EU Danube Region Strategy
PA 8 LIGHTHOUSE

DIGITALIZATION, ARTIFICIAL INTELLIGENCE, METAVERSE & VIRTUAL WORLDS

OPTIMUM

Constantine the Philosopher University in Nitra
Slovakia

Steinbeis Europa Zentrum – Enabling Innovators to Grow
PBN advanced management
Gospodarska zbornica Slovenije – Chamber of Commerce and Industry of Slovenia
DANUBE REGION strategy – Prosperity through Diversity
Interreg Programme Danube Region
Co-funded by the European Union
REPUBLIC of CROATIA Ministry of Economy
Baden-Württemberg Ministry of Economic Affairs, Labour and Tourism

OPTIMUM

DANUBE REGION strategy Competitiveness

Basics

Acronym: OPTIMUM

Name: Optimization of Manufacturing and Transportation Infrastructure Processes through Artificial Intelligence Methods

Country: Slovak Republic

Scoring: 49/50

Project Coordinator:

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PROUNION a.s.

Key Project Data:

2024-2026

999.493,88 €

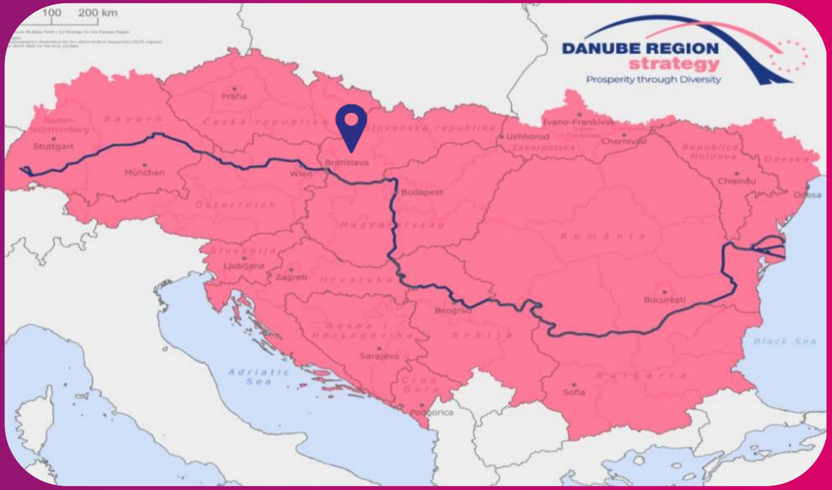
Funded by the NGEU Recovery and Resilience Plan of the Slovak Republic

Consortium:

Constantine the Philosopher University in Nitra

PROUNION a.s.

TTC, s.r.o.



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About the project

The **OPTIMUM Project** (Optimization of Manufacturing and Transportation Infrastructure Processes through Artificial Intelligence Methods) is a joint initiative of the Constantine the Philosopher University in Nitra, PROUNION a.s., and TTC s.r.o. The OPTIMUM project targets the **integration of AI methods into manufacturing and transportation infrastructure processes**, with the aim of achieving predictive, efficient, and sustainable industrial automation.

The objective is to create a system, fulfilling the following criteria:

- **Reduce unplanned downtimes** via predictive maintenance
- **Increase resource efficiency** by forecasting energy/air consumption
- Improve **product quality** through real-time anomaly detection
- Enable **prescriptive control using decision trees** for scheduling optimization
- Develop **transferable AI frameworks** for both manufacturing lines and fluid pipelines

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INNOVATIVE

AI-driven control enables real-time decisions. **Multi-source data fusion** helps the development of robust models. **Open Science** ensures transparency and validation.

SUSTAINABLE

AI models provoke **energy and resource optimization**, cut waste and prevent failures. Efficient use of cloud and targeted dataset processing enables a **low ecological footprint.** Complies with eco-standards, supports long-term maintenance and upgrades.

SCALABLE

Each **modular architecture of the AI framework** can be deployed. The methodology is **transferable across sectors**. The projects showcases **digital twin compatibility and cloud deployment**, while **training talent for future expansion.**

Work Packages and their Highlights

The project operates at TRL 1–3, focusing on foundational research and experimental validation. Its core activities are organized into five interrelated work packages (WPs), each addressing key technological challenges. Here are the main highlights from each work package:

WP1: Business Understanding

Creation of **two studies on AI applications** in manufacturing and pipeline monitoring and business understanding, forming the scientific foundation for the project's next phases.

WP2: Data Preparation

This work package develop **structured datasets ready for AI modeling** that involves both **real-world industrial data and simulated datasets** (e.g., pipeline leaks).

WP3: Modelling

The focus during WP3 is on selecting **models that balance accuracy and computational complexity**, using hybrid approaches and multi-source data fusion.

WP4: Model Evaluation

Highlight of WP4 is **scenario-based testing, cross-validation, and integration of classical statistical detection methods** with AI to create hybrid models.

WP5: Laboratory Verification

WP5 confirms the **models' capacity** to handle live-streamed data and informs design improvements for eventual field deployment.

→ **Each work package contributes to building an AI-enabled control system that is modular, scalable, and ready for future real-time industrial applications.**

Work Packages and their objectives

WP1: Business Understanding

Map the state-of-the-art in AI applications for industrial lines and pipeline infrastructure through systematic literature reviews

WP2: Data Preparation

Acquire, explore, and preprocess datasets for use in machine learning models

WP3: Modelling

Developing machine learning models for anomaly detection, prediction, and optimization

WP4: Model Evaluation

Calibrate and validate AI models through cross-validation, scenario testing, and robustness analysis

WP5: Laboratory Verification

Validate models in a simulated industrial environment, ensuring real-world applicability

Impact

The OPTIMUM project has a broad impact across multiple domains:

- **Industrial Transformation**: Reduction of downtime, material waste, and operational inefficiencies
- **Environmental Sustainability**: Lower energy consumption and a reduced ecological footprint
- **Economic Growth**: Enhancing the competitiveness of industrial enterprises, driving economic progress
- **Scientific Advancement**: Delivering advancements in AI, industrial automation, and digitalization to foster further innovation

Outcome

OPTIMUM also delivers significant added value through its AI-driven optimization framework. The table below illustrates how each key measure contributes to specific outcomes and benefits

Measure	Added value
Integrating machine learning, predictive analytics, and digital twins	Enhancement of operational efficiency, safety + sustainability
Predictive maintenance	Reduction of downtimes
Resource consumption forecasting	Minimization of environmental impact
Real-time anomaly detection	Improvement of product quality
Modular approach, hybrid approaches	Ensures scalability across sectors
Close collaboration between academia + industry	Strengthening of technology transfer and digital transformation + reinforcement of Slovakia’s + Europe’s competitiveness in smart industry solutions

Review and Tips

During the implementation of the OPTIMUM project, several barriers were encountered that provided valuable insights for future replication:

Barrier/Obstacle	Tips and idea for future replication
Limited availability of high-quality industrial data due to data sensitivity and the heterogeneous nature of sources	– Close **collaboration with project partners** + use of simulation data – Establish **early-stage data sharing protocols**: Formal agreements with partners regarding anonymized data sharing can accelerate initial stages.
Data heterogeneity + inconsistency: granularity across datasets required	– **Preprocessing + normalization of diverse formats** before modelling
Model generalizability concerns → limitations of early AI models, when applied across different process conditions	– Robust **multi-source data fusion strategies** + iterative model refinement – Create **modular AI model architecture**: This facilitates reuse across different industrial settings and supports integration with existing control systems.

Tips for other projects:

- **Invest time in WP1** - systematic reviews and stakeholder alignment: This ensures a shared understanding of scope and technology limits.
- Use **synthetic data generation** to augment training: Especially useful when real-world data is insufficient or imbalanced.
- **Validate models incrementally**: Layer simulations and test cases gradually to build performance robustness before real-world application