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INTEGRATING CLIMATE CHANGE INTO HIGHER EDUCATION QUALITY MANAGEMENT SYSTEMS: AN APPLIED ISO 9001:2015/AMD 1:2024 IMPLEMENTATION FRAMEWORK

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ABSTRACT

The climate crisis is a multidimensional issue with environmental, social, and institutional impacts, requiring governance-based and systematic approaches across all sectors, including higher education. The multifaceted effects of the climate crisis necessitate that universities make an effective contribution to achieving sustainability and institutional resilience goals. However, the integration of climate change into current quality management systems remains insufficient. This study presents an analytical examination of the integration of the ISO 9001:2015/Amd 1:2024 standard—which obliges organizations to assess the impacts of their activities on climate change—into quality management systems within higher education. Through the mapping of standard clauses with higher education processes

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and the assessment of relevant literature, a process-oriented and education-based implementation framework is proposed for universities. The examination reveals that climate change components should be integrated into quality policies, stakeholder engagement, risk–opportunity analysis, monitoring of learning outcomes, and continuous improvement processes. This integration has the potential to strengthen institutional adaptability, sustainability governance, and the professional development of academic staff. The updated provisions of the standard offer a practical and governance-oriented pathway to enhance environmental accountability, improve energy efficiency, and reinforce education planning with a high capacity for adapting to climate impacts in universities. Thus, quality management systems evolve from being merely administrative tools into strategic mechanisms that support climate-oriented institutional transformation. This study contributes to academic discussions on aligning quality assurance systems with climate governance and provides strategic recommendations for policymakers and higher education leaders to institutionalize climate-responsive management practices.

Keywords: ISO 9001:2015/Amd 1:2024, quality management systems, climate change, higher education institutions, sustainability, learning outcomes.

İKLİM DEĞİŞİKLİĞİNİN YÜKSEKÖĞRETİM KALİTE YÖNETİM SİSTEMLERİNE ENTEGRASYONU: ISO 9001:2015/AMD 1: 2024'E DAYALI UYGULAMALI BİR ÇERÇEVE

ÖZ

İklim krizi, yükseköğretim dâhil tüm sektörlerde yönetişim temelli ve sistematik yaklaşımlar gerektiren; çevresel, sosyal ve kurumsal etkileri bulunan çok boyutlu bir sorunsal niteliğindedir. İklim krizinin çok boyutlu etkileri, üniversitelerin sürdürülebilirlik ve kurumsal dayanıklılık hedeflerine etkin biçimde katkı sunmasını zorunlu kılmaktadır. Ne var ki, iklim değişikliğinin kalite yönetim sistemlerine entegrasyonu hâlâ yetersizdir. Bu çalışma, kuruluşların faaliyetlerinin iklim değişikliği üzerindeki etkilerini değerlendirmesini zorunlu kılan ISO 9001:2015/Amd 1: 2024 standardının yükseköğretim kalite yönetim sistemlerine entegrasyonuna yönelik analitik bir inceleme sunmaktadır. Standart maddeleri ile yükseköğretim süreçlerinin eşleştirilmesi ve konuya ilişkin literatürün değerlendirilmesi yoluyla, üniversiteler için süreç odaklı ve eğitim temelli bir uygulama çerçevesi önerilmektedir. Yapılan inceleme, iklim değişikliği unsurlarının kalite politikalarına, paydaş katılımına, risk–fırsat analizine, öğrenme çıktılarının izlenmesine ve sürekli iyileştirme süreçlerine entegre edilmesi gerektiğini ortaya

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koymaktadır. Bu entegrasyonun; kurumsal uyum kapasitesini, sürdürülebilirlik yönetişimini ve öğretim elemanlarının mesleki gelişimini güçlendirme potansiyeli bulunmaktadır. Standardın güncellenmiş hükümleri, üniversitelerde çevresel hesap verebilirliğin artırılması, enerji verimliliğinin geliştirilmesi ve iklim etkilerine uyum kapasitesi yüksek eğitim planlamasının güçlendirilmesi için pratik ve yönetişim odaklı bir yol sunmaktadır. Böylece kalite yönetim sistemleri, yalnızca idari bir araç olmaktan çıkarak iklim odaklı kurumsal dönüşümü destekleyen stratejik bir mekanizma niteliği kazanmaktadır. Bu çalışma, kalite güvence sistemlerinin iklim yönetişimi ile uyumlandırılmasına yönelik akademik tartışmalara katkı sağlamakta ve iklim duyarlı yönetim uygulamalarının kurumsallaştırılması için politika geliştiricilere ve yükseköğretim yöneticilerine stratejik öneriler sunmaktadır.

Anahtar Kelimeler: ISO 9001:2015/Amd 1: 2024, kalite yönetim sistemleri, iklim değişikliği, yükseköğretim kurumları, sürdürülebilirlik; öğrenme çıktıları.

INTRODUCTION

The climate crisis represents a multidimensional, urgent, and difficult-to-reverse set of impacts caused by anthropogenic changes in the global climate system, affecting ecosystems, social structures, and economic systems. Scientific evidence demonstrates that the increase in greenhouse gas emissions—primarily from fossil fuel consumption, land-use change, and industrial activities—has led to atmospheric warming, more frequent and severe extreme weather events, rising sea levels, and biodiversity loss (IPCC, 2023). In this context, the climate crisis is not only an environmental problem but also a systemic risk domain with social, economic, and institutional dimensions that directly influence governance and policy-making processes (Li, Wang, Zhao and Qi, 2021).

Higher education institutions (HEIs), as both centres of education and research and large organizational actors, play a critical role in achieving environmental sustainability goals (Madzík, Budaj and Chocholáková, 2018). From the perspective of HEIs, the climate crisis encompasses both physical risks (such as the exposure of campus infrastructure to climate-related hazards) and transitional risks (including compliance with policy and regulatory requirements and the management of institutional reputation).

Universities contribute to environmental sustainability through diverse activities ranging from energy consumption and waste management to curriculum design and strategic planning. These contributions, however, must be structured not only at the implementation level but also through institutional management systems. Therefore, integrating climate change strategies into quality management systems (QMS) is essential for enabling universities to take systematic steps toward adaptation and mitigation within their academic and administrative processes (Denham, Stokes and Rickards, 2025; Clarke and Kouri, 2009).

In this direction, one of the primary responsibilities of HEIs is to ensure that sustainability goals are translated into measurable outcomes in education, research, and community engagement. Quality management systems have the potential to support the improvement of student learning outcomes, the enhancement of teaching competencies, and the strengthening of stakeholder-centred governance models when aligned with climate-related targets. Thus, integrating quality management practices with climate-focused higher education policies has become critical for moving from awareness to action (Bui, Bui and Pham, 2024).

International standards and sustainability-oriented management systems serve as strategic instruments for minimizing environmental impacts, improving sustainability performance, and enhancing systematic management capacity (Tarí, Molina-Azorín and Heras, 2012; Ferreira, Poltronieri and Gerolamo, 2019**)**. In this context, the ISO 9001 Quality Management System and the ISO 14001 Environmental Management System play complementary roles in structuring institutional capability in both managerial and environmental dimensions (Ludușanu, Fertu, Tinică and Gavrilescu, 2025; Tarí et al., 2012). While ISO 14001 focuses on the systematic management of environmental impacts, ISO 9001 aims to enhance the effectiveness of operational processes through quality assurance, continuous improvement, and stakeholder satisfaction (ISO, 2024a; ISO, 2015). However, studies addressing the integration of these two standards—particularly in relation to active climate change governance—remain limited (Ludușanu et al., 2025). This gap highlights the inadequacy of traditional quality systems that overlook the multidimensional nature of climate change,

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making them insufficient for contemporary environmental and educational needs (Ferreira et al., 2019).

A major change has occurred with ISO 9001:2015/Amd 1:2024. With this amendment, organizations are now expected to evaluate the effects of their activities on climate change, analyse these effects within their strategic context, and consider the expectations of relevant stakeholders accordingly (ISO and IAF, 2024). The inclusion of climate change in ISO 9001 enables the explicit incorporation of environmental concerns into quality management processes, creating a stronger link between environmental management (ISO 14001) and educational quality assurance (ISO and IAF, 2024). For HEIs, this amendment provides a mandatory framework for embedding sustainability principles into curriculum development, assessment of learning outcomes, teaching-learning processes, campus operations, and strategic management systems. (Tutko and Woźniak, 2023; Leal Filho, Salvia, Frankenberger, Akib, Brandli, Disterheft, Olooto, and Kovaleva, 2021).

Although the relationship between quality management and sustainability has received increasing academic attention in recent years, research on the contribution of ISO 9001 to environmental sustainability remains scarce (Ozsen, Uslu and Aypay, 2023; Tarí, 2012). Existing literature in HEIs primarily focuses on accreditation, administrative efficiency, or stakeholder satisfaction, often neglecting environmental sustainability and its implications for teaching, learning, and student development (Singh, Meena, Khandelwal, and Dangayach, 2023). Therefore, there is a need for systematic, institutional, and holistic frameworks that connect quality management with climate-focused transformation in the education sector (Tarí, 2012).

This study provides an applied review that examines the requirements of ISO 9001 related to climate change within the context of higher education institutions and presents general principles and implementation recommendations. Specifically, the study analyses how the relevant clauses of ISO 9001 can be integrated into educational processes, academic support services, and institutional governance mechanisms, and offers practical implementation guidance through documentation requirements, process

scopes, and illustrative structures. Rather than focusing on a single institution, this approach is designed for broad applicability across diverse higher education settings, aiming to guide both policymakers and quality management practitioners.

With this perspective, the study contributes to the literature by addressing a critical gap at the intersection of quality management, climate change governance, and environmental sustainability in higher education institutions. While previous studies have largely examined quality assurance systems and sustainability initiatives separately, limited attention has been given to their systematic integration within an ISO 9001–based management framework. By explicitly embedding climate-related requirements into institutional context analysis, stakeholder engagement, risk management, and continuous improvement processes, this study provides one of the first comprehensive models that operationalizes climate-responsive quality management for HEIs. The proposed framework therefore offers not only a conceptual contribution but also a practical and transferable roadmap that supports institutional performance, educator development, and student learning outcomes through a structured, evidence-based approach to sustainability transformation.

1. METHOD

This study employs a systematic and applied review approach to evaluate how ISO 9001:2015/Amd 1:2024 can be integrated into the quality management systems of higher education institutions. The review process was designed to ensure methodological transparency, reproducibility, and practical applicability.

1.1. Systematic Literature Review

A structured literature search was conducted using major academic databases, including Scopus, Web of Science, and Google Scholar. Searches were performed using combinations of keywords such as “ISO 9001”, “quality management systems”, “higher education”, “sustainability”, “climate change”, “environmental governance”, and “education quality”. The review covered publications between 2000 and 2025 to capture both foundational and recent developments.

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Inclusion criteria comprised peer-reviewed journal articles, conference papers, international standards, and official policy documents directly related to quality management or sustainability in higher education. Studies unrelated to educational institutions or lacking methodological rigor were excluded. After removing duplicates and screening titles and abstracts, the remaining studies were subjected to full-text analysis. The selected sources were then thematically categorized to identify key dimensions such as governance, stakeholder engagement, risk-based thinking, continuous improvement, and sustainability performance.

1.2. Standards-Based Analytical Mapping

In the second stage, the clauses of ISO 9001 associated with climate change were systematically analysed within the context of higher education processes. Particular attention was given to Clauses 4, 6, 8, 9, and 10. For each clause, the mechanisms through which climate impacts are assessed, risks and opportunities are managed, institutional objectives are aligned with sustainability priorities, and educational quality outcomes are influenced were evaluated. This step enabled the translation of standard requirements into education-specific interpretations.

1.3. Framework Development and Practical Illustration

In the final stage, insights from the literature and standards analysis were synthesized to develop a practical and adaptable framework for climate-responsive quality management in universities. Internal and external climate-related issues were identified, stakeholder expectations were analysed, climate-driven risks and opportunities were defined, and performance indicators were established to monitor both educational and environmental outcomes. To enhance practical applicability, the framework was accompanied by an illustrative institutional application demonstrating how ISO 9001:2015/Amd 1:2024 requirements can be operationalized through strategic planning, stakeholder participation, monitoring systems, and continuous improvement practices.

All tables presented in this study were originally developed by the authors based on the analyses conducted within the scope of this research.

Overall, this methodology provides a structured and replicable roadmap for higher education institutions seeking to embed climate-responsive governance into their quality management systems and demonstrates how sustainability principles can be systematically operationalized within everyday educational and administrative practices.

2. GENERAL FRAMEWORK OF MANAGEMENT SYSTEM STANDARDS

2.1. ISO 9001 and Its Integration with Climate Change

ISO 9001 is internationally recognized as the central reference standard for establishing and improving quality management systems in organizations. The core objective of the standard is to support institutions in developing a quality-oriented culture through customer satisfaction, effective process management, and continuous improvement (Psomas, 2013). In higher education institutions (HEIs), these expectations correspond to the enhancement of educational quality, the strengthening of teaching and learning processes, and the systematic improvement of institutional performance.

The 2015 revision of ISO 9001 relies on key structural elements such as the Plan–Do–Check–Act (PDCA) cycle, risk-based thinking, stakeholder engagement, and context analysis. The PDCA cycle ensures that educational and administrative processes are planned, implemented, monitored, and continuously improved, while the risk-based approach encourages universities to proactively identify challenges that may affect student learning outcomes, academic program quality, and stakeholder experience (Martins, Silva, and Gaudencio, 2021). Through leadership commitment, documentation practices, and strategic support planning, ISO 9001 provides a holistic governance mechanism that influences both teaching and administrative practices (ISO, 2024a).

Historically, environmental issues have been handled under separate standards, particularly ISO 14001. However, the publication of ISO 9001:2015/Amd 1:2024 represents a major shift by formally integrating climate change considerations into the main governance framework of ISO 9001. This amendment introduces direct modifications to Clause 4.1

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("Understanding the organization and its context") and Clause 4.2 ("Understanding the needs and expectations of interested parties"):

- **Clause 4.1**: "The organization shall determine whether climate change is a relevant issue."
- **Clause 4.2**: A note clarifies that relevant interested parties may have climate-related requirements (ISO, 2024b).

As stated in the joint ISO–IAF communiqué, these additions do not change the intent of the clauses; instead, they emphasize that climate change must now be considered as an external factor influencing institutional operations (ISO and IAF, 2024). Accordingly, universities are required to systematically assess climate-related risks, including physical impacts (e.g., infrastructure vulnerability) and transitional pressures (e.g., regulatory adaptation), within the structure of their quality systems.

Table 1 summarizes the transition from the former structure to the amended version. While the technical framework of ISO 9001 remains unchanged, the scope of strategic alignment expands to include sustainability-oriented governance and climate adaptation. This creates opportunities to improve institutional resilience while reinforcing evidence-based decision-making in education.

For HEIs, this represents a transition from quality systems being perceived mainly as administrative compliance tools toward becoming strategic instruments that support climate policy integration into teaching, research, and community engagement processes (Table 2). As a result, HEIs can redesign their quality strategies to ensure that climate governance contributes to the improvement of learning environments, risk management in academic operations, and long-term institutional development.

Table 1. Comparison of ISO 9001: 2015 and ISO 9001: 2015/Amd 1:2024 and Their Expected Impacts

ISO 9001 Clause	Previous Requirement (2015)	New Requirement after Amd 1:2024	Expected Impacts in the Context of Climate Change
Clause 4.1 – Context of the Organization	Organizations were required to evaluate internal and external context, relevant stakeholder expectations, and strategic direction.	Organizations must explicitly assess whether climate change is a "relevant issue" in their context.	Integration of climate-related elements, such as physical and transitional risks, into context analysis, enhancing long-term strategic alignment.
Clause 4.2 – Needs and Expectations of Interested Parties	Identification of stakeholder requirements was required; environmental aspects could be addressed in general terms.	A clarifying note was added specifying that stakeholders may have requirements related to climate change.	Systematic identification of stakeholder expectations, including carbon reduction, adaptation measures, and green supply chain demands.
Clause 6.1 – Actions to Address Risks and Opportunities	Risks and opportunities were to be identified based on context and stakeholder analysis; no explicit obligation regarding climate change.	Climate change risks must be considered as an integral part of context and stakeholder analysis.	Integration of climate risks into quality management planning, fostering proactive measures and strengthening mitigation and adaptation strategies.

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Table 2. Integration of Climate Change Risk Assessment into the ISO 9001 PDCA Cycle

PDCA Stage	Conventional ISO 9001 Application	Integration of Climate Change in Amd 1:2024	Expected Institutional Outcomes
Plan	Context, stakeholder, and risk–opportunity analysis; setting of quality objectives	Integration of climate-related risks and opportunities into context analysis; definition of climate-focused objectives	Inclusion of climate adaptation and mitigation priorities in strategic plans
Do	Execution of operations and process control	Implementation of processes that reduce carbon emissions and enhance adaptation	Measurable reduction of environmental impacts
Check	Performance monitoring, internal audit, management review	Monitoring and reporting of climate change indicators (e.g., emissions, energy efficiency)	Transparent reporting and improvement of sustainability performance scores
Act	Continuous improvement, corrective and preventive actions	Implementation of preventive and corrective action plans addressing climate-related risks	Enhanced institutional resilience and reduced regulatory and market risks

2.2. Common Structural Themes Between ISO 9001 and ISO 14001

ISO 9001 and ISO 1401 are built upon the High-Level Structure (Annex SL), which promotes a unified approach to institutional management through common components: organizational context, leadership, planning, support, operation, performance evaluation, and continual improvement (Francisco, Costa, Sampaio, Domingues and de Oliveira, 2024). This alignment enables higher education institutions to integrate educational quality objectives with environmental sustainability priorities under a single governance model.

Risk-based thinking, as a central theme in both standards, encourages the assessment of risks and opportunities. In ISO 9001, this supports improvements in operational and educational quality, while ISO 14001 focuses on environmental threats and mitigation strategies (Martins, Sanches da Silva, Sampaio and Gabriel, 2021; El Fadel and Merzouki, 2024). The climate change amendment to ISO 9001 expands this view and requires institutions to document and manage climate-related risks that may affect student services, academic continuity, digital infrastructure, and stakeholder well-being.

Stakeholder analysis plays a key role in both standards. In the context of HEIs, it facilitates understanding how climate change influences expectations of students, educators, administrators, and external partners (Disterheft, Caeiro, Azeiteiro, and Leal Filho, 2015). As universities are multi-stakeholder learning ecosystems, this integration supports the development of climate-responsive teaching strategies and inclusive decision-making. Continuous improvement forms the backbone of both ISO 9001 and ISO 14001 through the PDCA cycle. The new version of ISO 9001 encourages the monitoring of climate-related performance indicators—such as energy efficiency, emission reductions, and climate literacy—within internal audits and management reviews. These indicators can be simultaneously used to support educational quality metrics, enabling HEIs to link sustainability achievements with student learning success (Mattos, Flach, Costa, and Moré, 2023; Tutko and Woźniak, 2023).

Documentation and process management also serve as shared structural elements. ISO 9001 emphasizes recording responsibilities and performance indicators to ensure transparency and accountability, while ISO 14001 requires detailed documentation of environmental controls (Almeida, Pradhan and Muniz, 2018). Through climate governance integration, universities can consolidate both quality and environmental documentation to enhance traceability of learning outcomes, build institutional memory, and support external evaluations.

Leadership, another key theme within both standards, is essential for embedding climate policies into institutional objectives (Leal Filho, Eustachio, Caldana, Will, Lange Salvia, Rampasso, Anholon, Platje, and

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Kovaleva 2020; Aung and Hallinger, 2023). When top management commits to sustainability targets, universities are better positioned to foster environmentally responsible educational cultures and support professional development pathways for educators (Leal Filho et al., 2020). Table 3 illustrates how these elements align conceptually and demonstrates that climate change integration into ISO 9001 strengthens institutional capacity by linking operational sustainability with academic performance indicators.

Table 3. Structural Evaluation of ISO 9001 and ISO 14001 in the Context of Climate Change

Structural Theme	**ISO 14001:2015 (Environment-Oriented)**	**(ISO 9001:2015 / Amd.1: 2024)**	**Academic and Applied Interpretation**
Risk-Based Thinking	Identification of environmental risks (e.g., pollution, resource use) and planning of preventive or mitigating actions	Inclusion of direct and indirect impacts of climate change in risk analysis processes (e.g., supply chain disruptions, extreme weather events)	Climate risk assessment reinforces a proactive management culture
Stakeholder Analysis and Understanding of Context	Evaluation of environmental expectations from local communities, environmental agencies, and regulatory authorities	Addition of climate adaptation and mitigation strategies to stakeholder expectations; carbon footprint reporting and transparent communication	In higher education practice, stakeholder analysis plays a critical role in identifying how climate change influences academic and operational priorities
Continuous Improvement (PDCA Cycle)	The same cycle applied to enhance environmental performance	Integration of climate risk assessment, adaptation measures, and impact monitoring into the PDCA process	Demonstrates that the PDCA cycle offers a flexible and replicable framework for climate adaptation strategies
Documentation and Process Management	Environmental management procedures, legal compliance records, and audit reports	Systematic documentation of climate-related risks, opportunities, and adaptation measures; reporting of climate performance indicators (KPIs)	Documented information plays a critical role in both internal audits and transparent stakeholder communication
Leadership and Strategic Orientation	Top management demonstrates leadership toward environmental goals	Top management integrates climate strategies into institutional objectives	Strategic leadership emerges as a key success factor in integrating climate change into the quality management system

2.3. Connection with Emerging Concepts in the Literature

In recent years, new concepts focusing on environmental sustainability have become increasingly prominent in the quality management systems literature. Among these, "Green Quality Management" refers to the design and management of quality processes in a way that minimizes environmental impacts (Abbas, 2020). This approach is directly related to the integration of the climate change dimension into ISO 9001:2024 and enables institutions to systematically improve their carbon footprint, energy consumption, and environmental performance. Similarly, the concept of "eco-efficiency" emphasizes optimizing resource use while reducing environmental impacts and addressing efficiency and sustainability in tandem (Zhang, Mao, Jiao, Shuai and Zhang, 2021). The updated requirements of ISO 9001 incorporate these concepts into quality processes, supporting universities in enhancing both operational efficiency and environmental responsibility.

The idea of a "Sustainable QMS" aims to integrate the social, economic, and environmental dimensions of quality management systems to create long-term value. Within the higher education context, this concept aligns with the climate change integration of ISO 9001, aiming to reduce environmental impacts across education, research, and administrative processes (Silva, Magano, Matos and Nogueira, 2021; Žalėnienė and Pereira, 2021). In academic literature, these concepts are discussed through analyses of the relationship between environmental and quality performance, the integration of sustainable supply chains into quality management, and the effects of compliance with environmental regulations on quality processes (Mugoni, Kanyepe and Tukuta, 2024). Therefore, the sustainability-oriented concepts highlighted in the literature find a concrete application through the integration of climate change considerations into ISO 9001, enabling universities to align their quality management systems with environmental responsibility and contribute to the Sustainable Development Goals.

Across the world, many universities have adopted this approach and assumed a leading role in the field of sustainable quality management. Some higher education institutions integrate environmental performance indicators—such as carbon footprint and energy consumption—into ISO 9001-aligned quality systems, while others restructure their sustainable

supply chains and campus operations within the quality management framework to minimize environmental impacts. In several cases, administrative processes incorporate ISO 9001-based green quality management practices to systematize energy conservation and waste management (Leiber, 2018; Bauer, Niedlich, Rieckmann, Jaeger and Bormann, 2020).

These emerging frameworks demonstrate that climate change integration is not merely a compliance requirement but a transformation pathway enabling universities to align their quality strategies with Sustainable Development Goals and global climate governance. Worldwide practices also affirm this trend: universities adopt emission performance indicators, restructure their campus operations to improve energy and waste management, and embed sustainability targets into quality assurance processes (Bauer et al., 2020). Through such implementations, quality systems become drivers of institutional learning and pedagogical innovation.

2.4. Climate-Responsive Quality Management in Higher Education: Relevance to Educational Processes, Teacher Development and National Policy Priorities

The integration of climate change considerations into higher education quality management is not only an environmental necessity but also a strategic requirement for enhancing educational processes, institutional governance, and societal responsibility (Leal Filho et al., 2021; Caeiro, Sandoval Hamón, Martins, and Bayas Aldaz, 2020). The ISO 9001:2015/Amd 1:2024 amendment encourages universities to evaluate the climate impacts of their activities within their operational and strategic contexts, which directly influences the quality of teaching and learning, curriculum development, and institutional planning (Gamit, Santos, Armas, Villegas, 2024).

In terms of educational processes, climate-responsive quality practices strengthen the improvement of student learning outcomes by aligning assessment systems, teaching–learning environments, and competency-based curriculum structures with sustainability-driven skills (Caeiro et al., 2020).

Such alignment supports the development of climate-aware graduates capable of responding to modern societal challenges (Caeiro et al., 2020; Iqbal, Taib, Allumi, and Abbas, 2025). Additionally, the continuous improvement principles embedded in ISO 9001 contribute to the professional growth of educators by promoting pedagogical innovation, digital competence, and sustainability-oriented instructional design (Gamit, 2024; Iqbal et al., 2025). These improvements are particularly important for providing teachers with the capacity to guide students through rapidly evolving environmental and technological contexts (Iqbal et al., 2025).

A key benefit of embedding climate considerations into quality systems is the enhancement of stakeholder participation (Caeiro et al., 2020). Students, educators, administrators, and external actors become active contributors to institutional decision-making processes, fostering a culture of transparency, accountability, and collaborative sustainability governance (Caeiro et al., 2020; Leal Filho et al., 2020). Strengthened stakeholder involvement also supports the development of inclusive educational environments in which diverse perspectives are recognized and used to shape institutional strategies (Caeiro et al., 2020).

The relevance of climate-responsive quality management is especially significant in national education policy contexts. In Türkiye, strategic frameworks such as the Council of Higher Education (CoHE) 2030 Vision and the 12th National Development Plan emphasize climate adaptation, environmental sustainability, and digital transformation as essential future competencies in higher education (Turkish Higher Education Council, 2023) — pointing national guidance toward sustainable transformation and alignment with quality assurance imperatives. Aligning ISO 9001 requirements with these national priorities enables universities to meet regulatory expectations while promoting long-term institutional resilience and social contribution (Leal Filho et al., 2021; Caeiro et al., 2020). Furthermore, integrating climate governance into quality systems advances the educational mission of universities, ensuring that sustainability is not addressed through isolated projects but through a systematic and institutionalized transformation (Caeiro et al., 2020).

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Overall, positioning climate change within university quality assurance contributes to the development of sustainable governance structures, strengthens the professional capacity of educators, and enhances student learning outcomes. This alignment offers higher education systems a practical and policy-oriented pathway for addressing current educational challenges and contributes to the scientific and societal goals of national and international quality agendas.

3. IMPLEMENTATION OF ISO 9001:2015/AMD 1: 2024 CLIMATE CHANGE CLAUSES IN HIGHER EDUCATION INSTITUTIONS

3.1. Defining the Climate Change Context (Clause 4.1)

Under Clause 4.1 of ISO 9001:2015/Amd 1:2024, the first step for universities is to determine the institutional context of climate change in a comprehensive manner (ISO, 2024a). This analysis includes both internal and external environmental factors that influence educational processes, teaching–learning environments, and institutional performance. Internal factors consist of campus infrastructure, energy consumption, waste management practices, academic programs, and research activities, while external factors encompass national and international climate policies, legal obligations, and societal expectations shaped by environmental risks. In terms of academic functions, this clause encourages universities to embed climate-related themes into curriculum development, research agendas, awareness programs, and student-cantered sustainability projects. Administrative operations are expected to implement climate-adaptive strategies such as energy-efficient facility management, sustainable procurement, and waste minimization. Monitoring key indicators—such as energy performance, carbon emissions, and water use—allows universities to measure institutional exposure to climate risks. The systematic identification of direct and indirect climate impacts creates the foundation for aligning quality management systems with institutional sustainability goals and educational mission (Idan, 2025).

3.2. Identifying Stakeholder Expectations Regarding Climate Change (Clause 4.2)

Clause 4.2 requires universities to analyse the expectations of stakeholders associated with climate change in a systematic and inclusive manner (ISO, 2024a). In higher education, stakeholders include students, academic staff, management bodies, administrative personnel, alumni, industry representatives, accreditation agencies, and the wider public (Giller, 2023). Understanding their expectations is critical not only for institutional accountability but also for improving student learning outcomes, teaching quality, and stakeholder engagement. Universities may use surveys, interviews, workshops, and participatory governance mechanisms—such as advisory boards—to assess stakeholder perspectives. Sustainability reports and environmental performance indicators also provide essential reference data (Ludușanu et al., 2025). Integrating these expectations into strategic planning, program design, and quality assurance processes ensures that climate-focused governance evolves into a transparent and inclusive system.

3.3. Identification of Risks and Opportunities (Clause 6.1)

Clause 6.1 mandates the identification of risks and opportunities arising from climate change and their influence on higher education operations (ISO, 2024a). These may include physical disruptions to facilities, increased energy demands, compliance obligations stemming from regulatory changes, and reputational risks linked to sustainability performance (Ludușanu et al., 2025; Leiber, 2018). At the same time, opportunities arise in renewable energy use, campus decarbonization initiatives, and green transformation projects such as sustainable building design and circular economy practices. These actions directly contribute to the creation of safer, climate-resilient learning environments and resource-efficient academic operations. Tools such as SWOT analysis, environmental impact assessment, and scenario planning support universities in anticipating potential disruption and aligning quality objectives with sustainability-driven improvements in educational continuity and institutional resilience (Markulik, Šolc and Blaško, 2024).

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3.4. Defining Quality Policies and Environmental Objectives (Clause 6.2)

Clause 6.2 requires universities to establish measurable and achievable quality policies that explicitly support climate-aligned sustainability goals (ISO, 2024a). This involves top management commitment to environmental responsibility as part of academic excellence and student-centered development. Objectives such as carbon footprint reduction, energy efficiency improvements, and responsible water use can be aligned with learning environments, campus services, and academic operations. Using SMART criteria ensures climate objectives remain traceable and performance-oriented (Ogbeiwi, 2017). Effective communication of these policies among students, academic staff, and administrative units facilitates shared ownership of sustainability targets and reinforces institutional culture change.

3.5. Establishing Operational Controls (Clause 8)

Clause 8 emphasizes implementing operational controls to ensure activities are aligned with environmental sustainability goals (ISO, 2024a). In universities, this relates to teaching, research, campus life, and administrative processes. Energy-efficient building management, smart control technologies, renewable energy integration, and carbon-neutral campus strategies directly support both environmental and educational performance by providing healthier and resource-conscious learning spaces. Waste prevention, recycling programs, and responsible hazardous waste management strengthen sustainability awareness among students and staff. Sustainable transportation solutions—such as pedestrian-friendly campus design, bicycle networks, and electric mobility—help reduce emissions while promoting an environmentally responsible student experience. Operational controls should be consistently monitored and improved to enhance both campus sustainability and educational quality.

3.6. Performance Monitoring and Evaluation (Clause 9)

Clause 9 requires universities to monitor measurable performance indicators related to climate change—such as energy use, carbon emissions, and waste generation—and to relate them to quality improvement cycles (ISO, 2024a). Tracking these indicators helps universities evaluate whether climate-related goals have been achieved and supports internal decision-making to improve program delivery, learning environments, and institutional sustainability scores (Fahim, Tan, Naz, Ain and Bazai, 2021). Reliable data, inter-unit coordination, and stakeholder participation are key to ensuring performance results guide the enhancement of educational outcomes and governance transparency.

3.7. Continuous Improvement Processes (Clause 10)

Clause 10 emphasizes cultivating a continuous improvement culture within the quality management system, requiring regular review and refinement of climate-responsive strategies (ISO, 2024a). For universities, this means making sustainability initiatives a permanent component of institutional transformation, not a temporary project approach (Durmuş Şenyapar and Bayındır, 2024). Performance data should inform improvement plans in teaching–learning processes, campus operations, and student engagement activities. Continuous improvement encourages innovation and promotes active involvement from both academic staff and students through training programs and awareness campaigns. As a result, the quality management system becomes a governance tool that advances educational innovation, environmental responsibility, and long-term institutional development simultaneously.

4. DOCUMENTATION SYSTEM AND REQUIREMENTS WITHIN IMPLEMENTATION PROCESSES

4.1. Formalization of Policies and Procedures

The ISO 9001:2015/Amd 1:2024 standard requires universities to formally document their climate change commitments within the quality management system (ISO, 2024a). This ensures that sustainability principles are not implemented through temporary initiatives but instead become institutional values supporting teaching and learning quality. Annual reviews

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of existing policies strengthen continuity, while transparent communication of these documents to students, academic personnel, and administrative units enhances awareness and participation in sustainability practices (Manatos, Sarrico and Rosa, 2017).

Quality procedures define operational responsibilities and implementation mechanisms for climate-related objectives (Leiber, 2018). Incorporating processes related to energy-efficient buildings, sustainable procurement, carbon reduction, and waste management into procedures ensures systematic control of environmental impacts in educational environments. Clear assignment of responsibilities through a matrix and continuous monitoring of performance indicators support institutional accountability (Table 4). Additionally, document management systems guarantee the secure storage and accessibility of the latest versions of climate-related records, enabling reliable and traceable decision-making.

Table 4. Implementation Steps of Policies and Procedures

Implementation Step	Description	Responsible Units	Performance Indicators
Policy Design and Approval	Drafting the climate change and sustainability policy and obtaining approval from the senate and board	Rectorate, Quality Coordination Office, Strategy Development Office	Policy approval date, number of revisions
Dissemination to Stakeholders	Communicating the policy to academic and administrative units, students, and campus stakeholders	Academic Units, Quality Coordination Office, Student Affairs	Number of information meetings, access rate (%)
Implementation of Operational Procedures	Deployment of energy-efficient building use, waste separation, sustainable procurement, and transportation plans	Construction and Technical Department, Procurement, Transportation Unit	Reduction in energy consumption (%), recycling rate (%)
Establishment of Document Management System	Digital management of climate and sustainability documents, version control, and access authorization	Quality Coordination Office, Information Technology Department	Access rate to updated documents (%), number of incorrect/missing documents

Monitoring and Evaluation	Regular measurement of performance indicators, preparation of climate performance reports	Quality Coordination Office, Environmental Commission	Number of annual reports, number of improvement suggestions
Continuous Improvement	Revising policies and procedures based on performance results	All Units, Quality Coordination Office	Number of revised documents, number of new initiatives

4.2. Climate Change Risk Analyses and Assessments

Regular documentation of climate-related risks and opportunities—guided by internal and external environmental conditions—creates a foundation for strategic educational planning and resource allocation (ISO, 2024a; Fahim et al., 2021). These analyses improve academic continuity by anticipating disruptions that may affect learning environments, digital infrastructure, and student well-being. By integrating both quantitative and qualitative data, universities can prioritize climate risks using probability–impact scoring and ensure preventive actions for high-risk areas. Opportunities such as renewable energy adoption, ecological campus design, and sustainable transportation systems strengthen sustainability competencies within the university community (Table 5).

Table 5. Sample ISO 9001:2015/Amd 1:2024 Climate Risk Analysis Matrix

Risk / Opportunity Area	Description	P* (1–5)	I* (1–5)	Priority Score (P × I)	Corrective Measures
Energy Consumption Increase	Rising energy use in buildings and laboratories	4	5	20	LED conversion, installation of smart energy system
Carbon Emissions	Increased CO_2 from transportation, energy, and heating	3	5	15	Electric vehicle infrastructure, public transit incentives
Waste Generation	High levels of non-recyclable waste	4	4	16	Waste segregation system, composting practices
Excessive Water Use	High water consumption in irrigation and laboratories	3	4	12	Rainwater harvesting, grey water reuse
Renewable Energy Potential Opportunity	Installation of rooftop solar panels	4	5	20	Feasibility studies, pilot project implementation

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Green Campus Practices Opportunity	Biodiversity enhancement ecological landscaping	3	4	12	Use of native plant species, green space management plan
Sustainable Transportation Opportunity	Bicycle lanes and sharing systems	4	4	16	Bicycle parking, student incentive programs

P*: Probability; I*: Impact

4.3. Performance Monitoring and Measurement Records

The systematic monitoring and documentation of environmental performance indicators enable universities to evaluate the effectiveness of their climate mitigation strategies and their impact on educational quality (Amrina and Imansuri, 2015). Data on energy consumption, carbon emissions, water use, and waste generation should be transformed into periodic reports and visual analyses to foster evidence-based institutional improvement. Transparent publication of results under "Climate Change Performance Reports" enhances governance reliability and encourages student and staff engagement (Table 6).

Table 6. Sample Climate Change Performance Indicators in Universities

Performance Indicator	Definition	Unit of Measurement	Responsible Unit	Reporting Format
Energy Consumption	Total annual energy consumption of the university	kWh / year	Construction and Technical Services Unit	Energy Performance Report
Carbon Emissions	Greenhouse gas emissions from activities (GHG Protocol)	tons CO_2e / year	Environment and Sustainability Unit	Carbon Inventory Report
Water Consumption	Amount of water used in academic and administrative buildings	m^3 / year	Construction and Technical Services Unit	Water Use Analysis Report
Waste Management	Total waste generated and percentage of waste recycled	tons / year, % recycled	Cleaning Services and Environmental Management Unit	Waste and Recycling Report

Share of Renewable Energy	Proportion of renewable sources in total energy consumption	%	Energy Management Unit	Energy Source Distribution Report
Sustainable Transportation Rate	Rate of bicycle, electric vehicle, and public transport use in campus mobility	%	Transportation and Logistics Unit	Transportation Sustainability Report
Green Space Ratio	Green space per capita across the campus	m^2 / person	Parks and Gardens Unit	Environmental Landscaping Report
Academic Participation	Number of climate and sustainability-related research projects, seminars, events	Number / year	Research and Projects Coordination Unit	Academic Activity Report

4.4. Training and Awareness Records

Training and awareness activities are essential to embed climate literacy into university culture (ISO, 2024a). Documenting seminars, workshops, online trainings, and field practices ensures measurable development of both academic staff and students. Tracking participation rates, knowledge gains, and satisfaction levels supports the continuous improvement of sustainability education. Hybrid and interactive activities help expand outreach and improve engagement, building environmentally responsible behaviours. Best practices—such as student-led sustainability projects—should be shared to inspire replication within and across institutions (Table 7).

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Table 7. Climate Change Training and Awareness Records within the Quality Management Framework

Activity Type	**Target Group**	**Training Scope / Content**	**Performance Indicators (KPIs)**	**Documentation / Evidence**
Seminar / Workshop	Academic and Administrative Staff	Climate policies, ISO 9001:2024 requirements sustainability principles	Participation rate (%)	Attendance list, presentation files
Student Awareness Program	Undergraduate Students	Energy efficiency, waste reduction, green campus culture	Student feedback score	Course syllabus, feedback reports
Technical Training	Maintenance and Facility Teams	Energy management systems, waste segregation, water conservation	Reduction in energy use (%)	Training certificates, inspection forms
Leadership Briefing	University Leadership & Rectorate	Strategic alignment of climate goals with institutional quality policy	Policy integration rate	Meeting minutes, updated QMS policy
Community Outreach	External Stakeholders	Local climate initiatives, collaboration for sustainable practices	Number of partnerships	Memoranda of Understanding, media coverage

4.5. Documentation of Corrective Actions

In universities, all corrective actions addressing nonconformities and improvement opportunities identified in climate change–related processes must be systematically documented and regularly monitored (ISO, 2024a). These records strengthen transparency and accountability while ensuring the effective operation of the continuous improvement cycle (PDCA). For example, measures taken when energy consumption exceeds defined targets or strategies developed to address shortcomings in waste management should be reported within this scope. In this way, an institutional memory is created to support the continuous monitoring and enhancement of performance.

4.6. Records on Communication and Stakeholder Engagement

In the process of managing climate change, it is crucial for universities to systematically document all communication activities with relevant stakeholders, including meetings, collaborations, and received feedback (ISO, 2024a).

The *Context of the Organization and Stakeholder Analysis Report* provides a detailed assessment of the university's internal and external environmental conditions, the impacts of climate change on institutional operations, and stakeholder expectations. Within this analysis, the SWOT (Strengths, Weaknesses, Opportunities, Threats) and PESTEL (Political, Economic, Social, Technological, Environmental, and Legal) methods can be used to comprehensively evaluate the current situation (Çitilci and Akbalık, 2019). Internal stakeholders include academic staff, students, and administrative personnel, whereas external stakeholders comprise local governments, non-governmental organizations, suppliers, and alumni. The differences in expectations and priorities among these stakeholders are reported and integrated into strategic planning processes.

Through the *Stakeholder Communication and Feedback Records* document, universities record the communication channels established with stakeholders on climate change issues and the feedback collected through these channels. Examples include suggestions from student clubs, meetings with local governments, and national or international collaborations. It should also be clearly stated how the received feedback is evaluated and reflected in

institutional policies and strategies. These transparent communication and participation processes strengthen internal and external collaboration in addressing climate change and enhance the effectiveness of sustainable management practices (Milovanović, Paunović and Casadesus, 2023).

4.7. Environmental Objectives Document

This document ensures the integration of sustainability objectives with the quality policy. The objectives are defined according to the SMART criteria—Specific, Measurable, Achievable, Realistic, and Time-bound (Ogbeiwi, 2017).

To enable effective monitoring and evaluation of the established environmental objectives, performance indicators are developed and reviewed at regular intervals. This process, in line with the principle of continual improvement under ISO 9001, allows for the analysis of progress toward objectives and the revision of targets when necessary (ISO, 2024a). Performance data should be discussed during strategic management meetings, where responsibility allocation and resource planning among relevant units are updated accordingly. In this context, sustainability objectives evolve from static documentation into a dynamic management tool (Table 8).

Table 8. Institutional Environmental Objectives and Monitoring Framework

Objectives	SMART Criteria	Performance Indicators (KPIs)	Status / Comments	Progress (%)
Reduction of institutional carbon footprint by 20%	Specific, Measurable Achievable Realistic Time-bound	Annual carbon emission (tons of CO_2)	A 7% reduction achieved in the first year	35% progress toward target
Recycling of 50% of total campus waste	Defined in line with SMART criteria	Recycling rate (%)	Recycling infrastructure established; awareness campaign launched	40% progress toward target
Increase renewable energy share in total consumption by 15%	Specific, Measurable Achievable Realistic Time-bound	Renewable energy ratio (%)	Pilot solar installation completed	25% progress toward target
Reduce water consumption per capita by 10%	SMART-based	Average water use per person (m^3/year)	Leak detection program initiated	10% progress toward target

4.8. Internal Audit and Management Review Reports

Internal audit reports are fundamental tools for evaluating the extent to which universities meet their climate-related objectives and ISO 9001 requirements (ISO, 2024a). These reports not only present environmental performance data but also identify nonconformities and areas for improvement. Audits should be systematically planned and conducted to cover all academic and administrative units (Gokoglan, Borutecene and Bilen, 2023). In management review meetings, top management considers these audit results to assess the achievement of objectives. Minutes should include performance analyses, deviations between actual results and targets, and corrective recommendations.

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RESULTS AND POLICY IMPLICATIONS

This study demonstrates that integrating climate change considerations into the Quality Management Systems (QMS) of higher education institutions (HEIs) through the ISO 9001:2015/Amd 1:2024 amendment is both feasible and strategically transformative. The inclusion of climate-related requirements into the institutional context, stakeholder analysis, risk–opportunity assessment, performance monitoring, and continuous improvement mechanisms establishes a strong foundation for sustainability governance within universities. The results indicate that embedding environmental dimensions into the quality system contributes to enhanced operational efficiency, reduction of institutional carbon footprints, and stronger accountability structures.

From an educational quality perspective, the integration of climate change into QMS supports curriculum enhancement, improves learning environments, and fosters climate literacy among students. When sustainability becomes an embedded objective within academic programs, universities can raise graduates who possess future-oriented competencies such as environmental awareness, problem-solving skills, and responsible citizenship. Professional development initiatives for academic staff, aligned with continuous improvement principles, also reinforce pedagogical innovation and resilience in teaching practices.

The findings highlight that stakeholder participation mechanisms within QMS enhance the transparency and legitimacy of climate governance. Students, educators, administrators, alumni, and external partners actively contribute to sustainability decisions, supporting a more inclusive and collaborative campus culture. This participatory approach strengthens the effectiveness of institutional climate policies and increases acceptance of environmental actions.

In the context of national policy priorities, the results demonstrate alignment with Türkiye's strategic agendas, such as the YÖK 2030 Vision and the 12th National Development Plan, which emphasize climate adaptation, resource efficiency, and digital transformation in higher

education. Integrating ISO 9001 climate clauses allows universities to meet emerging regulatory expectations while enhancing their role as societal leaders in sustainability. Alignment with the Sustainable Development Goals (SDG 4 and SDG 13) further positions HEIs as key actors advancing both environmental responsibility and educational excellence.

These results collectively indicate that the amended ISO 9001 standard provides a practical roadmap for higher education institutions to institutionalize climate action and transform sustainability objectives into measurable outcomes. Strengthened documentation, monitoring, and reporting practices create credible evidence for accreditation processes, public accountability, and international visibility. Therefore, universities are encouraged to:

- Integrate climate-focused quality objectives into strategic and academic planning,
- Establish structured mechanisms for student and educator involvement in sustainability governance,
- Use performance indicators linking environmental and educational outcomes,
- Allocate resources for innovation in green campus transformation,
- Develop nationally scalable model practices that can support other institutions.

Taken together, climate-responsive QMS implementation promotes institutional resilience, enhances educational quality, and contributes significantly to national and global sustainability goals. With ISO 9001:2015/Amd 1:2024 as a governance framework, universities can adopt a proactive and integrated response to the climate crisis, ensuring that their operations, academic missions, and societal responsibilities align with a sustainable future.

• **Policy Recommendations:** To ensure effective implementation, higher education authorities should embed climate adaptation and mitigation targets within institutional quality assurance frameworks that directly support student learning outcomes. Regulatory bodies and national policymakers can promote this process by introducing financial and tax incentives for

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universities that demonstrate measurable improvements in energy efficiency, carbon reduction, and sustainability performance.

The establishment of a centralized national climate performance platform—including indicators such as carbon footprint, energy use, waste management, and water efficiency—would enable sector-wide benchmarking and greater transparency, strengthening accountability within external evaluations and accreditation processes.

Integrating sustainability and climate change topics into curricula, teacher training programs, and pedagogical development activities will enhance the educational capacity of universities to equip graduates with sustainability-oriented competencies. Expanding international cooperation, especially through joint research, academic exchange, and global green campus initiatives, can accelerate the dissemination of model practices and reinforce Türkiye's alignment with international climate and quality standards.

• **Strategic and Institutional Outcomes:** The results of this study reveal that integrating climate-oriented practices into QMS yields significant institutional, educational, and societal outcomes.

Institutional Outcomes: The systematic monitoring of climate impacts promotes energy efficiency, reduces greenhouse gas emissions, and enhances campus sustainability through measurable key performance indicators, supporting data-driven strategic decision-making.

Educational Outcomes: Embedding climate change management into quality structures enhances environmental literacy among students, supports interdisciplinary skill development, and strengthens the pedagogical capacity of academic staff, making sustainability an integral part of the learning environment.

Societal Outcomes: HEIs emerge as influential actors contributing to national and regional climate policies, informing public awareness, and shaping stakeholder behaviour toward sustainability, reinforcing their role as knowledge leaders and agents of change.

CONCLUSION

The 2024 amendment to ISO 9001 represents a transformative milestone for quality governance in higher education institutions. By formalizing climate change considerations within the organizational context, the standard provides a coherent, evidence-based mechanism through which universities can align quality assurance processes with sustainability goals.

This approach shifts quality management in higher education from procedural compliance toward strategic climate action, supporting long-term institutional resilience, environmental accountability, and educational excellence. Universities implementing this integration can position climate governance as a core component of academic planning, stakeholder participation, and continuous improvement systems.

Ultimately, this framework contributes to the institutionalization of climate-responsive governance in higher education, ensuring that universities are not only centres of teaching and research but also leading agents of sustainability transformation within national and global development agendas.

Ethics Committee Approval

It has been declared that the research is one of the researches that do not require ethics committee permission.

Declaration of Conflict of Interest and Financial Contribution

No conflict of interest and financial contributions were declared by the author.

Author Contribution

Füsun Eyidoğan (30%): Research design, writing, critical review and research infrastructure support. Dilek Yalçın (35%): Research design, literature review, data analysis, writing and publication process. İlkay Açıkgöz Erkaya (20%): Literature review, writing and critical review. Yağmur Erikel Yılmaz (15%): Literature review and writing.

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