17th October 2016
VREF Conference on Urban Freight 2016

Data stories from urban loading bays

The use of timestamp data to analyse delivery vehicles at large urban establishments

Presented by **Giacomo Dalla Chiara**

Research team

Lynette Cheah (PI)
Ngai-Man Cheung
Ding Jiatao
Costas Courcoubetis
Sun Xin
Guo Ziqi

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN
Established in collaboration with MIT

1. Motivation
2. Data background
3. Data stories
4. Conclusion

Urban logistics initiatives

CHALLENGES

- Goods vehicles generate sizeable **externalities**
  - 17% of vehicle population*
  - 40% km travelled*

(* statistics from Singapore)

- Freight movement is adversely affected by **urban congestion**
- Location-specific congestion ➡ Large urban Freight Traffic Generators (LTGs) *Jaller et al. (2015)*

POSSIBLE SOLUTIONS

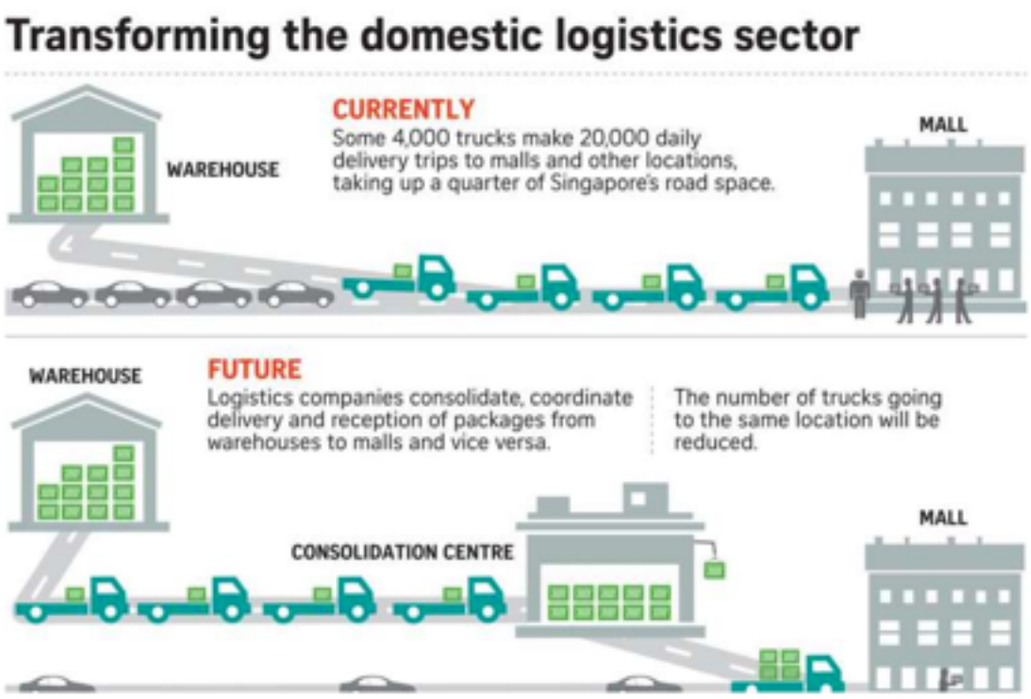
- **Urban logistics initiatives** can reduce freight traffic and improve freight distribution efficiency at LTGs.
  - **Off-site consolidation , Centralised receiving station, pricing …**

➡ Need for **data** and **models** to *(i)* understand freight delivery and quantify externalities, *(ii)* evaluate urban logistics initiatives.

1. Motivation

The Singapore urban logistics initiative

Plans to boost efficiency of logistics sector



PUBLISHED OCT 23, 2015, 5:00 AM SGT

Moves will inject technology and help firms cope with land, labour constraints: Tharman

Chia Yan Min Economics Correspondent

A slate of measures to boost Singapore's logistics industry were unveiled yesterday, including a pilot programme to make deliveries to shopping malls more efficient.

These moves will inject a much-needed dose of technology into the domestic logistics sector

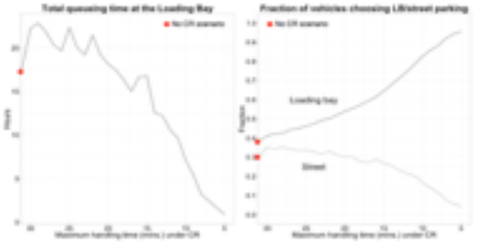
Project phases and objectives

Data collection

Data visualisation

Model a "typical" Loading Bay

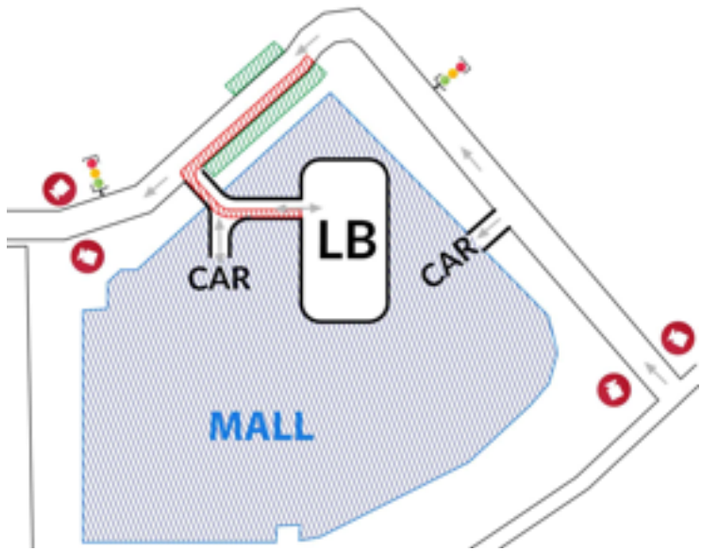
Evaluate urban logistics solutions



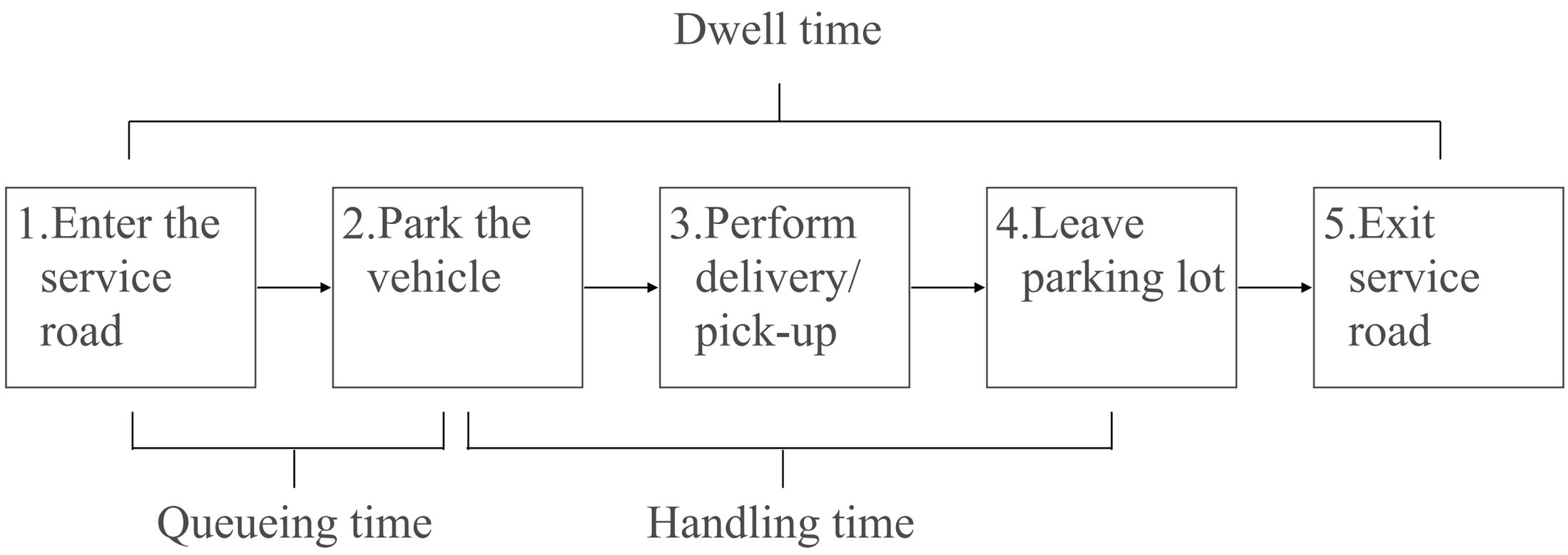
2. Data background

2. Data background
System description

We analyse **goods vehicles** delivering at **large urban retail malls**



- service road,
- parking facilities,
- in-mall stores.



2. Data background
Data collection methods

Automatic data collection

- road-side video recordings
- parking gate data

➡ **timestamp data** on vehicle activities: arrival time, exit time, handling, dwell time, queueing time …

Manual data collection

- driver survey
- vehicle observations

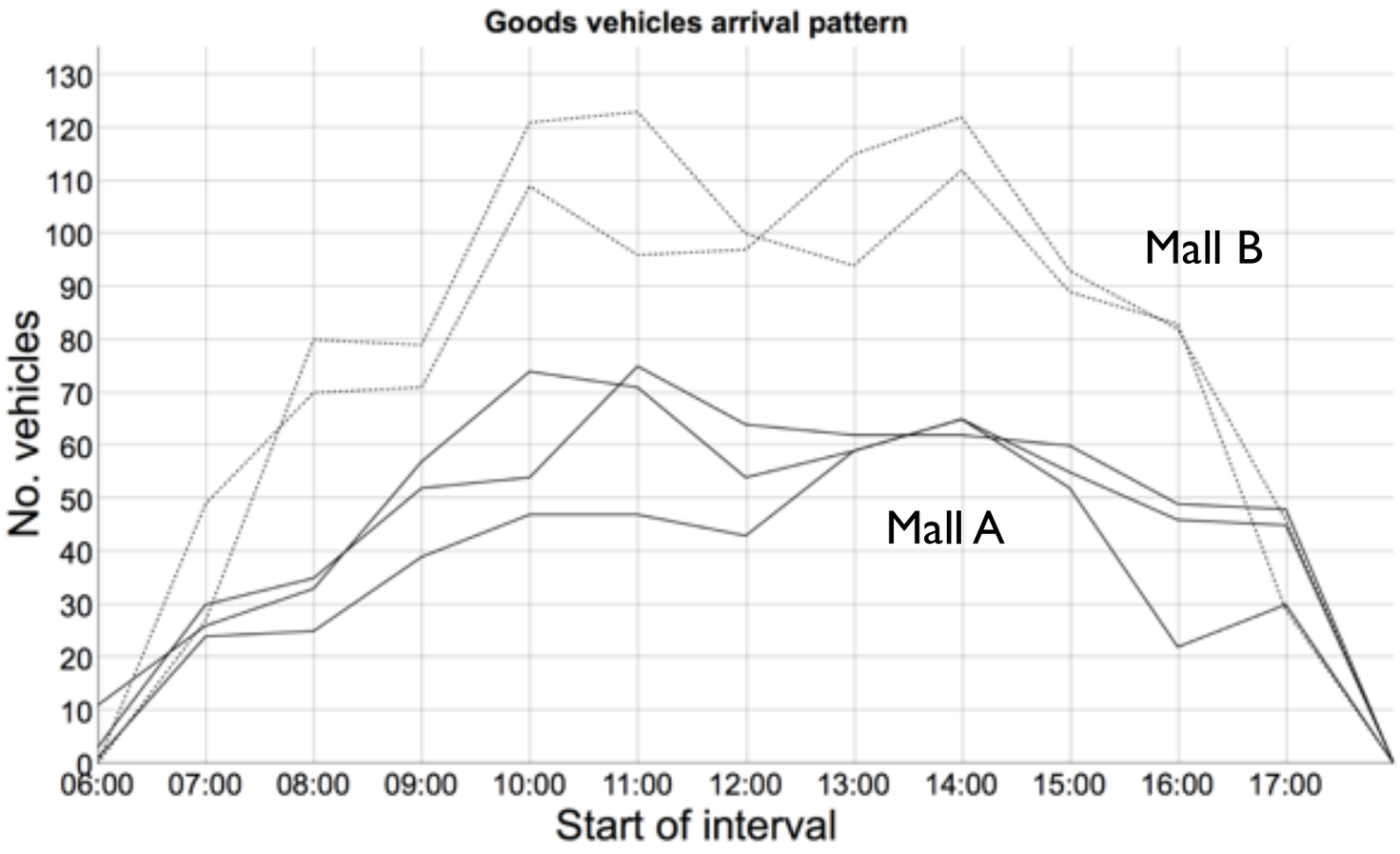
➡ shipment size, vehicle type, vehicle loading, no. helpers …

	no. stores	days	hours	vehicles observed
Mall A	160	3	6am - 6pm	1809 GVs
Mall B	173	2	6am - 6pm	2120 GVs
Mall B - gate data		6 months	24h	709574* (* include passenger vehicles)

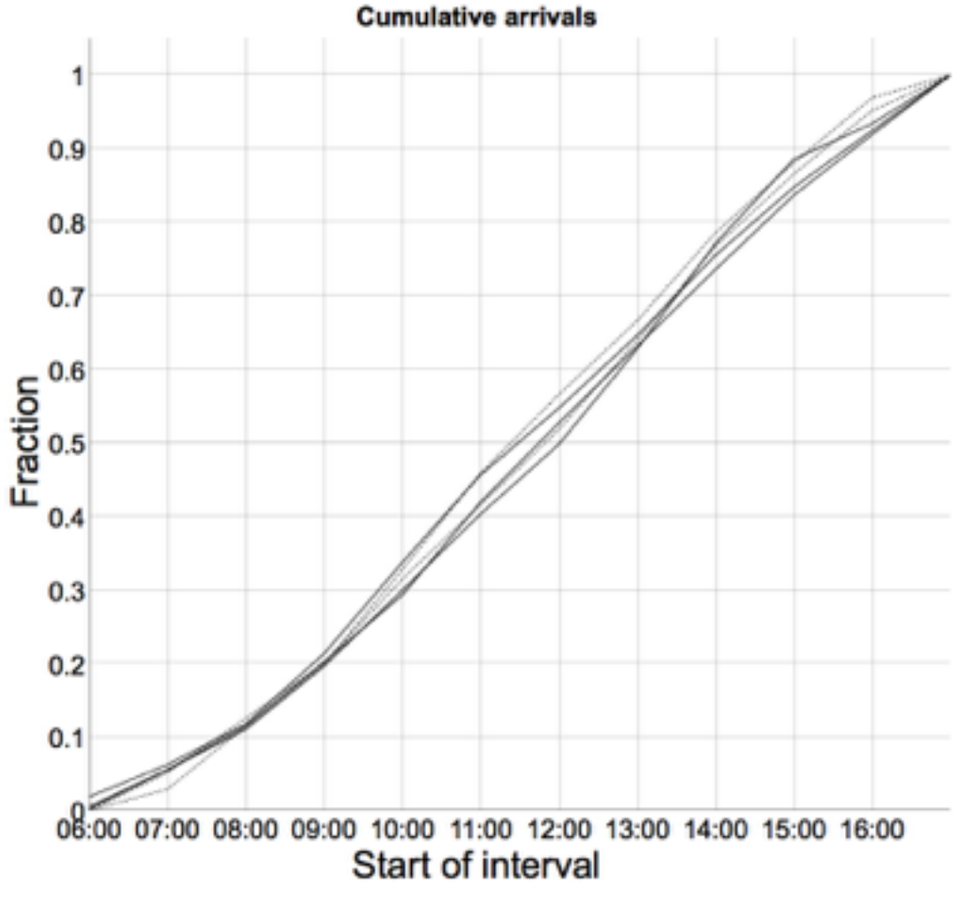
3. Data stories

Goods vehicles arrival patterns

Mall A			Mall B	
Wed 24 June	Thu 25 June	Fri 26 June	Thu 21 Jan	Fri 22 Jan
597	459	596	950	937



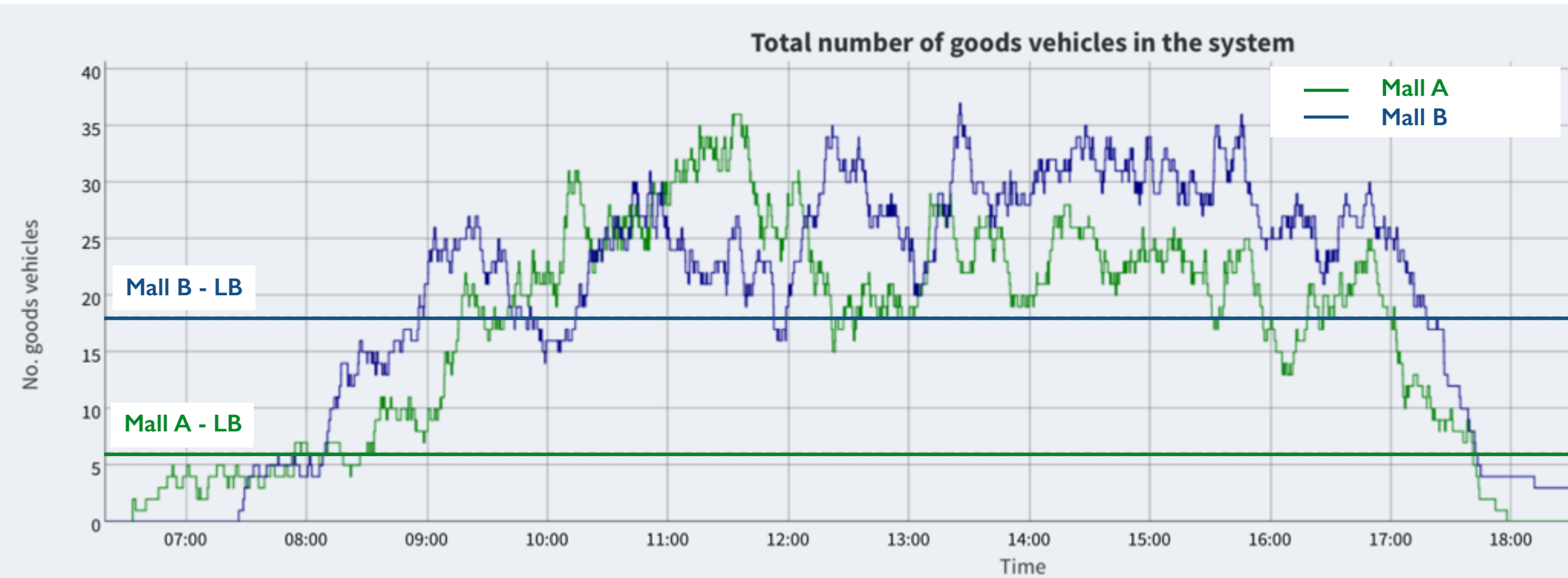
Good vehicle hourly arrival rates by time of the day.



Good vehicle cumulative arrivals by time of the day.

3. Data stories

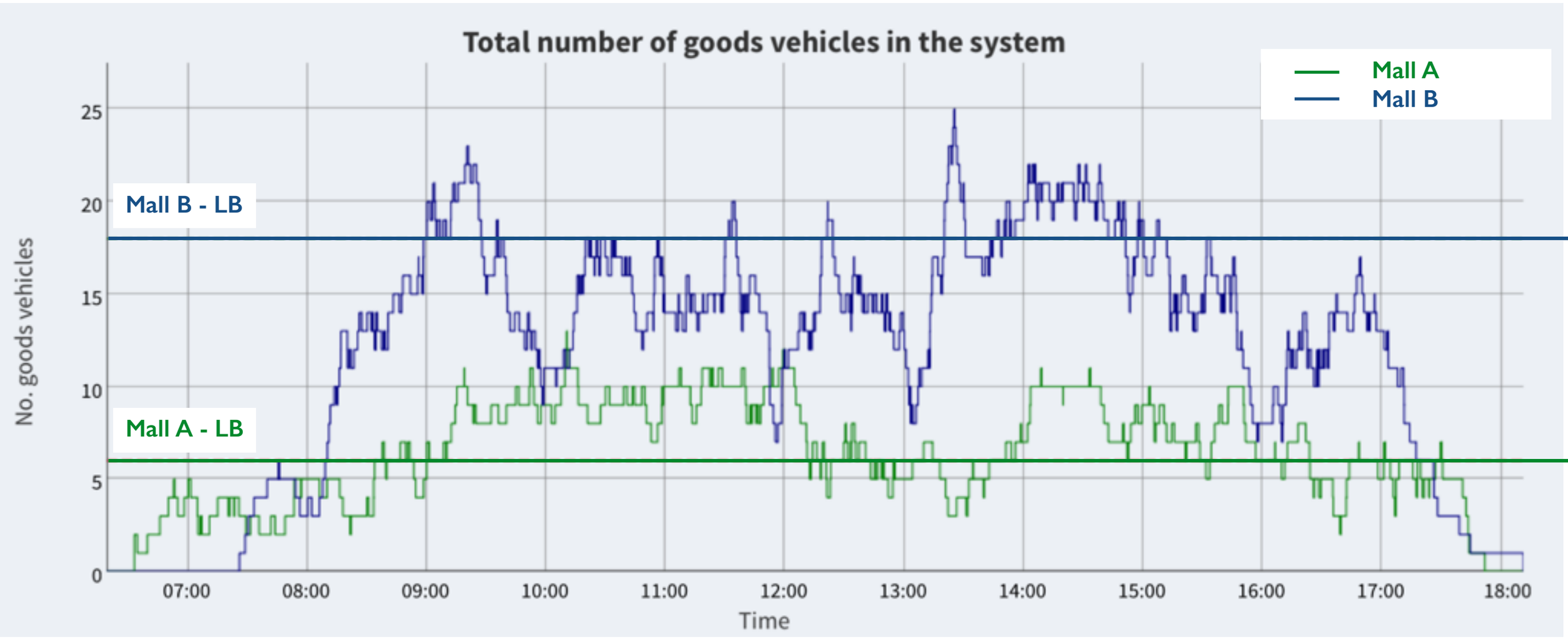
Number of goods vehicles in the system



Step plot: system entries (step-up) and exits (step-down) over time of the day.

3. Data stories

Number of goods vehicles in the loading bay



Step plot: loading bay entries (step-up) and exits (step-down) over time of the day. Source: A, B malls.

3. Data stories

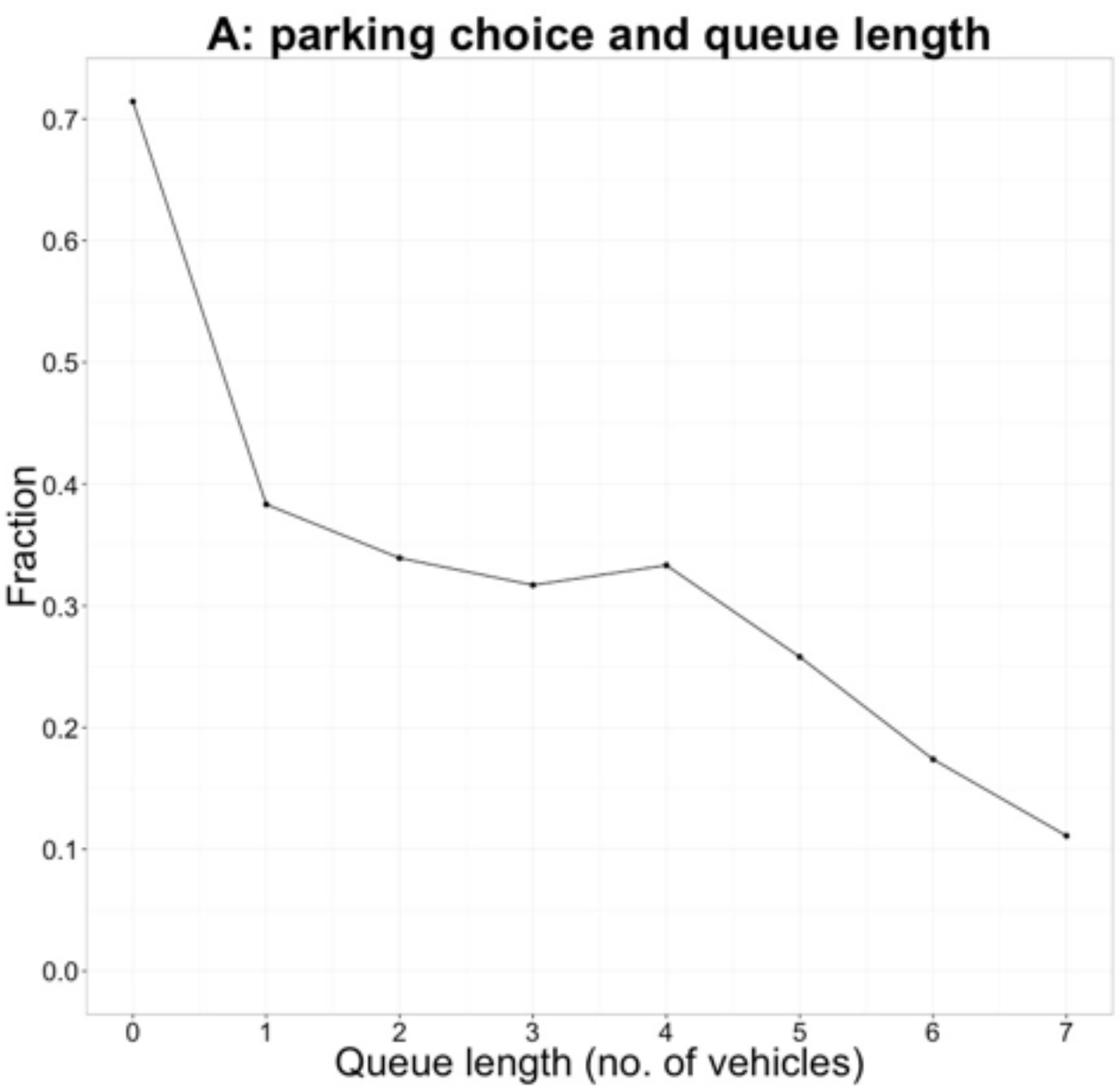
Parking location choices and handling time

Handling time distribution by parking location choice at Mall A.

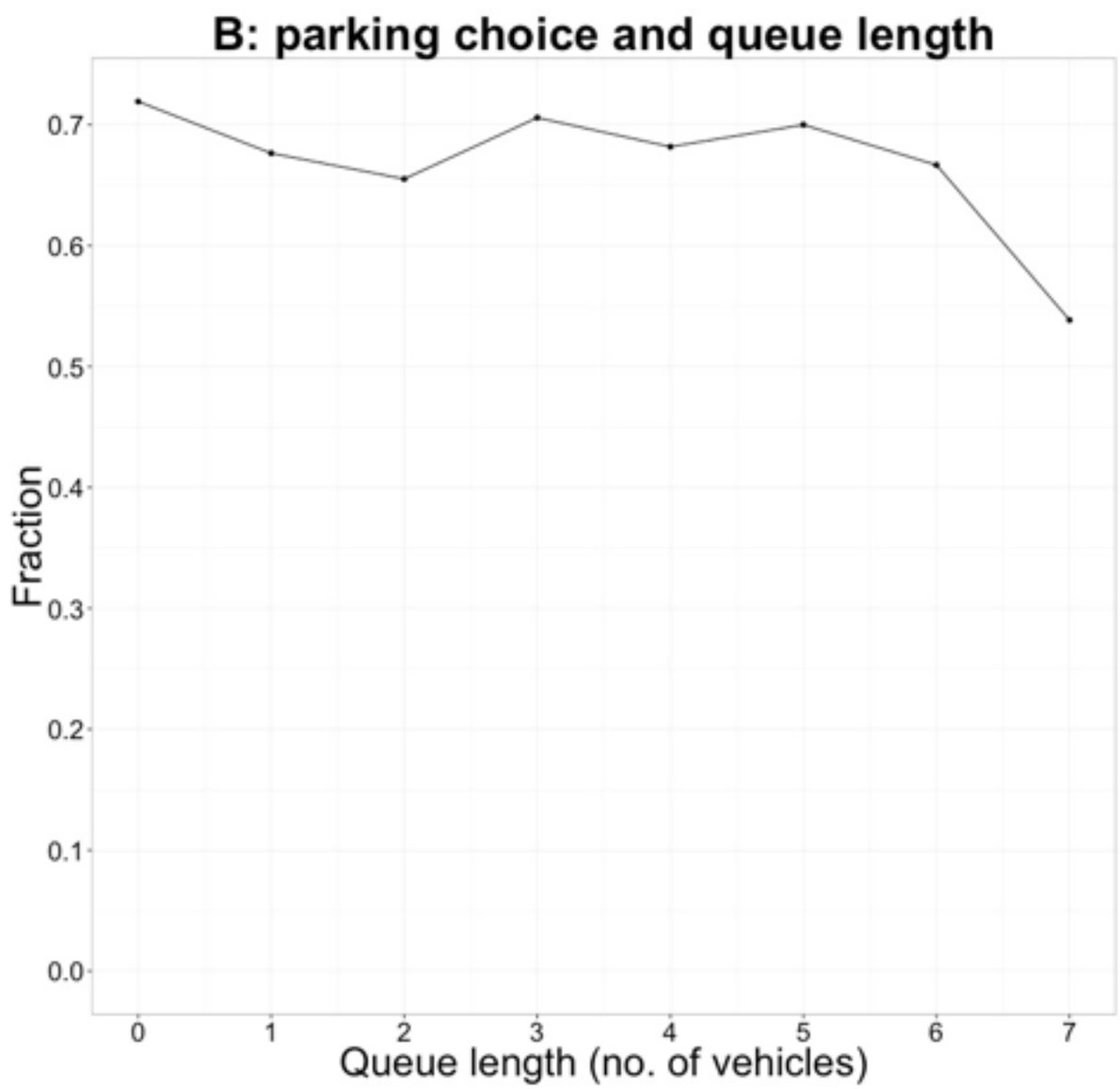
Handling time distribution by parking location choice at Mall B.

3. Data stories

How congestion influences parking choice?

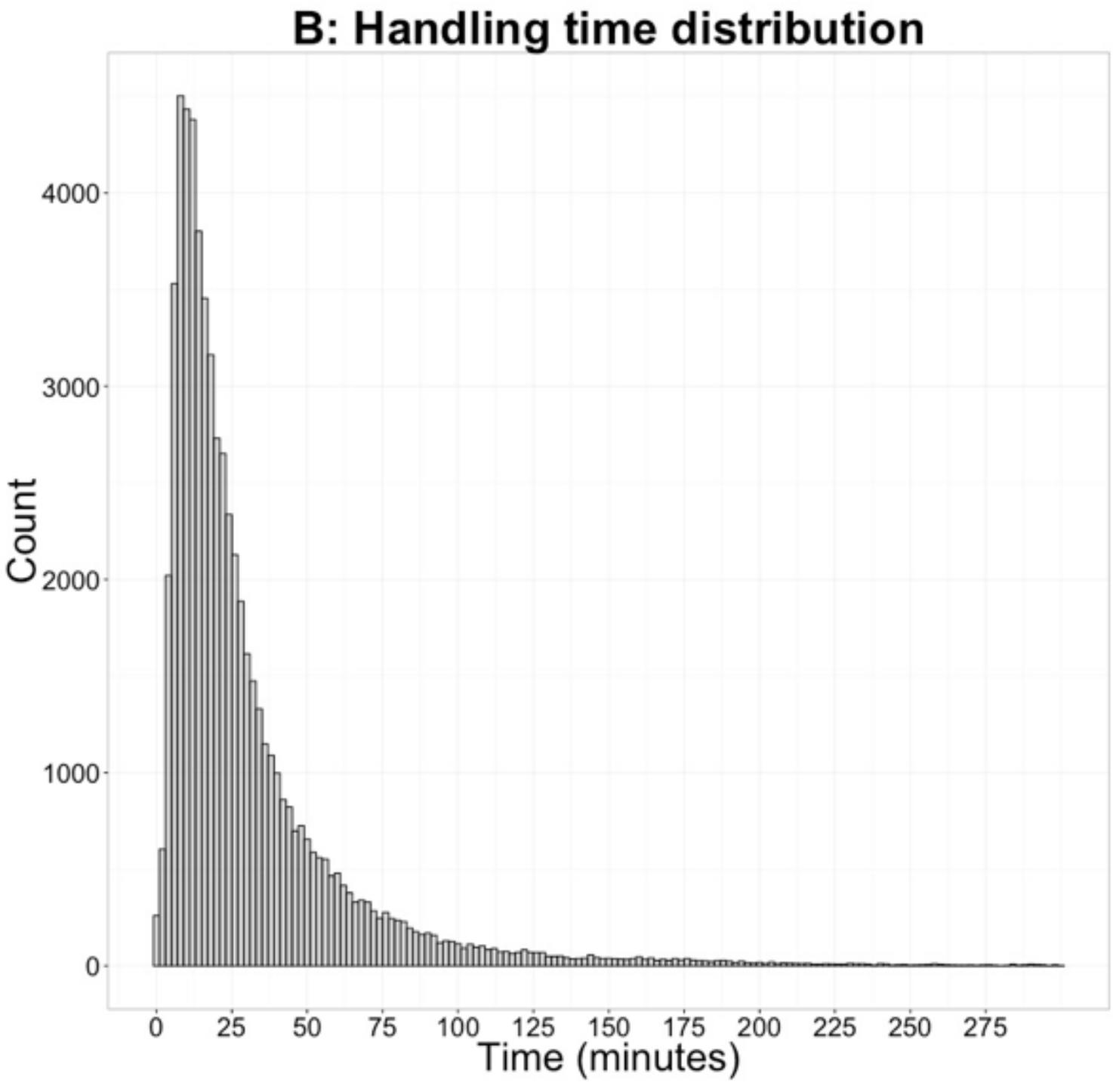


A. Fraction of goods vehicle parking in the loading bay vs. queue length (no. vehicles queueing). Source: Mall A.



B. Fraction of goods vehicle parking in the loading bay vs. queue length (no. vehicles queueing). Source: Mall B.

Loading bay handling time distribution

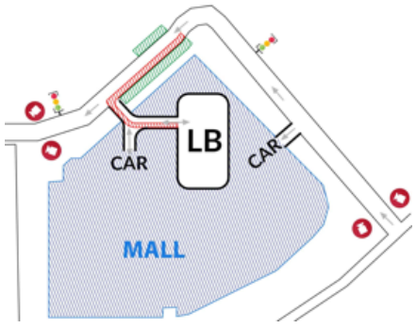


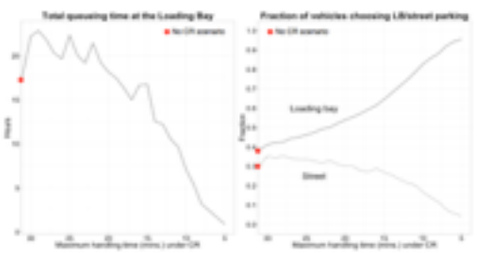
Empirical distribution of handling times. Source: Mall B, gates data.

Mean	31.1 min
1st quartile	11.2 min
Median	20.1 min
3rd quartile	37.2 min

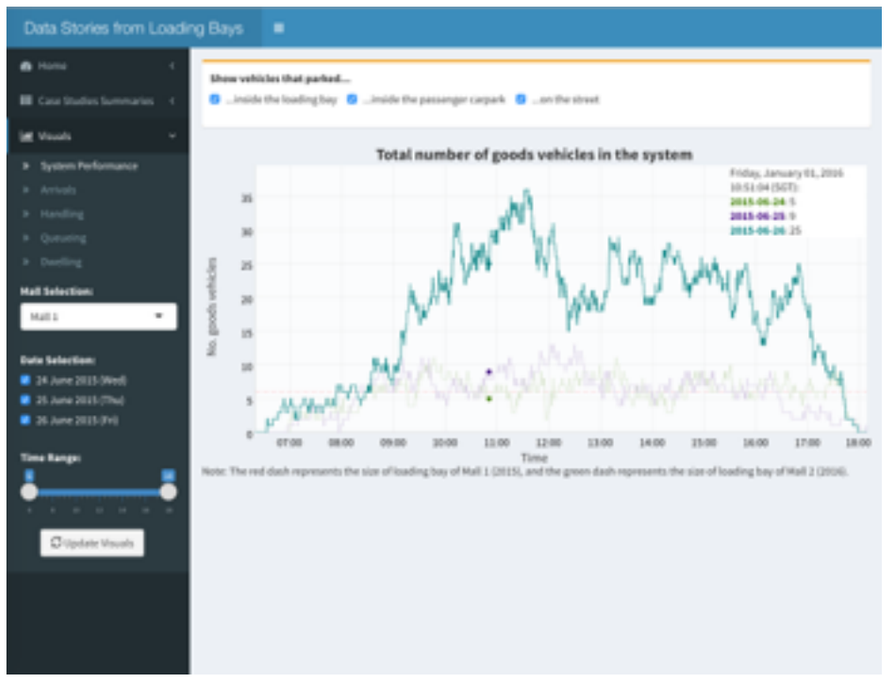
4. Conclusion

Data collection → Data visualisation → Model a "typical" Loading Bay → Evaluate urban logistics solutions





- modeling opportunities:
  - behavioural models (parking choice)
  - queueing (arrival process and service time distribution)



mobility.sutd.edu.sg/loadingbays

Prof. Lynette Cheah website

mobility.sutd.edu.sg/loadingbays

Thank you

Prof. Lynette Cheah *lynette@sutd.edu.sg*

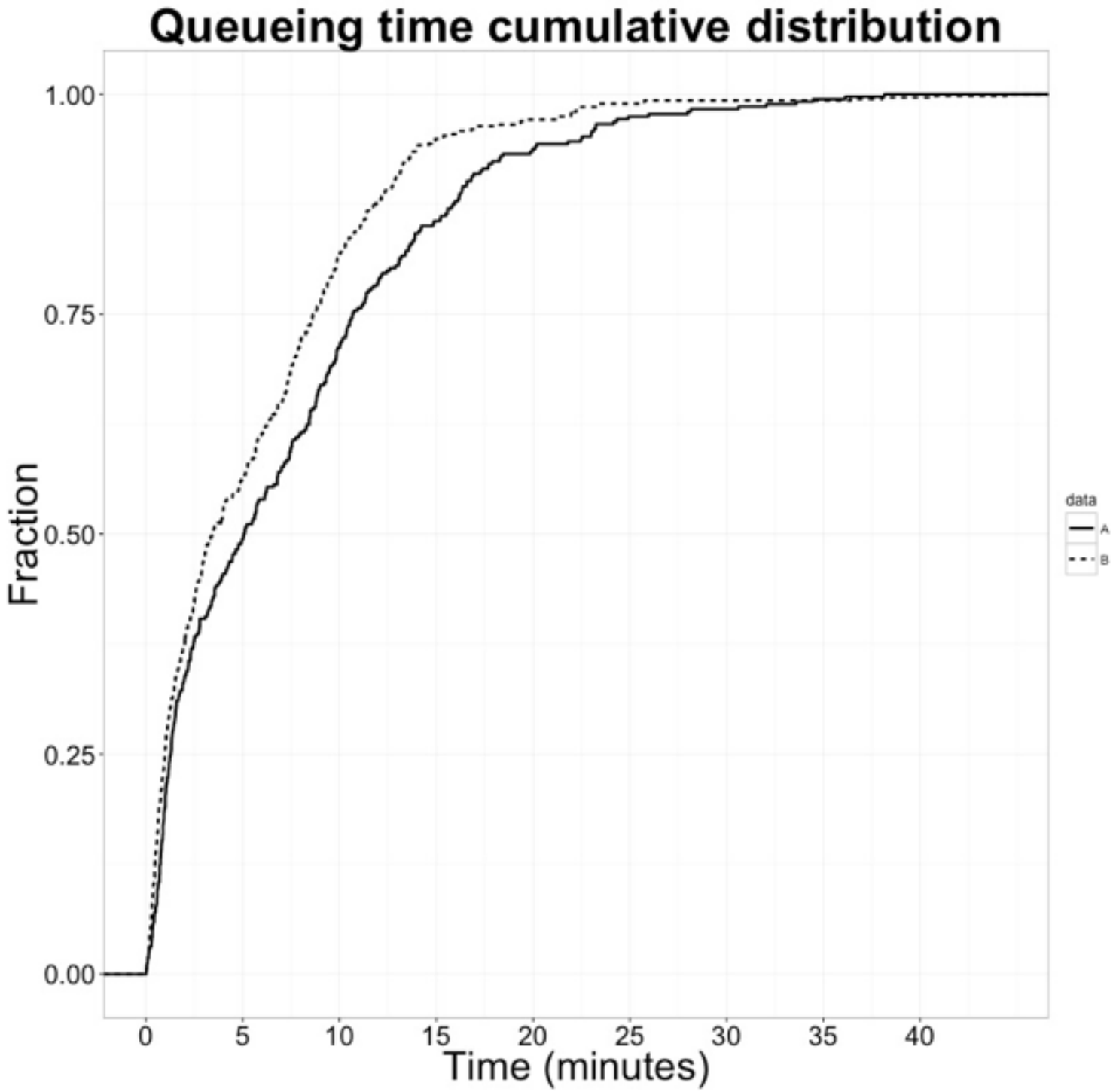
Giacomo Dalla Chiara *giacomo_dc@sutd.edu.sg*

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Established in collaboration with MIT

3. Data stories

Queueing times



Empirical cumulative distributions of queueing times. Source: malls A, B.

	Mall A	Mall B
Mean	7.2 min	5.6 min
1st quartile	1.3 min	1 min
Median	5.1 min	3.5 min
3rd quartile	10.7 min	8.6 min

3. Data collection: automatic video processing

INPUTS: video recordings
(10h x cam x day)

PLATE DETECTION

PLATE RECOGNITION

OUTPUTS: list of plates +
time stamps

MERGING & MATCHING

VALIDATION

3. Data collection: variables observed

VIDEO

TRAFFIC DATA

- **vehicle plate**
- park choice
- entry & exit times

MANUAL

VEHICLE OBSERVATIONS

- **vehicle plate**
- side plate
- vehicle loading
- car model
- refrigerated
- no. of helpers
- logo

SHIPMENT OBSERVATIONS

- handling time
- pick-up/delivery size
- commodity type

DRIVER SURVEY

- **store name**
- employer type
- routing (no. stops, re-loading, origin)
- decisions (ERP, gasoline refilling, decision makers, working hours etc.)

OTHERS *

STORE DATA

- **Store features**: floor, industry type, area, storage space, opening time, **store name**
- **Supply chain features**: no. branches, industry type, type of carrier used, type of distribution …

*other data sources include corporate websites and a retailer survey.

3. Data collection: site maps