ZDMP Blog

ZeroWasteZDM

AI-enabled zero defect zero waste production

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Project Details and Motivation

Sustainability is without a doubt one of the most widely discussed topics of recent years. Since manufacturing is associated with depletion of resources and overall negative impact on the environment, manufacturing companies need to rethink many concepts to adapt to the requirements of sustainable business practices[1]. On another hand, in a global business world, companies must stay competitive (or even ever more competitive), meaning to ensure a high quality of the product in parallel to having an environmentally friendly production. This should reinforce the synergies between the management of quality and of sustainability in manufacturing. Major manufacturers around the world give special attention to implementing sustainable workflows to their quality control processes[2]. However, this transformation toward "**zero defect zero waste**" is still missing for most manufacturing SMEs. It appears that they have been very slow in implementing formal quality models and environment monitoring tools, due to the need for expert modelling and analysis (expensive and time consuming). Moreover, the problem is challenging due to a huge amount of quality and environment-related data to be analysed in the real-time, which is not suitable for traditional process monitoring and control approaches.

A systematic and suitable approach for manufacturing SMEs for the integration of quality and sustainability in a holistic decision-making is missing. This project paves the way for revolutionising process & quality control for SMEs by taking advantage of the digital transformation not only to reduce costs and increase productivity, but also to lower the environmental impact. The main challenge is that this transition for manufacturing SMEs must be affordable and smoothly integrated in the existing automation of processes and quality control.

The main idea of the project is to extend ZDM strategies (i.e., detect, repair, predict, prevent) which are based on the quality control (zero defects), with the aspects related to the zero waste. The manufacturing wastes are considered in a broad scope including, as key target wastes, material usage and energy usage, and subsequent (CO2) emissions, leading to an environmentally friendly, zero defect zero waste production (reduced energy consumption, emission and waste).

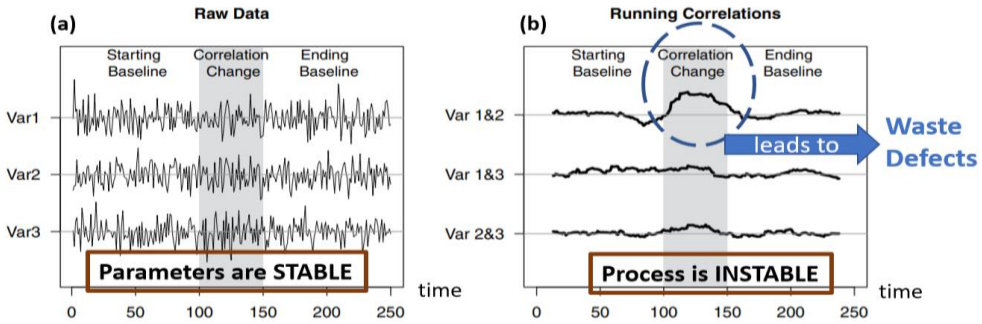
The main innovation of the project is an efficient approach for the integration of the monitoring of environmental aspects into existing quality control process. This integration leads to new/extended phases in the process monitoring and control cycle: Monitor & react (detecting anomalies in quality & environment data and immediate reaction on known situations), analyse & predict (understanding unknown situations and predicting the impact on quality / environment), learn & improve (learning new models from past data). In brief the integration is a novel AI-based multivariate analysis of heterogenous parameters in high dimensional space (quality and environment), which is sensitive on small variations in correlations between the parameters (especially quality and environmental aspects). It leverages existing work of Nissatech in the domain of AI and big data analytics (D2Lab).

The main novelty is using unsupervised deep learning methods for discovering change points (small deviations) in complex multidimensional spaces and understanding their impact on the instability in the process as a whole,

[1] https://fotonow.ai/sustainable-manufacturing-with-ai-based-quality-inspection/

[2] https://www.manufacturingglobal.com/top10/top-10-most-sustainable-manufacturing-corporations-world/lg

as indicated in Figure 1. Spotting these changes timely is especially important if a deviation is related to the relation between monitored quality and environmental parameters, indicating the process instability which leads to an increase in the emission/energy consumption in the selected period.



Motivating example: In (a), three monitored variables are uncorrelated. Then at the onset of the middle phase, an event occurs, causing two of them to become highly correlated. In (b), the correlations between all three pairs of variables are presented: huge increase for Var1-Var2

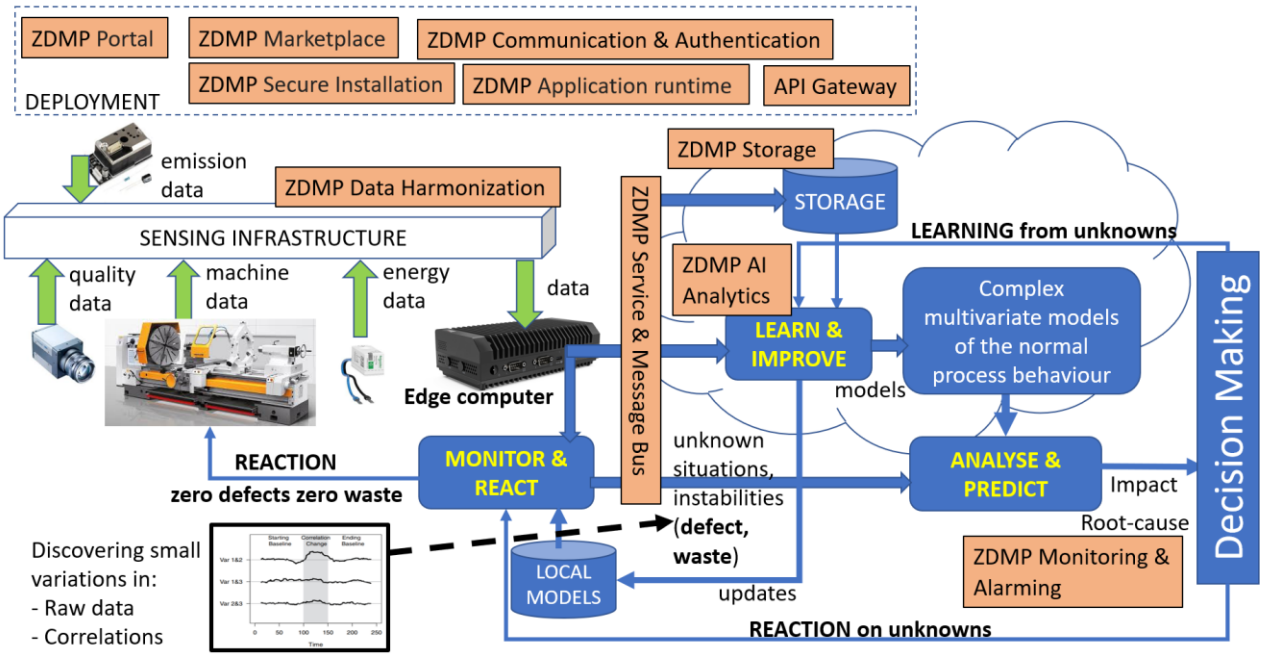
ZDMP Fit

The project contributes to ZDMP to provide an extendable platform to support factories to help them reach a goal of "zero defects zero waste" production, contributing explicitly to 3 ZDMP objectives: "To provide an Industry 4.0 (I4.0) Platform for developing zero-defect solutions", "To ensure outstanding process quality, through equipment, resource, and energy efficiency, by deploying novel AI based solutions", "To deliver core Industrial IoT support of data acquisition, interoperability, and analytics" by offering new AI-driven services for zero waste ZDM.

The following ZDMP components will be used:

- ZDMP **Data Harmonisation** for harmonising the data from a variety of sources into the required formats
- ZDMP **Service & Message Bus** for enabling asynchronous (pub-sub) communication between data providers and data users
- ZDMP **Storage** for storing the data collected from the edge as well as the data-driven models derived from the learning process
- ZDMP **AI Analytics Runtime** for supporting the Real-time smart services, by enabling an efficient deployment of learned AI (data-driven) models
- ZDMP **Monitoring and Alerting** for allowing data collection from machines and alerting in case a KPI get out of defined limits
- ZDMP **Portal** for enabling user interaction with available assets/services/data
- ZDMP **Secure Authentication and Authorisation** for enabling authentication and authorisation for ZDMP assets

The following figure illustrates the architecture.



ZeroWasteZDM high-level architecture. Blue: ZeroWasteZDM custom functionality, Orange: ZDMP zComponents

Participant Details

- **Organisation(s) involved: Nissatech:**
  - **Web: https://www .nissatech.com/research-development/**
  - **Contact**: Nenad.Stojanovic@nissatech.com
- **Profile:** Nissatech is a twelve-year old, innovation-driven SME with strong international cooperation and vision to become one of Europe's top innovators in the domain of advanced AI and cognitive industrial solutions. The main objective is to develop their own technological building blocks through an efficient implementation of the cutting-edge research and their usage for resolving very challenging real-world problems in different industrial domains.

  The company has very good connections with several leading research organisations in Europe, based on the past affiliations of the part of the management. The major competitive advantage is based on a very high innovation potential and strong engineering skills that enable an efficient early adoption of technologies that can improve our core competencies. Our social responsibility is driven by awareness of the need for green and social innovation in any technological progress.
  Current work is driven by innovations related to advanced multivariate analytics, where one of them is validated successfully by the European Commission's Innovation Radar[3]: " Zero-Defect Manufacturing (ZDM) Big Data Analytics for quality control in multi-stage production systems;"

ZDMP Details

The ZDMP – Zero Defects Manufacturing Platform – is a project funded by the H2020 Framework Programme of the European Commission under Grant Agreement 825631 and conducted from January 2019 until December 2022. It engages 31 partners (Users, Technology Providers, Consultants and Research Institutes) with a mission to "Provide the platform, components, services, and marketplace to achieve the right product, at the right time, with the right conditions using the right resources.". Further information can be found at www.zdmp.eu. ZDMP

[3] https://www.innoradar.eu/innovation/34919

channels 3.2M€ of SME orientated funding to subprojects, such as this one to both facilitate SMEs with their innovations and increase the value of the ZDMP ecosystem

Links

● **Sub project website/blog**	https://www.nissatech.com/research-development/
● **Architecture Component(s)**	https://www.zdmp.eu/documentation
● **ZDMP Website**	www.zdmp.eu