“Assessing ISO 14001:2015 compliance in Iraqi healthcare: A comparative study of environmental management in public and private hospitals”

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ASSESSING ISO 14001:2015 COMPLIANCE IN IRAQI HEALTHCARE: A COMPARATIVE STUDY OF ENVIRONMENTAL MANAGEMENT IN PUBLIC AND PRIVATE HOSPITALS

Abstract

The implementation of environmental management systems is increasingly recognized as essential for advancing sustainability in healthcare, particularly in resource-constrained contexts such as Iraq. This study evaluates the compliance of Iraqi public and private hospitals with ISO 14001:2015 standards, revealing significant discrepancies between the two sectors. Utilizing a quantitative descriptive approach, data were collected through field surveys, structured interviews, and document analysis to assess environmental management systems practices. Private hospitals demonstrated a compliance rate of 75%, while public hospitals achieved a compliance rate of only 50%. Key deficiencies in public hospitals were identified in operation (78% gap) and improvement (73% gap), indicating systemic weaknesses. Although private hospitals performed better, they still exhibited notable gaps, particularly in leadership and performance evaluation, both at 29%. Challenges common to both sectors included insufficient resource allocation, limited environmental awareness, and inadequate leadership involvement. These findings underscore the urgent need for targeted interventions to address barriers to adoption of environmental management systems. Strategies such as fostering stronger leadership commitment, optimizing resource allocation, incorporating advanced environmental technologies, and implementing ongoing staff training are recommended to bridge the compliance gap. This study provides critical insights into enhancing environmental performance and promoting sustainable healthcare practices in Iraq. Furthermore, it serves as a reference for addressing similar challenges in developing countries, emphasizing the importance of aligning healthcare operations with international environmental management standards.

Keywords sustainability, healthcare, environment, compliance, hospitals, leadership, performance, management

JEL Classification I18, Q56, Q51

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INTRODUCTION

The burgeoning healthcare sector has increasingly acknowledged the significance of integrating environmental management systems (EMS) to promote sustainability and enhance environmental performance. In Iraq, where healthcare institutions encounter challenges related to inadequate facilities and substantial environmental issues due to resource constraints, the relevance of the ISO 14001:2015 standard becomes particularly critical.

The primary focus of this study is the insufficient application of ISO 14001:2015 standards in Iraqi hospitals, which results in ineffective management of environmental impacts. This lack of implementation not only compromises the operational efficiency of healthcare facilities but also poses considerable risks to public health and the environ-

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ment. As a specialized area of inquiry, this paper seeks to contribute to the existing literature on the status of EMS in emerging economies, with a specific emphasis on Iraq in the contemporary context, while also exploring effective and minimally invasive healthcare delivery methods for patients.

This paper outlines three specific objectives. First, it evaluates the current environmental practices employed by hospitals in Iraq and identifies the obstacles that impede the successful implementation of EMS. Second, the analysis compares compliance with ISO 14001:2015 between the public and private healthcare sectors, addressing the observed discrepancies. Finally, the analysis proposes actionable recommendations that facilitate the effective application of EMS and enhance environmental sustainability within the healthcare sector, thereby addressing the health challenges faced in Iraq. The structure of this study is designed to significantly advance the understanding of environmentally conscious practices within the country's healthcare system.

1. LITERATURE REVIEW

The concept of measuring environmental performance in healthcare organizations has emerged as an important issue, particularly in hospitals experiencing significant environmental degradation. Hospitals generate large amounts of waste, a notable portion of which is hazardous, necessitating management measures to mitigate the adverse effects of microorganisms (Moldovan et al., 2023; Brogi & Menichini, 2019). While more studies on environmental sustainability are being conducted, there is still a lack of relevant frameworks for evaluating and benchmarking environmental performance in other healthcare institutions (Alsulamy et al., 2022).

This gap has led many researchers to develop new frameworks and processes to measure environmental performance, specifically in hospitals, thereby aiding in strategy development, goal setting, and performance measurement (Carrillo-Labella et al., 2020; Fonseca & Domingues, 2018). To advance healthcare organizations toward sustainable development, it is critical to view the environment as a performance indicator of operations management.

Integrating additional factors, particularly the environment, is necessary to promote sustainability (Arocena et al., 2021). However, developing countries still struggle to identify and apply appropriate, operationalized indicators at various levels of organizational hierarchy or contexts (Chen et al., 2020). Improving the understanding of how social organizations relate to the environment is essential. This relationship is not purely ecological, as it quantifies the impacts of human activities on the environment, while ecosystems do not rely on human actions (Alnavis et al., 2021). The field of ecology has evolved to address not only the adverse effects of human activity but also initiatives aimed at maintaining and enhancing the health and stability of the natural ecosystem for the future (AlDulijand et al., 2024).

As organizations increasingly commit to environmental preservation, the adoption of formal environmental management systems has become more prevalent. These standards provide a systematic framework for monitoring and reporting on organizational activities aimed at mitigating negative environmental impacts (Psomas et al., 2011). Factors contributing to the growing utilization of eco-labels and certification programs include heightened public pressure for environmental accountability and enhanced corporate social responsibility driven by stringent environmental regulations (Castka & Corbett, 2016).

Notable initiatives, such as the European Ecolabel and the Forest Stewardship Council (FSC), have emerged in the late 20th century, alongside the transformative ISO 14001 standard on EMS, which was introduced in 1996 (Tambovceva & Geipele, 2011; Massoud et al., 2010). This standard has proven instrumental in establishing a structure that enables organizations to enhance their environmental performance benchmarking (Heras-Saizarbitoria et al., 2020b).

The ISO 14001 EMS facilitates the strategic management of environmental performance while addressing socio-economic considerations (Carrillo-

Labella et al., 2020). It applies to organizations of all sizes and types, aiming specifically at pollution prevention and control (Lum et al., 2023).

In response to emerging developments, the standard for ISO 14001 undergoes periodic revisions. Environmental issues identified since 2015, including climate change and biodiversity loss, have been integrated with contemporary practices in corporate environmentally sustainable management. Efforts to gather the perspectives of nearly all stakeholders through a global questionnaire ensure that the standards under consideration in the revision process remain relevant to the evolving needs of stakeholders and the environment (Kojra et al., 2020). Additionally, recent advancements incorporated into ISO standards include regular updates to these standards. The implementation of an EMS is typically based on the most recent revision of ISO 14001, reflecting the organization's commitment to sustainable development, which may enhance its public image and reduce operational costs (Hidayati et al., 2023). The ISO 14001:2015 standard is structured into several key sections: scope, normative references, terms and definitions, organizational context, leadership, planning, support, operation, performance evaluation, and improvement (ISO, 2015). The sections and subsections of ISO 14001:2015 (refer to Table A1) are systematically arranged to support an organization's effective management of its environmental responsibilities, enhance its environmental performance, and integrate environmental management within its comprehensive business strategy.

EMS provide significant benefits to hospitals, including improved environmental outcomes and optimized operational performance. A systematic review by Boiral et al. (2018) indicates that implementing an EMS can lead to a 71% improvement in environmental performance, a 92% reduction in energy and resource consumption, a 33% decrease in water contamination, an 84% reduction in waste associated with healthcare risks, and an overall 88% improvement in mitigating environmental risks and safety concerns. Furthermore, implementing an EMS can address specific cultural counterforces within an organization and promote organizational learning, thereby enhancing the environmental competence of hospitals (Reis et al., 2018). However, implementing an EMS in hospitals often faces several challenges, including increasing demand for services, limited resources, aging infrastructure, technological advances, and regulatory compliance (Basnawi, 2024). Nonetheless, managing hospital resources efficiently is both an ethical and legal obligation. To overcome these challenges, a strong commitment from staff and an integrated systems management approach are essential to counter the influence of external organizations (Prajogo et al., 2014).

Research on the adoption of ISO 14001 across various sectors, including healthcare, highlights a range of motivations and benefits linked to its implementation. Internal motivations, such as enhancing efficiency and performance, typically exert a greater influence on perceived benefits than external pressures (Fonseca, 2015). Key drivers include developing a positive environmental profile, fostering goodwill, and integrating with other management systems (Ahmed & Mathrani, 2024). In healthcare institutions, factors like competition, ethical considerations, and legal constraints compel hospitals to meet their environmental responsibilities (Ejdys & Szpilko, 2022).

The revenue generated by residential architectural practices implementing ISO 14001 includes, among other benefits, increased commitment from top management, improved internal and external communication, and better alignment with corporate strategic goals. The introduction of EMS, particularly the ISO 14001:2015 standard, is widely recognized as an operational management measure aimed at improving corporate environmental practices and ensuring compliance with legal obligations (Oliveira et al., 2016). However, the transformation process presents challenges that may undermine the fundamental rationale for implementing ISO 14001. Risks encountered during the implementation phase can be holistic, spanning financial to cultural dimensions, affecting both the adoption of the standard and the benefits realized by stakeholders (Weerasinghe & Jayasooriya, 2020; Susanto & Mulyono, 2017). One of the most pressing challenges organizations in developing countries face is the financial burden and additional costs associated with obtaining certification under the ISO 14001 standard.

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This financial burden can dissuade many companies from integrating environmental management systems (EMS) into their operations, as these organizations may lack adequate resources for the certification process (Riaz et al., 2019). Organizational factors and the institution's international orientation are also critical in the adoption process. Larger organizations typically possess more resources and are better positioned to adopt comprehensive EMS compared to smaller organizations, where limitations in financial and human capital often hinder implementation (Alsulamy et al., 2022; Singh, 2019). Nevertheless, hospitals and other health organizations can realize the benefits associated with adopting EMS. These institutions, if willing to allocate appropriate resources for planning and address internal challenges, can effectively respond to external pressures, thereby enhancing both productivity and environmental performance (Hidayati et al., 2023; Perumal et al., 2012). The complexities associated with compliance with hospital accreditation systems, particularly in developing countries, further complicate EMS implementation.

The scarcity of adequately skilled personnel, insufficient infrastructure, and lack of necessary equipment and supplies have been identified as significant impediments to the effective application of EMS (Nugroho & Sjaaf, 2019; Laskurain et al., 2017). To enhance compliance with quality management systems in healthcare organizations, initiatives should focus on improving the quality management system itself and fostering a deeper understanding among healthcare professionals (Brubakk et al., 2015; Jaafaripooyan, 2014). However, challenges persist in the effective application of EMS, particularly within the oil and gas sector, where a notable implementation gap is evident. The distinctive characteristics of the healthcare service industry present unique barriers to incorporating EMS in hazardous waste management, complicating implementation (Heras-Saizarbitoria et al., 2020a; Qi et al., 2011). The standard revision ISO 14001:2015 addresses these challenges by incorporating contemporary environmental considerations and analyzing the organizational context and stakeholder expectations (Kafel & Nowicki, 2023; Ejdys & Szpilko, 2022). It can be argued that, despite the challenges during the implementation period, the benefits for many organizations justify the investment.

The effective implementation of EMS can yield improved environmental outcomes, enhance the organization's image, and ensure compliance with legal requirements, thereby contributing to environmental protection and the achievement of business objectives (Trisno et al., 2020; Schmaltz et al., 2011). In contemporary contexts, organizations face environmental challenges that must be addressed for long-term sustainability. Consequently, adopting the ISO 14001:2015 EMS standard has become imperative in various sectors, including healthcare and industry (Fonseca & Domingues, 2018; Fonseca, 2015).

Research indicates that the effective implementation of environmental management systems can significantly enhance organizational performance, as evidenced by improved outcomes in hospitals that have adopted comprehensive environmental training and management systems (Singh, 2019; Fonseca & Domingues, 2018; Perumal et al., 2012). The implementation of the ISO 14001:2015 EMS encompasses several interrelated actions, including stakeholder engagement, the formulation of a vision, the integration of circularity, and the promotion of environmental stewardship within the organization (Kafel & Nowicki, 2023; Perumal et al., 2014). Consequently, organizations are well positioned to implement ISO 14001:2015, thereby facilitating enhanced environmental and resource management. This standard is structured into fundamental components that assist organizations in managing their environmental responsibilities and integrating environmental management into their overall business practices (Fonseca, 2015).

The 2015 revision of ISO 14001 introduces novel methodologies, including the consideration of organizational context and stakeholders, risk-based thinking, and a life cycle perspective. These updates are designed to enhance environmental performance and ensure greater compatibility with other management system standards, such as ISO 9001 (Laskurain et al., 2017; Fonseca, 2015). This revision represents a strategic shift toward a more comprehensive integration of environmental management into organizational practices, promoting improved sustainability outcomes (Kafel & Nowicki, 2023; Ejdys & Szpilko, 2022).

The adoption of environmental management systems, particularly ISO 14001, within healthcare institutions is essential for enhancing environmental performance and ensuring compliance with legal requirements. The challenges associated with adopting these systems suggest that a comprehensive approach must address both internal and external factors (Trisno et al., 2020; Perumal et al., 2012).

Implementing ISO 14001:2015 in healthcare organizations, therefore, presents a significant opportunity to improve environmental performance, meet legal obligations, and support sustainable development. Effective integration of these standards can ultimately contribute to a healthier environment and more efficient healthcare systems worldwide. Therefore, this study aimed to evaluate the environmental impact of hospital activities in Iraq by assessing compliance with ISO 14001:2015.

2. METHOD

This study examines the environmental practices of public and private hospitals in Iraq through field research and comparative methodologies. By understanding the environmental impacts associated with hospital activities and services, effective strategies can be developed to mitigate pollution and minimize its negative environmental impact.

To ensure the accuracy of the findings, a quantitative descriptive method has been employed. A critical aspect of this investigation involves evaluating ISO-based environmental criteria, specifically the ISO 14001:2015 standards. These standards serve as recognized benchmarks for assessing the environmental performance of hospitals. The study systematically documents and analyzes the current state of the EMS, with specific emphasis on the following seven clauses of ISO 14001:2015: organizational context, leadership, planning, support, operation, performance evaluation, and improvement.

According to Efendi et al. (2024), various methods exist for collecting research data on quality management systems (QMS) using the ISO 14001:2015 Internal Audit Checklist Self-Assessment Guide. These methods include field observations, structured interviews with knowledgeable participants, and the examination of organizational documents. The data collection techniques involved checklists, structured interviews with hospital administrators, direct observations, and analysis of relevant reports and documents from the Ministry of Health.

To achieve a comprehensive understanding of environmental practices within Iraq's healthcare system, this study utilizes a double case study methodology. The selected case studies include a public sector hospital (Hospital A) and a private sector hospital (Hospital B), facilitating a comparative analysis of environmental practices across these entities. The hospitals examined represent both sectors; however, their specific names have been withheld to maintain confidentiality. By focusing on these hospitals, the analysis aims to delineate the strengths and weaknesses of environmental management in both sectors. This approach is expected to provide valuable insights into the potential advantages of implementing a standardized framework, such as ISO 14001:2015, to promote a more sustainable healthcare system in Iraq.

The paper uses a quantitative descriptive methodology to evaluate hospital environmental conditions through checklists and structured interviews with key personnel (Efendi et al., 2024). Personal observations and analyses of relevant reports and documents from the Ministry of Health are included.

A central aspect is the use of ISO-derived questions as standardized criteria for evaluating environmental performance and identifying areas for improvement. The descriptive survey method includes on-site inspections/observations and a checklist based on ISO 14001:2015 (Efendi et al., 2024; Kojra et al., 2020). Data collection involves a comprehensive review of various documents, reports, and environmental policies to achieve a thorough understanding of the environmental practices implemented within the hospitals.

To evaluate adherence to ISO 14001:2015 standards, the authors used a seven-point scale to measure compliance with the ISO 14001:2015 framework (Al-Khatib, 2022; Resen & AbdulRazzaq, 2022). Each category within this scale is assigned

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Table 1. Example of how questions and answer options are presented in the questionnaire

Performance Evaluation						
9.2 ISO 14001:2015 Internal Audit						
9.2.1. Senior management is required to conduct internal audits of the EMS to determine the degree of conformity with the standard						
Conformity to ISO 14001:2015						
0	1	2	3	4	5	6
N-C+ Lack Docs						C + Ext Docs

a weight that ranges from zero, which signifies non-compliance and inadequate documentation, to six, which represents full adherence supported by comprehensive documentation. This scale incorporates various items (refer to Table A1) along with their respective weights, thereby providing a detailed evaluation of adherence. An illustration of the structure of the questions and answer options, formatted according to the Likert seven-point scale (0 to 6), is presented in Table 1.

The utilization of this scale established a systematic framework for the present investigation, which sought to evaluate the implementation of the ISO 14001:2015 standard. This standard encompasses ten primary requirements, three of which pertain to scope, normative reference, terminology, and terms and definitions (refer to Table A1). Consequently, the paper assessed both the degree of compliance and the extent of discrepancies for each specified fundamental aspect. Various indicators were computed for each relevant section to accurately quantify these measures. Thus, the data analysis methodology employed in quantitative descriptive research involves the following steps.

2.1. Measuring the weighted arithmetic mean

This statistical measure calculates the average value of a given dataset, considering the significance of each value. Unlike the arithmetic mean, the weighted mean allows for different weights for each data point and can provide a more nuanced analysis when certain values are more significant than others. To calculate the weighted arithmetic mean, the following equation is used:

$$\bar{x}_w = \frac{\sum_{i=1}^{N}\left(x_i \cdot w_i\right)}{\sum_{i=1}^{N} w_i}, \quad (1)$$

where $\bar{x}_w$ is the weighted arithmetic mean; x_i represents each individual value in the dataset; w_i is the weight associated with each value; N is the number of values in the dataset.

The weighted arithmetic mean is employed across various academic and research domains, including performance evaluation, financial analysis, and quality measurement. This metric provides a more accurate representation of the average when analyzing data that exhibit differing degrees of significance or influence.

2.2. The calculation of the matching percentage

This is a methodological approach utilized to evaluate the level of concordance or compliance between two sets of criteria, documents, or data points. This percentage acts as an indicator of the extent to which observed practices or documentation correspond with the stipulated requirements, particularly within the context of assessing conformity with standards such as ISO 14001:2015. Generally, this value is articulated as:

$$Calculating\ the\ Matching\ Percentage = \frac{\Delta\left(Number\ of\ Criteria\right)}{\Delta\left(Number\ of\ Criteria\ Met\right)} \cdot 100. \quad (2)$$

In this study, the Matching Percentage serves as a key indicator for assessing how closely hospital practices align with the ISO 14001:2015 standards, thereby providing a quantifiable measure of compliance.

2.3. Gap analysis

Gap analysis is an essential tool for identifying discrepancies between existing standards and organizational processes (Efendi et al., 2024; Utomo

et al., 2022). Its primary objective is to delineate the differences between an organization's current operational state and the requirements specified by the ISO 14001:2015 standard. Nurfida et al. (2020) and Wairon et al. (2018) argue that the gap analysis methodology is the most effective way to assess a company's status and identify opportunities for improvement in implementing ISO 14001. This methodology is crucial for uncovering gaps and disparities between current organizational circumstances and the desired state. Furthermore, the ISO 14001 Environmental Management System (EMS) is recognized as a systematic approach designed to identify environmental aspects and impacts while establishing clear goals and objectives (Campos et al., 2015; Seiffert, 2008). Consequently, in this study, the calculation is represented by the following equation:

$$\begin{aligned} &Gap\ size\ for\ each\ requirement \\ &= 1 - Percentage\ of\ conformity. \end{aligned} \quad (3)$$

3. RESULTS

Based on the established equations, the study evaluated conformity and assessed discrepancies related to each fundamental aspect. Several indicators were calculated for each section to quantitatively measure these metrics. The results for the sections of ISO 14001:2015 are presented as follows.

3.1. Section 4: Context of the organization

This element represents a contemporary prerequisite outlined in the ISO 14001:2015 standard. It signifies the alignment between the organizational context of Hospital A and Hospital B and the standard's specified requirements. This assessment evaluates four sub-axes to determine the level of alignment. The gap rate for these four axes reflects the disparity between the hospitals' current status and the desired level of compliance. Upon evaluating the internal and external factors influencing the implementation of this element, it was determined that Hospital A had a compliance rate of 36%, indicating a 64% gap between its current status and the standard requirements. In contrast, Hospital B demonstrated a higher compliance rate of 73%, with a smaller gap of 27%. This analysis provides a framework to enhance understanding of the organizational context and support compliance assessment. These findings underscore the need for both hospitals to address the identified gaps to improve their alignment with the ISO 14001:2015 standards, as indicated in Table 2.

Table 2. The size of the gap in Section 4: Context of the organization

No.	Section	The sub-sections	Gap ratio for Hospital A	Gap ratio for Hospital B
4	Context of the Organization	4-1	62%	29%
		4-2	66%	23%
		4-3	58%	22%
		4-4	69%	33%
Overall Gap Rate			64%	27%

3.2. Section 5: Leadership

The primary focus of this analysis is the EMS in hospitals, particularly the responsibilities of senior management in achieving desired outcomes. This study emphasizes the crucial role of active leadership and direct involvement from senior management in implementing the hospital's EMS. The paper also highlights the importance of precise documentation and effective execution of the EMS, as shown by the results. Hospital A demonstrated a conformity rate of 35%, reflecting a deviation of 65% from the established standard. In contrast, Hospital B exhibited a higher level of adherence, with a conformity rate of 71% and a deviation of 29%. These significant findings are presented in Table 3.

Table 3. The size of the gap in Section 5: Leadership

No.	Section	Sub-sections	Gap ratio for Hospital A	Gap ratio for Hospital B
5	Leadership	5-1	67%	33%
		5-2	74%	36%
		5-3	53%	17%
Overall Gap Rate			65%	29%

3.3. Section 6: Planning

ISO 14401:2015 standard was developed to identify and document environmental opportunities and risks within a hospital setting. It necessitates a comprehensive evaluation of the poten-

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tial benefits associated with these opportunities, in conjunction with strategies to mitigate any identified risks. The findings in this section provide valuable insights into the level of compliance with this requirement at Hospital A, which currently stands at 39%. This indicates a significant disparity of 61% between the actual level of implementation and the standard's requirements. Conversely, Hospital B demonstrates a higher compliance rate of 65%, resulting in a smaller gap of 35%. These results underscore the importance of systematically addressing environmental opportunities and risks in hospital operations. While Hospital B exhibits better adherence to this requirement, both hospitals have substantial room for improvement to ensure comprehensive documentation and management of environmental opportunities and risks in accordance with the ISO 14001:2015 standard. For further information, please refer to Table 4.

Table 4. The size of the gap in Section 6: Planning

No.	Section	Sub-sections	Gap ratio for Hospital A	Gap ratio for Hospital B
6	Planning	6-1	75%	44%
		6-2	42%	33%
		6-3	54%	27%
		6-4	79%	36%
Overall Gap Rate			61%	35%

3.4. Section 7: Support

The administration plays a critical role in the efficient allocation of resources within hospitals. This section provides an overview of this aspect. In Hospital A, the compliance rate with the established standard is 30%, indicating a significant 70% disparity between current resource allocation and standard requirements. In contrast, Hospital B demonstrates a higher compliance rate of 78%, reflecting a smaller 22% gap. These findings underscore the essential role of administration in resource management and highlight the importance of effective allocation to meet the demands of Emergency Medical Services. While Hospital B exhibits commendable adherence to this requirement, Hospital A must address the identified gap to achieve full compliance and ensure effective implementation of the standard, as illustrated in Table 5.

Table 5. The size of the gap in Section 7: Support

No.	Section	Sub-axes	Gap ratio for Hospital A	Gap ratio for Hospital B
7	Support	7-1	71%	12%
		7-2	62%	23%
		7-3	75%	19%
		7-4	71%	36%
Overall Gap Rate			70%	22%

3.5. Section 8: Operation

Hospital management plays a crucial role in the documentation and execution of environmental management plans within healthcare facilities. The objective of this study is to assess and analyze the extent of implementation and recording of these plans. In the case of Hospital A, a significant disparity of 78% exists between its current documentation and implementation of environmental management plans relative to the standard requirements, resulting in a compliance rate of only 22%. In contrast, Hospital B exhibits a smaller gap of 34% between its documentation and implementation of environmental management plans, achieving a compliance rate of 66%. These findings underscore the importance of thorough documentation and effective implementation of environmental management plans by hospital management. Although Hospital B demonstrates superior adherence to this responsibility, both hospitals must address the identified gaps to achieve full compliance with the ISO 14001:2015 standard. This is illustrated in Table 6.

Table 6. The size of the gap in Section 8: Operation

No.	Section	The sub-axes	Gap ratio for Hospital A	Gap ratio for Hospital B
8	Operation	8-1	74%	31%
		8-2	81%	36%
Overall Gap Rate			78%	34%

3.6. Section 9: Performance evaluation

The processes of monitoring, measurement, analysis, and evaluation were undertaken to assess compliance with and documentation of

environmental activities. The findings revealed that Hospital A attained a compliance rate of 26%, indicating a deviation of 26% from the established standards. Conversely, Hospital B exhibited a compliance rate of 74%, with a deviation of 29% from the standard requirements, as outlined in Table 7.

Table 7. The size of the gap in Section 9: Performance evaluation

No.	Section	Sub-axes	Gap ratio for Hospital A	Gap ratio for Hospital B
9	Performance Evaluation	9-1	67%	26%
		9-2	79%	29%
		9-3	76%	33%
Overall Gap Rate			74%	29%

3.7. Section 10: Improvement

ISO 14001:2015 standard mandates the implementation of preventive and corrective actions, necessitating concrete and thoroughly documented information. This process encompasses the identification of accountable individuals, the determination of the root cause, and the documentation of the effectiveness of the measures implemented. The findings indicate discrepancies of 71% in Hospital A and 37% in Hospital B, as illustrated in Table 8.

Table 8. The size of the gap in Section 10: Improvement

No.	Section	Sub-sections	Gap ratio for Hospital A	Gap ratio for Hospital B
10	Improvement	10-1	71%	37%
		10-2	74%	33%
Overall Gap Rate			73%	35%

In conclusion, evaluating the discrepancies between the primary and secondary elements of the standard enables the determination of the extent of disparity and the degree of adherence to the ISO 14001:2025 standard for each item. Furthermore, a comparative analysis may be conducted between Hospital A and Hospital B, as illustrated in Figure 1.

The implementation of 14001:2015 at Hospital A and Hospital B revealed significant disparities in compliance and performance. Hospital A exhibited substantial deficiencies across all assessed dimensions, specifically in organizational context, leadership, planning, support, operation, performance evaluation, and improvement. These shortcomings were primarily attributed to limited resources, inadequate infrastructure, and a lack of environmental awareness and expertise. In contrast, Hospital B demonstrated a higher level of compliance; however, it still faced challenges.

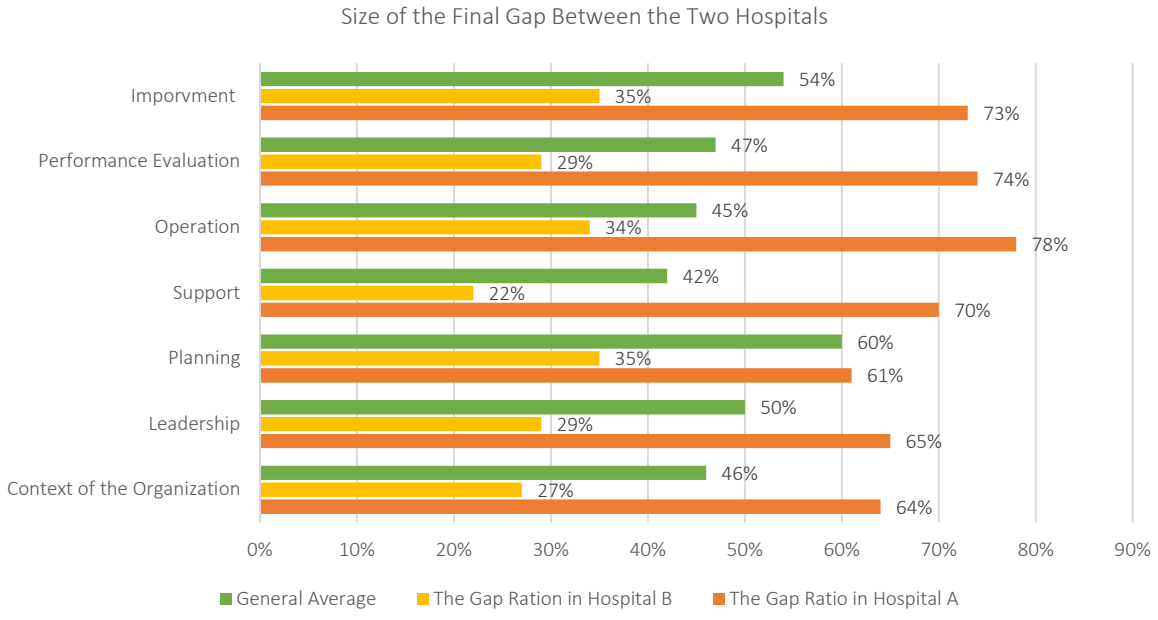

Figure 1. Size of the final gap in the research sample (Hospitals A and B)

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Notable gaps in leadership, planning, and performance evaluation indicate areas for improvement. Nevertheless, Hospital B excelled in resource utilization, waste management, and improvement initiatives. These findings underscore the complex nature of implementing environmental management systems in healthcare settings. Both hospitals would benefit from targeted interventions to address the identified deficiencies and enhance their overall environmental performance.

Based on the analysis of interviews and documentation from two hospitals, the study identified several factors contributing to non-compliance with the ISO 14001:2015 standards. The main issues include insufficient qualification of financial and HR personnel, lack of periodic compliance assessments, and inadequate methods for evaluating environmental performance. Additionally, there is a lack of effective leadership that does not prioritize environmental awareness and efficient resource use, as well as underdeveloped process documentation and a lack of tools for assessing environmental risks, which hinder standard implementation. Limited resources and inefficient management of them lead to higher costs and slow down improvement processes.

4. DISCUSSION

The research findings indicate significant differences in adherence to ISO 14001:2015 standards between public and private hospitals in Iraq. Private hospitals reported a compliance rate of 75%, while public hospitals achieved only 50%. These results align with earlier studies suggesting that private entities benefiting from greater financial resources and organizational independence are more adept at implementing EMS. For instance, Voinea et al. (2020) highlighted that resource limitations and outdated facilities significantly hinder EMS adoption in public hospitals, thereby supporting the outcomes of the current study. Public hospitals in Iraq, akin to their counterparts in other developing nations, face systemic challenges such as financial constraints, a lack of skilled personnel, and inadequate infrastructure, all of which obstruct effective EMS implementation.

The most significant deficiencies in public hospitals were identified in operation (78%) and improvement (73%), both of which are critical elements of ISO 14001:2015 that prior research has recognized as essential for successful EMS. Seifert (2018) noted that the absence of organized planning and a robust commitment to improvement diminishes hospitals' capacity to comply with environmental standards. This study identified inadequate operational planning and limited emphasis on continuous improvement in public hospitals as the primary reasons for their lower compliance rates. These observations corroborate findings from other studies that have identified these areas as common weaknesses in healthcare EMS (Fonseca & Domingues, 2018).

Leadership emerged as a pivotal element in this investigation. Public hospitals, characterized by their centralized and bureaucratic frameworks, demonstrated diminished leadership involvement in environmental management initiatives. This disengagement from upper management aligns with observations made by Chiarini and Vagnoni (2016), who posited that the effectiveness of environmental management systems (EMS) significantly relies on the proactive engagement of senior leaders. In contrast, private hospitals, which generally possess more adaptable organizational structures, exhibited a higher level of leadership commitment, leading to improved EMS outcomes. Nonetheless, it is noteworthy that even private institutions revealed a considerable deficiency in leadership and performance assessment, both at 29%, indicating that greater financial resources do not guarantee complete adherence to ISO 14001:2015 standards. As highlighted by Fonseca (2015), leadership dedication and a systematic approach to performance evaluation are essential for successfully incorporating EMS within healthcare settings, regardless of the institution's financial capabilities.

The effectiveness of private hospitals can be attributed to their improved resource management and operational independence. These institutions are better positioned to invest in sustainable environmental initiatives, attract specialized personnel, and adopt more flexible decision-making frameworks, facilitating alignment with ISO 14001:2015 standards. This financial agility enables private hospitals to implement changes and enhancements in their EMS more quickly, a trend that parallels observations in other industries where

financial resources and organizational independence are critical for successful EMS implementation (Waxin et al., 2023; Massoud et al., 2010). However, private hospitals still face challenges related to leadership and performance assessment, suggesting that financial resources alone do not ensure full compliance with environmental standards.

Furthermore, the study highlights systemic issues, such as inadequate resource distribution, low levels of environmental awareness, and insufficient leadership engagement, which are prevalent in both public and private healthcare facilities. These challenges underscore the urgent need for comprehensive policy reforms and a more organized strategy for EMS implementation within Iraq's healthcare sector. Waxin et al. (2019) posited that the implementation of an Environmental Management System (EMS) necessitates considerable organizational change, particularly within the domain of effective change management. The transformation of organizational cultures and structures presents significant challenges, with effective communication identified as a crucial factor for success. Moreover, insufficient communication from management has been recognized as a substantial obstacle to the successful execution of EMS (Daddi et al., 2011). Consequently, commitment and support from management are imperative; however, inadequate backing has been identified as a critical barrier (Waxin et al., 2023). The current findings support this perspective, indicating that public and private hospitals in Iraq face difficulties in embedding environmental management within their organizational culture.

Future research should prioritize expanding the sample size to encompass a broader range of hospitals from both the public and private sectors across diverse regions of Iraq. Such an expansion would enhance the generalizability of the findings and provide a more comprehensive understanding of EMS compliance within the nation's healthcare system. Furthermore, it would be beneficial to investigate the impact of specific policy interventions, such as government funding or regulatory measures, on the adoption of EMS in public hospitals, particularly in light of their resource limitations. Subsequent research could also examine the role of technology in facilitating EMS implementation, especially in resource-constrained environments. The integration of digital tools for environmental performance monitoring and operational optimization has the potential to significantly alleviate the burden on hospitals and improve compliance rates. Longitudinal studies are necessary to assess the long-term sustainability of EMS practices and their effects on environmental performance and operational efficiency. Finally, future research could explore alternative environmental management frameworks and compare their effectiveness to ISO 14001:2015, particularly in developing regions. This comparative analysis could inform the development of more adaptable and contextually relevant approaches to sustainability within healthcare settings.

CONCLUSION

The objective of this study was to evaluate the environmental impact of hospital operations in Iraq by examining compliance with ISO 14001:2015. The paper provides an in-depth analysis of the challenges and opportunities associated with adopting ISO 14001:2015 within hospitals across Iraq, highlighting notable discrepancies between public and private healthcare institutions. By exploring the operational dynamics involved in the implementation of environmental management systems (EMS) in both sectors, the study offers practical recommendations for enhancing environmental performance. The findings emphasize the significance of strong leadership, efficient resource allocation, and technological advancements in fostering sustainable healthcare practices. This analysis makes a valuable contribution to the existing body of literature on environmental management in the healthcare sector and lays the groundwork for future research and policy development aimed at advancing sustainability within Iraq's healthcare industry.

The study acknowledges several limitations that may impact the generalizability of the findings. The limited sample size, comprising only two hospitals, restricts the ability to extrapolate the results to the broader healthcare context in Iraq. Furthermore, the exclusive focus on ISO 14001:2015 may have

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neglected the influence of other environmental regulations and broader sustainability initiatives. Additionally, the lack of financial and operational data further constrained the scope of the economic analysis.

Subsequent studies should expand the sample size to include a more diverse range of hospitals across Iraq to enhance the generalizability and applicability of future research. Exploring alternative environmental management standards and assessing the long-term sustainability impacts of ISO 14001:2015 would provide valuable additional insights. Furthermore, investigating the role of governmental regulations and policies in shaping environmental management practices within the healthcare sector could offer a more comprehensive understanding of the current environmental management landscape.

The findings underscore the pressing need for targeted interventions to address the barriers hindering the effective implementation of environmental management systems (EMS) within Iraq's healthcare system. The study provides a comprehensive set of both theoretical and practical recommendations. Incorporating environmental management theories into hospital operations and the wider healthcare sector could yield important insights into enhancing compliance with ISO 14001:2015 and mitigating resource-related challenges. This paper also highlights the importance of implementing environmental sustainability measures and cost-effective strategies in both private and public healthcare settings. Additionally, it contributes to a deeper understanding of the systemic obstacles to achieving ISO 14001:2015 compliance, such as limited financial resources and insufficient infrastructure. This foundation is essential for developing effective systems and strategies that address these challenges and promote broader adherence to environmental management practices.

AUTHOR CONTRIBUTIONS

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APPENDIX A

Table A1. Overview of the ISO 14001:2015 requirements (Sections and sub-sections)

ISO 14001:2015			
No.	**Introductory Sections**		
1	Scope		
2	Normative References: There are no normative references for ISO 14001:2015		
3	Terms and Definitions: Terminology used throughout this standard comes directly from ISO 14001:2015, environmental management systems – Fundamentals and vocabulary		
Main Sections			
No.	**Sections**	**No.**	**Sub-Sections**
4	**Context of the Organization:** Considering Climate Change in ISO 14001:2015	4.1	Understanding the organization and its context in regards to ISO 14001:2015
		4.2	Understanding the needs and expectations of interested parties in ISO 14001:2015 EMS
		4.3	How to determine the scope of the EMS ISO 14001:2015
		4.4	Environmental Management System
5	**Leadership:** Top management is to demonstrate leadership and commitment, establish and communicate an environmental policy, and ensure responsibilities and authorities are assigned, communicated and understood	5.1	Leadership and commitment of EMS
		5.2	Environmental Policy of the EMS ISO 14001:2015
		5.3	Organizational roles, responsibilities, and authorities
6	**Planning:** Organizational Environmental Management System Planning to address organizational risks, opportunities, changes and quality objectives	6.1	Actions to Address Risk Associated with Threats and Opportunities (ISO 14001:2015 Risk Management)
		6.2	Environmental Objectives and Planning to Achieve Them
7	**Support:** Provide resource needs, ensure employees are competent and aware, and include documented information to support your environmental management system	7.1	Resources for EMS
		7.2	Competence
		7.3	Awareness of the EMS
		7.4	ISO 14001:2015 Communication
		7.5	Mandatory documents required by ISO 14001:2015
8	**Operation:** Plan and control processes needed to meet the requirements for products and services (Design and development, external providers, production and service provision, release of products and services, nonconforming outputs)	8.1	Organization's Operational Planning and Control for EMS
		8.2	Preparing and responding to emergencies
9	**Performance Evaluation:** Monitor, measure, analyze, and evaluate your environmental management system	9.1	Monitoring, Measurement, Analysis and Evaluation ISO 14001:2015
		9.2	ISO 14001:2015 Internal Audit
		9.3	Effective Management Review
10	**Improvement:** Select opportunities for improvement, act against nonconformities, implement corrective actions as necessary, and continually improve your environmental management system	10.1	General Requirements for Improvement
		10.2	Nonconformity and Corrective Action
		10.3	Continual Improvement ISO 14001:2015