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Bibliometric Analysis of Factors Influencing Poor Performance of Water Infrastructure

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Abstract

Purpose - Access to safe drinking water is still a challenge in developing countries. Water is a basic human needs and water quality already present a threat to serious health risks to humans, personal hygiene and livestock. Current droughts and poor performance of water infrastructure have a negative impact on the domestic demand for quality of water. Though, not much is published concerning factors influencing poor performance of water infrastructure in water sector.

Design/methodology – Scopus was used to gather existing literature for bibliometric analysis for this paper. Publications from the year 2017 and the year 2021 was gathered using bibliometric analysis. Keywords used for this search includes, *Water, Infrastructure, Poor and Performance.* From the analysis a total of 50 documents from Scopus database met these criteria. Further, Vosviewer (Visualization of Similarities) was used as a tool to analyse the data.

Findings – From the analysis, it was established that the number of studies on factors influencing poor performance of water infrastructure in water sector in the reviewed journals has not been increasing and not many articles are available.

Research limitations/implications – The dataset was mainly extracted from the Scopus database for the analysis.

Originality/value - This study will help policymakers in water sectors. Moreover, the study provides useful information on the key performance of water infrastructure and thus help in formulating better strategies and regulatory tools to enhance efficiency and effectiveness in the performance of water infrastructure.

Keywords

Performance, Water, Infrastructure,

1. Introduction

Water systems are a special kind of infrastructure systems since they perform a dual role: they provide water services while also reducing risks to other services from natural hazards such as floods and droughts (Stip *et al*., 2019). According to Dinka (2018) safe drinking (potable) water is the water that can be delivered to the user and is safe for drinking, food preparation, personal hygiene and washing. Futhermore, water is connected to every aspect of human day-to-day activities directly or indirectly. Nevertherless, at a basic level, everyone needs access to safe water in adequate quantities for drinking, cooking, personal hygiene and sanitation facilities that do not compromise health or dignity. Subsequently, access to safe and dependable (clean and fresh) water is the fundamental/basic right of humans. Cosgrove and Loucks (2015) alluded that the lack of adequate clean water to meet human drinking water and sanitation needs is indeed a constraint on human health and productivity and hence on economic development as well as on the maintenance of a clean environment and healthy ecosystems. However, water sector has numerous challenges, such as increased water deficits, waer pollution, droughts, floods, depleting ground water aquifers and degeneration of the quality of water, while the demand is increasing in form and quantity; water aging and waste water infrastructure; the impact onwater resources due to climate change (Saravanamuttu, 2022; Edokpayi *et al*., 2017). Feathermore, water- scarce with demand in certain cities that already exceeds supply. Roodbol (2021) alluded that water is not consistently distributed through the worlds geographic space and the condition of water). Feathermore infrastructure continues to deteriorate and therefore, the need for water infrastructure to be improved to addressissue of water scarcity and water quality. According to Herbig (2019) the deteriorating state of municipal

wastewater and sewage treatment management is one of the largest contributing factors to the numerous pollution problems experienced in most parts of the developing countries and a major contributor to environmental and human health problems. Moreover, Lukhele (2017) articulates that the deterioration of water infrastructure reduces economic growth and poor health for citizens. This study provides an in-depth literature review of factors influencing poor performance of water infrastructure. Despite a number of prior studies that have similarly investigated water infrastructure, studies specific to the factors influencing poor performance of water infrastructure in the developing countries within water sector remain scarce. Hence, the study aims to fill this knowledge gap within develpoing countries under water sector. As a result, through the scope presented in this article, aiming to close gaps in the literature, the study has adopted a comprehensive review approach, which incorporates bibliometric analysis by targeting the following objectives:

1) To determine factors influencing poor performance of water infrastructure;
2) To find out the most influential journals in this domain and
3) To propose research directions for future researches, gaps and opportunities do drive further studies.

2. Research Methodology

Bibliometric analysis has developed rapidly and applied to many research fields, because it is an effective way to evaluate the merits of a given subject area or a certain journal (Wang *et al*., 2020). Bibliometric analysis is an indispensable statistic tool to map the state of the art in a given area of scientific knowledge and identify essential information for various purposes, such as prospecting research opportunities and substantiating scientific researches (José de Oliveira *et al.*, 2019). Furthermore, methods compasses instruments to identify and analyse the scientific performance of articles, authors, institutions, countries, and journals based on the number of citations, to reveal the trends of the field studied through the analysis of keywords, and to identify and cluster scientific gaps from most recent publications (Zare *et al.*, 2017). Over the past years, a large number of publications related to factors influencingwater infrastructure were published. Ansorge *et al*. (2021) study focused on bibliometric analysis of water footprint research in countries of former Yugoslavia. Li *et al.* (2020) study focused on bibliometric analysis of water resource management. Olusanmi *et al*. (2021) applied bibliometric study on water management accounting research from 2000 to 2018 in Scopus database. Lastly, Goh and See (2021) looked at the twenty years of water utility benchmarking: a bibliometric analysis of emerging interest in water research and collaboration. This study looked at the bibliometric analysis of factors influencing poor performance of water infrastructure

This study piloted a documentary analysis of factors influencing poor performance of water infrastructure related papers published between 2011 and 2021, acquiring a diverse and in-depth of factors influencing poor performance of water infrastructure research within the water sectors using science mapping method. Bibliometric overview to analyse the evolution of the academic journals publications, identifying the main countries, authors citations and institutions working in water infrastructure and scientific relationships over time.

2.1. Preliminary Search

To enrich the quality of the preliminary search, only peer-reviewed articles were identified for further analysis. However, books and conference papers were excluded during preliminary search. This is due to reasons that journal publications provide more valuable and accurate information due to the rigorous review process, and most of the similar studies in the field of construction are journal publications (Zheng *et al*., 2016; Zhao, 2017). The preliminary controlled searching criteria were defined with a focus on the factors influencing poor performance of water infrastructure. To ensure that the research covered a wide range of review, other forms of search criteria were used. Therefore, each article selected in a search engine consisted of the “title or keywords or abstract” to regulate the level of relevance and eligibility. The search period was fixed between the years 2017–2021.

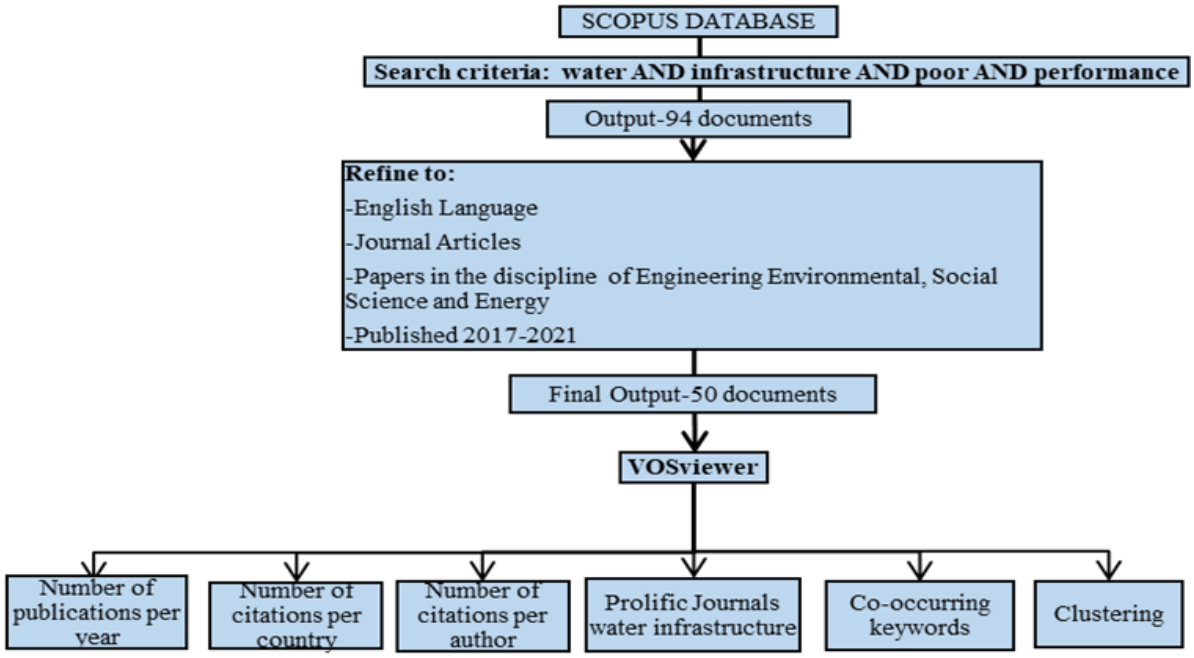

Fig.1. Research design

2.2. Identifying Research Articles

Focusing on the factors influencing poor performance of water infrastructure in the water sector. A more critical comprehensive and visual search of the targeted water infrastructure journals was concluded via the search engine. Under the search engine, the following were excluded from the analysis: "articles in papers", "letter to editors", "discussions and closures", "book review" and "editorial". This step excludes papers with an unclear application purpose or with little potential to apply for organisations, such as a purely technical system development or mathematical algorithms. After this screening process, 94 articles were identified as the review range for this study.

A total of 94 articles are aligned with the foundation and research scope of this research. The bibliometric data were downloaded in Comma Separated Values (CSV) file. However, the CSV file was imported into Vosviewer to scientifically map the factors influencing poor performance of water infrastructure research literature. The search string used was (water AND infrastructure AND poor AND performance). The research was further limited in the subject areas such as "environmental science", "engineering" and "social science" with the document type of "article". The full search code is as follows:

TITLE-ABS-KEY (water AND infrastructure AND poor AND performance) AND PUBYEAR > 2016 AND PUBYEAR < 2022 AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (SUBJAREA, "ENVI") OR LIMIT-TO (SUBJAREA, "ENGI") OR LIMIT-TO (SUBJAREA, "SOCI")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j")).

2.3. Selection of Database

Scopus was used to get the existing literature for bibliometric analysis for this paper. Bass *et al.* (2020) articulated that Scopus is one of the largest curated abstract and citation databases and ensures that only the highest quality data is indexed by a diverse Content Selection and Advisory Board (CSAB) by stringent content selection and re- evaluation. For this research, the study used journal articles published between 2017 to the 21st of November 2021.

2.4. Selection of Tool and Data Acquisition

The Vosviewer (Visualization of Similarities) was used as a tool to analyse the data. According to van Eck and Waltman (2017) Vosviewer is a software tool for creating maps based on network data and for visualizing and exploring maps. Moreover, the functionality of Vosviewer can be summarized as creating maps based on network data and visualizing and exploring maps. Dagiene and Xie (2021) articulated that Vosviewer was developed to construct various networks based on scientific literature. Furthermore, provide an overview of the topics in the publications. Networks are bibliometric; they are based on co-authorship or citations. Additionally, such maps

represent connections between researchers, their institutions, countries, or journals and individual papers. Therefore, researchers worldwide use Vosviewer to create, visualize, and explore networks based on textual and bibliographical data. A quantitative-based science mapping technique was arrayed for this paper. It was prudent to adopt a technique that could quantitatively map out particular networks and patterns in a larger set of bibliometric data (Cobo *et al*., 2011). The primary method used in the present study was "science mapping". This method was selected due to its proven capabilities in picturing systematic patterns in comprehensive bodies of literature and large bibliographical units. Science mapping acts both as a descriptive and a diagnostic tool for research policy purposes, processing immense reservoirs of bibliometric data (Tijssen and Raan, 1994). It allows researchers to conduct systematic literature-related discoveries by linking literature concepts that have been overlooked in manual review studies (Su and Lee, 2010).

3. Results

3.1. Research Articles Timeline Series

Annual timeline series of the 50 publications between the year 2017 and the year 2021 respectively. The number of publications on this field of science per year is described (see Fig.2).

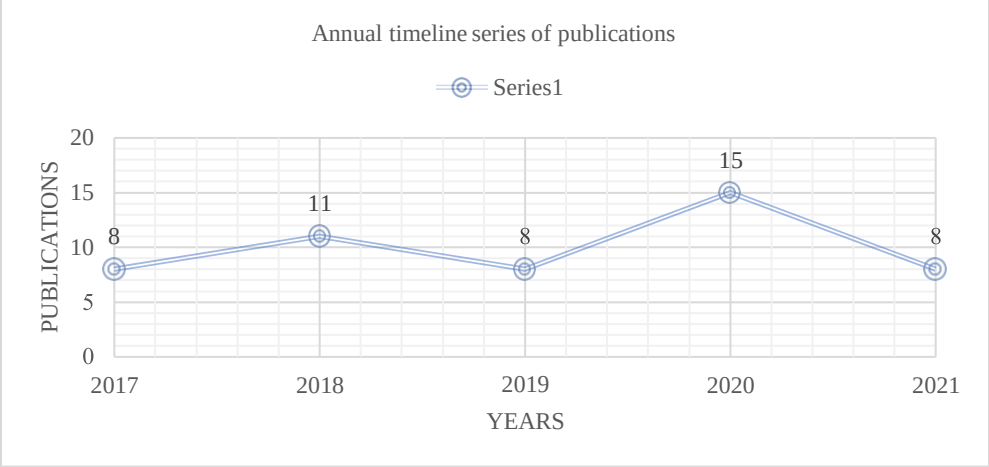

Fig. 2. A timeline series range of publications in water infrastructure from the year 2017 and the year 2021.

3.2. Countries research origins of Factors Influencing Poor Performance of Water Infrastructure

Table 1**.** below, is the analysis of top 10 countries that met these criteria with regards to the factors influencing poor performance of water infrastructure computed by VOs tool.

Table 1. Publications by 10 different countries

Countries	Documents	Citations
China	6	312
Malaysia	2	209
United Kingdom	4	120
United States	14	95
Australia	5	48
Canada	5	48
Spain	3	43
Brazil	3	36
Netherlands	6	34
Sri Lanka	2	16

Fig 3 and **4** below, is the analysis of top 10 countries that met these criteria with regards to the factors influencing poor performance of water infrastructure by citations and publications.

Fig. 3. Citations by top 10 countries

Fig. 4. Documents by top 10 countries

3.3. Publishing Journals

Table 2. Top 10 Profolic Journals Publications

Source	Documents	Citations
Journal Of Cleaner Production	4	136
Water (Switzerland)	3	18
Science of The Total Environment	2	29
Water Resources Management	2	15
Applied Energy	1	109
Sustainable Development	1	100
Construction and Building Materials	1	18
Environmental Impact Assessment Review	1	17
Water Research	1	17
Journal of Urban Affairs	1	16

3.4. Author Co-Citation Network

Table 3. Presents a summary of the top 10 most cited papers relating to factors influencing poor performance of water infrastructure 2017 to 2021.

Table 3. Top 10 Authors citations

Author(Years)	citations	Country
Tan *et al*.(2017)	109	China
Khan *et al*.(2019)	100	United Kingdom
Wu *et al*.(2018)	59	China
Perales-Momparler *et al.* (2017)	39	Spain
Lopes *et al.* (2017)	32	United States
Stroski *et al.*(2020)	21	China
Pickel *et al.* (2017)	18	Canada
Wang *et al*. (2019)	17	China
Van Genuchten *et al.* (2020)	17	Netherlands
Lewis (2017)	16	Australia

3.5. Co-Occurring Keywords Analysis

Table 4. Presents a summary of the most trending authors keywords relating to factors influencing poor performance of water infrastructure.

Table 4. Trending authors keywords

Keyword	Occurrences	Total Link Strength
Water Supply	13	30
Water Management	10	29
Water Treatment	5	19
Developing Countries	6	18
Water Quality	5	18
Performance Assessment	6	17
Potable Water	4	17
Canada	4	15
Runoff	4	15
Storms	4	15
Developing World	5	14
Environmental Management	4	14
Green Infrastructure	4	13
Infrastructure	6	13
Water Pollution	4	13
Article	4	12
Water Supply Systems	4	11
Infrastructure Planning	5	10
Sustainable Development	5	9
Irrigation	4	8
Utility Sector	4	7
Climate Change	4	5

Table 5. Outlines the cluster of keywords co-occurrences. However, the keywords occurrences have been categorised by clusters, colours and terms respectively.

Table 5. Cluster of authors keywords

Cluster No	Color	Terms
Cluster 1	Red	Climate Change, infrastructure, irrigation, performance assessment, portable water, utility sector, water management, water supply, water supply systems
Cluster 2	Green	Canada, green infrastructure, runoff, storms, sustainable development,
Cluster 3	Blue	Article, developing countries, developing world, environmental management, water pollution, water treatment

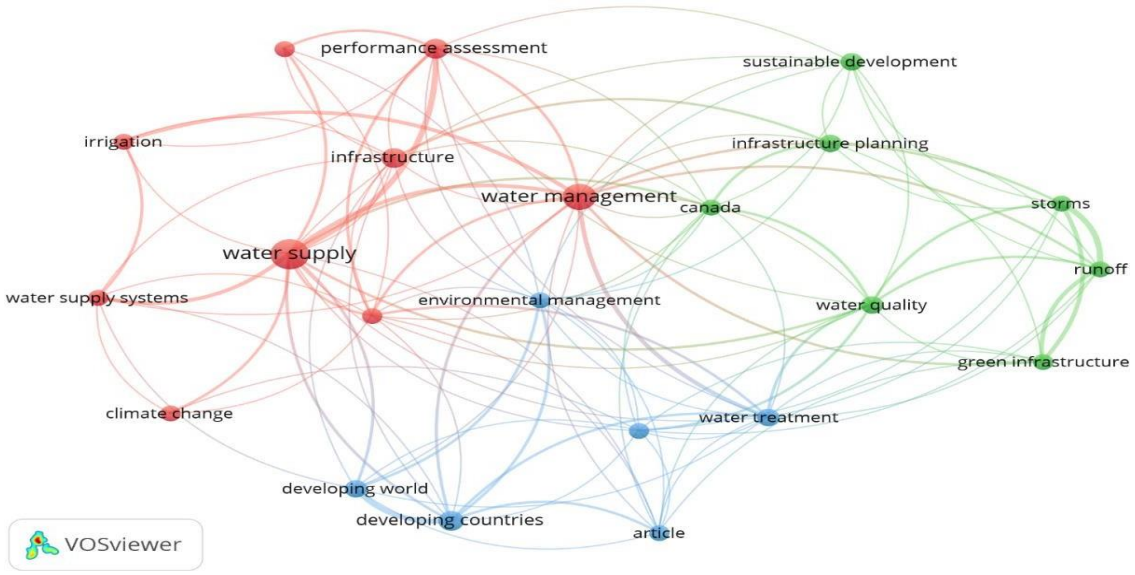

Fig. 5. Authors keywords

3.6. Cluster of Co-Occurrence Keywords

The following Table 6. Outlines the cluster of keywords co-occurrences. However, the keywords occurrences have been categorised by cluster 1, 2 and 3 respectively.

Table 6. Cluster of co-occurrence keywords

Cluster No	Number of Items	Terms
Cluster 1	9	Climate Change, infrastructure, irrigation, performance assessment, portable water, utility sector, water management, water supply, water supply systems
Cluster 2	7	Canada, green infrastructure, runoff, storms, sustainable development,
Cluster 3	6	Article, developing countries, developing world, environmental management, water pollution, water treatment

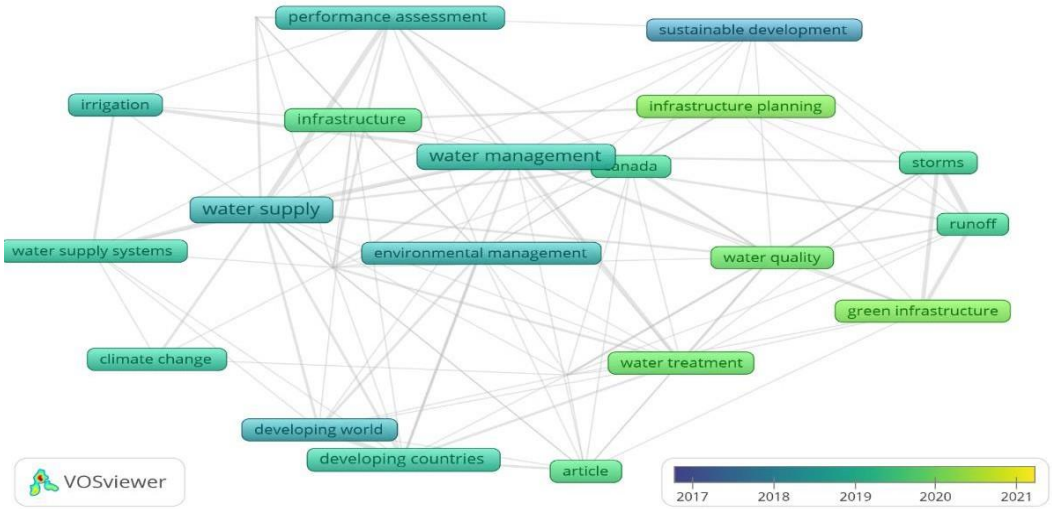

Fig. 6. Cluster of co-occurrence keywords

4. Discussion

The results contained extensive data in relation to the *Factors Influencing Poor Performance of Water Infrastructure* progression timeline series from the year 2017 to 2021 respectively. From the Scopus database only 8 publications were done in the year 2017, 2019 and 2021.In addition to the publications found in the Scopus database, there was also significant increase of publications that is worth noting, 11 publications in 2018 and 15 publication in 2020. Therefore, the timeline series revealed the evolution of researches relating to factors influencing poor performance water infrastructure has been conducted. The analysis revealed that studies relating to factors influencing poor performance water infrastructure are declining during the year 2021 with 8 documents. The results revealed that out of G20 countries (China, United Kingdom, United States, Australia, Canada, Spain and Brazil) met the search criteria and contributed 80% of documents and 73% of citations. Nonetheless, Malaysia, Spain and Netherlands account to 20% documents and 27 % citations contribution. China reported as the highest country with citations accounting to 312 and 6 documents. However, out of the top ten counties, non-African country met this criterion. The results revealed there's a decline in the number of water infrastructure publications in the year 2021. Moreover, from the analysis, the results also highlighted that Journal of Cleaner Production is the leading journal publication with 4 journals that account for 136 citations. The study also analysed the citations in order to involve the counting number of times and article cited by works to measure the impact of publications or authors. However, the study by Tan *et al*.(2017) was the highly cited with 109 citations, focusing on applied energy. Lastly, the results showed that co- occurrence keywords such as *Water Supply, Water Management, Water Treatment, Developing Countries, Water Quality, Performance Assessment, and Potable Water*, were the most frequently used and occurred the most from the researchers.

5. Conclusions

The study has been able to determine the perceived factors influencing water infrastructure in developing countries. Moreover, presented scientometrics analysis of factors influencing poor performance of water infrastructure in water sector. The results contained extensive data in relation to the *Factors Influencing Poor Performance of Water Infrastructure* progression timeline series from the year 2017 to 2021 respectively. The bibliometric analysis of *Factors Influencing Poor Performance of Water Infrastructure* indicated publications by countries, authors citations, institutions and academics journals publications working in water infrastructure and scientific relationships over time. The study has brought a light to the perceived challenges influencing poor performance of water infrastructure affecting the success. Devastation of poor performance of water infrastructure generally results in decrease access to suitable quantity and quality of water users. Poor performance of water infrastructure poses a great challenge on high water demand and supply in both urban and rural settlement. Furthermore, the lack of extensive support from the government on financing water infrastructure remain to be an issue in developing countries. This will result to a poor performance of water infrastructure. However, studies relative to the factors influencing poor performance of water infrastructure the numbers are extremely low. The data was primarily gathered from the Scopus database for the analysis. Moreover, the bibliometric results highlight the interest in this study and opens new doors for future publications this research field of study. In conclusion, access to safe drinking water is still a challenge in developing countries. Lastly, there is no studies specific to the factors influencing poor performance of water infrastructure in developing countries within water sector and remain scarce when compared to large organisations.

From a theoretical aspect of things, water sectors to implement adequate water by-laws and proper maintenance plan on existing and future water infrastructure for future sustainability. Financing water infrastructure projects will result in improvements such as enhancing profitability and enhancing good performance timeously. Moreover, this will result in efficiently, productivity and outstanding good performance on water infrastructure. National and provincial government may find these results helpful in policy formulation and research prioritisation of water infrastructure development in developing countries. Water policymakers could utilise this study as a starting point to identifying key issues amongst the factors influencing poor performance of water infrastructure in water sector for further research in policymaking. Lastly, this study will help water industry practitioners in developing a consistent view on the actions, movements and needs to advocate for the transformation on the water sector towards outstanding performance of water infrastructure by using emerging technologies such as automation, data gathering and analysis, and machine learning tools, commonly known as smart water technologies. This is important as these technologies

are widely employed in the water industry to improve access and supply of quality drinking water with the right level of service.

Acknowledgement

This work is part of collaborative research at the Centre of Applied Research and Innovation in the Built Environment (CARINBE).

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