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-RESEARCH ARTICLE-

WATER ACCOUNTING AS A CATALYST FOR SUSTAINABLE PERFORMANCE: A PROPOSED SEEA–IPSAS FRAMEWORK FOR IRAQI WATER DIRECTORATES

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─Abstract─

The absence of a specialized water accounting system integrally linking financial and water data in Iraq's water directorates hinders rational water resource management and climate change adaptation. This research assesses the application of water accounting, water loss, and integrated water resource management (IWRM) to evaluate the sustainable performance of the Al-Anbar Water Directorate. Consequently, a proposed water accounting framework was developed, grounded in the System of Environmental-Economic Accounting for Water (SEEA-Water) and integrated with International Public Sector Accounting Standards (IPSAS). This framework provides a standardized reference that links water data to economic accounts, enabling integrated water accounts to measure water use efficiency and enhance IWRM towards achieving Sustainable Development Goals. A composite methodology was adopted, combining an applied case study utilizing official financial and water reports from the Al-Anbar Water Directorate, supplemented by checklists and interviews, with an analytical field study employing inferential statistics. A questionnaire, designed based on the proposed framework, surveyed a stratified random sample of 200 specialists (accountants,

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auditors, experts, and department heads) across Iraq's 18 water directorates. Findings reveal that the current unified accounting system suffers from significant deficiencies, proving incompatible with the directorates' operational nature. Its focus on traditional financial aspects limits its capacity to accommodate water accounting requirements, thereby constraining its effectiveness in supporting IWRM and sustainable performance evaluation. The field study results statistically validated the proposed framework's robustness and applicability, confirming its potential to integrate financial and water data and enhance managerial efficiency. The research primarily recommends adopting the proposed SEEA-Water-based framework across Iraqi water directorates to achieve integration between financial, water, and operational data, thereby strengthening sustainable water resource governance.

Keywords: Water Accounting, SEEA-Water, IWRM, Sustainable Performance, Iraqi Water Directorates, IPSAS.

INTRODUCTION

In light of the escalating global challenges confronting water resources—driven by climate change, rapid population growth, and expanding water demand—the rational and integrated management of these strategic resources has become a fundamental prerequisite for achieving sustainable development, particularly in nations experiencing acute water scarcity, such as Iraq. These challenges have imposed an urgent need to transcend traditional water management systems and transition towards integrated accounting information systems capable of providing accurate and reliable financial and physical data to support the formulation of water policies and the rationalization of economic, environmental, and social decisions (Alsultani et al., 2025) (Al-Rikabi, 2012).

At the international level, water accounting has received increasing attention, culminating in the United Nations' issuance of the System of Environmental-Economic Accounting for Water (SEEA-Water). This system provides an integrated framework linking hydrological data with economic accounts, thereby enhancing Integrated Water Resources Management (IWRM) and supporting the assessment of sustainable performance. However, the reality of practice in Iraq's water directorates remains unable to keep pace with this progress. These directorates rely on traditional accounting systems and conventional administrative methods that are fundamentally focused on purely financial data and lack the provision of integrated information on water stock, its uses, flows, and loss levels. This deficiency limits their capacity to adopt an integrated water resources management approach, weakens their ability to measure and evaluate sustainable performance, and hinders strategic decision-making in the face of water scarcity challenges (Kumar et al., 2024).

The global accounting literature has witnessed growing efforts to address this issue, yet

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these efforts have remained fragmented. The vast majority of international studies have concentrated on the quantitative, hydrological, and environmental dimensions of water accounting, such as assessing water balances using advanced systems like WA+ (Zahra Rahimzadeh Kivi, 2022) or modeling the assimilative capacity of pollutants (Zhao et al., 2018), while relatively neglecting the integration of these aspects with the financial and institutional dimensions of sustainable performance assessment (Feng et al., 2025). Arabic studies, particularly from Egypt, have paid notable attention to water accounting applications but have primarily focused on the agricultural sector and the context of scarcity management (Taleb, 2019)(El-Sayed, 2024; Abdel Hamid, 2024). The generalizability of their findings to the drinking water sector and the institutional management of water resources in Iraq remains limited due to differing geographical, legal, and organizational contexts. Within the Iraqi context specifically, previous studies have addressed water resources management from the perspectives of policy and legal challenges (Fadhil & Sajad, 2020), the evaluation of management plans and infrastructure (Al Saffar & Al Fatlawi, 2025), or sustainability accounting according to the Global Reporting Initiative (GRI) standards in one of the water directorates (Al-Shammari & Al-Kanani, 2021). Despite the importance of these contributions, they have not—to the best of the researcher's knowledge—addressed the fundamental knowledge and practical gap represented by the absence of an integrated water accounting framework specifically designed for the operational nature of Iraqi drinking water directorates, simultaneously based on the requirements of the SEEA-Water framework and International Public Sector Accounting Standards (IPSAS), and systematically linked to the assessment of sustainable performance in its multiple dimensions (operational, economic, social, environmental, and institutional).

Building on this identified gap, the current research aims to achieve three primary and interrelated objectives. First, to assess and analyze the current state of water accounting application, integrated management methodology, and the level of sustainable performance in the Anbar Water Directorate, diagnosing the gap between this reality and the targeted benchmark. Second, to develop a proposed framework for a water accounting system grounded in SEEA-Water and integrated with IPSAS, tailored to the operational nature of Iraq's water directorates. Third, to test the validity and acceptability of this proposed framework and analyze its expected impact on enhancing the sustainable performance of water resources management from the perspective of specialized professionals working in Iraqi water directorates. Through these objectives, the research seeks to answer a central question: "How can a proposed water accounting framework, based on SEEA-Water and IPSAS, contribute to enhancing the sustainable performance of water directorates in Iraq?"

The significance of this research is twofold: scientific and practical. Scientifically, it enriches the accounting literature on water accounting by presenting an original theoretical and applied framework that integrates, for the first time in the Iraqi context,

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SEEA-Water and IPSAS to assess sustainable performance in vital non-profit institutions, thereby filling a clear knowledge gap. Practically, the research provides decision-makers in the institutions responsible for water resources management in Iraq with a practical and applicable framework offering integrated water, financial, and operational information that supports planning and control efficiency, enhances transparency and accountability principles, and guides strategic decision-making. This directly contributes to improving water resource management, rationalizing its use, and fulfilling sustainable development requirements in Iraq.

To achieve its objectives, the paper is organized as follows. Following this introduction, Section 2 reviews the theoretical framework and scientific background. Section 3 details the research methodology and methods. Section 4 presents the results of the first phase, which assesses the current reality and tests the gap. Section 5 presents the proposed framework in light of the assessment and identified gaps. Section 6 covers the results of testing the validity of the proposed framework and its expected impact on the sustainable performance of Iraqi water directorates. Section 7 discusses the results and analyzes them in light of previous literature. Finally, Section 8 presents the research conclusions and recommendations.

THEORETICAL FRAMEWORK AND SCIENTIFIC BACKGROUND

This section reviews the theoretical foundations on which the research is based, focusing on the axes that directly serve its objectives. Given that the research aims to develop a proposed water accounting framework based on SEEA-Water and integrated with IPSAS, and then to test its impact on sustainable performance, this section is concerned with establishing these core variables and illustrating the relationships between them, without expanding on the historical details or multiple definitions that can be found in specialized literature.

Water Accounting and the SEEA-Water System

The United Nations defines water accounting as a systematic approach to organizing and presenting information concerning the physical quantities of water in the environment and the economy, alongside the economic aspects of water supply and use, with the possibility of expressing this information in monetary units (Vardon et al., 2007). This definition combines the physical and economic dimensions, distinguishing water accounting from traditional water information systems that are limited to quantitative measurement.

This concept was formalized with the UN's issuance of the System of Environmental-Economic Accounting for Water (SEEA-Water) in 2012, a subsystem of the broader SEEA framework. The system aims to link water data with economic accounts within a unified statistical structure, enabling the development of indicators and analyses on the

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relationship between the economy and water resources (Accounting, 2021). It consists of physical flow accounts recording water movement between the environment and the economy, water asset accounts describing the hydrological cycle during the accounting period, and economic accounts recording costs and revenues related to water services (Comte et al., 2022).

Despite the advantages offered by SEEA-Water at the national level, its application at the individual institutional level—such as water directorates—remains limited. The system was designed as a national statistical tool, not as an institutional accounting system that a single administrative unit can fully adopt. This opens the door to the need for developing institutional frameworks that draw inspiration from SEEA-Water and adapt it to the working nature of institutions concerned with water management.

International Public Sector Accounting Standards (IPSAS)

While SEEA-Water represents the statistical and environmental reference, the International Public Sector Accounting Standards (IPSAS) represent the financial and institutional one. Considering that Iraq's water directorates are government entities managing massive, long-term assets (transmission and distribution networks, treatment plants, reservoirs) and are financed by the public budget, the application of IPSAS is a necessity for improving the quality of financial reporting and enhancing transparency (Bassi et al., 2020).

The role of IPSAS in this context comprises several aspects. First, IPSAS 17 (superseded by IPSAS 45 as of 2025) explicitly classifies water networks and supply systems as "infrastructure assets" that must be recognized, measured, and depreciated. Second, applying the accrual basis—the core of IPSAS—enables government entities to move beyond limited cash-basis reports to a more comprehensive financial reporting system that reveals liabilities, assets, and accrued revenues (Vardon et al., 2007). Third, IPSAS contributes to improving disclosure, transparency, and accountability, which are essential elements in managing the public funds that encompass the water sector.

Integration Between SEEA-Water and IPSAS – The Theoretical Gap

Despite the separate development of SEEA-Water and IPSAS, the accounting literature lacks a framework that integrates them at the institutional level. SEEA-Water provides hydrological and environmental information but does not capture manufactured assets or financial liabilities, while IPSAS provides financial reporting on manufactured assets and cash flows but does not include natural resources such as water (Chalmers et al., 2012).

A recent applied experiment at Sydney Water in Australia demonstrated the practical feasibility of bridging this gap, where SEEA physical data (natural filtration services)

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were linked with accounting recognition criteria to include the water-filtering vegetation as a disclosable asset. The study proposed three disclosure pathways suitable for different levels of institutional capacity: a line item in the statement of financial position, a note within the financial statements, or voluntary disclosure (Tello et al., 2016). This experiment confirms the viability of integrating the two systems and provides a precedent that can be built upon in other institutional contexts.

This constitutes the theoretical gap addressed by the current research: the absence of an institutional accounting framework that integrates SEEA-Water and IPSAS within government water institutions, which the proposed framework aims to provide.

Sustainable Performance of Water Resources

The sustainable performance of water resources is defined as the capacity of institutions responsible for water management to achieve operational and economic efficiency, maintain the quality of water resources and their associated ecosystems, and ensure equitable water distribution among beneficiaries through effective institutional frameworks and sound governance (Dhanasekaran et al., 2026; Gleick, 1998). This definition rests on a multi-dimensional model comprising:

1. Operational Dimension: Focuses on the efficiency of water production, treatment, transmission, and distribution, and reducing losses and waste.
2. Environmental Dimension: Concerns the conservation of water resources, limiting pollution, and protecting associated ecosystems.
3. Economic Dimension: Focuses on raising water use efficiency, rationalizing costs, and achieving financial sustainability.
4. Social Dimension: Concentrates on equitable water distribution, beneficiary satisfaction, and enhancing community participation.
5. Institutional Dimension: Focuses on developing organizational structures and strengthening governance and transparency.

Recent literature (Althnayan et al., 2022; Jarzebski et al., 2024) has affirmed that assessing sustainable performance in the water sector requires moving beyond traditional financial indicators to multi-dimensional measures that capture environmental, social, and institutional performance alongside economic performance.

Water Accounting as a Tool for Enhancing Sustainable Performance

Water accounting represents a strategic tool for influencing the dimensions of sustainable performance by providing accurate data to support decisions across each dimension:

1. Economically: It provides data on water quantities used and their costs, supporting

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rational pricing, cost recovery, and investment direction (Zucaro et al., 2024).
2. Socially: It helps ensure equitable water distribution and assess the impact of community programs (Sojamo & Rudebeck, 2024).
3. Environmentally: It enables the monitoring of pollutant levels and compliance with environmental standards (Chen & Vardon, 2024).
4. Institutionally: It supports sound governance, transparency, and disclosure, providing an objective basis for decision-making (Yu et al., 2024).

This multi-dimensional impact is what the fourth hypothesis of this research seeks to test in the context of Iraqi water directorates.

Previous Studies and the Positioning of the Current Research

The accounting literature has shown a growing interest in water accounting, but it remains fragmented. Globally, most studies have focused on quantitative and hydrological aspects, such as assessing water balances using WA+ (Zahra Rahimzadeh Kivi, 2022) or modeling the assimilative capacity of pollutants (Zhao et al., 2018), with relative neglect of the integration between financial and institutional dimensions. In the Arab context, studies—particularly Egyptian ones—have concentrated on the agricultural sector and scarcity management (Taleb, 2019) (El-Sayed, 2024), without addressing the drinking water sector in a governmental institutional context. In the Iraqi context, previous studies have addressed either political and legal aspects (Fadhil & Sajad, 2020), management plans and infrastructure (Al Saffar & Al Fatlawi, 2025), or sustainability accounting according to GRI (Al-Shammari & Al-Kanani, 2021). None of these studies—to the best of the researcher's knowledge—have examined the relationship between water accounting based on SEEA-Water integrated with IPSAS and the assessment of sustainable performance in Iraqi drinking water directorates.

Accordingly, the research gap that this study seeks to fill is defined as the absence of an integrated water accounting framework, specifically designed for Iraqi drinking water directorates, based on SEEA-Water and integrated with IPSAS, and systematically linked to the assessment of sustainable performance in its multiple dimensions.

In summary, the current literature provides scattered components (SEEA-Water for the environmental and statistical dimension, IPSAS for the financial and institutional dimension, and sustainable performance models for multi-dimensional measurement). However, it lacks a unified framework that integrates these components and designs them to operate at the institutional level in Iraq's drinking water sector. This is precisely what the framework proposed in this research seeks to achieve.

Research Hypotheses

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In light of the constructed conceptual framework and the identified research gap, this research seeks to test four main hypotheses, with their sub-hypotheses, covering its three phases:

H1: *There is a fundamental gap between the current state of the water accounting system's application and water loss control in the case study directorate and the targeted benchmark.*

- H1-1: There is a fundamental gap between the current state of the water accounting system's application in the case study directorate and the targeted benchmark.
- H1-2: There is a fundamental gap between the current state of water loss control accounting in the case study directorate and the targeted benchmark.

H2: *There is a fundamental gap between the current state of applying IWRM and sustainable performance in water management in the case study directorate and the targeted benchmark.*

- H2-1: There is a fundamental gap between the current state of applying IWRM in the case study directorate and the targeted benchmark.
- H2-2: There is a fundamental gap between the current state of sustainable performance in the case study directorate and the targeted benchmark.

H3: *The proposed framework for water accounting and enhancing the sustainable performance of Iraqi water directorates will receive a high degree of acceptance and validity from the perspective of specialized professionals.*

- H3-1: The proposed water accounting system framework will receive a high degree of acceptance and validity from the perspective of specialized professionals.
- H3-2: The proposed framework for enhancing the sustainable performance of IWRM will receive a high degree of acceptance and validity from the perspective of specialized professionals.

H4: *There is a statistically significant relationship and impact between water accounting and the assessment of sustainable performance in water resources management.*

- H4-1: There is a statistically significant relationship and impact between water accounting and the assessment of sustainable operational performance.
- H4-2: There is a statistically significant relationship and impact between water accounting and the assessment of sustainable environmental performance.
- H4-3: There is a statistically significant relationship and impact between water accounting and the assessment of sustainable economic performance.
- H4-4: There is a statistically significant relationship and impact between water accounting and the assessment of sustainable social performance.
- H4-5: There is a statistically significant relationship and impact between water accounting and the assessment of sustainable institutional performance.

RESEARCH METHODOLOGY AND TOOLS

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To test the formulated hypotheses, the research adopted a multi-phase methodological design that responds to the nature of its three objectives: diagnosing reality, developing a proposed framework, and testing its validity and expected impact. For this purpose, a mixed-methods approach was adopted, combining quantitative and qualitative analysis distributed across three sequential and integrated phases.

Phase One – Diagnostic Case Study

1. Case Study Method: This phase adopted the case study method to conduct a precise and in-depth assessment of the current state of the water accounting system, IWRM practices, and the level of sustainable performance in the Anbar Water Directorate, subsequently determining the gap between the current reality and the targeted benchmark (testing H1 and H2). The selection of this directorate is based on several justifications: its vital service importance as the entity responsible for providing drinking water to the largest Iraqi governorate by area, its exclusive reliance on the Euphrates River as the sole source of raw water, and the significant challenges it faces due to water scarcity and deteriorating infrastructure, making it a suitable model for diagnosing the institutional and accounting gap. It is noteworthy that the similarity of Iraqi water directorates in their administrative and accounting structures makes the study of a single case sufficient to extract analytically generalizable results.

Data Collection Tools: To achieve methodological triangulation and enhance the credibility of the results, four main tools were relied upon:

a. Official documents and reports: Including laws, instructions, annual financial reports, reports on quantities of produced, supplied, and lost water, and operational performance reports.
b. A standardized checklist: Designed to assess the application of the water accounting system and water loss accounting, based on a set of international frameworks and standards: the System of Environmental-Economic Accounting for Water (SEEA-Water), the SDG 6.5.1 indicator issued by UN-Water, International Water Association (IWA) standards, and the WA+ water accounting methodology issued by the Food and Agriculture Organization (FAO).
c. Semi-structured interviews: Conducted with the directors of the financial, technical, and information technology divisions in the directorate, to supplement data not available in documents.
d. Field observation: Through site visits to pumping stations, control centers, and inspecting a sample of subscriber meters.

Checklist Design and Gap Measurement: To transform the checklist into a quantifiable assessment tool, a "Water Accounting Compliance Index" model was designed. The assessment of water accounting system items relied on a Likert scale converted to a relative range (0–100) used by the United Nations Environment Programme (UNEP),

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where each item is awarded a score based on its fulfillment level: (0 = Non-existent, 20 = Very weak, 40 = Limited, 60 = Moderate, 80 = Good, 100 = Fully integrated). The assessment of water loss accounting used a three-point scale (1–3) reflecting different application levels.

Tool Validity Verification: The content validity of the checklist was verified using two standard tests: the Content Validity Ratio (CVR) and the Content Validity Index (CVI), based on the opinions of a panel of specialized experts. The results showed that the overall CVR was 96.29%, and the Scale-level CVI (S-CVI) was 98.25%, which are very high values exceeding the minimum acceptable thresholds (0.78 for CVI and 0.90 for S-CVI), confirming the tool's high degree of clarity, relevance, and comprehensiveness.

Phase Two – Developing the Proposed Framework

Based on the results of the first phase that diagnosed the gap between the current reality and the targeted benchmark, a proposed water accounting framework was developed based on three main sources:

1. Case study results: Which revealed the deficiencies and actual needs in the current accounting system.
2. Previous studies: In the fields of water accounting and water sustainability.
3. Prominent international practices: Foremost among them the SEEA-Water system and IPSAS standards, adapted to suit the working nature of Iraqi water directorates and their institutional specificities.

The proposed framework is centered on the idea of integrating SEEA-Water (to provide physical and environmental accounts) and IPSAS (to provide financial and institutional accounts) within a context supporting Integrated Water Resources Management (IWRM), ultimately leading to the enhancement of sustainable performance across its five dimensions: operational, environmental, economic, social, and institutional. The framework and its components are detailed in the results section.

Phase Three – Testing Validity and Expected Impact

Method and Measurement Tool: This phase adopted a field-analytical method using a questionnaire specifically designed to test the validity, acceptance, and expected impact of the proposed framework (testing H3 and H4). The questionnaire consisted of three main sections:

a. Personal information: Comprising 4 items covering specialization, academic qualification, years of experience, and current job role.
b. The proposed water accounting system: Comprising 25 items covering seven areas: system structure and foundations, conceptual framework, system inputs, processing

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operations, system outputs, feedback and internal control, and the system's application environment.

c. Sustainable performance of water resources management: Comprising 20 items covering five dimensions: operational, environmental, economic, social, and institutional.

Respondents were asked to rate each item on a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

Research Population and Sample: The research population consists of professionals in accounting, auditing, and supervisory roles (accountants, auditors, experts, division heads) in Iraq's 18 water directorates. Based on the statistical directory of the Ministry of Construction, Housing, and Municipalities for 2025, the total target population was 822 individuals. By applying the Krejcie and Morgan (1970) formula at a 95% confidence level and a 5% margin of error, a sample size of 262 individuals was determined and distributed using a stratified random sampling method proportional to each functional category's size in the population. After distributing the questionnaires and excluding incomplete ones, the final sample valid for analysis was 200 questionnaires, representing an effective response rate of 76%.

Demographic Characteristics of the Sample: Descriptive analysis revealed that 57% of the sample held a bachelor's degree, 28% a master's degree, and 15% a doctorate. Experience varied, with 29% having 5 years or less, 23.5% having 16-20 years, and 18% having more than 20 years. Regarding specialization, accountants represented 59.5% of the sample, followed by water resources engineers (23%) and administrators (17.5%). This diversity reflects the comprehensiveness and balance of the collected opinions.

Questionnaire Validity and Reliability: Face validity was verified by presenting the questionnaire to a panel of specialized arbitrators. The instrument's reliability was measured using Cronbach's alpha coefficient, which reached 0.954, far exceeding the minimum acceptable threshold of 0.70. The split-half reliability, corrected by the Spearman-Brown formula, reached 0.952. The self-validity index (the square root of the reliability coefficient) reached 0.977, confirming that the questionnaire items possess a high degree of validity and internal consistency.

Normal Distribution Test: To verify the suitability of the data for using parametric statistical tests, the Kolmogorov-Smirnov and Shapiro-Wilk tests were performed, along with skewness and kurtosis coefficients. The results showed that the significance values for all tests were greater than 0.05, and the skewness and kurtosis values fell within the acceptable range (±1.96), confirming the data's normal distribution and justifying the use of parametric tests in the analysis.

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Statistical Methods Used: Data were analyzed and hypotheses tested using a range of statistical methods via the Statistical Package for the Social Sciences (SPSS) software. These included frequencies and percentages, arithmetic means and standard deviations, Pearson's correlation coefficient, and simple and multiple linear regression analysis to test the impact relationships between variables.

PHASE ONE RESULTS – REALITY ASSESSMENT AND GAP ANALYSIS

The Current State of the Water Accounting System in the Anbar Water Directorate

Table (1) presents the aggregate results of assessing the application of water accounting system requirements in the Anbar Water Directorate, according to the relative weights of each dimension.

Table 1: Aggregate Assessment Results of the Water Accounting System's Current State

Dimension	Relative Weight	No. of Items	Max Score	Achieved Score	Compliance Rate	Weighted Compliance
Water Accounting System Structure	15%	6	600	0	0%	0%
Water Balance & Physical Accounting	20%	6	600	0	0%	0%
Revenue Cycle	10%	7	700	300	42.8%	4.3%
Pricing & Cost Recovery System	10%	4	400	100	25%	2.5%
Fixed Assets	10%	3	300	100	33.3%	3.3%
Water Tables & Accounts	10%	3	300	120	40%	4.0%
Internal Control & Reports	10%	6	600	210	35%	3.5%
Technology & Digital Transformation	10%	4	400	20	5%	0.5%
Training & Development	5%	3	300	0	0%	0%
Directorate-Level Results	100%	42	4200	850	20.2%	10.1%

The results showed that the highest compliance rate was recorded for the "Revenue Cycle" dimension (42.8%), followed by "Water Tables & Accounts" (40%), while three vital dimensions scored a 0% compliance rate: Water Accounting System Structure, Water Balance & Physical Accounting, and Training & Development. The overall unweighted compliance rate was 20.2%, which dropped to 10.1% when weighted, reflecting the impact of the relative weights of core dimensions that recorded very low compliance levels, especially the Water Balance and System Structure dimensions. According to the classification matrix adopted in the research, these results fall within the "Very Weak" level.

The Current State of Water Loss Accounting

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Table (2) presents the assessment results of water loss accounting application in the directorate.

Table 2: Assessment Results of the Current State of Water Loss Accounting

Dimension	Score	Assessment Result
Flow Measurement Quality & Accuracy	3	33.3%
Commercial/Apparent Loss Management	5	41.7%
Real/Physical Loss Management	4	44.4%
Data Analysis & Reporting	3	50.0%
Overall Assessment	15	42.4%

The "Data Analysis & Reporting" dimension recorded the highest score (50%), while "Flow Measurement Quality & Accuracy" recorded the lowest (33.3%). The overall rate was 42.4%, falling within the "Moderate" level. These results indicate the directorate's heavy reliance on traditional procedures and operational estimates, versus weaknesses in modern measurement systems and limited use of smart meters and digital technologies.

Gap Analysis and Testing the First Main Hypothesis (H1)

To compare the actual reality with the targeted benchmark (100%), Table (3) presents the gap analysis for the water accounting system components and water loss accounting combined.

Table 3: Gap Analysis Between Current State and Targeted Benchmark

Area	Actual Compliance	Benchmark	Gap
Water Accounting System (Overall)	20.2%	100%	79.8%
Water Loss Accounting (Overall)	42.4%	100%	57.6%

The results revealed a significant gap of (79.8%) at the overall water accounting system level and a 57.6% gap in water loss accounting. At the sub-dimension level, the System Structure, Water Balance, and Training dimensions recorded an absolute gap (100%), while the Revenue Cycle dimension showed the smallest gap (57.2%). Based on these results, the first main hypothesis (H1) and its two sub-hypotheses are accepted.

The Current State of Integrated Water Resources Management (IWRM)

Table (4) presents the assessment results of IWRM application in the Anbar Water Directorate.

Table 4: Assessment Results of the Current State of IWRM

No.	Dimension	Score	Average

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1	Enabling Environment	420	52.5%
2	Institutional Framework & Participation	340	42.5%
3	Management Tools	400	36.4%
4	Financing	60	10.0%
5	Overall Assessment	1220	35.3%

The "Enabling Environment" dimension recorded the highest score (52.5%), indicating the existence of a relative legal and regulatory framework. In contrast, the "Financing" dimension recorded the lowest score (10%), reflecting limited financial resources, weak investment, and partnerships. The overall average was 35.3%, falling within the "Low" level according to the adopted classification matrix. This result is mainly attributed to a lack of funding, weak institutional coordination, and limited use of modern technologies.

The Current State of Sustainable Performance of Water Resources

Table (5) presents the assessment results for the five dimensions of sustainable performance in the directorate.

Table 5: Assessment Results of Sustainable Performance of the Anbar Water Directorate

No.	Dimension	Measurement Result	Assessment per Overall Benchmark	Interpretation
1	Operational Performance	51.0%	Moderate	Limited improvement in continuity, with clear weakness in efficiency and loss.
2	Economic Performance	47.0%	Weak	Significant financial deficit and severe weakness in cost recovery.
3	Social Performance	48.5%	Weak	Relatively good coverage with weak equity and absence of satisfaction measurement tools.
4	Environmental Performance	44.9%	Moderate	High water stress, significant water loss, and weak energy efficiency.
5	Institutional Performance	58.4%	Moderate	Existence of an organizational framework but weak transparency and participation.
Directorate-Level Result		49.9%	Weak	Reflects an imbalance across the five dimensions.

The overall average for sustainable performance was (49.9%), falling within the "Weak" level. Institutional performance recorded the highest score (58.4%), while environmental performance recorded the lowest (44.9%). This variance reflects interconnected structural imbalances, including weak financial sustainability, high water losses, and limited governance and transparency mechanisms.

Gap Analysis and Testing the Second Main Hypothesis (H2)

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Table (6) compares the actual state of IWRM and sustainable performance with the targeted benchmark.

Table 6: Gap Analysis Between Current State and Targeted Benchmark

Area	Actual Compliance	Benchmark	Gap
Integrated Water Resources Management (Overall)	35.3%	100%	64.7%
Sustainable Performance (Overall)	49.9%	100%	50.1%

The gap at the IWRM level was (64.7%), with the Financing dimension recording the largest gap (90%). At the sustainable performance level, the gap was (50.1%), with environmental performance recording the largest gap (55.1%). Based on these results, the second main hypothesis (H2) and its two sub-hypotheses are accepted.

PHASE TWO RESULTS – THE PROPOSED FRAMEWORK

Based on the gap analysis results that revealed a comprehensive deficiency in the current water accounting system (a total gap of 79.8%) and weaknesses in IWRM and sustainable performance, a proposed water accounting framework was developed. This framework is based on integrating the System of Environmental-Economic Accounting for Water (SEEA-Water) with International Public Sector Accounting Standards (IPSAS) and is specifically designed for the operational nature of Iraqi water directorates.

Framework Philosophy and Foundations

The framework is grounded in a philosophy that water is not merely an economic commodity but a natural resource with economic, social, environmental, and institutional dimensions that an accounting system must reflect. It rests on four main principles:

1. Dual Measurement: Combining physical measurement (cubic meters) and monetary measurement within a unified information system.
2. International Standardization: Relying on SEEA-Water for managing physical accounts and IPSAS for managing financial accounts.
3. Data Integration: Linking financial, water, and operational data, along with subscriber data, within a unified accounting framework.
4. Contextual Adaptation: Considering the specificities of the Iraqi environment, including decentralization, water scarcity, and weak infrastructure.

Framework Components

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The framework consists of seven main interconnected components, as illustrated in Figure (2).

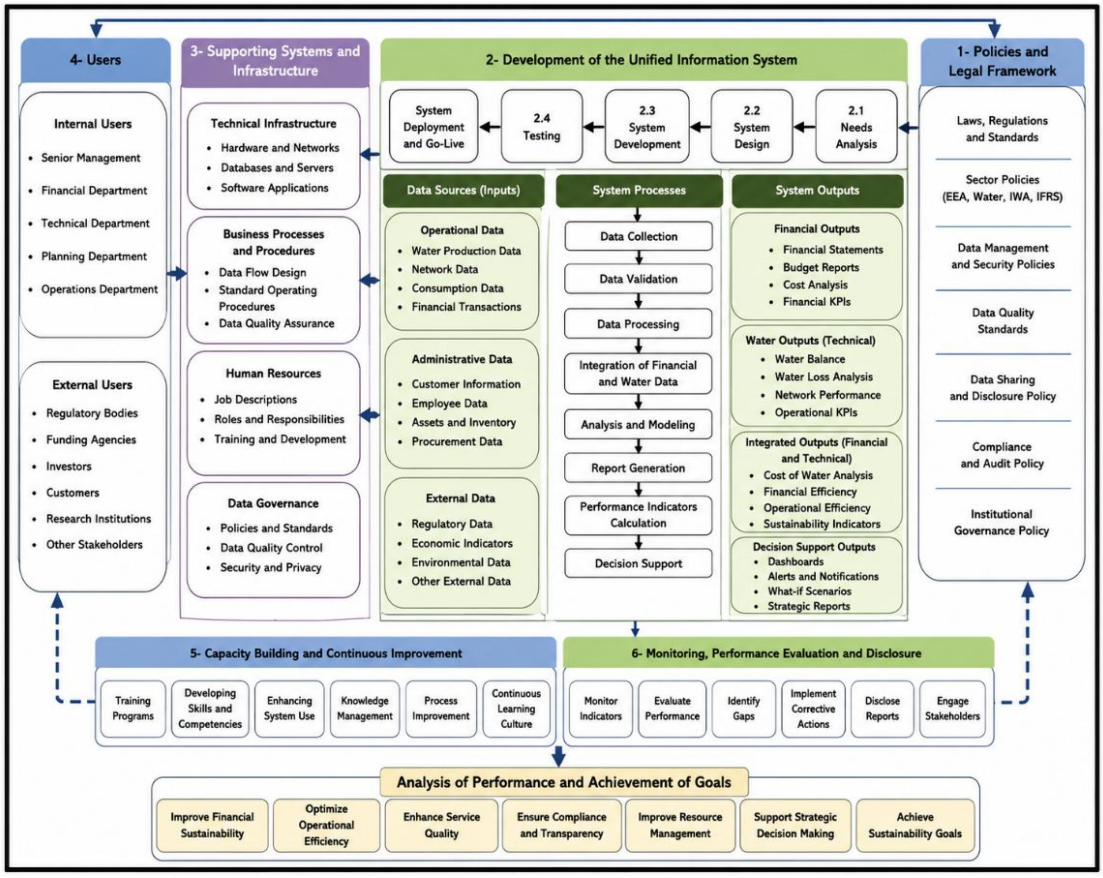

Figure 2: The Comprehensive Proposed Water Accounting Framework

1. Structure and Foundations of the Water Accounting System: This comprises six integrated pillars: (a) the legislative pillar, involving the issuance of regulations organizing water accounting; (b) the administrative pillar, reorganizing roles and responsibilities and creating specialized units; (c) the technical pillar, adopting GIS, SCADA systems, and smart meters; (d) the accounting pillar, developing a unified chart of accounts that integrates water assets alongside manufactured assets; (e) the environmental pillar, embedding environmental dimensions into measurement and disclosure; and (f) the control pillar, developing internal control to cover financial and water aspects jointly.
2. Conceptual Framework of the System: The system operates on an accrual accounting basis under IPSAS, with the recognition of water as a strategic asset. Dual measurement is the core of the system, as water resources are tracked from the

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stages of abstraction, production, supply, and distribution through to consumption and loss, linking these flows to associated costs, revenues, assets, and liabilities.

3. System Inputs: The system relies on four categories of inputs collected from various organizational units: (a) financial data, including revenues, costs, assets, and liabilities; (b) physical water data, including quantities of produced, supplied, and lost water, and its quality; (c) operational and technical data, including energy consumption, maintenance, and faults; and (d) subscriber data, including their numbers, classifications, consumption quantities, and receivables.
4. Accounting Processing Operations: The novel accounting treatments include: (a) applying the accrual basis under IPSAS; (b) adopting dual (physical and monetary) measurement; (c) classifying water accounts into five main groups: water assets, water liabilities, water uses, water resources, and statistical and control accounts; (d) preparing a new chart of water accounts including new items such as 'Available Water Stock,' 'Water Pollution Treatment Provisions,' and 'Evaporation and Leakage Losses'; and (e) applying novel accounting entries for recording water loss, pollution treatment provisions, and recognizing treated reusable water.
5. System Outputs: The system produces an integrated set of water statements and reports inspired by SEEA-Water and adapted to the work of water directorates. Key outputs include:

- Physical and Monetary Supply and Use Tables.
- Water Income Statement (Water Supply and Demand): Showing available water resources and corresponding uses and losses.
- Water Balance Sheet (Statement of Water Position): Showing water assets, water liabilities, and net water assets.
- Water Flow Statement: Illustrating the movement of water entering and leaving the system.
- Statement of Changes in Net Water Assets: Reflecting the impact of water flows and activities on water stock.
- Standardized IWA Water Balance: According to the International Water Association methodology, to identify revenue and non-revenue water components and analyze commercial and real losses.
- Specialized Reports: Including water performance indicator reports, water loss and quality reports, water sustainability reports, and water auditing and control reports.

6. Control and Feedback Mechanisms: The system integrates internal control and feedback mechanisms, including: (a) periodic calculation and review of financial and water performance indicators; (b) continuous digital control using SCADA and GIS; (c) periodic water auditing to verify data and report accuracy; and (d) segregation of duties between meter reading, billing, and collection to ensure independence and reduce errors.

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7. Sustainable Performance Indicators Under the Framework: The framework provides a set of analytical indicators to measure water use efficiency, the most important of which are the Water Productivity Index, the Water Use Efficiency Index, the Water Sustainability Index, and the Cost per Cubic Meter Supplied Index. It also provides detailed indicators such as the ratio of lost water resources, the ratio of water operational obligations, and the percentage change in water stock balances. The framework reveals a relationship of similarity between water indicators and financial indicators in terms of measurement, analysis, and evaluation methods.

Framework Operational Mechanism

The framework operates in an integrated informational cycle as illustrated in Figure (3): beginning with the collection of financial, water, and operational inputs, proceeding through their accounting processing in accordance with SEEA-Water and IPSAS, and culminating in the preparation of water and financial statements and reports, with a feedback mechanism that allows for continuous improvement. This framework ensures the integration of hydrological and financial data, providing an objective basis for supporting IWRM decisions and enhancing the dimensions of sustainable performance.

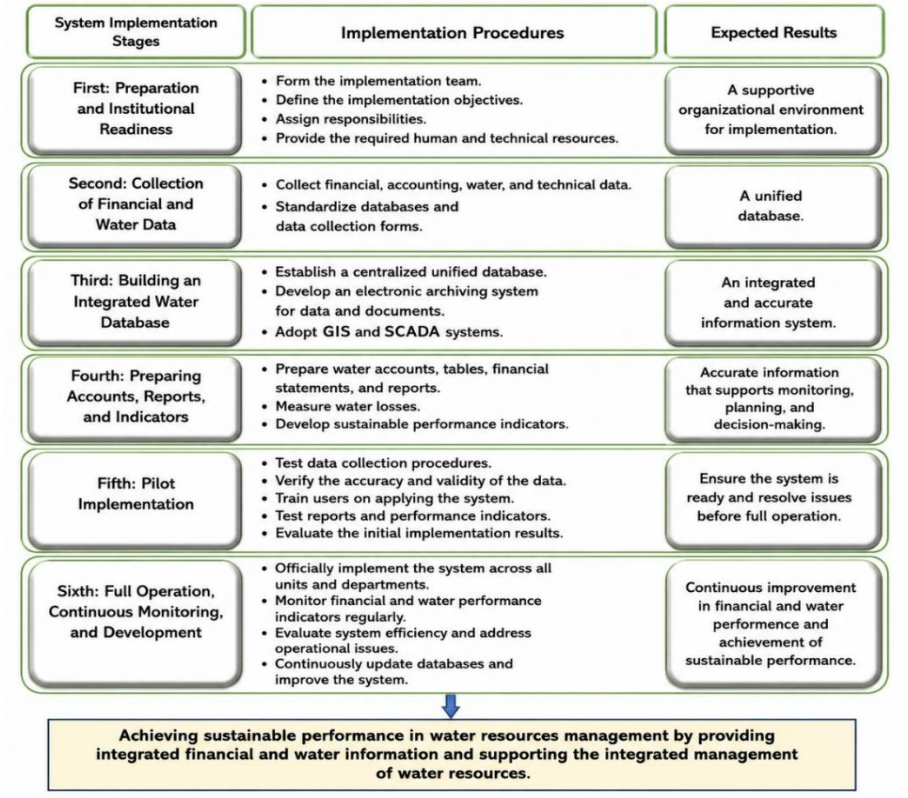

Figure 3: Implementation Stages of the Proposed Framework

Alignment with Sustainable Development Goals

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The proposed framework is directly linked to the sixth Sustainable Development Goal (SDG 6), particularly target 6.4 concerning increasing water-use efficiency and ensuring sustainability. It also supports the achievement of target 6.5 by providing quantitative and financial indicators that support the implementation of integrated water resources management.

Advantages of the Proposed Framework

The proposed framework distinguishes itself from previous accounting models—which focused on either the financial or the hydrological aspect alone—by achieving: (1) integration of financial, water, and operational data; (2) a dual grounding in SEEA-Water and IPSAS; (3) applicability in water directorates and similar service units; (4) direct support for assessing sustainable performance in its five dimensions; and (5) a contribution to developing water accounting control and disclosure systems.

PHASE THREE RESULTS – TESTING FRAMEWORK VALIDITY AND EXPECTED IMPACT

Proposed Framework Validity (Testing the Third Main Hypothesis - H3)

After developing the proposed framework, a questionnaire was designed to assess its validity and acceptance from the perspective of specialists in Iraqi water directorates. The questionnaire comprised 25 items covering the seven areas of the system and 20 items covering the five dimensions of sustainable performance. After distribution to a stratified random sample of 200 specialists, the third main hypothesis was tested using a One-Sample t-test to compare the arithmetic means against the hypothetical midpoint of 3. Table (7) summarizes the results.

Table 7: Results of the Proposed Framework Validity Test

Area	Mean	t-value	Sig.	Decision
Proposed Water Accounting System	4.366	86.942	0.000	Accept H3-1
Enhanced Sustainable Performance	4.339	106.511	0.000	Accept H3-2
Overall Proposed Framework	4.354	129.727	0.000	Accept H3

The results showed that the arithmetic means for all areas significantly exceeded the hypothetical midpoint of 3 ($p < 0.001$). The overall mean for the proposed framework was 4.354, falling within the "Strongly Agree" category on the five-point Likert scale. The sub-means for the water accounting system components ranged between 4.298 for processing operations and 4.451 for the application environment, while the sustainable performance dimensions ranged between 4.313 for the environmental and economic dimensions and 4.363 for the institutional dimensions. These results reflect a strong consensus among specialists on the validity of the proposed framework and its

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acceptance for application in Iraqi water directorates. Accordingly, the third main hypothesis (H3) and its two sub-hypotheses are accepted.

Expected Impact of the Framework on Sustainable Performance (Testing the Fourth Main Hypothesis - H4)

To test the impact of water accounting on enhancing sustainable performance, Pearson's correlation coefficient and simple linear regression analysis were used. Table (8) summarizes the results of testing the fourth main hypothesis and its sub-hypotheses collectively.

Table 8: Results of the Relationship and Impact Test Between Water Accounting and Sustainable Performance Dimensions

Hypothesis	Dimension	R	R^2	β	F	Sig.	Decision
H4 (Main)	Sustainable Performance (Overall)	0.843	0.711	0.843	271.384	0.000	Accepted
H4-1	Operational Performance	0.736	0.541	0.945	260.405	0.000	Accepted
H4-2	Environmental Performance	0.751	0.564	1.016	285.805	0.000	Accepted
H4-3	Economic Performance	0.655	0.429	0.862	166.056	0.000	Accepted
H4-4	Social Performance	0.633	0.401	0.900	148.099	0.000	Accepted
H4-5	Institutional Performance	0.730	0.533	0.917	252.431	0.000	Accepted

The results revealed a strong, positive, and statistically significant correlation between water accounting and overall sustainable performance ($R = 0.843$, $p < 0.001$). Water accounting explained 71.1% of the variance in sustainable performance ($R^2 = 0.711$). At the sub-dimension level, the environmental dimension recorded the highest impact coefficient ($\beta = 1.016$) and the highest explanatory power ($R^2 = 0.564$), followed by the operational dimension ($\beta = 0.945$, $R^2 = 0.541$), then the institutional dimension ($\beta = 0.917$, $R^2 = 0.533$), then the economic dimension ($\beta = 0.862$, $R^2 = 0.429$), and finally the social dimension ($\beta = 0.900$, $R^2 = 0.401$). All relationships were significant at the $p < 0.001$ level. Accordingly, the fourth main hypothesis (H4) and all its sub-hypotheses are accepted.

Comparative Analysis of Impact Strength

A comparative analysis of the sustainable performance dimensions (Table 9) reveals a clear pattern: the dimensions closest to the core of the water accounting system (environmental, operational, institutional) are the most affected by it, while dimensions requiring interventions beyond the scope of accounting (economic and social) showed a relatively lesser impact.

This gradation suggests that water accounting exerts its strongest influence in the areas it directly engages with, such as measuring water flows, monitoring losses, and

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supporting governance. In contrast, maximizing its impact in the economic and social domains requires its integration with supportive government policies, infrastructure investments, and community awareness programs. This finding confirms that water accounting is an effective strategic tool, but it is not the sole solution; rather, it operates within an integrated water resources management system.

Table 9: Comparison of Water Accounting Impact Strength on Sustainable Performance Dimensions

Rank	Dimension	β	R^2	Impact Level
1	Environmental Performance	1.016	0.564	Highest Impact
2	Operational Performance	0.945	0.541	Very High
3	Institutional Performance	0.917	0.533	High
4	Economic Performance	0.862	0.429	Moderate
5	Social Performance	0.900	0.401	Moderate

Summary of Research Findings

Through its three phases, the research substantiated the following:

1. A Wide Structural Gap Exists: The current water accounting system in the Anbar Water Directorate suffers from a comprehensive deficiency (79.8% total gap), with an almost complete absence of fundamental components like the water balance and physical accounting.
2. Weakness in IWRM and Sustainable Performance: Integrated Water Resources Management recorded a low level (35.3%), and sustainable performance a weak level (49.9%), confirming the critical need for a developmental intervention.
3. High Acceptance of the Proposed Framework: The proposed water accounting framework, based on SEEA-Water and IPSAS, received very high acceptance from specialists (overall mean of 4.354 out of 5), proving its validity for application.
4. A Strong Positive Impact: The results proved a statistically significant positive impact of water accounting on enhancing sustainable performance across all its dimensions ($R^2 = 0.711$), with the highest impact on the environmental, operational, and institutional dimensions.

DISCUSSION OF RESULTS

Interpreting the Gap in the Water Accounting System and IWRM

The results of the first phase revealed a wide structural gap in the water accounting system of the Anbar Water Directorate (79.8%), an equally critical gap in Integrated Water Resources Management (64.7%), and a weak level of sustainable performance (50.1%). The significance of these findings lies in the fact that they do not represent

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merely diagnostic figures but rather expose a deep-rooted structural deficit attributable to three interconnected factors.

First, the legislative and regulatory vacuum. The recording of an absolute gap (100%) in the "Water Accounting System Structure" and "Water Balance and Physical Accounting" axes does not merely reflect administrative shortcomings, but a complete absence of the legal and institutional framework governing water accounting in Iraq. This is consistent with the findings of Fadhil and Sajad (2020), which documented the weakness of legal systems governing the water sector in Iraq, and with the ESCWA report (2023) on the low level of IWRM implementation in the Arab region. In the absence of legislation mandating water directorates to adopt a water accounting system, these directorates remain captive to the traditional government accounting system based on the cash basis, which, by its nature, does not capture natural assets such as water, nor does it measure loss or depletion.

Second, institutional fragmentation. The Law of Governorates Not Incorporated into a Region (No. 21 of 2008) led to the decentralization of water management—a sound administrative direction in principle. However, in the absence of unified accounting standards, it has produced eighteen water directorates operating as isolated islands, without a unified information system linking them. This partially explains the low scores for the "Institutional Framework and Participation" (42.5%) and "Management Tools" (36.4%) dimensions in the IWRM assessment. This result aligns with what was documented by Al Saffar and Al Fatlawi (2025) regarding the difficulties in sustaining water supply in Karbala due to weak institutional coordination.

Third, the financing gap. The low level of sustainable performance (49.9%) cannot be understood in isolation from the near-total collapse of the financing axis (10%). When the directorate is unable to recover its operational costs and lacks alternative funding sources, it becomes incapable of maintaining its deteriorating networks or investing in modern technologies for leak detection, thus entering a vicious cycle: weak funding leads to deteriorating infrastructure, which increases water loss, which in turn exacerbates the financial deficit. This is entirely consistent with the World Bank (2017) report on the impact of weak cost recovery on undermining the sustainability of the water sector.

Nevertheless, it is worth noting a bright spot in this bleak picture: the recording of the smallest relative gap in the "Revenue Cycle" axis (57.2%). This indicates that the directorate possesses a functioning core of a traditional financial accounting system, which can be built upon rather than starting from scratch. This is an important lesson: reform does not require demolishing everything, but rather development and integration.

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Acceptance of the Proposed Framework: Between Theoretical Rigor and Practical Need

Perhaps the most prominent result of this research is the exceptionally high acceptance of the proposed framework (overall mean of 4.354 out of 5, $p < 0.001$). This acceptance did not rise in a vacuum; it reflects a rare intersection of theoretical solidity and urgent practical need.

On one hand, the framework derived its strength from the fact that it was not invented in isolation from international practices, but was grounded in two well-established standards: the SEEA-Water system, which has proven its worth in multiple national contexts from the Netherlands to Australia to Jordan (Clarke et al., 2023; Zahra Rahimzadeh Kivi, 2022), and the IPSAS standards, which have become the international reference for government accounting reform (Bassi et al., 2020). This dual theoretical foundation—physical and financial—is what distinguished the proposed framework from previous partial attempts. For example, the study by Al-Shammari and Al-Kanani (2021) focused on sustainability accounting according to the GRI without including physical water accounting, while the study by El-Sayed (2024) designed an accounting framework for water in Egypt but did not integrate IPSAS. Herein lies the contribution of the current research: the integration of the environmental-statistical dimension (SEEA-Water) with the financial-institutional dimension (IPSAS) in a single framework specifically designed for Iraqi water directorates.

On the other hand, specialists in water directorates—who daily suffer from the absence of accurate water data and their inability to answer basic questions such as "What is the cost per cubic meter produced?" or "Where does the loss go?"—saw in this framework a genuine opportunity to escape the information crisis they are experiencing. This explains why the "Application Environment" axis received the highest mean among the framework components (4.451): specialists recognize that the success of any new system depends not only on its technical design but also on institutional readiness, training, and digital infrastructure. This awareness, in itself, is a positive indicator of the institution's readiness for change. Conversely, the relatively lower mean for "Accounting Processing" (4.298) points to a justifiable concern about the complexity of new accounting procedures, which aligns with the caution raised by Hewawithana (2019) that the adoption of complex accounting terminology in water accounting may constitute a barrier to user understanding, necessitating intensive training programs and simplified guidance materials.

Variation of Impact Across Sustainable Performance Dimensions: Implications and Limits

The detailed analysis of water accounting's impact on the dimensions of sustainable performance (Tables 8 and 9) reveals a logical gradation that reflects the nature of this

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tool, its capabilities, and its limits simultaneously.

At the Top: Environmental and Operational Dimensions. The ranking of the environmental dimension ($R^2 = 0.564$, $\beta = 1.016$) and the operational dimension ($R^2 = 0.541$, $\beta = 0.945$) at the top of the most affected dimensions is not coincidental; it is a direct reflection of the essence of water accounting. It was fundamentally designed to provide accurate quantitative information on water flows, sources of loss, and efficiency of use. This information has an almost immediate impact on environmental decisions (such as controlling abstraction quantities from natural sources) and operational decisions (such as repairing network leaks). This is entirely consistent with the findings of Zhao et al. (2018) on the importance of quantitative water accounting in environmental protection, and with the conclusions of Mohamed M. M. Anwar (2023) that the application of water accounting systems contributes to reducing water losses and improving operational efficiency.

In the Middle: Institutional Dimension. The strong impact on the institutional dimension ($R^2 = 0.533$, $\beta = 0.917$) reflects the role played by IPSAS—on which the framework is based—in strengthening governance, transparency, and accountability. The inclusion of water assets in statements of financial position, the preparation of periodic reports on water performance, and the existence of an internal control system covering both financial and water aspects are all factors that contribute to improving institutional performance. This is consistent with what was documented by Chalmers et al. (2012) that water accounting enhances the efficiency of water management procedures, and with the observation by Yu et al. (2024) that water accounting provides an objective basis for sound governance.

At the Relative Base: Economic and Social Dimensions. As for the relatively lesser impact on the economic ($R^2 = 0.429$) and social ($R^2 = 0.401$) dimensions, this does not imply that water accounting is unimportant for these dimensions. Rather, it suggests, in our assessment, that improving them requires interventions beyond the scope of accounting. The economic sustainability of the water sector is contingent on additional factors: fair pricing policies that reflect true costs while considering the purchasing power of citizens, government investment in infrastructure, and sustained financial support. This aligns with the findings of Raj (2016), which revealed the complexity of the relationship between water performance and financial performance, finding no strong correlation between them. The social dimension—such as distributional equity and beneficiary satisfaction—depends on broader societal and political factors such as community awareness, community participation in water decision-making, and the fairness of public policies. This is consistent with the assertion by Gleick (1998) that achieving water sustainability requires a transformation in policies, institutions, and community participation, not just improved measurement and information. In other words, water accounting provides the "map" that shows where the problems lie, but it

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does not alone possess the "resources" needed to solve them. It is a necessary condition, but not a sufficient one, for achieving sustainability in its economic and social dimensions.

Research Limitations and Future Studies

Despite the important findings reached by this research, it is not without limitations that should be acknowledged, and which in turn open horizons for future research.

First, limits to generalizability. The diagnostic case study was limited to the Anbar Water Directorate. Although the similarity of Iraqi directorates in their administrative and accounting structures enhances the potential for analytical generalization, caution remains warranted when transferring results to other governorates that may differ in water resource availability or human capacities. This limitation calls for expanding future research to include other water directorates, enabling the construction of a comparative database and testing the framework's validity in diverse Iraqi contexts.

Second, expected versus actual impact. It is important to emphasize that the results of the third phase measure the "expected impact" of the proposed framework as perceived by specialists, not the "actual impact" after its implementation. The framework has not yet been applied on the ground, and the perceptions of specialists—while a valuable indicator—may differ from actual results upon application. Hence, the most important recommendation for future research is to apply the proposed framework in one of the water directorates, for a sufficient period, and measure its real impact on sustainable performance before and after implementation (a longitudinal quasi-experimental study).

Third, sample size and composition. The third phase sample (200 individuals) represented approximately 24% of the target population. Despite its statistical adequacy, the fact that 41% of the respondents were accountants may have influenced the direction of the results towards highlighting the importance of accounting aspects.

Fourth, mediating variables. The research focused on the direct relationship between water accounting and sustainable performance. However, it is logical to assume the existence of mediating or moderating variables that affect this relationship, such as organizational culture, administrative leadership, the level of available funding, or digital infrastructure readiness. This can be addressed in future studies using more complex statistical models such as Structural Equation Modeling (SEM).

Summary of Discussion

In conclusion, the results of this research provide strong empirical evidence for two central points. The first is that water directorates in Iraq suffer from a profound accounting and institutional gap that hinders their sustainable management of water resources. The second is that a viable solution exists in an integrated water accounting

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framework based on SEEA-Water and IPSAS, which has demonstrated high acceptance among specialists and a strong positive expected impact on sustainable performance in all its dimensions. However, the path from the "proposed framework" to "lived reality" remains long. It requires supportive political will, investment in digital infrastructure, systematic development of human resources, and, above all, a firm conviction that water is not merely a free natural resource but a strategic asset that must be managed with accounting professionalism and institutional transparency.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study addressed the fundamental problem of the absence of an integrated water accounting system in Iraqi water directorates and its repercussions on Integrated Water Resources Management (IWRM) and sustainable performance. In light of the results obtained across the three research phases, a number of pivotal conclusions can be drawn.

First: At the Diagnostic Level. The field study of the Anbar Water Directorate revealed a wide structural gap in the water accounting system amounting to 79.8%, with an almost complete absence of fundamental components such as the water balance and physical accounting (a 100% gap). IWRM recorded a low level of 35.3%, and sustainable performance a weak level of 49.9%. These gaps are attributable to three interconnected factors: the legislative vacuum regulating water accounting, institutional fragmentation resulting from the decentralization of water management, and chronic underfunding that prevents the development of infrastructure and the modernization of measurement systems.

Second: At the Developmental Level. Based on the diagnostic results, a proposed water accounting framework was developed, grounded in the integration of the System of Environmental-Economic Accounting for Water (SEEA-Water) and International Public Sector Accounting Standards (IPSAS). The framework is based on the principle of dual (physical and monetary) measurement of water resources, consists of seven interconnected main components covering inputs, processes, outputs, control, and feedback, and produces an integrated set of water statements and reports inspired by SEEA-Water and adapted to the operational nature of Iraqi water directorates.

Third: At the Empirical Level. The proposed framework received very high acceptance from specialists in Iraqi water directorates (overall mean of 4.354 out of 5, $p < 0.001$), reflecting its validity for application. The regression analysis results demonstrated a strong, statistically significant positive impact of water accounting on overall sustainable performance ($R^2 = 0.711$, $\beta = 0.843$, $p < 0.001$), with the highest impact on the environmental ($R^2 = 0.564$), operational ($R^2 = 0.541$), and institutional ($R^2 = 0.533$)

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dimensions, and a moderate impact on the economic ($R^2 = 0.429$) and social ($R^2 = 0.401$) dimensions. These results confirm that water accounting represents an effective strategic tool for enhancing IWRM and improving sustainable performance, yet it remains a necessary but insufficient condition, as maximizing its impact requires its integration with supportive financial and social policies.

Fourth: At the Theoretical Level. This study contributes to enriching the accounting literature by presenting an original conceptual and applied framework that integrates—for the first time in the Iraqi context—SEEA-Water and IPSAS to assess sustainable performance in government water institutions. It also provides new empirical evidence on the nature of the relationship between water accounting and sustainable performance in its multiple dimensions, and reveals the variation in the strength of this relationship across different dimensions, opening new horizons for research into the mediating and moderating variables affecting this relationship.

Ultimately, this study confirms that the transition from the traditional accounting system to an integrated water accounting system—combining SEEA-Water and IPSAS—is no longer an academic luxury but has become a strategic necessity for water directorates in Iraq, given the growing water crisis and increasing pressures on water resources. However, the success of this transition remains contingent upon the availability of supportive legislative will, sufficient investment in digital infrastructure, and systematic development of human resources.

Recommendations

In light of the findings and conclusions reached by the research, the following recommendations can be presented, distributed across three levels.

First: Recommendations at the Legislative and Institutional Level

1. Issue dedicated legislation for water accounting that defines the bases for measurement, disclosure, and the preparation of water reports and accounts, thereby creating the legal environment necessary for its application in the institutions responsible for water resources management.
2. Establish a specialized organizational unit for water accounting and sustainability within the organizational structure of water directorates, tasked with preparing water accounts, statements, reports, and indicators, and following up on the implementation of the proposed framework's requirements.
3. Strengthen institutional coordination between water directorates and related entities (Ministry of Water Resources, Ministry of Planning, statistical departments) to ensure the integration of data and policies.

Second: Recommendations at the Accounting and Technical Level

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4. Adopt the proposed water accounting framework by water directorates in Iraq, thereby achieving integration between financial, water, and operational data, supporting IWRM, and enhancing sustainable performance.
5. Adopt the accrual accounting basis under IPSAS and the requirements of the SEEA-Water system, creating specialized water accounts and integrated water statements and reports within the accounting system.
6. Build a centralized, integrated database linking financial, water, and operational data, employing modern technologies such as Geographic Information Systems (GIS), Supervisory Control and Data Acquisition (SCADA) systems, and smart meters to raise information quality and support decision-making.
7. Develop mechanisms for periodically measuring and disclosing water loss and waste, linking their results to the outputs of the water accounting system, and directing investments towards the rehabilitation of water networks and the development of measurement and maintenance systems.

Third: Recommendations at the Administrative, Financial, and Human Level

8. Provide the necessary financial and technical support for the implementation of the water accounting system, ensuring the development of infrastructure, the provision of modern technologies, and the preparation of the capabilities needed for the efficient execution of the system.
9. Implement continuous training and qualification programs for staff in water directorates in the fields of water accounting, IWRM, data analysis, water reporting, and the use of modern digital technologies.
10. Adopt an integrated sustainable performance evaluation system based on the outputs of water accounting, encompassing the operational, economic, social, environmental, and institutional dimensions, with the mandatory periodic disclosure of sustainable performance indicators by water directorates.
11. Develop a water services pricing policy based on actual consumption and expand the use of smart meters, achieving equity in water distribution, enhancing the financial sustainability of the sector, and rationalizing water resource use.
12. Expand investment in non-conventional water resources, particularly treated water, and encourage its reuse in agricultural, industrial, and service activities, contributing to enhanced water security.
13. Enhance the participation of the local community, the private sector, and academic institutions in supporting the application of water accounting, disseminating a culture of water consumption rationalization, and linking its outputs to sustainable development indicators and national water security policies.

Fourth: Recommendations for Future Research

14. Apply the proposed framework in practice within one of the water directorates and measure its real impact on sustainable performance before and after implementation (a longitudinal quasi-experimental study).
15. Expand the scope of the research to include other water directorates in different Iraqi governorates, enabling the construction of a comparative database and testing the framework's validity in diverse contexts.
16. Investigate mediating and moderating variables that may affect the relationship between water accounting and sustainable performance, such as organizational culture, administrative leadership, funding levels, or digital infrastructure readiness, using more complex statistical models such as Structural Equation Modeling (SEM).

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