

CLIMATE ADAPTATION OF RAILWAY INFRASTRUCTURE MAINTENANCE

(ClimRail)

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Nyttor och effekter

ClimRail introduces a Reliability-Centered Maintenance (RCM)-based decision-support framework designed to adapt railway maintenance to evolving climate conditions. The framework enables infrastructure managers to identify and prioritize vulnerable track sections and to define adaptive maintenance strategies that safeguard operational safety, reliability, and cost efficiency. By integrating climate considerations into maintenance planning, ClimRail strengthens the resilience of railway infrastructure, enhances the availability and robustness of critical track assets, and reduces life-cycle costs and unplanned disruptions. It provides a scientific foundation for updating maintenance regulations and supports Sweden's transition toward a sustainable, climate-resilient, and internationally competitive railway system. The innovation addresses the needs of infrastructure owners in maintaining dependable, cost-efficient, and environmentally responsible assets under changing climatic conditions, while also meeting the broader needs of society and residents for reliable, safe, and climate-resilient rail transport that ensures sustainable mobility, accessibility, and economic stability.

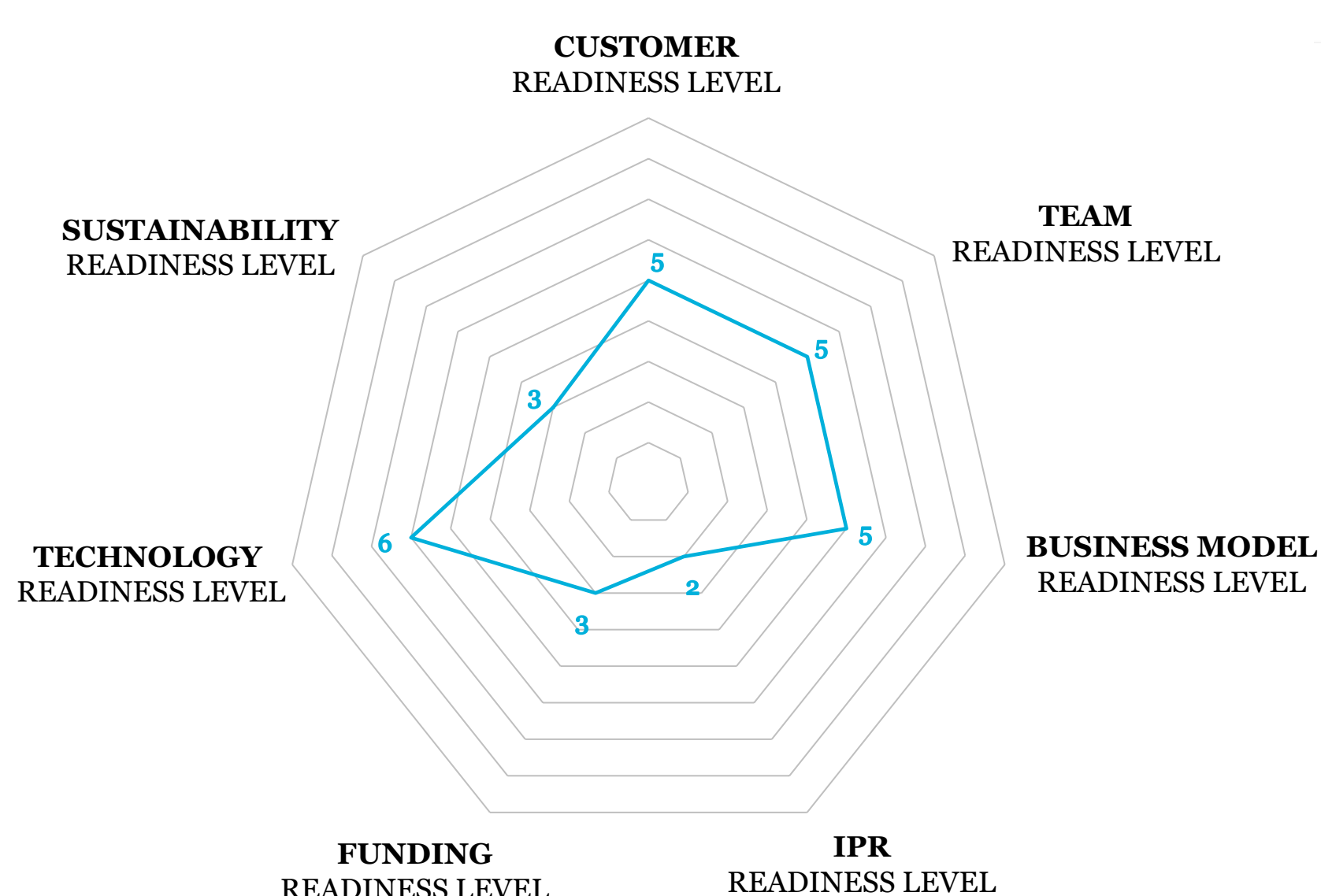
Aktörskonstellation

Luleå University of Technology (LTU)
Luleå Railway Research Center (JVTC)
Trafikverket – Infrastructure manager
LKAB – Industry partner,
BDX Rail AB – Maintenance contractor,

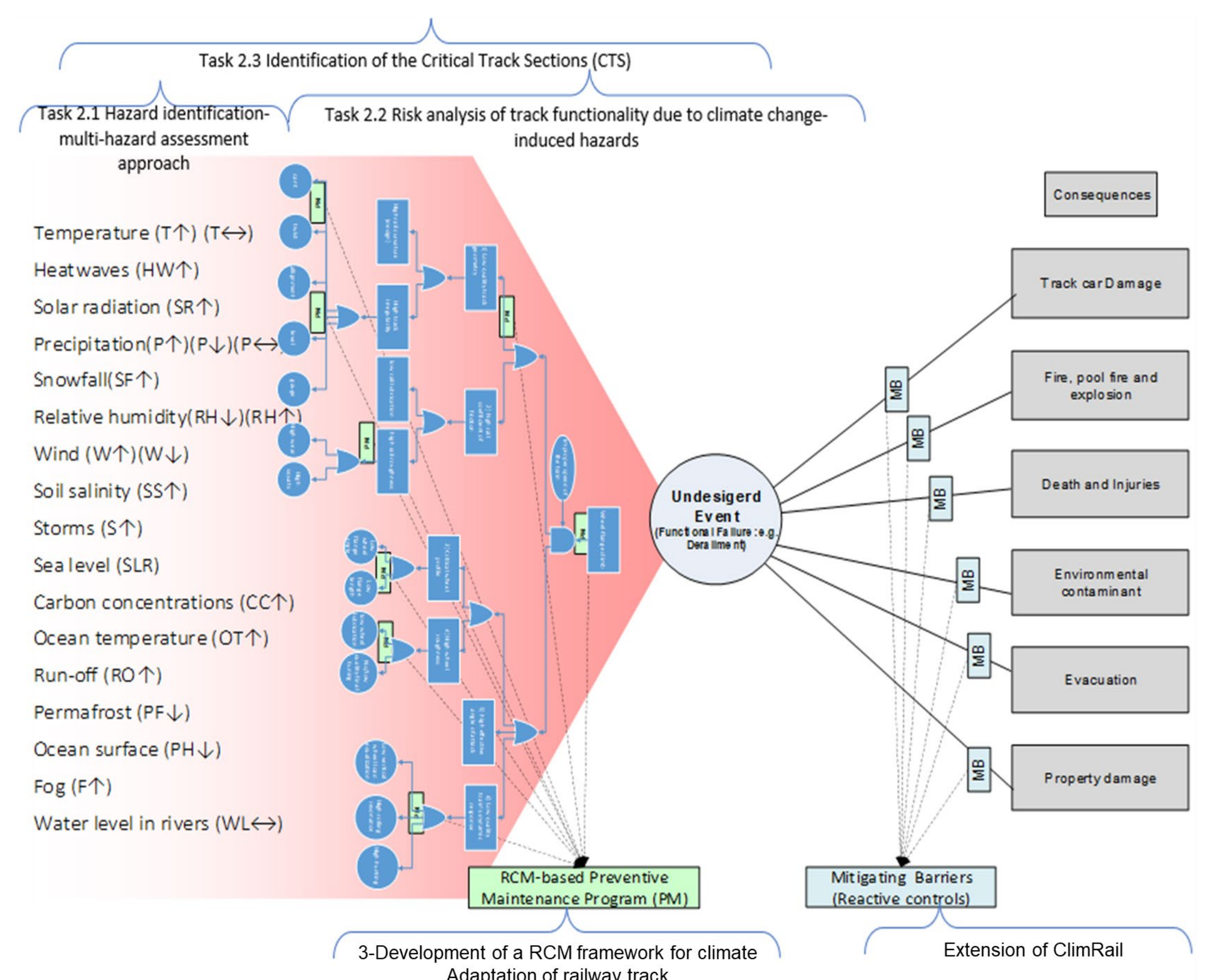
Leveranser

- A decision-support demonstrator for evaluating and prioritizing climate impacts on track functionality.
- A guideline for implementing the RCM-based framework within Trafikverket's asset management system.
- A review and recommendation report for adapting maintenance regulations and practices to climate change.
- A risk assessment report for the Iron Ore Line identifying critical and climate-sensitive sections.
- Workshops, training, and dissemination activities to ensure knowledge transfer and practical implementation.

Innovationsstatus



ClimRail demonstrates a high level of technological and methodological innovation by transferring Reliability-Centered Maintenance (RCM) principles from aerospace and nuclear sectors to railway infrastructure. The project currently stands at Technology Readiness Level (TRL) 3–6, moving from conceptual formulation to proof-of-concept validation on the Iron Ore Line. Strong collaboration among academia, Trafikverket, and industry partners ensures high team readiness and sustainability integration, while the business model and funding readiness will be further strengthened during implementation. The innovation is therefore positioned at a pre-operational stage, with clear potential for national integration and future scalability across European railway systems.



Vidareutveckling och implementering

ClimRail will progress from proof-of-concept to operational implementation through the integration of its RCM-based decision-support framework into Trafikverket's asset management and climate adaptation processes.

The framework will first be validated on the Iron Ore Line to demonstrate its functionality, usability, and operational relevance. In the subsequent phase, it will be incorporated into Trafikverket's "Reality Lab – Digital Railway", enabling continuous monitoring, learning, and improvement of maintenance and regulatory practices.

In the longer term, the framework is intended to be extended to other railway assets, such as bridges, tunnels, and signaling systems, and adapted for application to other linear infrastructures.

This development pathway offers significant opportunities to reinforce Sweden's leadership in climate-resilient infrastructure maintenance, lower life-cycle costs, and enhance the long-term reliability and robustness of the railway system. Furthermore, the ClimRail framework provides a transferable model for European railways aiming to integrate climate adaptation into maintenance management.

Key challenges include ensuring high-quality and consistent data for model calibration, aligning the new reliability-based methods with Trafikverket's existing safety and regulatory standards, and achieving strong organizational engagement to embed the framework in future maintenance planning and investment decisions.

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