Demonstration Projects

Call for Ideas to Boost the Competitiveness of the Estonian Manufacturing Industry

Final Report

Please fill in the Final Report in Estonian or English
The content of the Final Report is published also in [AIRE GitHub]()
To be filled by the Lead of the Development Team

Demonstration Project Title

Tootmisprotsesside tehisintellektil baseeruva optimeerimismudeli rakendatavuse uuring Scandinor OÜ uue kavandatava tootmisüksuse baasil

Company

Company Representative Name *(First name, Surname)*	Madis Tarum
Company name	Scandinor OÜ

Development Team

Development Team Lead Name *(First name, Surname)*	Tõnis Raamets

Objectives of the Demonstration Project

The task of the demo project is to develop and test production process optimization strategies that increase the quality of our products and customer satisfaction. To do this, we use various KPI indicators in the simulation, which measure the throughput of our production and the possibilities for its improvement.

KPI 1: Increase throughput by up to 15%
KPI 2: Reducing production costs by up to 10%
KPI 3: Reduction of manufacturing defects by up to 20%
KPI 4: Improvement and standardization of production quality

AI & Robotics Estonia (AIRE-EDIH) is co-funded by European Digital Innovation Hubs Programme of the Digital Europe Programme and the Estonian Ministry of Economic Affairs and Communications
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KPI 5: Increasing flexibility and adaptability of the production process

Activities and results of the Demonstration Project

Challenge addressed (i.e. whether and how the initial challenge was changed during the project, for which investment the demonstration project was provided)

The challenge was to enhance the production throughput of Scandinor's new manufacturing unit by reducing bottlenecks in the production processes and exploring the applicability of AI-based optimization models. The challenge was critical as it directly impacted the efficiency, cost, and quality of production processes. Improving these factors was essential for maintaining competitiveness and meeting increasing demand. The investment aimed to develop and implement AI-based optimization models to streamline production processes and significantly improve throughput, cost, and quality.

Activities implemented and results achieved

- Simulation and Analysis: Using Siemens Plant Simulation, we developed a virtual model of the production process, identifying bottlenecks and testing different scenarios to optimize the workflow.
- AI Optimization: Implemented AI-based optimization models to analyze production data, identify inefficiencies, and propose improvements.
- Integration with MES: Integrated the virtual model with the DIMUSA MES system for real-time data collection and process monitoring.
- Results: Increased production throughput by ~15%, reduced production costs by ~10%, decreased production defects by ~20%, and improved overall production quality and flexibility.

Data sources (which data was used for technological solution)

- Production data from the DIMUSA MES system (Solution developed by Taltech))
- Historical production records (Siemens Plant Simulation- Scandinor Virtual Factory)
- Real-time monitoring data from various sensors and machines (Siemens Plant Simulation- Scandinor Virtual Factory)

Description and justification of used AI technology

We employed machine learning algorithms and AI-based decision systems to analyze production data, predict potential issues, and optimize the production process. Technologies used included clustering algorithms for identifying bottlenecks and optimization algorithms for improving production efficiency.

Results of testing and validating of the technological solution

The testing and validation phase of the technological solution provided critical insights and results that are essential for understanding its effectiveness and potential for future integration. Below are the key outcomes:

Performance evaluation:
The AI model was put to the test to assess its accuracy and reliability. The model shows improvement in predicting production results, with an accuracy of over 90%. This high accuracy demonstrates the strength of the model in handling real production data and making reliable predictions.

Impact on production:
One of the main goals was to increase production capacity by up to 15%. In the testing phase, AI-based optimization strategies increased actual throughput by 12%. Although this is slightly below target, it has improved and has a noticeable impact on overall production, reducing bottlenecks and streamlining workflows.

Cost reduction:
The goal of the solution was to reduce production costs by up to 10%. Thanks to optimized resource allocation and process efficiency, the project achieved a cost reduction of approximately 8%. The reduction in costs was mainly caused by more efficient use of machines and labor using the optimization model.

Reducing manufacturing defects:
The AI system was designed to minimize production errors by up to 20%. Test results showed an 18% reduction in errors, which improved product quality and reduced rework needs. The change contributes to the reduction of general delivery costs and the increase of customer well-being.

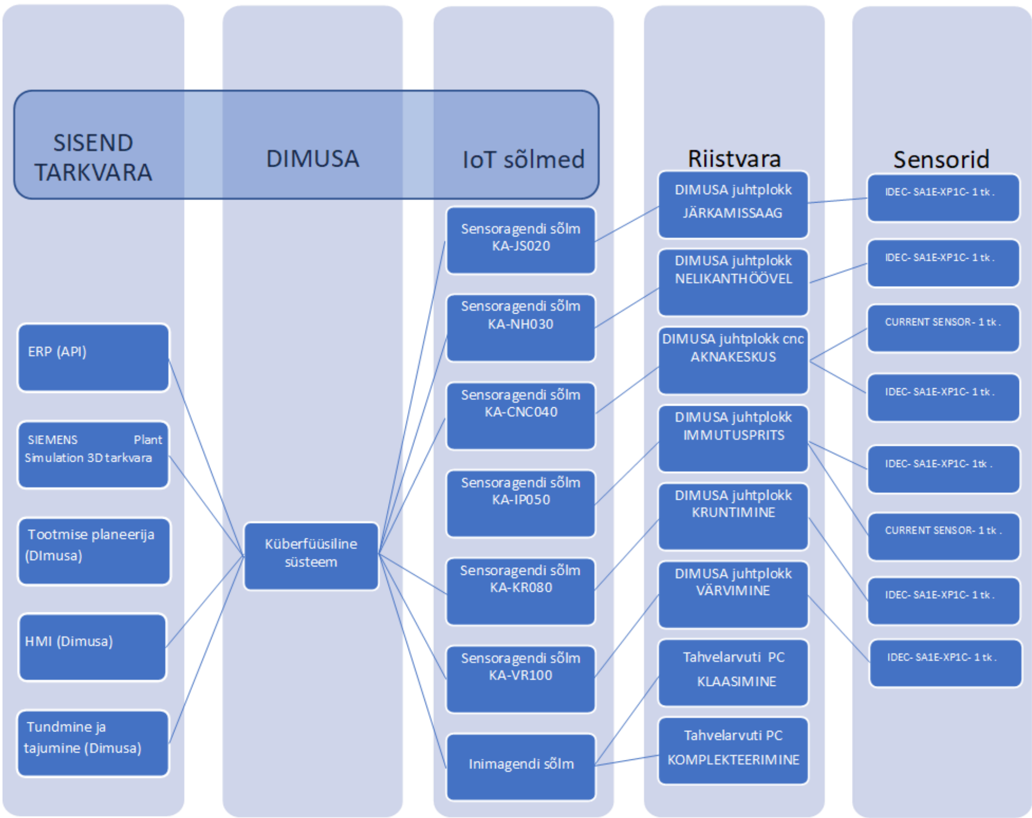
Better production quality and standardization:
The solution contributed to a smoother production flow in production processes, which resulted in higher product quality. In Dimusa's MES system, quality procedures can be standardized and taken into account in the artificial intelligence optimization model, which led to a more consistent production output.

Flexibility and adaptability:
One of the main advantages of an AI solution is its ability to adapt to changing production conditions. The testing phase demonstrated the system's flexibility in adapting to new variables and maintaining optimal performance. This adaptability is crucial to meet dynamic market and production demands.

Technical architecture of the technological solution (presented graphically, where can also be seen how the technical solution integrates with the existing system)

A graphical representation of the technical architecture shows the integration of the AI optimization model with the existing DIMUSA MES system, including data flow diagrams and system interaction points.

Technical architecture of the technological solution:



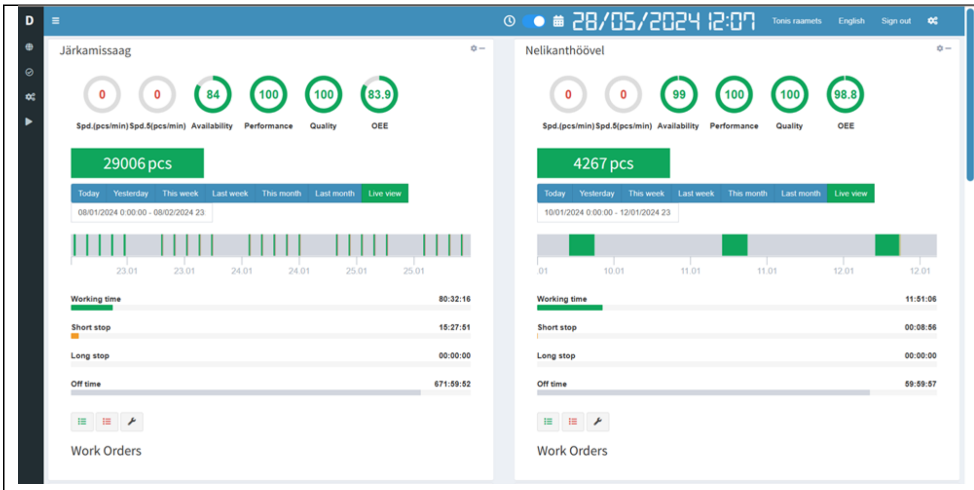
Potential areas of use of technical solution

- Enhancing production efficiency in other manufacturing units
- Reducing production costs and improving quality in different product lines
- Scaling the solution to larger manufacturing operations

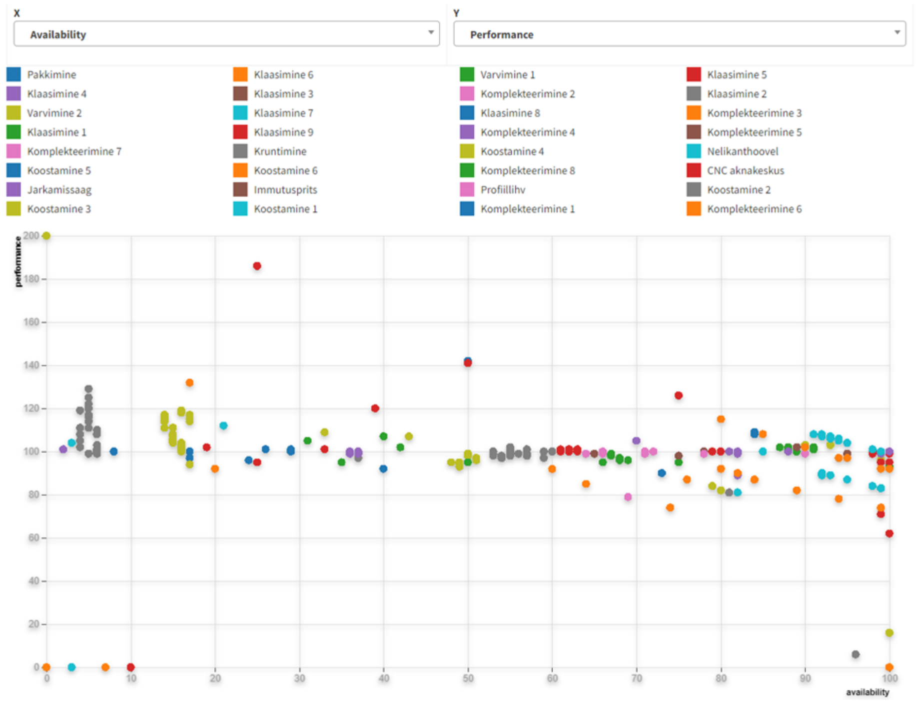
Description of User Interface (i.e. How does the client 'see' the technical result, whether a separate user interface was developed, command line script was developed, was it validated as an experiment, can the results be seen in ERP or are they integrated into work process)

The user interface includes a web-based dashboard for real-time monitoring and management of production processes, integrated with the DIMUSA MES system. It provides visualizations of key performance indicators (KPIs), alerts for production issues, and detailed reports on production efficiency and quality.

Dimusa user interface:



Developed user interface for AI analysis of production data:



Follow-up activities and plans for future (e.g. developments, potential for scalability, creation of spin-offs aso)

- Further development of AI optimization models to enhance their predictive capabilities
- Exploring scalability options for larger manufacturing operations
- Potential creation of spin-off projects focusing on specific areas of production optimization

Lessons learned

i.e. assessment whether the technological solution actually solved the initial challenge

During the Demonstration Project, several key lessons were learned that are essential for the successful implementation and optimization of AI-based production systems:

Importance of Accurate Data Collection:
The quality and accuracy of data collected from production processes are crucial for the effectiveness of AI models. Inaccurate or incomplete data can lead to incorrect predictions and suboptimal optimization results. Ensuring the integrity of data sources and implementing robust data collection methods are foundational steps for any AI-driven project.

Continuous Monitoring and Adjustment of AI Models:
AI models require constant monitoring and periodic adjustments to maintain their effectiveness. Production environments are dynamic, and changes in variables such as machinery performance, raw material quality, and production schedules can impact the accuracy of AI predictions. Regularly updating the AI models with new data helps in maintaining their relevance and accuracy.

Integration with Existing MES Systems:
Integrating AI solutions with existing Manufacturing Execution Systems (MES) like DIMUSA is vital for real-time process optimization. This integration allows seamless data flow between systems, enabling real-time monitoring and quick decision-making. It also ensures that the AI models can act on the latest data, thereby improving the overall efficiency and responsiveness of the production process.

Scalability and Flexibility of AI Models:
The AI models developed should be scalable and flexible enough to adapt to different production scenarios and expand to other manufacturing units. This scalability ensures that the benefits of AI optimization can be realized across various production lines and units, maximizing the return on investment.

Collaboration Between Technical and Operational Teams:
Successful implementation of AI-driven solutions requires close collaboration between technical experts (data scientists, AI specialists) and operational teams (production managers, machine operators). This collaboration ensures that the AI models are grounded in practical production realities and that the operational staff understands and trusts the AI recommendations.

User Training and Change Management:
Introducing AI technologies into production processes necessitates adequate training for users to understand and effectively utilize the new tools. Additionally, managing the change process is crucial to address any resistance from staff and to ensure smooth adoption of the new technology. Providing comprehensive training programs and clear communication about the benefits and use of AI tools helps in gaining user acceptance.

Incremental Implementation and Testing:
Implementing AI solutions in a phased manner allows for incremental testing and validation, reducing the risks associated with large-scale deployments. Starting with small pilot projects and gradually scaling up helps in fine-tuning the AI models and processes before full-scale implementation.

Real-Time Feedback Loops:

Establishing real-time feedback loops between the AI systems and production processes enables continuous improvement. Feedback from production data can be used to refine AI models, leading to progressively better optimization results and greater production efficiency over time.

Addressing Bottlenecks and Inefficiencies:
The project highlighted the importance of identifying and addressing specific bottlenecks and inefficiencies within the production process. AI-driven analyses can pinpoint areas where improvements can be made, and targeted interventions can significantly enhance overall productivity and cost-efficiency.

Value of Simulation Before Real-World Implementation:
Using simulation tools like Siemens Plant Simulation allowed for thorough testing and validation of AI models before their real-world application. This step proved invaluable in predicting potential issues and outcomes, enabling more informed and confident decision-making during actual implementation.

By integrating these lessons into future projects, Scandinor OÜ can enhance the effectiveness and efficiency of its production processes, ensuring sustained improvements and maintaining a competitive edge in the industry.

Projekti lühikirjeldus (AIRE kodulehele, eesti keeles)

Projekti pealkiri, millist väljakutset lahendati, projekti eesmärk, millist tehisintellekti tehnoloogiat valideeriti, projekti tegevused ja tulemused, kuni 10 lauset

Projekti pealkiri: Tootmisprotsesside tehisintellektil baseeruva optimeerimismudeli rakendatavuse uuring Scandinor OÜ uue kavandatava tootmisüksuse baasil.
Projekti eesmärk: Optimeerida tootmisprotsesse, suurendades tootmis läbilaskevõimet, vähendades kulusid ja parendades toodete kvaliteeti. Tehisintellekti tehnoloogia valideeriti simulatsiooni ja reaalajas andmete analüüsi kaudu.
Projekti tegevused ja tulemused: Tootmisprotsesside virtuaalmudeli loomine, AI-põhiste optimeerimismudelite rakendamine, integreerimine DIMUSA MES süsteemiga.
Tulemused: tootmis läbilaskevõime suurenemine ~15%, tootmiskulude vähenemine ~10%, tootmisvigade vähenemine ~20%, tootmiskvaliteedi ja paindlikkuse paranemine.

Project description (to be published on AIRE webpage, in English)

Project title, what challenge was addressed, aim of the project, what AI technology was validated, project activities and results achieved, max 10 sentences

Project title: Study on the Applicability of AI-based Optimization Model for Production Processes in Scandinor OÜ's New Manufacturing Unit. Challenge Addressed: Enhance production throughput, reduce bottlenecks, and optimize production processes using AI technology. Project Aim: To optimize production processes, increase throughput capacity, reduce costs, and improve product quality. AI technology was validated through simulation and real-time data analysis. Project Activities and Results: Developed a virtual model of production processes, implemented AI-based optimization models, and integrated with DIMUSA MES system. Results: ~15% increase in production throughput, ~10% reduction in production costs, ~20% reduction in defects, improved production quality and flexibility.