LUND UNIVERSITY

Fire safety in metro trains, tunnels and stations – Evacuation

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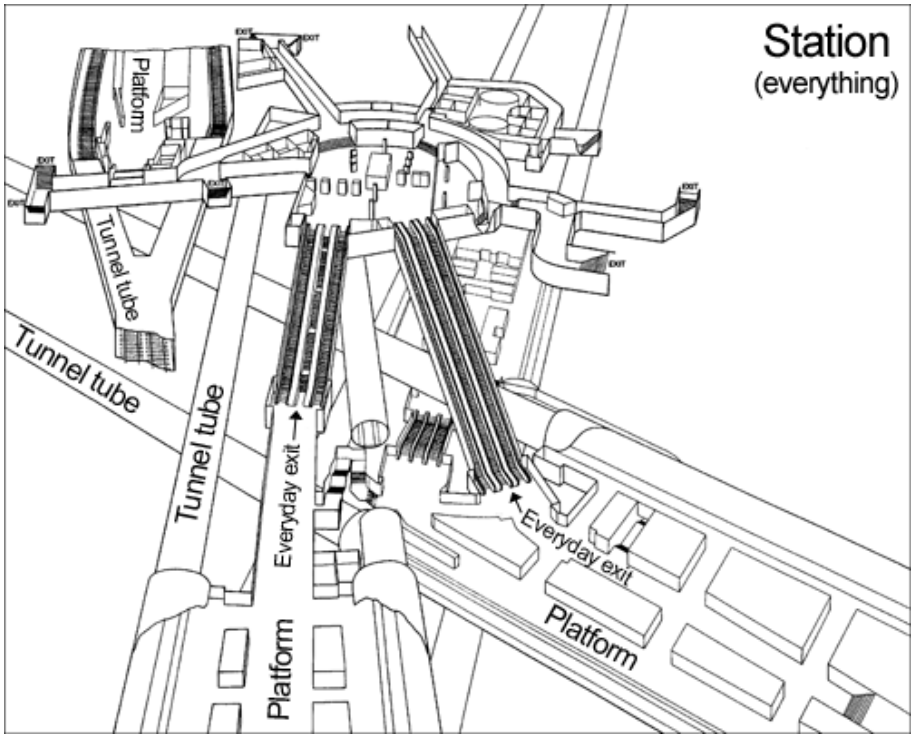
Outline

- Background
- WP2 - Objectives
- WP2 - Steps
  - Literature review
  - Questionnaire
  - Laboratory experiment - train to track
  - Laboratory experiment - tunnel
  - Evacuation - Stockholm METRO
  - Egress model

Background

- Previous fires in tunnels
  - Kings cross, 1987 - 31 fatalities
  - Baku Metro
  - Kaprun
  - etc



Background

- Previous fires in tunnels
  - Long pre-movement times
  - Difficulties moving through smoke
  - Complex environment
- Needs
  - Effective notification systems
  - Way-finding systems
  - More information about walking speed, flow rates, behaviour, etc

Background

- The METRO/KESØ project
  - WP2 - Evacuation

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ÖRESUND – KATTEGAT – SKAGERRAK

WP2 – Evacuation

- Objectives
  - investigate how train passengers can be safely evacuated in case of an emergency
  - study initial behaviour
  - examine way-finding behaviour
  - examine walking speeds
  - test different way-finding systems
  - include many populations

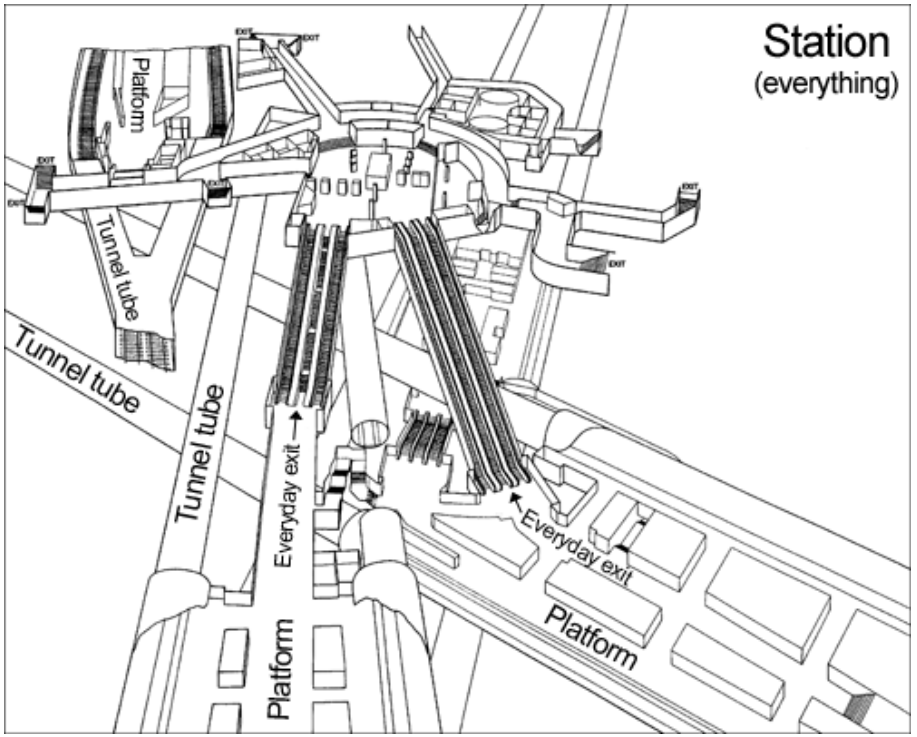
WP2 – Evacuation

- Steps
  - 1. Literature review – accidents

Example:

King's cross fire
- fire in escalator
- 31 fatalities

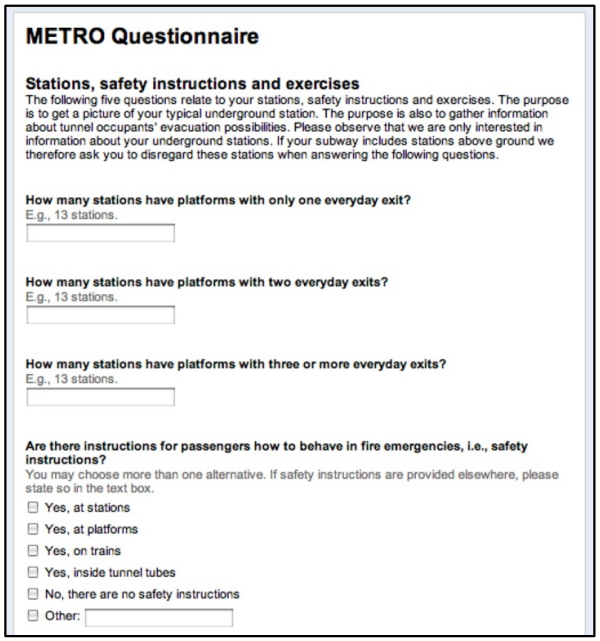
Conclusions
- roles important
- inaction initially
- police/fire service



WP2 – Evacuation

- Steps
  - 1. Literature review – accidents
  - 2. Questionnaire survey – operators

Example topics:
- installations
- training
- organizational
- suggested research



METRO Questionnaire

Stations, safety instructions and exercises

The following five questions relate to your stations, safety instructions and exercises. The purpose is to get a picture of your typical underground station. The purpose is also to gather information about tunnel occupants' evacuation possibilities. Please observe that we are only interested in information about your underground stations. If your subway includes stations above ground we therefore ask you to disregard these stations when answering the following questions.

How many stations have platforms with only one everyday exit?
E.g., 13 stations.

How many stations have platforms with two everyday exits?
E.g., 13 stations.

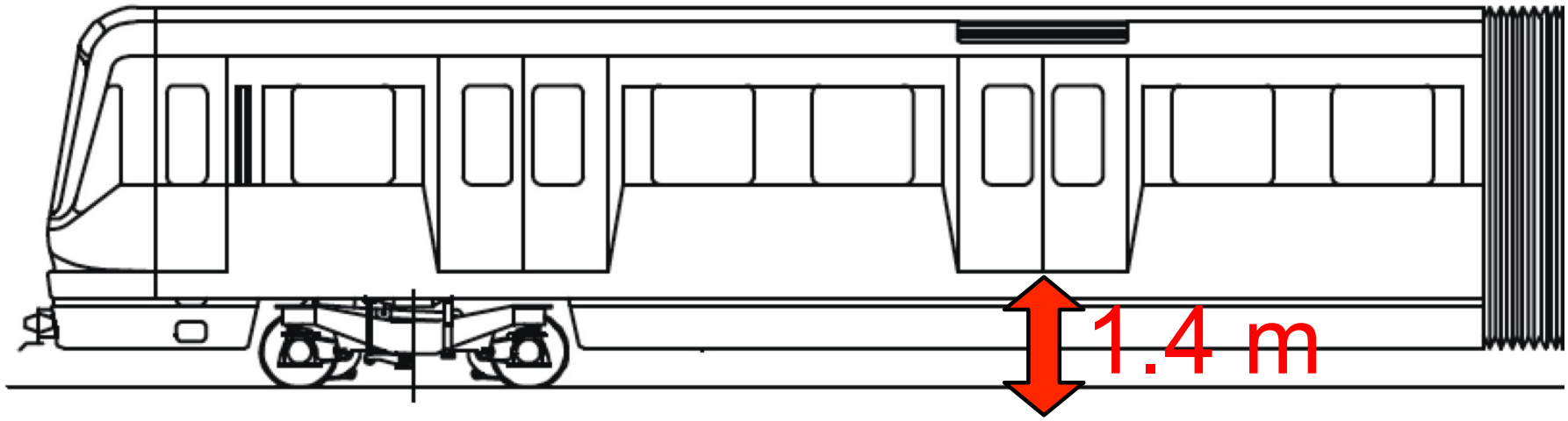
How many stations have platforms with three or more everyday exits?
E.g., 13 stations.

Are there instructions for passengers how to behave in fire emergencies, i.e., safety instructions?
You may choose more than one alternative. If safety instructions are provided elsewhere, please state so in the text box.

- ☐ Yes, at stations
- ☐ Yes, at platforms
- ☐ Yes, on trains
- ☐ Yes, inside tunnel tubes
- ☐ No, there are no safety instructions
- ☐ Other:

WP2 – Evacuation

- Steps
  - 1. Literature review – accidents
  - 2. Questionnaire survey – operators
  - 3. Laboratory experiment - train to track



WP2 – Evacuation

WP2 – Evacuation

- Experiment 1
  - Relative study with students
    - Flow rate = f(height, floor material, lighting conditions, handles, ladder)
- Experiment 2
  - Interview study with senior citizens and people with disabilities
    - Acceptable height
    - Exit strategies
    - Handles, etc

WP2 – Evacuation

- Steps
  - 1. Literature review – accidents
  - 2. Questionnaire survey – operators
  - 3. Laboratory experiment – train to track
  - 4. Laboratory experiment – tunnel

WP2 – Evacuation

- Studied aspects
  - walking speed
  - behaviour
  - way-finding
  - systems
- Participants
  - 100
  - all ages

WP2 – Evacuation

- Installations
  - wall signs (always)
  - std design
  - green flashing lights
  - illuminated exit + strong lights
  - sound (siren + voice message)

WP2 – Evacuation

- Procedure
  - arrive
  - safety instructions
  - video of train trip
  - enter the tunnel
  - walk in the tunnel
  - led out by fire fighter
  - questionnaire
  - interview

WP2 – Evacuation

WP2 – Evacuation

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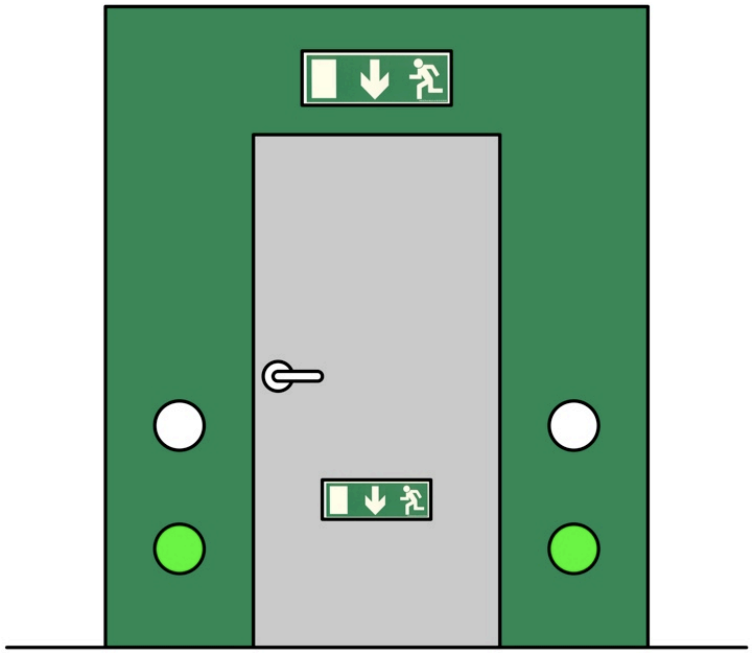
WP2 – Evacuation

- Results
  - Wall sings very important
  - Exit design
    - Std design - sometimes worked
    - Flashing lights - good
    - Illuminated + strong lights - misinterpretations
    - Sound - excellent
  - Data on walking speeds and movement patterns

WP2 – Evacuation



WP2 – Evacuation

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WP2 – Evacuation

- Steps
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  - 3. Laboratory experiment – train to track
  - 4. Laboratory experiment – tunnel
  - 5. Evacuation - Stockholm METRO

WP2 – Evacuation

- Postponed– fall 2013 (?)

WP2 – Evacuation

- Steps
  - 1. Literature review – accidents
  - 2. Questionnaire survey – operators
  - 3. Laboratory experiment – train to track
  - 4. Laboratory experiment – tunnel
  - 5. Evacuation - Stockholm METRO
  - 6. Egress model

Summary

- Background
- WP2 - Objectives
- WP2 - Steps
  - Literature review
  - Questionnaire
  - Laboratory experiment - train to track
  - Laboratory experiment - tunnel
  - Evacuation - Stockholm METRO
  - Egress model

Contributors

- People involved in WP2
  - Karl Fridolf, LU
  - Enrico Ronchi, LU
  - Håkan Frantzich, LU
  - Stefan Svensson, LU
  - Sven-Ingvar Granemark, LU
  - Axel Jönsson, Brandskyddslaget
  - Rita Fahy, NFPA
  - Sam Grindrod, Edinburgh University