Modelling multimodal transit networks
integration of bus networks with walking and cycling (PPT)

Brand, Judith; Hoogendoorn, Serge; Van Oort, Niels; Schalkwijk, Bart

Publication date
2017

Document Version
Final published version

Citation (APA)
Brand, J., Hoogendoorn, S., Van Oort, N., & Schalkwijk, B. (2017). *Modelling multimodal transit networks: integration of bus networks with walking and cycling (PPT)*. 5th IEEE International Conference on Models and Technologies for Intelligent Transportation Systems, MT-ITS 2017, Naples, Italy.

Modelling Multimodal Transit Networks

Integration of bus networks with walking and cycling

Judith Brand, Niels van Oort, Serge Hoogendoorn, Bart Schalkwijk

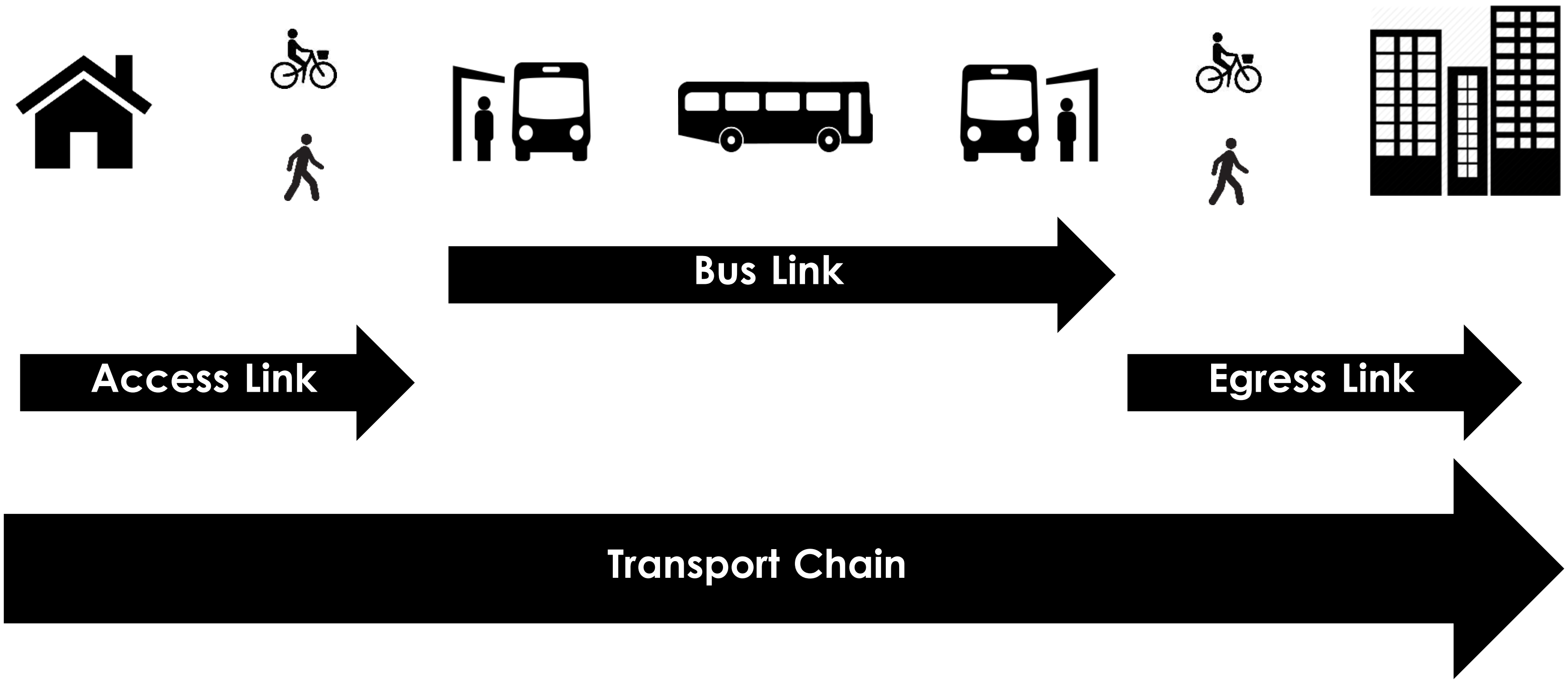
Friday, 30 June 2017

Introduction

- Worldwide trends create an increase in travel demand:
  - Growing cities
  - Changes in travel patterns
- Constraints limit the upgrading and construction of (new) infrastructure
  - Financial
  - Spatial
  - Governmental
- There is a need for the ***optimised use of existing services and infrastructures,*** to bridge the gap between demand (passenger) and supply (transit services and infrastructure)

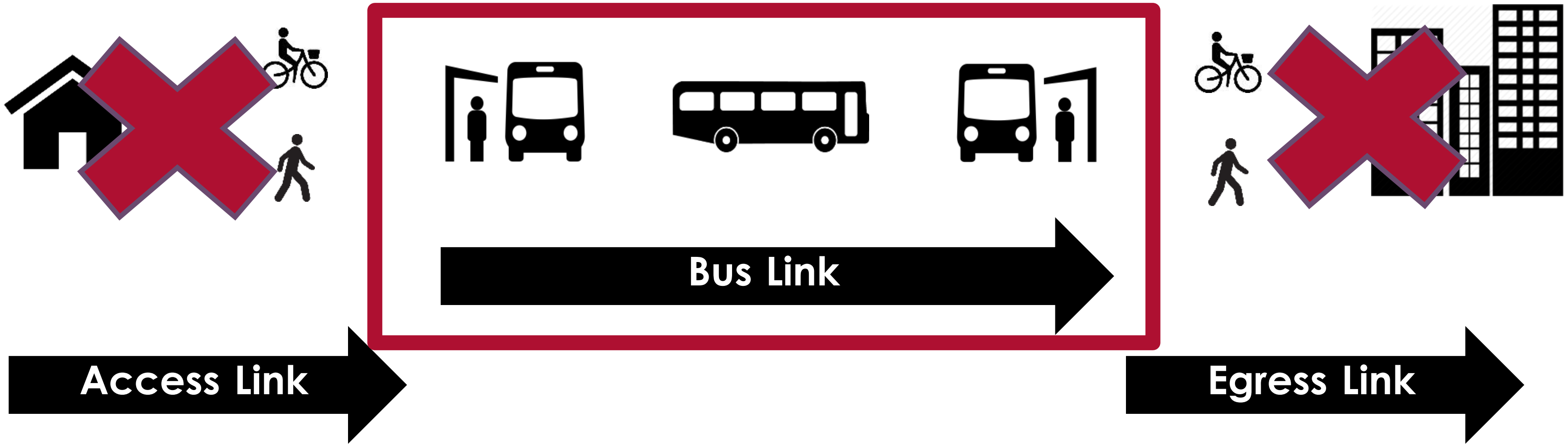
Integration and modelling of multimodal transit networks

Integration – Demand



Integration and modelling of multimodal transit networks

Integration – Supply



Integration and modelling of multimodal transit networks

- Efficient transport systems reduce costs:
  - Travel times (passengers)
  - Capacity to meet demand (supply)

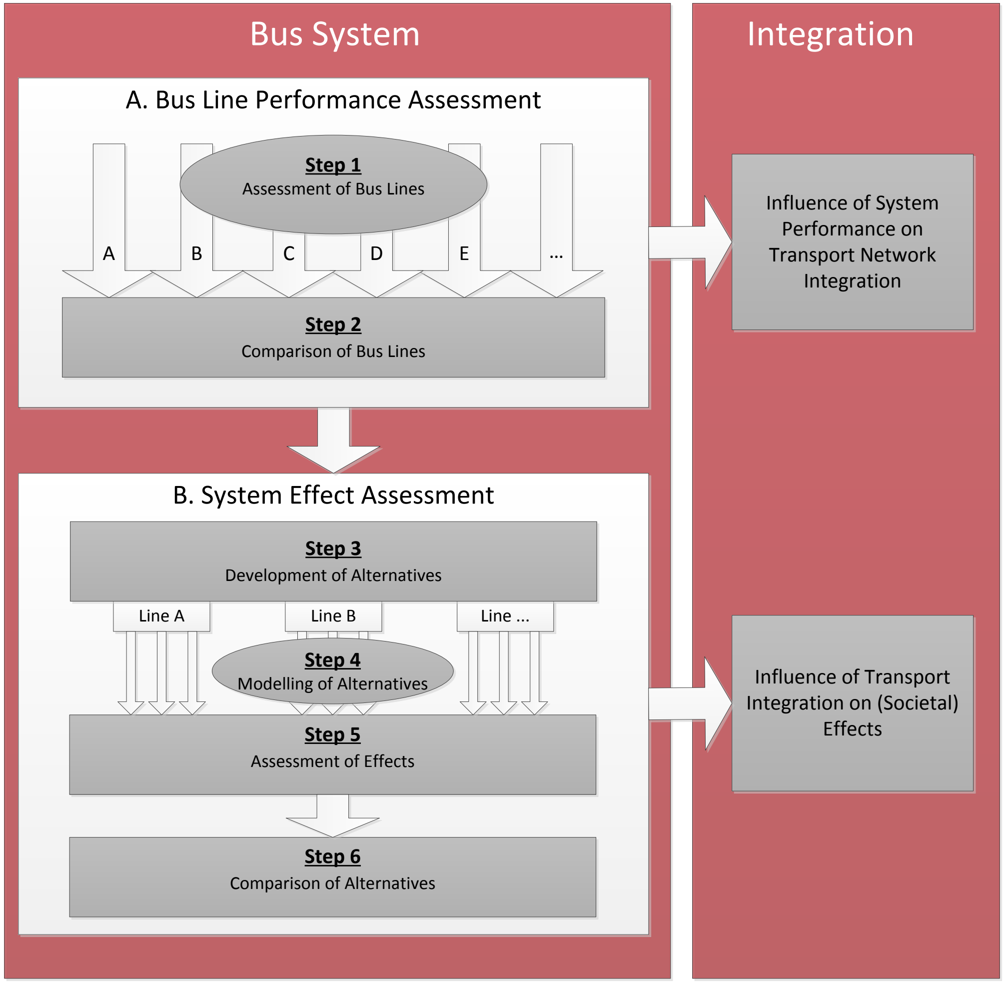
- Reduction of costs and inconvenience of travel can be made possible through integration of services:
  - Access and Egress modes
  - Integration in bus networks

- Need for tools and modelling approaches that can be used in practice

The assessment framework

- From the previous slides, we identified the need for:
  - Insights in the influence of characteristics of the trip chain on demand and consequently transport network integration (***Demand side***)
  - The influence of integration (approach of assessment of the entire chain) on system effects (***Supply side***)
  - The difference between different types of bus systems and the effects of upgrading from conventional to hierarchically higher systems (BRT)
- An assessment framework has been developed that captures all these needs:
  - Allows for the comparison of different types of bus systems
  - Helps in the decision making process (supply side) when faced with capacity issues: upgrading of services instead of reliance on new infrastructure

The assessment framework

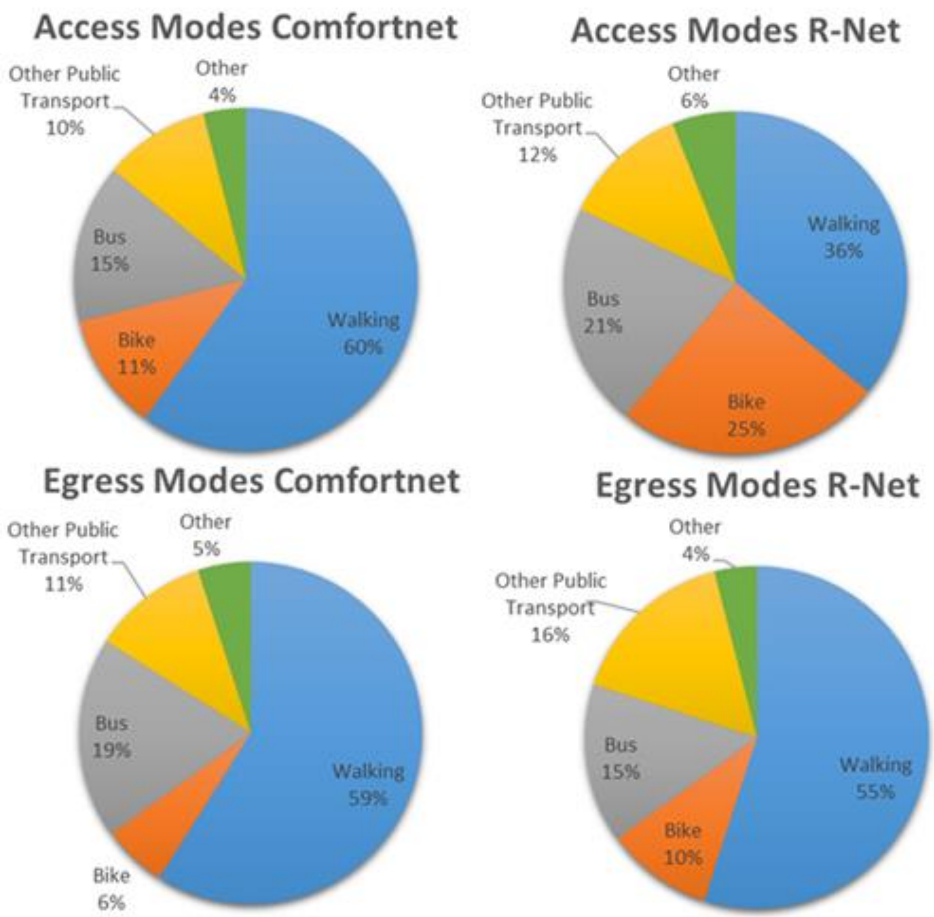


Testing: case study results

Vervoerregio Amsterdam

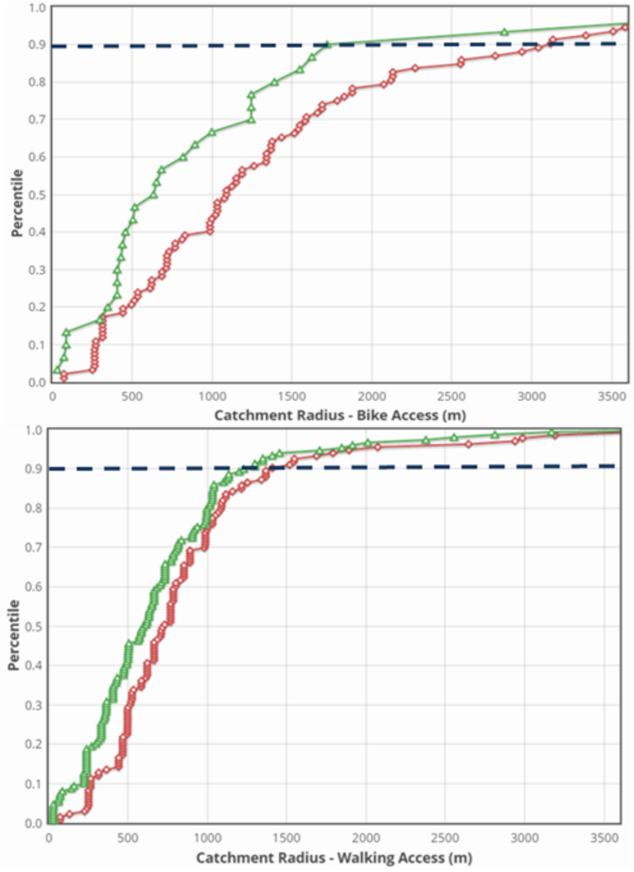
Testing: case study results

- Part A: Bus Lines Performance Assessment
  - Step 1: Assessment of Bus Lines
  - Assessment of 10 bus lines
    - 5 Conventional (Comfortnet)
    - 5 BRT (R-Net)
  - See paper for a list of assessed characteristics
  - Data sources:
    - Zonal Data (post code)
    - Travel behaviour (Surveys)
    - GOVI data (public transport data)



Testing: case study results

- Part A: Bus Lines Performance Assessment
  - Step 2: Comparison of Bus Lines
  - Assessment at three different levels:
    - Bus type (conventional VS BRT)
    - Bus line
    - Bus stop

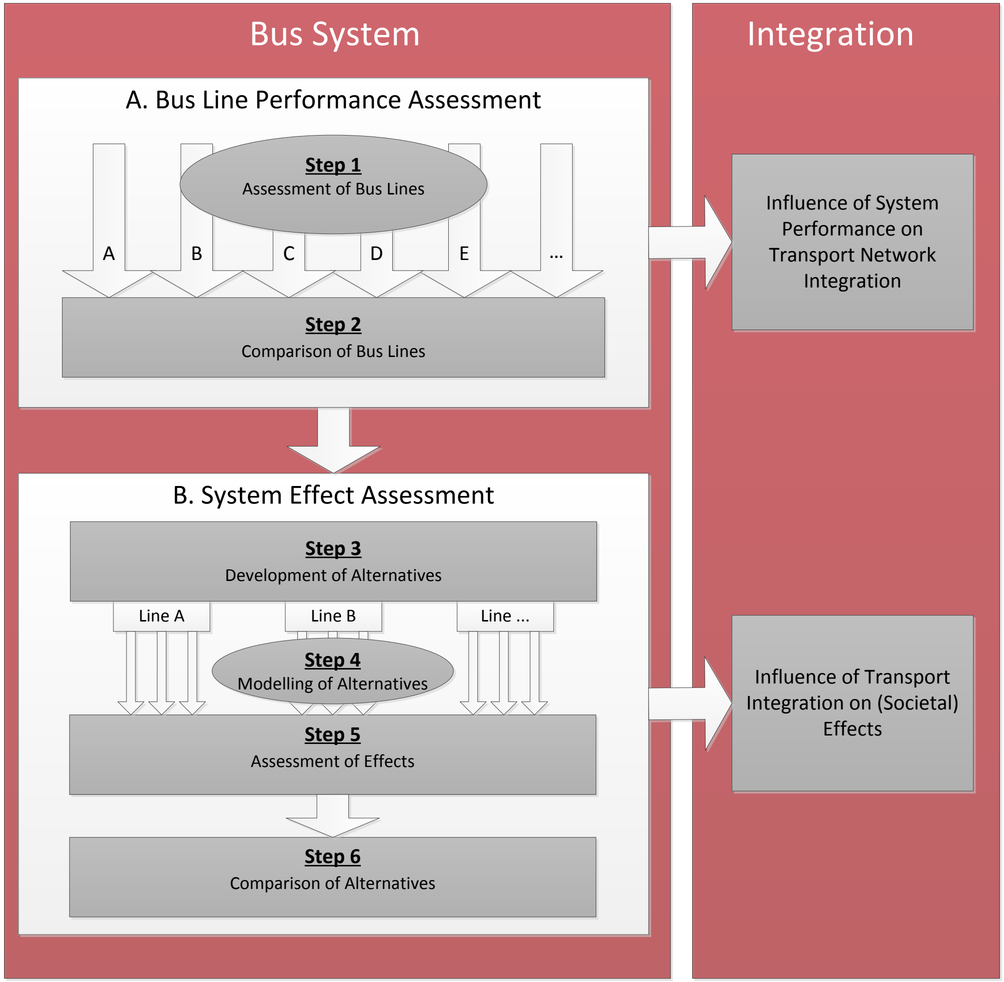


Testing: case study results

- Part A: Bus Lines Performance Assessment
  - Step 2: Comparison of Bus Lines
  - Assessment at three different levels:
    - Bus type (conventional VS BRT)
    - Bus line
    - Bus stop

(1) Catchment area speed (access)	**Where**
Catchment (m)=0,269+0,011v	v=speed (km/h)
(2) Catchment area frequency (access)	f=service frequency (bus/h)
Catchment (m)=0,482+0,036f	
(3) Catchment area frequency (egress)	
Catchment (m)=0,459+0,023f	

The assessment framework



Testing: case study results

- Part B: System Effect Assessment
  - Total Travel Time (demand side)
  - Number of passengers (supply side)
- Step 3: Development of alternatives
  - Alternatives for 2 different lines:
    - One Conventional
    - One BRT
- Step 4: Modelling of Alternatices
  - The alternatives have been modelled in VENOM, the regional model of Stadsregio Amsterdam (Vervoerregio Amsterdam)
  - The model has been validated using passenger counts (from PT-card data) and boarding/alighting data

(4) Travel Time

$TT_{y,m} = \mu_a T_a + \mu_{wt} T_{wt} + T_{iv} + \mu_e T_e + T_h$

Where	a=access
$TT_{y,m}$ is the total travel time of line y with modes am and em	wt=waiting time
μ=multiplier per link type	iv=in-vehicle
T=travel time per link type	e=egress
	h=hidden waiting time

Testing: case study results

- Part B: System Effect Assessment
  - Total Travel Time (demand side)
  - Number of passengers (supply side)
  - Step 3: Development of alternatives
    - Alternatives for 2 different lines:
      - One Conventional
      - One BRT
  - Step 4: Modelling of Alternatices
    - The alternatives have been modelled in VENOM, the regional model of Stadsregio Amsterdam (Vervoerregio Amsterdam)
    - The model has been validated using passenger counts (from PT-card data) and boarding/alighting data

A. Base Alternative	
B. Frequency Alternative	The frequency of the service is increased. For this alternative, the frequency is increased to 10 busses per hour (peak hour), in line with the frequency of the average R-Net line.
C. Speed Alternative	The commercial speed of the service is increased. For this increase, dedicated infrastructure is constructed in the modelling environment to minimise the influence of other traffic on the bus service.
D. Stop Density Alternative	Although no significant relation has been found between the stop density and the catchment area, this alternative is researched as an extra check. This alternative is modelled to see what would happen to the service if one of the characteristics of high quality services is imposed on the network.
E. Speed and Frequency Alternative	For this alternative, the frequency of the service is increased to 10 busses per hour, and the speed is increased to 30 kilometres per hour through the construction of dedicated infrastructure.
F Speed, Frequency and Stops Alternative	Three characteristics of high quality services are combined. Although stop distances do not influence the catchment area an increase in distances between stops does influence the speed.

Testing: case study results

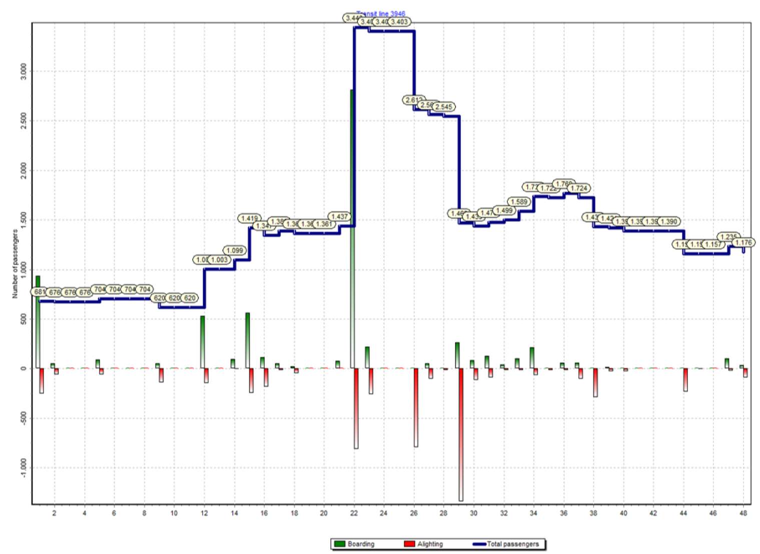
- Part B: System Effect Assessment
  - Total Travel Time (demand side)
  - Number of passengers (supply side)
- Step 3: Development of alternatives
  - Alternatives for 2 different lines:
    - One Conventional
    - One BRT
- Step 4: Modelling of Alternatices
  - The alternatives have been modelled in VENOM, the regional model of Stadsregio Amsterdam (Vervoerregio Amsterdam)
  - The model has been validated using passenger counts (from PT-card data) and boarding/alighting data

A. Base Alternative	
B. Express Service Alterative	An extra bus line is added next to the existing R-Net service, creating an express service that connects the most important and strategically positioned stops on the line.
C. Speed Alternative	A tunnel could influence the speed. This alternative assesses the effect of increased speeds through the construction of a bus-only tunnel in the city centre of Haarlem, an area where the bus shares the road with other users.

Testing: case study results

- Part B: System Effect Assessment
  - Total Travel Time (demand side)
  - Number of passengers (supply side)
- Step 3: Development of alternatives
  - Alternatives for 2 different lines:
    - One Conventional
    - One BRT
- Step 4: Modelling of Alternatices
  - The alternatives have been modelled in VENOM, the regional model of Stadsregio Amsterdam (Vervoerregio Amsterdam)
  - The model has been validated using passenger counts (from PT-card data) and boarding/alighting data

Busline	172	300
Number of Passengers Base Alternative	187436	621501
Number of Passengers Qlik Data March 2015	177093	600206
Percentage Comparable	94%	97%



Testing: case study results

- Part B: System Effect Assessment
  - Step 5: Assessment of Effects
    - Modelled alternatives are compared based on previously mentioned travel time equation and equations found in step 2 (comparison of systems)
  - Step 6: Comparison of Alternatives
    - Societal Cost-Benefit Analysis (SCBA)
    - Allows to access the alternatives based on societal viability by taking into account both:
      - the costs implementation (e.g. construction costs, operational costs)
      - The benefits (travel time savings, operational income and revenue)

Comfort-net	**Alternative**	**Travel Time (hh:mm)**	**Time gains/losses (hh:mm)**	**SCBA ratio (in €m)**
	A	01:05		
	B	01:10	+ 00:05	+ 36,2
	C	00:57	- 00:08	+ 12,6
	D	01:08	+ 00:04	+ 0,3
	E	01:08	+ 00:04	- 0,3
	F	01:09	+ 00:05	- 69,8
	H	01:02	- 00:03	- 62,6
R-Net	**Alternative**	**Travel Time (hh:mm)**	**Time gains/losses (hh:mm)**	**SCBA ratio (in €m)**
	A	00:49		
	B	00:52	+ 00:03	+ 491,3
	C	00:52	+ 00:03	+ 5,4

Conclusion and recommendations

- R-Net, a BRT-like service, can attract twice the amount of cyclist on the access and egress side
- Passengers of bus services are prepared to travel longer distances on the access and egress side when bus services are more frequent and/or have higher speeds.
- The bicycle is an important mode on the acess side, whereas its share on the egress side is much smaller.
  - Need for bicycle parking facilities near access stops
  - Need for bicycle-sharing and bike-renting opportunities near egress stops

Conclusion and recommendations

- Presentation of a new methodology of assessment of integration in transit networks, useful both academically (explaining phenomena) as well as in practice (altering transit networks for the benefit of both the passenger as well as for the transit supplier)
- The outcomes of the application of the framework to the case study clearly show a mutual dependency between access/egress parts of the trip and transit parts of the trip
- The framework is capable of assessing and identifying characteristics responsible for integration, as well as assessing the effects of the transport system.

The developed framework allows helps in the decision making process when faced with capacity issues: upgrading of services instead of reliance on new infrastructure

Questions

Judith Brand

judith.brand@sdgworld.net

Niels van Oort

N.VanOort@tudelft.nl

http://nielsvanoort.weblog.tudelft.nl/