WIN - Wissensbasierte Optimierung des Flotten-Asset-Management

Knowledge-based optimization of fleet-asset management

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Motivation

Improving Safety and Reliability: Traditional time-based maintenance approaches are increasingly inadequate in meeting the growing demands for safety, availability, and reliability in public transportation.

Goal

The WIN project aims to optimize the maintenance of metro train vehicles, with a specific focus on the pneumatic systems of Wiener Linien's V-trains. The objective is to minimize operational disruptions, improve resource efficiency, and increase the lifespan and reliability of the fleet. Through the WIN project, maintenance strategies will be modernized by integrating advanced data analysis and sensor technology, transitioning to a predictive and knowledge-based maintenance model that enhances fleet performance.

Navigating Key Challenges in Modern Fleet Management

- Maximized Disturbance Reduction: Are We at the Limit?
- Balancing Safety, Reliability, and Costs
- Unlocking the Potential of Unused Data in New Vehicle Fleets
- Managing the Generational Shift in Workforce

Use Case

The project specifically examines the air pressure systems in V-trains, which are critical for safe operation. By analyzing subsystem components and failure modes, the WIN project aims to address approximately 10% of all operational disruptions in the fleet.

Data Sources

Asset Data (ERP System Data): all the information documented through Wiener Linien's ERP (Enterprise Resource Planning) system related to the maintenance activities of the V-trains. It covers various aspects such as the scheduling, execution, and documentation of maintenance tasks.

Sensor Data: real-time information collected from the sensors installed on the V-trains. Data collection for 5 trains over 2+ years. The sensor data consists of operational data that is recorded from specific ports using already installed sensors and stored on the vehicle.

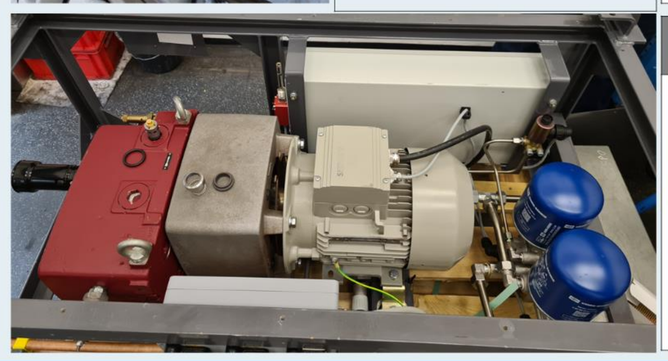
Use case of the V-train of Wiener Linien

Metro V-Train

- First introduced in operation: 2000-2001
- Continuous train with a 6-car structure
- Fleet size: 61 trains
- Length of one train: 111 meters

Air Compression System

Systems	Demand
Air Compression System	▪ Highest percentage of V-Train malfunctions ▪ Safety-related
Drive/Break System	
Power supply	
...	



Function
▪ 2 Compressors per V-Train (one per direction) ▪ Pressure range: 6.5 – 8 bar

Basis for Optimization Towards Predictive and Knowledge-Based Maintenance

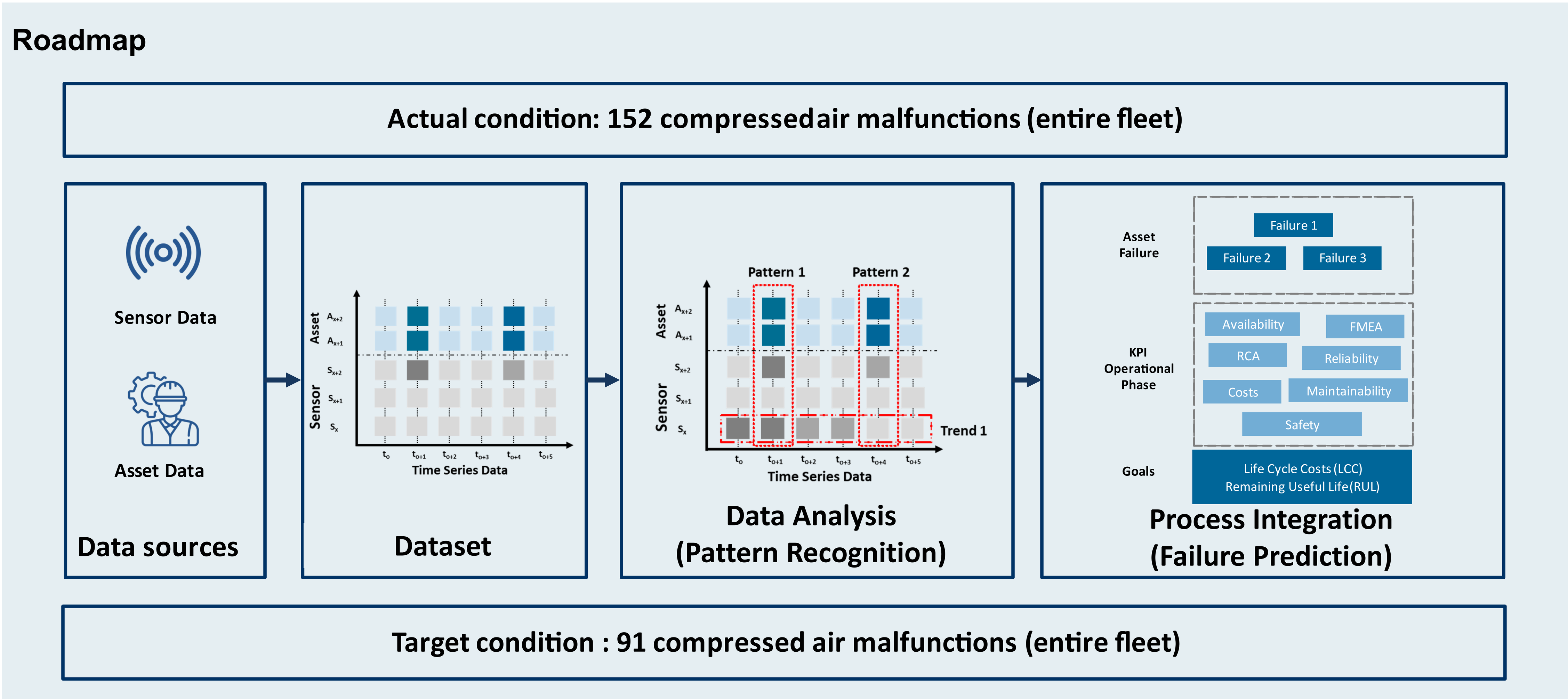
1. **Asset Information:** About functionality, maintenance & historical interventions
2. **Sensor Data:** Recording of vehicle data during operations: 5 trains & +2 years

Methodology

The WIN project combines data-driven analysis with expert knowledge to create a high-quality dataset for maintenance optimization. This involves the selection and preparation of sensor data, identification of failure patterns, and the application of machine learning techniques for predictive maintenance.

Development Steps:

1. Data Collection and Integration: Asset Data Collection, Sensor Data Acquisition
2. Data Preparation and Cleaning: Data Quality Assessment, Data Reduction
3. Exploratory Data Analysis (EDA): Trend Identification, Failure Mode Analysis
4. Predictive Modeling: Machine Learning Integration, Expert Knowledge Incorporation
5. Validation and Feedback: Model Validation, Feedback Loop
6. Implementation and Continuous Improvement: Deployment in Maintenance Operations, Ongoing Monitoring and Adjustment



Results

Exploration and development of a dynamic model that captures and simulates the complex interactions between vehicle data, faults, maintenance activities, and key performance indicators such as reliability, availability, maintainability, supportability (RAMS), and life cycle costs (LCC). This model enables informed decision-making by visualizing the impact of changes in maintenance strategies and fleet operations over the entire life cycle as well as should be capable of simulating optimizations or changes in fleet deployment or fleet maintenance and their effects.

Partner

- Wiener Linien GmbH & Co KG
- TU Wien, Research Group of Production- and Maintenance Management

Towards Predictive Maintenance

The WIN project represents a forward-thinking approach to urban rail vehicle maintenance, leveraging data and expert insights to ensure safer, more reliable public transportation.

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