Passenger-oriented traffic control for rail networks:

considering crowding effects on passenger choices and train operations

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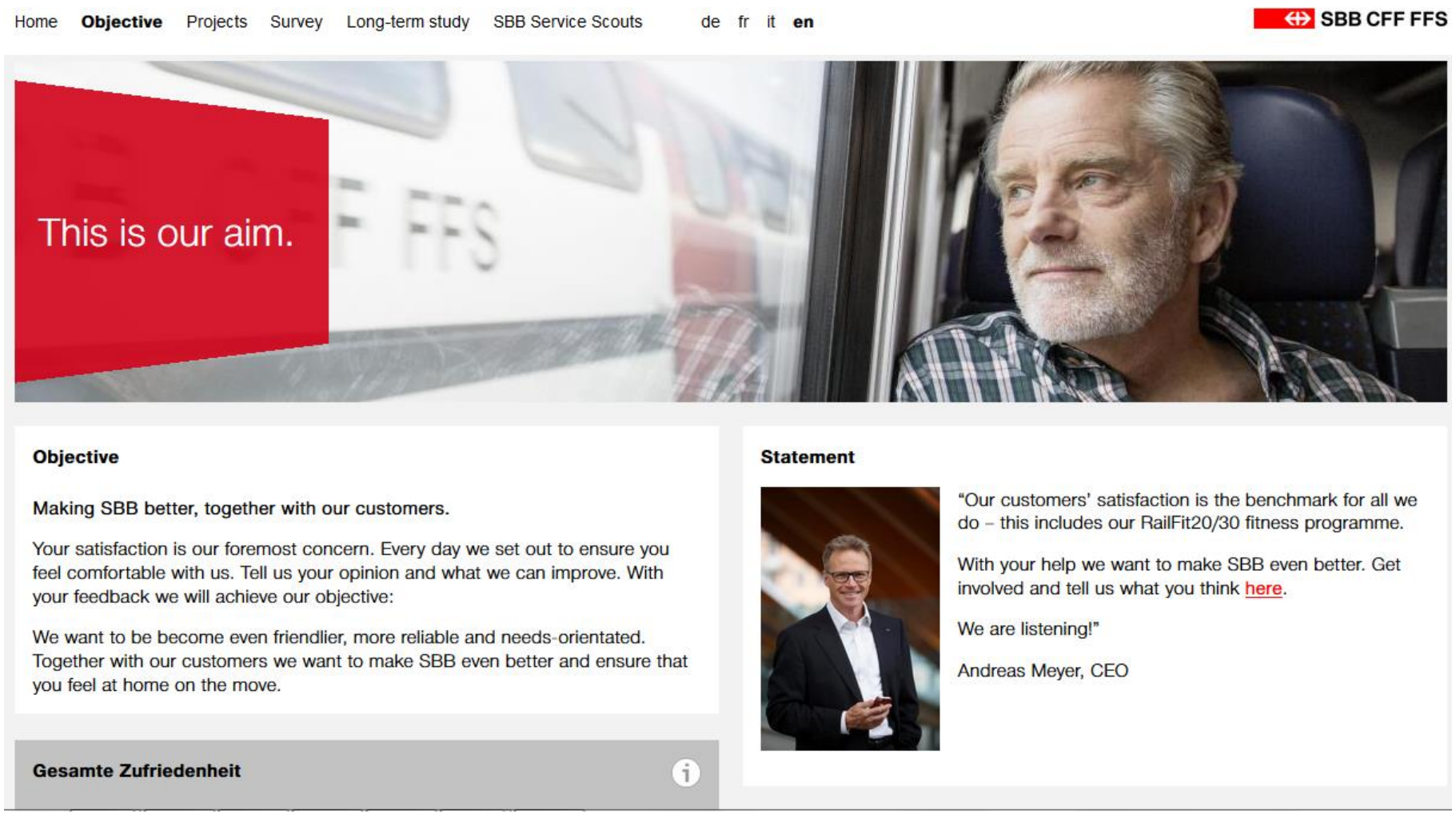
INFORMS 2020

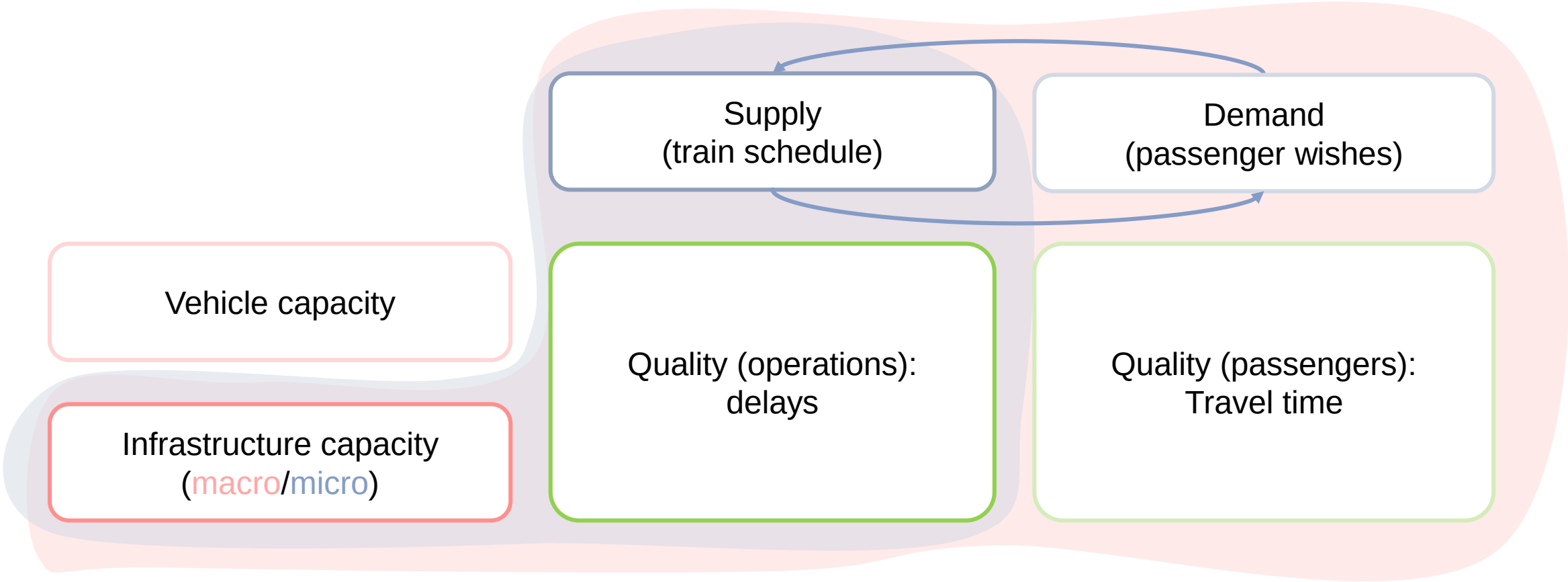
Outline

- Introduction
- Problem statement
- Model formulation
- Case study
- Conclusions and future work

Introduction



Introduction



Vehicle capacity & crowding effects

- Assume to be sufficient
  - Passengers of a group follow exactly *one and the same* route, no split
- The fact:
  - Limited physical space in trains
  - Crowding issues:

    affect passenger choices

    affect train operations

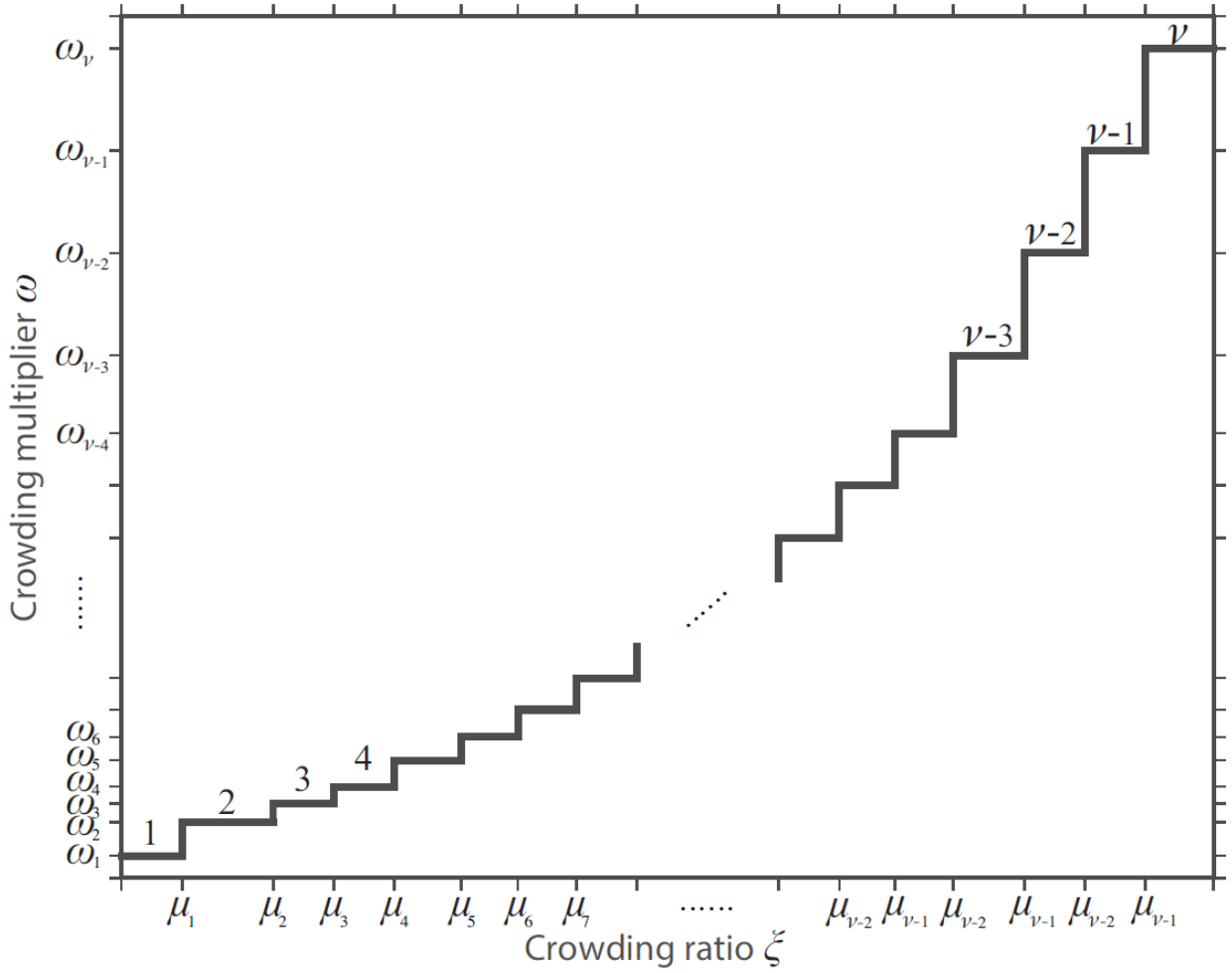
Problem statement

- Rescheduling trains and rerouting passengers
- Decisions to be optimized:
  - train orders and departure and arrival times
  - passenger choices on their itineraries
- Goal:
  - Find the system optimum

Model formulation

- Assumption
  - Rational passenger choices
  - Good information
- Objective: min weighted sum of
  - *passenger disutility*: passenger delay, travel time, additional travel time, stranded passenger
  - *train delay*
- Constraints:
  - train operation (micro)
  - passenger transition (macro)
- Variables:
  - train departure and arrival times, dwell time
  - passenger itinerary selection

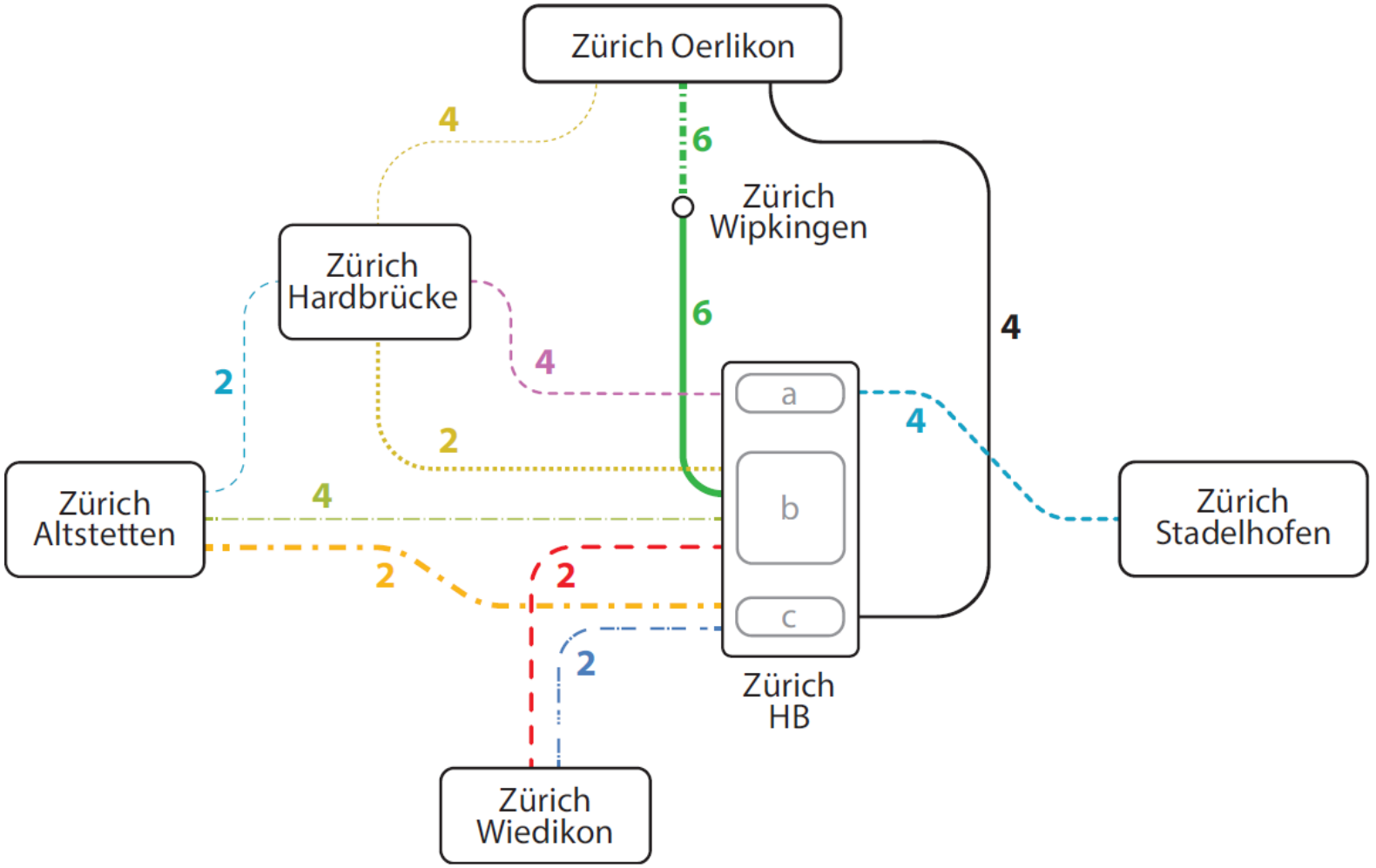
Model formulation



exact method

transformation properties

Case study


Zürich Oerlikon
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Zürich Stadelhofen
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Zürich HB
Zürich Wiedikon

Case study

- Computation configuration:
  - Config_1: no crowding effects
  - Config_2: crowding effect on passenger choices
  - Config_3: crowding effects on passengers and train traffic, no delay, allow stranded passengers
  - Config_4: crowding effects on passengers and train traffic, allow delays, no stranded passenger
  - Config_5: crowding effects on passengers and train traffic, allow delays and stranded passengers

Case study

	Train delay (s)	Prolongation of train dwell time (s)	Total passenger disutility	Passenger delay + travel time + penalty due to stranded passengers	Additional passenger travel time (crowding)
Config_1 (excl.)	0	142.88	499932	499932	-
Config_1 (incl.)	0	142.88	553238	499932	53306
Config_2	0	126.19	538962	506696	32266
Config_3	0	0	1061200	1039444	21756
Config_4	537	65.44	529902	506258	23107
Config_5	377	65.81	532257	507840	24041

increase

Case study

	Train delay (s)	Prolongation of train dwell time (s)	Total passenger disutility	Passenger delay + travel time + penalty due to stranded passengers	Additional passenger travel time (crowding)
Config_1 (excl.)	0	142.88	499932	499932	-
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Config_3	0	0	1061200	1039444	21756
Config_4	537	65.44	529902	506258	23107
Config_5	377	65.81	532257	507840	24041

decrease

increase

decrease

Case study

	Train delay (s)	Prolongation of train dwell time (s)	Total passenger disutility	Passenger delay + travel time + penalty due to stranded passengers	Additional passenger travel time (crowding)
Config_1 (excl.)	0	142.88	499932	499932	-
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decrease

Conclusions

- Improvement on the overall system performance by rerouting some passengers onto alternative routes
- If train dwell time is highly sensitive to the alighting and boarding passengers, the transport network will become vulnerable and less reliable
- Flexibility in the train decisions helps in providing better services to passengers

Future research

- Solution approaches, decomposition and distributed approaches
- Passenger behavior model
- Social rerouting of passengers

Thank you for your attention!