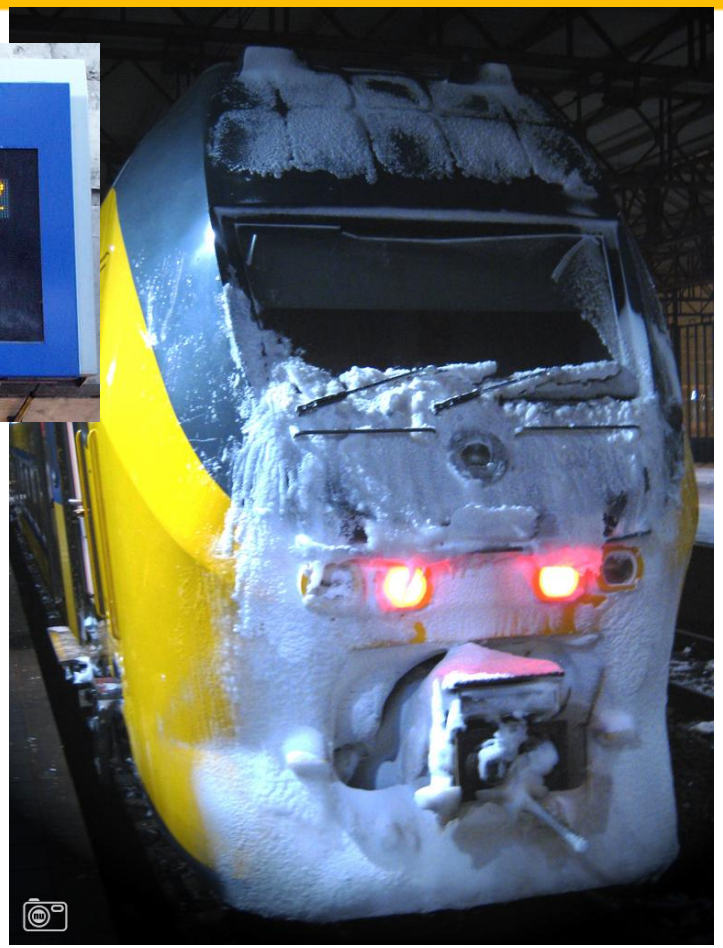
Overview

- Introduction
- Design methodology
- Case study
- Results
- Conclusions

Introduction



Introduction

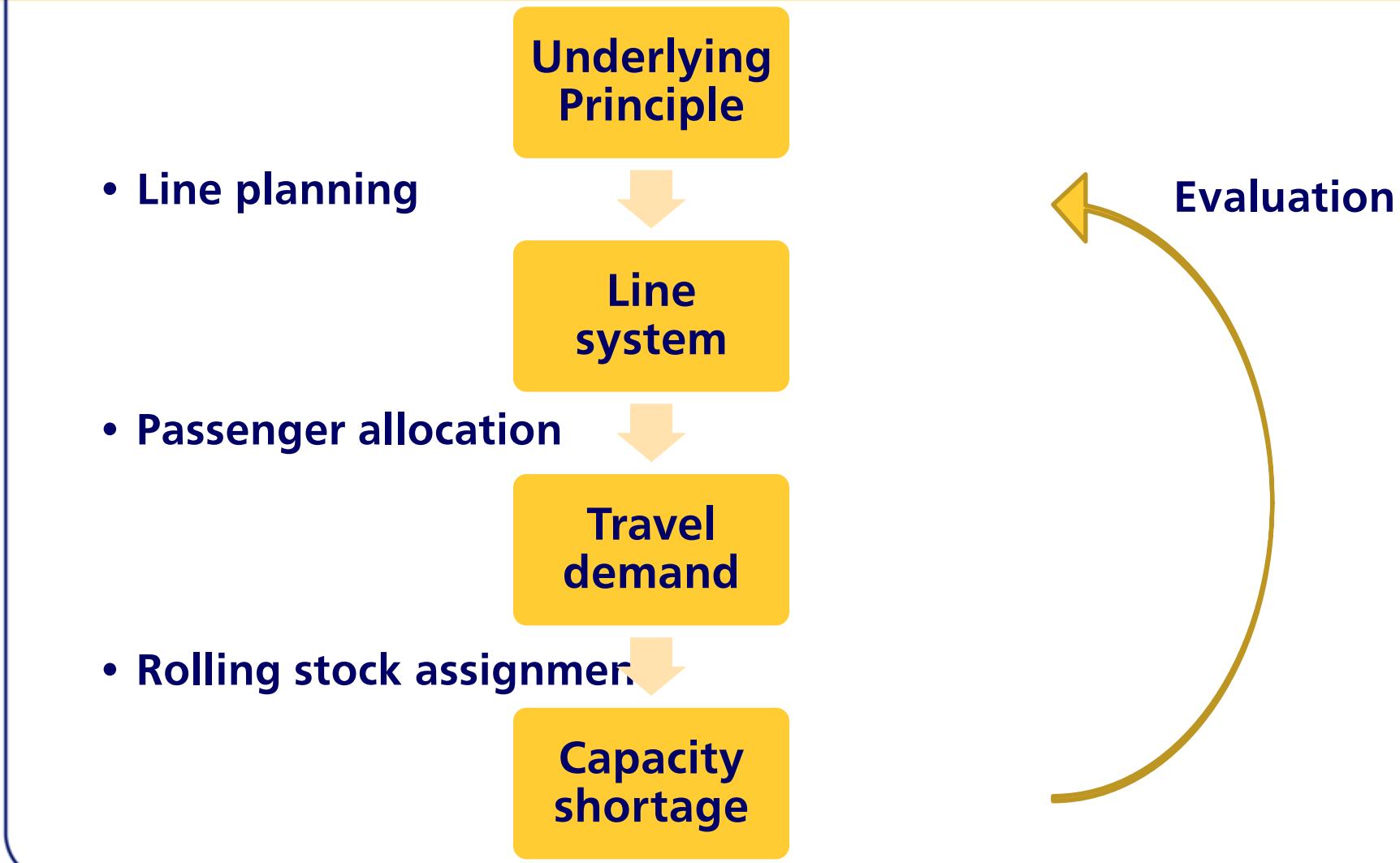
- Extreme winters in NL since 2009/2010
- Train traffic OUT-OF-CONTROL
  - Rolling stock broken down
  - Malfunctioning infrastructure
  - Snowball effect
- Measures: Comprehensive winter programme

Research objective

- Current alternative timetable (LUD)
  - Reduced timetable, based on original line system
  - Robust by cancelling trains
  - Insufficient transport capacity

- Is another line system capable to transport more passengers, while conserving robustness?

Method


Underlying Principle
• Line planning
Line system
• Passenger allocation
Travel demand
• Rolling stock assignmen
Capacity shortage
Evaluation

Design of alternative line systems

- Robust perspective
- Underlying principle
- Arbitrary or model
- Iterations to optimize the alternatives
  - Basic frequency
  - Calculate robustness and capacity shortage
  - Adapt line system

Passenger allocation

- TRANS model
- Input: Origin – Destination matrix
- Multinomial Logit (MNL) model for route choice
- Distribution over trains in time
  - Busiest hour
  - 2nd busiest hour
  - Off-peak
- Result: Passengers per train

Rolling stock assignment

- Assign compositions to trains
- Demand – capacity of composition = shortage (≥0)
- Objective: Minimize total capacity shortage
- Constraints:
  - Maximum train length
  - Fleet size

Evaluation: Robustness

- Line length → Attended stations
- Traffic intensity → Frequency & line density
- Control region attendance → Trains / region / hour
- Disruption risk → Operation of HS switches

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- Weighted sum yields *robustness index*

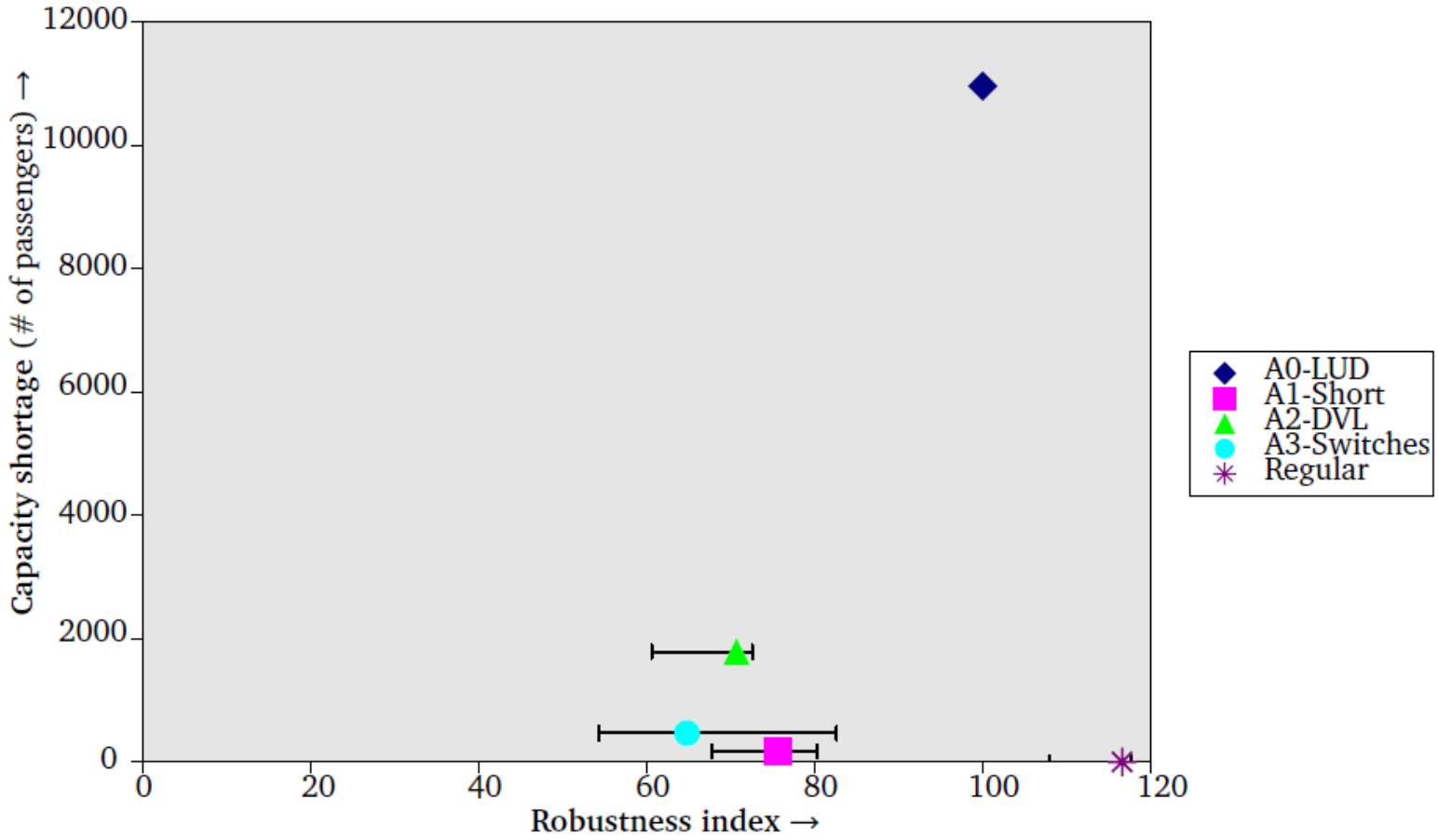
  A lower value is better

Case study: Dutch railway network

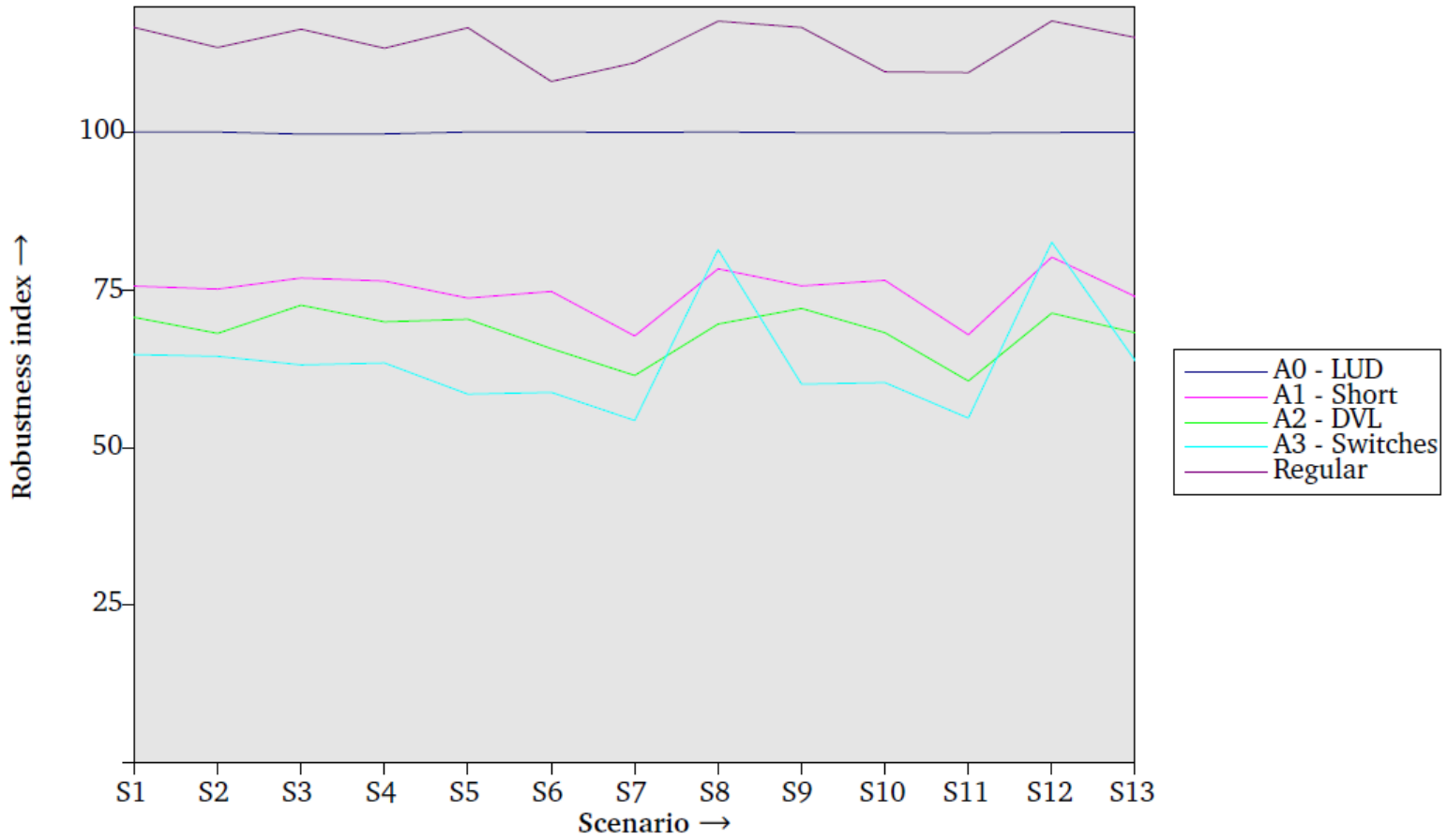
- A0: LUD
- A1: Short lines
- A2: DVL-based lines
- A3: Evading High-Speed switches

- Evaluating alternatives
  - Robustness index
  - Capacity shortage
  - >> Adapting the line system if possible
- Secondary ‘commercial’ evaluation

Robustness index vs. Transport capacity

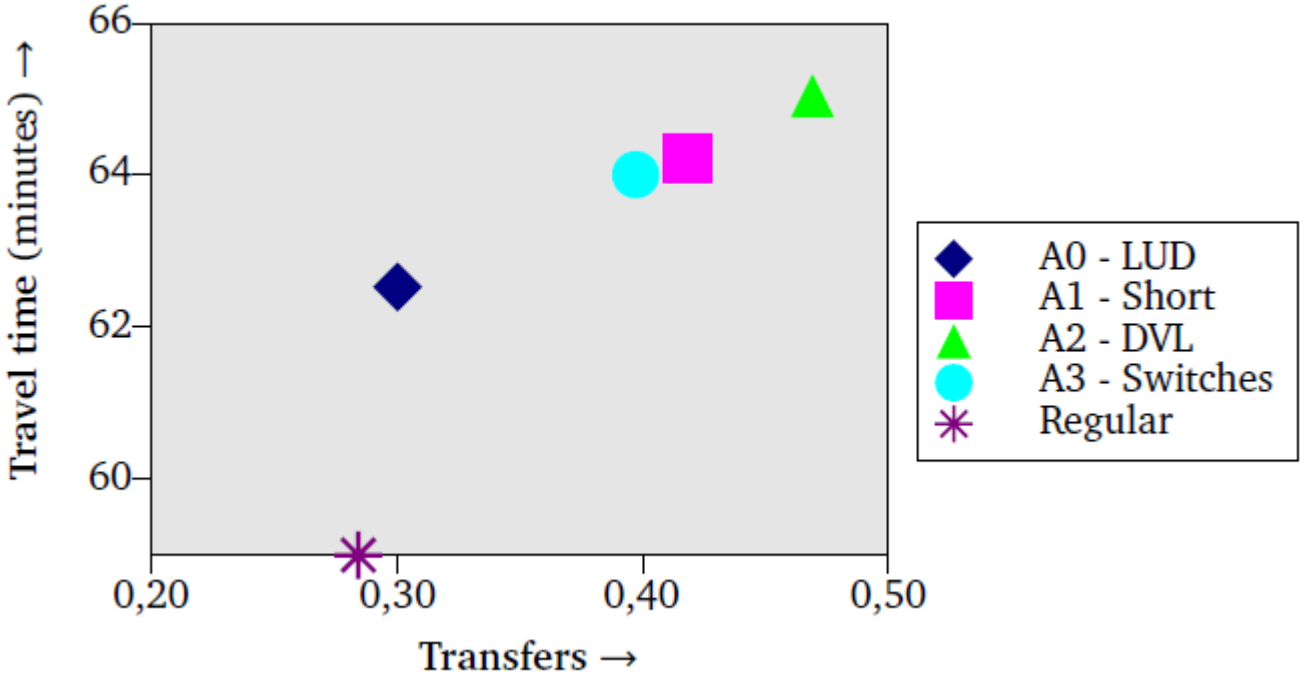


Sensitivity Analysis



Evaluation of commercial effects

- Increased number of transfers
- Increased travel time



- Intensive use of infrastructure at terminal stations

Conclusions

- Based on the line system, robustness and transport capacity can be roughly estimated
- Enlarging trains in LUD not sufficient
- All alternatives are more robust
- All alternatives yield more transport capacity
  - Frequency = 2 satisfies most axes
  - Frequency = 3 on busy axes

Thank you for your attention!
Are there any questions?