Assessment of Commuter Train Timetables Including Transfers

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Outline

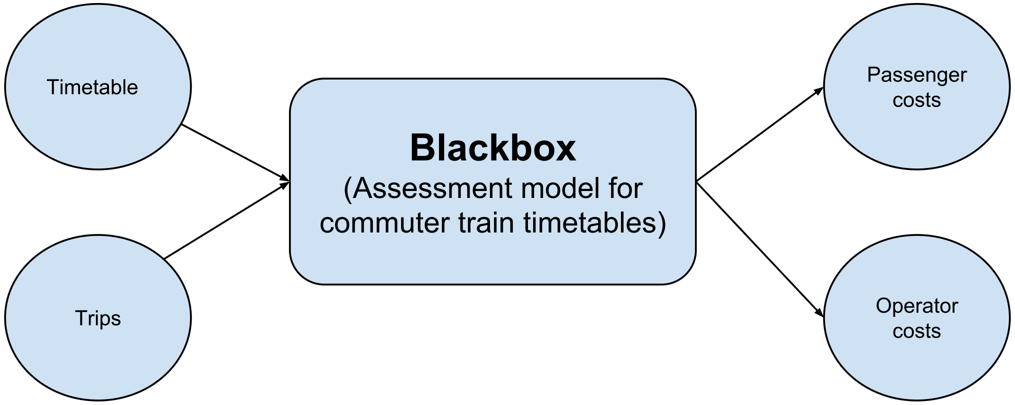
- Introduction
- Literature Review
- Methodology
- Case Study
- Results
- Conclusions
- Future Work

Introduction – The Problem?

- Inefficient use of railway capacity for commuter services
  - ➔ Long travel, waiting and transfer times.
  - ➔ Crowded trains
  - ➔ High operation costs.

Introduction – A Solution!

- Need for models to evaluate this “efficiency”
  - Socio-economic impact
    - Travel time (including crowding).
    - Waiting and transfer times.
    - Operation costs



Literature Review - Methods

- Kunimatsu et al. (2012)
  - Microsimulation of passenger flow
  - Passenger specific costs (i.e. disutility)

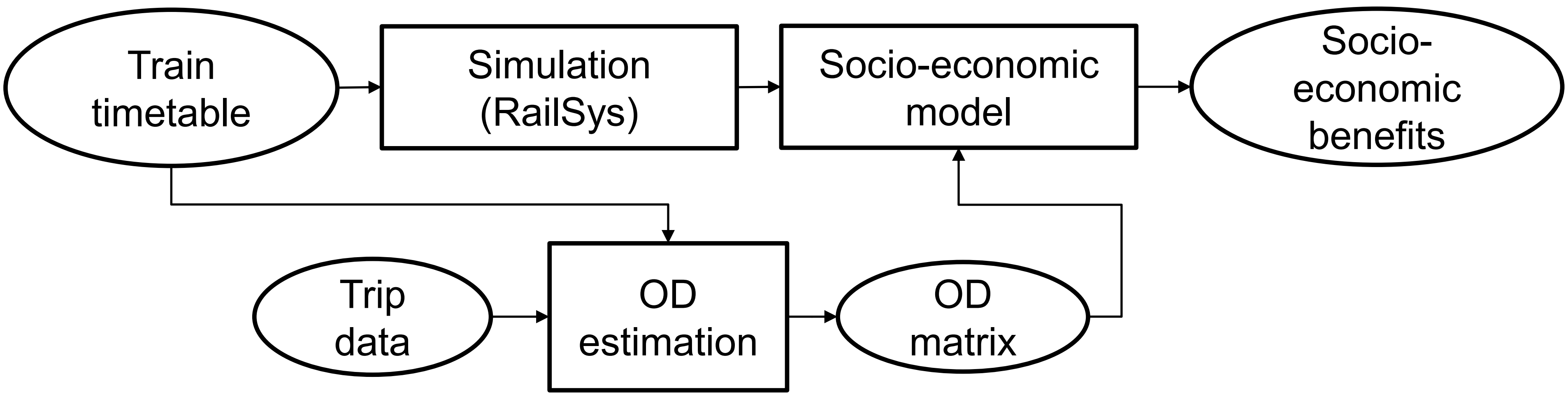
- Finger et al. (2014)
  - Integrated regular interval timetables (IRIT).
  - Reduce transfer costs.

Literature Review - Tools

- Wardman et al. (2004).
  - Use of stated preference (SP) data
  - Estimation of timetable effects (e.g. value of time).
- Radtke and Bendfeldt (2001)
  - Railsys software
  - Train timetable management and simulation
- Bangman (2016) and SLL (2017)
  - Swedish guidelines for cost-benefit analysis
  - Recommendations for local commuter services

Methodology – Reference

- Background model, see. Ait Ali et al. (2017)
  - Concept-model description
  - Evaluation of socio-economic benefits
  - Example on commuter line (without transfer).



Methodology – Direct trips

- Passenger flow in link segments

$$f^k(i) = f^k(i-1) + \sum_{st \in SV(i,k)} n^k(i, st) - \sum_{st \in SD(i,k)} n^k(st, i),$$

will be served by train k after station i

served stations before reaching station i.

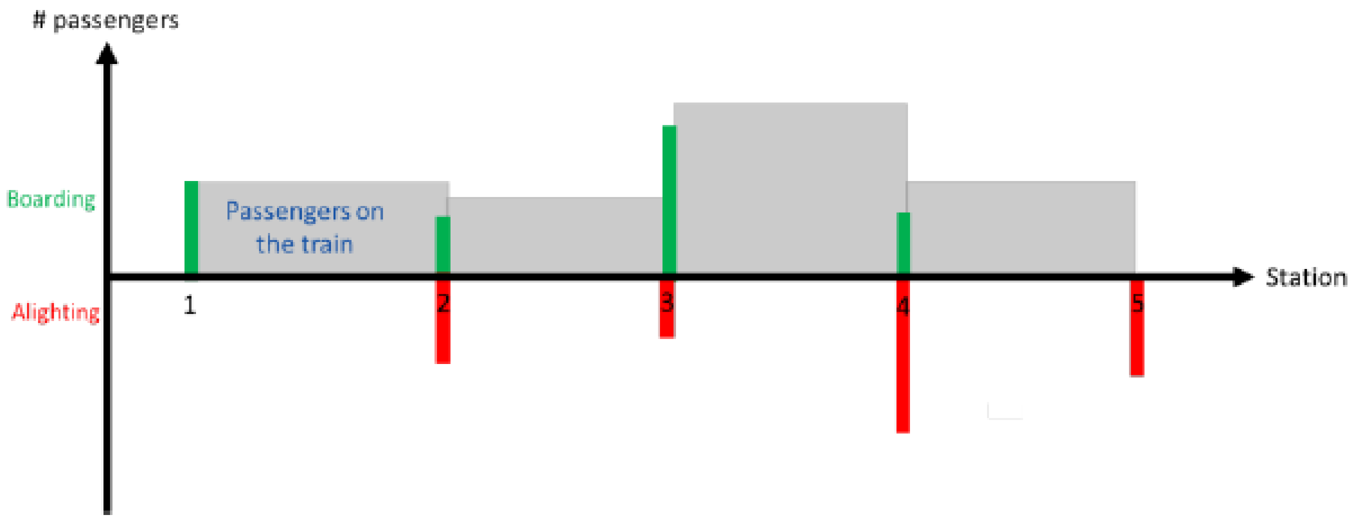


Fig. 1. Illustration of passenger flow per link segment between stations

Methodology – Transfer trips

- Assumptions
  - Transfer ASAP (i.e. exit at first transfer station)
  - Max 1 transfer (e.g. X-form networks)

- Implementation
  - Transfer = 1st leg (direct) + 2nd leg (direct)
  - Passenger flow iterations
    - Iteration 1 -> direct trips + 1st leg transfer trips
    - Iteration 2 -> (+) 2nd leg transfer trips

Methodology – Timetable assessment

- Valuations recommendation
  - Bangman (2016) and SLL (2017).

- Total socio-economic cost $C^{tot} = C^{con} + C^{pro}$
  - Consumer costs (i.e. passengers)
    - Travel time (include crowding)
    - Waiting time (i.e. initial station)
    - Transfer time
  - Producer costs (i.e. operator(s))
    - Distance, time-dep costs
    - Rolling-stock, overhead costs.

Case Study – OD and network

- Dynamic OD
    - Week day in 2016
    - Counts every 15min time interval
- Commuter network in The Greater Stockholm area

Fig. 2. Schematic sketch of the network in the case study

Case Study – Timetable

- Commuter train timetable of a weekday in 2016
- Line 35 and 36.

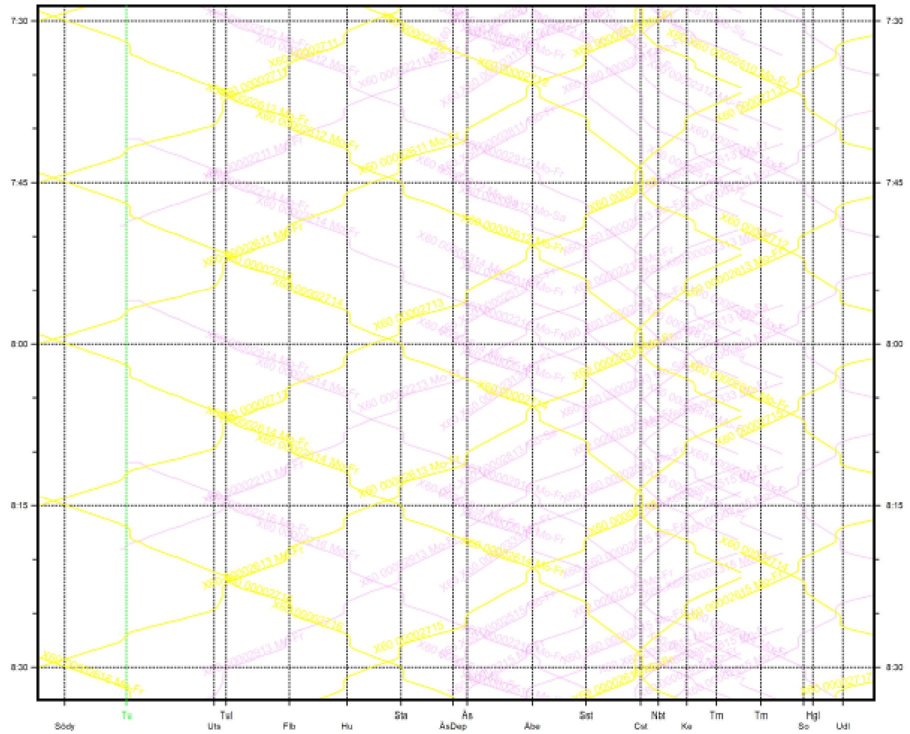


Fig. 3. Extract of the graphical timetable with regular services line 36 in yellow and extra services and others in pink

Results A0 – Passengers on-board

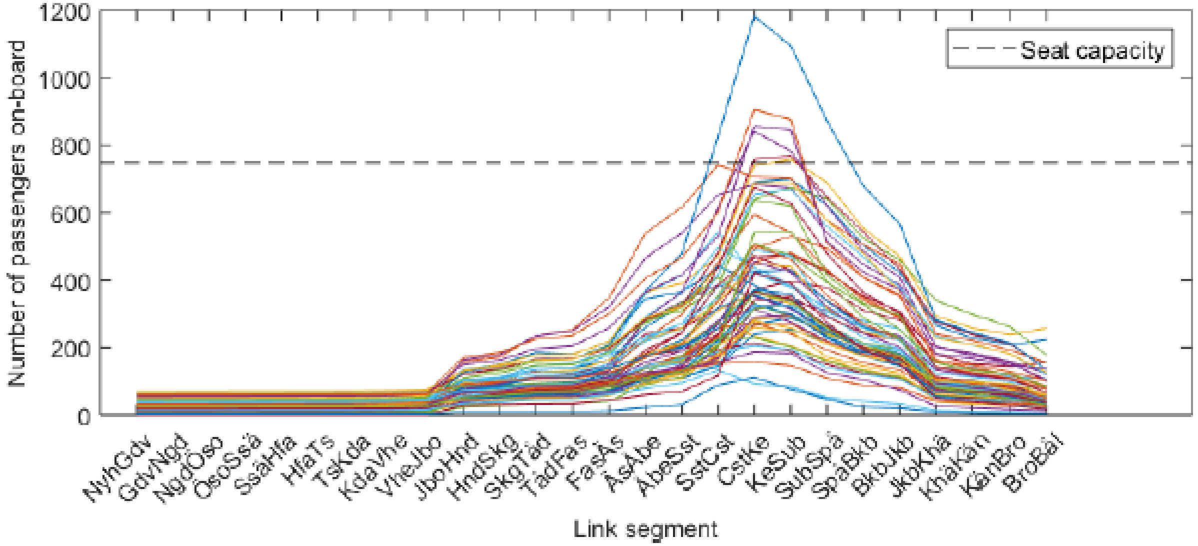


Fig. 4. Number of passengers on-board some of the trains on running in line 35 with train seat capacity

Results A1 – Departure times

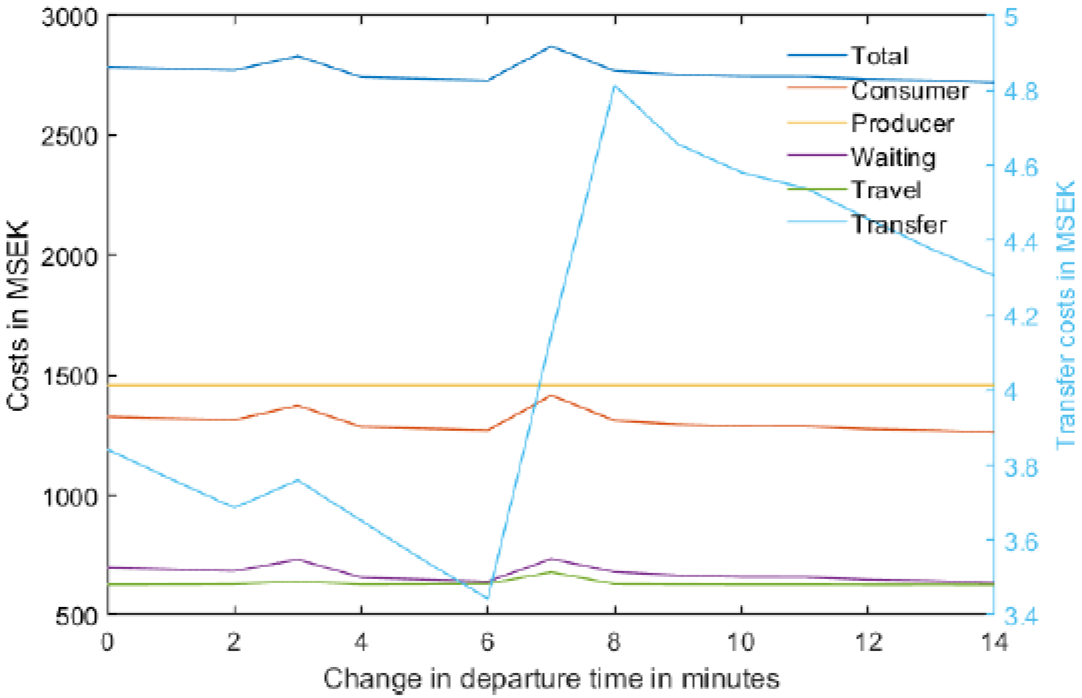


Fig. 5. Socio-economic assessment of changing departure times for all trains from *Märsta* to *Södertälje* on line 36

Results A2 – Departure cancellation (conflicts)

Table 1. Comparison between socio-economic costs for cancelling round trips under different periods of the day

	Total	Producer	Consumer	Waiting	Travel	Transfer
Original (absolute costs in MSEK)	8,70	4,55	4,15	2,28	1,96	0,012
Morning - absolute costs in MSEK	8,69	4,54	4,15	2,18	1,96	0,011
(relative costs in %)	*(-0,1)*	*(-0,3)*	*(+0,1)*			
Lunch - absolute costs in MSEK	8,74	4,54	4,20	2,23	1,96	0,011
(relative costs in %)	*(+0,4)*	*(-0,3)*	*(+1,2)*			
Afternoon - absolute costs in MSEK	8,82	4,54	4,28	2,30	1,96	0,011
(relative costs in %)	*(+1,3)*	*(-0,3)*	*(+3,1)*			

Conclusions

- Passenger flow (Results A0)
  - Explain and predict the crowding in the trains
  - Visualization of train slots (with passenger in focus)
- Departure times (Results A1)
  - Timetable planning (with transfer in focus)
  - Control transfer costs
- Departure cancellation (Results A2)
  - Higher/lower frequency.
  - Price train slots.

Future Work

- Applications
  - Price railway capacity slots (for commercial sales).
  - Skip-stop timetable planning.
- Extensions
  - Include data on socio-economic groups
  - Determine winning/losing groups (who? How much?)
- Studies
  - Railway capacity analysis and simulation.
  - Include in a timetable optimisation model.

Thank you for your attention!

Questions?

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