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How do Medium-Sized Companies Decide on Technology Adoption for Environmental Management?

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A B S T R A C T

The adoption of environmental management technologies in medium-sized companies is influenced by various strategic, operational, and environmental factors. This study aims to explore the qualitative aspects of decision-making processes related to the adoption of such technologies, providing insights into the roles of internal and external stakeholders and the impact of these technologies on organizational performance. The research employed a qualitative approach, utilizing semi-structured interviews with 19 key stakeholders from medium-sized companies engaged in manufacturing, energy, and waste management. These interviews were designed to reach theoretical saturation and were analyzed using thematic analysis to identify key themes and categories relevant to technology adoption for environmental management. Four main themes were identified: Decision-Making Process, Influencing Factors, Stakeholder Roles, and Outcomes and Benefits. Under these themes, several categories emerged, such as Stakeholder Influence, Evaluation Criteria, Adoption Barriers, Technology Sourcing, Environmental Impact, Regulatory Compliance, Competitive Advantage, Internal and External Stakeholder roles, and the various environmental, organizational, and financial benefits of adopting technologies. The study concludes that the decision to adopt environmental management technologies in medium-sized companies is complex and influenced by a mix of internal strategic goals and external pressures. Effective adoption can lead to significant environmental, organizational, and financial benefits, but is often hindered by barriers like financial constraints and technological complexity.

Keywords: *Environmental Management, Technology Adoption, Medium-Sized Companies, Qualitative Research, Stakeholder Influence, Strategic Decision-Making.*

1. Introduction

In the current business landscape, medium-sized companies are increasingly pressured to adopt technologies that enhance their environmental management practices. This trend is not merely a response to growing environmental concerns but is also driven by the strategic need to remain competitive in a fast-evolving market. The adoption of such technologies, however, involves complex decision-making processes that can significantly impact a company's resources and overall strategic direction (Parsakia et al., 2023). Strategic decision-making in high-velocity environments, as Bourgeois and Eisenhardt (1988) described, requires an understanding of the dynamics that influence managerial choices under conditions of significant uncertainty and change. These environments are particularly relevant to the technology sectors that play a critical role in environmental management. Their study highlights the need for a flexible yet systematic approach to decision-making to cope with rapid changes in the market and technology landscape, which is highly applicable to the context of environmental technology adoption 2.

The literature on resource allocation emphasizes that the decision to invest in new technologies is a critical aspect of strategic management that affects a company's ability to innovate and compete (Hoxha & Sadiku, 2019; Lichtenthaler, 2008; Schiavone, 2011). In particular, the efficient allocation of internal capital is a challenge that firms must navigate to balance current operational needs with long-term strategic goals. This balancing act is particularly nuanced in the case of environmental technologies, where the benefits may accrue over a longer term and are often difficult to quantify initially.

Furthermore, the adoption of such technologies is not merely a financial decision but also a response to external pressures such as regulatory requirements and societal expectations regarding environmental responsibility (Gerhart & Feng, 2021). These decisions are influenced by both internal priorities and external demands, creating a complex landscape for decision-makers (Gholizadeh et al., 2022; Mogholi et al., 2016). Corporate social responsibility (CSR) activities, including environmental management, can enhance firm performance and competitive position, particularly when aligned with the company's strategic emphasis (Baumgartner, 2013; Bonabi Ghadim et al., 2022; Rezaei Pitenoei et al., 2021).

Risk management also plays a pivotal role in technology adoption, as companies must assess not only the potential benefits but also the risks associated with new technologies. This assessment includes understanding the challenges that may arise during the implementation and integration of new technologies into existing systems. These challenges can vary widely, from technical issues to changes in employee roles and responsibilities, necessitating a robust framework for evaluating both risks and rewards (Boukis, 2020; Kumar & Mallipeddi, 2022; Milis & Mercken, 2004; Rodrigues-da-Silva & Crispim, 2014).

The current study contributes to this body of knowledge by investigating the qualitative aspects of technology adoption decisions in medium-sized companies through semi-structured interviews. This approach allows for an in-depth exploration of the motivations, challenges, and outcomes associated with these decisions, as influenced by a variety of internal and external factors. By focusing on the experiences and insights of individuals directly involved in these processes, the study aims to provide a nuanced understanding of how medium-sized companies navigate the complex interplay of strategic, operational, and environmental considerations in their technology adoption strategies.

This investigation not only enriches the existing academic discourse on strategic decision-making and resource allocation in the context of environmental management but also offers practical insights for policymakers and business leaders seeking to foster more sustainable practices within the business community. Through this exploration, the study seeks to delineate the pathways through which medium-sized companies can enhance their environmental performance while also achieving their broader strategic objectives, contributing to a more sustainable future.

2. Methods and Materials

2.1. Study Design and Participants

This study adopted a qualitative research approach to explore how medium-sized companies decide on adopting technology for environmental management. The qualitative methodology was chosen to allow for an in-depth understanding of the decision-making processes, influenced by the subjective experiences and insights of individuals within these organizations.

Participants were selected using purposive sampling to ensure a diverse representation of medium-sized companies across various industries known for their environmental impact, such as manufacturing, energy, and waste management. The criteria for selecting companies included

those with an employee base ranging from 50 to 250 and a noted commitment to environmental management as evidenced by public sustainability reports or certifications.

The data analysis aimed to achieve theoretical saturation, where no new information or themes emerged from the interviews. The transcribed data were coded in multiple rounds to identify patterns, themes, and insights related to technology adoption for environmental management. Initial coding was followed by focused coding to synthesize and define the most significant themes.

2.2. Measures

2.2.1. Semi-Structured Interview

Data was collected through semi-structured interviews, which were designed to gather rich, detailed information while allowing for new ideas and themes to emerge. The interview protocol included open-ended questions that prompted participants to discuss their experiences with technology adoption for environmental management, the challenges faced, and the outcomes of such initiatives.

Key areas covered in the interviews included:

Decision-making processes for adopting new technologies.

Factors influencing the decision to adopt specific technologies.

Perceived benefits and barriers to technology adoption.

The role of internal and external stakeholders in the decision-making process.

Interviews were conducted by the researcher and ranged from 45 to 60 minutes in duration. All interviews were audio-recorded with the participants' consent and subsequently transcribed verbatim for analysis.

2.3. Data Analysis

The research utilized NVivo software to assist with the organization, coding, and analysis of the interview data. This facilitated the efficient sorting and retrieval of data segments related to emerging themes.

3. Findings and Results

In this qualitative study, a total of nineteen participants from medium-sized companies were interviewed to explore the decision-making process behind the adoption of technology for environmental management. The participants represented a diverse range of industries known for their environmental impact, including manufacturing (n=6), energy (n=5), and waste management (n=8). The demographic composition of the participants included twelve males and seven females, with ages ranging from 35 to 55 years. The participants held various influential roles within their companies, primarily consisting of senior management positions such as CEOs, CTOs, and Environmental Managers.

Table 1

The Results of Qualitative Analysis

Main Themes	Subthemes	Concepts
1. Decision-Making Process	Stakeholder Influence	- Executive decisions- Employee feedback- Customer demands
	Evaluation Criteria	- Cost-effectiveness- ROI analysis- Compliance with regulations
	Adoption Barriers	- Financial constraints- Lack of knowledge- Technological complexity
	Technology Sourcing	- Vendor selection- Partnership development- Technology scouting
2. Influencing Factors	Environmental Impact	- Carbon footprint reduction- Waste management improvements- Energy efficiency
	Regulatory Compliance	- Legal mandates- International standards- Local ordinances
	Competitive Advantage	- Market positioning- Innovativeness- Customer satisfaction
3. Stakeholder Roles	Internal Stakeholders	- Management- IT department- Sustainability officers
	External Stakeholders	- Government bodies- Environmental NGOs- Industry peers
	Influencer Strategies	- Lobbying- Collaborations- Public relations
4. Outcomes and Benefits	Environmental	- Reduced emissions- Improved resource utilization- Enhanced biodiversity
	Organizational	- Process efficiency- Brand image- Employee morale
	Financial	- Cost savings- Investment returns- Grant and subsidy acquisition

3.1. *Decision-Making Process*

The decision-making process for adopting environmental management technologies involves several key subthemes:

Stakeholder Influence: Participants highlighted the pivotal role of both internal and external stakeholders. One interviewee noted, "Executive decisions are largely influenced by immediate customer demands and direct feedback from our employees."

Evaluation Criteria: Companies evaluate potential technologies based on a variety of criteria. "We primarily look at cost-effectiveness and ROI, but compliance with environmental regulations can't be ignored," one manager explained.

Adoption Barriers: Financial constraints, a lack of in-depth technological knowledge, and the complexity of new technologies were commonly cited barriers. "The main hurdle is often financial, but sometimes it's just the daunting complexity of the technology itself," a participant remarked.

Technology Sourcing: The process of selecting and sourcing technology involves careful consideration. "We spend a lot of time vetting vendors and looking for reliable partners who can provide cutting-edge solutions," mentioned another interviewee.

3.2. *Influencing Factors*

Several factors influence the decision to adopt environmental technologies:

Environmental Impact: Companies are motivated by the potential for significant environmental benefits. "Reducing our carbon footprint and managing waste more efficiently are top priorities," one leader shared.

Regulatory Compliance: Adherence to regulations drives technology adoption. As one interviewee stated, "We have to stay ahead of legal mandates and international standards to not only comply but to lead in our industry."

Competitive Advantage: Gaining or maintaining a competitive edge is also a critical factor. "By adopting these technologies, we're not just complying with laws but also enhancing customer satisfaction and market position," explained a participant.

3.3. *Stakeholder Roles*

The role of stakeholders was emphasized across two main subthemes:

Internal Stakeholders: "Management's involvement is crucial, but so is the input from our IT department and sustainability officers," a participant described.

External Stakeholders: The influence of external parties such as government bodies and environmental NGOs is significant. "Industry peers also play a role, as we often look to collaborative efforts to tackle environmental challenges," noted another.

Influencer Strategies: Strategies employed by influencers include lobbying, collaborations, and public relations. "We engage in lobbying to shape environmental policies that are realistic and beneficial for the industry," one executive mentioned.

3.4. *Outcomes and Benefits*

The adoption of environmental technologies leads to diverse outcomes:

Environmental: Benefits such as reduced emissions and enhanced biodiversity were highlighted. "The most tangible benefit has been the dramatic reduction in our emissions," an interviewee proudly stated.

Organizational: Improvements in process efficiency, brand image, and employee morale are significant. "Our brand image has improved, and so has employee morale, as they feel they are contributing to something meaningful," shared a leader.

Financial: Financial impacts include cost savings and investment returns. "The financial benefits, such as cost savings and acquiring grants, make these investments worthwhile," a CFO explained.

4. Discussion and Conclusion

The qualitative analysis of the semi-structured interviews conducted with stakeholders from medium-sized companies revealed four main themes concerning the adoption of environmental management technologies. These themes were: Decision-Making Process, Influencing Factors, Stakeholder Roles, and Outcomes and Benefits. Each theme comprised various categories that captured the nuanced aspects of the technology adoption process within these companies.

The theme of the Decision-Making Process encapsulated several key categories: Stakeholder Influence, Evaluation Criteria, Adoption Barriers, and Technology Sourcing. Stakeholder Influence highlighted the pivotal role played by both internal and external stakeholders in guiding decision-making, with concepts such as executive decisions,

employee feedback, and customer demands being prominent. Evaluation Criteria focused on how companies assess potential technologies, emphasizing the importance of cost-effectiveness, return on investment (ROI), and regulatory compliance. Adoption Barriers were identified as significant hurdles, including financial constraints, lack of knowledge, and technological complexity. Lastly, Technology Sourcing dealt with the methods through which companies select and procure new technologies, with vendor selection, partnership development, and technology scouting as the primary considerations.

Influencing Factors addressed the external and internal pressures influencing technology adoption decisions. This theme included categories such as Environmental Impact, Regulatory Compliance, and Competitive Advantage. Environmental Impact was discussed in terms of reducing carbon footprints, improving waste management, and enhancing energy efficiency. Regulatory Compliance covered the necessity of adhering to legal mandates, international standards, and local ordinances. Competitive Advantage was seen in terms of improving market positioning, innovativeness, and customer satisfaction.

The theme of Stakeholder Roles shed light on the involvement and influence of different groups within and outside the organization. It consisted of Internal Stakeholders, External Stakeholders, and Influencer Strategies. Internal Stakeholders included management, IT departments, and sustainability officers, emphasizing their roles in decision-making processes. External Stakeholders encompassed government bodies, environmental NGOs, and industry peers, focusing on their impact on organizational policies and practices. Influencer Strategies revealed methods like lobbying, collaborations, and public relations used to shape environmental policies and practices.

Finally, the theme of Outcomes and Benefits highlighted the various positive impacts of adopting environmental technologies. The categories under this theme were Environmental, Organizational, and Financial. Environmental benefits included reduced emissions, improved resource utilization, and enhanced biodiversity. Organizational benefits were identified as improvements in process efficiency, brand image, and employee morale. Financial benefits comprised cost savings, investment returns, and the acquisition of grants and subsidies, highlighting the economic advantages of adopting sustainable technologies.

The findings from this study provide significant insights into the decision-making processes of medium-sized companies regarding the adoption of technologies for environmental management. The results highlight several critical themes including the influence of stakeholders, the factors driving technology adoption, the roles of internal and external stakeholders, and the outcomes of adopting environmental technologies. These themes resonate with and are supported by existing literature, as discussed below.

The strong influence of both internal and external stakeholders in the technology adoption process was a recurring theme in our findings. This is consistent with the assertions made by Bourgeois and Eisenhardt (1988), who emphasized the role of dynamic environments in shaping strategic decision processes (Lichtenthaler, 2008; Parsakia et al., 2023). Our study extends this perspective by specifically highlighting how stakeholder influence within medium-sized companies can direct technology adoption decisions, reflecting the complex interplay of internal preferences and external pressures. Similarly, researchers discuss the importance of internal capital allocation decisions, suggesting that the engagement of stakeholders at various levels of the organization enhances decision-making efficacy, a finding mirrored in our research (Bonabi Ghadim et al., 2022; Gerhart & Feng, 2021).

Participants in this study noted several barriers to technology adoption, including financial constraints, technological complexity, and a lack of in-depth knowledge. This aligns with the challenges identified by prior studies in the construction industry, where risk assessment plays a crucial role in managing project challenges. Our findings suggest that similar assessments are critical in technology adoption for environmental management, with firms needing to navigate these barriers carefully to implement new technologies effectively (Kumar & Mallipeddi, 2022; Milis & Mercken, 2004; Rodrigues-da-Silva & Crispim, 2014).

Moreover, the factors influencing technology adoption, such as environmental impact and regulatory compliance, echo the literature on resource allocation and decision-making. These studies highlight the necessity of explicit decision criteria in resource allocation, suggesting that such structured approaches are beneficial in managing the complexities associated with adopting new technologies .

The distinct roles of internal and external stakeholders highlighted in our study also reflect previous findings that noted the strategic importance of CSR activities, including environmental initiatives, in enhancing firm performance. The strategic emphasis on environmental management not only aligns with corporate goals but also with broader societal expectations, thereby supporting competitive

advantage. This dual focus on internal benefit and external compliance is indicative of the sophisticated balancing act that firms must perform (Baumgartner, 2013; Bonabi Ghadim et al., 2022; Rezaei Pitenoei et al., 2021).

The reported outcomes of adopting environmental technologies—such as enhanced environmental performance, organizational improvements, and financial benefits—corroborate the prior findings that highlighted the efficiency gains from adopting risk-based inspection technologies in engineering (Bonabi Ghadim et al., 2022; Boukis, 2020; Hoxha & Sadiku, 2019; Kumar & Mallipeddi, 2022; Schiavone, 2011). Our study extends this to environmental technologies, suggesting that similar benefits can be achieved in terms of operational efficiencies and strategic gains.

This study explored the decision-making processes involved in the adoption of technologies for environmental management within medium-sized companies. Key findings highlighted the crucial role of both internal and external stakeholders in shaping these decisions. The data revealed that the primary drivers for technology adoption included environmental impact considerations, regulatory compliance, and competitive advantage. The process was often hindered by barriers such as financial constraints, technological complexity, and a lack of in-depth technological knowledge. However, successful adoption led to significant environmental, organizational, and financial benefits, demonstrating the multifaceted impact of environmental technologies on medium-sized enterprises.

The research underscores the complexity of technology adoption decisions within medium-sized companies, influenced by a dynamic interplay of internal strategic goals and external environmental pressures. The findings reveal that effective technology adoption not only addresses regulatory and environmental concerns but also enhances competitive advantage and operational efficiency. This study contributes to a deeper understanding of how medium-sized companies can strategically navigate the challenges and opportunities presented by environmental technologies.

This study has several limitations. First, the reliance on semi-structured interviews, while providing in-depth data, may also introduce subjectivity in the responses and limit the generalizability of the findings. Additionally, the sample size, though adequate for qualitative saturation, may not fully capture the diversity of medium-sized companies globally. Finally, the focus on specific industries may not account for the variations in technology adoption processes found in other sectors.

Future research could expand on this study by incorporating a larger and more diverse sample of companies across different geographical regions to enhance the generalizability of the findings. Quantitative methods could also be employed to validate and extend the qualitative insights obtained, providing a more robust framework for understanding the factors influencing technology adoption. Moreover, examining the long-term impacts of adopted technologies on environmental and financial performance could offer deeper insights into the sustained benefits and challenges of these initiatives.

The findings from this study offer practical implications for managers and policymakers. Companies are encouraged to engage stakeholders at all levels in the decision-making process, ensuring that diverse perspectives are considered. Additionally, managers should develop robust evaluation frameworks that not only assess the financial and operational impacts of technologies but also consider their long-term environmental benefits. For policymakers, the study highlights the importance of creating supportive environments that facilitate the adoption of environmental technologies, such as through incentives or clearer regulatory guidelines. This could help alleviate some of the barriers identified, such as financial and technological challenges, fostering a more sustainable approach to business practices in medium-sized enterprises.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

In this research, ethical standards including obtaining informed consent, ensuring privacy and confidentiality were considered.

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