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Identifying and explaining the indicators and components of water reporting in corporate level using the Best-Worst Method

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GRAPHICAL ABSTRACT

Corporate water reporting indicators and components in order of importance

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ABSTRACT

The occurrence of global environmental crises, combined with population growth and increased global water demand, highlights the pressing need for effective management of water resources. This includes comprehensive attention to water administration, consumption, and reporting. The objective of this research is to investigate the frameworks of global water reporting and provide a robust and comprehensive model for water reporting in Iranian listed companies. To achieve this goal, a survey was conducted in 2023 involving sixteen experts in water reporting. The participants consisted of engineers and managers from prominent companies in the water consumption and sustainability reporting sector, as well as university professors specializing in sustainability studies and research. The aim was to identify the appropriate components of water reporting for companies listed on the Iran Stock Exchange. Subsequently, the Best-Worst Method (BWM), a multi-criteria decision-making approach, was employed to determine the importance of each reporting item and establish the priorities of the reporting components. The results revealed that the main components of water reporting, ranked in order of importance, are as follows: performance, business strategies, water-related impacts, metrics, water governance, risks and opportunities, and finally regulations and rights. These findings hold valuable implications for stock market policymakers and company managers. By recognizing these critical indicators and components, they can effectively mandate water reporting for Iranian listed companies. Furthermore, they can ensure that water reporting accurately reflects the significant aspects of corporate operations related to water resources.

1. Introduction

Nowadays, water is one of the most valuable environmental factors that plays an essential role in human life (Dehghan et al., 2021). Water scarcity has become one of the most important issues worldwide, a matter of social, financial, and environmental insecurity (Zahed et al., 2020). The water disaster has now grow to be one of the major global challenges (Mohd Ali et al., 2021). A report titled "Sustainability of water

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and energy," published by the United Nations in 2014, projected that by 2025, two out of three countries will experience water stress, and 2.4 billion people will face water shortages (Zeng et al., 2020; Zhou et al., 2018a; Zhou et al., 2018b). This scarcity of water resources poses significant risks to businesses in terms of physical, credit, and financial aspects (Jones et al., 2015), emphasizing the need for effective management to ensure socio-economic development, continuity, and growth of businesses (Deng et al., 2022; Singh et al., 2022; Maxwell, 2015). However, the issue of measuring and reporting water resources at the corporate level, or financial reporting related to water consumption, has received inadequate attention despite being a critical aspect.

Although water accounting is a relatively new topic in the social and environmental accounting literature (Gibassier, 2018), its importance has garnered increased attention in recent years. Water accounting involves the systematic process of identifying, quantifying, reporting, assuring, and publishing information about water (Australian government Bureau of meteorology, 2012). Corporate water accounting entails the use of accounting standards to evaluate a company's or product's water performance (ACCA, 2010).

Given the significance of water accounting, it is crucial to recognize that poor water resource management can impact a company's operations and result in detrimental effects on the business (Wedawatta & Ingirige, 2012), particularly in industries where water resources are integral to their activities. Consequently, many companies now focus on water resources and provide increased information through disclosure as part of their commitment to sustainable development goals (Mohd Ali et al., 2021). The growing demand for responsible, transparent, and accountable water management and monitoring activities from businesses is evident (Lambooy, 2011; WBCSD, 2012). However, the literature indicates a lack of studies addressing water management issues at the corporate level (Zhang, 2018). Periodic disclosure of water management information is necessary for public companies and organizations that consume a significant amount of water (Larson et al., 2012; Leong et al., 2014; Squillace, 2012). Understanding the motivations behind voluntary corporate disclosure regarding water is essential, as these factors can influence the quality of disclosure and stakeholders' reliance on it for decision-making and water resource management (Zhou et al., 2018a). The disclosure of water information aids company managers in understanding water-related risks, cost and profit opportunities, and effective implementation of water resource management (Talbot & Barbat, 2020). Consequently, stakeholders, policymakers, regulatory agencies, and academia have increasingly focused on corporate water disclosure in recent years (Zeng et al., 2020; CDP, 2018; Burritt et al., 2016).

Moreover, various theories explain the necessity of water accounting. According to stakeholder theory (Liao & Khan, 2022; Yu et al., 2020), corporate water disclosure is expected to be significantly influenced by demands from interest groups (Huang & Kung, 2010). Unique industries contain unique stakeholders whilst addressing water issues, making it critical to identify the main stakeholders that influence the quality of water management accounting in every enterprise (Perkiss et al., 2019). In the field of corporate water accounting, there are multiple standards and frameworks, resulting in fragmentation. Various institutions and organizations are involved in the risk assessment, accounting, and reporting of water-related guidelines and standards. Some of these institutions include the United Nations Water Mandate (UN Global Compact), the Alliance for Water Stewardship (AWS), Ceres , the Global Environment Management Initiative (GEMI), the Water Footprint Network (WFN), the World Business Council for Sustainable Development (WBCSD), the World Resources Institute (WRI), the World Wildlife Fund (WWF), the Australian Government, Food and Agriculture Organization (FAO), and the Institute of Hydraulic and Environmental Engineering at Delph University in the Netherlands (Godfrey & Chalmers, 2012; Gibassier, 2018).

The use of different standards and frameworks leads to different requirements and approaches in water accounting. In Iran, several water accounting frameworks have been used, including general water accounting, international water institute accounting, water footprint accounting, water accounting plus (WA+), and economic-environmental accounting for water. However, these frameworks are limited, and there is a need for a suitable framework that explains the components of corporate water reporting (Jalali Borban & Bagheri, 2017). Researchers such as Gibassier (2018) and Hazelton (2015) have highlighted important water reporting frameworks, such as the Carbon Disclosure Project (CDP) water program and the GRI303 standard titled "Water and Effluents". Maxwell (2015) found that tools such as life cycle assessment and water footprint are currently used to measure water consumption and related pollution in international business.

Despite extensive research on corporate water accounting in developed countries, there has been limited research in developing countries. This research aims to examine how the framework of water reporting in companies listed on the emerging stock market of Iran aligns with developed countries.

Iran is situated in the southwest of the Asian continent within the desert belt of the Northern Hemisphere. This geographical location exposes a significant portion of the country to dry and semi-arid climates, leading to water scarcity (Hakimipour et al., 2019). It made decision-makers make appropriate rules and regulations for the use of limited water resources (Salimi et al., 2021).

Consequently, effective water management necessitates meticulous planning and access to sufficient and relevant information. In light of this, the development of a standardized model for water reporting at the corporate level can offer valuable insights to stakeholders and assist in assessing the sustainable resource management practices of business units. Hence, the primary objective of this study is to explore global accounting and reporting frameworks for water, identify pertinent components, and subsequently determine the appropriate elements for water reporting among companies listed on the emerging Iran Stock Exchange.

To accomplish this objective, a comprehensive model of water reporting for listed companies on the Iran Stock Exchange will be developed through an extensive analysis of existing literature and expert surveys. This research will take into account global reporting frameworks while considering the unique climate conditions of Iran. Additionally, the study will involve surveying experts to identify the necessary components for water disclosure. These components will then be assessed for their relative importance using the Best-Worst Method. Finally, the optimal form of water reporting in Iranian listed companies will be presented based on the findings of this study.

In summary, this research aims to establish a robust and comprehensive model for water reporting in Iranian listed companies. By examining existing literature, surveying experts, and considering Iran's specific climate conditions, the study seeks to determine the appropriate reporting framework tailored to various industries operating within the country.

This paper makes a twofold contribution. Firstly, it presents a water reporting model specifically designed for listed companies in Iran, which can also serve as a useful reference for companies in other developing countries. Secondly, it introduces the Best-Worst Method (BWM) as a multi-criteria decision-making approach for weighting the components of water accounting, marking the first application of this method in the field of water accounting. The findings of the study revealed the order of importance for the main components of the corporate water reporting model in Iran. These components, in descending order of significance, are as follows: performance, business strategies, water-related impacts, metrics, water governance, risks and opportunities, and finally regulations and rights. Furthermore, the study was able to validate these findings through an examination of actual practices. Analysis of sustainability reports and board activity reports from various companies indicated that the reporting of water performance and water strategies had the highest level of disclosure, aligning with the research findings. The remainder of this article is structured as follows: Section 2 provides a review of the relevant research literature and existing water reporting frameworks. Section 3 outlines the methodology employed in this study. In Section 4, the research findings are presented, and lastly, Section 5 offers the concluding remarks.

2. Materials and methods

The literature review on water accounting addresses various crucial aspects, with a particular emphasis on the experiences of both Iranian listed companies and international countries.

Water accounting entails a systematic quantitative assessment of the status and trends of water supply, demand, distribution, access, and utilization within specific regions. Its purpose is to generate information that informs water science, management, and governance, ultimately supporting sustainable development outcomes for society and the environment (Hazelton, 2015). Water accounting plays a vital role in identifying business risks and projecting future water consumption and availability (Mahmud et al., 2022). Another definition characterizes water accounting as a gadget hired by firms to degree and calculate their water intake while addressing elements which include water amount, storage, water quality, and the effects of its usage (Escriva-Bou et al., 2016).

Various international organizations and countries have proposed different frameworks and standards for measuring and reporting water, broadly categorized into the following groups:

a) Standards and frameworks that primarily focus on the physical flow of water. b) Standards and frameworks that emphasize the economic aspects of water flow. c) Standards and frameworks that advocate for a hybrid approach.

It is essential to examine these different approaches in order to develop a comprehensive understanding of water accounting practices globally and draw relevant insights for the context of Iranian listed companies.

General purpose water accounting (GPWA) is an accounting framework that become first of all added by the Water Accounting Scheme in Australia in 2004. Subsequently, the Australian water accounting standard become published, supplying suggestions for the preparation and presentation of public-purpose water accounting reports (Chalmers et al., 2012).

The Australian standard 1 focuses on the quantitative attribute of volume and sets out the requirements for water accounting reports. These reports resemble cash flow statements in financial accounting and include a physical circulation statement that illustrates changes in water flows over time (Hakimipour et al., 2019). The key elements of a general-purpose water accounting report encompass water assets, water liabilities, net water assets, changes in water assets, and changes in water liabilities (Australian government Bureau of meteorology, 2012). The adoption of the GPWA framework in Australia has contributed to the establishment of standardized practices for water accounting, providing a structured approach to reporting on water resources and their management. Understanding the principles and components of GPWA can offer valuable insights for the development of water accounting frameworks in other regions, including Iran and other developing countries.

The accounting framework provided by the International Water Institute, established by an international research center in Sri Lanka, enables informed decision-making and strategy development regarding water storage and increasing productivity (Jalali Burban & Bagheri, 2017). By means of utilizing the accounting strategies of the International Water Institute, it becomes possible to evaluate various aspects, inclusive of (1) the amount of available water, (2) water consumption throughout different sectors, and (3) the perceived value completed from water resources (Godfrey & chalmers, 2012).

Water footprint analysis is another important component of water accounting. The global water footprint assessment standard, first developed in 2009 and updated in 2011, serves as a comprehensive framework for assessing water footprints. The water footprint is an indicator that measures the total volume of freshwater consumed directly or indirectly by an individual, society, or organization to produce goods or provide services. This assessment considers water consumption and pollution throughout the entire production chain of a product (Hakimipour et al., 2019).

The Global Water Footprint Assessment Standard has been widely applied and tested across various sectors globally. It offers detailed guidelines and instructions on:

- Calculating green, blue, and gray water footprints to understand the spatial and temporal allocation of water resources for industrial, agricultural, and domestic water supply purposes.
- Conducting a water footprint sustainability assessment, including criteria for evaluating environmental sustainability, resource efficiency, and social equity related to water use, both in terms of consumption and pollution.
- Utilizing the outcomes of water footprint accounting and sustainability assessment to identify and prioritize strategic actions on local, regional, national, and global scales, both individually and collectively (Hoekstra et al., 2011).

The incorporation of the International Water Institute's accounting framework and the utilization of the Global Water Footprint Assessment Standard contribute to comprehensive water accounting practices, allowing for better understanding and management of water resources in various sectors and geographical contexts. The water environmental-economic accounting system (SEEA-Water) was developed by the United Nations Statistics Division (UNSD) in collaboration with the London group on environmental accounting, specifically the subgroup on water accounting. This system serves as a conceptual framework for organizing hydrological and economic information consistently (SEEAW-UN, 2012).

The final version of the SEEA system was published in 2012, aiming to integrate environmental and economic information. It provides information in both physical and monetary forms. This framework brings together various disciplines such as economics, statistics, energy, and water engineering, each contributing unique concepts and structures (Hakimipour et al., 2019). It prepares a framework underneath which the go of water from the environment to the economy, in the economic system, and back to the environment may be organized (Salminen et al., 2018). The water accounting framework+ (WA+) is a comprehensive tool widely used for water accounting that integrates various fields including hydrology, water and environmental management, water allocation, reporting, communication, and decision-making. This framework, applied in river basins, adheres to the rules of the Water Accounting Framework established by the International Water Organization and incorporates remote sensing data combined with discharge and flow methods (Singh et al., 2022). The primary process of this framework revolves around quantifying water consumption based on different land and water uses (Khazaei et al., 2019). WA+ enables the visualization of current conditions through graphical representations, making it a user-friendly and comprehensive approach. Additionally, it enhances strategic management decisions. Notable features of this framework include the presence of four types of tables: resource table, evaporation-transpiration table, productivity table, and harvest table (Karimi et al., 2013).

The incorporation of the SEEA-Water framework and the utilization of WA+ contribute to the advancement of water accounting practices by combining hydrological, economic, and environmental information. These frameworks facilitate a holistic understanding of water resources, support informed decision-making, and aid in the effective management and allocation of water in various contexts.

The carbon disclosure project (CDP) water program operates through the CDP disclosure platform, which provides a reporting mechanism aligned with the recommendations of the Task Force on Climate-Related Financial Disclosure (TCFD). Companies that disclose their information through CDP do so in a manner that is consistent, comparable, relevant, and accessible to the global economy. CDP scores are widely utilized to inform investment and procurement decisions towards achieving a zero-carbon, sustainable, and resilient economy. The CDP questionnaire covers various sectors, including governance, risks and opportunities, strategy, and goals. Specific methodologies are developed for influential sectors such as financial services, energy, agriculture, transportation, and materials (CDP, 2022).

The sustainability accounting standards board (SASB), now overseen by the International Sustainability Standards Board (ISSB) of the IFRS foundation, has criteria specifically addressing water and wastewater. These criteria include aspects such as distribution network effectiveness, wastewater quality management, affordable water access, water quality, final use efficiency, and water supply flexibility (SASB, 2022). The ISSB aims to build upon the industry-based SASB standards and incorporate SASB's industry-focused approach to standards development.

The international financial reporting climate standard 2021 (IFRS) responds to the increasing connection between business operations and the environment, which exposes companies to climate-related risks and opportunities. The draft IFRS report addresses the demand from users of general-purpose financial reports for more consistent, comparable, complete, and verifiable information, including standardized measures and qualitative disclosures. This information helps assess how climate-related issues, risks, and opportunities are linked. The draft aims to provide globally comparable information for markets, with water being a fundamental pillar alongside carbon and energy (IFRS, 2021).

Considering the significance of water as a crucial aspect alongside carbon and energy in the context of climate-related reporting and financial disclosure, the study of the International Financial Reporting Climate Standard adds value to the examination of water accounting frameworks. It emphasizes the importance of consistent and standardized reporting to provide relevant and comparable information regarding climate-related risks and opportunities.

The GRI 303 standard (water and effluents) is part of the Global Reporting Initiative (GRI) Standards, developed and published by the global sustainability standards board (GSSB). The standard is structured into two sections, with the first section containing two disclosures focusing on how corporate water-related impacts are managed, and the second section containing three disclosures providing information on corporate water impacts. The standard encourages organizations to provide additional information on their water management practices in the report (GRI, 2021). Other sources for water reporting include the Corporate Water Disclosure Guide by The CEO Water Mandate (2014) and the European Water Stewardship Standards (2012). In addition to the frameworks and standards, various tools have been developed to evaluate water-related risks and opportunities. These tools include the Water Sustainability Tool, the Global Environmental Management Initiative (GEMI) (2002), the Global Water Tool (2007), The Aqueduct Water Risk Atlas by the World Resources Institute (WRI) (2013), and the Water Risk Filter by the

World Wildlife Fund (WWF) (2014). Each tool has its specific features and is used to measure water risks (Gibassier, 2018).

The literature review indicates that water accounting research generally encompasses three areas: water reporting, corporate accounting/product accounting, and risk assessment. While there are differences among the frameworks and standards, they all emphasize specific aspects of measurement and disclosure. The lack of a standardized method for measuring and reporting water and the lack of coordination and uniform procedures among countries and organizations are identified as two primary challenges in water accounting. This research aims to address these issues by identifying components that can be used to develop a framework for Iranian companies and potentially be applied in other countries facing similar circumstances.

2.1. Components of water information disclosure

Table 1 presents the components of water disclosure that are commonly found in various frameworks and standards. These components cover different aspects such as performance, impacts, risks and opportunities, water governance, strategy, water regulations, rights, and restrictions, metrics, water accounts, and verification of water information and assurance. The Table provides a summary of the indicators, criteria, sub-criteria, and the references where these components can be found in the respective frameworks and standards.

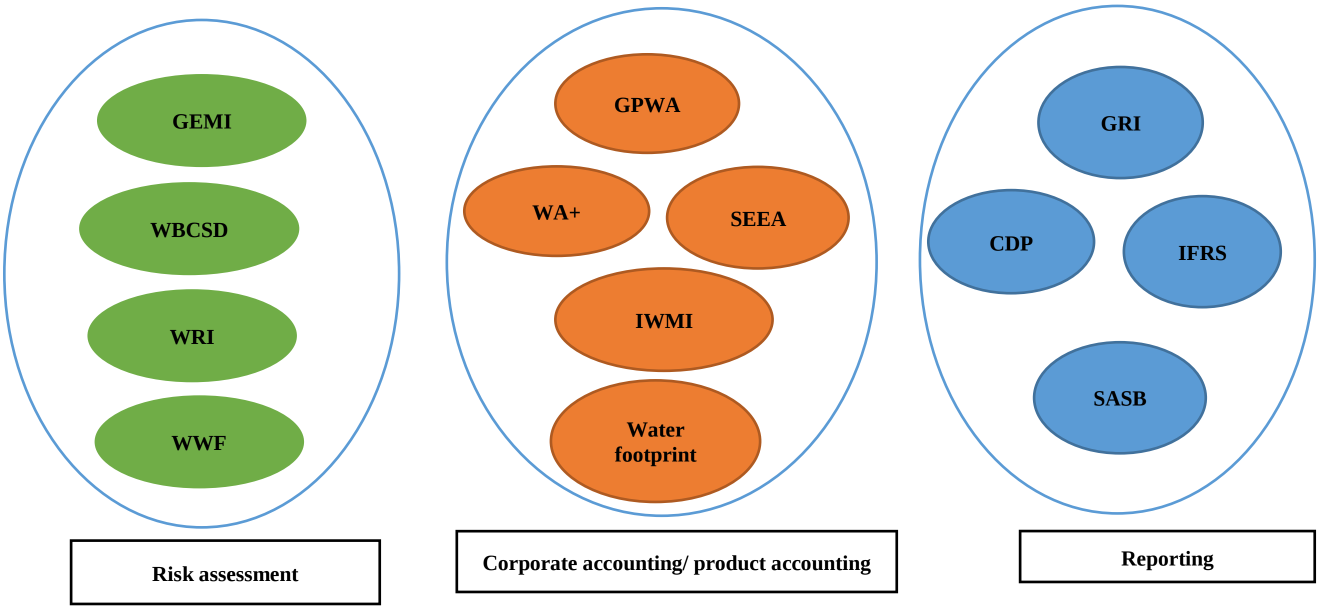

Fig. 1. Water accounting fields at the international level.

Table 1. Components of water disclosure.

Indicators	Criteria	Sub-criteria	Adapted from
Performance	Water target		CDP
	Corporation performance	Water withdrawal	GRI303- IFRS-SASB
		Water consumption	GRI303- IFRS-SASB
		Wastewater discharge	GRI303- IFRS-SASB
		Wastewater discharge quality	GRI303
		Water recycling and reused	GRI303
	Analytical data for performance	Amount of hydrocarbon content in discharged water	IFRS-SASB
		Amount of water efficiency	CDP
		The deviation of water consumption by the standards	Interview with experts
		Separation based on life cycle stages	Water footprint
		Blue, green, and gray water analysis	Water footprint
		Analysis of water ratios with population data	SEEA-Water
		Providing comparative information related to water compared to previous years	General accounting- CDP
	Facility related to performance	Water withdrawal	GRI303-SASB-IFRS
		Water consumption	GRI303-SASB-IFRS
		Wastewater discharge	GRI303-SASB-IFRS
		Wastewater discharge quality	GRI303
		Water recycling and reused	GRI303
Impacts	ESG benefits		General accounting
	The impact of water pollution or flooding on business		CDP- GRI303- Water footprint- The international water management Institute- SEEA-Water
	The impact of penalties for water-related regulatory violations		CDP- GRI303
Risks & Opportunities	Business risks	The location of identified risks	CDP-IFRS- SASB- General accounting
		Tools used for risk assessment	
		The types of risks they face	
		The potential consequences of those risks for the business	
		The timeframe in which the risks are anticipated to occur	

	Business opportunities	The location of identified opportunities	
		The types of opportunities identified (cost saving/new market)	
		The potential consequences of those opportunities for the business	
		The timeframe in which the opportunities are anticipated to occur	
	Risk management	Discussion on risk management strategies related to the quality of water resources	
		Discuss risk management strategies related to water resource availability	
Water governance	Provide water policy		CDP-GRI303-IFRS
	Board's oversight of water policy		
	Employee education		
	Provide incentives to employees or board members for the management of water – related issues		
	Stakeholder engagement		
	Supplier engagement (collaboration/training)		
Strategy	Determine plan strategy related to water		CDP- GRI303-IFRS – General accounting - The international water Management institute
	Organization's water-related capital expenditure (CAPEX) for the reporting year		
	Organization's water-related operating expenditure (OPEX) for the reporting year		
	Use scenario analysis to inform its business strategy		
	Water pricing		
	Classify any of your current products and, or services as low water impact		
	Necessary actions to steward water in company		
Water regulations, rights, and restrictions	Amount of deviation of regulation and standards related to water		SASB-IFRS
	Water rights		General accounting
	Water restrictions		General accounting
Metrics	Disclosure of water stress		CDP
	Assessment of water quality		CDP
	Water accounts	Physical account for supply and use of water	SEEA-Water
		Water emission account	
		Hybrid account for supply and use of water	
		Water asset account	
		Water quality account	
	Water accounting statements	Statement of water assets and water liabilities	General accounting
		Statement of changes in water assets and water liabilities	
		Statement of water flows	
	Verification of water information and assurance	Compliance of reports with accounting standards and water laws	General accounting- CDP

The review showed that the research in water accounting and reporting has primarily been conducted in developed countries, but there has been an increasing trend of research in this area, even in emerging economies.

The origins of water accounting can be traced back to the early 1990s when the United Nations Environment Program (UNEP) started developing a framework for environmental accounting that included water accounting.

Scudder (1995) is one of the influential papers in water accounting that focuses on improving water accounting to support sustainable water use and management. The paper likely discusses the importance of accurately accounting for water resources and developing systems to ensure sustainable water management practices (Matanzima, 2021).

In a more recent study, Lyu et al. (2023) propose a novel framework for water accounting and auditing. Their framework combines traditional water accounting approaches with water mass balance calculations to enhance the management of industrial water resources. This approach likely aims to provide a more comprehensive and integrated understanding of water usage and efficiency within industrial operations.

Overall, these studies and others contribute to the development of water accounting methodologies and frameworks that can help organizations and policymakers make informed decisions regarding water management and conservation.

Mahmud et al. (2022) conducted a study that found water accounting to be beneficial for clean water service providers as it reduces business risks and supports sustainable water management. The study highlighted the importance of transparent information provided by water accounting components such as gross inflow, net inflow, available water, water depletion, and output.

Zhang et al. (2021) explored the factors influencing corporate self-regulation in water disclosure. They found that water governance, water policy, water actions, and water performance were significantly related to companies' willingness to disclose water information through platforms like the CDP database. This suggests that companies with strong water management practices are more likely to disclose water-related information.

Liu et al. (2021) investigated the impact of water disclosure on the quality of financial reporting in China. Their findings, based on panel data from 781 companies, revealed that water disclosure significantly improves the quality of financial reporting. They also observed that water disclosure indirectly affects financial reporting quality through its impact on financing constraints.

Gibassier (2018) conducted a comprehensive analysis of corporate water accounting tools and methods, focusing on the practices of French CAC 40 companies. The research highlighted the importance of water disclosure and found that while many companies provided basic water consumption figures, most did not report based on the comprehensive water disclosure questionnaire of the CDP.

Zhang (2018) examined the relationship between water quality management, regulatory risk detection, and water consumption. The study found that better water quality management was associated with lower regulatory risk detection. However, in the short term, self-regulatory motivation in water management did not necessarily reduce water consumption.

Zhou et al. (2018a) investigated the relationship between water disclosure, risk-taking behavior, and organizational legitimacy. Their findings indicated that water disclosure had a negative relationship with a company's risk-taking behavior, and the relationship was influenced by factors such as property rights and the level of water information disclosure. The study also highlighted the moderating role of organizational legitimacy.

Ben-Amar & Chelli (2018) examined the influence of institutional factors on voluntary water disclosure. They found that uncertainty avoidance and social trust had a negative relationship with the willingness to provide voluntary water disclosure, while countries' future orientation had a positive relationship. The study emphasized the conditional nature of informal institutional influences on water disclosure practices, which depended on the power of formal institutions at the country level.

Namazi & Mossalanejad (2021) identified various indexes related to water accounting and management in their study, with the most abundant indexes including environmental efficiency index, cost of water, water exploitation, and water consumption index.

Finally, Jalali Borban & Bagheri (2017) explored different water accounting systems, including general water accounting, international water institute accounting, water footprint accounting, water plus accounting, and economic-environmental accounting for water.

This research has conducted a practical survey with company managers to validate the components corporate water reporting that were identified from the literature. The findings from the survey indicated that the identified components were agreed upon by the managers of the companies.

In addition to determine the appropriate components for disclosure in corporate water reporting, we employed the Best-Worst Method questionnaire so that we could weigh the components and choose the best component for water reporting. This questionnaire was completed by sixteen experts, including engineers and managers from leading companies in the field of consumption and sustainability reporting. These experts possessed extensive knowledge of water standards and reporting, with over 20 years of experience. Additionally, university professors specializing in sustainability and related research were also involved in the study. The selection of experts followed a purposeful sampling method.

2.2. The Best-Worst Method (BWM)

The Best-Worst method (BWM) is a Multi-Criteria Decision-Making (MCDM) approach that was first introduced by Jafar Rezaei in 2015 and further developed in 2016 to replace nonlinear equations with linear equations for problem solving. This method offers several advantages over other weighting methods. Firstly, it requires fewer comparative data points (2n-3). Secondly, the output of the BWM method provides more reliable answers. Finally, due to its expert-oriented nature, the BWM method can be implemented with a small number of experts.

The steps to perform the Best- Worst method are:

Step 1: Specifying the set of criteria.

Step 2: determining the best (most desirable, most important) and worst (least desirable, least important) criteria. In this step, the experts were asked to identify the most important and least important criteria in each group, and then by averaging, the best and worst criteria were selected in each group.

Step 3: The BWM method utilizes two vectors of pairwise comparisons to determine the weights of criteria. Score the best criterion against the other criteria using numbers between 1 and 9 (refer to Table 2).

$A_B = (a_{B1}, a_{B2}, \ldots, a_{Bn})$

Step 4: Score all criteria relative to the worst criteria using numbers between 1 and 9.

AW= (a1W, a2W, ….., anW)

Step 5: finding optimal weights (W1*, W2*, ..., Wn*)

To find the optimal weight of the criteria, a min-max problem is subsequently formulated and solved to obtain the weights of the different criteria, the following linear model formula should be written for it.

$Min = \xi^*;$

!S.t.

$|WB - aBj * Wj| \leq \xi^*;$

$|Wj - ajw * Ww| \leq \xi *;$

$\sum Wj = 1;$

$Wj \gg 0$, for all j;

The specific consistency ratio (ξ*) of the BWM method is employed to assess the reliability of the comparisons made. The closer the consistency rate is to zero, the more consistent and stable the comparisons are, and the closer to one, the less consistent and stable the comparisons are. Considering that the compatibility rate of this research is close to zero, it is acceptable. In this paper, the linear BWM model is used and solved using 'Excel Solver'.

Table 2. BWM scoring scale (Rezaei, 2016).

Scale	Equal importance	Moderately more important than	Strongly more important than	Very strongly important than	Absolutely more important than	Intermediate values
Score	1	3	5	7	9	2-4-6-8

3. Results and discussion

3.1. Weighting of indicators

Performance (C1); Impacts (C2); Risks & opportunities (C3); Governance (C4); Strategy (C5); Regulation & rights (C6); Metrics (C7).

Table 3. Best-to-others (BO) and others-to-worst (OW) pairwise comparison vectors.

BO	C1	C2	C3	C4	C5	C6	C7
Best criterion: C1	1	3/750	4/625	4/375	2/812	7/937	3/937
OW	**Worst criterion: C6**						
C1	7/937						
C2	4						
C3	3/500						
C4	3/687						
C5	5/937						
C6	1						
C7	4/375						

Table 4. Weights of Indicator.

Criteria	Weight	Rank
C1	0/375	1
C2	0/118	3
C3	0/096	6
C4	0/102	5

C5	0/158	2
C6	0/038	7
C7	0/113	4
ξ*= 0/069		

According to the results of Table 4, the water reporting components can be written as follows:
Water reporting= 0.375 Performance+ 0.118 Impacts+ 0.096 Risks & opportunities+ 0.102 Governance+ 0.158 Strategy+ 0.038 Regulations & rights+ 0.113 Metrics

3.2. Weighting of performance criteria

Targets related to water (C11); Corporation performance (C12); Analytical data (C13); Facility related performance (C14).

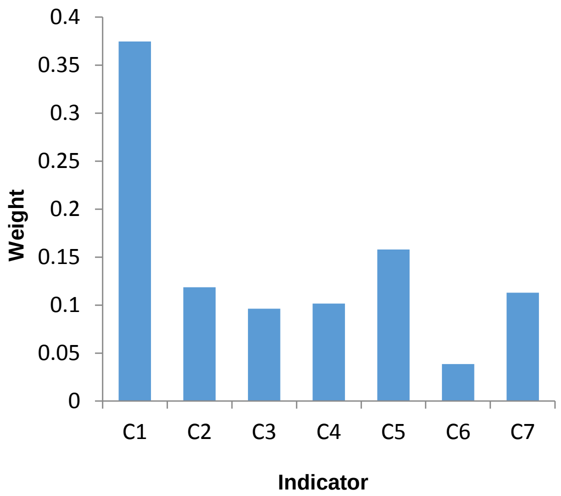

Fig. 2. Ranking of corporate water reporting Indicator.

Table 5. Pairwise comparison vector for the best and worst criterion.

BO	C11	C12	C13	C14
Best criterion:C12	7/250	1	3/687	3/187
OW	**Worst criterion: C11**			
C11	1			
C12	7/250			
C13	4/562			
C14	4/437			

Table 6. Weights of performance.

Criteria	Weight	Rank
C11	0/062	4
C12	0/553	1
C13	0/179	3
C14	0/206	2
ξ*= 0/1		

According to the results of Table 6, the performance components can be written as follows:
Performance = 0.062 Targets + 0.553 Corporation performance + 0.179 Analytical data + 0.206 Facility related performance.

3.3. Weighting of impacts sub-criteria

ESG benefits (C21); The impact of water pollution or flooding on business (C22); The impact of penalties for water-related regulatory violations (C23).

Table 7. Pairwise comparison vector for the best and worst criterion.

BO	C21	C22	C23
Best criterion:C21	1	4/687	7/062
OW	**Worst criterion: C23**		
C21	7/062		
C22	2/750		
C23	1		

Table 8. Weights of impacts.

Criteria	Weight	Rank
C21	0/734	1
C22	0/174	2
C23	0/092	3
ξ*= 0/080		

According to the results of Table 8, the impacts components can be written as follows:
Impacts= 0.734 ESG benefits +0.174 Water pollution + 0.092 Water-related regulatory.

3.4. Weighting of risks & opportunities criteria

Business risks (C31); Business opportunities (C32); Risk management (C33).

Table 9. Pairwise comparison vector for the best and worst criterion.

BO	C31	C32	C33
Best criterion:C33	2/437	7/312	1
OW	**Worst criterion: C32**		
C31	5/062		
C32	1		
C33	7/312		

Table 10. Weights of Risks & opportunities.

Criteria	Weight	Rank
C31	0/294	2
C32	0/075	3
C33	0/631	1
ξ*= 0/084		

According to the results of Table 10, the risks & opportunities components can be written as follows:
Risks & opportunities= 0.294 Risks+ 0.075 Opportunities+ 0.631 Risk management

3.5. Weighting of water governance criteria

Provide water policy (C41); Board's oversight of water policy (C42); Employee education (C43); Provide incentives to employees or board members for the management of water –related issues (C44); Stakeholder engagement (C45); Supplier engagement (C46).

Table 11. Pairwise comparison vector for the best and worst criterion.

BO	C41	C42	C43	C44	C45	C46
Best criterion: C41	1	7/312	4/625	4/125	4/437	4
OW		**Worst criterion: C42**				
C41		7/312				
C42		1				
C43		3/937				
C44		3/500				
C45		3/812				
C46		4/187				

Table 12. Weights of water governance.

Criteria	Weight	Rank
C41	0/451	1
C42	0/051	6
C43	0/115	5
C44	0/130	2
C45	0/120	4
C46	0/133	3
ξ*= 0/082		

According to the results of Table 12, the governance components can be written as follows:
Governance= 0.451 water policy + 0.051 Board's oversight + 0.115 Employee education + 0.130 Incentives + 0.120 Stakeholder engagement + 0.133 Supplier engagement

3.6. Weighting of strategy criteria

Determine plan strategy related to water (C51); Organization's water-related capital expenditure (CAPEX) for the reporting year (C52); Organization's water-related operating expenditure (OPEX) for the reporting year (C53); Use scenario analysis to inform its business strategy (C54); Water pricing (C55); Classify any of your current products and, or services as low water impact (C56); Necessary actions to steward water in the company (C57).

Table 13. Pairwise comparison vector for the best and worst criterion.

BO	C51	C52	C53	C54	C55	C56	C57
Best criterion: C51	1	4/687	4/625	8/562	3/562	4/437	4/187
OW	**Worst criterion: C54**						
C51	8/562						
C52	3/437						
C53	3/562						
C54	1						
C55	5						
C56	3/812						
C57	5/312						

Table 14. Weights of strategy.

Criteria	Weight	Rank
C51	0/399	1
C52	0/102	6
C53	0/104	5
C54	0/037	7
C55	0/135	2
C56	0/108	4
C57	0/115	3
ξ*= 0/081		

According to the results of Table 14, the strategy components can be written as follows:
Strategy= 0.399 Plan+ 0.102 CAPEX + 0.104 OPEX + 0.037 Scenario analysis + 0.135 Water pricing + 0.108 Low water impact + 0.115 Actions

3.7. Weighting of water regulations, rights, and restrictions criteria

Water regulations (C61); Water rights (C62); Water restrictions (C63).

Table 15. Pairwise comparison vector for the best and worst criterion.

BO	C61	C62	C63
Best criterion: C61	1	3/500	5/562
OW	**Worst criterion: C63**		
C61	5/562		
C62	3/937		
C63	1		

Table 16. Weights of regulations.

criteria	Weight	Rank
C61	0/672	1
C62	0/233	2
C63	0/095	3
ξ*= 0/1		

According to the results of Table 16, the regulations components can be written as follows:
Regulations= 0.672 Water regulations+ 0.233 Water rights+ 0.095 Water restrictions

3.8. Weighting of metrics criteria

Water stress (C71); Water quality (C72); Water accounts (C73); Water statements (C74); Assurance (C75).

According to the results of Table 18, the metrics components can be written as follows:
Metrics= 0.180 Water stress+ 0.535 Water quality+ 0.121 Water accounts+ 0.057 Water statements+ 0.107 Assurance Finally, the ideal model of corporate water reporting for Iranian companies has been obtained according to the components listed in the Fig. 3.

Table 17. Pairwise comparison vector for the best and worst criterion.

BO	C71	C72	C73	C74	C75
Best criterion: C72	3/562	1	5/312	7/500	5/937
OW	**Worst criterion: C74**				
C71	4/875				
C72	7/500				
C73	2/250				
C74	1				
C75	3/750				

Table 18. Weights of metrics.

Criteria	Weight	Rank
C71	0/180	2
C72	0/535	1
C73	0/121	3
C74	0/057	5
C75	0/107	4
ξ*= 0/1		

Water accounting and reporting have become crucial elements of sustainable development, attracting significant attention from researchers in recent years. In Iran, given its arid and warm climate and limited water resources, along with the increasing need for relevant information from stakeholders, water information reporting is essential. This research aimed to identify the components that should be considered for voluntary disclosure of water information in Iran, with a focus on developing a uniform reporting format applicable to all companies. By reviewing existing research literature and corporate water accounting frameworks, indicators, and components, this study identified and validated these components through a practical survey of company managers. Performance, as the highest-scoring component, emphasized the disclosure of information on water withdrawal, consumption, and runoff and wastewater production. Industries are increasingly focused on water reuse and desalination to address water scarcity and high costs. Companies implement strategies in voluntary reports to enhance effective water management, which falls under the "Metrics" component in this research. The "Regulation" component received the lowest score as there are currently no mandatory laws governing water management across all companies. There are international water reporting frameworks such as CDP and GRI, and the results of our research show that they are close to these frameworks, and in this paper, the prioritization of water disclosure components is also specified.

4. Conclusions

The results revealed that the indicators of the water reporting framework, in order of importance, were performance, business strategies, water-related impacts, metrics, water governance, risks and opportunities, and regulations and rights. The criteria within each indicator were also examined and weighted. An analysis of sustainability reports and Board Activity Reports from various companies confirmed that the level of disclosure of water information related to performance and strategy components received the highest scores, aligning with the sample companies listed on the Tehran Stock Exchange and validating the reasonableness of the results. Considering that Tehran Stock Exchange member companies often follow the GRI framework, the disclosure of components outlined in this framework is more prominent. However, to provide a comprehensive water report, it is recommended to include components from other relevant frameworks as well. The research proposed a comprehensive model specifically tailored to high-water-consumption companies listed on the Tehran Stock Exchange. Nevertheless, standardization and harmonization of water reporting frameworks are crucial for addressing the challenges and achieving agreed-upon frameworks or standards in Iran and potentially internationally. Future research directions include developing a water reporting model in Iran that considers industry-specific water needs and classifying reporting components based on the requirements of stakeholders such as shareholders, managers, professors, and researchers. Continued study, and research in this field are essential for sustainable development and may lead to the establishment of standardized or harmonized water reporting frameworks at both national and international levels.

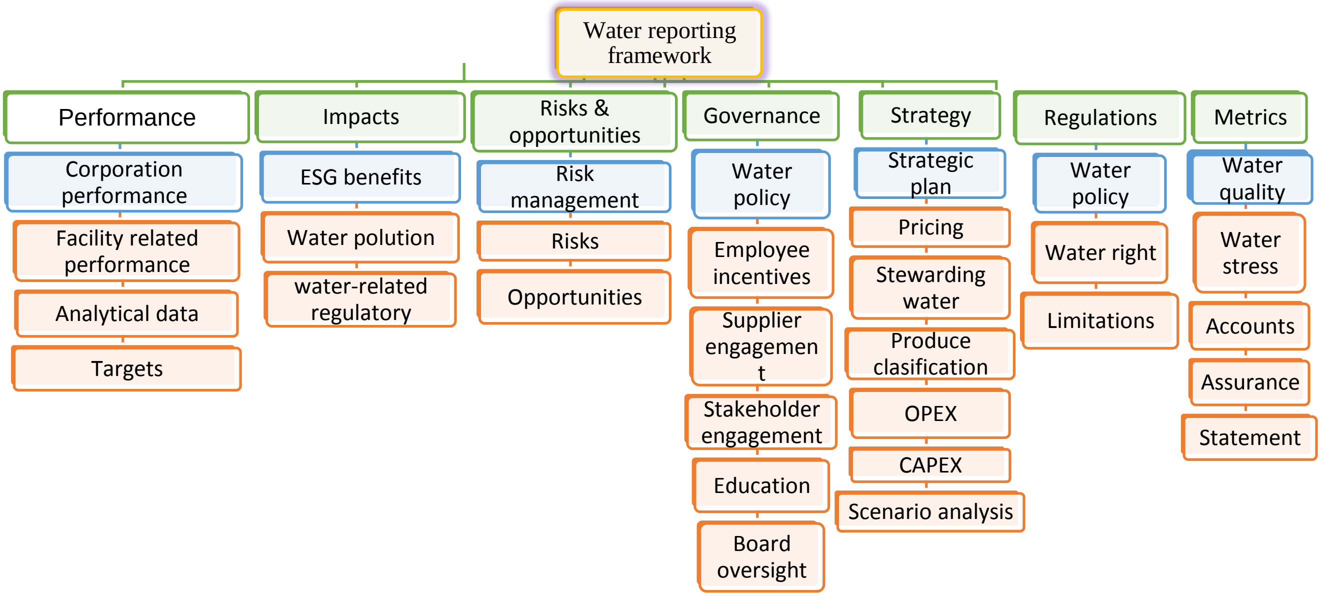

Fig. 3. Corporate water reporting Indicators and components in order of importance.

Author Contributions

Fatemeh Asnad: Conceptualization, methodology, analysis and interpretation of results, writing original draft.
Hossein Fakhari: Conceptualization, methodology, interpretation of results, Supervision, Reviewing and editing.

Conflict of Interest

We confirm that the manuscript has been read and approved by all the authors and declare that this manuscript has not been published or presented elsewhere in part or in entirely, and is not under consideration by another journal. Also we have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data Availability Statement

The data of this article were collected through a survey of experts. If readers need the data, they can correspond with the authors.

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