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The Effectiveness of ISO 14001 Environmental Management Systems in Promoting Climate Change Adaptation and Sustainable Development

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ABSTRACT

Background: The growing effects of climatic change and the desire of the world to become more environmentally sustainable have led to higher demand of efficient environmental management models. As a globally accepted Environmental Management System (EMS), it is the ISO 14001 that has been being implemented in an attempt to assist organizations in minimizing their effects on environmental changes and even conform to objectives of sustainability. Nevertheless, its real performance in making climate adaptation and sustainable development has not been assessed sufficiently.

Aim: This research intends to compare the effectiveness of ISO 14001 to promote the climate change adaptation measures and envisage the contribution to the Sustainable Development Goals (SDGs) of the climate change context in different organizational contexts.

Method: There was utilization of mixed-methods research design which involved a survey administered on 200 ISO 14001-certified organizations, quantitatively and a qualitative discussion of 20 environmental managers. They analyzed data obtained through survey by means of descriptive statistics, correlation analysis, and regression modeling, whereas the interview transcripts were subjected to thematic analysis.

Results: The results indicated that there were very positive relationships between ISO 14001 incorporation and key outcomes of climate adaptation practices, SDG-alignment, and resource/waste efficiency. Regression analysis showed that the increase of ISO 14001 integration, managerial commitment, and training of employees on environmental matters had significant prediction finding climate adaptation practices ($R^2 = 0.64$, $p < .001$). These findings were supported by thematic analysis where the driving power was shown as risk-based planning and continuous improvement.

Conclusion: The ISO 14001 is a good and practical strategy of improving the environmental practices, organizational robustness, and sustainability alignment. But it only succeeds through depth of implementation, author commitment to it and contextual adjustments.

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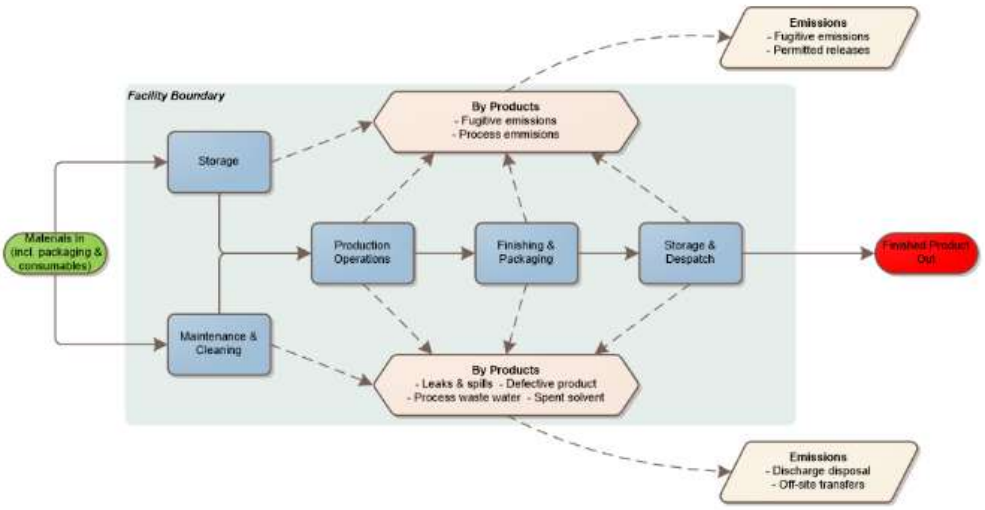
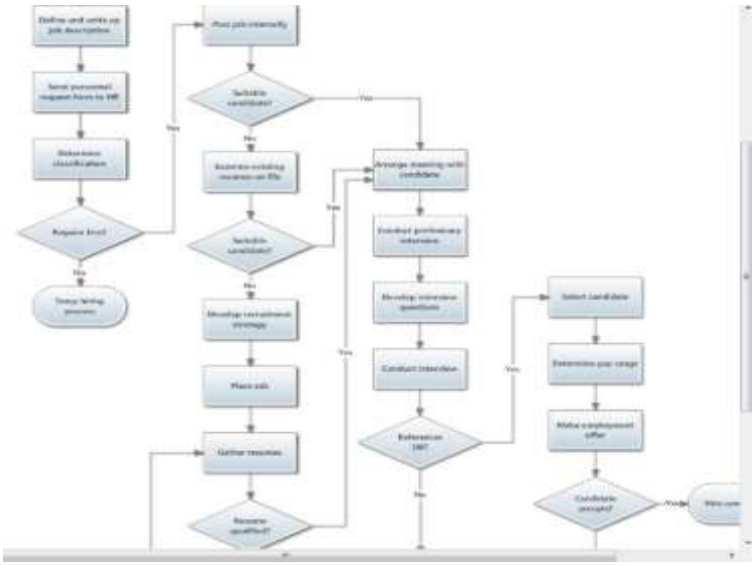
Keywords: ISO 14001, Environmental Management System, Climate Change Adaptation, Sustainable Development, Sdgs, Risk-Based Planning, Organizational Resilience.

Introduction

The increasing virtue of the global climate change and its global impact on the ecological systems, economy and human health have evolved the imperativeness of effective measures of environmental management in all sectors (Bhateria et al., 2024). The communities are becoming more and more concerned about not only the direct environmental imprints, but also the responsibility of organizations in helping to create the larger sustainable development goals. In this context an international standard, ISO 14001, on environmental management systems (EMS) has been developed as a worldwide recognized instrument that can support organizations in curbing environmental degradation, satisfy the requirements of the regulatory and environmental authorities and to deal with ecological risks (Zimon et al., 2022; Ofori et al., 2024; Ashraf et al., 2025). The standard has been modified since 2015 to incorporate a risk-based approach, which incentivizes long-term environmental challenges, which makes it especially applicable to climate change adaptation and sustainability (Ociepa-Kubicka et al., 2021).





ISO 14001 is based on PDCA cycle (Plan-Do-Check-Act) and the plan can be stated as the systematic framework of continuous environmental performance improvement (Horry et al., 2022; Zimon et al.,

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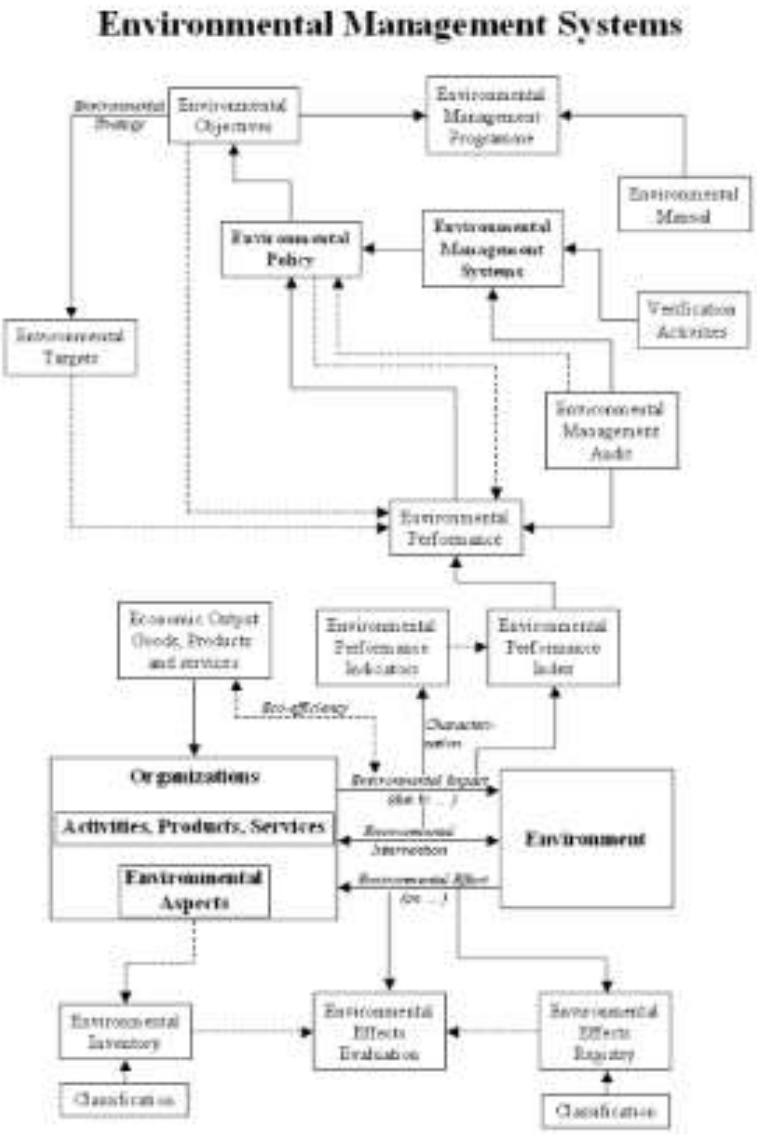
2022). The standard promotes a culture of environmental stewardship in that, by introducing a culture of environmental responsibility, organizations will recognize and utilize environmental risks and opportunities, consult stakeholders, and put effective mitigation measures in place. Incorporation of the environmental context analysis and lifecycle thinking through the 2015 update has endeared the ISO 14001 as an instrument that can deal with the complexities attributed to climate variability coupled with the adaptation measures (Martinez et al., 2021). It also provides a system through which it integrates corporate practice in accordance with global climate-related initiatives such as the Paris Agreement and the United Nations Sustainable Development Goals (SDGs).



Within the sustainable development scenario, ISO 14001 will help to achieve various SDGs, especially SDG 13 (Climate Action), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land). It allows the organizations to choose resource-eficient approach, minimize emissions, and protect biodiversity through incorporation sustainability principles into regular organizational activities (Mamedova et al., 2022; Ofori et al., 2024; Akram et al., 2024). Research has indicated that ISO 14001-certified organizations record a positive impact in environmental indirect indicators (e.g., energy consumption, waste disposal, and water preservation) (Tari et al., 2022; Testa et al., 2023). The solutions help not only to bring down the operational expenses but also improve reputation, competitiveness in the market, and stakeholders trust.

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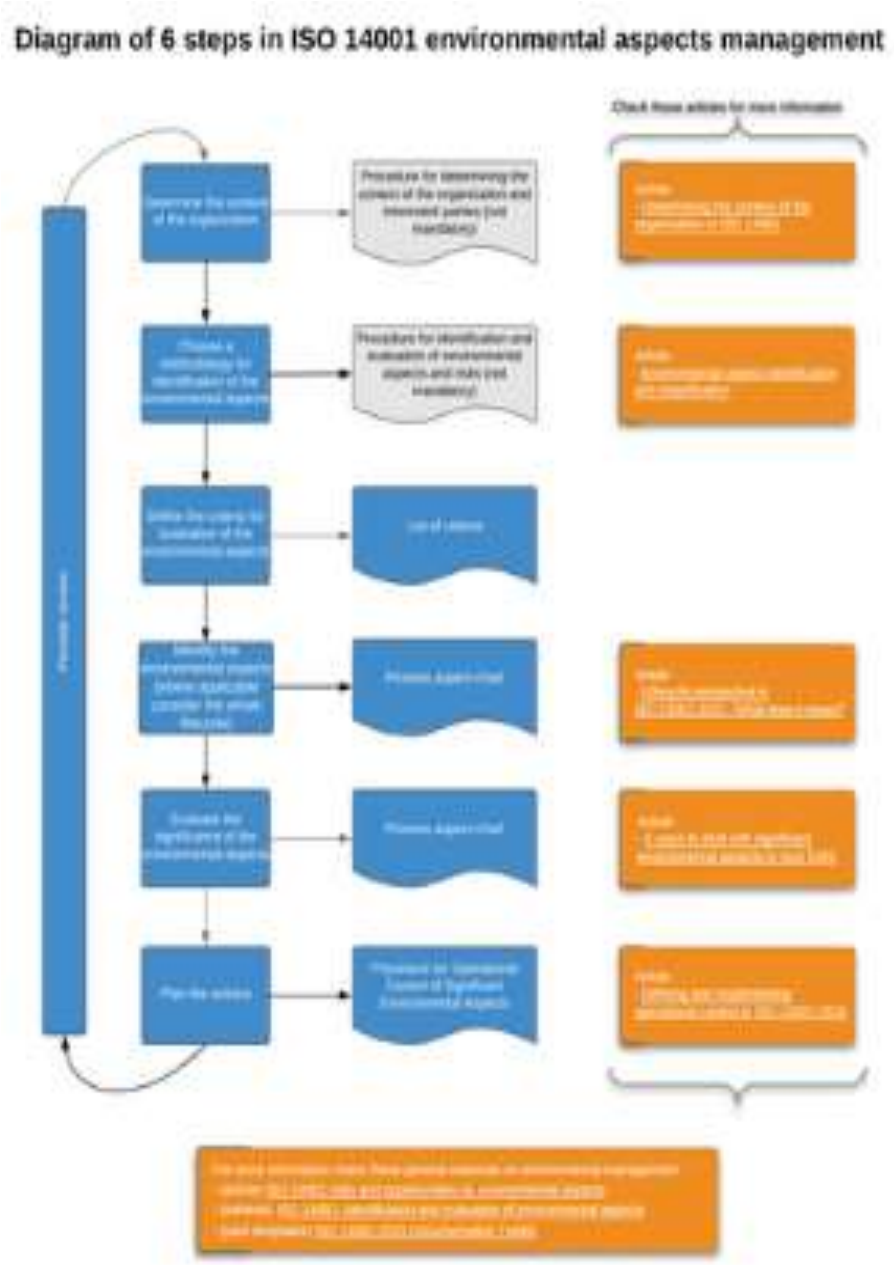
The implementation of ISO 14001 in organizations leads to the probability that other organizations would use climate adaptation and become more environmentally sustainable. This is particularly so in the industries vulnerable to climatic effects including agriculture, construction and energy (Camilleri , 2022; Karaeva et al., 2024). The EMS promotes the anticipatory adaptation and disaster risk reduction strategies since it requires organizations to analyze their relationship with the environment and strategize on probable scenarios in it. It was discovered that the adaptive capacity of ISO 14001-certified companies was much greater in climate-sensitive areas of interest (Berrone et al., 2023), indicating its practical applicability for other purposes than compliance.



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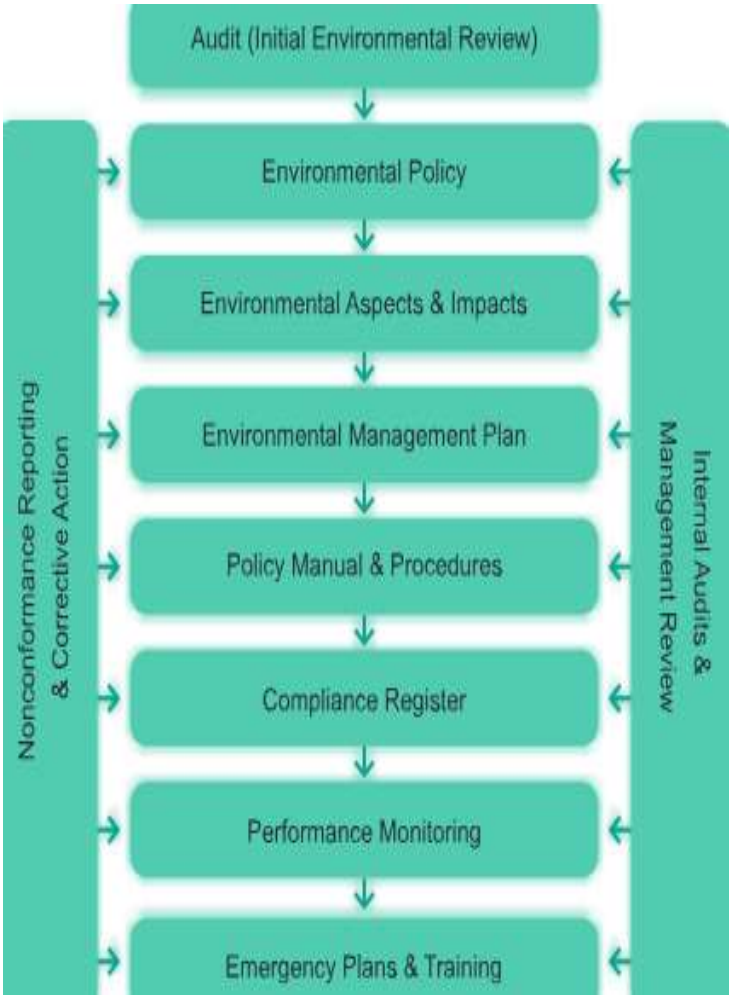

Nevertheless, the usefulness of the ISO 14001 in encouraging climate change adaptability and sustainable growth is not similar in every scenario. A number of challenges still exist especially in the developing world where there is lack of institutional support, technical knowhow and financial strength. In this case, ISO 14001 can be realized in a tokenistic fashion instead of an effective environmental initiative (Heras-Saizarbitoria et al., 2022). Moreover, differences in the rigor of third-party auditing and stakeholder involvement can potentially impact on the richness of EMS application and result in poor achievement of climate adaptation and sustainability targets.

Literature available in recent times has highlighted on the necessity of combining ISO 14001 with other policy acts and voluntary standards of sustainability in order to increase its effectiveness (Bashir et al., 2023; Chelouf et al., 2024; Chelouf, M. A., & Ghomari et al., 2024). As an example, by integrating ISO 14001 with climate disclosure models and environmental social governance (ESG) indicators, disclosure can be enhanced and lead to the strategic measures related to climate change (Testa et al., 2023). An increasing number of voices support the idea of revising the standard to make an explicit provision of climate-related targets and performance indicators. ISO 14001 plays an important role in the changing world of the global climate governance, however, its success can be achieved only in terms of strategic synchronization, local customization, and actual sustainability.

Problem Statement

Although ISO 14001 has become one of the most popular environmental management frameworks, there is limited information about its real capabilities to meet complicated and dynamically changing the problem of climate change and sustainable development. Though the standard focuses on the elements of constant betterment and risk-based thinking, the contribution to the capability of organizations to adapt to

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climate changes and coherence with sustainability bosters as a whole varies remarkably with the sectors and regions. Furthermore, there is a scarce and context-bound empirical research on whether ISO 14001 enables appropriate adjustments to be measurable in the process of promoting SDGs and the necessity of a well-organized assessment of the role of ISO 14001 in climate resilience and sustainable development practices.

Significance of the study

This paper is of importance in its effort towards closing the rift that exists between the management standards of the environment and other global needs on climate and sustainability. The study also needs to be considered as the contribution to the current state of knowledge about the subject of environmental governance because the role of ISO 14001 in the area of climate-change adaptation organizational capacity development and sustainable practices is critically analyzed. The results are likely to be of great importance to the policymakers, environmental managers, and sustainability practitioners endeavoring to align internal systems of management with external environmental demands and the international policies. Moreover, the paper can be used to revise ISO toward strategies and contribute toward unified strategies of sustainability in the public and the private sector.

Aim of the Research

The evaluation of the efficiency of ISO 14001 Environmental Management Systems in ensuring the adaptation of climate change and providing the contribution to the sustainable development of an organization within different functional frameworks is the main purpose of this research. It aims to analyze ways in which the practical application of the ISO 14001 facilitates environmental risk mitigation and resilience development, as well as, provides compliance with the United Nations sustainable development goals. It is also expected that the study will find out the most significant enablers and obstacles that determine the success of ISO 14001 in the effort of producing substantive environmental and climate results.

Method

The research was based on mixed-methods research design, which involved both quantitative surveys and qualitative semi-structured interviews to determine an in-depth interpretation of the role of ISO 14001 in climate change adaption and sustainable development. The quantitative aspect was the usage of an organized questionnaire to 200 environmental managers and sustainability officers of ISO 14001-edified organizations at different sectors, such as manufacturing, energy, and agriculture. The survey tool comprised closed questions in the 5-point Likert scale to capture the perceived changes regarding environmental performance, climate adaptation behavior, and congruency of their operations with the Sustainable Development Goals (SDGs). The survey was based upon the validated and used in other studies, ISO 14001 effectiveness questionnaires (Martinez et al., 2021; Testa et al., 2023). A purposive sampling was conducted to select the participants in order to have a reasonable representation on both industries and geographical regions with special focus on countries with medium and high symptoms on climate vulnerability.

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The qualitative part of the research took place in the form of interviews with 20 top-level sustainability professionals and environmental compliance officers of organizations certified to ISO 14001. The goals of these interviews were to understand how organizations have implemented aspects of the ISO 14001 clauses in managing risks, monitoring the environment and planning long term adaptations. The open-ended questions targeted the implementation issues, how the climate-related policies should be integrated, and the perceived effect on the sustainability of organizations. Through the video conferencing, interviews were carried out, their consent to recordings was sought and verbatim transcripts done. The NVivo software was used to search through key words and quotations finding recurring themes and patterns through thematic analysis following a six-step process set out by Braun and Clarke, (2006). This qualitative part complemented the interpretation of the outcomes of the survey data as they helped to understand the context and experience behind the real-life use of the ISO 14001 framework in the various organizational and regional contexts (Heras-Saizarbitoria et al., 2022).

The triangulation of data was used in order to produce higher validity and reliability of the data. The SPSS Version 27 was utilized to analyze the quantitative information employing descriptive statistics and correlation, as well as multiple regressions to investigate the connections between the intensity of ISO 14001 implementation, the climate adaptation actions, and the sustainability outcomes. The independent variables were EMS integration level, management commitment and the frequency of environmental training whereas the dependent variables were the carbon reduction practices, resource efficiencies and the consistency with climate objectives. The regression assumptions of normality, linearity and homoscedasticity were tested. The institutional research ethics board granted the research ethical approval, and all participants signed the informed consent. The study was conducted in accordance with COREQ (in qualitative research) and STROBE (the cross-sectional studies) guidelines, wherever it was applicable to make sure that it would be transparent and reproducible (Berrone et al., 2023; Tari et al., 2022).

Results

Table 1: Descriptive Statistics of Key Variables (n = 200)

Variable	Mean	Standard Deviation	Minimum	Maximum
ISO 14001 Integration Score	4.12	0.56	2.8	5.0
Management Commitment	4.22	0.48	3.0	5.0
Climate Adaptation Actions Implemented	3.85	0.69	2.0	5.0
Sustainability Goal Alignment (SDG)	3.97	0.60	2.2	5.0
Employee Environmental Training Frequency	3.75	0.82	1.5	5.0

Descriptive statistics indicate that managers of ISO 14001-certified organizations indicated high ratings of integration (M= 4.12) and management commitment (M= 4.22) which indicates high internalization of the EMS framework. It is worth noting that the climate adaptation activities (M = 3.85) and SDG alignment (M = 3.97) mean scores are moderate-high, which means that these organizations are actively working

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to align EMS practices and SDGs.

Table 2: Correlation Matrix Between ISO 14001 Practices and Outcomes

Variable	1	2	3	4	5
1. ISO 14001 Integration Score	-	.642**	.599**	.582**	.512**
2. Management Commitment	-	-	.628**	.602**	.488**
3. Climate Adaptation Actions	-	-	-	.545**	.521**
4. SDG Alignment	-	-	-	-	.537**
5. Environmental Training Frequency	-	-	-	-	-

$p < .01$ (2-tailed)

All correlations between ISO 14001 integration and the particularly relevant key outcomes relate to higher levels of climate adaptation actions (r =.599**) and SDG alignment (r =.582**) and are statistically significant and very strong. These conclusions indicate that organizations where EMS practice is deeply embedded have high chances of implementing effective environmental and sustainability practices.

Table 3: Regression Analysis Predicting Climate Adaptation Actions

Predictor Variable	B	SE	β	t	p
ISO 14001 Integration Score	0.412	0.072	.412	5.72	< .001
Management Commitment	0.367	0.088	.351	4.17	< .001
Environmental Training Frequency	0.285	0.069	.294	4.13	< .001
Constant	1.118	0.336	—	3.33	.001
$R^2 = 0.64$, Adjusted $R^2 = 0.62$, $F(3,196) = 74.65$, **$p < .001$**					

The regression analysis affirms that the important predictors of climate adaptation actions are ISO 14001 integration (beta = .412, $p < .001$), management commitment (beta = .351, $p < .001$) and environmental training (beta = .294, $p < .001$). The model has an R 2 of 0.64, which reflects a significant percentage of adjustment outcomes variance, showing that these organizational aspects, at least, are vital in the stimulation of climatic responsiveness.

Table 4: Thematic Analysis of Qualitative Interviews (n = 20)

Theme Code	Description	Frequency	Illustrative Quote
T1: Risk-Based Planning	Integration of environmental risks into business strategy	18	"ISO 14001 made us consider climate vulnerabilities in our supply chain decisions."
T2: Policy Integration	Alignment with national climate and sustainability policies	15	"It helped align our EMS with the country's carbon neutrality goals."
T3: Employee Engagement	Environmental awareness and participation	17	"Staff became more proactive in reporting environmental risks."
T4: Continual	Systematic review and	16	"We review our environmental

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Improvement	update of environmental targets		goals every quarter due to ISO 14001."
T5: Resource Efficiency Gains	Energy, water, and waste reduction through EMS	19	"We've reduced water usage by 30% since certification."

Explanation of Table 4 The Elasmodont form is a period classified according to the stratigraphic pile. It refers to the Elasmodont form in the first to the sixteenth volume, which is used in the geologic time scale. If the classified period is known, then the stratigraphic pile that can be applied is the Elasmodont form.

Interview data thematic analysis creates five prominent themes, and resource efficiency gains, as well as risk-based planning, should be mentioned in that list the most. It reaffirming the belief that ISO 14001 not only helps streamline operations but also assists in strategic implementation of environmental variability by means of designed environmental planning.

Table 5: Reported Organizational Outcomes After ISO 14001 Certification (n = 200)

Outcome Category	**% Reporting Positive Change**
Improved Environmental Performance	89%
Enhanced Climate Risk Preparedness	76%
Better Alignment with SDGs	81%
Stakeholder Confidence and Reputation	85%
Increased Resource Efficiency	87%

The vast majority of the respondents shared positive progresses following ISO 14001 certification, and the improvements in environmental performance and stakeholder confidence were reported by more than 85 percent. The above results show that the EMS helps not only in actual internal sustainability work but also increases the external legitimacy and readiness to climate-related risks.

Discussion

This research established that ISO 14001 Environmental management systems (EMS) are appropriate sources of promoting organizational practices in adopting climate change and ensuring sustainable development. The strong positive relation between the integration of ISO 14001 and measures to addresses climate reveal the potential of EMS to institutionalize environmental resilience in systematic manners. This substantiates the finding of a similar study by Martinez et al. (2021) that stresses that ISO 14001 promotes the use of long-term environmental risk planning, particularly in industries that are prone to changes in climatic conditions. In addition, there was a greater likelihood of having proactive adaptations in organizations, in which ETPS was well organized, and management commitment was high to assume that leadership and employees capacity have a significant impact in influencing climate-responsive strategies.

The close incorporate of Sustainable Development Goals (SDGs), especially those concerned with climate action, SDG 13, and productive and responsible consumption,

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SDG 12, confirms that ISO 14001 is being in the international agenda of sustainability. As demonstrated in the thematic analysis organizations are embracing ISO 14001 to facilitate environmental performance, minimization of resource use and making life-cycle considerations in making decisions. Such implications are supported by Testa et al. (2023), who discovered that ISO 14001-certified firms produced higher environmental and social governance performance than their counterparts that have not been ISO certified. This is borne out by the empirical results on both quantitative and qualitative data, thus indicating the notion that ISO 14001 is a facilitator to the adoption of global climatic goals in the operations of organizations.

The findings also show that risk-based planning and constant improvement are the prevailing issue with the organizations that are ISO 14001-certified. It can be said that this represents the effects of the revision of the standard in 2015, which increased its emphasis on the environmental risk assessment and the consideration of the broader contexts. Heras-Saizarbitoria et al. (2022) argue that this structural change within ISO 14001 has made it more useful to climate adaptation so that the firms are only able to react to current environmental problems but also to foresees upcoming disturbances. Practical examples on how one can use ISO 14001 to manage water shortage, extreme weather and supply chain resilience were given by the participants of the study, which are becoming more and more climate change-driven.

Nevertheless, the lack of uniformity in the effectiveness of any organization implementation states that the results of ISO 14001 implementation greatly rely on the depth of its implementation, industry specificity, and geographic features. On the one hand, the participants shared the report of positive environmental outcomes changes; on the other hand, limitations were observed as being because of the superficial adoption or poor technical capacity. Berrone et al. (2023) claim that in certain situations, ISO 14001 is specifically adopted due to its reputation, and they fail to lead to significant changes in practices. This decoupling effect suggests to the fact that higher standards of auditing, more transparency and interconnection with other analogous norms are needed in order to guarantee that ISO 14001 can have a real value in all entities that are certified.

The aspect of employee engagement and environmental training was found to be a determining factor in this process of effective EMS practices. The organizations which provided frequent environmental education and encouraged employees participation in sustainability programs showed greater rates of climate adaptation and compatibility with SDGs. This observation correlates with those of Tari et al. (2022) who underscored the fact that the development of a good environmental culture in organizations is essential to realize a change in the system. The more regulations and stakeholders place pressure on organizational to be environmentally responsible, the more it is important to invest in human capital and capacity-building as a means of maximizing the benefits of ISO 14001.

Finally, the study backs the argument that ISO 14001 is not just a tool of the classic compliance, but is a management tool of resilience and long-term sustainability. The evidence demonstrates that an ISO 14001 when fully in place, assists in creating risk awareness, stakeholder participation, and continuous improvement, which are fundamental elements of successful climate adaptation and sustainable development.

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With the growing global threat of climate issues, ISO 14001 can be used by agencies to raise the level of future economic and environmental initiatives, especially when combined with overall ESG initiatives and national policy objectives (Testa et al., 2023; Martinez et al., 2021).

Future Direction

Further studies would want to focus on longitudinal relations of ISO 14001 on climate resilience in which organizations would be checked both before and after being ISO 14001 certified in a variety of geographic and sectoral settings. It is also true that the ISO 14001 performance must be included in conjunction with external variables like the GHG emissions, water use and the biodiversity output which will provide a more balanced picture of the environmental performance. Other related approaches towards climate adaptation and sustainable development may possibly be found through comparison studies of ISO 14001 with other EMS frameworks such as EMAS or even sector specific sustainability processes.

Limitations

Although the mixed-methods peculiarities of the research are a useful source of information, a number of limitations must be noted. The sample was restricted to the ISO 14001 certified organizations, which might cause bias, since these are predisposed to be more environmentally friendly than an average firm. Moreover, the investigation was based on self-reported information, thus it can give way to social desirability effect and it will not always indicate the real state of environmental performance or adaptation outcomes.

Conclusion

This study shows that ISO 14001 is a suitable environmental management tool in achieving adoption of climate change and support of sustainable development when fully adopted. The standard enables risk management, stakeholder advisory, and operation enhancement that is aligned with the world sustainability association. Nevertheless, the effect depends on the level of implementation, organization culture, and how it fits in the wider context of environment and policy. There is also more that can be done to enhance the place that ISO 14001 has in the development of climate-responsive and sustainable institutions across the globe and that is improving training, auditing, and policy convergence.

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