# Research topic: "Critical Infrastructure Analysis in Single Wagon Load (SWL) networks"

**Description**

SWL networks play a crucial role in freight transportation by enabling flexible and cost-effective logistics solutions for small-to-medium shipments. However, their decentralized nature and interdependencies make them vulnerable to disruptions, whether caused by accidents, operational inefficiencies, or deliberate attacks. Understanding and mitigating these vulnerabilities is vital to ensure reliable service and maintain economic stability in industries dependent on rail freight.

This research explores critical infrastructure in Single Wagon Load (SWL) networks, focusing on identifying key nodes (yards) and/or links that are vital for operational efficiency. The research addresses system vulnerabilities to disruptions and develops strategies to mitigate their impacts. A generic SWL demand will be created to capture operational variability. By extending existing disruption management models, the study employs interdiction modelling to simulate targeted disruptions and design effective response strategies. Network performance will be evaluated over multi-day or weekly timeframes to reflect realistic operations and recovery dynamics.

**Assignment**

- Conduct a literature review on SWL networks, disruption scenarios, and network interdiction approaches.
- Create a generic SWL demand to represent multi-day requests
- Formulate and implement a new mathematical optimization model to identify critical nodes and links.
- Run multi-day or weekly simulations to evaluate the effectiveness of strategies under dynamic conditions.
- Compile results and provide practical recommendations for improving network operations and protecting critical infrastructure.

**Expected Knowledge and Skills**

The topic is suitable for diploma/MSc thesis. The candidate should possess knowledge of and/or strong willingness to master freight transport systems, SWL network logistics, and mathematical optimization modelling. Strong programming skills (e.g., Python, R, or MATLAB) are required for computational modelling and simulation. Analytical skills are necessary to design experiments, interpret results, and translate findings into actionable insights for practical application.

**Background**

This topic is suitable for a diploma or MSc thesis.

**Contact:**


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