Educational Administration: Theory and Practice
2025, 31(2), 72-79
ISSN: 2148-2403
https://kuey.net/

Research Article

Sustainable Development: Integrating ISO 14001 Environmental Management Systems in the Construction Industry for Sustainable Construction Practices

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Citation: Ridwan Bin Nordin et al. (2025), Sustainable Development: Integrating ISO 14001 Environmental Management Systems in the Construction Industry for Sustainable Construction Practices, *Educational Administration: Theory and Practice, 31(2)* 72-79
Doi: *10.53555/kuey.v31i2.10175*

ARTICLE INFO

ABSTRACT

Construction has always been considered to be a risky business for the environment. Even with the right management system in place, many opportunities exist to improve the system's sustainability. This investigation aims at the integration of ISO 14001 EMS in the construction industry, which is an expression of its international recognition as an environmental management standard. In so doing, this study reveals the effectiveness of ISO 14001 in environmental standards as well as the underlying motivations and barriers to the incorporation of this standard in construction businesses. This research is important because it provides practical guidance to construction organizations and policy leaders on how to maintain environmentally conscious practices. The study adopts a mixed approach of surveys and interviews to construction firms adopting ISO 14001. Cost, complexity, and resistance are the central barriers, and compliance and client demand are the essential drivers. Additionally, companies that implemented ISO 14001 showed a huge increase in energy consumption, waste management as well and carbon emissions. This study highlights the need for the use of ISO 14001 as a tool towards sustainable construction practices and provides practical recommendations for overcoming the identified barriers. It also points to the need for more research on the implementation experiences of non-certified firms and the role played by emerging technologies in the operations of ISO 14001.

Keywords: ISO 14001, Environmental Management System, construction industry, sustainability, barriers, drivers.

Introduction

However, among all the problems of our time, the sustainable development is one of the most important. As construction activities are significant contributors to environmental harm, they also provide the greatest potential for achieving sustainable development goals. According to the United Nations, sustainable development is a process through which resources are utilized sustainably, meaning that the current needs are met, and enough is left for the future generations. Based on environmental sustainability goals, the construction professionals should focus primarily on the adoption of practices that minimize environmental harm, enhance energy efficiency and conserve resources as recommended by Ball (2002). Griffith, 2002).
ISO 14001, a particular form of Environmental Management System (EMS), is well known as a key instrument for achieving sustainability goals. By ISO 14001, businesses create an extensive system for the management and control of environmental responsibilities across the globe. ISO 14001 offers guidelines for specific construction companies to operate in a sustainable manner;<< reduce waste levels, maximize energy usage and reduce the environmental impact of project works (Christini et al., 2004; Zeng et al., 2005). For startups to gain financially from an international environmental certification, they require Lam et al., 2011).
ISO 14001 has been popular in multiple sectors but is not popular in the construction sector (Horry *et al.,* 2022). However, the numerous parties that are involved in constructing the project, along with diverse

environmental effects, make it difficult to implement ISO 14001 successfully. An urgent need is henceforth to learn more about how best to integrate ISO 14001 into the methods of construction and how they can work towards the achievement of long-term sustainable goals.

Despite its massive contribution to carbon emission, waste generation, and raw material consumption, the construction industry's impact on the environment is still high. The most ambitious goal for this industry is to attain growth that is environmentally friendly because there are numerous environmental issues other than climate change that significantly deplete natural resources (Griffith & Bhutto, 2009; Yusoff et al., 2015). Yusoff et al., 2015). However, the adoption of ISO 14001 in construction firms has been haphazard and in some cases inadequate, despite being encouraged for extensive use in other industries. Financial is one of the major factors that hinder practical application of ISO 14001 for many construction companies. Jackson, 1997).

Moreover, numerous firms fail to consider the long-term benefits of going green, such as cost savings, enhanced brand image, and increased levels of regulatory compliance, because there is no systematic approach towards environmental management in construction (Zutshi & Creed, 2015). To solve the above mentioned issues, the present study tries to discuss the problems encountered while implementing ISO 14001 in construction companies and describes the strategies adopted to make ISO 14001 Environmental management system more effective.

Objectives

The primary objectives of this study are:

1. To examine the barriers and drivers for the successful integration of ISO 14001 in the construction industry: This includes identifying the challenges construction firms face in adopting the ISO 14001 standard and exploring the motivations behind its implementation, such as regulatory compliance, market demand, and internal environmental goals.
2. To assess the impact of ISO 14001 implementation on the environmental performance of construction companies: This objective will explore how ISO 14001 influences key environmental metrics such as energy consumption, waste management, carbon emissions, and the overall sustainability of construction practices.

This research brings new perspectives to the ISO 14001 implementation in the construction industry by identifying distinctive opportunities and challenges of the industry. There have been previous studies of the introduction of ISO 14001 in various industries, from manufacturing to services (Petros Sebhatu & Enquist, 2007). Nevertheless, the building sector has received little attention, despite the fact that it presents certain operational and environmental challenges (Tambovceva & Geipele, 2011). By focusing on construction and expanding on the general, but not always practical, suggestions in the literature, this study fills a significant vacuum in the body of knowledge.

This research is important because it is likely to motivate construction firms to use sustainable practices, which will result in improved environmental impact and enhanced market competitiveness. There is increased need for industries to respond to climate change and depletion of resources, and the contribution of the construction industry to sustainable development is even more important. According to findings by Horry et al. (2022), the introduction of ISO 14001 helps construction firms in mitigating Zimon et al., 2022).

In addition, this study may assist industry managers and policymakers in understanding the advantages of promoting ISO 14001 adoption in the construction industry. Governments and regulatory agencies can improve their policies for supporting an environmentally conscious building industry by better understanding what deters implementation and the benefits that can be gained from integration. Analogous to this, the findings of this study can also inform future agendas for varying the design and applicability of ISO 14001 standards in construction.

Methodology

1. Research Design

This was an exploratory and descriptive research design applied. The exploratory nature of the study allowed an insight into the barriers, drivers and contextual factors that affect ISO 14001 integration in construction companies. The descriptive technique was applied to study the environmental performance of these businesses post-ISO 14001 adoption. The survey, interviews, and secondary data analysis were used to collect the qualitative and quantitative data.

2. Population and Sample

For this study the target population was the construction firms that had implemented ISO 14001 with large scale and SMEs being given priority. The sample was drawn from a number of geographical areas to get an overview of the different challenges and drivers in different regulatory environments.

Sampling Strategy:

- **Survey Participants:** For the quantitative survey, a randomly selected sample of 100 ISO 14001-certified construction companies was selected for contacting. In order to ensure variation in answers, the sample was stratified by project scale, firm size, and geographic location.
- **Interview Participants:** 15–20 important employees from the chosen companies, such as sustainability officers, environmental managers, and upper management, participated in in-depth semi-structured interviews. The reasons for adopting ISO 14001, as well as the obstacles and difficulties faced during implementation, were better qualitatively understood thanks to these interviews.

3. Data Collection Methods

Quantitative Data Collection: The primary tool for collecting quantitative data was a structured questionnaire. The questionnaire was organized in such a way as to gather the barriers, drivers, and consequences of the ISO 14001 implementation on environmental performance. It had Likert scale and multiple-choice questions in the following areas:
Barriers to ISO 14001 Implementation: Cost, complexity, lack of knowledge, and resistance to change.
Drivers for Adoption: Regulatory compliance, client demand, internal environmental goals, and competitive advantage.
Environmental Performance Metrics: Energy consumption, waste management practices, carbon emissions, and sustainability of construction practices.
The questionnaire was accessible either by email or in person, and follow-up was conducted to ensure a high response rate.
Qualitative Data Collection: Qualitative data were collected using semi-structured interviews. The themes around which the interview guide was constructed were as follows:

- **Challenges and Barriers:** Exploring the specific challenges faced by construction firms in implementing ISO 14001, including financial constraints, operational disruptions, and the perception of ISO 14001 as an unnecessary burden.
- **Motivations for Adoption:** The reasons for an organization's adoption of ISO 14001, such as compliance obligations, market competition, customer requests, or a real dedication to sustainability.
- **Impact on Environmental Performance:** Understanding the long-term effects of ISO 14001 on key environmental metrics, such as improvements in waste management, energy efficiency, and carbon footprint reduction.

Interviews were conducted through video or phone conferencing for remote participants and in person for local participants. All sessions were recorded and transcribed with participant consent for thematic analysis.

4. Data Analysis

Quantitative Data Analysis: Statistical analysis techniques such as those for describing data were used to examine survey results and identify the key factors that promote or discourage firms from adopting ISO 14001. An analysis of results using mean, median, and standard deviation allowed us to reveal the major influential factors. Also, the use of inferential statistical methods such as correlation analysis and chi-square tests enabled an evaluation of the relationships between firm characteristics (size, location, project type) and the effectiveness of ISO 14.
Qualitative Data Analysis: Using thematic coding, common themes and important patterns that emerged from the responses of the interviews were identified in the data. Using thematic coding, the researcher grouped themes into larger categories such as "environmental performance", "implementation drivers" and "ISO 14001 challenges". The use of this approach allowed the researcher to draw conclusions and increase knowledge about the reasons for the adoption of ISO 14001 in construction firms.
A member check process was used to verify the findings, where the participants were able to view the results and verify them for accuracy. In addition, triangulation was also used to validate findings by examining both survey and interview findings.

Results

This section presents the results of a survey of construction businesses that are certified under ISO 14001. It examines why businesses decided to adopt ISO 14001, what problems occurred during the process, and how the environmental performance was enhanced. The results reported here were derived from the analysis of tables and visual data using descriptive statistics.

1. Barriers to ISO 14001 Implementation

The report outlines various major barriers to construction companies effectively implementing ISO 14001. Cost, complex processes, lack of knowledge and reluctance to adopt new methods were the major challenges mentioned by companies. Participants rated each barrier using a Likert scale, and a higher score meant greater impediments.

Construction firms reported cost (mean score = 4.0), complexity (mean score = 3.7), and lack of knowledge (mean score = 2.6) as the main challenges. Resistance to change was also a major challenge with a mean score of 3.6, which means that firms always find it hard to implement organizational change that is needed to adopt new management practices. The variation in responses indicated that there were differences in firm size and project scale, with larger firms reporting fewer barriers than smaller firms, probably because of their availability of resources. Table 1 shows the mean values for every identified barrier. Figure 1 graphically illustrates the distribution of responses to barriers, with the most important challenges to ISO 14001 adoption.

Table 1: Mean Scores for Barriers to ISO 14001 Implementation

Barrier	**Mean Score**
Cost	4.0
Complexity	3.7
Lack of Knowledge	2.6
Resistance to Change	3.6

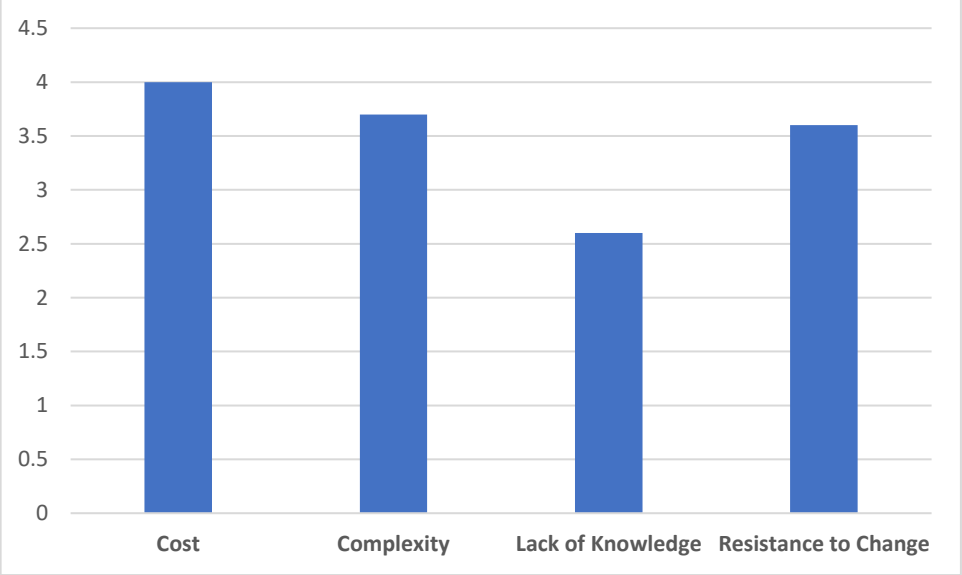

Figure 1: Barriers to ISO 14001 Adoption

2. Drivers for ISO 14001 Adoption

Regarding the drivers of adoption of ISO 14001, the survey found the following main drivers: regulatory compliance (mean score = 4.9), client demand (mean score = 3.7), internal environmental goals (mean score = 4.3), and competitive advantage (mean score = 4.3). The results indicated that regulatory compliance was the most important component in the implementation of ISO 14001, and this means that legal and regulatory pressures were a strong driver for construction companies. The relatively high level of the client demand score indicates that many construction companies have embraced ISO 14001 to align themselves with the client's environmental needs.

Furthermore, based on the poll, a significant part of businesses was driven by their internal environmental objectives (mean score = 4.3), which indicated that there is a real commitment to sustainability. Firms based on the competitive advantage (mean score = 4.2) dimension adopted ISO 14001 to differentiate themselves from the competition and show that they were willing to take up environmental stewardship. The average values for each of the identified drivers are presented in Table 2. The drivers are shown graphically in Figure 2, and they show the main driving components that will make businesses implement ISO 14001.

Table 2: Mean Scores for Drivers of ISO 14001 Adoption

Driver	**Mean Score**
Regulatory Compliance	4.9
Client Demand	3.7
Environmental Goals	4.3
Competitive Advantage	4.3

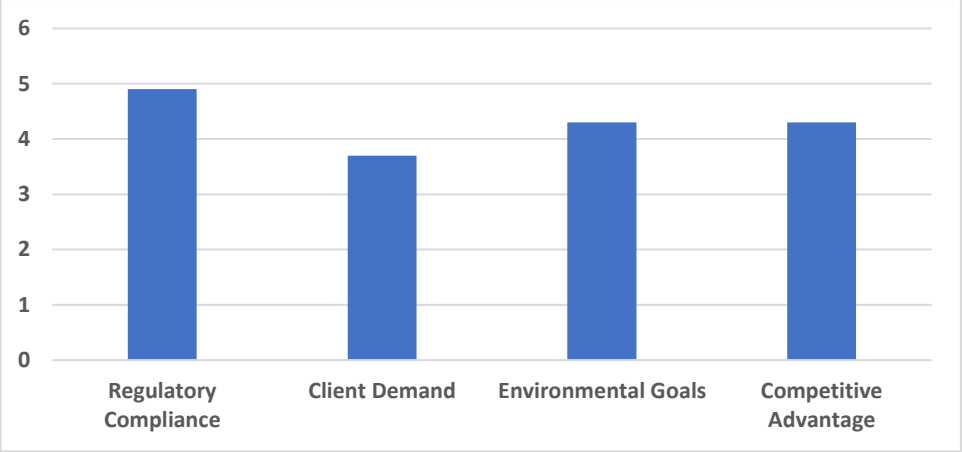

Figure 2: Drivers for ISO 14001 Adoption

3. Environmental Performance Improvements Post-ISO 14001 Implementation

This section contains the results of the survey among construction firms that have adopted ISO 14001. The discussion examines what motivates the adoption of ISO 14001, the obstacles encountered by implementing firms, and its impact on the environmental performance of these enterprises. The analysis of the survey data and the presented results in tables and visual aids was based on the use of descriptive statistics:

Energy Consumption (Improvement): The mean score of improvement in energy consumption was 4.1, implying that firms recorded a significant reduction in energy consumption following the implementation of ISO 14001 practices.

Waste Management (Improvement): Firms reported gains in their practices in waste management with a mean score of 4.3. This implies that ISO 14001 was essential in enhancing waste reduction, recycling, and disposal processes in construction projects.

Carbon Emissions (Reduction): The reduction in carbon emissions received a mean score of 4.1, highlighting the positive impact of ISO 14001 on minimizing the carbon footprint of construction firms.

Sustainability (Overall Improvement): The overall sustainability of construction practices, on average, improved to 4.3 on the scorecard. Adoption of ISO 14001 resulted in the adoption of sustainable construction practices that would have a positive impact on the environment in future.

Table 3 shows average figures for environmental performance indicators, including sustainability improvements, waste management, energy use, and carbon emissions. Figure 3 shows improvements in environmental performance, which include energy efficiency, waste management, and carbon footprint reduction.

Table 3: Mean Scores for Environmental Performance Improvements

Environmental Metric	Mean Score
Energy Consumption	4.1
Waste Management	4.3
Carbon Emissions	4.1
Sustainability	4.3

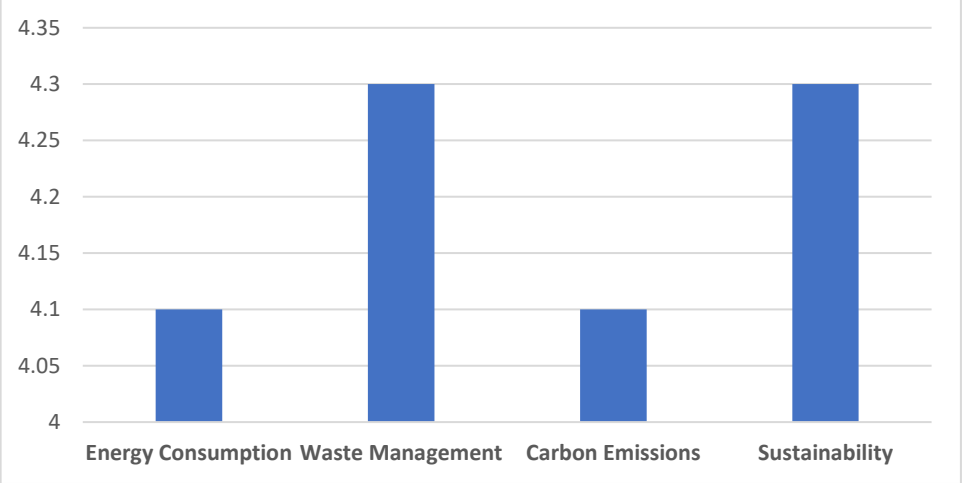

Figure 3: Environmental Performance Improvements Post-ISO 14001 Implementation

4. Statistical Analysis and Trends

The mean scores for barriers, drivers and environmental performance metrics were computed and analyzed to identify data patterns. Descriptive statistics were applied to bring out critical factors influencing ISO 14001 adoption and their results. The subsequent observations included:

1. **Barriers**: Cost and complexity were the most significant barriers, especially for smaller firms. Resistance to change also emerged as a notable challenge, indicating the need for better organizational support during the implementation process.
2. **Drivers**: Regulatory compliance was the most powerful driver, closely followed by client demand and internal sustainability goals. These drivers were more influential in larger firms compared to smaller firms.
3. **Environmental Performance**: The implementation of ISO 14001 led to major improvements in energy consumption, waste disposal, carbon footprint, and sustainability of large organizations that have plenty of resources.

Discussion

This research presents the way ISO 14001 is applied in the construction industry and its contribution to enhancing environmental performance. Implementation of ISO 14001 was hindered by high costs, complexity, lack of understanding of its benefits, and unwillingness to change, and cost was the main barrier. Further researches reinforce the idea that resistance in organizations and economic barriers are the major obstacles to businesses in acquiring and retaining certification (Griffith, 2002). Zimon et al., 2022). The smaller firms faced particularly great challenges in implementation, probably because of lack of resources and the cost of getting certification (Petros Sebhatu & Enquist, 2. Adoption of ISO 14001 was motivated by the need to comply with regulations (mean score = 4.9), meet client needs (mean score = 3.7), fulfill internal environmental targets (mean score = 4.3), and gain a competitive advantage (mean score = 4 This is consistent with earlier studies that indicate that the implementation of environmental management system is typically motivated by external factors such as government regulations and customer requests (MacDonald, 2005; Lam et al., 2011). Lam et al., 2011). Lam et al., 2011). Internal motivation to attain environmental goals was a powerful factor in adoption, which indicated an increasing awareness among construction firms to pay attention to environmental sustainability beyond the legal requirements. Adoption of ISO 14001 resulted in improvement in several key areas such as energy efficiency, waste management, carbon footprints and overall sustainability. The results show that firms recorded a decrease in energy consumption and efficient waste management (mean score = 4.1 for energy, 4.3 for waste) which is consistent to prior studies on the positive impacts of ISO 14001 on resource efficiency and waste minimization (Griffith & Bh Furthermore, reduction in carbon emissions and enhanced sustainability levels show room for ISO 14001 to help achieve other environmental targets (Christini et al., 2004). Horry et al., 2022).

Just like the current literature on environmental management systems in construction, this study shows that the same barriers impede ISO 14001 adoption. The findings of Hui Zhang et al. (2000) and other studies show that cost and complexity are major barriers to ISO 14001 certification for construction firms. Kein et al., 1999). The construction industry is plagued with significant challenges, which are primarily due to high resource needs for projects and the absence of internal capabilities to integrate environmental practices effectively (Griffith, 2002). Based on this study, the adoption drivers for construction firms are similar to those reported in the existing literature, with regulatory compliance and client demand being the main drivers. MacDonald, 2005). Internal environmental goals becoming major ISO 14001 adoption factors provide new perspectives on current debates. This shows that firms are also embracing ISO 14001 to fulfill their social responsibilities, and to promote sustainability and meet regulatory and client expectations (Horry et al., 2022). The findings of this study confirm previous research, that ISO 14001 leads to energy reduction and environmental performance gains. Zimon et al., 2022). With the construction industry's emphasis on environmental resource impacts, the implications of this study are more important.

This research highlights important recommendations that can be applied to legislators as well as to construction companies. Based on the findings of the study, construction companies are encouraged to overcome the barriers to ISO 14001 adoption especially for small businesses which are resource and operationally challenged. These businesses have better chances of obtaining favorable results with concentrated support and help, for example, government subsidies, training programs, and knowledge access to minimize the cost and complexity of ISO 14001 certification (Massoud et al., 2010). The report also lists client demand and regulatory compliance as critical drivers of the implementation of ISO 14001. Businesses that actively pursue ISO 14001 certification will have better environmental health and gain a competitive advantage in the marketplace, which will lead to long-term cost savings and will align with sustainability goals (Ofori et al., 2002). For policymakers, the research suggests that the policy measures that can be taken to increase the rate of adoption of ISO 14001 include policy measures that will increase incentives for participation such as financial support, income tax deductions or regulatory measures that will encourage environmental certification leading to increased participation in sustainable construction practices (Mustapha et al, 2017). In addition, awareness of the internal environmental goals that encourage firms to pursue ISO 14001 will help promote the widespread incorporation of sustainability into business practices (Salim et al., 2018).

There are numerous limitations on this study. First of all, since the data were from companies that had already adopted ISO 14001, the drivers and barriers described could not reflect the views of companies that had not adopted it. Future studies should consider comparing the views of ISO 14001-certified companies to those of non-ISO 14001-certified companies to understand the problems and benefits related to adoption from a more inclusive point of view (Zutshi & Creed, 2015). Additionally, the qualitative interviews had a small sample size (15-20 respondents), which could constrain the generalization of the conclusions. Even though the study adopted the random sampling methodology when conducting the quantitative survey, the limited number of interviews implies that the information gained may not reflect the experiences of all construction firms. Expanding the sample would provide richer insight into the factors behind the adoption of ISO 14001 (Zimon et al., 2022). Lastly, although this study delved into the adoption and effects of ISO 14001, it did not address other systems of environmental management that may play a part in the construction industry's attempt to promote sustainability. Future research may examine the effectiveness of different environmental standards and certifications, considering the issue from a broader perspective of using sustainable construction practices (MacDonald, 2005).

Future research should be carried out on what it is like for firms that have not adopted ISO 14001 to examine the barriers and incentives that deter such firms from adopting this. Moreover, longitudinal research that examines the long-term effects of ISO 14001 on environmental performance would help determine the sustainability benefits of such a certification over time (Christini *et al.,* 2004). A second avenue for future research may be to examine the correlation between corporate culture and leadership and the successful implementation of ISO 14001 as a useful resource. Knowledge on the role that organizational values and leadership play in the implementation of environmental management systems might shed more light on why some organizations succeed in obtaining certification and continue to improve (Horry *et al.,* 2022). Finally, an analysis of the effect of digital technology on the effectiveness and application of ISO 14001 in construction, for example, Building Information Modeling (BIM), data analytics, may produce new insights on how digital technology can improve environmental management practice in this sector (Tambovceva & Geipele, 2011).

Conclusion

From this research, we identified the major factors that either facilitate or impede the implementation of ISO 14001 in the construction industry, both barriers and drivers. The purpose of this research is to reveal the critical barriers and incentives that influence the construction industry. Also, the research examines major impediments (cost, complex processes, and resistance) and triggers (compliance requirements and pressure from clients) that affect the adoption of ISO 14001 in construction. This research also highlights important environmental benefits of ISO 14001 such as increased energy conservation, reduced waste output, and reduced carbon footprint, and its effectiveness in promoting

The findings of this investigation are of vital importance to organizations in the construction sphere and those involved in the development of policy. With the knowledge of the challenges SMEs face in 4Y implementation, this study can help construction firms to partner with SMEs during the implementation process effectively. The findings of this research allow the policymakers to customize their actions, including providing financial assistance and educational programs, to help firms adopt ISO 14001 and fulfill their environmental responsibilities.

The expansion of this study may have the capacity to change the perception of sustainability in the broader community of construction organizations. Adoption of ISO 14001 on a larger scale in construction organizations is a promising approach to global environmental goals. Detailed study of non-certified companies may reveal the barriers that they encounter while implementing ISO 14001. The incorporation of technologies like Building Information Modeling (BIM) could help to make the process of meeting the ISO 14001 standards easier and encourage sustainability in the construction industry.

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