An Interoperable Decision-Support Platform for Drinking-Water Treatment

Public thesis abstract · Akrivi Alexandraki · TU Delft

Drinking-water utilities face changing source-water quality and treatment conditions while relying increasingly on measurements, predictive models, and digital advisory services. The engineering challenge extends beyond forecasting: information from different sources must be brought together without losing its meaning, provenance, validity, or the distinction between advice and operational responsibility.

In my Engineering Doctorate project, I developed and evaluated an interoperable decision-support platform for drinking-water treatment in collaboration with Waternet, the utility serving Amsterdam and its surroundings. The case addressed source-water awareness at Nieuwegein and the coagulation–flocculation and ozonation processes associated with the Leiduin treatment system.

Twenty requirements informed four design principles: separation of platform functions; explicit interfaces for interoperability; human-in-the-loop decision support; and separation of data acquisition from model execution. The resulting platform combines measurements, predictive soft sensors, advisory services, operational risk interpretation, and external data exchange. Its services address source-water turbidity, coagulation performance, ferric-chloride dosing, ozone exposure, bromate formation, and microbial-removal performance.

The implemented platform was assessed through software and requirements verification, communication with Waternet’s process information system, external interoperability testing, and stakeholder review. It distinguishes measurements from predictions and recommendations, and communicates unavailable information explicitly. Selected outputs are interpreted as Low, Moderate, High, or Unknown operational states. Invalid or missing information is not silently treated as safe; operational decisions remain with water professionals.

In addition, I developed an innovative reliability-centred method for assessing soft sensors and associated software services as digital assets. Applied to an ozonation concentration–time soft sensor, the method identified incomplete or unavailable inputs and model drift as important failure concerns. By connecting failure analysis with input validity, degraded-service visibility, and lifecycle monitoring, it extends reliability thinking from physical equipment to the digital tools on which operators increasingly depend.

A techno-economic evaluation examined adoption and continued use alongside implementation and maintenance needs. It indicated that positive economic value is possible under favourable conditions, particularly when existing digital infrastructure can be reused; outcomes are sensitive to the assumptions made. Beyond prospective resource efficiencies, the platform offers a foundation for greater operational flexibility and more informed water-quality control. These are potential operational benefits, not claims of demonstrated full-scale improvements.