

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)

Can cause problems when *trip-chaining*

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

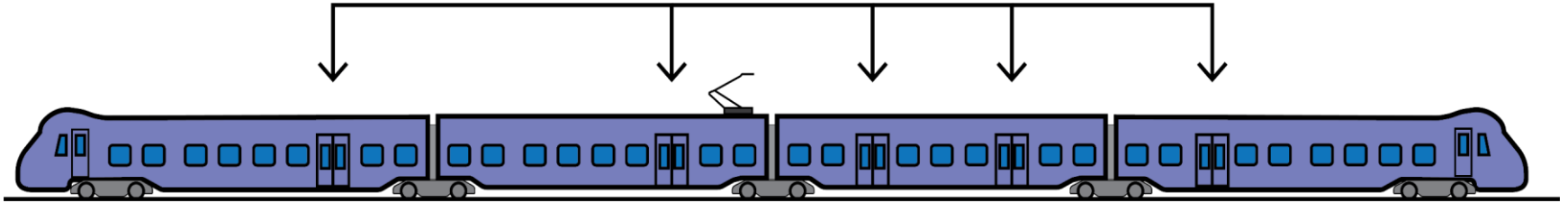
What is the influence of stations and services on dwell times for commuter trains?

Research question 4

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



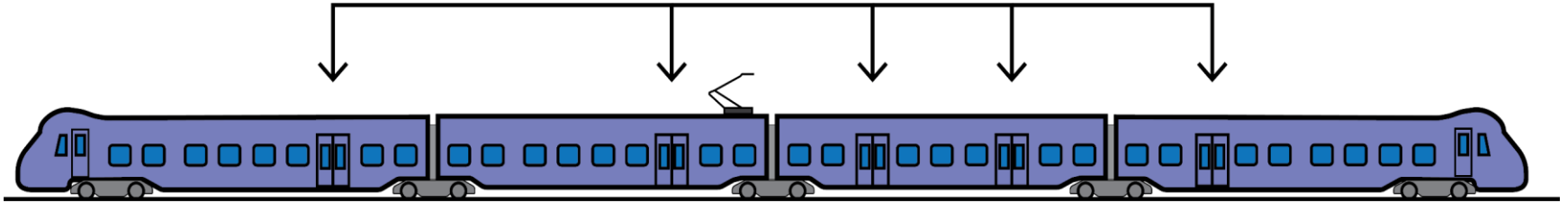
Infrared passenger counters at each door



Automatic passenger count data provides

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

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.	
	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%



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

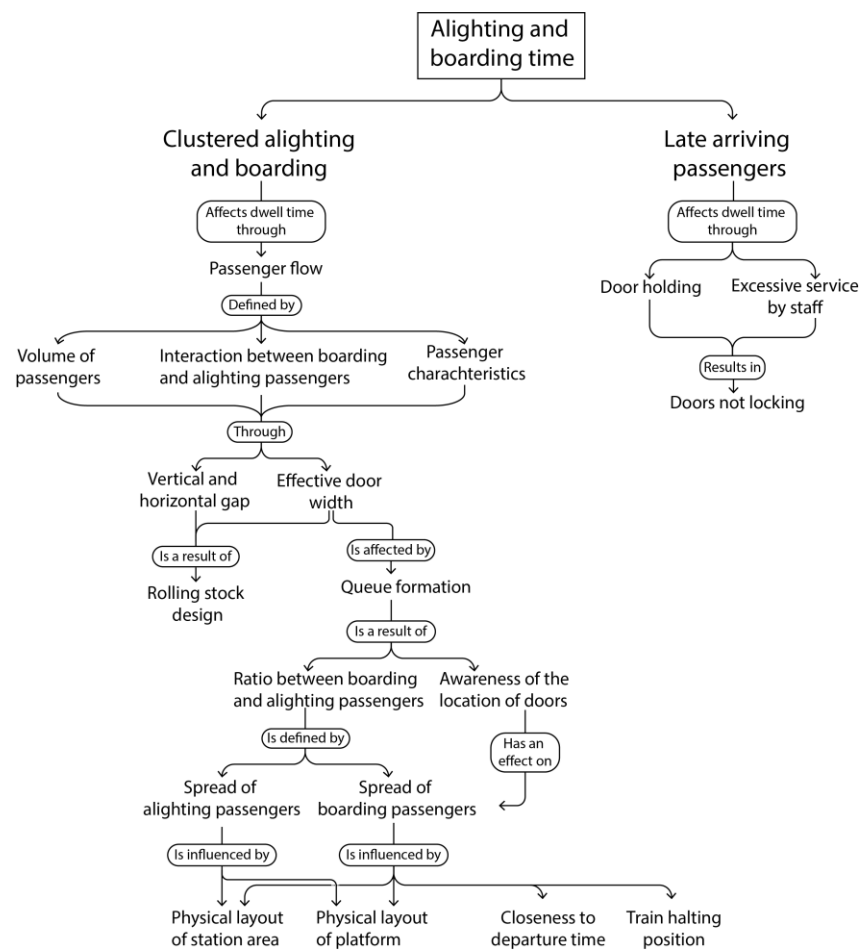
Arrival punctuality of trains – late trains extend dwell times (Kecman & Goverde, 2015)



Research question 2

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





Quantifying the effect of passengers on dwell times

Based on the available data we could quantify the effect of:

- The volume of passengers
- The ratio between boarding and alighting passengers
- The spread of boarding passengers



Volume of passengers

Studies show/assume a linear relationship between passenger volume and dwell time

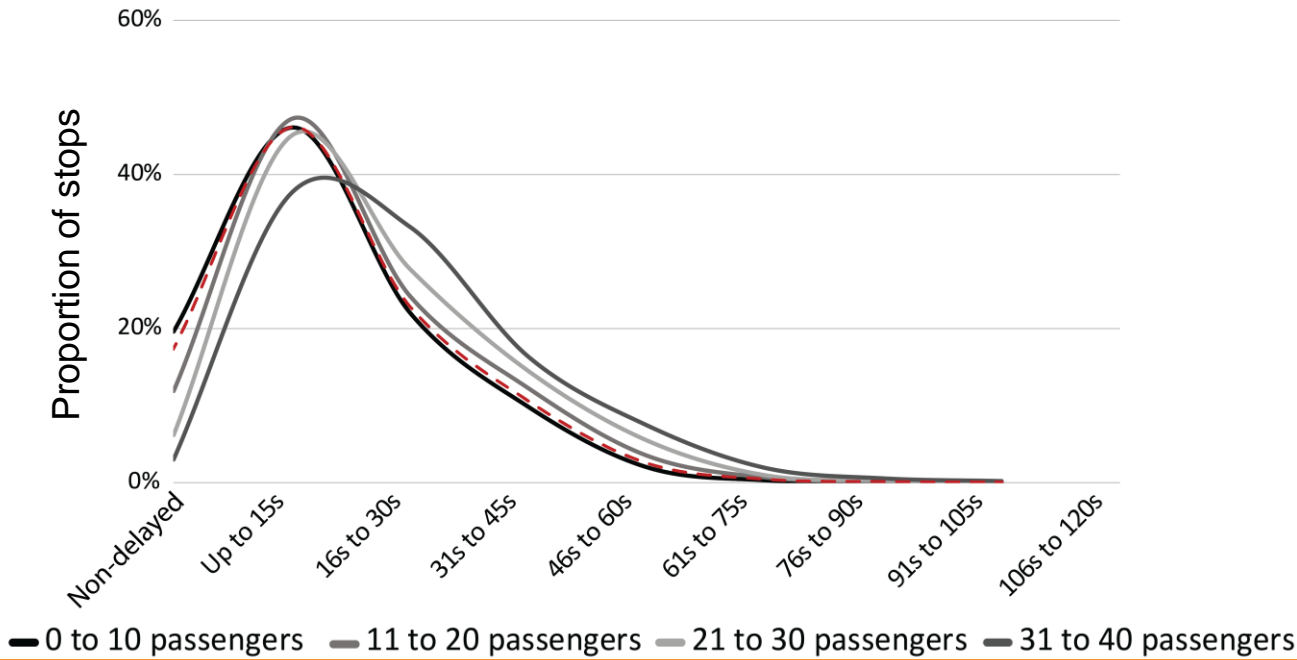
(Antognoli et al., 2018; Lee et al., 2018; Palmqvist et al., 2020)

The relation between the volume of passengers and dwell time delays is not necessarily linear – frequency goes up, size does not

(Kuipers & Palmqvist, 2022)



Volume of passengers



Data taken from (Kuipers & Palmqvist, 2022a)



Ratio between boarding and alighting passengers

Studies indicate that a ratio towards more boarding passengers, or even ratio leads to longer dwell times

(Harris, 2005; Seriani et al., 2019)

Findings show limited effect of ratio of boarding and alighting passengers, with a ratio in favour of boarding passengers leading to smaller dwell times



Spread of boarding passengers

Uneven spread increases the probability of a dwell time delay

This effect occurs mostly under higher passenger volumes

In line with previous studies

(Fox et al., 2017; Oliveira et al., 2019)



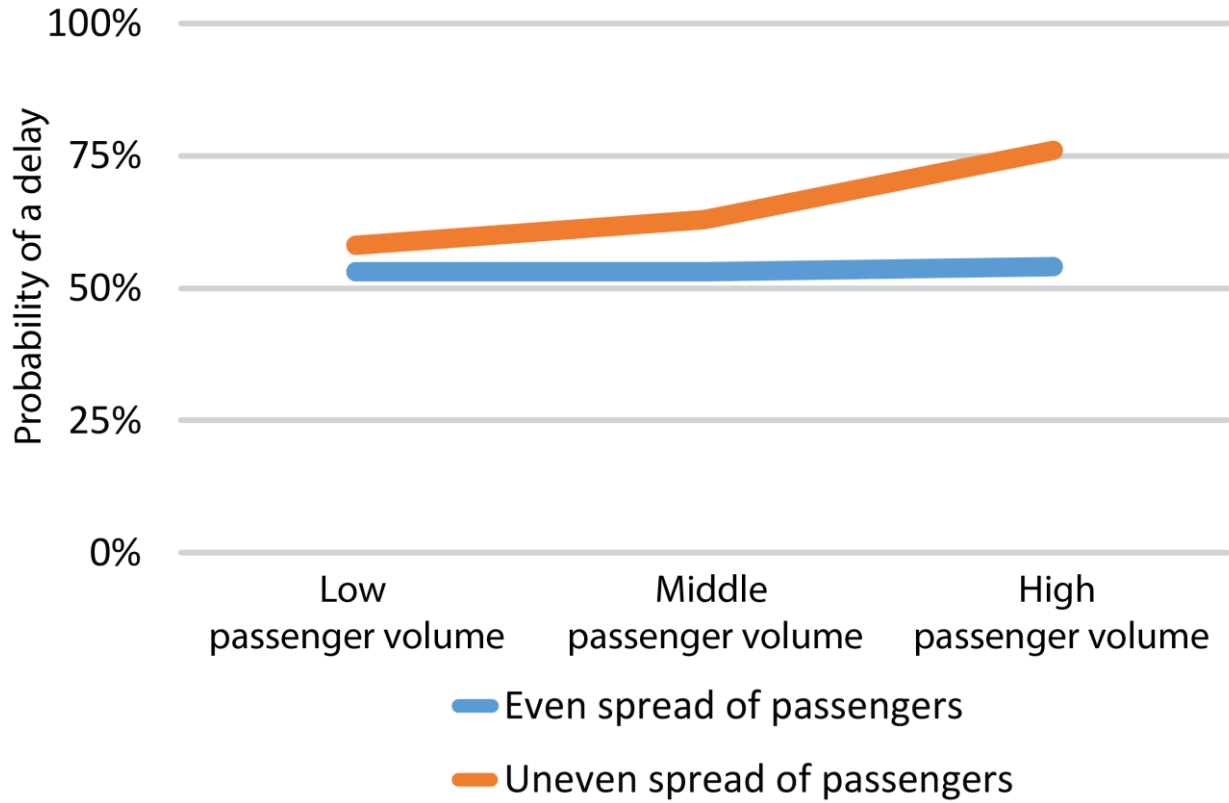
Key finding

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

Reduced passenger volumes during COVID-19 improved dwell times but improvements were found across all passenger volumes.

(Kuipers & Palmqvist, 2023)

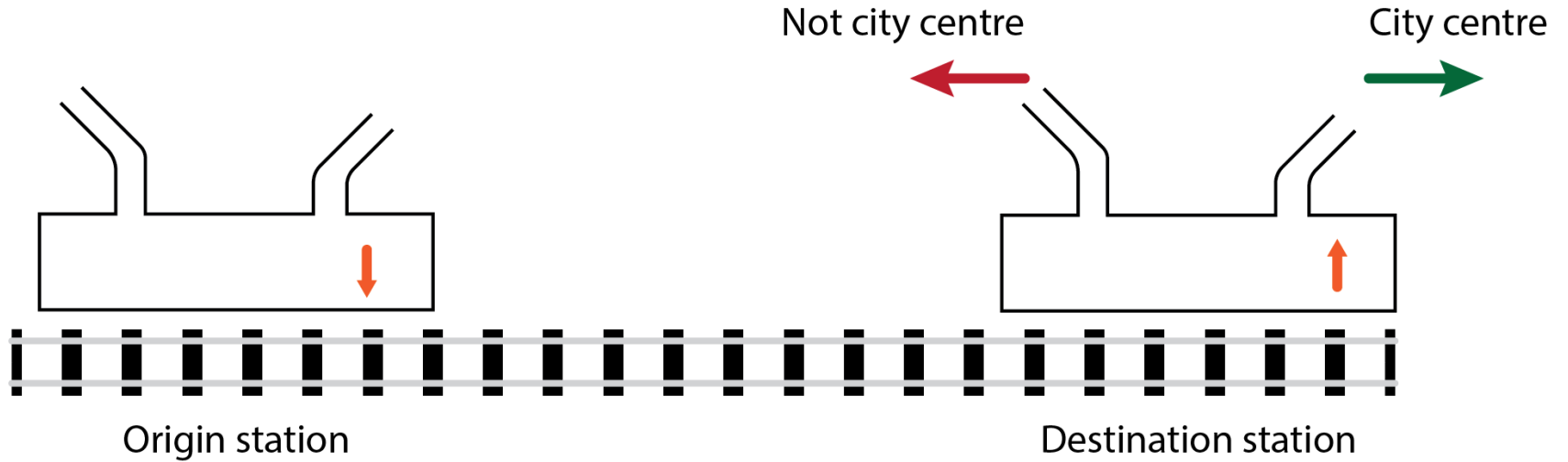


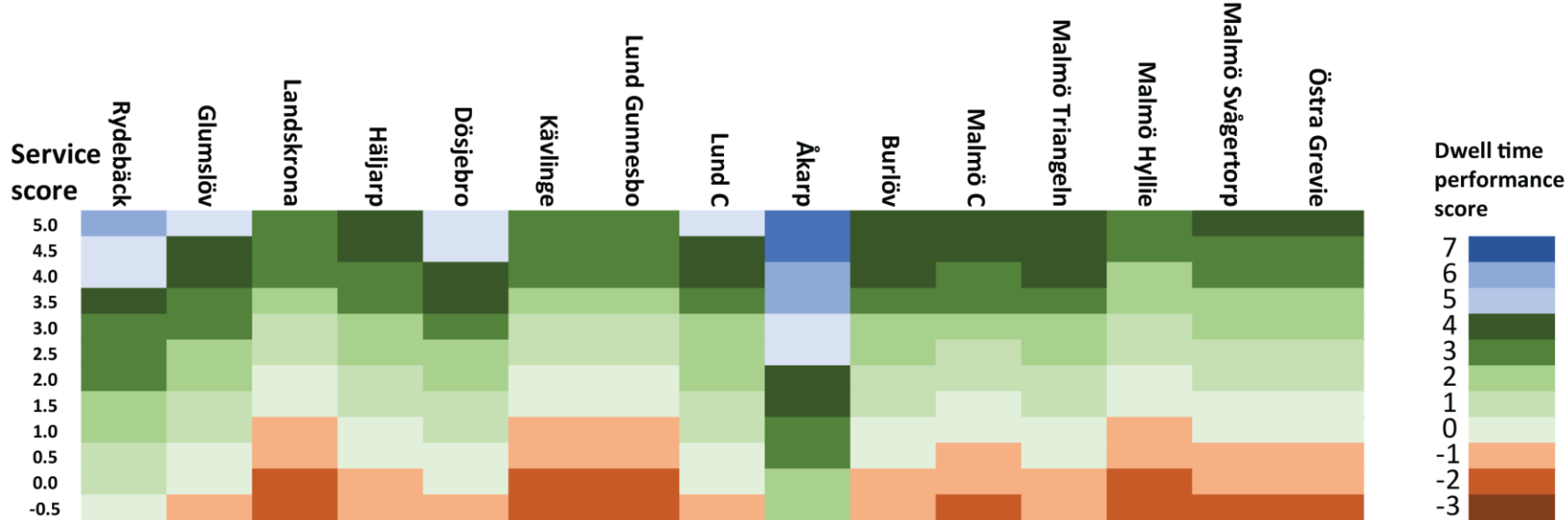


Research question 3

What is the influence of stations and services on dwell times for commuter trains?

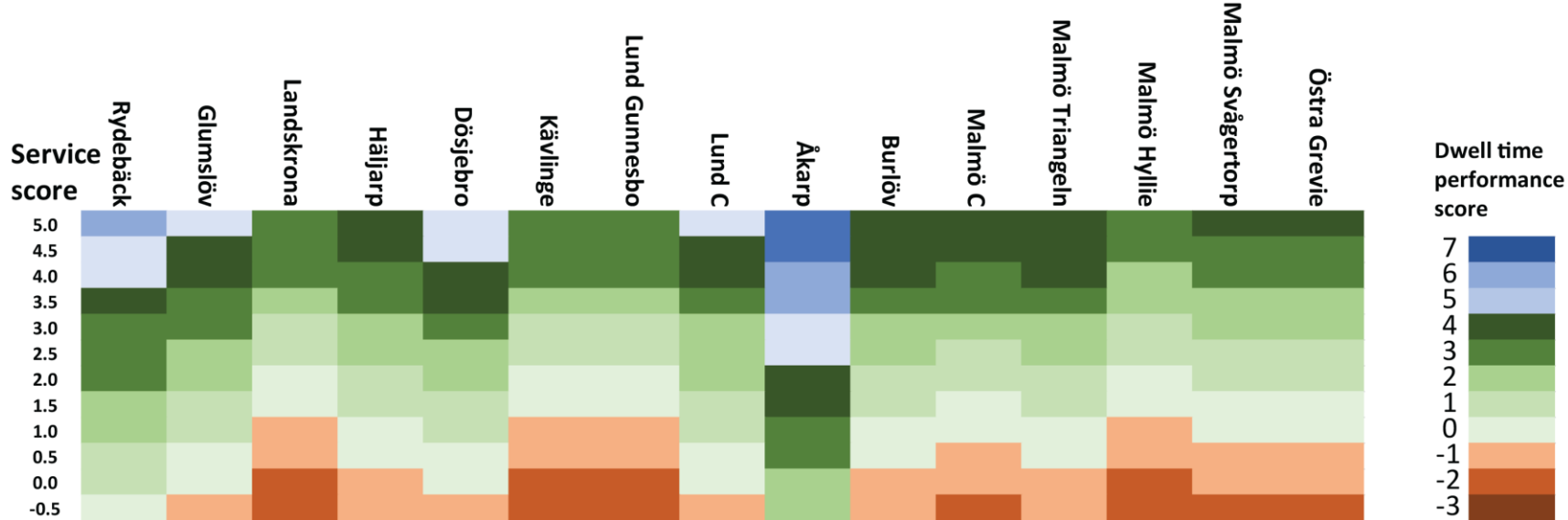






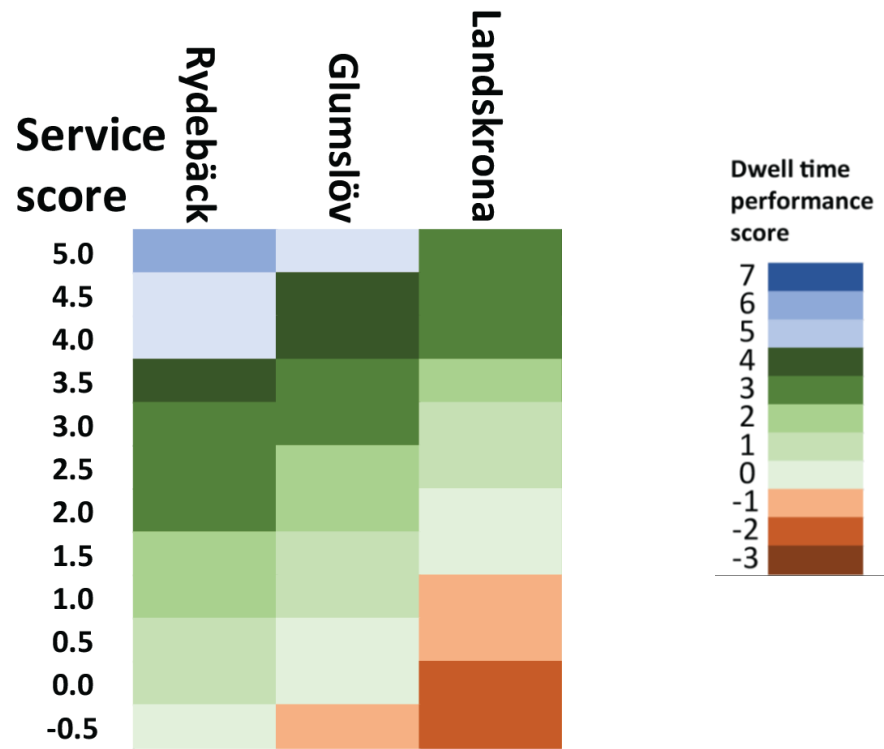
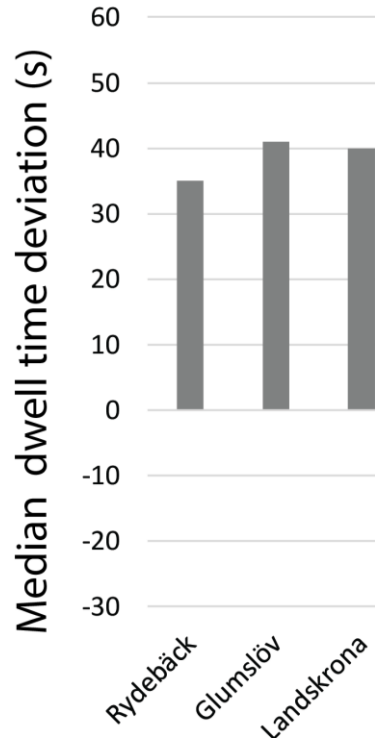
Dwell time performance score = how good a service is at being on time – how difficult it is to not have a delay at the station





No such thing as a station where there is always a delay





Small number of services can cause station to have a delay on average



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



Practical implications

No silver bullet for punctual dwell times, but:

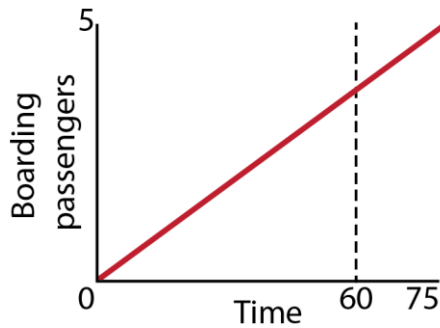
- Dwell time should be scheduled more dynamically
- Planners should understand and adapt (to) passenger behaviour
- Planners should make (more) use of the available automatic passenger count data



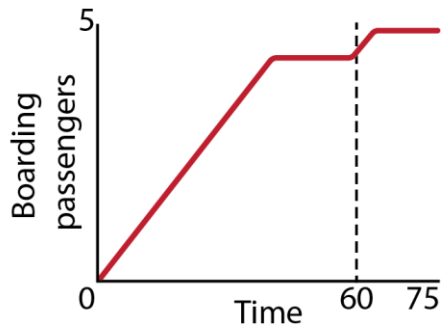
Practical implications

Need for better data collection methods

More in-depth data on passenger flows



a



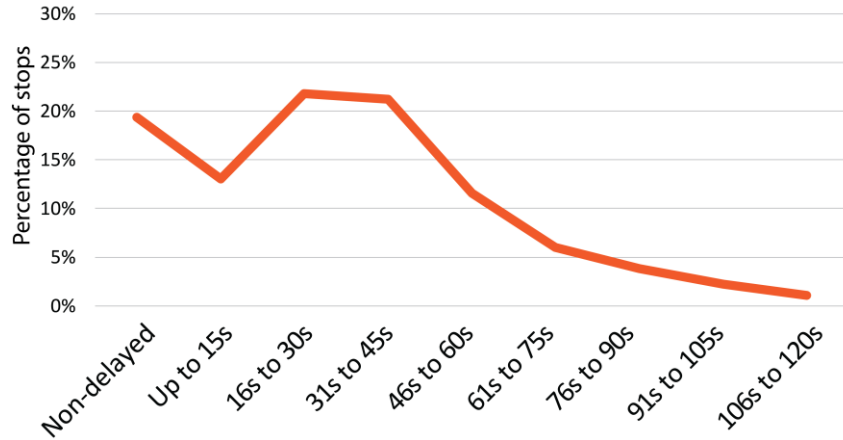
b

Both cases will show
5 passengers
75 seconds dwell time

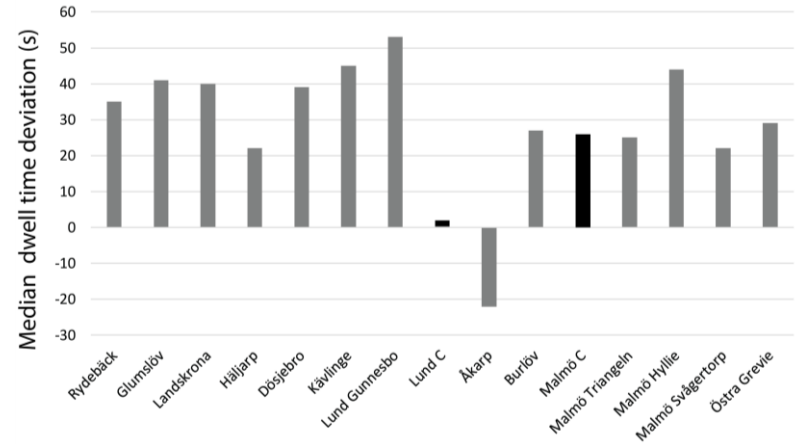


Practical implications

Show dwell time delays as a frequency



VS



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



