

Everyone's Smart University

Project (Spring 2021)

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Project Risk Management

Water Resources and Industry

1. Introduction :

The concept of sustainable risk assessment in industrial wastewater treatment is vital to determine the causes and consequences of plant failure. The potential wastewater-related risks that could hamper the operation of the entire manufacturing facility are currently inadequately defined and under researched. This work proposes a framework that includes the comparison of literature and experimental data to quantify the impact of the significant process parameters on the critical process outputs. From the business perspective, managing and minimising risks will be possible when the number of impact parameters is low and the relationships between different parameters are clearly understood. The results show that even only the evaluation of technical risks can provide an assessment platform template for other risk types. Also, the structured and statistically analyzed data sets applied might be further used in the design and development of machine learning platforms algorithms to inform sustainable process outcomes adjusted for various geographical locations and human factors which significantly affect the industrial water sector globally.

The definition of the term “risk” is essential for the successful management of many activities and technologies. The risk definition can affect the outcome of policy debate, the allocation of resources among safety measures, and the distribution of political power in society. A general framework development depends on the risk definition that can be considered as a political act expressing the definers’ values leading to adverse consequences for a particular decision . No definition of the term “risk” can be advanced as the correct approach because there is no one definition that is suitable for all definers’ values . Water risks can only be coordinated as a collective action from industry, policy makers, customers, and citizens aiming to protect water resources and mitigate long-term water-related risks . The effectiveness of the possible risk mitigation depends on the selection of methods and tools used for the residual risk measurement. The establishment of a risk assessment framework will guide enterprises on how to reduce their impact on global water resources through development of an innovative risk management culture . Development of new approaches to assess and evaluate various risks could open new possibilities to manage water resources worldwide.

2. Literature Review

The risk of an emerging “global water crisis” is regarded as the third highest ranked risk, in terms of overall impact on the industry. There is a clear need for the implementation of better practices and more holistic measures that can rectify risks related to water use on industrial sites. In common with many other industries, the water sector is formalizing explicit approaches to risk management and decision-making, that have formerly been implicit . Many industries follow the accepted standards of performance and codes of practice . However, the overall complexity of the industrial water sector may require the integrated risk analysis to better understand what drives the risk from or to the plant, process, or operation. Risk management frameworks establish a platform based on the risk identification, evaluation, and management to drive decision making by industrial stakeholders . The framework of an iterative approach recognizes that continuous improvement of the risk analysis to develop a mature capacity in risk management . The implementation of a portfolio of risk techniques within a water sector depends on enterprise size, existing management

culture, and the governmental regulations. The implementation of a risk assessment framework should not be considered as the end – point of risk management, but as an inspiration for the continuous process re-assessment to mitigate any potential risk . Overall, risk analysis can be considered as a tool that informs the decision-making process . The risk management activity should reflect sensible and meaningful conclusions rather than theoretical perspectives, as previously suggested . The efficient risk management of a water utility requires both methods for proper risk assessment and multiple criteria decision analysis. Risks are not limited to the boundaries of a single enterprise and are often driven by customer pressures and increased stakeholder interest . Thus, the dependencies between suppliers, customers, competitors, and organization must be identified, assessed, mitigated, and monitored. To the author knowledge, no previous work has been carried out on the development of qualitative methods for integrated risk assessment in the wastewater sector.

Understanding risks originating from human errors, management weaknesses, technological failures, irrational exploitation of natural resources and generation of non-disposable waste can prevent industry from accidents, disruptions, and financial bankruptcy . Risk management is often linked to significant uncertainties and associated complexity, which emphasize the need for the development of rigorous and sophisticated modeling approaches. Supply chain consideration have attracted an increasing focus on wastewater-related risks.

3. Methodology

2.1. Risk assessment

Risk assessment can be performed in a closed loop. Implicit to Fig. 1 are an initial identification of the roots causing risks; an analysis of roots and consequences of the risk being realized in the industrial and public water sectors; a consideration of their combined outcome by evaluating the magnitude of the risk; some judgement of the significance of the acceptability of the risk; and then a decision to act - either in risk mitigation or in demonstrating that the risk is low, and the residual risk is being acceptably managed. The risk assessment process is represented by the continuous control loop that is an iteration of data collection, analysis and decision making. Fig. 1 is a framework suggesting actions which can effectively manage the risk followed by any additional analysis or action to mitigate the risks. The risk assessment is shown as an iterative process that can be repeated an unlimited number of times to mitigate the risks. Risk assessment is considered as a process that does not reduce risk alone. Its purpose is to inform decision making and associated actions to manage risk in the enterprise. Management action related to risk mitigation assumes the responsibility has been passed to the risk owner who is accountable for action and takes responsibility for seeing the actions and its completion, so that the risk is mitigated accordingly. The enterprise water use may exacerbate the water risk by depleting the water catchment area it relies on for sustained operations. Therefore, companies must take measures to respond to water risk. Responses to water-related risk range from purely financial strategies to actions that reduce demand or increase supply, and usually include a mix of these actions. Fig. 1 illustrates a decision framework for analysing the consequences of industrial revenue maximization, minimization of environmental impact, integration of novel and cost-efficient technological solutions, etc. and developing a response strategy. When examining water use, it is critical to understand when and where the water is withdrawn. Unlike greenhouse gas emissions, which have the same impacts regardless of where the emissions are generated geographically, the absolute volume of water used is often less important

than the timing and location of use. Previous studies showed that one cubic meter used in an arid urban region poses a greater physical risk than one cubic meter used in a wet rural region because the uncertainty of water supply in the future is significantly greater. Consequently, organisations need to examine their water carbon footprint and identify whether there are any physical water-risk hot spots in their value chain.



Fig. 1. Flowchart of the risk assessment methodology.

2.2. Data collection

The operational data is collected using literature sources and using online monitoring tools at industrial sites. A large number of different types of sensors distributed across the system is involved in the data collection. This network is often associated with a distributed data storage and pre-processing/control units. The collected data passes through many connections and middleware and therefore it is crucial to guarantee that the data is being reliably transmitted and received at the destination in a timely manner. Also, the collected data should be properly stored for future analysis to obtain higher accuracy levels. However, qualitative aspects of the data collection have a strong impact on the way the data can be statistically processed and evaluated using various risk assessment tools. The efficiency of wastewater treatment is basic indicator of wastewater treatment plant function. Municipal wastewater is mainly comprised of water together with relatively small concentrations (<0.01%) of suspended and dissolved organic and inorganic solids. Among the organic compounds present in sewage fraction are carbohydrates, lignin, fats, soaps, synthetic detergents, proteins, and their decomposition products, etc.. Overall, the wastewater plant efficiency depends on the amount and composition of wastewater, on condition and type of sewer network, plant operating conditions, equipment design, geographic location, and climatic conditions. The efficiency of the wastewater plant is often associated with COD that is indirectly used to determine the concentration of organic compounds in water by measuring the mass of oxygen needed for the total oxidation to carbon dioxide. The wastewater processes depend largely on the level of treatment required as prescribed by the discharge permit issued by the governmental agency. Levels of treatment required are defined customarily as “preliminary” with the removal of coarse solids, “secondary” with the substantial removal of organic material and suspended and dissolved solids, and “tertiary” with the complete removal of organic matter and suspended solids, which are typically accompanied by the reduction in nutrients such as nitrogen and phosphorus. Previous studies have shown that suspended solids, chemical oxygen demand, total nitrogen and ammonia content are main indicators of effluent quality of

wastewater treatment . The list with output parameters can be also extended to active autotrophic biomass, active heterotrophic biomass, slowly biodegradable substrate, biological oxygen demand (BOD), Kjeldahl nitrogen, etc.. However, the inclusion of more output parameters can make the model more complicated and less accurate due to the absence of available validation data and missing equipment to characterize these parameters within the required sensitivity range.

2.3. Limitation of the present work

Previous studies have identified that where there is a lack of overarching company or government policy and structure around water conservation, cultural attitudes to minimising water use and effluent discharge. In the present methodology, only the risks related to the environmental impact, health and technology will be assessed. Overall, this work focuses on how risk assessment results can be used in decision analysis to evaluate and compare measures for the risk reduction. Since an integrated approach is used, the work aims to include a wide range of possible scenarios and water technologies instead of analysing only a specific type of event or specific water system that may cause harm. This manuscript does not deal with designing specific measures for reducing certain risks or the process of implementing and monitoring selected measures. Although risk assessment and decision analysis results provide a necessary basis for risk communication, the present research aims to outline a general strategy for the development of a comprehensive tool for recording information regarding water system processes. Although risk assessments and decision analyses play an important role in crisis management, this work is not focused on crisis management. The financial and reputational risks (i.e. water price, market regulations, basic human rights, etc.) will be outside the scope of the current research.

Results & Discussion

(a) Model for the low-risk outcome.

Process Effects of Failure	Potential Failure Model					
Eutrophication	Nitrate	Phosphorus	Ammonia	Total Nitrogen	Suspended Solids	Chemical oxygen demand
Evaluation risk	10	10	20	20	50	200

(b) Model for the high-risk outcome.

Process Effects of Failure	Potential Failure Model					
Eutrophication	Nitrate	Phosphorus	Ammonia	Total Nitrogen	Suspended Solids	Chemical oxygen demand
Evaluation risk	15	50	60	40	260	1500



Fig. 2. Risk assessment using classification of articles.

Previous risk assessment models in the water sector were complex and did not provide an easy to communicate tool which links the heat mapping to sustainable output. The present study led to the development of the comprehensive and simple research framework for risk assessment in the water sector, as shown in Fig. 2. The main input variables enter a risk assessment framework with the integrated impact factors influencing the present system. Initially, all potential risk sources can be analyzed using statistical tools, then evaluated and later minimized or prevented. Most of the current research focuses on the risk data processing either historical or real-time numerical data. However, research on the use of combined literature and industrially collected data to prevent risk assessment is comparatively uncommon. The reason for this may be linked to the nature in which the data is collected, usually by human narratives. Previous studies were limited to the description of excellent data sets without giving equal attention to the outliers and missed data which could require additional post-treatment.

The developed framework is the first attempt in the academic literature to assess the potential risks in the industrial wastewater treatment sector. The present model has limitations which are related to the SMRA design that is based on the maximal significance of all risk parameters. The next stage of research could be the development of appropriate weights for individual risk parameters which may include ecology, economics, health, and social sciences. They will be assigned to individual parameters based on their impact on the quality of treatment plant operations and possibly geographical location. These weights are necessary to define strategies to minimize risks and to prepare the risk management procedures in the industrial water sector. Moreover, confirmatory runs will be required to assess the industrial plants according to the existing legislation ns and health standards at various geographical locations.

The novelty of the present work relies on the fact that the developed framework can predict and minimize the risks at the wastewater treatment plants using a simple SMRA method. The results have shown that the risk assessment must integrate analysis, evaluation, and control steps of data using statistical tools, literature research, and heat mapping within the process failure model. The extension of the framework to identify further aspects, such as for instance the significance of the parameters from technical, ecological, social, health, and economic spheres would provide a platform for future research. Also, interdependence among parameters, such as the frequent coexistence of risks, or risks amplifying each other, are recommended avenues of research to be further investigated and experimentally validated.

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