



## Master thesis project:

# Modelling and predicting dynamics of disruption and recovery in railway networks

### Problem description

Train delays and cancellations occur when disruptive events create an imbalance between system capacity and demand. For example, in the Netherlands, internal factors causing failures (e.g. infrastructure, vehicle) take up to 70% of all disruptions in the network. On average, about 14 of such disruptions occur every day. Some of these disruptions remain even unnoticed by passengers; however, others generate problems spreading all over the network causing many cancelled and heavily delayed trains leading to great dissatisfaction of passengers.

Therefore, the question is: how can we predict performance of the system during disruptions? The aim of this project is to study resilience curves (as depicted above) in railway networks and capture the magnitude and spatial impact of delays and cancellations. By using historical railway traffic data, we want to identify representative resilience curves and uncover the interaction between disruption and recovery. This will enable us to predict the future behavior of the system once a disruption occurs. Finally, such prediction system can help railway operators in better estimating and anticipating impacts of future disruptions and thus define best mitigation measures.

### Assignment

- Analyse current approaches for estimating and predicting resilience in transport networks
- Develop a parametric model for resilience curves (e.g. using splines) to analyse real historical railway traffic realization data AND/OR
- Apply a principal component analysis to analyse real historical railway traffic realization data and to detect new resilience metrics
- Determine advantages of the new approach to predict deterioration for railway operators
- Write a report/thesis

### Background

A student will have an opportunity to further develop skills in optimization, data analysis, and programming. The research topic can be suitable as MSc thesis project or a diploma (at Faculty of Transport and Traffic Sciences).

### Reference

Bešinović N., (2020). Resilience in railway transport systems: a literature review and research agenda. *Transport Reviews*, <https://doi.org/10.1080/01441647.2020.1728419>

Knoester, M. J., Bešinović, N., Afghari, A. P., Goverde, R. M., & van Egmond, J. (2024). A data-driven approach for quantifying the resilience of railway networks. *Transportation Research Part A: Policy and Practice*, 179, 103913.

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