Learning from smart cards: Lessons from Singapore

Presentation

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Learning from smart cards: Lessons from Singapore

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Acknowledgments

Module 8 of FCL, Singapore, but especially:

- A Erath
- P Fourie,
- S Ordonez
- L Sun

Starting point

Current options summarized

Variable	Diary	GPS (logger or mobile) (no prompted recall)	GSM traces
$/reported day	High	High-medium	Very low
Duration	1 day (- 6 weeks)	1 day (- 6 weeks)	1 day (Unlimited)
Stage	Yes, underreported	(Yes)	No
Trip	Yes, underreported	Yes	(Yes)
Journey	Yes	Yes	(Yes)
Time	Rounded	Exact	Imputed
Location	Rounded	Exact	Imputed
Mode	Yes	Imputed	Imputed
Purpose	Yes	Imputed	Imputed
Group composition	Yes	No	No
Expenditure	Yes	**No**	**No**

What do smart cards add?

Variable	Smart cards	Comments	
$/reported day	Very low		
Duration	Unlimited	but for their churn	
Stage	Yes	but transit only	
Trip	(Yes)	but for long walks or longer activities	
Journey	No	unless one makes strong assumptions	
Time	Yes		
Location	Yes	but not the true origin of the trip	
Mode	Yes	but transit only	
Purpose	Imputed		
Group composition	Yes	if everybody uses smart cards	
Expenditure	(Transport only)		

Singapore context

Singapore context

Objective:

- Build an agent-based model of Singapore using MATSim
- Extend the capabilities of MATSim

Data available

- National travel diary (HITS)
- EZ-link/Cepas, national smart card (transit, tolls, other services)
- Usual network data
- Usual operational data

CEPAS data for public transport

System:

- Tap in/tap out
- Covering 98% of all stages, even if they are free of charge

Issues:

- Late tap-in/Early tap-out
- Precision of on-board GPS units
- Time between tap in/out and boarding/egress from MRT trains

MATSim

MATSim

Software:

- Open source and well documented
- About 80+ person years development effort
- JAVA

Approach:

- SUE of the activity schedules of the agent (networks)
- Co-evolutionary search
- User chosen facets: duration, start time, route, mode, location, parking, number/sequence of activities

MATSim applications around the world

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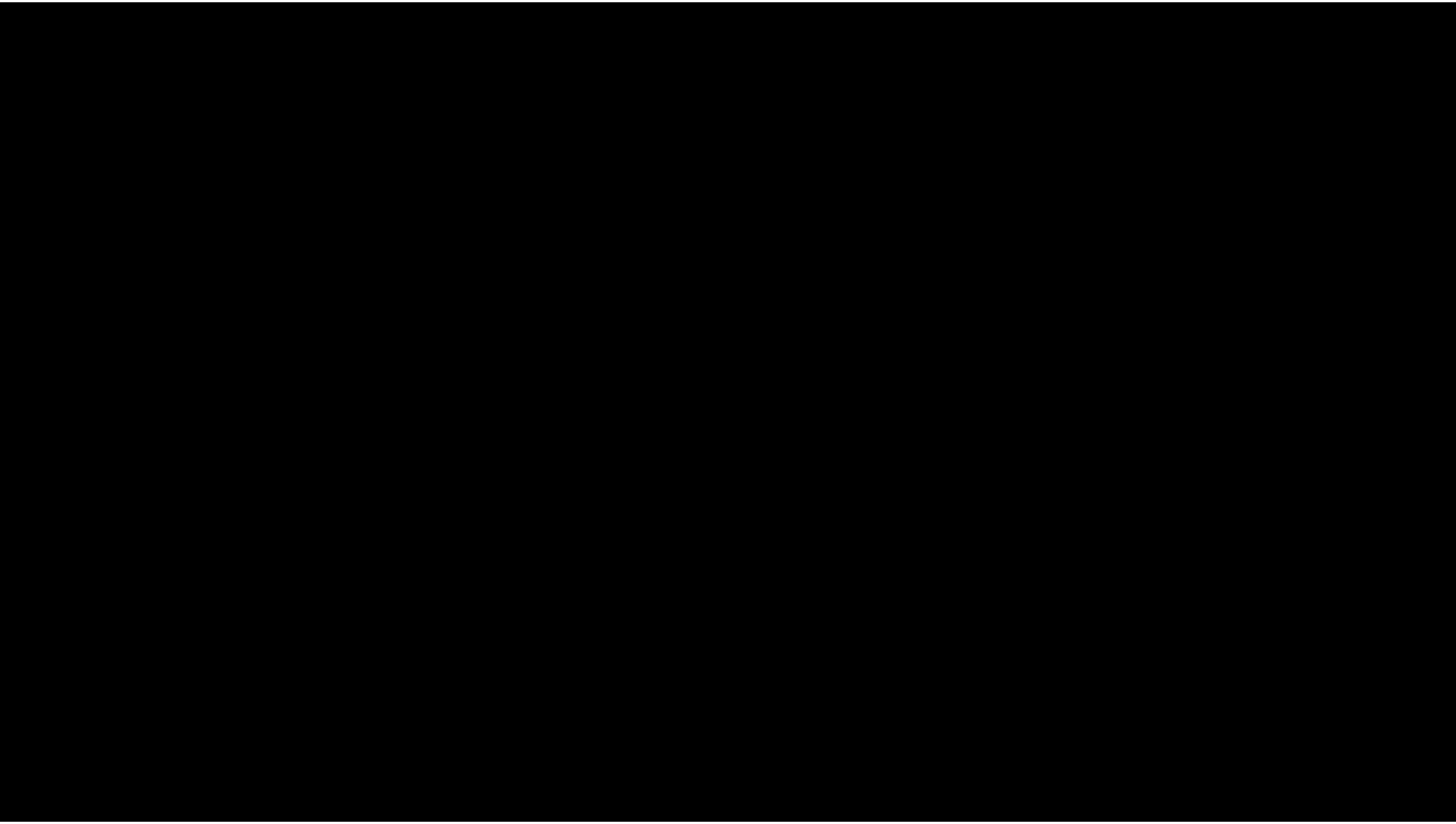
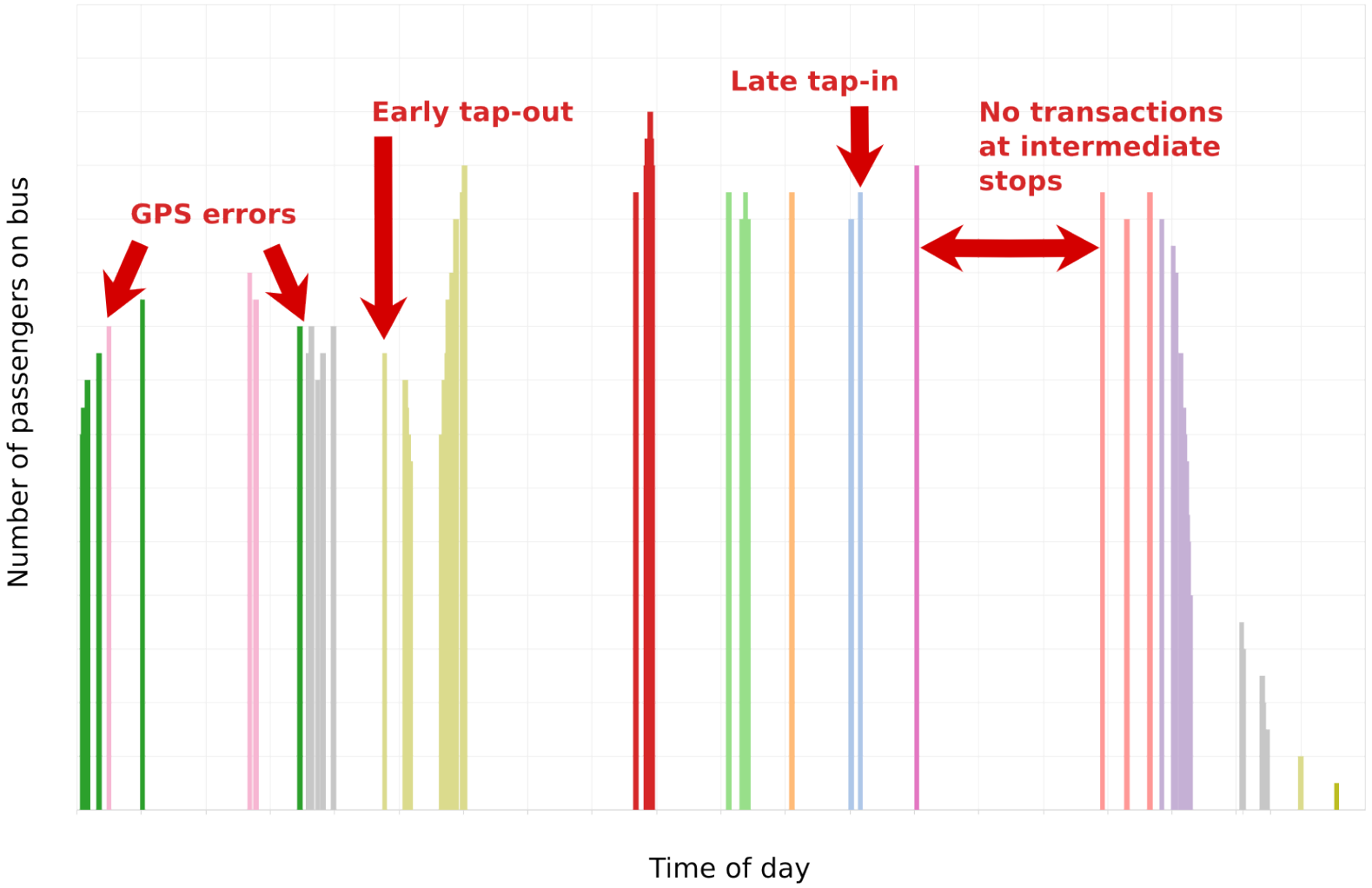
MATSim Singapur



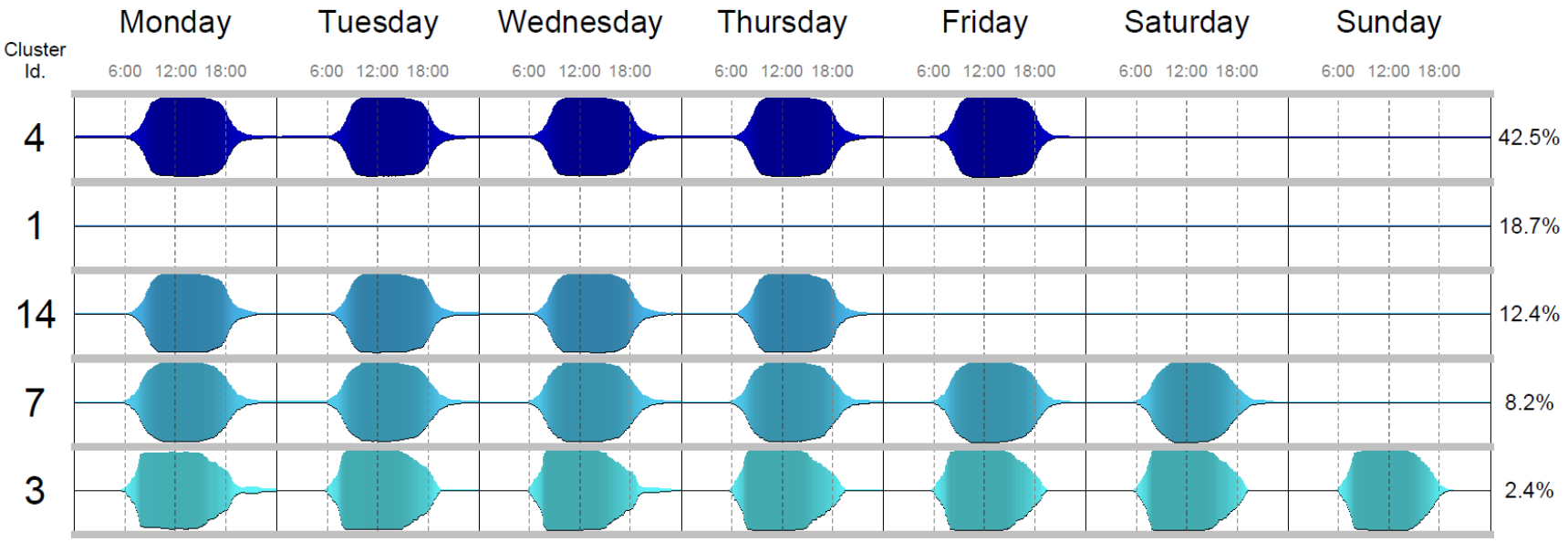
Challenge of using smart card data

Cleaning it



Source: Fourie (2016).

Clustering weekly work patterns

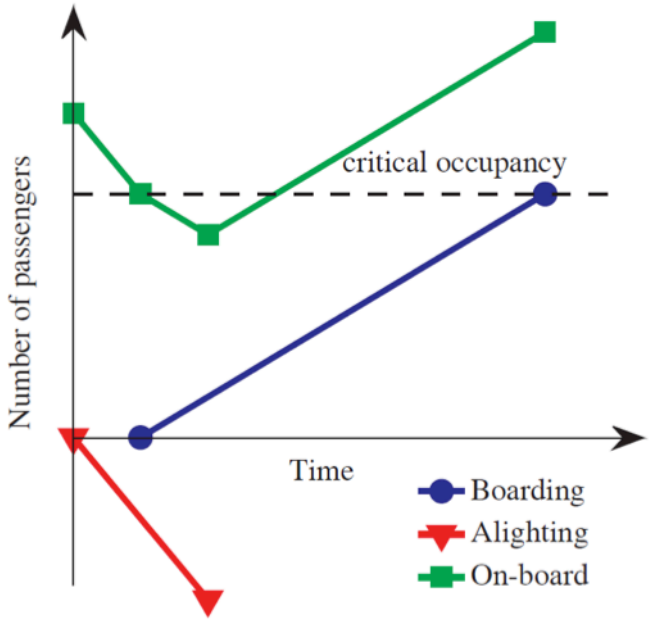


DBScan based on purpose imputation which integrates HITS data and location

Source: Ordóñez Medina, S. A. (2016b)

Dwell time model

Boarding and alighting process



Results of statistical model

Critical occupancy at 63% of total capacity.

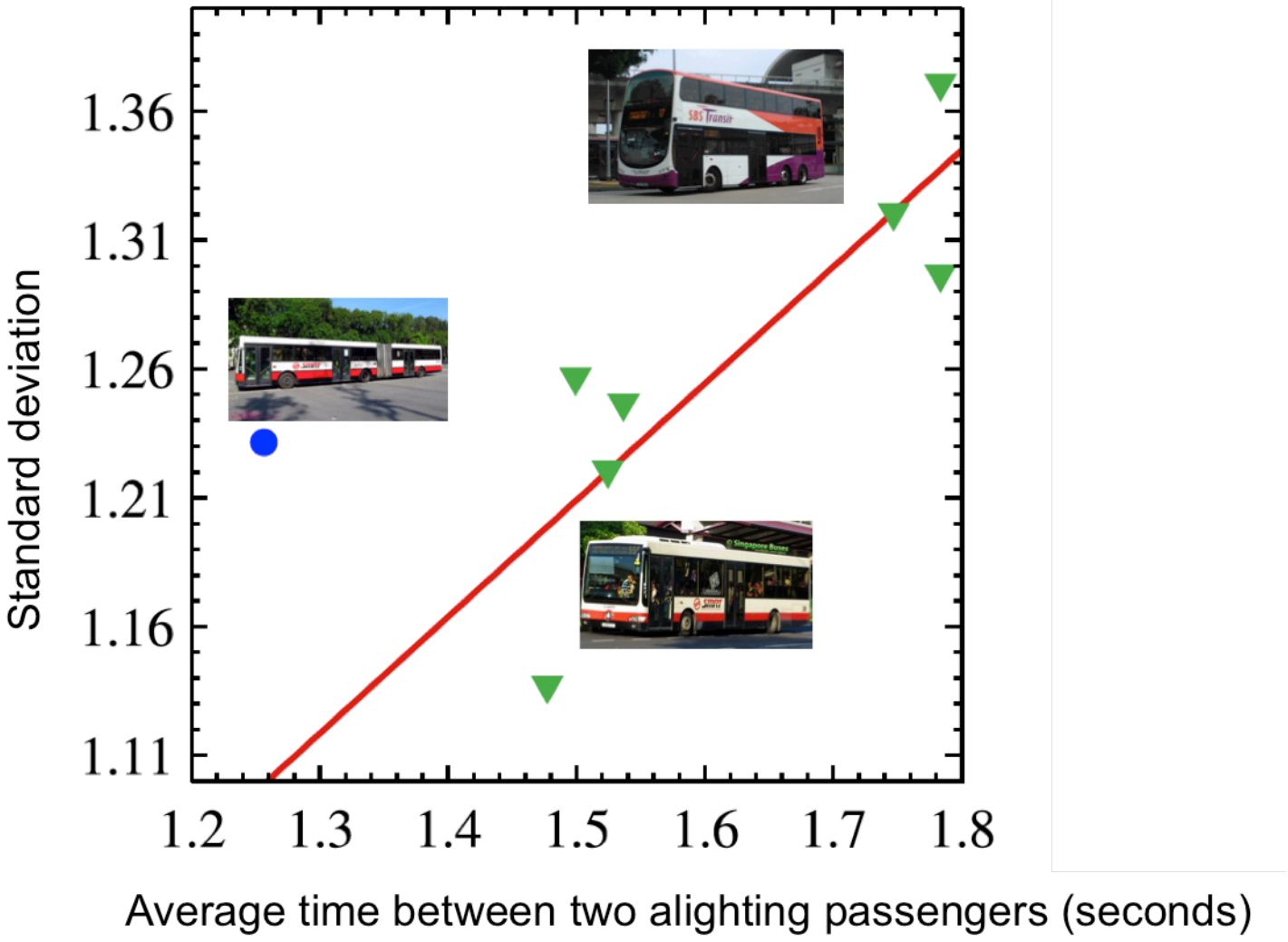
Low floor allows short dwell processes.

Double decker alighting time per pax 0.285 seconds longer.

With higher occupancy and number of boarding and alighting passenger -> shorter activity time

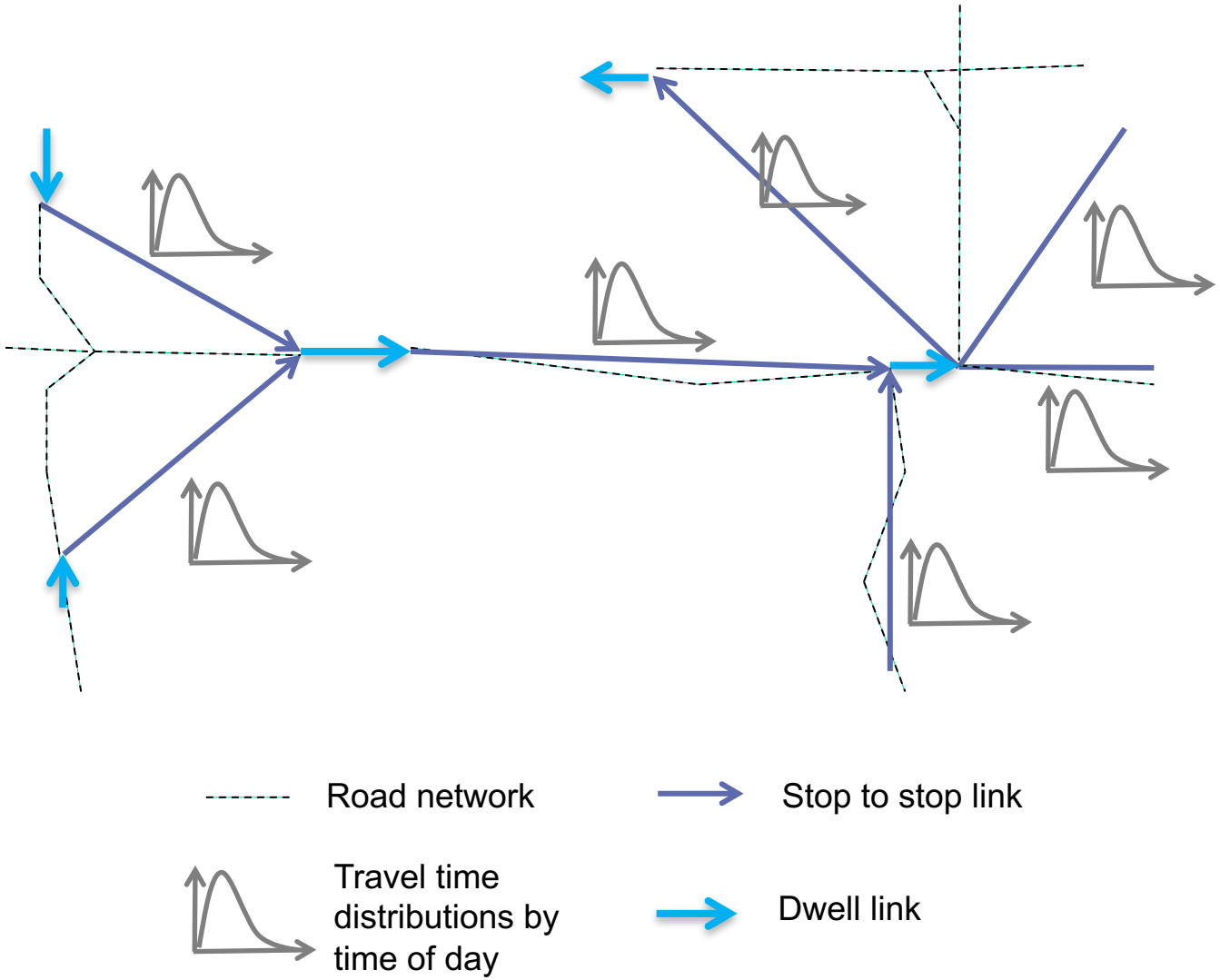
Source: Sun, Tirachini,. Axhausen, Erath and Lee (2014).

Heteroscedasticity of dwell times



Source: Sun, Tirachini,. Axhausen, Erath and Lee (2014).

Accounting for travel time and its variability



Modelling stop to stop travel times

Spatial regression of travel times/speeds

Static variables

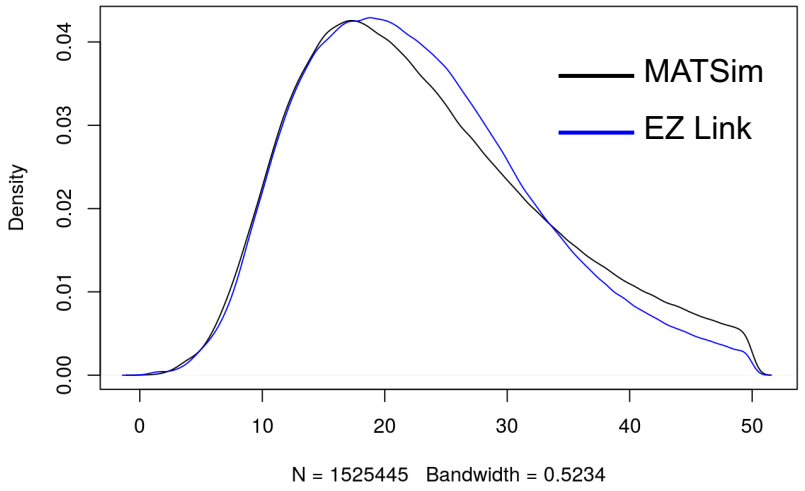
- Availability of bus lane
- Number of intersections
- Number of left/right turns
- Curviness
- Deviation from crowfly distance
- Number of traffic lights
- Intersection density

Time-dependent variables

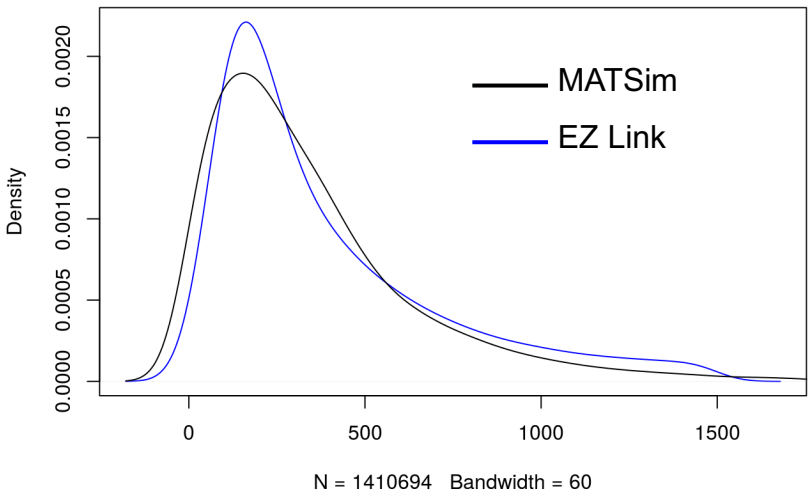
- Boarding/alighting activites in 500m radius

Validation

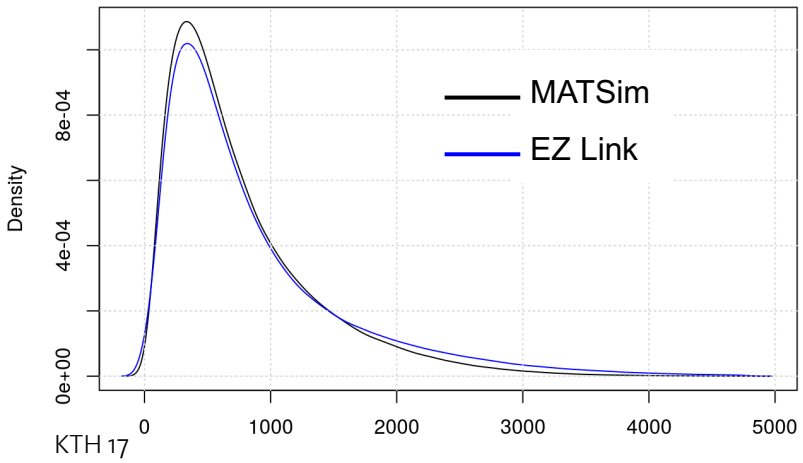
Bus speed



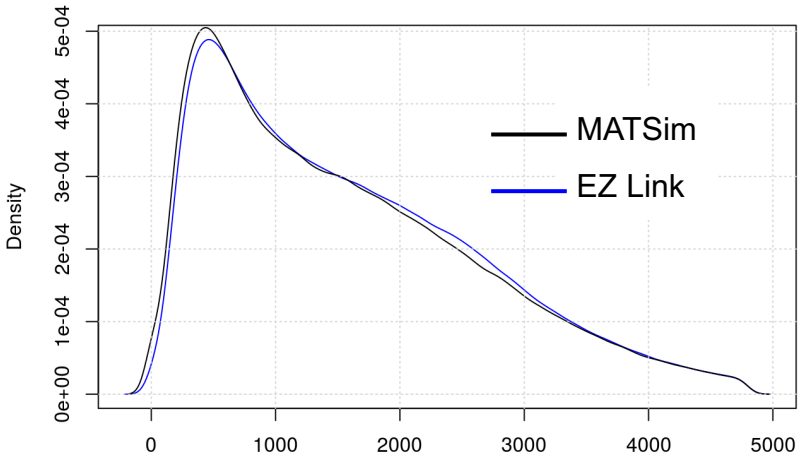
Transfer times



Trip duration (Bus)



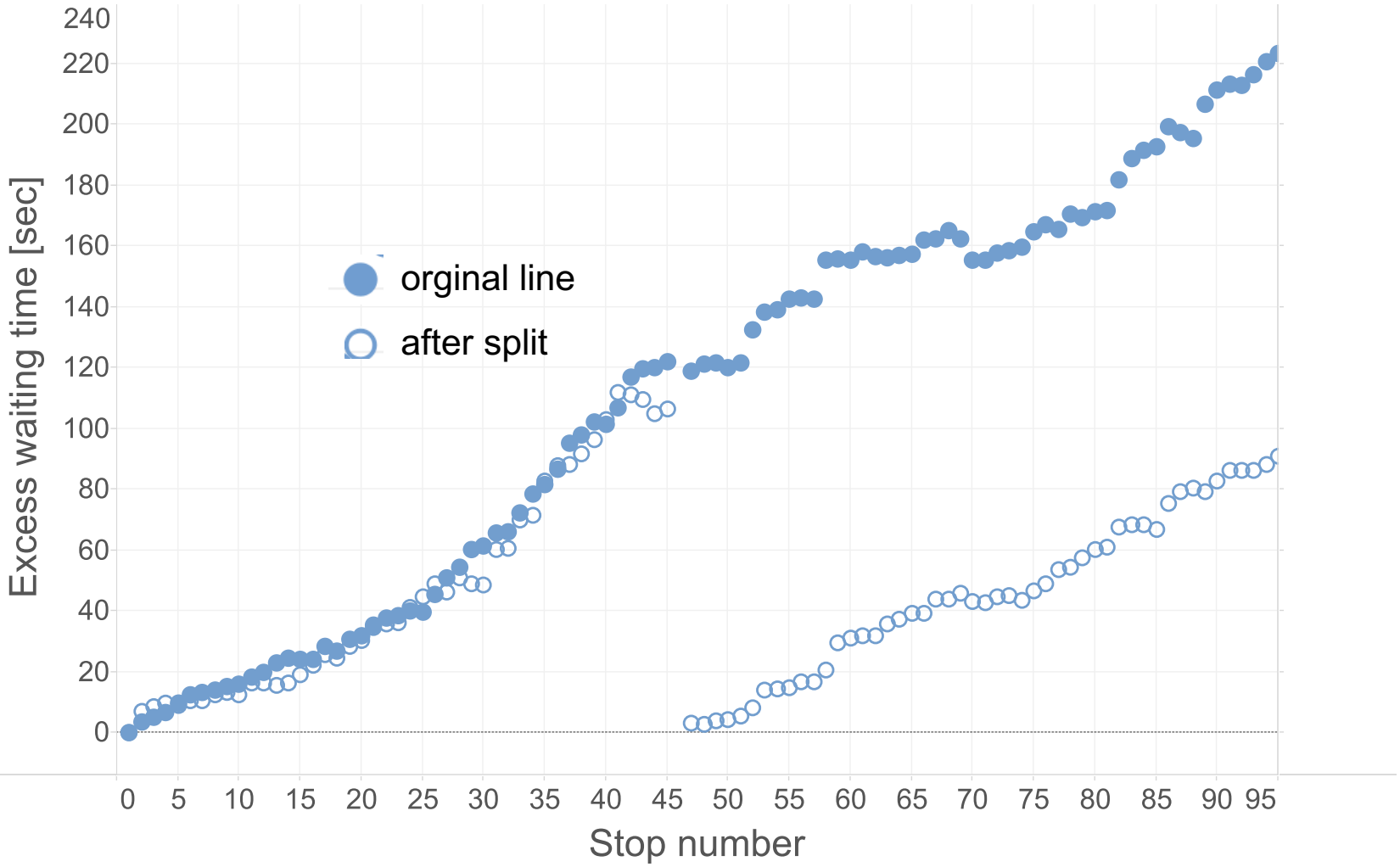
Journey duration all modes



Source: Fourie (2016).

The reliability of a long bus line

Reliability: Excess waiting time along line EW



Source: Fourie (2016).

Conclusion

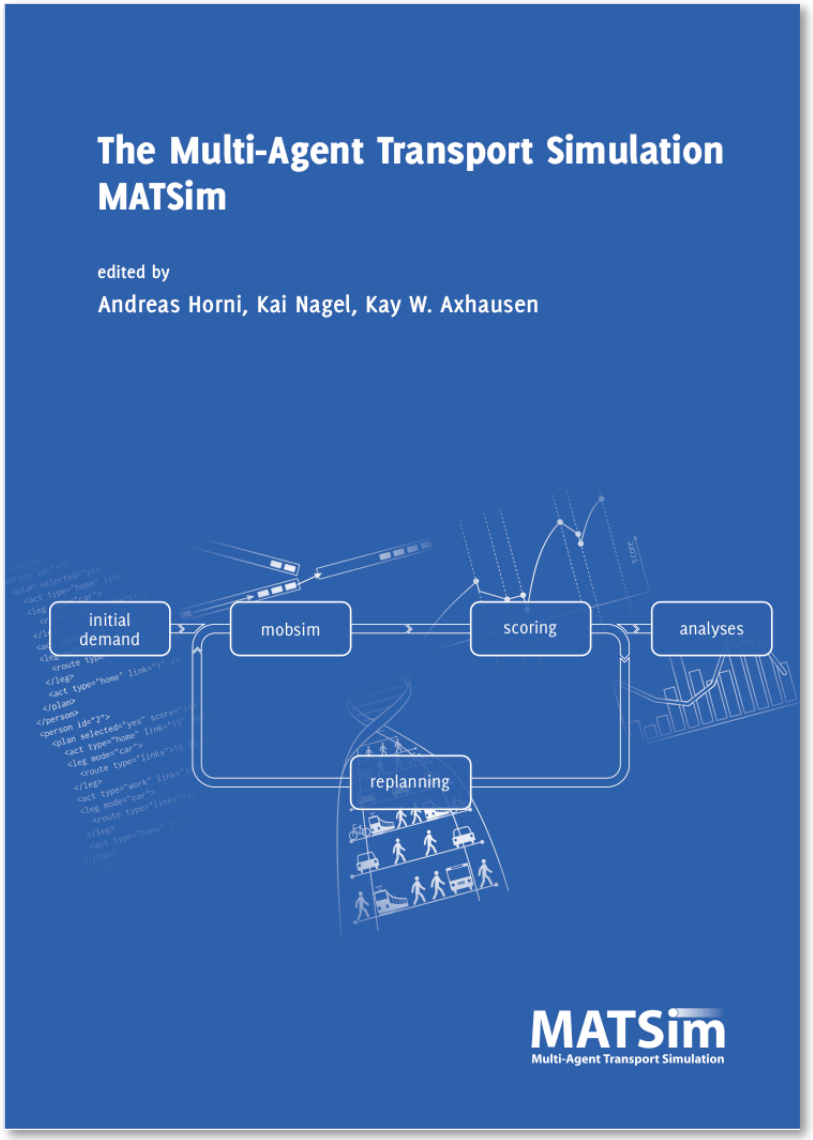
Smart cards are

- Useful supplement, especially if
  - Matched with a domain specific simulation platform

Otherwise

- Sampling issues
- Identification of tours (journeys)
- Identification of leisure/shopping purposes

Questions?


The Multi-Agent Transport Simulation
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