WATEREXE4.0 - RESULTS OF THE FIRST META-STUDY ON DIGITIZATION IN THE WATER INDUSTRY IN THE GERMAN-SPEAKING REGION

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Abstract

When it comes to addressing climate change, water is at the centre of many aspects and measures. Especially in urban areas where the negative consequences of heavy rainfall events and prolonged dry periods are increasing worldwide. In the future, urban water management will have to examine water use in terms of its various objectives and provide alternative water resources for different purposes (groundwater, river water, rainwater, treated wastewater, etc.). The technological networking of water management systems requires intelligent and digital systems to manage the challenges of the future. Similarly, the contribution of water management to global CO2 reduction through more efficient procedural treatment processes will only succeed with adequate digital systems ((Balogun, 2020), (Kröhling, 2017), (Randhahn, 2020))

Researchers at Hof University of Applied Sciences have investigated the status quo of digitization within the first meta-study in the German-speaking water industry (WaterExe 4.0 project) funded by the German Federal Ministry of Education and Research. The research was conducted with four methodologically different sub-surveys (literature and market research, survey, expert interview and workshops). 120 industry participants took part in an online survey and 30 water sector experts were interviewed.

Keywords

Digitization, Smart Water, Meta-Study, Climate Chance, Water Sector

Introduction

Digitisation has become a core topic in the water industry over the last 5 years. Many products and solutions have been developed and can be found in numerous applications and projects worldwide. Research is also enormously active, especially in the area of networked and complex solution ideas. Although there is a great variety of offers and services on the market side, many digitalization topics show a consistent persistence on the part of public clients. New things are still hesitantly put into practice. Despite an increasing willingness to innovate in the public water sector (Thom and Ritz, 2017), the water industry still lacks the necessary implementation momentum to address current and future challenges more effectively (Müller-Czygan, Wimmer, Wagner & Tarasyuk, 2021). It turns out that the reluctance is not so much due to a general rejection of technology, but rather to the feared effects that new digital solutions mean for the organisation and people. These observations are confirmed by the results of the WaterExe4.0 study. Internationally, too, it has now been recognised that a sole focus on technology is not sufficient ((Seetharaman, Mathew, Sein & Tallamraju, 2020),(Eigenstetter, 2020)). Although global research on smart water solutions is accelerating to meet

industry and government demand ((Mvulirwenande and When, 2019), (Kim, 2019), (Espinosa Apráez and Lavrijssen, 2018)), the conceptual, technical and practical gaps between providers and customers are still not well bridged (Jiada, Yang, and Sitzenfrei, 2020).

Study Reuslts

Literature and market research identifies approx. 700 digitization solutions

In the done literature and market research, around 700 projects, products, complete solutions, services and studies were identified. That contain a high proportion of innovative digital methods and solution approaches. For this purpose, for example, all German-speaking universities and colleges were contacted that had planned, started or completed research projects on the topic of digitalization in the water industry between 2015 and 2021. Furthermore, an internet research and the evaluation of company presentations in trade journals and at the internet about available products and solutions (cyber-physical machines, sensors, software solutions, AI systems, etc.) were part of this work. In addition, suppliers were contacted directly. As a third pillar, a literature and internet research on realised digitization projects in the municipal sector was carried out. If the publicly available information was not sufficiently informative, the municipalities were contacted and asked for further information. The results were assigned to various aspects and categories, which are summarised in Table 1.

Only 11% of these 700 or so digitisation solutions could be identified as being implemented on a large-scale and permanent basis in a water management application. This left the study authors with the impression of a large gap between available solutions and actual implementation. In order to find possible reasons for this apparent discrepancy, an online survey and expert interviews were also conducted.

Table 1: Distribution of digital solution variants - Source: WaterExe4.0

	Waste Water	Potable Water	Rainwater	Water Bodies	Re-Used Water	Sludge
Part of identified digitization solutions in total	28%	30%	13%	11%	16%	2%
thereof:	34%	40%	50%	61%	30%	13%
Inter-municipal	25%	17%	21%	14%	18%	17%
Cross-system	13%	12%	11%	8%	17%	38%
Overall system	13%	12%	7%	5%	14%	29%
Partly system	11%	10%	6%	6%	13%	0%
Object level	4%	9%	6%	5%	9%	4%
Product level	34%	40%	50%	61%	30%	13%

Capturing the complexity of digitization requires a multi-perspective analysis

In the done online survey in which around 120 industry representatives took part, various aspects of digitalization in the water industry were addressed, in particular to find out why the implementation of digitalization is progressing so slowly in many places. In addition to the question about previous

experiences with digitalization projects, the interest lay in non-technical influencing variables as a success factor or implementation obstacle, which the respondents could identify or derive from their project experiences. They were also asked in which areas digitalization should shape the future of water management and what benefits are expected from digitalization projects. Since digitalization must also be increasingly sustainable, the survey participants were asked for their personal assessment of the role of sustainability in future digitalization projects. The online survey was primarily designed as a quantitative survey. It also allowed participants to add the quantitative questions with their own thoughts. This made it possible, for example, to identify further digitalization projects that had not yet been reported on publicly and which could then find their way into the database.

In order to minimise the risk of unintentionally limiting possible influencing factors on digitalization projects through the type and content of the quantitative questions, around 30 experts from the water industry were interviewed in addition to entering free thoughts into the survey questionnaire. The survey was designed using guided interviews, which on the one hand focused on personal experiences in digitalization projects in the German-speaking water industry. But on the other hand also left enough room for thoughts and hypotheses beyond this. The experts were selected according to the theoretical sampling model, which originates from the so-called grounded theory methodology (Mey, and Ruppel, 2018). Care was taken to ensure that the selection of experts was neither purely theory-based nor based on subjective assumptions in the sense of a defined top-down strategy. The selection of experts was carried out as a data-driven bottom-up process, whereby the specific selection criteria were always set in relation to the collected data material of the first method section in order to also be able to compare new findings from the research work with expert statements. The evaluation is based on a multi-level content analysis (Mayring, 2020). In order to be able to make an additional quantitative comparison of survey participants and experts, the experts were asked to answer some quantitative scaling questions at the end of the interviews.

Furthermore, as a fourth research component, the results of several special workshops on the topics of cost-benefit analysis and competence requirements were evaluated. In the surveys and interviews conducted, it was repeatedly mentioned that the assessment of digitisation solutions in terms of costs and benefits was extremely difficult and that this sometimes delayed decisions or even made them impossible. If an easy-to-use and targeted evaluation tool were available to compare one's own digitisation ideas with the solutions available on the market, a meaningful cost-benefit analysis would be possible. Workshop participations and interviewed experts see this as an important future success factor.

From sensor to network management - technological diversity vs. implementation barriers

The identified digitization elements are the evidence of high-sophisticated technology development in the German-speaking water industry. Currently, the industry offers digital solutions for almost all areas of water supply and wastewater disposal. Their spectrum ranges from simple sensors to cyber-physical systems up to networked complete solutions. About two thirds of the identified digitalization elements were found on the company side. Research even accounts for a quarter. Only 11 % are currently placed at the municipal water supply and wastewater side, which indicates an imbalance between supply and demand. Although more than 60 % of the digitization solutions presented to the public can now be described as ready for the market (Figure 1), there has been a reluctance to procure on the municipal side since the beginning of the digitization wave (Müller-Czygan, 2020). While companies are increasingly focusing on product development, municipalities tend to look for complete or system solutions. 34% of all identified digitization elements are represented by corporate products, but less than 1% are identified as pure product solutions in municipalities. In addition, products are also found as part of projects on the municipal side, their share is estimated at max.

50%. If this empirical value is taken into account, the product share on the municipal side still only amounts to 6% of the total digitization elements considered. On the research side, three quarters of the identified digitization elements refers to studies. Only 2% of the accessible projects concern concrete product developments, which can also be attributed to possible confidentiality agreements when participating in industrial product developments. About one fifth of the digitization elements deal with complex solutions, which are predominantly of a project nature. Previous studies have already pointed out that industrial development is far ahead of municipal needs ((Holländer, 2019),(Müller-Czygan, 2020),(Schuster, & Wimmer, 2018),(Wybrands, 2019)). Therefore, the pure analysis of published research papers, available information on industrial products as well as publications on municipal practical examples was supplemented by a quantitative survey and qualitative expert interviews to determine the reasons for the apparent discrepancy between supply and demand.

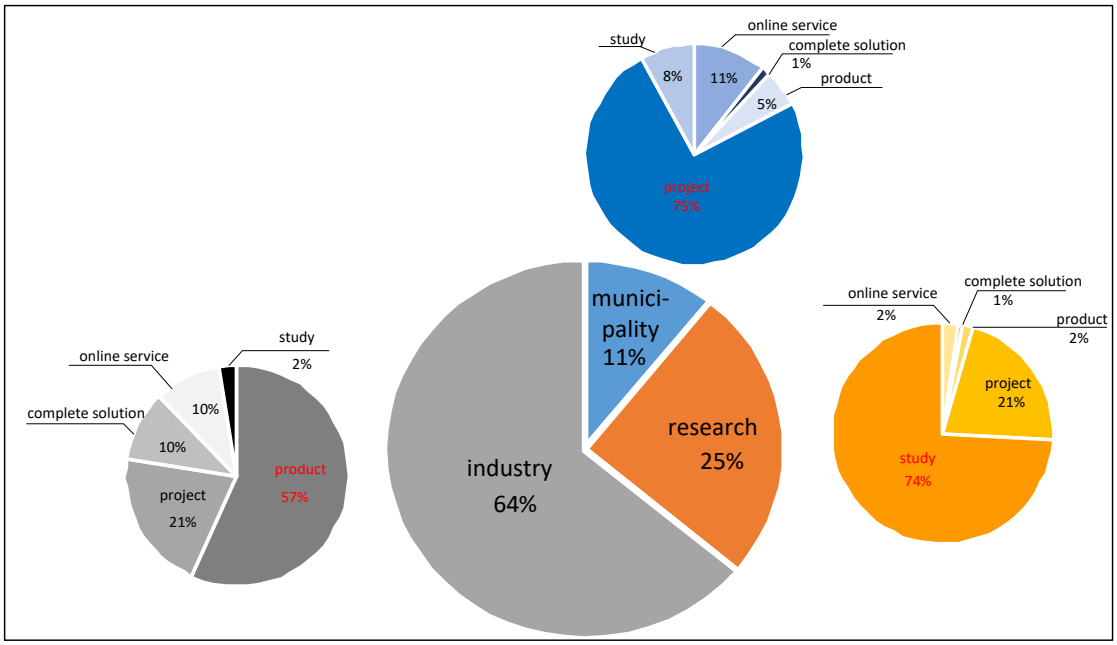

Figure 1: Distribution of the identified digitization elements (n= 698) - Source: WaterExe4.0

The right choice of technology is important, but the human factor determines success or failure

The main obstacle cited by participants in the online survey is a lack of staff, closely followed by an unexpectedly high overall effort. By some distance, the lack of internal skills and insufficient funding are also seen as relevant. In addition, survey participants were allowed to name other, very individual obstacles in the survey. These included typical factors such as fear of change or insufficient involvement of employees as well as technical aspects such as unresolved IT security and lack of standardized interfaces. But also the lack of time to sufficiently deal with the existing digital possibilities due to their existing complexity or the priority of everyday tasks keeps many from starting a digital project. The problem of lack of time could be defused if the practical benefits of digital offerings and the relationship between benefits and price were made visible in a very early state of project. It would also help if providers showed more commitment to respecting the needs of the municipal side and providing more individualized advice. With regard to the factors that were positively evaluated in the project (see Table 2), it is ultimately the own staff competences and a reasonably successful internal communication that, with the support of the external experts, ultimately

led the project to success. The respondents were also allowed to name their individual success factors. These range from needs-based digitization, clear project goals, practical relevance, internal understanding of digitization and trust in the subject matter to clear benefits such as simplification of processes and structures, acceleration of workflows and improvement of transparency.

Table 2: Success factors in digitization projects, results of the online survey - Source: WaterExe4.0

Which of the following factors have positively supported your project? (n = 94)	Arithmetic mean	Variance	Standard deviation
Sufficient time	2,84	1,83	1,35
Sufficient financial resources	3,51	1,66	1,29
Cross-departmental communication	3,63	2,06	1,44
Competence of the project manager	3,97	1,37	1,17
Competence of the staff	4,00	1,19	1,09
Expertise from specialists	3,68	1,59	1,26
Orientation towards available best practices	3,02	1,89	1,38
Exchange with third parties who already have experience	3,25	2,35	1,53
More training opportunities	2,31	2,18	1,48

Due to the methodology, the 30 interviewed experts from the water sector expressed a much broader range of opinions on possible success factors in digitization projects than the respondents of the online survey. A total of 31 different factors were named by the experts, ranging from sufficient time and the preparation of a risk analysis to an overarching strategy and attention to sustainability. Sufficient employee acceptance, a recognisable added value of the digital solution as well as the responsible key persons were named as the most important success factors. From the experts' point of view, obstacles are seen in a false expectation of quick solutions, in poor usability as well as in insufficient infrastructure requirements up to communication inability and leadership failure. The lack of resources (money, staff, time), the employees' reluctance to learn new things and the lack of infrastructure are the strongest obstacles. As much as the human factor is seen as a central role by the experts, just as it was by the participants in the online survey, the success or failure of a digitization project is influenced by a large number of different criteria. For example, the exact definition of what a digitization solution is to be used for is also of decisive importance, or the existing pressure to be able to present data as quickly as possible, but also the creation of work facilitation. The most important elements mentioned were the introduction of pilot projects or the orientation towards best practices, i.e. the early creation of a real practical reference instead of the pure pursuit of theoretical ideas. This is followed by paying attention to generational change with the associated cultural adaptation and establishing digitisation as a process and not as a one-off, time-limited and thus concludable project.

Discussion

Despite 5 years ago, the WaterExe4.0 study has shown that today hardly anyone in the German-speaking water industry is in contact with the topic of digitalization. Although criticism of digitalization, is still part of all discussions ((Müller-Czygan, 2018),(Schuster, & Wimmer, 2018)): For almost all respondents and interview partners, the consequences of the experiences of the last 5 years and the deduction for the future are almost identical. It does not play a significant role whether the respondents have their own practical experience with digitalization or if they deal with the topic purely theoretically. Survey participants and interviewed experts named the topics of creating standards, IoT, automatic maintenance / predictive maintenance, intelligent data analysis, AI, sensors / data collection and the central collection of all data as the essential topics that research and industry should address in the coming years.

In addition, the topic of sustainability, one of the central political topics for the future (Deutsche Nachhaltigkeitsstrategie, 20219, was queried separately: It was shown that more than 70 % of the respondents rate the importance of sustainability in future digitization projects as "very important" or "important". The most common view is that digitalization supports sustainability in the water industry in general, but also offers the solution to many other challenges. However, it is also expected that sustainability aspects cannot be considered in every digitization project.

For the interviewed experts, the staff that municipal organizations need or have to train for digitization projects will be the first priority in the future. Furthermore, it is of central importance that digitization solutions must have a clear added value (benefit) that is connected to the individual situation of the respective organization. Technologically, the experts see the topics of cloud application, automatic maintenance / predictive maintenance, IT security and artificial intelligence in the focus of future developments and applications. In particular, the topics of human resources and artificial intelligence (AI) must be seen in each individual context. Due to the increase of available data (Big Data), it is possible to obtain evaluable data for almost all areas of operational water management and to design processes and procedures more efficiently, more targeted and more benefit-oriented. All the industry participants have to cooperate intensely on this way. WaterExe4.0 shows how multi-layered digitalization in the water industry is. There is no recipe for success that can be applied to all use cases, but rather a catalogue of multi-criteria that must be considered in context. Further application-oriented research is therefore called upon to develop the corresponding guidelines and action aids.

Conclusion

The meta-study WaterExe4.0 of the iwe Institute for Water and Energy Management at Hof University of Applied Sciences, done in 2020 and 2021, has addressed the state of digitization in the German-speaking water industry using different research methods. In a comprehensive literature and market research, it was possible to identify approx. 700 different products, projects and studies that deal with special digitization solutions for different areas of application, such as drinking water, wastewater or water bodies. The spectrum ranges from individual sensors to complex and inter-municipal network management systems. However, only around 11% of the solutions surveyed are already in use in the municipalities, although digital solutions are now available or in prospect for almost every water management application. In order to answer the question why implementations are apparently so low compared to the variety of offers, an online survey was conducted with 120 participants and 30 experts in Switzerland, Germany and Austria were also interviewed. The staff at the water/wastewater companies are seen as crucial for success, but also for failure, as they become the project driver or the brake depending however, they are dealt with. Furthermore, it is enormously important to connect the digitalization solutions under consideration as closely as possible to everyday working life. It has been shown that the use of digitalization for task fulfilment requires a strong technical view, but the success of implementation depends much more on the people involved and the attention to individual working conditions. Both have to be optimally combined with each other.

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