Global Business and Management Research: An International Journal
Vol. 13, No. 4s (2021)

Corporate Water Management: A Systematic Literature Review

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Abstract
Purpose: This study aims to review systematically the articles published in the corporate water management area. The study discusses the steps in conducting systematic literature review.
Design/methodology/approach: This present study reviews relevant articles available from the Scopus database using related keywords. A number of criteria were introduced before a list of pertinent articles was finalised. The articles were downloaded and divided into main categories for further discussion.
Findings: There are three main categories or themes found from the selected articles, namely water-related risks, water opportunities and water initiatives. The categories are selected based on the research questions formulated for this study.
Research limitations/implications: Aiming for suitability and pertinent articles in the corporate water management area, this study limited the articles to those being available in a particular database (i.e., Scopus). Future researchers could extend the investigation to, hence review articles from, other databases such as Web of Science.
Practical implications: This study responds to water management issues which is of significance for steering corporate endeavours in achieving SDG6 – Clean Water and Sanitation. This study lays forth water management agenda that may be used to guide more related research in the future. Government and non-profit organisations may use the outcomes of the study to foster commitment among all the stakeholders.
Originality/value: This study denotes an early effort of systematic literature review on corporate water management to observe the past and current collective actions globally.
Paper type: Literature review

Keywords: Corporate water management, Water related risks, Water opportunities, Water initiatives, Systematic literature review

Introduction

The recent status of water reserves focuses the demand for management of water resources improvement (UN, 2021). Yet the global water resources are in rising stress from increasing pollution, water consumption, climate change, and weak governance, exposing firms and corporations to intensified risks related to water (World Economic Forum, 2019; CDP, 2021).

A survey done by CDP (2021) indicated that 44 percent from 3,000 companies reaching a total potential financial impacts of USD301 billion for reported water-related risks.

Companies have had no clear direction on how to create enterprise water targets before recently (Reig et al., 2021). Businesses strive to fixed a particular goal that is pertinent to the units of the value chain where water is highly important, reacts to water-related risks according to location-specific, which can be aggregated across locations, according to Reig et al. (2021), because water risks are an action of a group of distinct mutual water challenges (e.g., governance, accessibility, quality, quantity).

Following best practise recommendations in defining water targets can help businesses increase their chances of success (UN Global Compact CEO Water Mandate et al., 2019). In other words, water target setting is important for companies as this steers employees to work in achieving sustainable development goals, particularly the SDG6. Setting from the top of companies in corporate governance leading companies to attain the sustainable water goal. The water commitment include identifying water challenges which varies according to location across the value chain, prioritise opportunities in engagement of water management towards reducing water-related risks and joint action to meet the interest of the stakeholders.

Upgraded integration of water values throughout the comprehensive water improvement or engineering cycle, from pre-feasibility and planning to adaptive monitoring and management, will benefit socio-economic sectors and all stakeholders, from water supply and sanitation to industry, agriculture and energy (UN, 2021). The demand for hydrological data is predicted to grow in the future as the world changes due to population growth, urbanisation processes, and economic developments. Though these changes will raise demand for and competition for water, climate change will create the spatiotemporal allocation of water reserves further unpredictable and challenging to anticipate, jeopardising water supply reliability (IPCC, 2018). This will necessitate institutional reforms and creative governance techniques that minimise trade-offs while maximising synergies between the SDGs and policy domains (OECD, 2017; Breuer et al., 2019).

The preventive measures should be taken to reduce the water risks and its impact on businesses. However, the extent to which the companies have done so far is to our little knowledge to be uncovered. Thus, there are two questions remain – (1) What are the main categories or themes discussed in the literatures related to corporate water management or governance? (2) Do the shared water risks bringing companies to work together with government or any organisation in collective action to achieve water goal? To answer these two questions, this study aims to provide some insightful articles reviews linked to water management in companies. The first question was responded by explaining major themes from articles downloaded and the latter aims to uncover water initiatives globally formed by different organisations and government to tackle the water risks.

The sections are organised as follows: first, this study will explain the process of systematic literature review. Secondly, after deriving the number of articles that could be worked on, this study will carefully identify and segregate the articles downloaded in a few categories or themes. Subsequently, this study will present the main findings of the reviews. The last section will explain discussion including the limitation of this study.

The Process of Systematic Literature Review

The process of systematic review in choosing suitable articles for this study include three key phases. According Shaffril et al. (2019), the first phase is identifying keywords and related words based on previous studies. Researchers may also use thesaurus to find the terms associated with the research topic. Hence, for this study, in July 2021 search strings were formed using keywords as presented in Table 1. The Scopus database was chosen as it was the

relevant database available at the time. From the search in Scopus database, the keywords selected retrieved 9,320 articles.

Table 1: Identification of Related Keywords

Keywords	Scopus search string	n
Corporate water	TITLE-ABS-KEY (("corp* water") OR ("corp* water govern*") OR ("corp* water manag*") OR ("corp* water steward*") OR ("corp* water acc*") OR ("corp* water strateg*") OR ("corp* water secur*") OR ("corp* water information") OR ("corp* water disclos*"))	132
Corporate water + Business water	TITLE-ABS-KEY (("corp* water") OR ("corp* water govern*") OR ("corp* water manag*") OR ("corp* water steward*") OR ("corp* water acc*") OR ("corp* water strateg*") OR ("corp* water secur*") OR ("corp* water information") OR ("corp* water disclos*") OR ("busines* water") OR ("busines* water govern*") OR ("busines* water manag*") OR ("busines* water steward*") OR ("busines* water acc*") OR ("busines* water strateg*") OR ("busines* water secur*") OR ("busines* water information") OR ("busines* water disclos*"))	154
Corporate water + Business water + Industrial water	TITLE-ABS-KEY (("corp* water") OR ("corp* water govern*") OR ("corp* water manag*") OR ("corp* water steward*") OR ("corp* water acc*") OR ("corp* water strategy") OR ("corp* water secur*") OR ("corp* water information") OR ("corp* water disclos*") OR ("busines* water) OR ("busines* water govern*") OR ("busines* water manag*") OR ("busines* water steward*") OR ("busines* water acc*") OR ("busines* water secur*") OR ("busines* water information") OR ("busines* water disclos*") OR ("industr* water") OR ("indust* water govern*") OR ("indust* water manag*") OR ("indust* water steward*") OR ("indust water strateg*") OR ("indust* water acc*") OR ("indust* water strateg*") OR ("indust* water secur*") OR ("indust* water information") OR ("indust* water disclos*"))	9,056
Overall (Corporate water + Business water + Industrial water + Sector water)	TITLE-ABS-KEY (("corp* water")OR ("corp* water govern*") OR ("corp* water manag*") OR ("corp* water steward*") OR ("corp* water acc*") OR ("corp* water strategy") OR ("corp* water secur*") OR ("corp* water information") OR ("corp* water disclos*") OR ("busines* water") OR ("busines* water govern*") OR ("busines* water manag*") OR ("busines* water steward*") OR ("busines* water acc*") OR ("busines* water secur*") OR ("busines* water information") OR ("busines* water disclos*") OR ("industr* water") OR ("indust* water govern*") OR ("indust* water manag*") OR ("indust* water steward*") OR ("indust water strateg*") OR ("indust* water acc*") OR ("indust* water secur*") OR ("indust* water information") OR ("indust* water disclos*") OR ("sector water") OR ("sector water govern*") OR ("sector water manag*") OR ("sector water	9,323

	steward*") OR ("sector water strateg*") OR ("sector water acc*") OR ("sector water secur*") OR ("sector water information") OR ("sector water disclos*"))

Secondly, this study performed screening phase to inspect any duplicate articles and remove articles that are not suitable including articles in foreign languages. Observing the articles retrieved from the year of publication, this study used articles from fifteen years back as this offers understanding on longitudinal research. Furthermore, at this stage, articles from journal will be used because it contains empirical research data (Shaffril, 2019). In the subject area criteria, those articles with the irrelevant title are filtered, for example titles in physics area such as carbon matters, solid motion and removal of phosphate will be excluded. The subject area will be removed after considering each titles in the area.

Having said the process of removing some subject areas, articles from conference proceedings, review, conference review, book, book series, trade journal, note, report, editorial and undefined sources will also be excluded. Some articles containing keywords such as "*zinc"* (for example article with the title of zinc oxide nanoparticles) has also been omitted as this study focuses on corporate water management particularly water commitment of the companies. In addition, this study only select the articles using English language. Thus, performing the screening stage looking for articles by carefully chose the suitable keywords from the related subject area.

In the third phase, the articles that will be chosen are those eligible for this study by checking the abstract of the research. The present study aims to investigate the state of corporate water management and therefore articles linked with the area such as chemistry or biochemistry are not included. By reviewing the abstract and the keywords used in the article, the total number of articles for this study after those excluding criteria is 242 as presented in Table 2. In this earlier stage of the third phase, reading the abstract could not immediately provide direct judgment on the suitability of the articles to be included. For example, although the abstract did state about the water management but the whole article may explained water management in any river basin. Ensuring the finalised number of articles to be used in this study, authors decided to review the articles' content from the total of 242.

Table 2: Number of Documents with the Excluding Criteria

Criteria	Item limited to or excluded	n
	From Table 1	9,323
Year(s)	Limit to fifteen years: 2007 to 2021	7,107
Subject Area	Exclude: Computer Science; Chemistry; Biochemistry Genetics and Molecular Biology; Agricultural and Biological Sciences; Toxicology and Pharmaceutics; Physic and Astronomy; Immunology and Microbiology; Nursing; Chemical Engineering; Materials Science; Earth and Planetary Sciences; Engineering; Health Professions; Neuroscience; Pharmacology, Veterinary.	2,035
Document type	Exclude: Conference Paper; Review; Book Chapter; Book; Note; Short Survey; Editorial; Erratum; Business Article; Conference Review; Letter; Retracted.	1,488
Language	Limited to: English only	1,376

	Excluded: Chinese; French; German; Spanish; Polish; Russian; Persian; Czech; Ukrainian.	
Source type	Limited to: Journal only Excluded: Trade Journal; Book Series.	1,342
Keyword	Exclude: Zinc; Iron; Membranes; Phosphorus; Aqueous Solution; Carbon; Bioreactors; Oxidation; Ammonia; Activated Sludge Process; Activated Sludge; Bacteria microorganisms; Nitrogen; Anoxic Conditions; Chlorine Compounds; Dye; Membrane; Reaction Kinetics; Phenols; Bioremediation; Chemical Analysis; Heavy Metals; Heavy Metal; Biodegradation; Oxygen; Chromium; Lead; Sulphur or Sulfur Compound; Sulfate; Oxidation Reduction Reaction; Oxidation-Reduction; Bacterium; Bacteria; Unclassified drug; Turbidity; Organic Carbon; Organic Compound; Organic Matter; Heavy Metal Removal; Bioreactors; Hydrogen-Ion Concentration; Antibiotic Resistance; Hydrogen Peroxide; Microbial Community; Chemicals Removal (water treatment); Scanning Electron Microscopy; Microbiology; Chemistry.	482
Source title	Excluded some journals, for example: Ozone Science And Engineering; Thermal Engineering; Annals Of Nuclear Energy; Journal Of Environmental Radioactivity	385
Title reading	Example of titles that were removed: “Removal of 4-nitrophenol from aqueous solution by using recycled carbon black from waste tyres”; “Hazardous wastewater treatment by low-cost sorbent with in situ regeneration using hybrid solar energy-electrochemical system”.	323
Abstract reading	Example of excluded abstract: “The aim of the work was to determine the effect of changes in the proportion of decarbonised water in the process water stream on its parameters (oxidability, general hardness) and parameters of cooling water in water cycles”.	242

Carefully reviewing the articles, this study aims to look for the most appropriate and suitable articles to be analysed. There were articles excluded because of irrelevant to this study such as articles without empirical data, pure economic like equilibrium, pure science explaining components of hydro, management of river basin and wastewater costing. The finalised number of articles is 19 as indicated in the Figure 1 below.

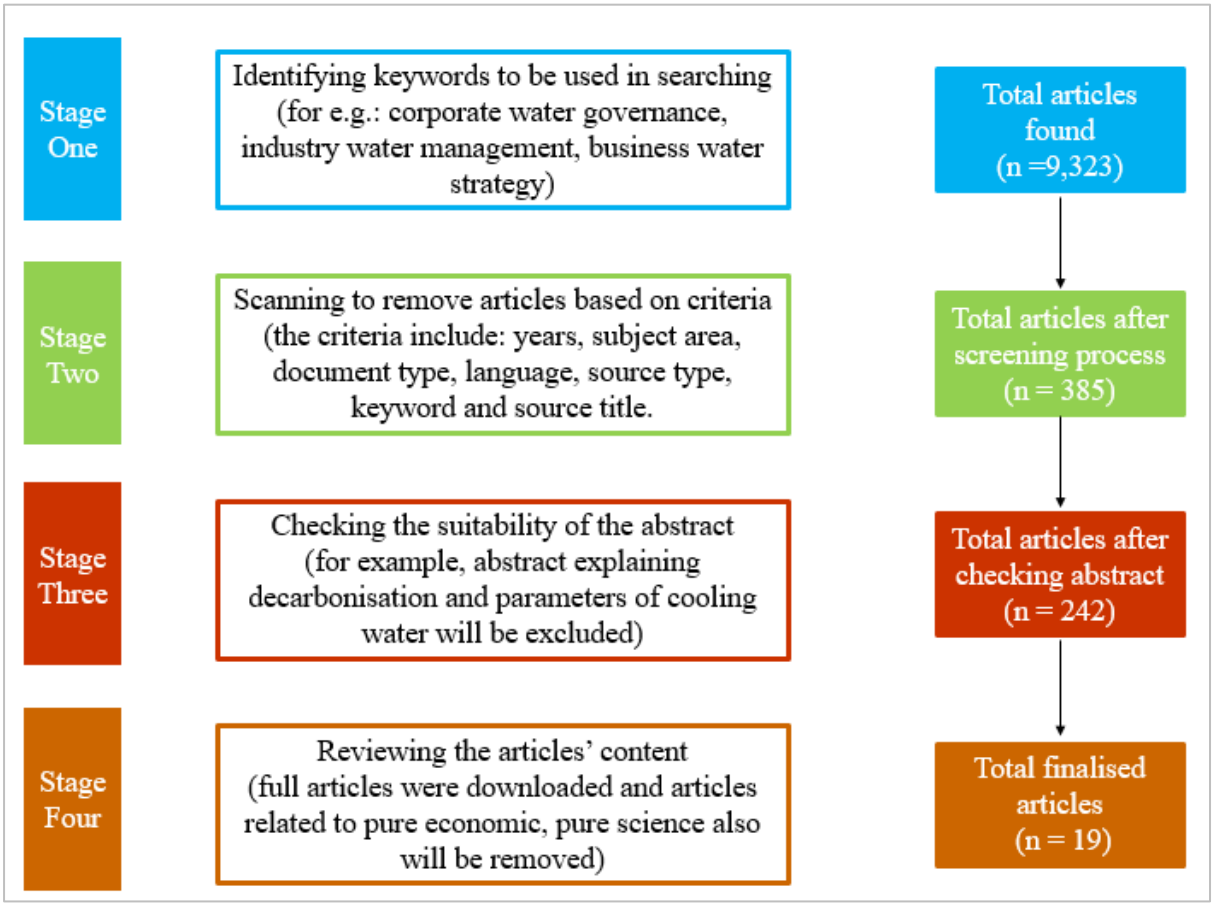

Figure 1: Four Stages in the Process of Systematic Literature Review

Findings

The related full articles downloaded mainly focused on the discussion on water-related risk, water opportunity and water initiative. This section will explained about the main findings from those articles.

Water-related Risks

Management of water risks should not be studied in segregation from other issues of sustainability (Barton et al., 2011). Morrison et al. (2010) stated that water management which previously more internally driven is now directed on risks resulting from suppliers, the environmental context and the socio-political context. Through engagement in water management (Yu et al., 2020), which contains classification of limitations and disclosure of information on water-related opportunities and risks (Barton, 2010), companies can attain the sustainable water use (Lambooy, 2011). Carbon Disclosure Project (2010) found that the global companies participated in a survey had experienced negative water-related impacts. The impacts include interruption in business operations from flooding, drought or natural disaster, reducing water quality which involve costly pre-treatment onsite, rising water prices and litigation or fines linking to pollutant cases.

Water-related risks for business commonly divided into three classes: (1) physical water risks (2) regulatory risks and (3) reputational risks. Physical water risks relate to water quantity and quality. It also relate to inaccessible of water resources (Schulte & Morrion, 2014). The water if too little, too much or too bad resulting impacts on water access and water quality (Barton et al., 2011). Climate change may exacerbate the impacts faster and this challenge face by

companies globally. The rise of global temperature may affect the water availability and precipitation volume. Therefore, water management is not to be avoided by companies in order to sustain water use for the planet. As argued by Heritier and Eckert (2008) water withdrawals reflects physical risk because amount of water withdrawn for operation and industrial processes, if not restored in its original quality and quantity to the same water body, may lead to the weakening of that water body and subsequent decline of groundwater tables.

The regulatory risks explained by the poorly implemented pubic water policy (Schulte & Morrison, 2014). The implication of ineffective regulatory for water policy may affect stakeholders. Water-related risks can also be affected by the systems water reserves are distributed and regulated, as well as how major stakeholders such as customers, communities, and NGOs consider a business' influence on the water resource (Barton et al., 2011). Barton et al. (2011) further argued that water incorporates a strong combination of environmental and social values, and in large places its use is managed or governed capably by regulators. The pressures on supplies rises and primary reserves are depleted, hence, tough decision must be made by regulators in distributing the resources. The decision is either on increasing water prices, water access restriction or wastewater discharge permits leading such an impact to the businesses. Therefore, businesses now encounter water rights redistribution, higher tariffs, and stricter standards and rules governing water quality (KPMG, 2013).

Complicated transformation in a regulatory landscape may lead to business operations substantially more challenging, resulting to fine and penalties for the violation of rules and regulations associated to water pollution cases, distressed habitats, and other undesirable outcomes (Zhang & Tang, 2019). The constraints on water resources can trigger conflicts between businesses with communities and other water users. The level of this reputational risks are growing as public are more attentive of the legitimate rights to the water access. The dedicated SDG6 "*Clean water and sanitation for all"* aims to ensure availability and sustainable management of water and sanitation for all. In the situation of limited water resources, if the pressures continue, the businesses may be difficult to remain and being seen legitimate to operate in the region or in the country. As argued by Yu et al. (2020), firms' focus on water commitment such as in disclosing and reporting to meet the stakeholder's expectations by assisting the firm to achieve sustainable development and establish legitimacy in society.

Water Opportunities

Ahead of an emphasis on water-related risks, companies must comprehend that policy of water involvement can initiate chances in conditions where operations are not subject to direct water-related threats, substantial or immediate (Morrison et al., 2010). As argued by Yu et al. (2020), most companies have commenced to focus on water reserves and are challenged with both opportunities and risks in water management because companies realised that water-related crises could impact profitability or returns if companies not appropriately tackled the water issue. The opportunities from the relevant articles downloaded generally classify the opportunities into internal and external opportunities. For example, Zhang and Tang (2019) stated about the market opportunities of the firm while Morrison et al. (2010) mentioned about the financing opportunities for the firms.

According to Zhang and Tang (2019) the acknowledgement of water opportunities by executives in the companies stimulate better water management systems and motivate self-discipline. The motivation supports companies to build better image and reputation by creating green product. Companies can distinguish themselves by uplifting their share in niche markets in their prearrangement of inventive water efficient goods and technology (Klassen & McLaughlin, 1996). Miles and Covin (2000) also support this by stating that the shifting accessibility of water reserves, specifically freshwater, might also create prospects to

businesses through the need of green consumers for water-efficient services and products. This effort could overcome the reputational risks faced by the companies.
In addition, Morrison et al. (2010) further stated that there are ample opportunities for active corporate encouragement to water management sustainability. Proactive engagement of companies in local, regional, national and global efforts could progress legislation for pollution control and water management, as to expand access to adequate water system services, and enhance water infrastructure financing. The proactive moves by companies can foster companies' goodwill among investors, communities, customers and regulators. Companies are portraying the image and exceed stakeholders' expectation and thus could motivate employees and attract talented workers. Government and regulators also play an important role in overcoming issues in water related to physical, regulatory and reputational risks.

Water Initiatives

Regulators are involved progressively with corporate water management and how this impacts other programmes such as emissions reduction (Morrison et al., 2010; CDP, 2016). To manage water reserves efficiently, companies demand access to proper and applicable information (Christ & Burritt, 2017). According to Kuo et al. (2015), companies will use environmental policies or protection initiatives to enhance legitimacy and solicit social support. Moreover, accountable business action and engagement in water rules and policy should be inspired by a sincere interest in fostering rightful, effective, and ecologically sustainable water management (Morrison et al., 2010). Therefore, the water initiative is one of the responses of the investors and companies to water risks. Ben-Amar and Chelli (2018) mentioned that countries' informal and formal institutions might clarify the companies' reaction to important stakeholders' requests for expanding disclosure of companies' mitigation strategies, as well as their exposure to risks related to water challenges,. Furthermore, corporate water initiatives, for example, the UN Global Compact CEO Water Mandate, have occurred to redefine the manner companies react to water challenges (Morrison et al., 2010). The initiatives from past literatures and current articles are summarised in Table 3.

Table 3: Water Initiatives

Initiative	Explanation
Alliance for Water Stewardship	This effort seeks to be a crucial tool for businesses to guarantee that their internal operations are properly managed and have minimal environmental impact, to have a better understanding of the catchments in which they operate, and to communicate to stakeholders that they act responsibly.
Berlin Rules on Water Resources	The Berlin Rules provide an important foundation for assisting governments in managing water resources in a sustainable manner, as well as assisting businesses in participating in this process when necessary. Useful when foreign countries or other organisations (such as industrial facilities) operating across national borders impacting water pollution and scarcity.
Carbon Disclosure Project Water Disclosure	A framework prepared to collect companies' water-related policies and information. It emphasises the fact that these types of analysis not only do facilitate drive down water-related risks and impacts, but that consumers, investors, and the main stakeholders are also beginning to anticipate companies to accumulate and communicate such information.

Carbon Disclosure Standard Board	Application guidance for water-related disclosures.
CERES Aqua Gauge	An Excel-based flexible tool and linked methodology that tolerates investors to scorecard a firm's water management activities against detailed definitions of leading practice. Its primary aims are to help equity investors interpret and evaluate the information provided by companies on their management of water issues, and to provide a framework to guide investor engagement and dialogue with companies.
European Union Water Framework Directive	Frameworks for refining coastal marine ecosystems, water-related human health issues, river basin management, water quality and water supply, are all included in this policy. The directive serves as a good model for groundwater management, water quality management, human health management, public engagement, and so on.
McKinsey water report: Charting Our Water Future: Economic Frameworks to Inform Decision-Making	The McKinsey report offers a tool for determining which methods or technologies can protect the most water for the minimum amount of money in various political and geographic settings; it could be a critical pace in assisting businesses and governments in mitigating water scarcity while promoting economic growth.
The Ruggie Framework for Business and Human Rights	This framework though not specific to water, has played a crucial role in the evolving discussion in business' role in safeguarding the human right to water access. This framework offers assistance on these questions and could advice companies and governments recognise while establishing relevant functions and foster efficient approaches.
UN Millennium Development Goals	A useful framework offered by MDGs for businesses to comprehend broad policy goals, analyse whether their business operations obstruct those aims, and develop engagement methods to help them accomplish those goals. They're especially useful in catchments where public entities don't have visibly stated water-related policy objectives.
Water Footprint Network	A methodology for water footprinting was developed as a tool for water resource management. This is currently its major application. Water footprinting allows managers, policymakers, and planners, to plan several water uses in a system for these reasons (for example; industrial, municipal, agricultural.)
Water Witness International	The organisation promotes responsibility to incentivise improved performance of water management institutions by establishing greater openness and knowledge. To strengthen and widen its work, Water Witness is forming a global network of partners.
World Business Council for Sustainable Development Global Water Tool	The Tool assists companies in determining where policy engagement is most needed by categorising where they are located in water-stressed populations and areas or with insufficient access to water services.
World Economic Forum Water Initiative	The Initiative's Steering Board is made up of major corporations including Dow Chemical, Coca-Cola, PepsiCo and Nestlé, as well as non-governmental organisations and other groups like the

	Swiss Agency for Development and Cooperation, International Federation of Agricultural Producers and World Wildlife Fund. It can encourage engagement of business with water policy by detecting business' main strengths.

Source: Adapted from CDSB (2021); Burritt and Christ (2017); WBCSD (2012); and Morrison et al. (2010).

Discussion and Conclusion

The authors in related area in corporate water management articles mentioned about water-related risks, water opportunities and water initiatives established globally. The three main categories can be classified as mitigation and adaptation strategies of climate change issue in particular the water security matters. The water risks are shared between businesses and government, necessitate in finding chances and prospects even the risks are not directly present, and initiate decision making into policy engagement.

Theoretical Implications

From the key articles, the authors implied a few theoretical framework such as stakeholder theory, legitimacy theory, self-discipline theory, and institutional theory. Implying both legitimacy and stakeholder theory, Yu et al. (2020), enterprises with a higher blockholder ownership ratio are more bothered about their reputation, image, and the effects of water-related concerns on the companies. Zhang and Tang (2019) discovered that corporate self-discipline incentives are strongly linked to great quality of water management systems. In order to examine a country's response to corporate water management, Ben-Amar and Chelli (2018) discovered that there is support that a country's legal origin acts a crucial role in a voluntary corporate water reporting programme.

Practical and Social Implications

Water policy engagement requires government, businesses, suppliers, customers, communities to coordinate and work on together to achieve SDG6. The risks, opportunities and initiatives can be seen in those articles reviewed so far. Currently, it may not the best methods or initiatives that can be adopted but this study underline the efforts initiated by various bodies in the interests of the stakeholders. Future works may consider various level of stakeholders in achieving the water target.

Limitations and Suggestions for Future Research

This study only search and review articles from Scopus database and not the WOS and other databases. Thus it limits the other articles that were included in WOS and other databases. Assuming the articles could be the same in Scopus and WOS database which only a few of insignificant number of articles generated by the database system, this study presents the main findings of the review. However, it still could not generalise the main findings as it may be different if other articles found and added to the number of articles reviewed. Future research may look into articles in other databases and include other theme or categories of the corporate water management area.

Acknowledgment

We gratefully acknowledge the financial support from Universiti Tenaga Nasional (Project code: J510050002/2021172)

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