A Smart-card Based Analysis of During and Post-Disruption Impacts on Public Transport Passengers' Travel Pattern

A case study of Stockholm, Sweden

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Background

Most studies have only concentrated on analyzing impacts during disruption of **one or two modes** of travel in **multimodal Public Transport (PT)**

- **Liu et al. (2021)**

-passengers' behavior changes

-two modes: urban railway and bus bridging

- **Yap and Cats (2022)**

-ridership impacts

-one mode: trams in Amsterdam

- **Mo et al. (2022)**

-inferring passenger responses

-one mode: urban railway

Introduction & Research Questions

This study **holistically examines the impacts of planned disruptions**
on multimodal public transport passengers' travel patterns

What is **the impact of planned PT disruptions** on Stockholm's multimodal network?
What are the **alternative paths and presence of affected passengers** before, during, and after the disruption?
Is there a **prolonged effect** of these disruptions on PT passengers?

Case Study

Arkivbild. Foto: Lisa Mattisson (DN.se)

Arkivbild. Johan Jeppsson / TT (nyteknik.se)

The drivers' strike in the commuter rail (Pendeltåg)

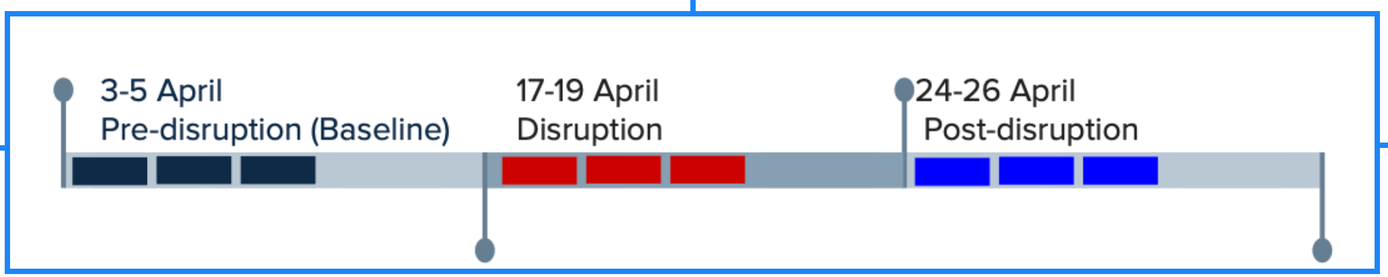
between 17th - 19th April 2023

Methodology (1/2)

Region Stockholm

GTFS-Real time
GTFS
AVL
AFC

PT
Network



Aggregate Level

- System level
- Line level
- Station level
- Passenger onboard loads on segments

Individual Level

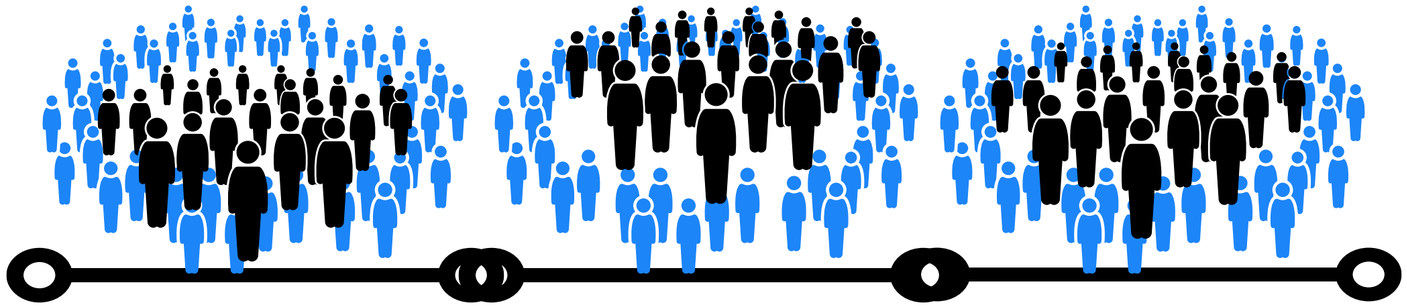
- Commuter rail passenger onboard loads on segments across the network

Methodology (2/2)

$$\Delta\overline{q_a} = \frac{\overline{q_a^{\text{during}}} - \overline{q_a^{\text{pre}}}}{\overline{q_a^{\text{pre}}}}, \quad \forall a \in \text{PT network}$$

Aggregate Level

All passengers



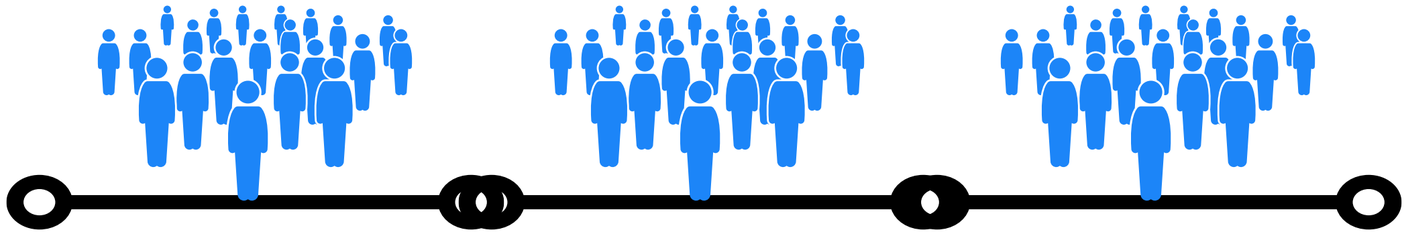
Passenger onboard loads on segments

Individual Level

> 5 and ≤ 300

commuter rail passengers'

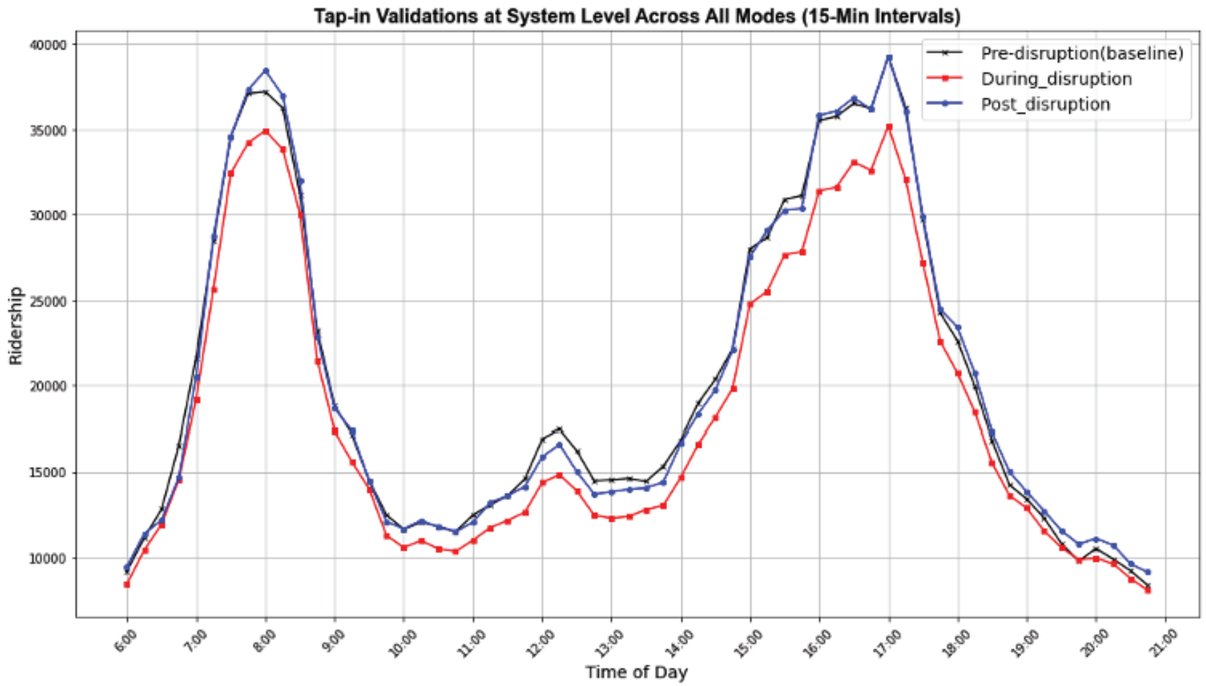
tap-in validations in April 2023



Commuter rail passenger onboard loads on segments

Results and Discussions (1/6)

System Level

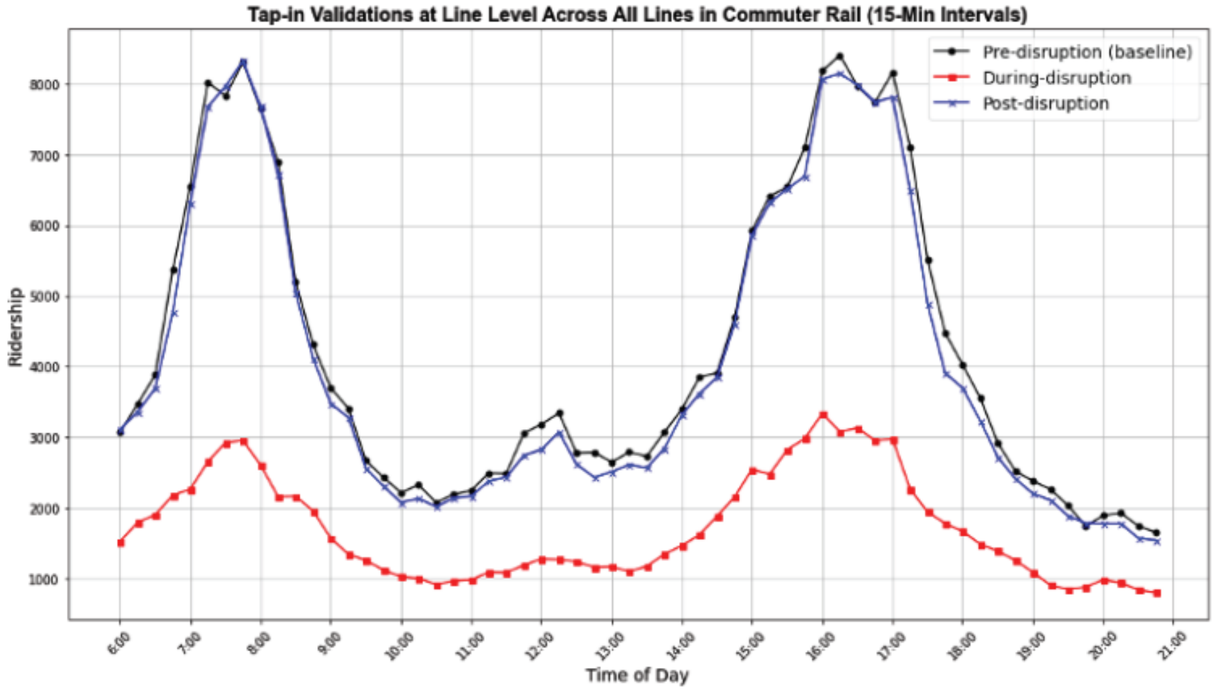


Pre-disruption : 1.2 million passengers

During-disruption: decrease 9 % (108,000)

(significant difference at 95% CI)

Line Level

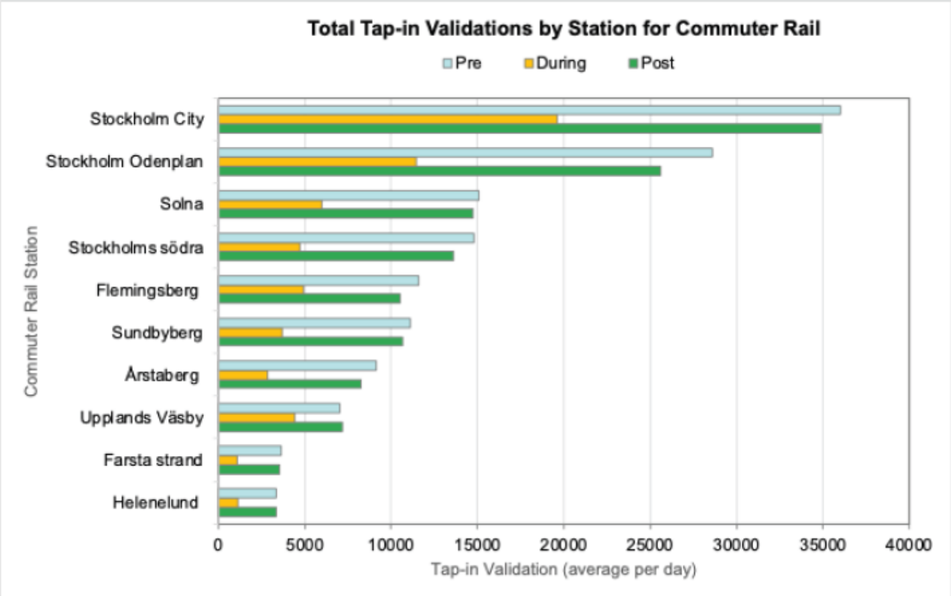


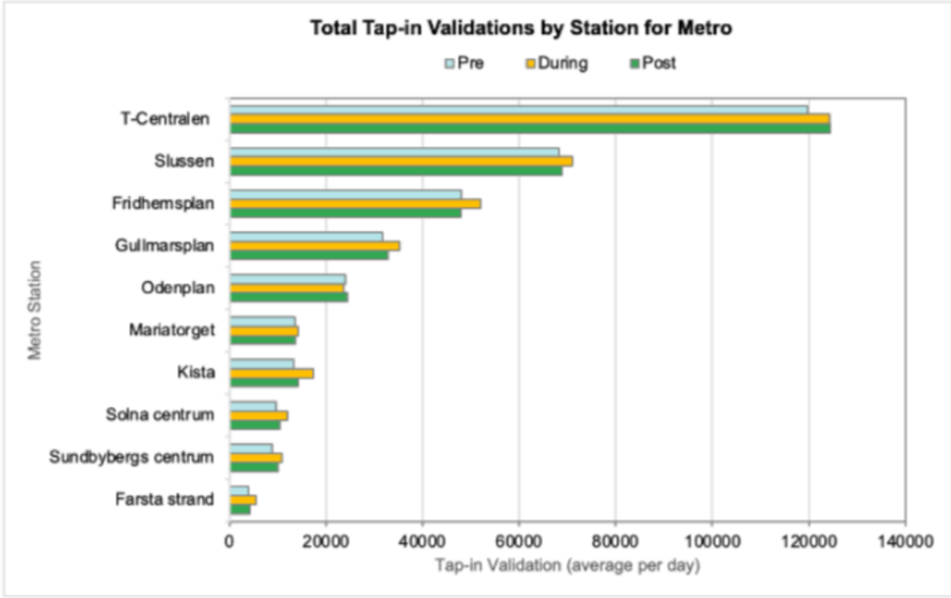
Pre-disruption : 250,000 passengers

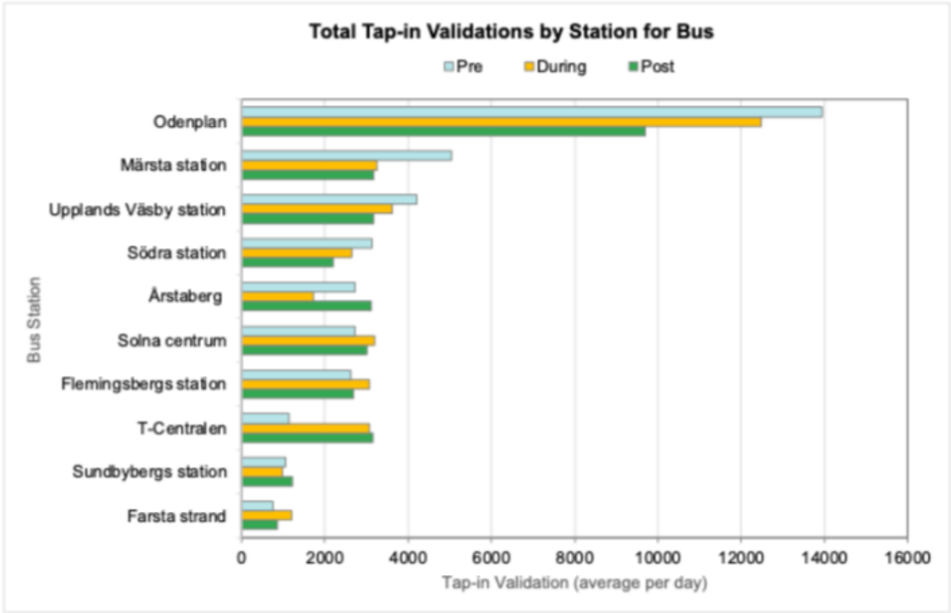
During-disruption: decrease 60 % (150,000)

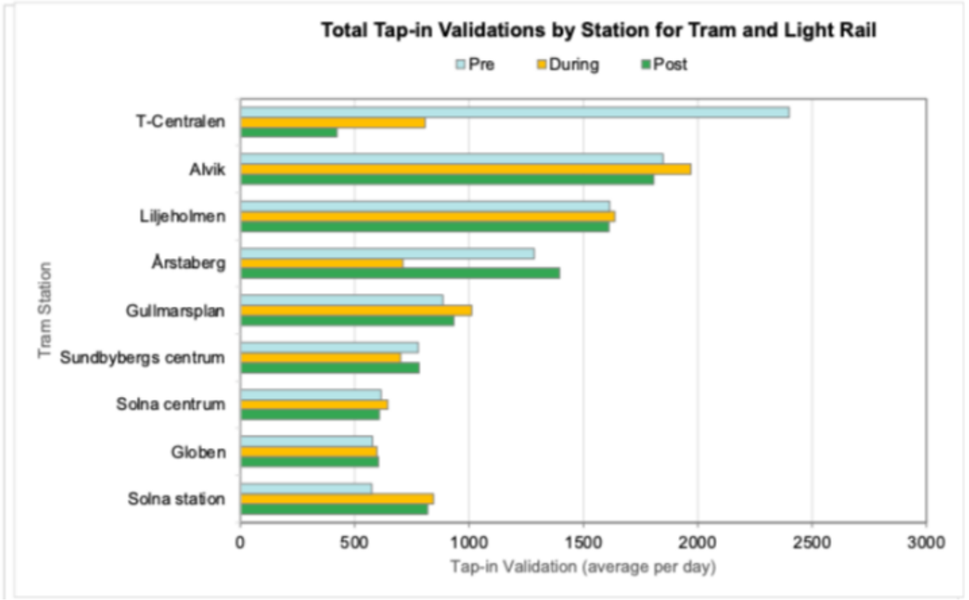
(significant difference at 95% CI)

Results and Discussions (2/6)

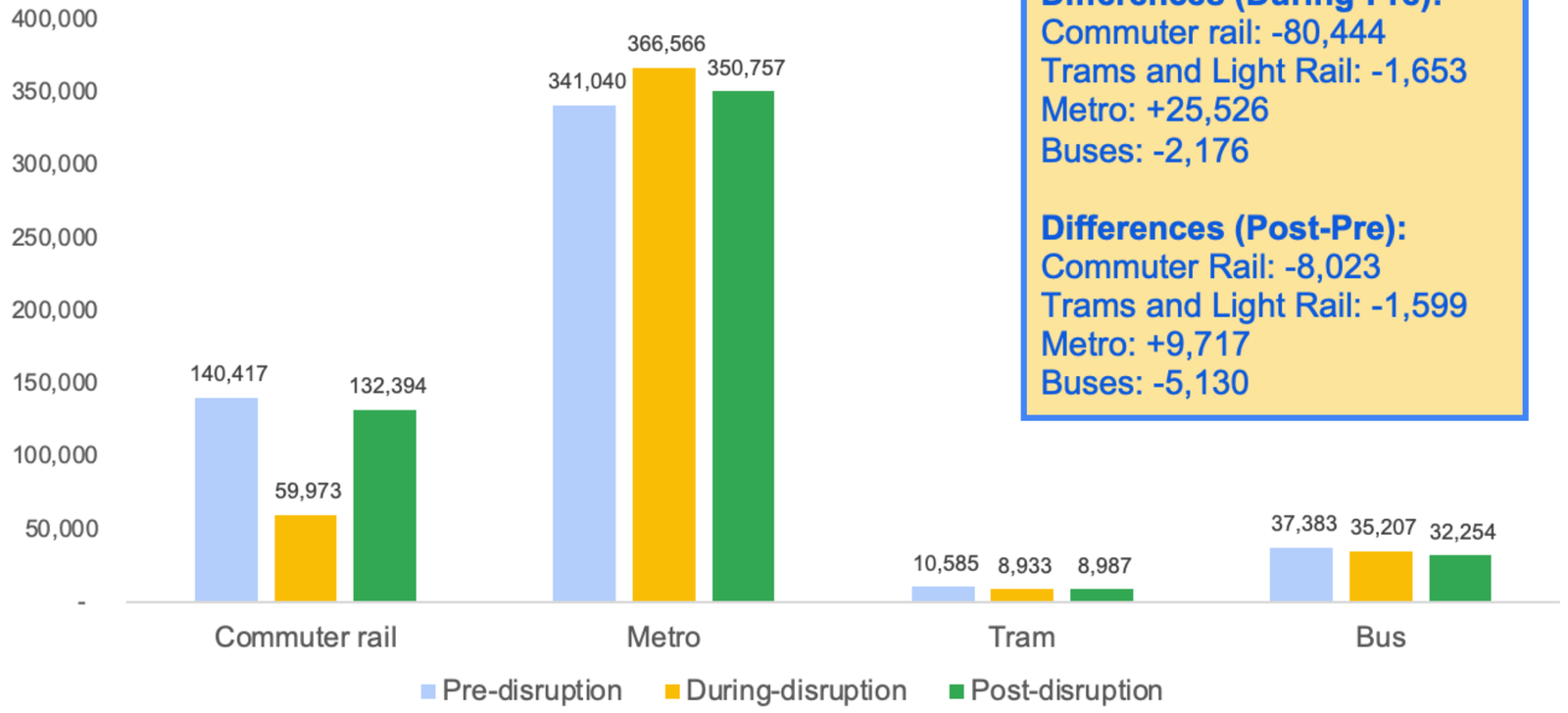








Results and Discussions (3/6)



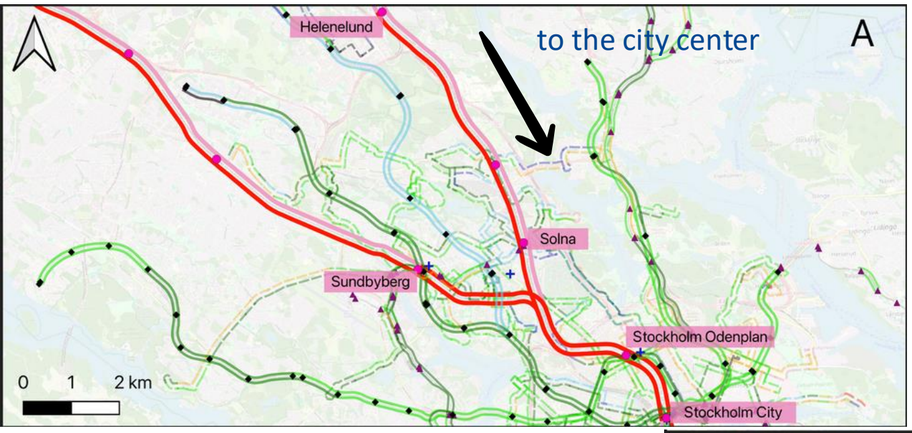
About 25,000 trips gained in the metro

That number does not offset the total lost from commuter rail, tram and bus.

diff= 60,000 trips

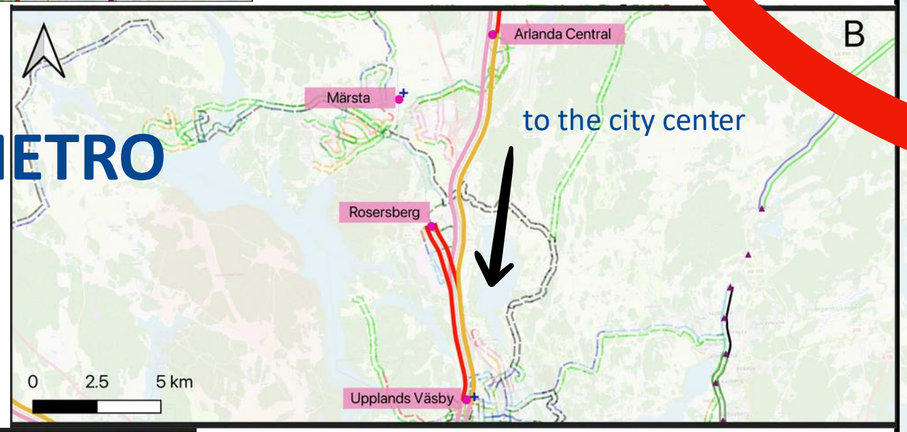
The disruption resulted in network-wide impacts beyond the affected area

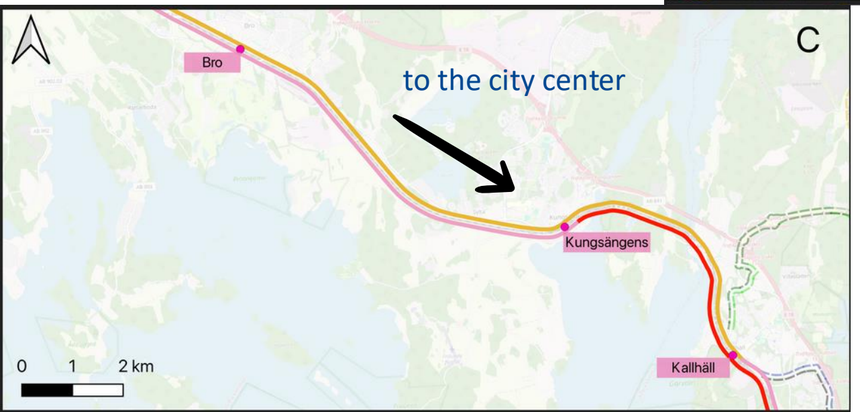
Results and Discussions (4/6)

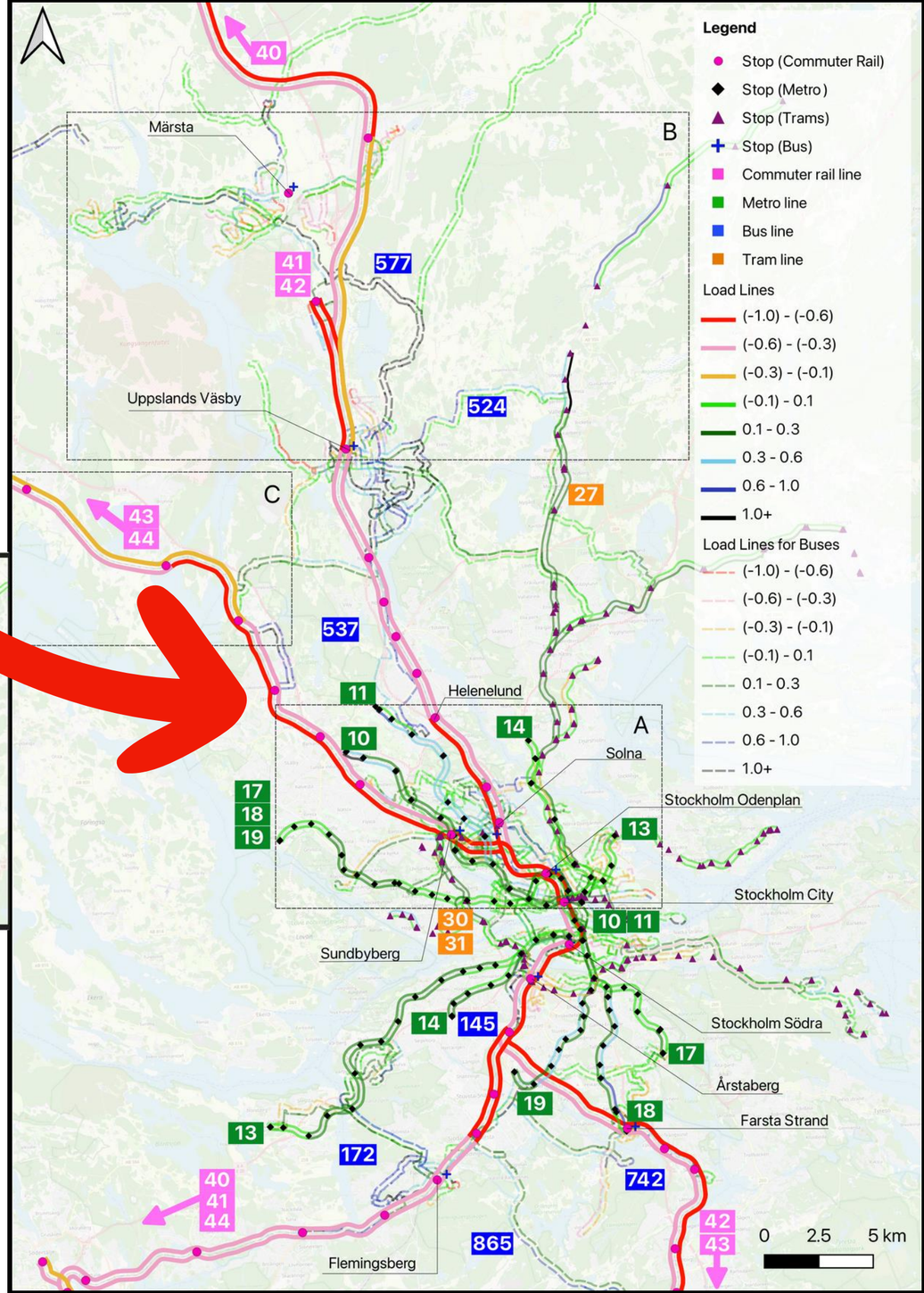


decrease 60-100%

METRO

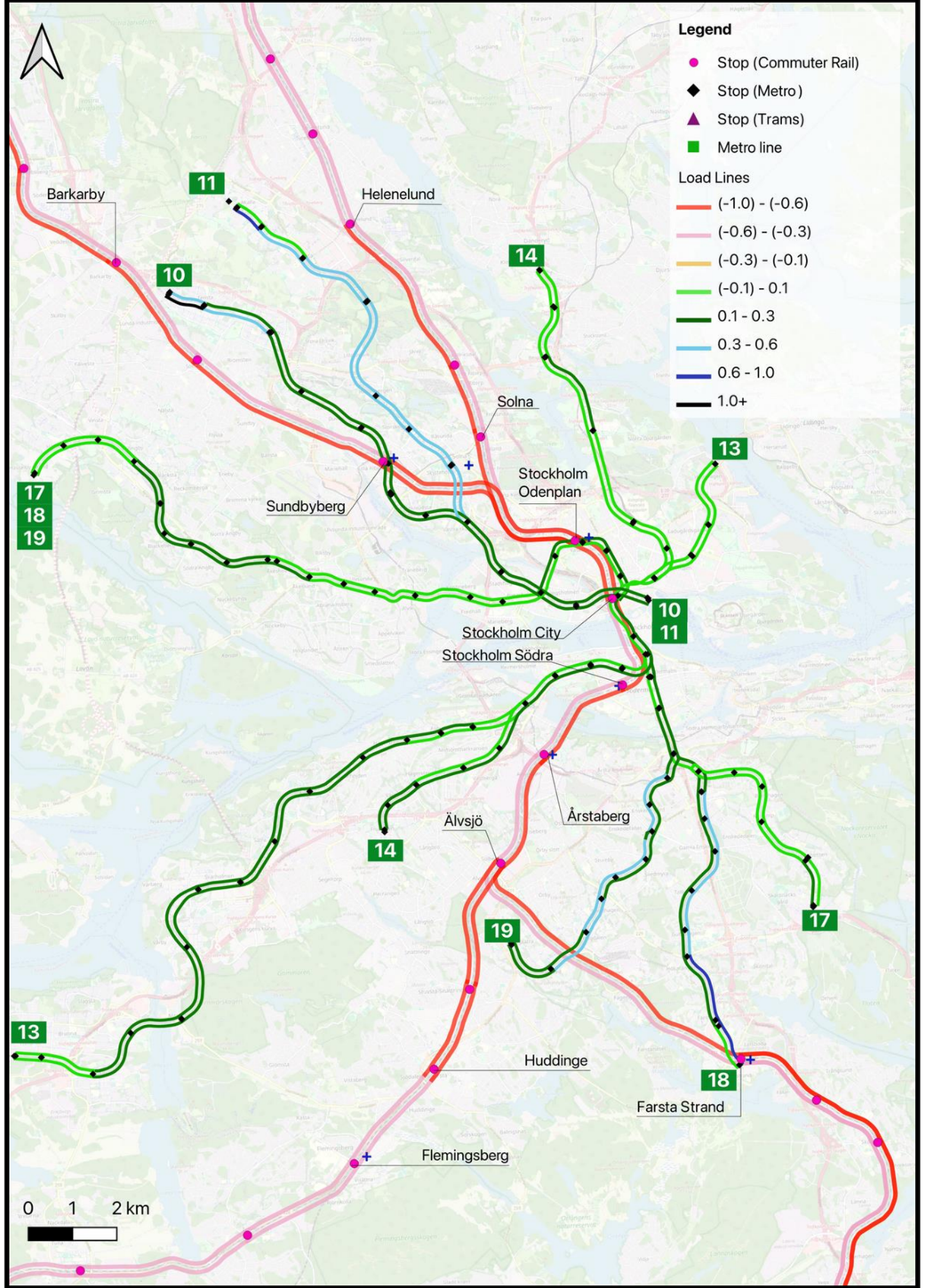




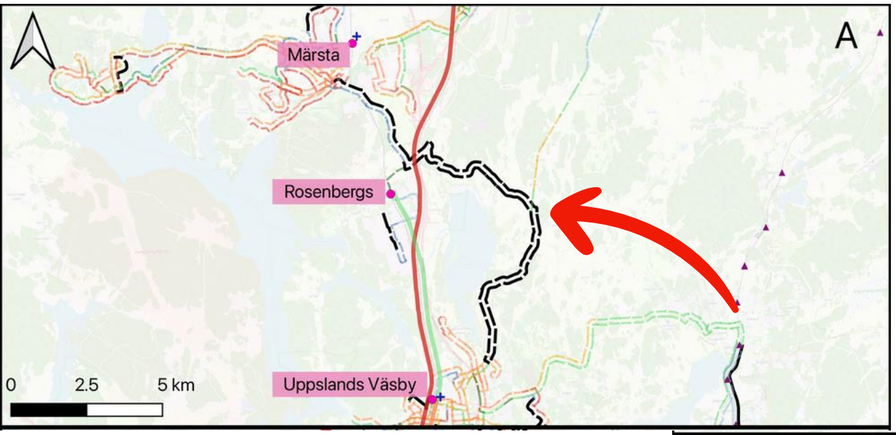


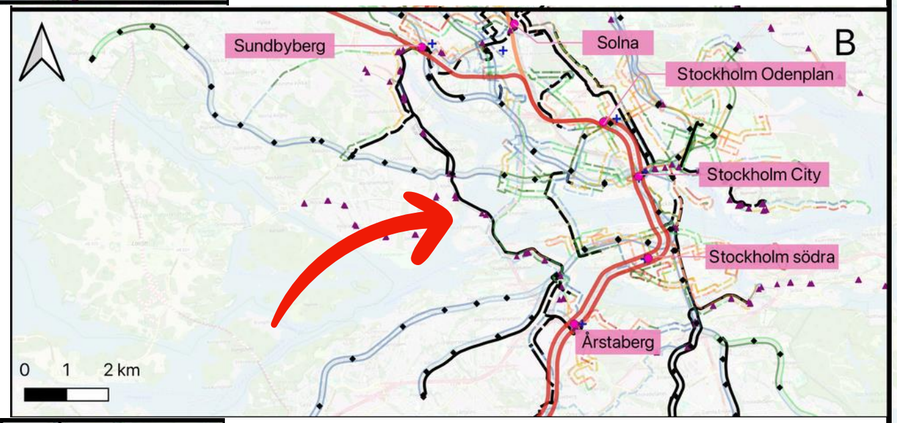
Results and Disc

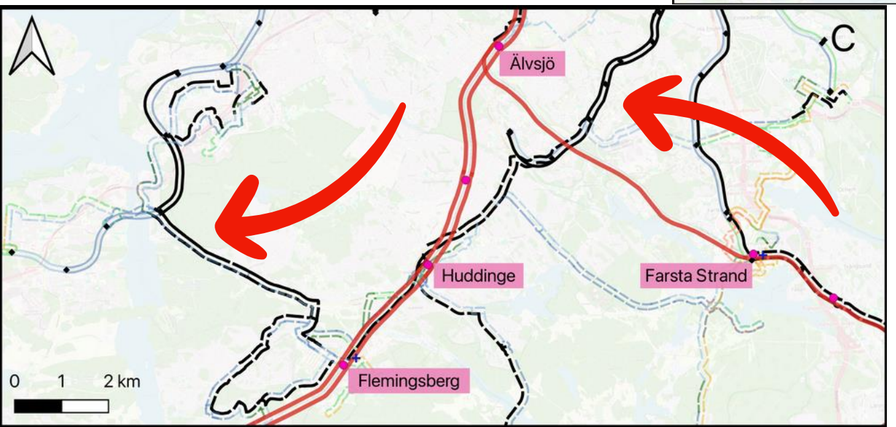
METRO

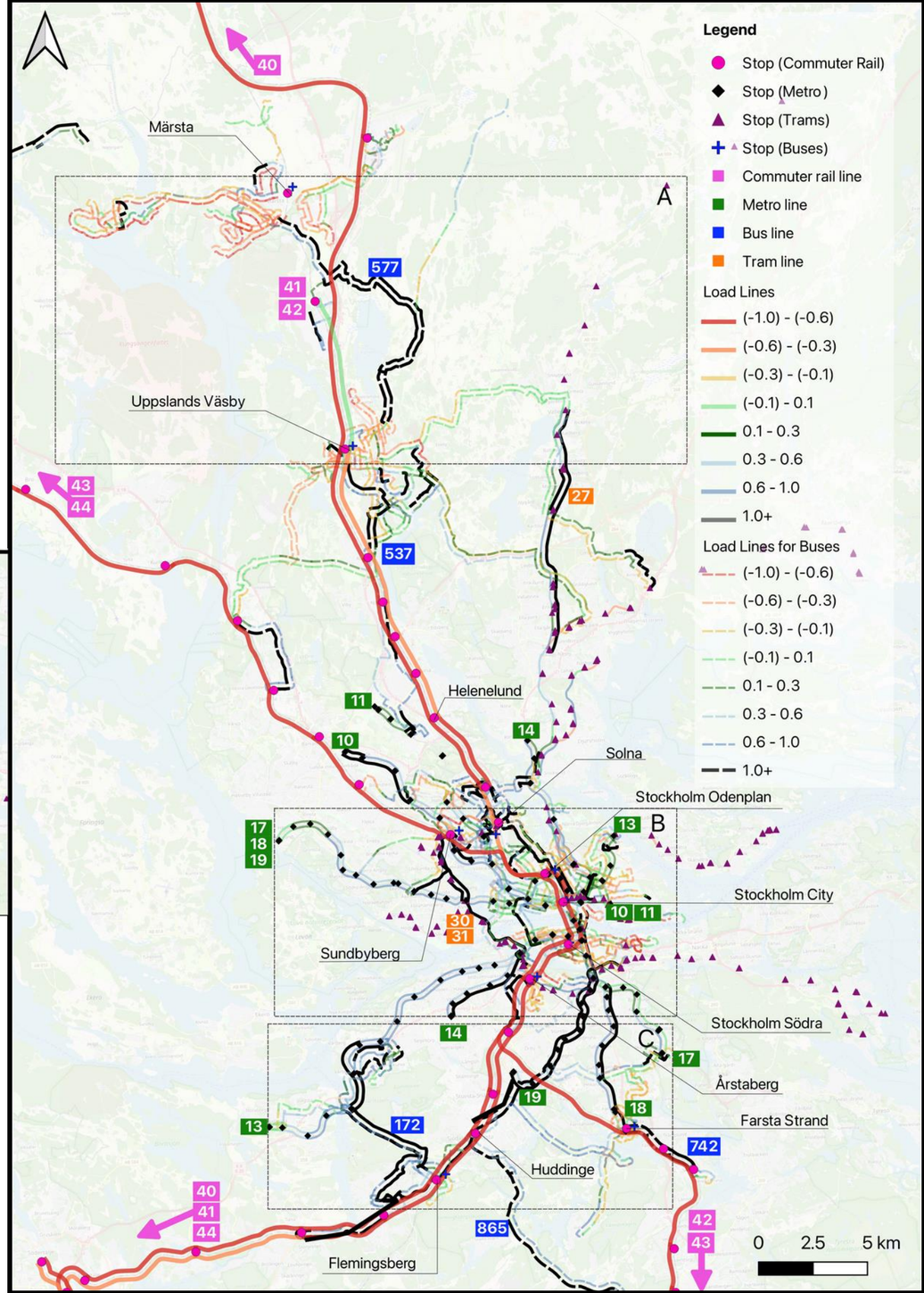


Results and Discussions (6/6)









Limitations and Future Work

- Ticketing machines
- The nature of ticket validation practices in the tram system

- **Identify passengers** that decided not to travel during the disruption

- Applying factors, such as demographics, and ticket types to **identify the most effected passenger groups**

- Applying an econometric method to **assess losses**

- Incorporate **risk-based resilience management**, such as passenger adaptability

Contributions

- Helps traffic planners and operators to **anticipate the impacts** of disruptions to **improve disruption management strategies**

- **Highlights affected areas** that are vulnerable to disruptive events in the network

- **Identifies alternative paths (passengers' travel patterns)**

- **Addresses a real challenge** in PT systems and **identifies losses** in ridership and demand during disruption

Thank you

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