Improving Access By Increasing Mode Share

Juan Carlos Muñoz  @JuanCaMunozA

Department of Transportation Engineering & Logistics
Pontificia Universidad Católica de Chile
What do people seek when travelling in public transport?

- Fast
- Low waits
- Comfortable
- Reliable
How can we achieve these attributes?

- **Fast**
  - Decrease travel time
  - Increase speed

- **Low waits**
  - Increase frequency
  - Increase fleet or increase speed

- **Comfortable**
  - Increase transport capacity
  - Increase fleet, vehicle size or increase speed

- **Reliable**
  - Decrease travel time variability
  - Regular headways
How can we **achieve** these attributes?

*Fast*  
*Low waits*  
*Comfortable*  
*Reliable*

**INCREASE SPEED!**

AND THEN MAYBE IF WE HAVE SPARE TIME FOCUS ON REGULAR HEADWAYS....
How can we **achieve** these attributes?

Fast  Low waits  Comfortable  Reliable

**INCREASE SPEED AND REGULAR HEADWAYS!**
Vehicles in public transport systems behave like magnets....

Regular intervals is an unstable equilibrium

Any perturbation and the equilibrium is lost... all around the world.
Bus bunching... found in London
Bus bunching... found in Beijing
Bus bunching... found in Santiago
Today we will address **three questions**

1. Why does bus bunching happen?
2. What are the impacts?
3. Does it have a solution?
Why does bus bunching happen?

- Dispatch strategy
- Speed variability
  - Travel time variability
  - Dwell time variability
Why does **bus bunching** happen?
Why does **bus bunching** happen?

- Dispatch strategy
- **Speed** variability
- Travel time variability
- Dwell time variability
Why does **bus bunching** happen?

- Travel time variability
- Congestion
- Traffic lights
- Driver heterogeneity
Why does **bus bunching** happen?

Dwell time variability

Stochastic passenger arrivals at each stop

Capacity of buses and stops
Today we will address **three questions**

1. Why does bus bunching happen?
2. What are the impacts?
3. Does it have a solution?
What are the impacts?

Impacts are various, affecting:

Users

Operators
What are the **impacts**?
What are the **impacts**?

Increase in average occupancy

- Longer waiting times correlate with high occupancy
- More users suffer high occupancy

Increase in occupancy variability

- Generates uncertainty in the level of service
What are the impacts?

- Increase in waiting times
  - One minute of waiting is perceived as two or three minutes of in-vehicle time
- Increase in the variability of waiting times
  - Leads to earlier departures for users
What are the impacts?

- Increase in dwell times
  - Boarding and alighting is slow and friction
- Increase in the variability of dwell time
  - Damages the reliability of the service
  - Operators need extra fleet and drivers due to variable cycle times
What are the impacts?

User Satisfaction

Occupancy
What are the impacts?

Imagine a regular service with a 5 minute interval and 80% occupancy.
What are the impacts?

Suppose the service is not regular, and operates with intervals of 2 and 8 minutes alternately (with occupancies of 25% and 100% respectively).
What are the impacts?

Average occupancy of buses will be 63%, with an apparent satisfaction of 50%.
What are the **impacts**?

Average occupancy of perceived by users will be 85%, with a satisfaction level of only 26%!
What are the **impacts**?

This is what we planned for...

This is what we achieved with no control!
Today we will address three questions

1. Why does bus bunching happen?
2. What are the impacts?
3. Does it have a solution?
Does it have a **solution**?

Yes!

- Dedicated infrastructure
- Transit signal priority
- Real-time control at dispatching and along the route
Does it have a **solution**?
Does it have a **solution**?

Source: mto.gov.on.ca
Does it have a solution?

Ok!  Hold  Go faster (if possible)  Slow down
Does it have a solution?

No control

With control

Color indicates bus load!
Does it have a solution?
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