Impact analysis of a new metro line in Amsterdam using automated data sources

Transit Data 2019

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Smart Public Transport

Background

- The north-south metro line (NZL) opened on 22nd July 2018 in Amsterdam
- Changes to the whole network

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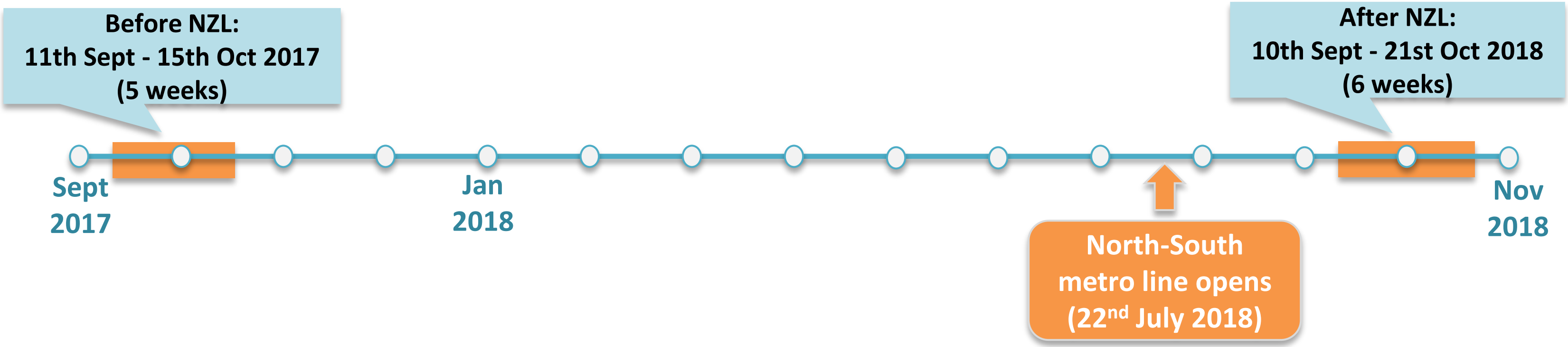
Objective

- To study the impact of the network change on
  - ridership,
  - travel times,
  - reliability
- from a passenger perspective - considering journeys including transfers within and across modes
- distributional analysis

Data sources

- Smartcard data
  - Tap-in and tap-out location and times
- Automatic Vehicle Location (AVL) data
  - Vehicle number, stop location and time stamps



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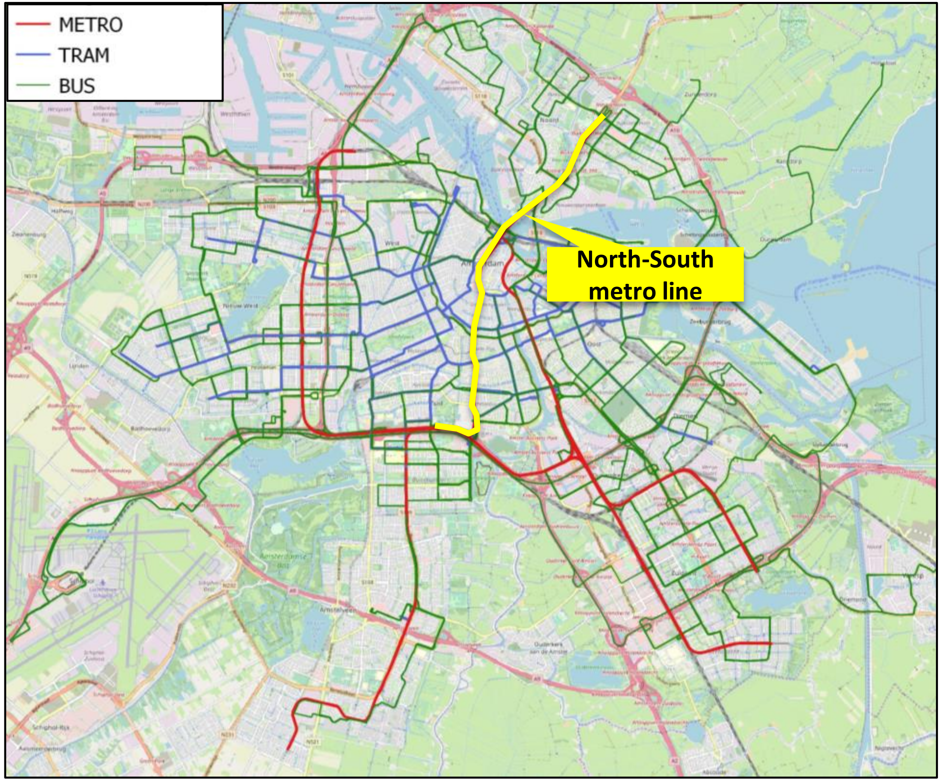
Amsterdam PT Network

- ~850,000 inhabitants
- 5 metro lines
- 15 tram lines
- 44 bus lines
- >700,000 smartcard transactions per day



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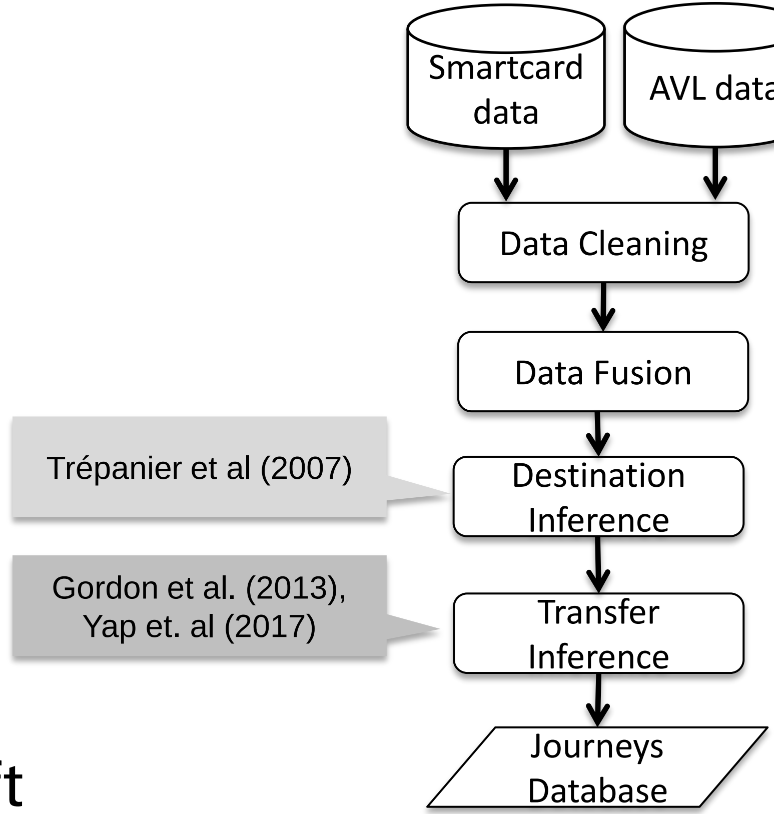
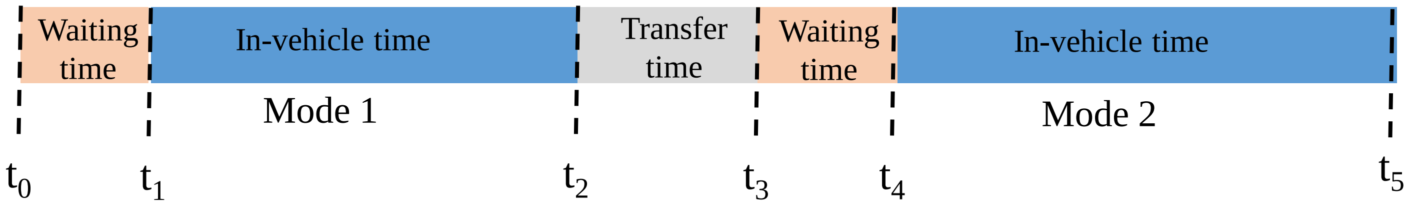
Data pre-processing

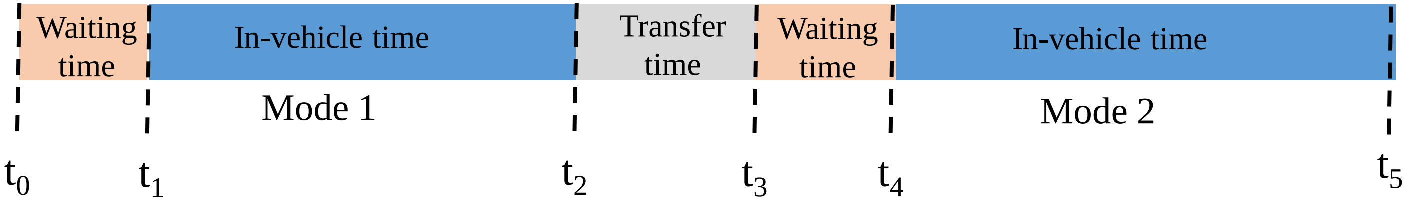


Travel time using smartcard data



Travel time using smartcard data

- Where first tap-in at station (eg. Amsterdam Metro)
  - Total travel time (t_5-t_0)
- Where first tap-in inside vehicle (eg. Amsterdam buses & trams)
  - Total travel time minus waiting time at origin (t_5-t_1)



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Waiting time at origin

- For journeys where first tap-in is inside the vehicle
  - Time passenger arrived at stop is not known
  - Headway of services known (from AVL data)
  - For short headway services – passengers assumed to arrive randomly
  - Continuous random variables generated and sampled over uniform distribution [0, observed headway] to estimate waiting time for each journey

Ref : Dixit et al (2019)

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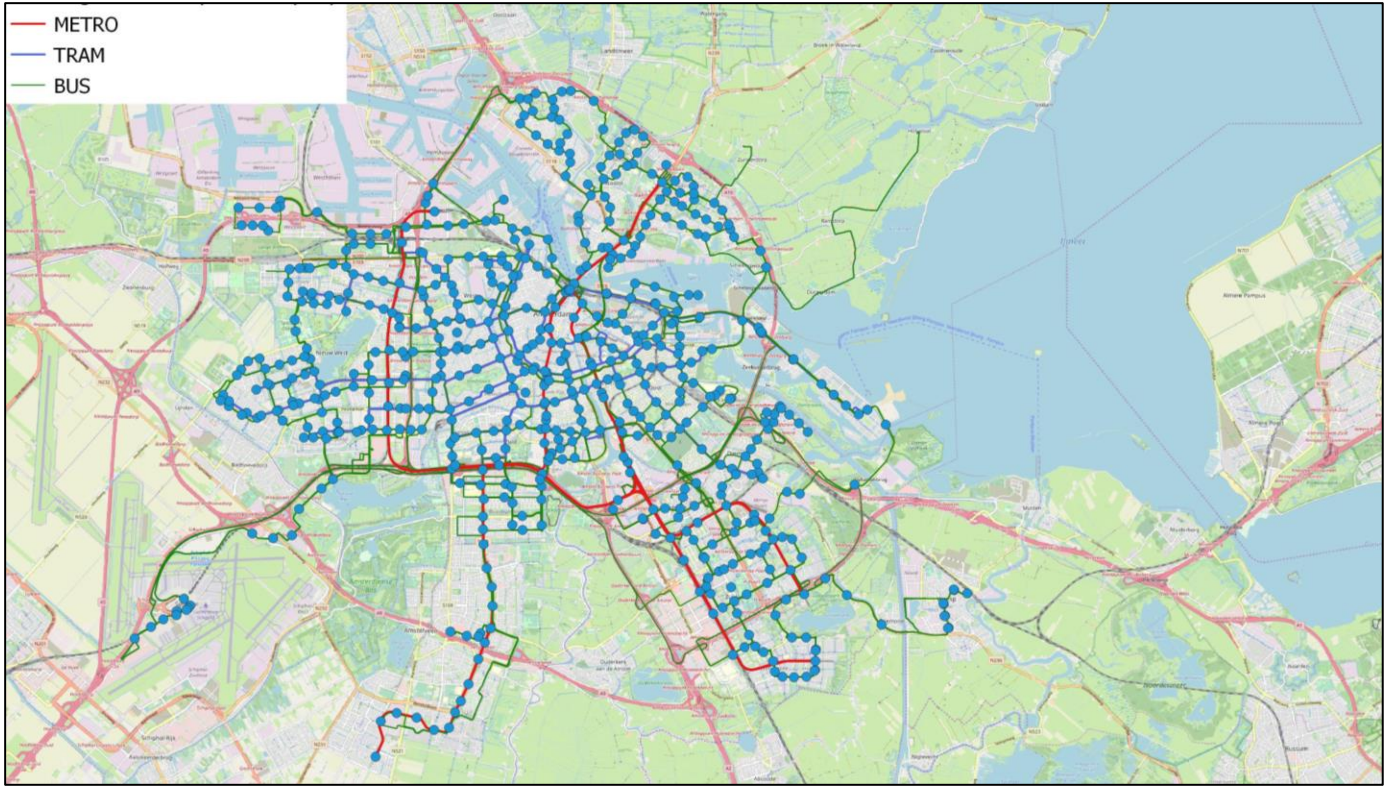
618 Transit Stops



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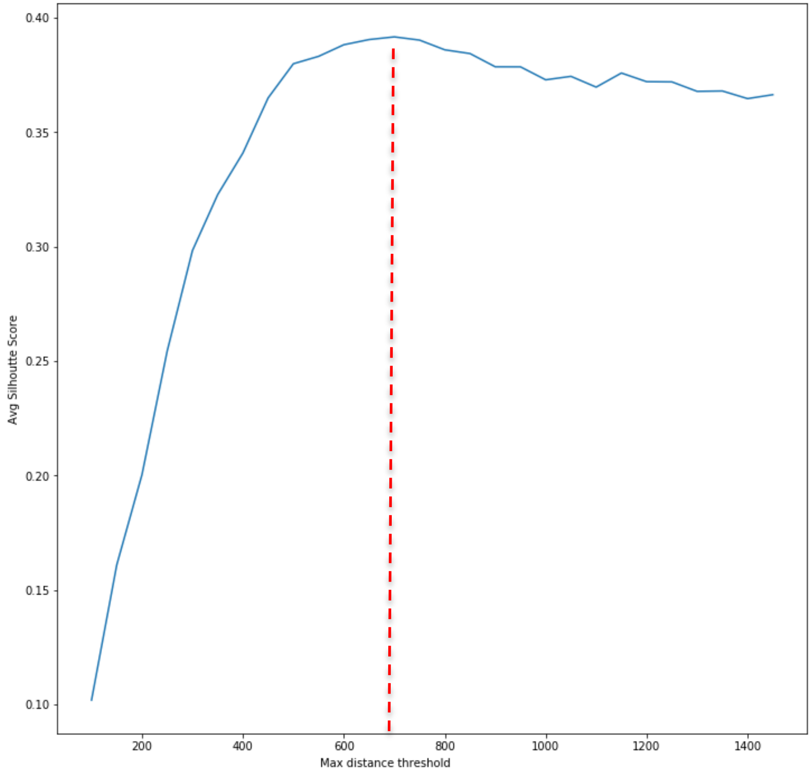
Transit Stop Clustering

- To make before and after situation comparable
- Increased sample size →
  only OD pairs with minimum 40 journeys preserved due to privacy regulations

Transit Stop Clustering

- Hierarchical clustering
- Maximum (Euclidean) distance threshold of 700m between transit stops



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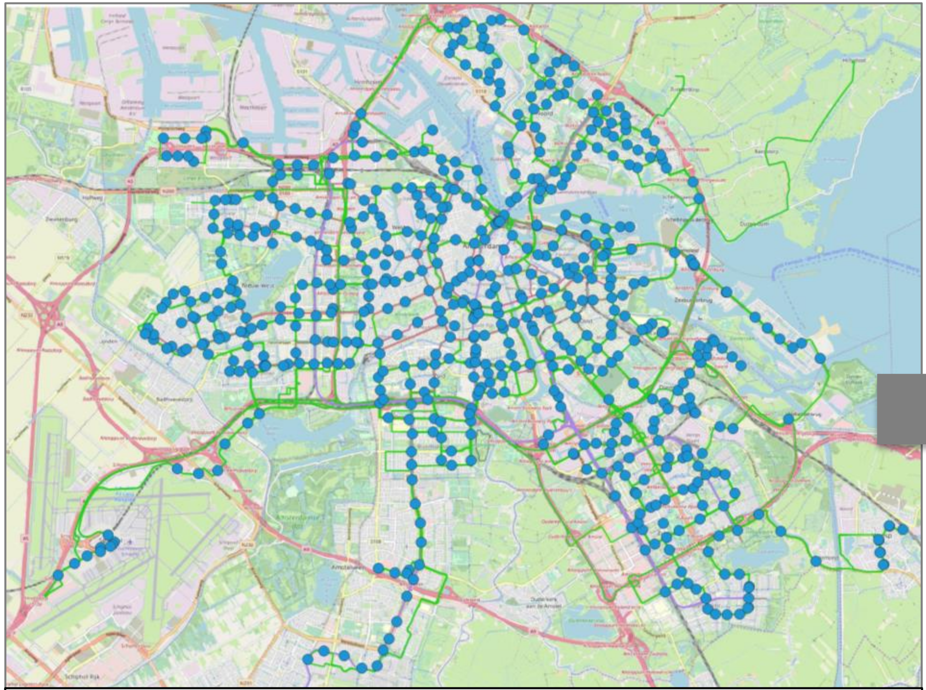
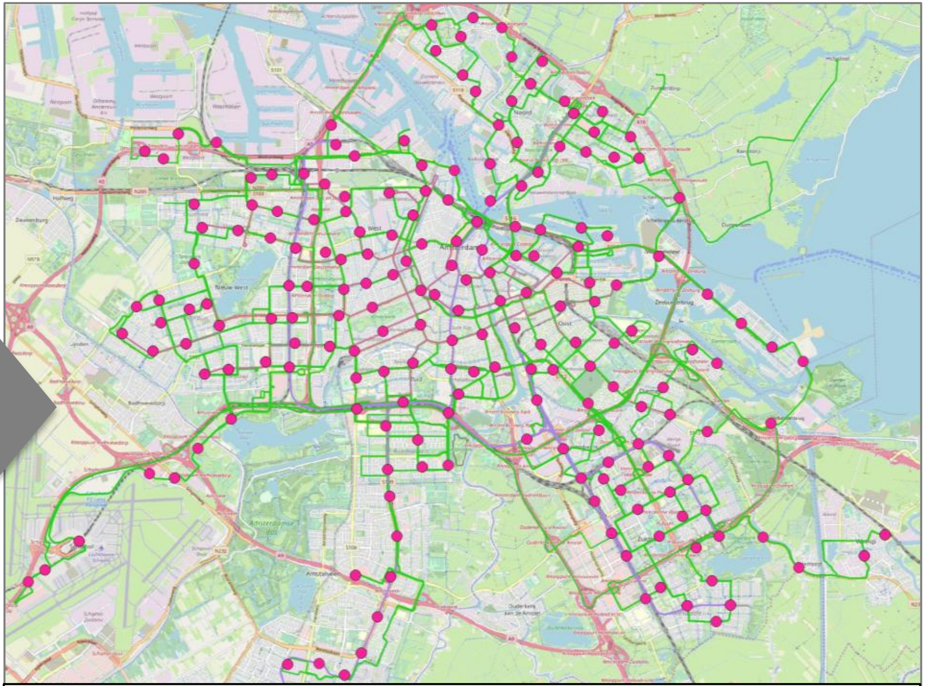
Transit Stop Clustering



618 Transit Stops



201 Transit Stop Clusters

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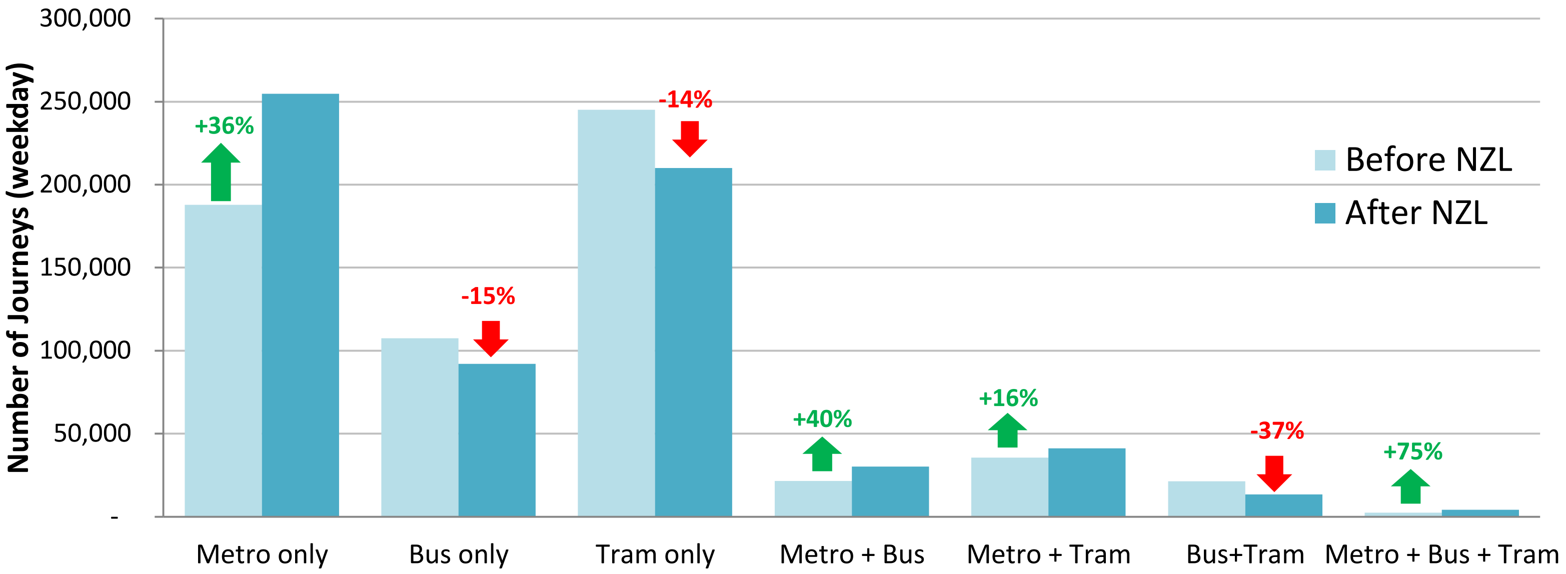
Journey Statistics

Statistic	Before NZL	After NZL	Change
Total Journeys	19,577,474 (5 weeks)	24,569,654 (6 weeks)	
Average journeys per weekday	621,099	645,667	+4.0%
Total stop cluster pairs per weekday	31,650	31,523	-0.4%

Impact on Mode Shares



>50% of journeys after NZL include a metro leg

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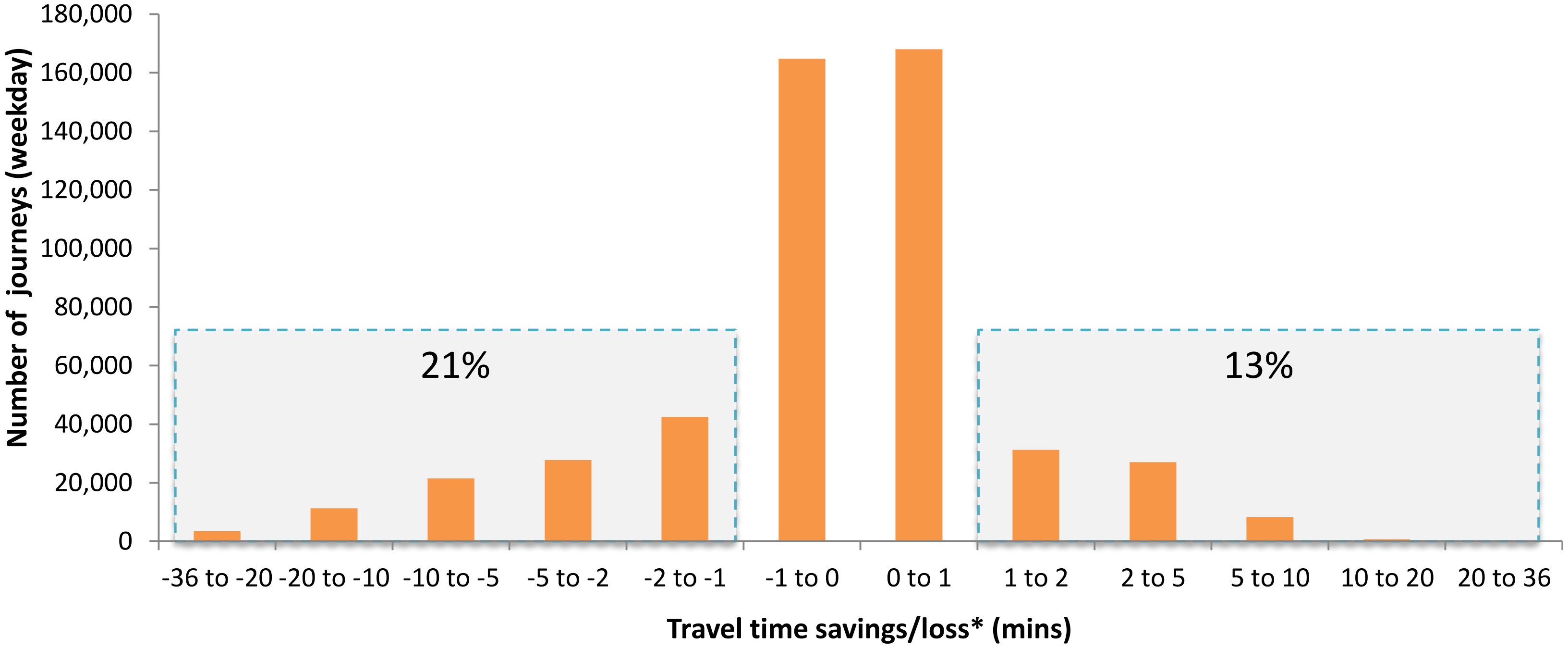
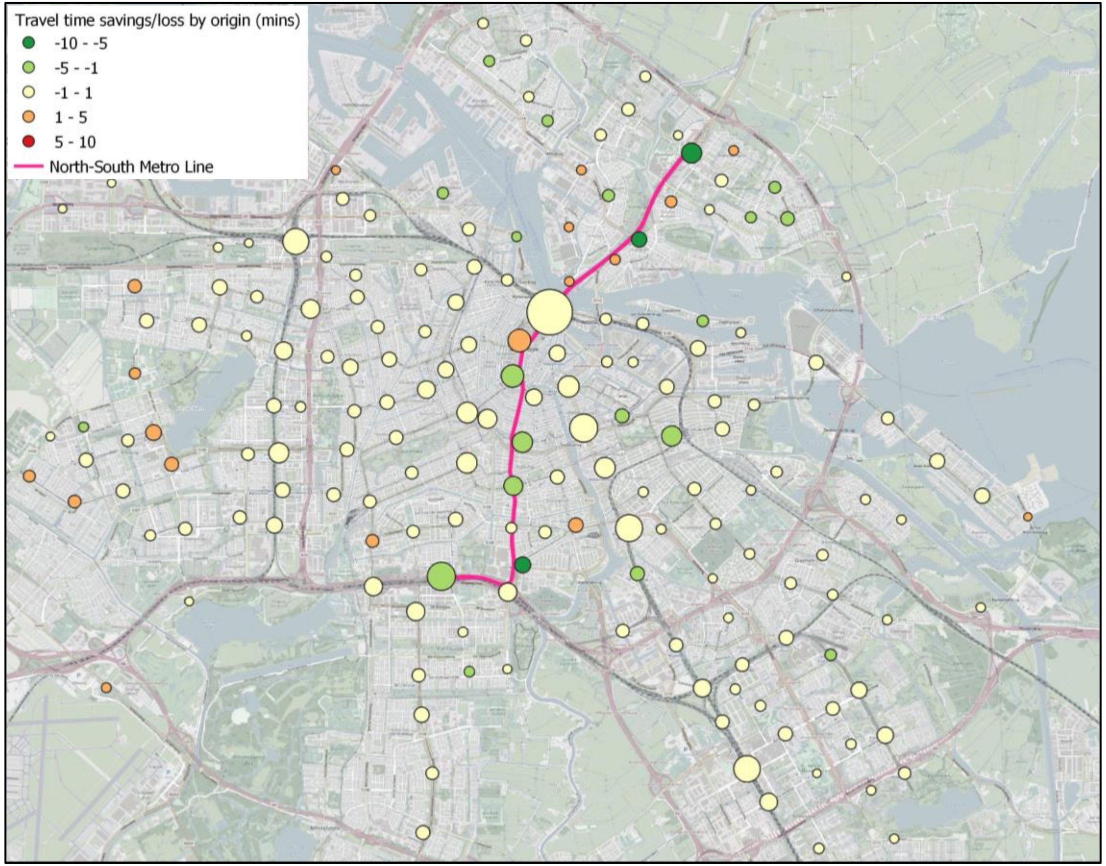
*Based on average journeys for a weekday (24 hours)

Travel time savings & loses



TU Delft *Based on stop cluster pairs with minimum 40 journeys for weekdays (7am to 7pm)

Travel time savings & loses – by origin



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Reliability measurement

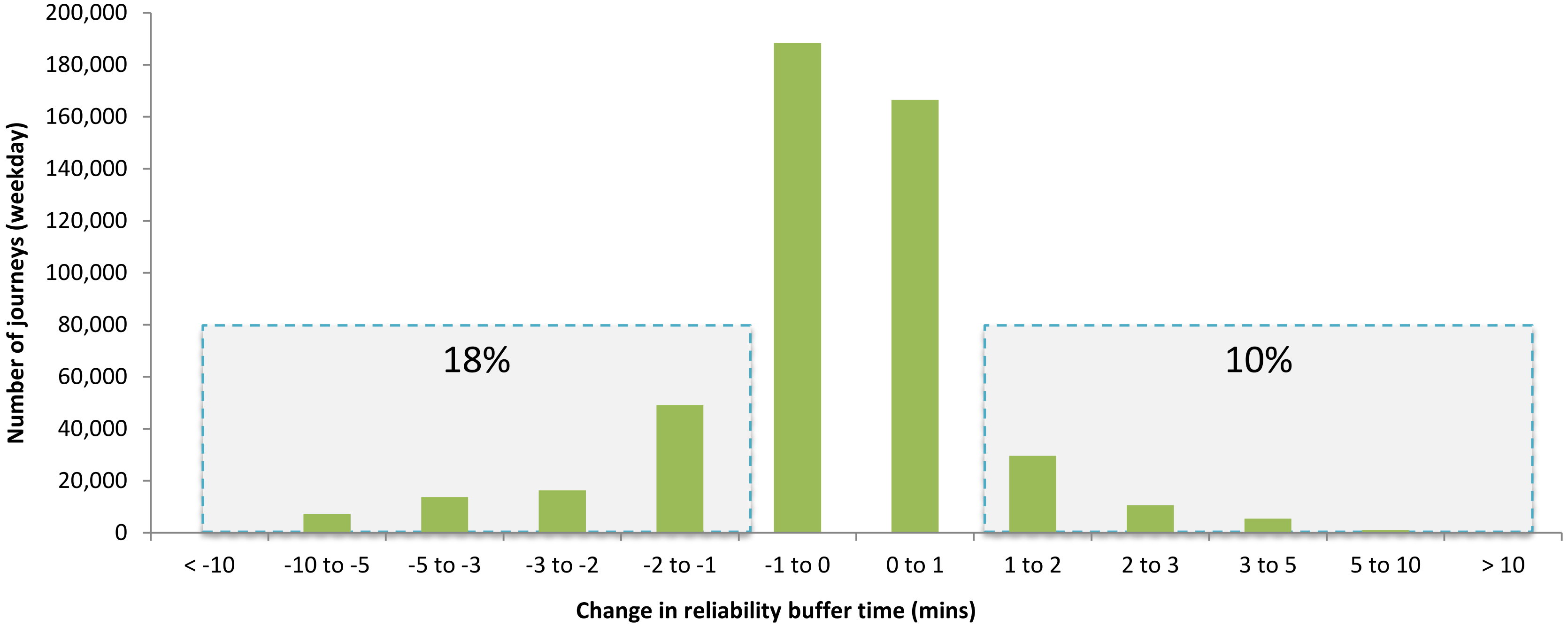
- **Reliability buffer time (RBT)** (Chan, 2007; Uniman et al, 2010)

  Difference between the 95th and 50th percentile travel time experienced by travelers between a stop-stop pair using a specific route

$$RBT_{o,d,r} = tt_{95}^{o,d,r} - tt_{50}^{o,d,r}$$

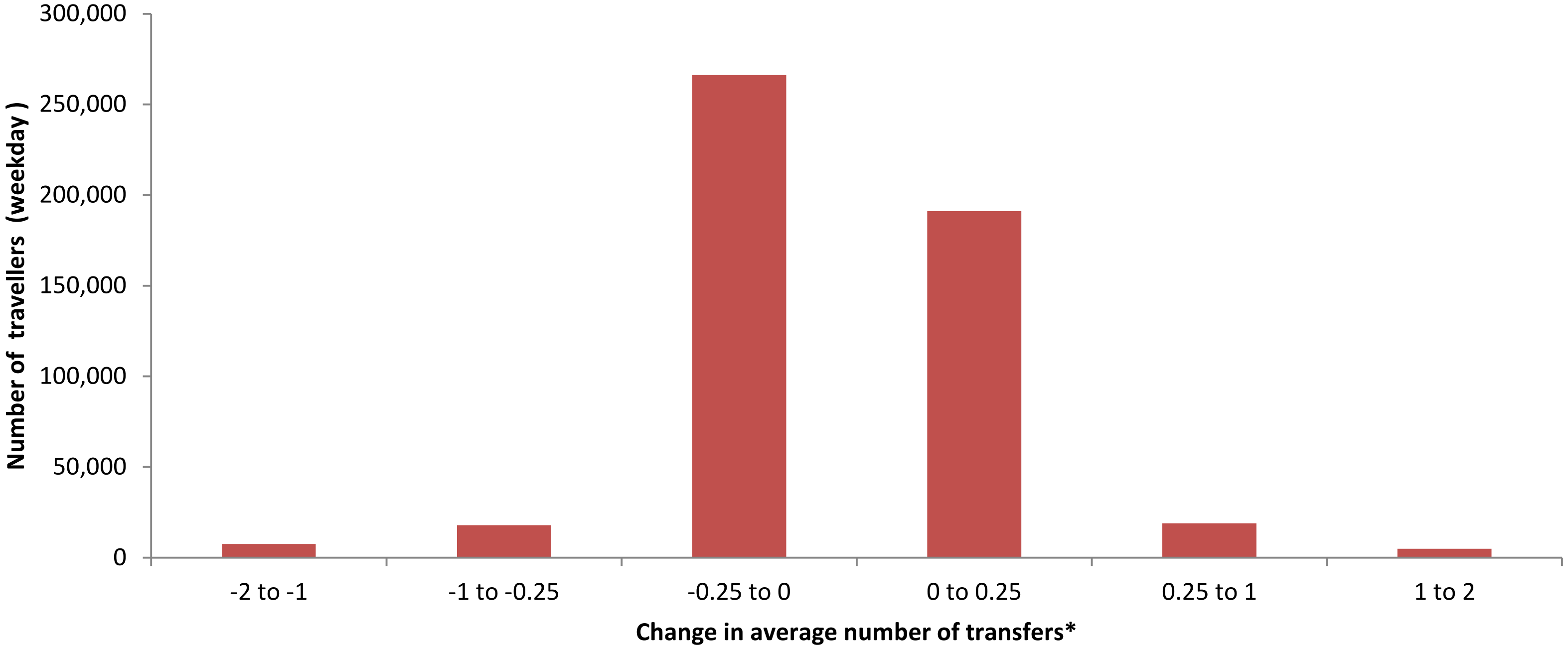
Interpreted as the additional time passengers have to budget for their travel to ensure on-time arrival one out of twenty times

Impact on reliability



**Based on OD-route pairs with minimum 20 journeys and stop cluster pairs with minimum 40 journeys for weekdays (7am to 7pm)*

Impact on number of transfers made



**Based on stop cluster pairs with minimum 40 journeys for weekdays (7am to 7pm)*

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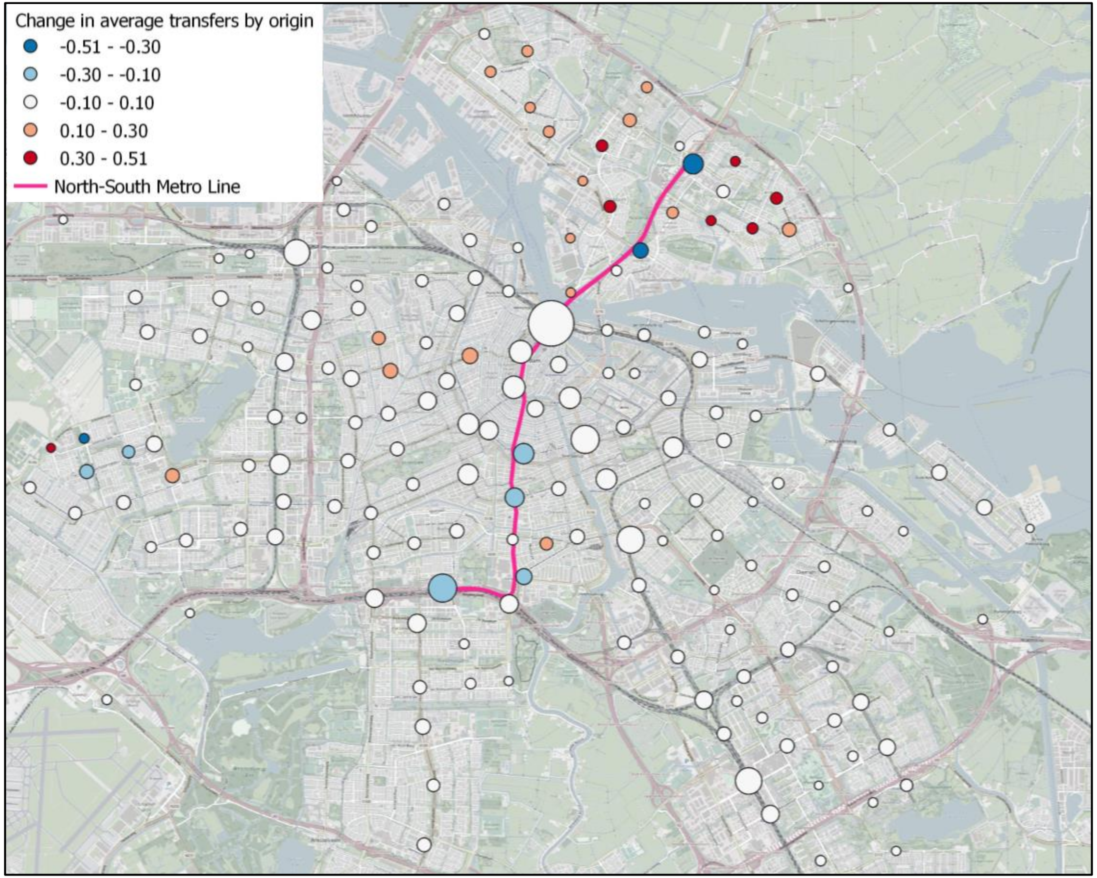
Impact on number of transfers made



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Conclusion

- Application of smart card and AVL data for evaluation of a major infrastructural change
  - Consistent measurement of travel times across modes and routes
- Transit stop clustering enabled before/after comparison at a disaggregate level
  - Overall travel savings, but large differences between OD-pairs
  - Better reliability on average
  - Trade-off between transfers and travel times
- Could be used to refine the demand predictive ex-ante tools

Future Work

- Impact on crowding & transfers
- Equity impact of the network change
- Comparison with more aggregate (zonal) analysis
- Route choice behaviour

Thank you!

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