WATER TREATMENT IN THE AI AGE: OPPORTUNITIES AND CONCERNS FROM THE FRONTLINES

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ABSTRACT

Artificial intelligence (AI) has enormous potential to revolutionise water and wastewater treatment operations by optimising efficiency, predictive maintenance, and quality control. For example, AI can predict changes in raw water quality or simulate the performance of a treatment plant by analysing the information that is collected from online sensors to detect and avoid process failure and optimise treatment processes. AI use can lead to improved resource allocation, reduced operational costs, and enhanced system performance. Furthermore, AI can automate routine tasks, enabling operators to focus on value-adding tasks, preventative maintenance, and operational improvements. However, the water industry has only begun to scratch the surface of what is possible with AI. Along with the AI benefits, comes several significant challenges which we believe are holding back progress. These challenges include anxiety regarding job security, redundancy of expertise, cybersecurity, and ethical implications. This paper explores and documents the opportunities and concerns associated with the use of AI the water treatment plants from the operators' perspective. A collection of operators opinions from different water utilities nationally were interviewed and surveyed to gain insights regarding the impediments to AI, and just as importantly, to generate ideas on how else AI could be effectively employed. The aim of this research is ultimately to ensure operators are informed and empowered to ensure the responsible integration of AI in water treatment operations.

1.0 INTRODUCTION

AI has emerged as a potential tool for transforming the future of engineering. The AI booming is mainly due to its unique ability to learn and adapt a system based on historical data and make real-time decision. This is achieved through the integration of AI-based systems with intelligence, adaptability, and intentionality in their proposed algorithms (Gulzar et al., 2022).

The application of various AI tools has gained considerably in the last decade for assessing performance and improving efficiency in water, wastewater, and recycled water treatment plants (Doorn, 2021). AI can optimise processes and help extract more meaningful insights from data, automate routine tasks, and allow operators to focus on value-adding tasks, preventative maintenance, and operational improvements. This, in turn, frees up operators to be more innovative in their plant operations.

AI capability is fuelling the imagination of the water sector, but it also raises concerns about the potential implications of this seemingly revolutionary technology. A diverse group of operators from different water utilities across the nation were surveyed to gain insights into the obstacles to AI adoption and, just as importantly, to generate ideas on how AI could be effectively utilized. This paper explores and document the opportunities and concerns associated using of AI in water and wastewater treatment plants from the operators' perspective.

2.0 METHODOLOGY

A web-based survey was employed using Microsoft Forms targeting operators in water, wastewater, and recycled water utilities across three Australian states: New South Wales, South Australia, and Victoria (Figure 1). Operators were chosen based on prior interest in surveys. To ensure comprehensive demographic representation, factors such as age, experience, and

educational background were considered. Additionally, efforts were made to guarantee a well-rounded representation across various settings, encompassing major cities, urban locales, as well as smaller towns and cities.

The 15-minute survey comprised questions on demographics, AI familiarity, perceptions of AI, and organizational aspects. The survey aimed to glean strategies to boost operator awareness and training about AI. The demographic section solicited information about the respondents' professional roles, years of experience, utility locations, and sectors. Regarding AI literacy, questions gauged the operators' familiarity with AI and machine learning (ML), as well as their proficiency in implementing AI techniques. The perception category centred on opportunities and concerns or obstacles linked with AI. Lastly, the organizational segment encompassed questions exploring potential opportunities for organizations to involve operators in IT and innovation.

3.0 RESULTS AND DISCUSSION

3.1 Survey Coverage

The majority of survey responses were from NSW (70%), followed by Victoria (20%) and South Australia (10%). Sixty percent lived in regional areas, while 40% lived in a metropolitan area. The respondents' roles were as follows: 78% were water operators, and 22% were wastewater and recycled water operators. More than 60% of operators had more than ten years of experience in the industry, while 10% had less than two years of experience.

3.2 AI awareness and knowledge

We asked our survey respondents to rate their knowledge of AI awareness and understanding, and more than 90% responded that they had moderate or less familiarity (see Figure 1). However, when we asked if they had encountered AI in the workplace, only 40% said yes, and their experience was positive and encouraging. The AI applications included decision support, automation, process control, and image recognition. Twenty-five percent of the respondents who encountered AI stated that it was very helpful and made their task or activities quicker and easier compared than doing it routinely.

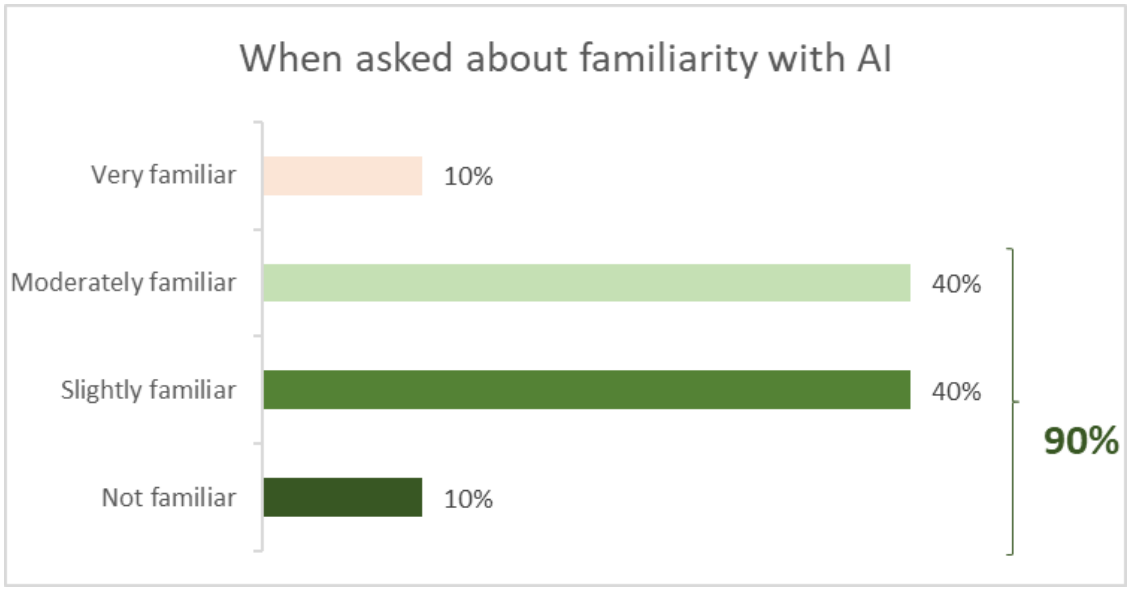

Figure 1: Familiarity with AI

Twenty-five per cent of the respondents have encountered AI in the workplace include

Supervisory Control and Data Acquisition (SCADA). However, SCADA relies heavily on traditional control and monitoring methods and typically does not incorporate AI as a core component. In recent years, there has been a growing trend toward integrating AI and machine learning technologies into SCADA systems for enhanced monitoring, predictive maintenance, and anomaly detection. AI can be used to analyse the vast amounts of data generated by SCADA systems to identify patterns, predict equipment failures, and optimize processes. Incorporating AI in SCADA is a great opportunity in water utilities as most use SCADA for data monitoring, and the operator is familiar with the system.

3.1 AI technologies opportunities and concerns

When we asked the respondents if they perceive any opportunities AI technology can bring to water operations. Twenty percent of the respondents were not aware of any opportunities while the rest of participants perceived multiple opportunities. From the analysis of the responses, the opportunities perceived can be classified as:

- Process support and control: AI can identify areas of the operation that can be over or underused, which can serve as a decision-making system to adjust the process operations and ensure efficient plant operation.

- Chemical dosing management: AI can optimise chemical dosing in water and wastewater treatment by analysing and forecasting water quality and flows.

- Predictive maintenance: AI can forecast equipment malfunctions and maintenance requirements, enabling maintenance teams to proactively resolve these concerns before they escalate into significant problems.

- Water quality: AI technology can predict water quality trends by utilising comparable sensor data and detect changes in water quality. This enables the operator to have an action plan to respond to water quality issues.

The respondents were also asked about the concerns or challenges of the implementation of AI in water operations. Thirty percent of the participants did not perceive any concerns or unaware aware of any. The main concerns raised by the respondents can be categorised as:

- Cyber-attacks: AI data can be vulnerable due to weak security protocols, leading to sensitive data theft.

- Reliability and accuracy: AI algorithms depend on high volume, high-quality and accurate data for effective decision making. AI is only beneficial when historical data exist and reliable instruments to collect them are available, which can be an issue for remote treatment plants. Inaccurate and unreliable data can lead to severe consequences to water treatment.

- Loss of human knowledge of the correct decision to make the AI is not available. There is a threat perceived that AI could take all the interpretation away from people trained and experienced in the treatment plants– there are still some judgements that operators have to make and in-field testing to execute.

- Incursion of a traditional industry with low tolerance of error in the first place: the water industry has traditionally operated with a low tolerance for error, and introducing AI raises concerns about maintaining this standard.

- Environmental impact: while AI can help optimise water treatment process, the energy consumption associated with running AI algorithms and maintaining data centres, will impact the environmental footprint of the treatment.

To address these concerns, it is important that the water industry approach adoption of AI thoughtfully, with a focus on data security, transparency, and responsible AI governance. Regular risk assessments of implementation of AI, robust cybersecurity measures, and ongoing training for the operators can help mitigate these challenges.

3.2 Opportunities for improvement in the implementation of AI

When we asked the participants about ways that the business or water industry could help, train or improve operator awareness in the implementation of AI in treatment plant operations, 40% said that training will be very beneficial. Some respondents stated that showcases of the application of AI in other utilities, facilitating their input of AI development and professional development to keep pace with changes of AI technology would be beneficial. Exchange experiences and capabilities were other areas that training could be beneficial.

The responses were asked if they are engaged in their company's digital innovation. Only 60% of participants responded that they were not or were only slightly engaged. The operators' engagement in the plant's digital innovation is an opportunity to showcase the AI's capability and their intention. There is an opportunity for digital business to include the operators in the digital innovation of the plant operation, and ultimately to ensure operators are informed and empowered to ensure the responsible integration of AI in water treatment operations.

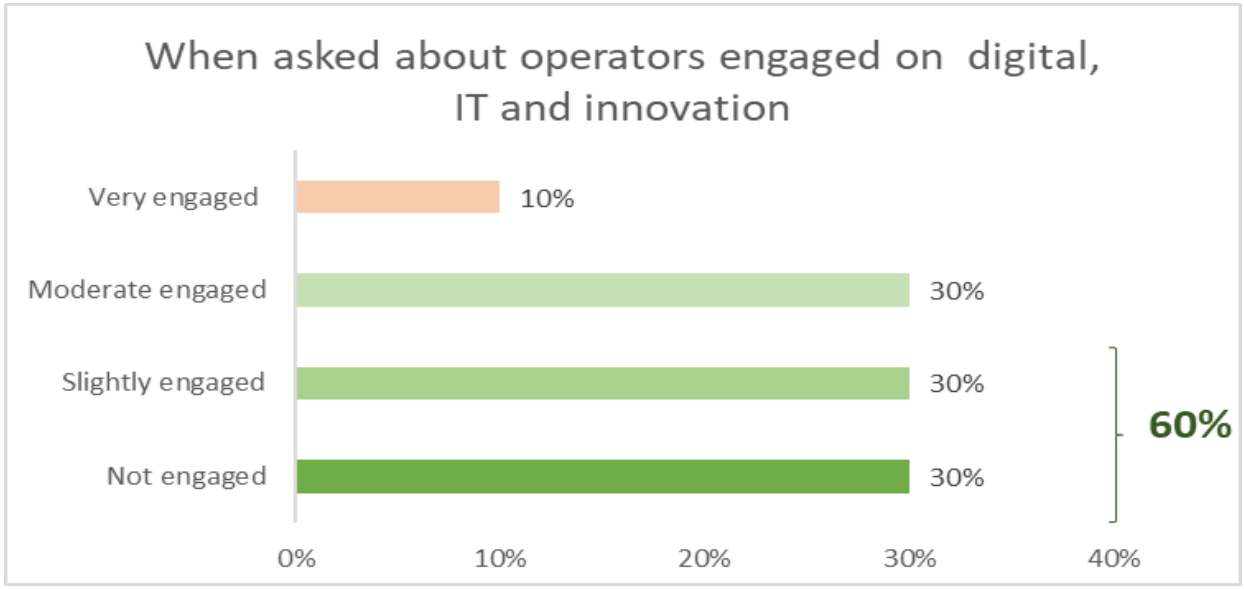

Figure 2: Operators engaged in digital innovation.

CONCLUSION

This paper presents the perception of AI in the water and wastewater industries by some Australians operators through an online survey. Operators highlighted a broad spectrum of AI's applicability, ranging from process control to chemical dosing optimization. Notably, while most operators were aware of AI's capabilities, a considerable proportion felt like they had limited personal knowledge or exposure to its practical applications within their workplace. This disparity indicates a clear need for enhanced training and awareness.

The enthusiasm for AI was tempered by valid concerns. Cybersecurity, the potential loss of human expertise, the reliance on historical data, and the intrinsic challenges of integrating AI into an industry where mistakes can have significant consequences, all emerged as issues that need to be addressed. Additionally, in shifting to a data driven organisation the quality and relevance of this data cannot be overlooked. The sentiment shared by many operators suggests a two-pronged approach: utilising AI for its analytical prowess, while continuing to value the irreplaceable human judgment developed through years of experience. The operators' needs should be included in the AI development, allowing this technology to be used harmoniously as a tool for them to operate the plant.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

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