Dwell time delays for commuter trains

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Important indicators for attractiveness of trains are *punctuality*, travel time *reliability*, and travel time *predictability* (Brons & Rietveld, 2008; van Loon et al., 2011)

Although on-board experience is essential, *improvements* here *will only be beneficial* when passengers are also *satisfied* with the *reliability* of the service they use (van Lierop et al., 2018)

Dwell time delays at a *single station might be small*, however, the cumulative dwell time delays over an entire train run can amount to a *large portion of the journey time* (Christoforou et al., 2020)

Dwell time delays can lead to *knock-on delays* when a subsequent train cannot enter the station
(Yamamura et al., 2012)

Problem description

- Much effort into optimizing run times and headways

- Scheduling practices for dwell times have remained stagnant during this time

- Lack of understanding of the underlying causes for dwell time

Research gap

- Most in-depth studies took place in laboratory settings

- Studies using real-world data are limited in sample size and geographical spread

- Only few studies using rich datasets to study dwell times on a network wide level

Aim of my thesis

Develop knowledge of how dwell time delays arise in relation to operational and passenger variables and describe potential ways in which dwell time delays can be reduced.

Research question 1
What are the likely causes of dwell time delays for commuter trains?

Research question 2
How do boarding and alighting passengers influence the duration of dwell times for commuter trains?
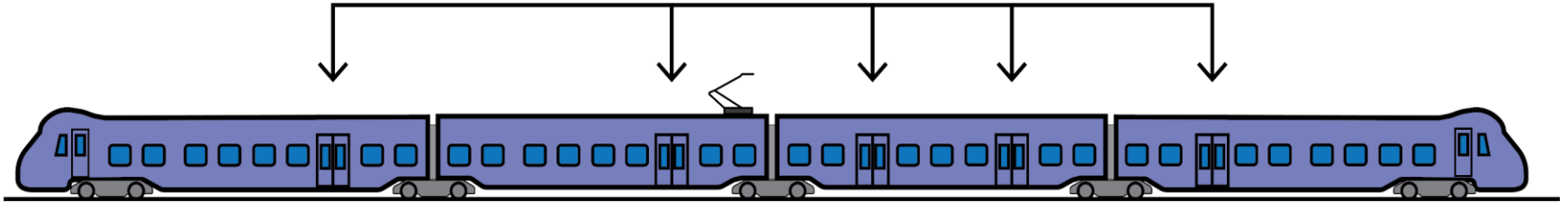
Research question 3
What is the combined influence of stations on dwell times for commuter trains?

Research question 4
What kind of measures can be taken to reduce dwell time delays for commuter trains?

Infrared passenger counters at each door

Automatic passenger count data provides

- Number of passengers boarding per door
- Number of passengers alighting per door
- Dwell time in seconds

Year /Delay size	No delay		1 min.		2 min.		3 min.		4 min.		5 min.	
	LUPP	APC	LUPP	APC	LUPP	APC	LUPP	APC	LUPP	APC	LUPP	APC
2017	67%	24%	29%	65%	3%	9%	1%	1%	0%	1%	0%	0%
2018	68%	10%	27%	77%	3%	11%	1%	2%	0%	1%	0%	0%
2019	69%	15%	26%	71%	3%	12%	1%	2%	0%	1%	0%	0%

Year /Delay size	No delay		1 min.		2 min.		3 min.		4 min.		5 min.	
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2017	67%	24%	29%	65%	3%	9%	1%	1%	0%	1%	0%	0%
2018	68%	10%	27%	77%	3%	11%	1%	2%	0%	1%	0%	0%
2019	69%	15%	26%	71%	3%	12%	1%	2%	0%	1%	0%	0%

Research question 1

What are the likely causes of dwell time delays for commuter trains?

Influence of passengers

Flow of passengers - Interaction between rolling stock design and passenger behaviour (Li et al., 2016)

Door width may not be as significant as commonly stated (Harris et al., 2014)

Positioning and behaviour of passengers can be more influential (Harris et al., 2014; Harris & Anderson, 2007)

Influence of operational variables

Current scheduling regimes are not realistic and not updated often enough

Arrival punctuality of trains – late trains extend dwell times (Kecman & Goverde, 2015)

Research question 2

How do boarding and alighting passengers influence the duration of dwell times for commuter trains?

(Buchmueller et al., 2008)

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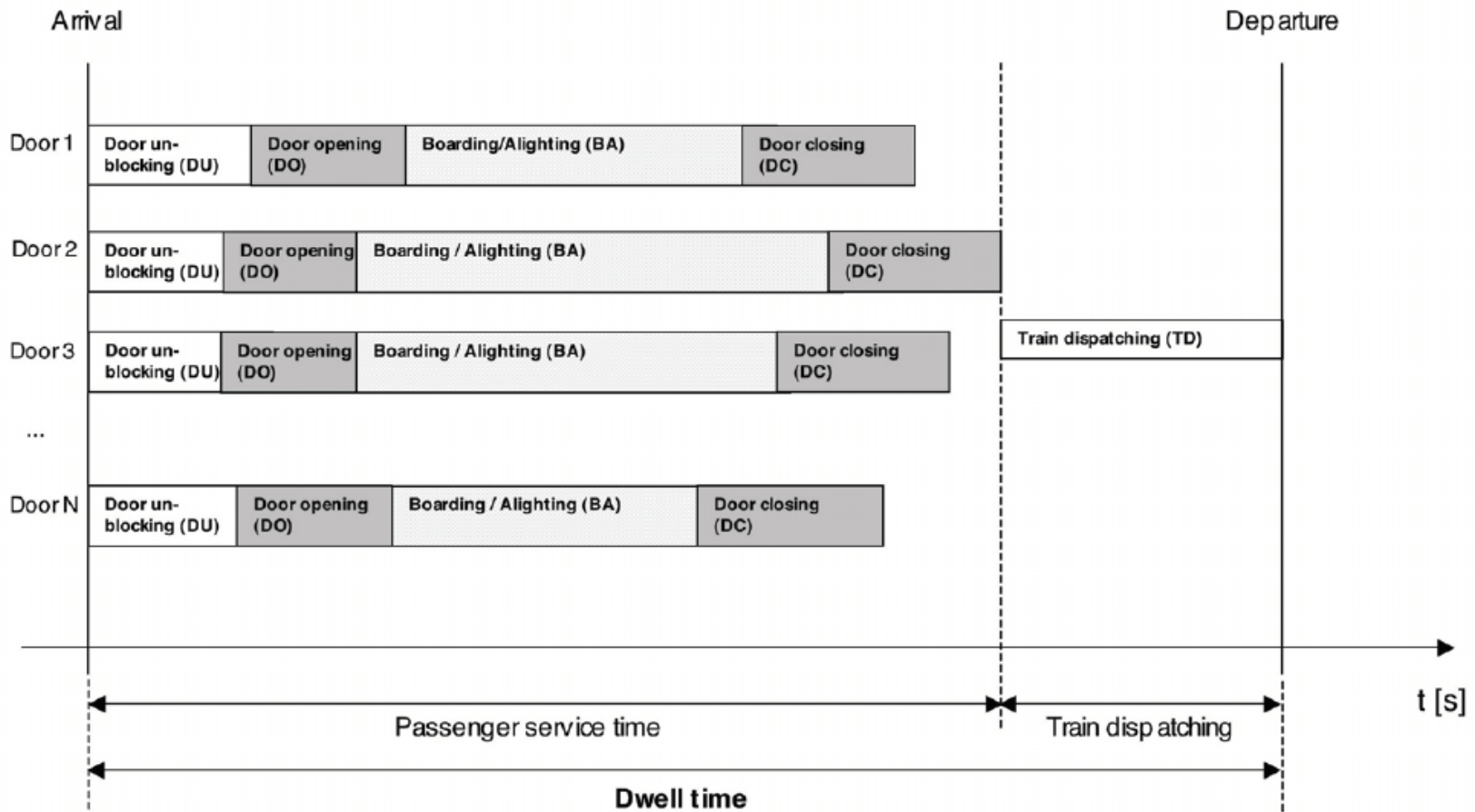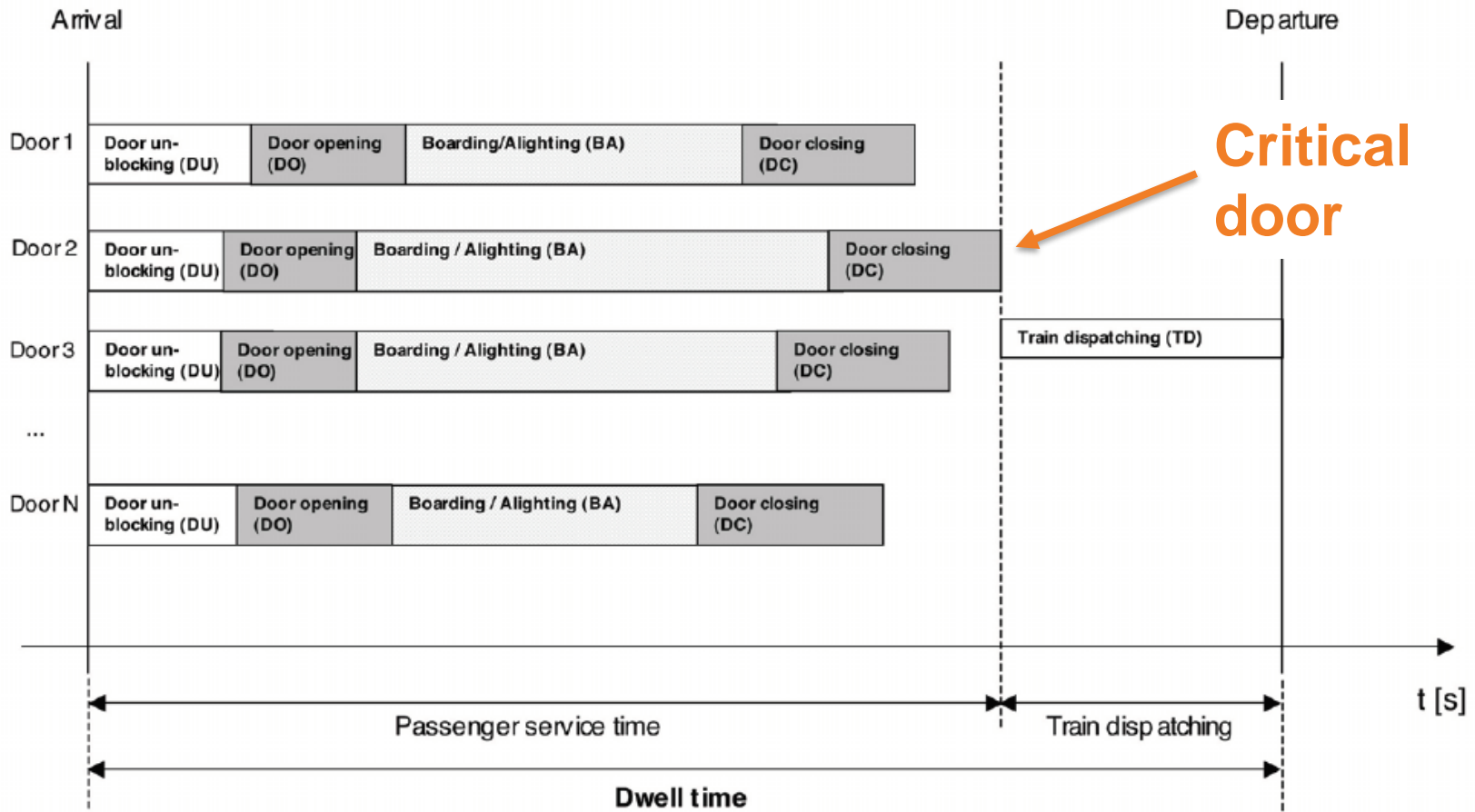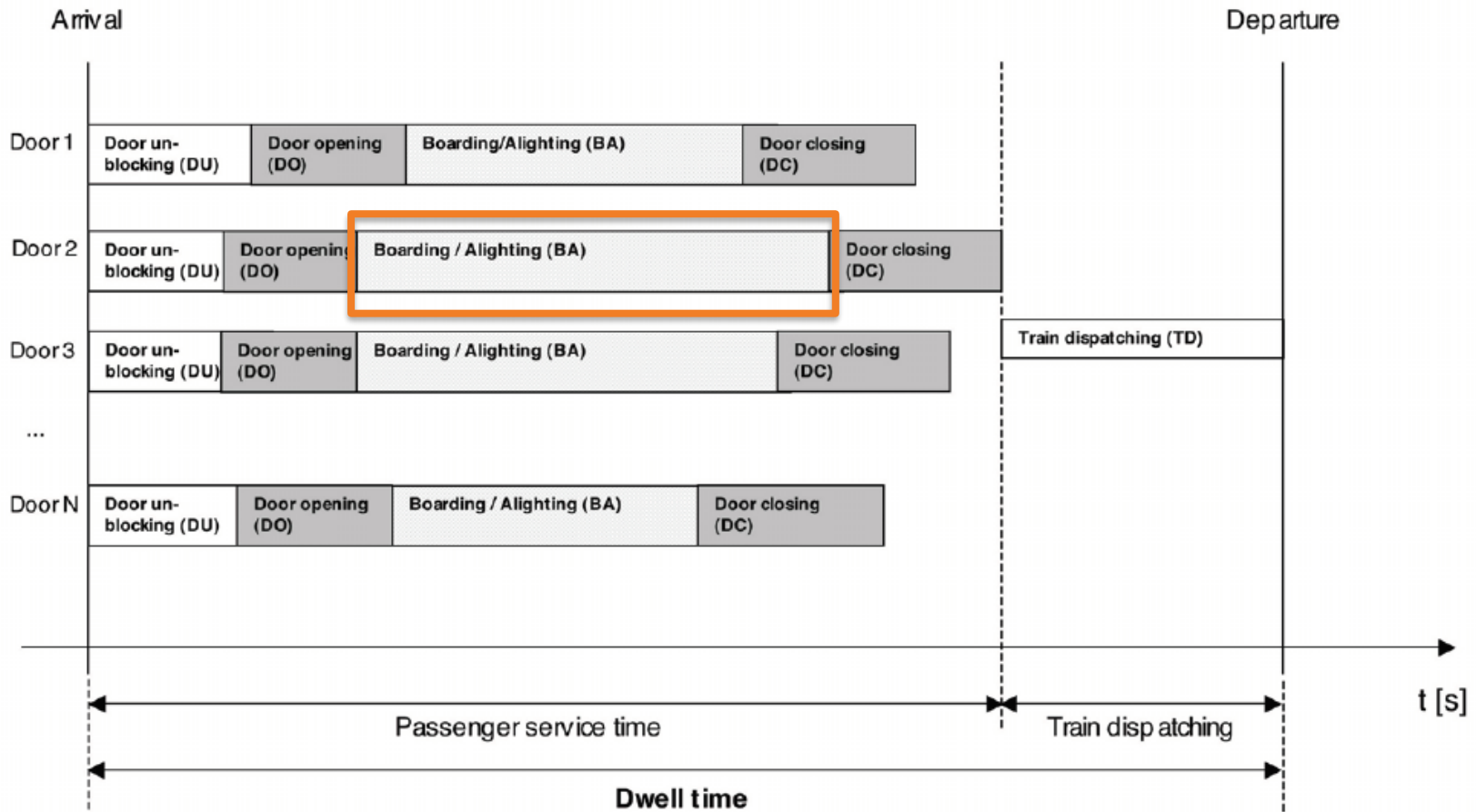
Flow of passengers (Li et al., 2016)

Studies show linear relationship between passenger volume and dwell time
(Antognoli et al., 2018; Lee et al., 2018; Palmqvist et al., 2020)

The relation between the volume of passengers and dwell time delays is not necessarily linear
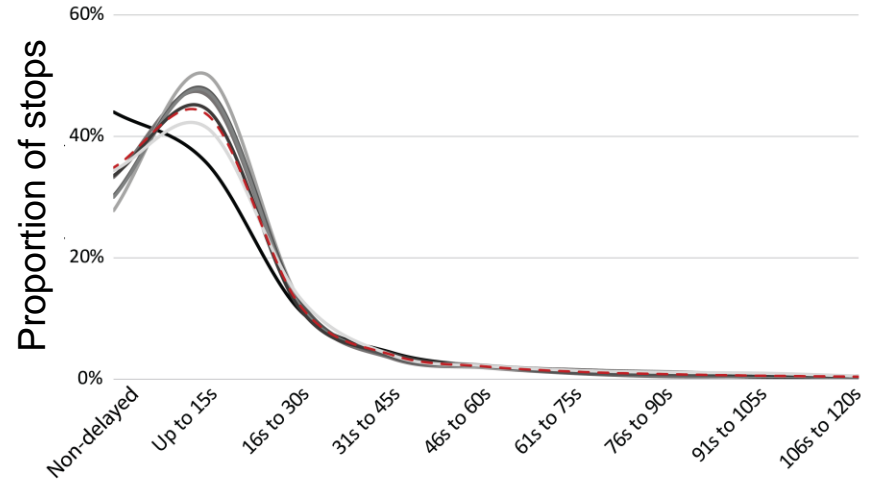(Kuipers & Palmqvist, 2022)

Scheduled dwell time = 42s
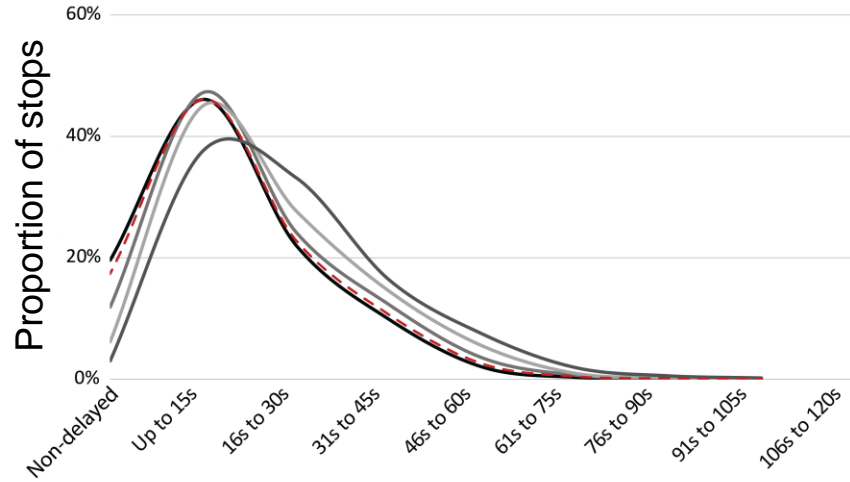
Scheduled dwell time = 120s

Legend: 0 to 10 passengers — 11 to 20 passengers — 21 to 30 passengers — 31 to 40 passengers — 41 to 50 passengers — 51 to 60 passengers — 61 to 70 passengers — Unconditional proportion

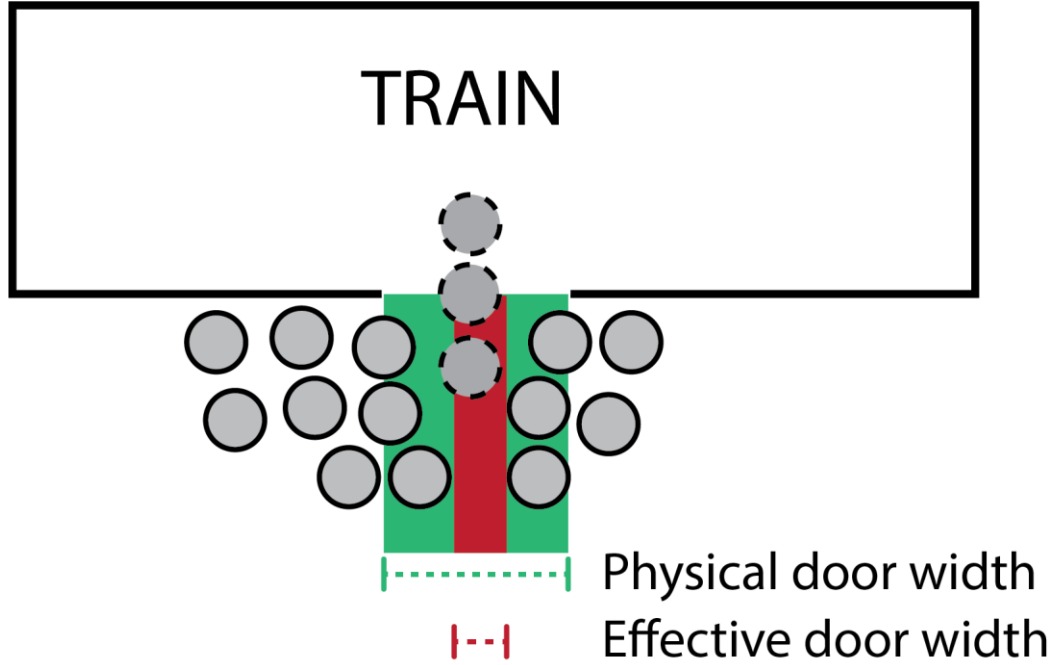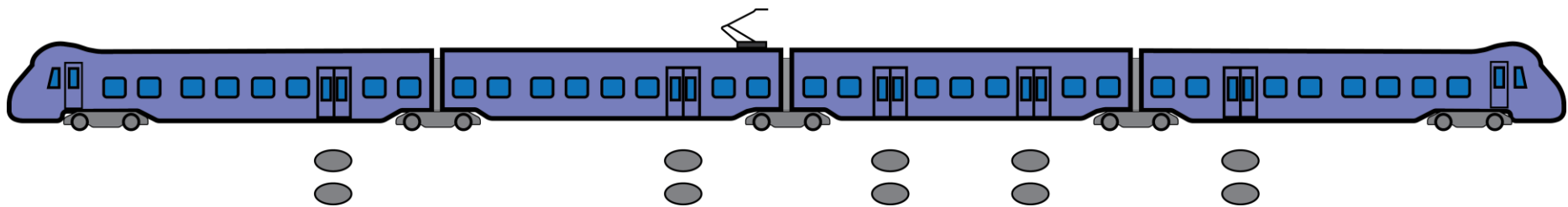Based on APC data from Stockholm collected between 2013–2016

Reduced passenger volumes during COVID-19 improved dwell times but improvements were found across all passenger volumes.
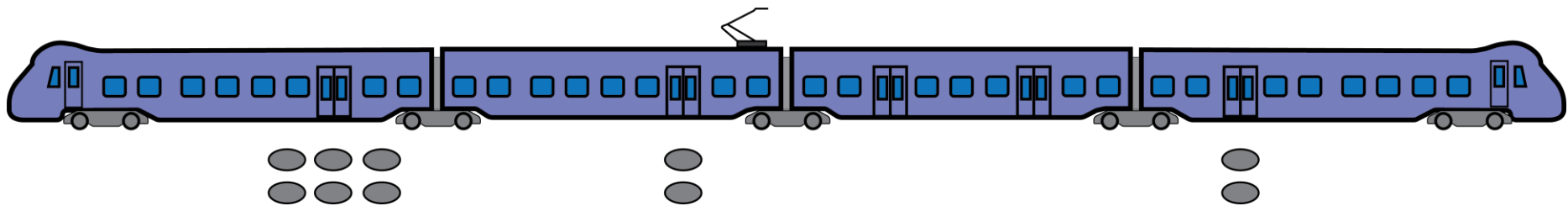(Kuipers & Palmqvist, 2023)

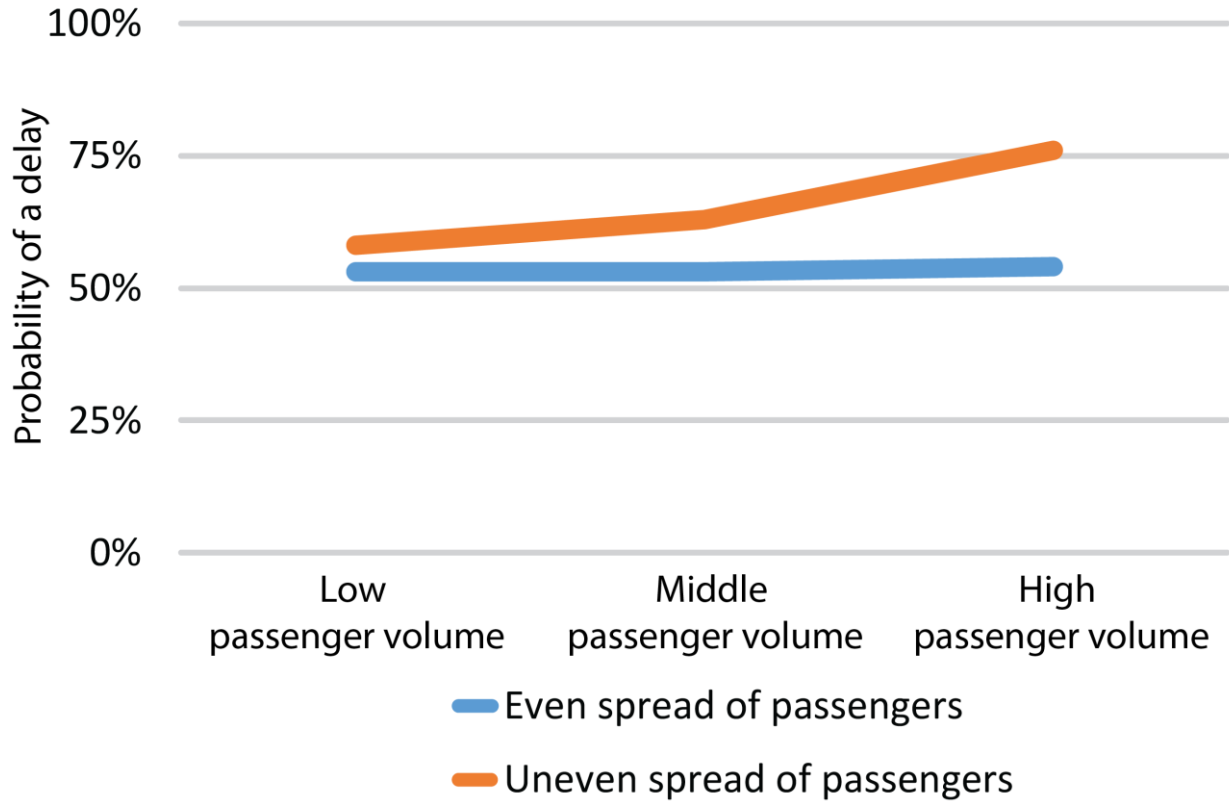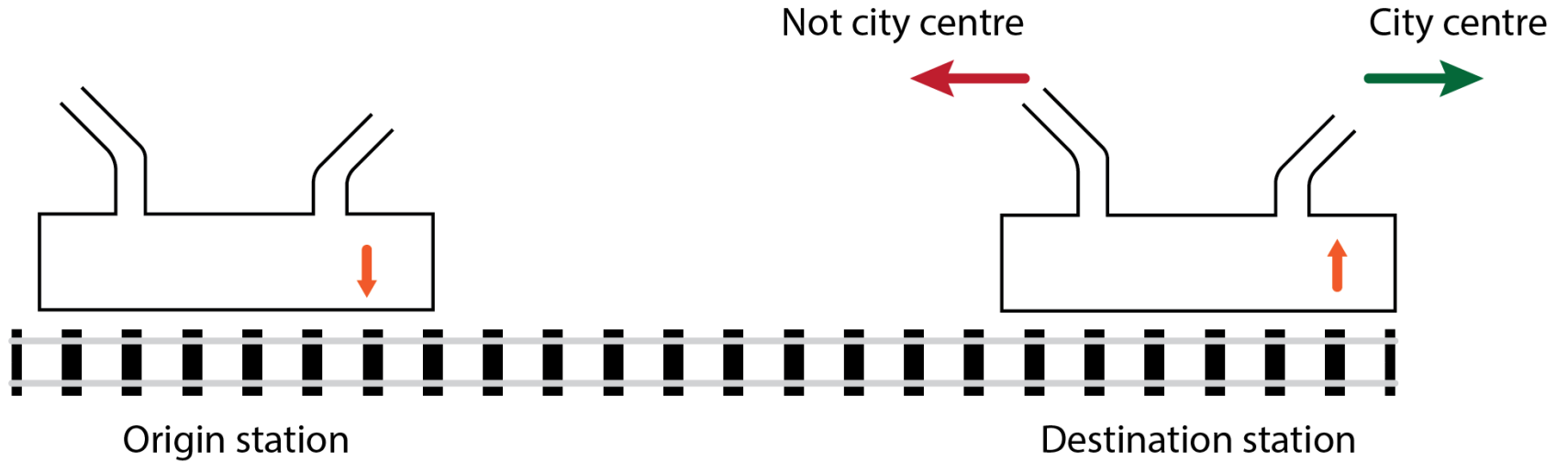The volume of passengers acts as an *accelerator* for the effect of other passenger flow related variables.

Adapted from (Harris et al., 2014)

VS

Research question 3
What is the combined influence of stations on dwell times for commuter trains?

Not city centre

City centre

Origin station

Destination station

Research question 4
What kind of measures can be taken to reduce dwell time delays for commuter trains?

A different approach to scheduling for dwell times

Dynamic scheduling – different dwell times for services and the time of the day

Platform management

Spread out passengers more evenly – make the critical door less critical

Avoid crowding around doors

Conclusion

Policy implications

No silver bullet for punctual dwell times, but:

- Dwell time should be scheduled more dynamically

- Planners should understand and adapt (to) passenger behaviour

- Planners should make (more) use of the available automatic passenger count data

Future research

Study the relation between stations on a network level

Observe passenger behaviour on a qualitative level

Try out dynamic timetabling within simulations, or real-world situations

Study the effect of platform management