

Article

Challenges and Solutions in Green Innovation Practices: A Case Study of a Manufacturing Firm in Turkey

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Abstract

This study aims to identify the fundamental barriers to the implementation and success of green innovation practices in Turkey, a developing country, through in-depth interviews, as well as to determine strategies to address the causes of these barriers. Responses to semi-structured questions were collected through interviews of employees in management positions, and qualitative data analysis was performed using the content analysis module in the Maxqda24 program. Following interviews with 11 participants, a total of 150 codes were generated under four themes. Drawing on the participants' experiences regarding how green innovation practices should be converted into competitive advantages from a broad perspective, possible strategies and solutions to emerging problems were examined under each theme. A review of the literature revealed that the vast majority of studies on green innovation practices are based on quantitative methods and do not include case studies; thus, there remains a lack of practical explanations. There are gaps in the literature regarding the steps followed and the types of strategies developed by companies that have successfully implemented green innovation practices. In particular, studies addressing the obstacles encountered in green innovation practices lack information on how to solve these problems.

Keywords: green innovation practices; strategic management; green innovation barriers; Turkey; semi-structured interviews



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1. Introduction

The rapid growth of the global economy has led to financial benefits, but has also led to increased environmental pollution and ecological degradation. Over the past 20 years, along with the development of the concept of sustainability, there has been a significant increase in environmental sensitivity regarding organizational activities. Especially in industrial contexts, the transition to green innovation practices has accelerated in parallel with sustainable business strategies. With this transition, businesses have been encouraged to fulfill social responsibilities. However, existing studies have indicated that not all businesses have transitioned towards green innovation practices to the same extent. The complex progression of environmental awareness has led to considerable concern among governments, suppliers, customers, and producers, and each country has attempted to tailor its environmental protection measures to its own conditions [1,2].

A review of the literature reveals that the vast majority of businesses contribute directly or indirectly to reductions in environmental pollution [3–5]. As a result, businesses have been forced to include environmental elements into their strategic plans [1,6,7].

It has also been observed that organizations that incorporate sustainability into their business strategies also emphasize green innovation practices. Ultimately, innovation is critical to gaining a competitive advantage in the market [1,8]. Businesses must remain competitive in the face of rapid technological developments, and innovative businesses must operate efficiently while also being able to respond quickly to customer demands [9]. Successful innovation is a process that involves significant investments in terms of time, labor, and money. In this context, green innovation practices combine environmental considerations with innovative approaches, serving as a bridge between the economy and the environment.

In line with the above findings, a review of the relevant literature reveals that green innovation practices have mostly been documented in developed countries in Asia and Europe. In particular, research conducted in China is export-oriented and supported by government policies. Turkey, on the other hand, is a developing country which is in a critical position regarding green innovation. It is predicted that green innovation practices will yield macroeconomic benefits for businesses, in addition to corporate benefits related to the integration of management systems. On the other hand, although green innovation is expected to give businesses a competitive edge, there have been limited case studies on the obstacles and uncertainties encountered during this process and their relevant solutions. Therefore, this study aims to reveal the strategies and success factors related to the experiences and expertise of senior managers in a manufacturing company ranked in the ISO Top 100 ranking. In this context, internal and external factors were identified by drawing on the experiences of these experts, allowing recommendations to be developed from a managerial perspective.

Based on the aim of the study and the conceptual framework, this research is guided by the following research questions:

- RQ1—How do leadership and decision-making processes shape the adoption and implementation of green innovation practices within manufacturing firms?
- RQ2—What are the key barriers hindering the implementation of green innovation practices in manufacturing firms operating in Turkey?
- RQ3—Which basic solution areas are identified by senior managers in order to overcome barriers to green innovation practices?
- RQ4—Which improvement areas are perceived as critical for strengthening and sustaining green innovation practices in the long term?

2. Conceptual Framework

2.1. Green Innovation Practices and Sustainability

Although the environment is the fundamental resource provider for businesses, uncertainties, imbalances, and environmental degradation lead to various managerial problems. Managing such problems and seeking relevant solutions has made businesses more open to development [10].

With this knowledge, perspectives in the production and service sectors have changed, increasingly becoming oriented towards environmentally friendly behavior. When resources are used consciously, waste and environmental pollution may be prevented and recycling and environmental problems can thus be minimized. This determined transformation began globally with the 1972 Stockholm Conference. Under the banner of sustainability, attention has been drawn to issues such as global warming, climate change, species extinction, declining productivity, and reduced capacity. From this perspective, green innovation

is a fundamental concept affecting sustainability. According to the OECD [11], green innovation refers to the creation or implementation of new or significantly improved products (goods and services), processes, marketing methods, organizational structures, and corporate regulations that lead to environmental improvements compared to alternatives. In the literature, green innovation is split into three categories: green process innovation, green product innovation, and green managerial innovation [12–15]. Green product innovation is defined as the development of sustainable products; green process innovation is defined as production activities related to waste reduction, recycling, and raw material usage; and green organizational innovation refers to the application of management practices to reduce the environmental impacts of business activities [15].

Studies in the literature, such as that of Porter [8], indicate that innovation provides a competitive advantage. This advantage is achieved through new business methods and models, particularly environmentally friendly processes; it is known that green innovation practices are a driving force behind sustainability through the development of new business models.

Oltra and Saint Jean defined green innovation as the name collectively given to products, technologies, and systems used to benefit the environment [16], while Chen et al. described green innovation as technological products and activities that save energy, prevent greenhouse gas emissions, and affect the waste conversion process [13]. Arfi et al. emphasized that green innovation is the name collectively given to new ideas, products, and activities that mitigate environmental issues while achieving sustainability goals [17]. Environmental awareness is a factor considered by consumers when making product choices, with conscious consumers tending to avoid businesses that offer products and services contributing to environmental problems. Due to increasing legal requirements, media scrutiny, and pressure (from environmental groups, NGOs, and environmentally conscious customers) [18], businesses have been forced to take substantial steps [19,20]. Furthermore, businesses have been compelled to develop environmentally focused strategies to address consumer concerns as a result of global or regional activities. Thus, it is critical to develop environmentally conscious strategies, adopt environmentally friendly production technologies while creating a brand image, and adapt marketing strategies accordingly [21]. Consumers' increasing environmental awareness is reflected in product/service demands, highlighting the importance of green innovation for businesses. Through green innovation practices, businesses support sustainable development at the macro level while also contributing to the financial structure of the business at the micro level; that is, the competitive advantage that businesses gain through green innovation practices reduces their costs while increasing the quality and efficiency of input transformation processes [8]. These market- and stakeholder-driven pressures make green innovation not only an environmental necessity but also a strategic imperative for manufacturing firms.

2.2. Leadership and Decision-Making in Green Innovation

The manufacturing industry needs to take greater responsibility for environmental issues. However, viewing environmental issues as a problem within a company may result in a loss of competitive advantage [22–25]. Therefore, examining green innovation practices in the Turkish manufacturing sector is considered an important step towards sustainability. Proactive managerial support for green innovation practices can emerge as a collective activity that increases business performance while also enabling continuous improvement [26]. Green management, which results from the management and integration of green innovation practices, also encompasses the positive effects of every step taken by a business to reduce and prevent environmental pollution, waste, and emissions [27]. From a business ethics perspective, fulfilling sustainability responsibilities towards stakeholders,

the environment, and even the world should be the fundamental aim of every business. It is believed that the strategic integration of these green innovation practices into the management sphere requires the joint efforts of all stakeholders and leaders. These practices, which primarily target economic prosperity, require leaders who resolutely implement strategic policies and programs [28,29]. When evaluated in terms of processes, it has been observed that managers support environmental practices more for the economic benefits of sustainability rather than prioritizing ethical and social values [30].

Innovation practices centered on sustainability have been increasingly discussed over the past 10 years [31–34]. Environmental issues have been the most significant problem observed, leading to strategic changes [35], including the creation of strategies based on environmental rather than financial factors [36,37]. Along with increased awareness regarding this issue, the transition to practices such as clean production, life cycle production, or environmental design has accelerated [38,39].

2.3. Barriers to Green Innovation Practices

A review of the literature revealed that very few studies have addressed the barriers to green innovation. For example, Christopher et al. examined barriers to green innovation in production lines in the UK and the Netherlands, and listed the following as key barriers: transition and unit cost increases, the risk of changes in consumer needs and expectations, retailers' influence on the decision-making process, lack of consumer demand and willingness to pay a premium, technology/retail product acceptance, high risks and unproven technologies, limited perceived benefits, lack of environmental and production competencies, and inconsistent policies from regulatory bodies [40]. Huang et al. examined the barriers to green innovation practices in the Vietnamese manufacturing sector using an interpretive model [41]. They noted financial structural limitations, a lack of government support and incentives, and competition and uncertainty in the market. In the literature, it has also been observed that green innovation practices contribute to business sustainability. For example, Lin and Xie reported that green product innovation has an impact on financial performance and corporate reputation [42], and Padilla-Lozano and Collazzo stated that companies implementing green innovation strategies are more competitive [43]. Arsawan et al., Malk et al., Niazi et al., Başköy and Öztürk, Le et al., and Kumar et al. all concluded that green innovation practices have a positive effect on environmental performance [44–49], while Wang et al. stated that the technology related to green innovation practices increases operational efficiency and reduces energy costs in the long term [50]. However, some studies have reported conflicting results. Qiang and Yang found no relationship between green product innovation and environmental performance in their study focused on 214 manufacturing companies in South America [51]. Qin et al., reviewing 224 studies, showed that the literature on green innovation practices can be separated into resource-based, sustainable value-based, and corporate environmental approaches [52]. They found that, while green innovation produces various benefits including non-financial outputs such as reputation/green image its effects are mostly long-term, indirect, and uncertain.

2.4. Solution Areas and Improvement Mechanisms for Green Innovation

Green innovation practices, which have been highlighted as a critical priority by the European Commission, positively contribute to competitive advantages for both businesses and countries [53–56]. As the requirements and enforcement of environmental laws and regulations increase, it has been observed that businesses adapt to them and improve their performance [57,58]. It has been reported that incentives motivate businesses; notably, it has been estimated that the low-carbon energy product sector will exceed USD 500 billion per

year by 2050 [59]. Alnaim et al. noted that challenges such as high R&D costs and internal stakeholder resistance make it difficult to implement green innovation, and even companies that are suitably prepared may not take this risk [60]. Wang et al. examined the impact of green innovation on profitability, emphasizing that it varies from company to company depending on government policies and consumer awareness [61]. Some studies have observed that green innovation has a limited direct impact on financial performance [62]. Another study indicated that factors such as high R&D costs, lack of technical knowledge, and uncertain investment returns are among the main obstacles that companies face in the transition to green innovation [63]. However, relevant solutions are typically not discussed in the literature. In the context of developing countries, it has been emphasized that institutional capacity, lack of regulation, and financing constraints play significant roles in hindering the spread of green innovation [54,64]. Silv rio et al. systematically examined green innovation strategies in their study and observed that green innovation increases performance and competitive advantage [65]. According to Zhang et al., stakeholder integration is vital in promoting green innovation because it enables companies to respond to and be aware of the diverse needs and contributions of their stakeholders through their environmental strategies [66]. Gelmez and I  klar observed that green process innovation improves both environmental and business performance [67]. According to Jamal, the industry context should be included alongside company factors when designing and promoting environmental policies [68]. In particular, ensuring sufficient infrastructure should be a focal point. Development of waste management systems, environmentally friendly transportation networks, and renewable energy facilities can also minimize the damage to the environment caused by production [69]. K  tahyalı and Y  ldız stated that green innovation practices within corporate sustainability help to increase business performance while reducing environmental damage [70]. Kazdal et al. mentioned that there is a positive and meaningful relationship between green innovation and corporate sustainability [71]. Education campaigns and environmental awareness programs can play important roles in increasing public understanding regarding the importance of sustainability and the impacts of human activities on the environment [72].

Recent regulatory developments, particularly the European Union’s Carbon Border Adjustment Mechanism (CBAM), have emerged as a significant external pressure shaping green innovation practices in export-oriented manufacturing firms. The aim of the CBAM is to prevent carbon leakage through imposing carbon-related costs on imported goods based on their embedded emissions, thereby extending the EU’s climate policy beyond its borders. For manufacturing firms in emerging economies such as Turkey, which maintains a strong trade relationship with the EU, the CBAM creates both compliance challenges and incentives to adopt green innovation. In this context, green innovation becomes not only an environmental commitment but also a strategic response to regulatory pressure, encouraging firms to invest in cleaner technologies, improve energy efficiency, enhance emissions monitoring, and integrate sustainability into organizational processes. Accordingly, the CBAM functions as an external institutional driver that reinforces the importance of proactive leadership and organizational capabilities in facilitating green innovation and sustainable transformation.

2.5. Research Gap and Positioning of the Study

There are few studies in the literature that explain the barriers to green innovation and subsequently address solutions. Musaad et al. and Chien et al. specifically mentioned legal barriers in their studies [3,73].

Tseng et al. stated that technology and management functions in green innovation should be divided into different categories based on product designs and activities, but

noted that most studies focus on only one of these aspects, thus highlighting other areas for investigation in the field [15].

Furthermore, some studies in the relevant literature have examined green innovation practices only from a financial and fiscal perspective [30,74–78].

It has been determined that there are biases in the existing literature on green innovation. Most empirical studies have examined the outcomes of green innovation practices (e.g., financial, environmental, or reputational performance) through econometric modeling using quantitative methods. While these studies contain valuable and generalizable information, they offer limited insights into how green innovation is implemented in organizational settings, how managers perceive obstacles, and how they develop solutions. Studies with a qualitative design, and even in-depth case studies involving managerial decision-making and organizational dynamics, are quite rare. Consequently, practical explanations are lacking in the literature, particularly for developing countries like Turkey. This study directly addresses this gap with an in-depth qualitative case study approach based on semi-structured interviews with senior managers. It is expected that this study will contribute to the literature by offering concrete, sector-specific strategies for promoting the achievement of sustainable development goals in Türkiye.

3. Materials and Methods

The study employed a qualitative research method known as case study. A case study is a qualitative research approach that helps to obtain in-depth information when limited information is available on a given research topic [79,80].

In this research, using a semi-structured interview form consisting an in-depth interview method was employed (i.e., a method for collecting data conveyed by research participants regarding their experience and areas of expertise). This method enables researchers to obtain rich data by accessing the feelings, thoughts, and opinions of different experts with different perspectives [81,82].

3.1. Sample

The research sample consisted of managerial employees from a packaging manufacturing company operating within the manufacturing sector which ranks among the ISO Top 500 industrial enterprises in Turkey. In the Turkish manufacturing context, relatively few firms operate at a large scale while maintaining a high export intensity and actively implementing sustainability and green innovation practices. The ISO Top 500 list, published annually by the Istanbul Chamber of Industry, is based on objective criteria such as production volume, sales revenue, export performance, and value creation. Inclusion in this list indicates a high level of organizational maturity and compliance with internationally recognized management and sustainability standards. For these reasons, the selected company represents a suitable and information-rich case for examining green innovation practices.

The company was selected through convenience sampling, and its name has been kept confidential in accordance with ethical principles. Face-to-face, in-depth interviews were conducted with 11 senior managers, each possessing between 13 and 18 years of industry experience. The interviewees included one sustainability engineer, one sustainability manager, three aerosol managers, three plastics managers, and three industrial and metal managers.

The sample size was determined based on the principle of data saturation, a widely accepted criterion in qualitative research. Following interviews with 11 senior managers, no new themes or substantive insights emerged, indicating that theoretical saturation had been reached. Previous methodological studies suggest that data saturation is typically

achieved in interview-based qualitative research with approximately 10 to 15 participants, particularly when the sample consists of knowledgeable participants with substantial professional experience [79,83]. Considering the seniority of the participants, their involvement in strategic decision-making processes, and their extensive industry experience, the selected sample size was deemed sufficient to ensure analytical depth, methodological rigor, and the credibility of the study findings.

A semi-structured interview approach was adopted to collect in-depth qualitative data. The interview protocol consisted of open-ended questions designed to explore key dimensions related to green innovation practices. The interview guide was developed in alignment with the conceptual framework presented covering the main themes of leadership and decision-making, barriers to green innovation, basic solution areas, and improvement mechanisms.

The semi-structured format allowed for flexibility during the interviews, enabling participants to elaborate on their experiences while ensuring consistency with the conceptual framework. The interview questions used in this study are provided in Appendix A.

Table 1 presents the demographic and professional characteristics of the research participants. All participants were engineering graduates and held senior-level positions as production managers in manufacturing plants, indicating a high level of technical expertise and organizational responsibility. The sample consists exclusively of male participants, with ages ranging from 34 to 67 years and professional experience between 13 and 18 years, reflecting extensive industry knowledge. The interviews were conducted online via the Zoom platform at the request of the participants, as they were employed within the same organization but worked in manufacturing facilities located in different provinces, making face-to-face interviews impractical. Interview transcripts ranged from 5 to 11 pages, indicating a rich and in-depth qualitative dataset.

Table 1. Summary of research participants.

Participant Code	Gender	Age	Professional Experience (Years)	Education	Positions Held
K1	Male	45	18	Bachelor's Degree	Senior Executive
K2	Male	40	15	Master's Degree	Senior Executive
K3	Male	43	13	Bachelor's Degree	Senior Executive
K4	Male	52	17	Bachelor's Degree	Senior Executive
K5	Male	46	13	Bachelor's Degree	Senior Executive
K6	Male	41	17	Master's Degree	Senior Executive
K7	Male	55	14	Master's Degree	Senior Executive
K8	Male	45	18	Master's Degree	Senior Executive
K9	Male	43	16	Bachelor's Degree	Senior Executive
K10	Male	67	16	Master's Degree	Senior Executive
K11	Male	45	18	Bachelor's Degree	Senior Executive

3.2. Validity and Reliability

Validity and reliability were addressed through specific, concrete applications of the study protocol throughout the research process. To enhance internal validity, the interview protocol and research design were reviewed and revised with expert opinions prior to data collection. During the pilot study phase, the suitability of interview questions to the research topic and their alignment with research objectives were evaluated; data collection and analysis processes were finalized accordingly.

Analytical reliability was supported by transparent reporting of sample size and the rationale for participant selection, as well as by clearly explaining the data saturation process. Interview transcripts were iteratively reviewed during the analysis process and

codes and themes were reviewed to ensure consistency with the data; direct quotations are included in the findings section to demonstrate that the interpretations were data-driven.

Ethical and procedural reliability was ensured by informing participants about the purpose of the research, data usage, and their right to withdraw from the study at any stage. While statistical generalizability of the findings was not the goal, the transferability of the results to similar institutional and sectoral contexts was supported through detailed contextual descriptions [84].

4. Results

This study is based on a qualitative analysis of interviews with senior executives and reveals the key obstacles to green growth and the solution mechanisms to overcome these obstacles. The findings are developed under four flexible themes: leadership and decision-making in green innovation, obstacles to green innovation, key solutions to these obstacles, and areas for improvement to tackle these green innovation barriers (Figure 1).

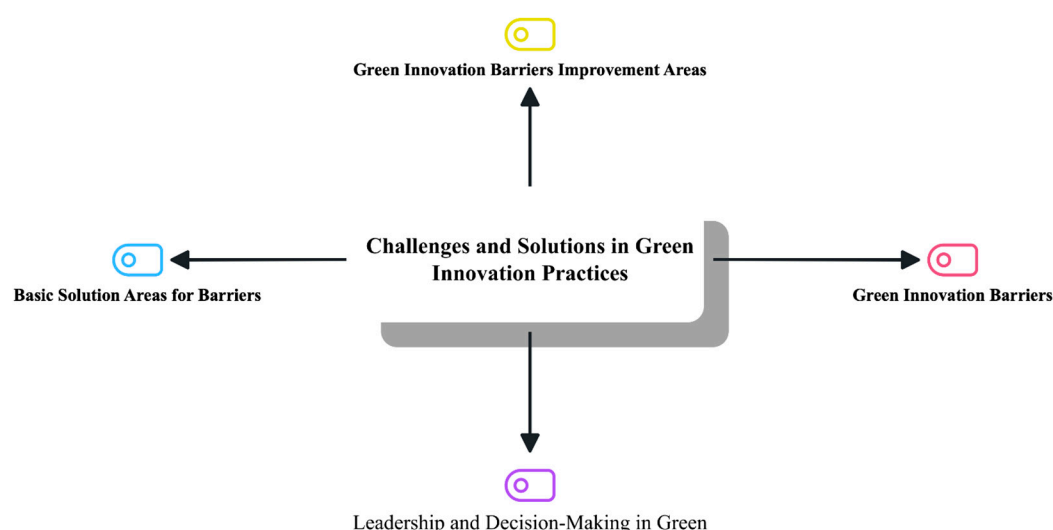


Figure 1. Presentation of themes.

Table 2 shows the themes, codes, and frequencies obtained from the qualitative analysis conducted in this study. The frequencies reveal which issues participants prioritize most in green innovation practices.

The findings indicate that leadership and decision-making processes play a significant role in the implementation of green innovation, with management support and leadership influence having high frequencies. This suggests that strong leadership support and the effective implementation of decisions are considered fundamental elements for green innovation.

The results show that the most significant obstacles to green innovation are human-related factors, the quality of recycled materials, and financial constraints. Employee reaction, the quality of recycled materials, and investment costs are among the most frequently cited problems, while regulatory and supplier-related issues also stand out as significant obstacles.

From a solution perspective, financial support and energy investments are seen as key tools for overcoming these obstacles. At a more strategic level, regulatory compliance, cost-saving projects, and employee participation in the process are considered important for ensuring that green innovation practices are carried out in compliance with both economic and legal requirements.

Table 2. Research scope.

Codes	Frequencies
1. Leadership and Decision-Making in Green Innovation Theme	0
1.1. Management Support	7
1.2. Integration of the Decision into Implementation	6
1.3. Proactive Decision-Making	5
1.4. Leadership Impact	7
2. Green Innovation Barriers Theme	0
2.1. Infrastructure Problems	4
2.2. Problems Experienced in Regulation	6
2.3. Investment Return Process	3
2.4. Employee Response	7
2.5. Supplier Awareness	5
2.6. Decision-Making Process	3
2.7. Recycling Material Quality	7
2.8. Investment Cost	7
3. Basic Solution Areas for Barriers Theme	0
3.1. Education and Awareness	3
3.2. Energy Investment	6
3.3. Financial Support and Incentives for Investments	7
3.4. Raw Material Standardization	4
3.5. Pre-Planning for Regulations	4
4. Green Innovation Barriers Improvement Areas Theme	0
4.1. Strategy Development	7
4.2. Supply Chain Harmonization	6
4.3. Sustainable Education	6
4.4 Regulatory Compliance	8
4.5. Focus on Cost-Saving Projects	8
4.6. Ensuring Employee Participation	7
4.7. Recycling Raw Material Supply	6
4.8. Renewable Energy Investment	5
4.9. Digital Tracking Systems	6

Overall, leadership support, effective cost management, regulatory compliance, and employee engagement stand out as key factors determining the success and sustainability of green innovation practices.

Table 3 summarizes the distribution of challenges and solutions related to green innovation practices with different themes based on qualitative analysis conducted using MAXQDA 24. The findings indicate that green innovation barriers—improvement areas represents the most frequently emphasized theme, highlighting participants’ strong focus on solution-oriented practices such as regulatory compliance, cost-saving initiatives, employee participation, and digital tracking systems. This is followed by green innovation barriers, which reflect key regulatory, financial, organizational, and operational challenges encountered during implementation. Leadership and decision-making in green innovation emerged as a moderately high-frequency theme, underscoring the importance of managerial support, leadership impact, and proactive decision-making processes. In contrast, basic solution areas for barriers was a theme mentioned less frequently, suggesting that while foundational mechanisms such as education, pre-planning, and financial incentives are recognized, they are perceived as supportive rather than dominant drivers of green innovation practices.

Table 3. Thematic frequency distribution of challenges and solutions in green innovation practices.

Main Theme	Sub-Themes/Codes	Total Frequency (f)	Interpretation
Green Innovation Barriers	Problems Experienced in Regulation (6); Employee Response (7); Investment Cost (7); Infrastructure Problems (4); Decision-Making Process (3); Supplier Awareness (5); Recycling Material Quality (7); Investment Return Process (3)	42	High
Leadership and Decision-Making in Green Innovation	Leadership Impact (7); Management Support (7); Proactive Decision-Making (5); Integration of the Decision into Implementation (6)	25	Medium–High
Basic Solution Areas for Barriers	Pre-Planning for Regulations (4); Education and Awareness (3); Financial Support and Incentives for Investments (7); Energy Investment (6)	20	Medium
Green Innovation Barrier Improvement Areas	Regulatory Compliance (8); Strategy Development (7); Focus on Cost-Saving Projects (8); Ensuring Employee Participation (7); Sustainable Education (6); Digital Tracking Systems (6); Recycling Raw Material Supply (6); Renewable Energy Investment (5); Supply Chain Harmonization (6); Raw Material Standardization (4)	63	

4.1. Leadership and Decision-Making in Green Innovation Theme

When the findings were examined, it was determined that leadership and decision-making processes related to RQ1 play a critical role in the adoption and implementation of green innovation practices in manufacturing firms. Participants emphasized that strong support from higher management facilitates the integration of green innovation practices into operations. They stated that proactive decision-making accelerates employee adaptation and reduces resistance to change. Furthermore, the findings indicate that leadership vision helps improve organizational culture. The identification of employee motivation as a critical factor indicates that it positively influences participation and commitment to green innovation initiatives. Four codes were created for the “leadership and decision-making in green innovation” theme, including managerial support, integration of decisions into practice, proactive decision-making, and leadership impact.

Figure 2 illustrates the relationships among the sub-dimensions identified under the main theme of “leadership and decision-making in green innovation”, as well as the relative emphasis placed on each dimension during the interviews. The central position of the main theme represents the integrative role of leadership and decision-making processes in shaping green innovation practices. The arrows extending from the center indicate the key subcodes that constitute this theme and reflect their conceptual connections.

The numbers shown in parentheses correspond to code frequencies, indicating how many times each sub-dimension was referenced by participants during the qualitative analysis conducted using MAXQDA. In this context, leadership impact (7) and management support (7) exhibit the highest frequencies, highlighting the critical importance of these sub-themes in enabling green innovation initiatives. The subcode integration of the decision into implementation (6) underscores the significance of effectively translating strategic decisions into operational practices, suggesting that implementation capacity plays a vital role in the success of green innovation. Proactive decision-making (5) reflects the emphasis placed on

forward-looking and anticipatory managerial actions, which support firms' ability to adapt to environmental challenges and regulatory pressures.

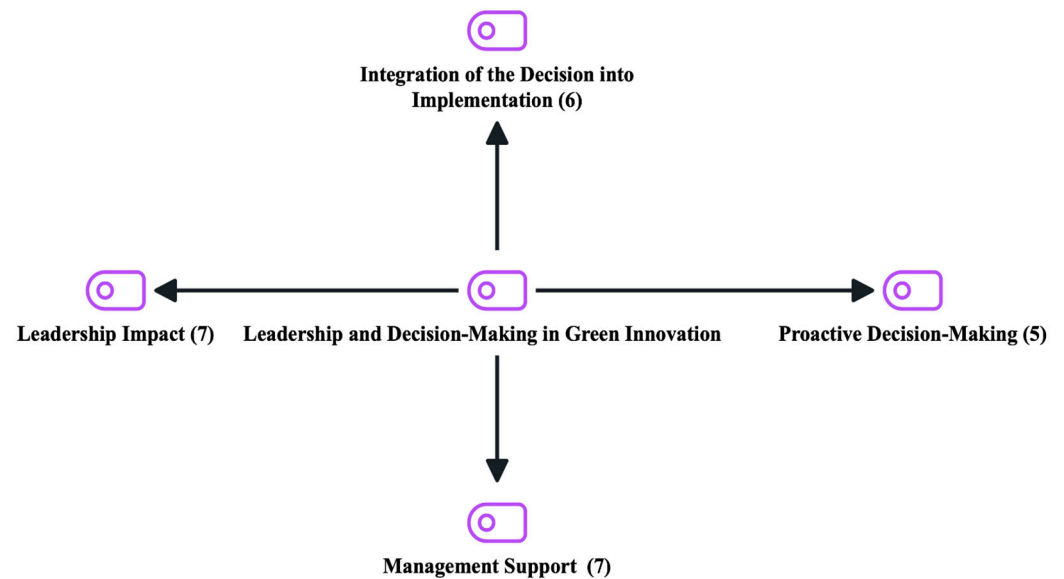


Figure 2. Hierarchical code–subcode display for the leadership and decision-making in green innovation theme.

Overall, the figure demonstrates that leadership and decision-making in green innovation are multidimensional processes that extend beyond strategic intent to include implementation mechanisms and organizational support. By presenting these interrelated dimensions together with their frequency values, the figure provides a holistic view of how managerial practices contribute to the effective adoption of green innovation within the studied organization.

Table 4 displays the frequency at which four subcodes (management support, integration of the decision into implementation, proactive decision-making, leadership impact) were mentioned by the participants in various positions. The results indicate that plant managers, particularly those in the metal and plastic manufacturing sectors, were more actively involved in green innovation processes. A total of 22 codes were generated, highlighting the significant role of leadership and decision-making in shaping sustainability initiatives across different organizational levels.

Table 4. Detailed results for the leadership and decision-making in green innovation theme.

RQ1	Sustainability and Process Engineer	Sustainability Manager	Aerosol Manufacturing Plant Manager	Plastic Manufacturing Plant Manager	Metal Manufacturing Plant Manager	Total
Management Support		1	1	2	2	6
Integration of the Decision into Implementation		1	2	1	2	6
Proactive Decision-Making			3	1	1	5
Leadership Impact		1		2	2	5

4.1.1. Management Support

The code managerial support, related to the theme of leadership and decision-making, implies that leaders play a role in decision-making through strategic headings. This process involves decisions made not only by the board of directors, but also in regular

meetings conducted by an internally formed committee. Participants K1 and K2 mentioned the following:

“We have a sustainability committee chaired by our CEO that sets goals. This Sustainability Committee holds meetings at specific intervals. They set goals and communicate these goals to us through various notes and publications”. (K1)

“Our company has a sustainability committee chaired by our CEO, and we implement the decisions taken together with collective wisdom. There are monthly, quarterly, six-monthly, and weekly meetings if necessary. This process is carried out with consultants and company members chaired by the sustainability officer, Mr. R., who is based at our headquarters”. (K2)

4.1.2. Integration of the Decision into Implementation

The participants emphasized that strategies to manage human resources, which could be created to address the resistance that may occur when implementing decisions made by committees, are important for leadership and decision-making in green innovation. Participant K4 made the following statement on this subject:

“If you set it up correctly from the employee’s perspective, you don’t encounter resistance. I can say we are lucky in that regard. Employees adapted very quickly to the Promanage (Manufacturing Execution System) process. There isn’t a heavy workload on the operator. We don’t expect too much effort from the operator. We just need them to enter the expected downtime. Let’s say the machine stopped. The operator first provides this information. Then they write down the reason. For example, it stopped due to power consumption, the machine hose burst, the machine stopped. We want them to enter this as data. It’s not a very serious workload, but some factories are very successful, while others are not. I would like to point out that we are making very good progress in our plastic factories at the moment”. (K4)

4.1.3. Proactive Decision-Making

Leadership efforts toward green innovation practices should not be limited to environmental regulations; when managing this process, it is critically important for leaders to analyze risks and opportunities correctly. Indeed, Rennings—who emphasized that environmental innovations should become a strategic goal for businesses—points out that leadership plays a decisive role in this process [85].

Participants K4 and K9 mentioned the following regarding this topic:

“We need proactive approaches rather than reactive ones. As a result, we have used energy and resources abundantly. Then let’s go collect the waste from the trash and reuse it. Yes, we will collect it, but this will remain a reactive approach. We cannot manage the crisis or take corrective action. We actually need to approach and think in terms of preventive action or risk management, even a proactive approach. I think pre-engineering studies can be extremely effective in this important area. One of the most important points when we make decisions is to guide our customers in the right direction. How can I reduce the weight of this product from 100 grams to 95 grams, 90 grams, or 80 grams while maintaining the same physical properties? This is our main goal. What does this achieve? It allows us to produce using less raw materials, less energy, and leaving a smaller carbon footprint. Today, at ÇEVKO (Environmental Protection and Packaging Waste Recycling Foundation) meetings at, many international companies leave no trace. They say they use recycled raw materials for their products. But the caps they produce are colored. There are many colors available, such as red, green, and purple. Water bottles are produced, but the caps are black or red. There is no need for such production. If you don’t produce them

in colors, you will have taken a proactive approach to production. If you produce red caps, green caps, or colored products and put them on the market, the environment will suffer. Saying that you collected and reused them after this incident does not prove that you are environmentally conscious. You should not do it in the first place". (K4)

"What is the purpose of a business? To make a profit. How can we reduce our costs and generate this profit? In the past, there was a selling price for a product. We call this the cost minus the remaining amount, which was our profit. Now there is a market price. You reduce your costs and the profit remains. The more you reduce your costs, the more profitable and competitive your company becomes. You can become more competitive by reducing your costs through both digital and sustainability practices. Continuing with the Promanage example, I would like to mention an incident that occurred yesterday evening. Two of our machines in Çerkezköy stopped at around 7 p.m. Under normal circumstances, it is not possible to monitor these by phone. But with an app on your cell phone, you can see which machine is down and why from your home. We intervened immediately. Despite being a major malfunction, it was back in operation within 7–8 hours. So how did this help? Everyone reduced each other's costs. Because the operator comes to the factory to produce. If the operator waits at the malfunctioning machine, this becomes a labor cost. Similarly, a malfunctioning machine constantly causes waste and raw material loss. Thus, with quick control, the problem is solved quickly and the cost is also reduced. This makes us more competitive". (K9)

4.1.4. Leadership Impact

When any innovation is implemented in a company, it is important for factory leaders to take the lead in encouraging employees to adopt the new strategies. Several studies have addressed barriers to employee acceptance of green innovation practices, but few have offered solutions. However, the present case analysis shows that strategic leadership at the company helped to manage this process effectively. Participants K2 and K5 commented on this as follows:

"Here, awareness is of critical importance, and we help motivate people to increase their awareness. We hold meetings on this topic, led by factory managers. There are daily Asakaya meetings. There are Obeye meetings. Of course, we can ensure continuity with kaizens, A3s, and 5S meetings related to these. We can further increase employee motivation in this way. Information is provided through brochures, meetings, and training documents. The company allocates resources to us for such practices and projects. We also make preparations for the process together with the employees". (K2)

"Leadership is a critical step for employee motivation. We try to support them with suggestion systems. We also expect support from them through this suggestion system. Small rewards are given here. We conduct three-month training, followed by monthly evaluations. We have one consultant. Not just for this issue. More of a consultant related to lean production. For example, if there was a study related to energy here, they are examined. We have a small formula here. We evaluate under certain headings. For example, there are specific questions such as quality authority, efficiency authority, environmentalism authority, and material consumption authority. So, is there quality authority? No, it gets zero points there. Is there OHS authority? Yes, it gets 10 points there. Does it ensure less material consumption? Yes, it gets 50 points. We have a multiplier at the bottom of our list; the multiplier determines the specific reward that will be given directly to us. So, some people get a thank you, while others might get 2000 lira, 3000 lira, or 4000 lira. They receive a reward based on that evaluation. Maybe they gain visibility. Maybe they win a pair of shoes. We have an automated system for this kind of evaluation". (K5)

4.2. Green Innovation Barriers Theme

An examination of the findings related to RQ2 revealed multiple barriers hindering the adoption of green innovation practices in manufacturing firms. Participants highlighted infrastructure issues, regulatory challenges, long payback periods, and high investment costs as key obstacles. They specifically reported that strict environmental regulations, particularly those related to exports, complicate compliance processes. They noted that insufficient financial incentives and limited government support slow down green innovation investments. Most companies stated that they generally have to meet their financing needs using their own resources.

Eight codes were created under this theme: infrastructure problems, regulatory issues, investment return process, employee response, supplier awareness, decision-making process, recycling material quality, and investment costs.

Figure 3 illustrates the main theme of “green innovation barriers” and the key challenges identified through the qualitative analysis. The central theme represents the overall category of barriers, while the surrounding elements indicate specific obstacle areas encountered during the implementation of green innovation practices. The numbers in parentheses represent code frequencies, showing how often each barrier was mentioned by the interview participants.

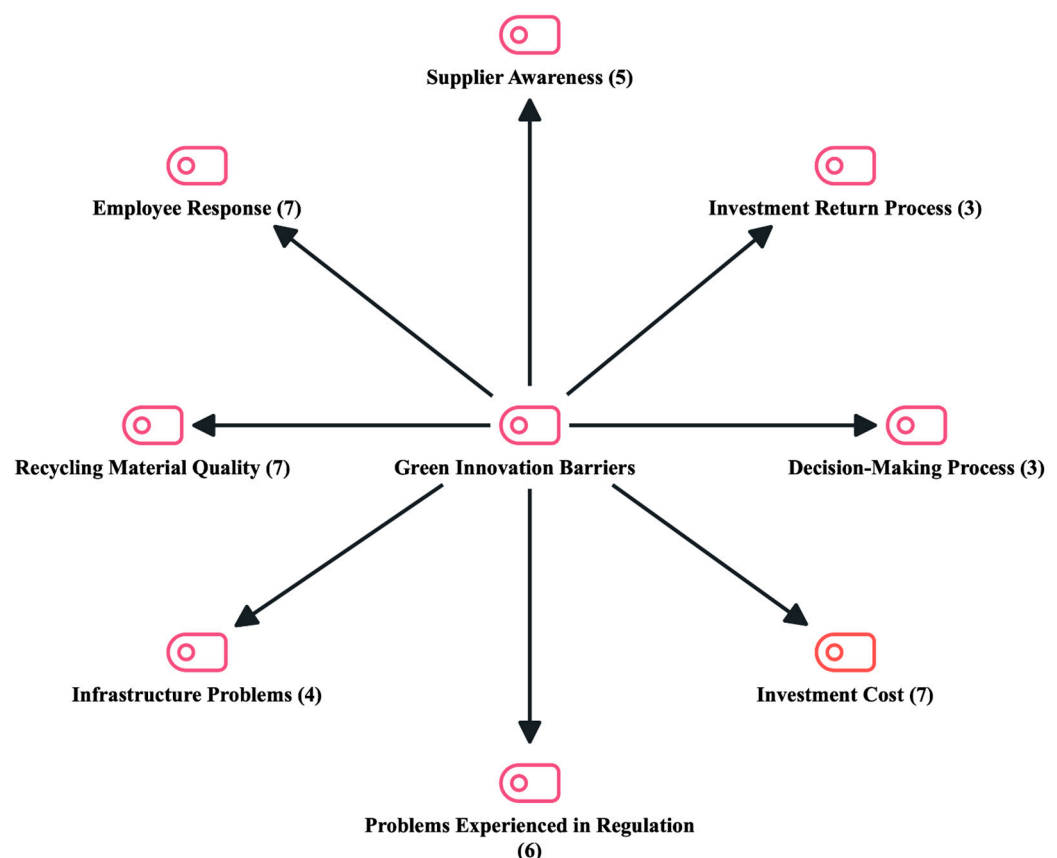


Figure 3. Hierarchical code–subcode display for the green innovation barriers theme.

The most frequently cited barriers are investment cost (7), recycling material quality (7), and employee response (7), highlighting financial constraints, material-related challenges, and organizational resistance as major obstacles. The mention of problems experienced in regulation (6) and supplier awareness (5) indicates that regulatory complexity and limited environmental awareness within the supply chain also pose significant challenges. Infrastructure problems (4), the investment return process (3), and the decision-making

process (3) were mentioned less frequently, suggesting that while these issues exist, they are perceived as relatively less critical.

Overall, the figure shows that green innovation barriers are multidimensional, involving financial, regulatory, organizational, and supply chain-related factors.

Subcodes under the “green innovation barriers” theme were distributed according to participant role.

Table 5 illustrates the distribution of eight subcodes representing various barriers to green innovation, as reported by participants in different roles. The most frequently mentioned challenges include recycling material quality (5), the decision-making process (5), and problems experienced in regulation (5).

Table 5. Detailed results for the green innovation barriers theme.

RQ2	Sustainability and Process Engineer	Sustainability Manager	Aerosol Manufacturing Plant Manager	Plastic Manufacturing Plant Manager	Metal Manufacturing Plant Manager	Total
Infrastructure Problems	0	1	1	3	1	6
Problems Experienced in Regulation	0	1	2	1	1	5
Investment Return Process	0	0	2	0	0	2
Employee Response	1	0	3	1	0	5
Supplier Awareness	0	1	2	1	0	4
Decision-Making Process	0	1	1	1	1	4
Recycling Material Quality	0	0	1	2	2	5
Investment Cost	1	0	1	2	2	6

Notably, plastic manufacturing plant managers and metal manufacturing plant managers were the most common codes (13 and 10, respectively), suggesting that frontline managers are more exposed to implementation-level obstacles. Meanwhile, participants in sustainability roles emphasized concerns related to investment costs, regulatory issues, and infrastructure problems.

A total of 35 codes were generated under this theme, revealing a wide range of perceived challenges that vary by function and industry sector.

4.2.1. Infrastructure Problems

Participants stated that infrastructure problems created significant challenges for them in the implementation processes. Participant K6 mentioned the following on this subject:

“There is no incentive for technological innovation. Certain criteria exist. There are rules regarding greenhouse gases, energy consumption, and waste, but they are not sufficient. The government sets the criteria, and waste is controlled for gas, paint, and production. These are the important issues in production. It is already impossible to give an award. We are experiencing difficulties even in what we want to do. For example, I want to talk about solar energy systems (GES). It is planned to be established in the Gebze campus as well. They have been established in the Adana-Manisa campuses. There is a technical aspect to this system. The reason it has not been established yet is that the transformer power here may or may not be sufficient, and there are also issues with obtaining permits. Even the lack of sufficient infrastructure for the GES project here changes the cost. These processes are constantly being discussed. Even if you want it, the process is difficult to move forward in this way. They said incentives would be provided, so we waited, and we also put our money on the line financially, but the lack of regular industrialization is breaking our backs. These difficult conditions affect us more than our cost problems; it is

the failure of the state to create suitable conditions. We interpret this situation as perhaps there being a problem at the starting point". (K6)

4.2.2. Problems Experienced in Regulation

The participants stated that changes in regulations affected the mandatory participation in implementation, and that they were trapped in this situation regarding exports. Participant K5 mentioned the following on this subject:

"We act in accordance with Swiss and European standards as required by export regulations. Decisions are made in this direction. Europe's stance is clear. If your carbon footprint is not at a certain level, if recycled products are not used, if renewable energy is not used in production, even the best product will remain unsold. Laws abroad are quite strict. Both suppliers and customers are aware of this. Therefore, it is an important responsibility for us to renew and monitor our resources in a controlled manner". (K5)

4.2.3. Investment Return Process

The participants stated that they faced cost challenges in the investments to be made, and that they had to wait to see the benefits of the investment while managing this process. In addition, participant K4 mentioned the following:

"We developed our own R&D. We are converting the trial-and-error automation into investments using our own financial resources. For us, even the free air circulating in the factory is considered waste and is controlled. The cost of the automation required for this control system is quite high. The automation we have acquired will cover its own costs in at least 3 years and then work for us to generate profit. The environment is important to us. We have a structure that gains value as we value our employees, our suppliers, and our environment. This is what sets us apart from our competitors. However, in this process, just as the law supports us, the state must also contribute to us". (K4)

4.2.4. Employee Response

The participants mentioned that employees resisted the implementation of green innovation strategies. Explaining the importance of convincing them and supporting change, participants K3 and K11 mentioned the following:

"To overcome employee resistance, we visit them on-site. We visit employees on-site. Because some of our employees cannot use computers, especially older people. We are also working to digitize sustainability issues as much as we can. The SAP (Systems, Practices, and Products in Data Processing) program is an actively used software. Thanks to this program, we can access our historical data, and we want to support this infrastructure in the field of sustainability as well". (K3)

"Prejudice is the biggest reaction. Employees who see these systems complain to us, saying things like, 'Are you dissatisfied with our work? Is there a problem? Can't we do our jobs?' They say machines can't save money better than us. When we set up these systems, their initial reaction was to not touch them at all. We couldn't get them to accept it easily. We provided continuous training. We taught them how to use it at the device. We addressed their concerns. We tried to break down their prejudices, and we succeeded. Now we provide training to our employees when we hire them. We have created teams that will continuously support our colleagues and our teams. If a problem arises, they immediately connect to the relevant unit and solve the problem quickly". (K11)

4.2.5. Supplier Awareness

The participants mentioned that, due to a lack of necessary awareness of procurement processes, procurements that were not in line with green innovation strategies were carried out. Participant K5 mentioned the following on this subject:

“We have some problems with the customers we work with. As a plastic manufacturer, our main goal is to consume less plastic. We are looking for the answer to the question: How can we manage the current business by producing less plastic? In my opinion, there are shortcomings on the customer side. Because sometimes we go to our customers with very innovative projects. For example, we indicate that we can produce a plastic bottle weighing 100 grams under the same conditions down to 70 grams, but when the process takes longer, we cannot get support from suppliers. I think this is the biggest problem we face”. (K5)

4.2.6. Decision-Making Process

The participants stated that the necessary resolve is not being shown with regard to green innovation. Participants K4 and K10 mentioned the following regarding this issue:

“In line with the institution’s main objectives, and also because I am a technical person, I always try to make decisions with careful consideration of the subject matter. For example, if we are going to order a machine, we try to choose one that is a new generation machine and uses scarce resources more appropriately, and also causes minimal damage to the environment. In line with those goals, the solution we want does not immediately present itself; we encounter many obstacles. We try to overcome them and manage the decision-making process accordingly”. (K4)

“I worked for many years in this field, even with this database, in my previous career. I think we have made very little progress in some areas. In others, we have made sudden progress. Wind energy took off when you least expected it. It is very important for the government to take consistent steps in this regard. Leadership and education are important”. (K10)

4.2.7. Recycling Material Quality

Regarding this theme, the participants who mentioned having problems with the quality of recycled materials stated that the recycling process is not as easy as it seems. Participants K5 and K9 mentioned the following on this subject:

“Recycling is an area full of laws. In fact, many laws are one of the biggest obstacles to recycling. For example, today it is illegal to use recycled material in food packaging. It is prohibited according to the decisions of the Turkish Food Codex. You cannot use recycled packaging material. By recycling, I mean material that has been collected from the trash and processed. You cannot use this. I think this is a huge obstacle. Because technology has now developed to such an extent that there is a value called IV, which is a value that provides fluidity. You change the IV of these materials by passing them through X-rays at the facilities. With today’s technology, forget about food freedom; you are now altering the material itself. A long time ago, there was a notion that materials converted back to food freedom couldn’t be used. These existed in the years 2014–2015, as stated in the Turkish Food Codex. We need to move past these issues here, pave the way for producers, and support them. And as in the UK example, support should be provided to those who reach a certain level in this regard. The law also provides support. Perhaps there should be support such as tax breaks. Do you know why this support is important? It is important for this reason: today, you buy a material for \$1000, and you don’t buy this material from Turkey; 99% of it comes from countries like Germany, Arab countries, Mexico, and South

American countries. Let's assume you buy it for \$1000. Then you take this material, put it into a visual facility, separate it, process it, and it comes back to you. Currently, the separation cost is higher than the raw material cost. So, while you buy a raw material for \$1000, you can buy recycled material for \$1200. That's why these supports are important. You can do this, yes, for certain customers. Without charging a price difference. But if the government doesn't support these issues and doesn't pave the way, this will never improve. As long as it doesn't improve, no one will say, 'I'll pay more, but I'll use 20% recycled material'. (K5)

"We have a customer in the UK. Tetroselit is a mineral oil company. They make vehicle maintenance products. Not just mineral oil, but car shampoo and vehicle interior cosmetic products. And we produce a very significant amount of these products each year, though I don't have the exact figures in mind. Now, after this law came into effect, we wanted to produce packaging from 30% recyclable raw materials in the UK. However, every time we bought Recycle HDP or Recycle polypropylene from the market, we received materials of varying quality. So, the bags you buy in stores are also polyethylene. The 200-liter barrels are also polyethylene. The 1-ton tanks we call IVC are also polyethylene. But one is LDPE, Low Density Polyethylene. Another is HDPE, High Density Polyethylene. Those are the large 200-liter barrels we call big grams. They are High Molecular Weight HDPE. Now you can only produce from HDPE. When you try to produce bottles from LDPE, i.e., plastic bags, you cannot achieve good quality. When you try to produce from high molecular weight HDPE, you will again encounter problems during bottle production. For this reason, a company was established within S.Bünyesi. PetPak recycling. We processed our own scrap and went one step back in the chain to try to achieve more traceable production. We succeeded. That was the challenge for us. Now, it's what we call battle-to-battle recycling. What was this recycled material in its previous life? Was it a bag, a barrel, or a bottle? It was a bottle, okay. We take bottle waste. We crush it ourselves, we wash it ourselves. Then we use it in bottle production and use recycled material with minimum quality acceptance. And we have started using it for other customers who request it. This was a challenge for us". (K9)

4.2.8. Investment Cost

The investment costs for all the raw materials needed to produce the technological tools for use in green innovation practices are quite high. As most companies cannot afford these investment costs, they stand back and remain unenthusiastic about green innovation. The participants stated that financial assistance is needed in this regard. Participants K2 and K10 mentioned the following:

"Government support and policies are critically important in today's competitive environment. I believe the government could pave the way a little more in terms of external competition. There are difficulties. It is definitely an important issue in economic terms, related to purchasing and finance. Because the processes are becoming more difficult every day. Some investments in solar energy are planned, while others are even delayed. Here, government decisions play a bigger role". (K2)

"We have benefited from Ges, but not everywhere yet; we are striving for change, such as automation, which is costly, but I am not sure if the support is sufficient. Within energy management, we have placed more emphasis on automation systems in some areas, but we expect that climate control will also be a requirement. We are applying for as much as we can get". (K10)

4.3. Basic Solution Areas for Barriers Theme

When the findings related to RQ3 were examined, it was observed that senior executives identified various solution areas for overcoming obstacles to green innovation practices. It was emphasized that education and awareness play a critical role in supporting successful green innovation practices. Furthermore, it was observed that training activities increased employee awareness and positively contributed to recycling and energy management practices. Financial support and investment incentives were identified as key fundamental solutions, particularly regarding energy investments. Emphasis was placed on the standardization of recycled raw materials and ensuring sufficient pre-planning periods for compliance with environmental regulations. Five codes were created for this theme, including education and awareness, energy investment planning, financial support and incentives for investments, raw material standardization, and advance planning for regulations.

Figure 4 presents the main theme “basic solution areas for barriers” and illustrates the key solution areas identified through the qualitative analysis. The central node represents the overarching solution framework, while the surrounding elements indicate the primary strategies proposed by participants to overcome green innovation barriers. The numbers in parentheses denote code frequencies, reflecting how often each solution area was mentioned during the interviews.

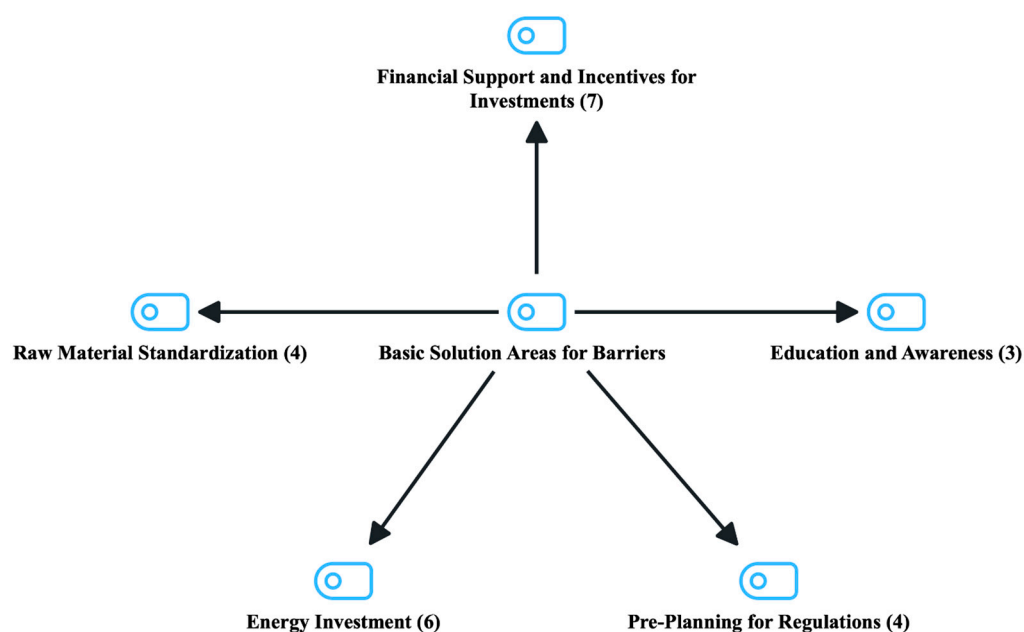


Figure 4. Hierarchical code–subcode display for the theme of basic solution areas for barriers.

Among the identified solution areas, financial support and incentives for investments (7) and energy investment (6) emerged as the most frequently mentioned, highlighting the importance of financial mechanisms and energy-related investments in facilitating green innovation. Raw material standardization (4) and pre-planning for regulations (4) indicate the need for structural and regulatory preparedness, while the mention of education and awareness (3) reflects the role of training and knowledge dissemination in supporting sustainable practices.

Overall, the figure demonstrates that addressing green innovation barriers requires a combination of financial support, technological investment, regulatory planning, and organizational learning.

Table 6 presents the distribution of five subcodes reflecting the participants' suggestions for overcoming barriers to green innovation. The most frequently cited solutions include raw material standardization (5) and financial support and incentives for investments (4), followed by energy investment (4).

Table 6. Detailed results related to the basic solution areas for barriers theme.

RQ3	Sustainability and Process Engineer	Sustainability Manager	Aerosol Manufacturing Plant Manager	Plastic Manufacturing Plant Manager	Metal Manufacturing Plant Manager	Total
Education and Awareness		1	1		1	3
Energy Investment			1	1	2	4
Financial Support and Incentives for Investments	1		2		2	5
Raw Material Standardization			2	2		4
Pre-Planning for Regulations	1		2			3

Aerosol and metal manufacturing plant managers contributed the most responses (8 and 5, respectively), indicating their hands-on understanding of practical solutions in industrial contexts. Meanwhile, participants in sustainability-related roles highlighted the importance of education and awareness and pre-planning for regulations as proactive strategies for facilitating green innovation.

A total of 19 codes were generated under this theme, suggesting a balanced mix of operational, financial, and regulatory strategies proposed by different functional roles.

4.3.1. Education and Awareness

The participants stated that they primarily focused on education and awareness as fundamental solution areas for barriers to green innovation practices. They mentioned that, when initiating innovation, they first had to raise awareness and then educate people on what these concepts entail. Participant K8 stated the following on the subject:

“A world without packaging is not possible. Because no food product should be unpackaged; we might consider it dangerous from a health perspective. Because packaged food products always have the producer’s name on them and indicate when they were produced. When you encounter a problem, you know what to do, but that’s not the case with no packaging. This packaging doesn’t mean that either. Packaging isn’t what pollutes the world. Actually, it’s about education because when you look at how high recycling is; recycling is higher in educated and more developed countries. Maybe in Japan this rate is 100%, but I don’t know about Africa. I don’t think this rate is the same in India either. That’s why education is important for all of us. Within equal innovation. The same applies to green innovation; we must be conscious first, then overcome these obstacles through education. It is very valuable to raise awareness among our employees by telling them that they are also saving their children’s future. We are succeeding in this. We put signs on toilets, for example, or hang posters saying not to leave the lights on and to save water. For example, we talk about green innovation, we talk about sustainability, there is definitely a topic every month, they look at that table and try to do what they can”. (K8)

4.3.2. Energy Investment

The participants mentioned that these practices, particularly in the field of energy investment, had a significant impact on them in the year they were implemented.

Participants K7 and K11 discussed the following:

“Energy is everything in production. Using less energy is very valuable to us. We have 22 factories. There are many machines inside, and we would like them all to be energy

efficient, but replacing all the motors and the entire system at the same time is a bit difficult. Sometimes we get stuck in such areas. Other than that, there are areas that are easy for us. We converted the interior of the factory to LED lights. We changed the drying systems for our printing machines. They used to be oven-based and natural gas-powered. Now we've switched to UV. They've been operating with UV since 2012. Now there are also LED conversions. We switched to LED at our Gebze factory. The products we use with LED don't need to be on standby all the time. They operate with less energy". (K7)

"We started using infrared dryers. We used to use gas. Gas has environmental emissions. Moreover, it is costly. But thanks to these dryers, infrared dryers, we no longer use gas to dry the boxes. We consume less energy. We also have a project called GES that has started in many of our factories. These are solar energy systems on top of our factories. For example, the Adana factory meets 37% of its energy needs from GES. Another detail is forklifts. We used to use diesel forklifts, and there was smoke everywhere. We switched to gas-powered ones, which are still costly, but they don't emit smoke or gas. Most recently, we started switching to electric ones. Many of our factories have switched to using electric forklifts. These kinds of things, these steps towards greater innovation, are all for energy". (K11)

4.3.3. Financial Support and Incentives for Investments

The participants mentioned that they faced challenges during this transformation process in Turkey, and emphasized that support and incentives provided by the government are crucial during this time. Participant K8 discussed the following regarding this topic:

"The inks we use for printing in the factory are UV inks and dry under UV light. This is actually more efficient compared to conventional methods, which involve drying in a heated oven. There is a new transformation. It is starting from the G factory and the A factory. We are continuing with many factories that have printing presses. As I said, the excesses in the work processes also cause an increase in energy consumption. Considering the environmental support in this transformation, investment support is needed. We would like more support. Support is being received but in limited amounts, and as long as this support is not 100%, we have to use our own budget in some way. We are financing more of the transformation ourselves. Financially, the biggest challenge was the SAP HANA transition from our own budget. The same goes for Promanage. In fact, there is no support for automation in this area either". (K8)

4.3.4. Raw Material Standardization

The fact that raw materials used in recycling still lack standardization has left producers with a degree of uncertainty regarding what to produce and how and where to produce it. In this context, legislators emphasize that establishing a standard framework for products that are produced from certain raw materials would both facilitate the collection of recycled products and make the use of recycled products more widespread. Participant K6 mentioned the following regarding this issue:

"We currently have to charge our customers who use recycled raw materials for this. This is entirely related to green innovation. It is an action taken for a green world. We have such demands from our major global customers. In particular, our UK customers, to whom we export, require the use of 30% recycled material. We use it there, but as you know, it is much more expensive than the original raw material. This is because there is collection, separation, and a whole series of processes involved. There is washing, re-granulation, re-energy consumption, and so on; it is a very serious issue. We only use it for customers who request it. We have a recycling facility, but since we have not yet standardized the raw material, there are also problems with collection and disposal.

When our customers want recycled material rather than raw material, we often have to purchase it from outside sources. However, we believe that if this process were the same in our country as it is abroad, it would be much easier. After all, bags can be produced from raw material that was once bags, or pipes can be produced again from pipes that were once pipes. There is still no standardization". (K6)

4.3.5. Pre-Planning for Regulations

As the Carbon Border Adjustment Mechanism (CBAM) is implemented under the European Green Deal, new rules and obligations will apply to importing and exporting companies. It has been emphasized that advance planning for green innovation is necessary for both governments and businesses, due to the legal reporting and potential taxation obligations that will arise during this process. Participant K7 mentioned the following:

"As you know, we have the European Green Deal here. SiBAM (Border Carbon Adjustment Mechanism) has regulations regarding packaging waste that can be reused or recycled by 2030, and we are working to reduce thickness in line with these regulations. With these thickness reduction efforts, we were producing aerosol cans with a thickness of 0.17 millimeters until 2–3 years ago. That's 0.17 millimeters. Currently, we have production lines that manufacture cans with a thickness of 0.14 millimeters. This way, using thinner materials results in a lower carbon footprint in raw material usage. We pay attention to water. The decrease in rainfall and lack of snowfall in this region this year is already having an impact. In this context, we use treated water here. We pass it through the cooling systems. We collect the water from these systems, filter it again, and reuse it. Furthermore, after filtration and salt treatment, we may be able to transfer the effluent water from this area to another area for reuse. We achieved this with coolers. It was an important project we undertook in terms of sustainability". (K7)

4.4. Green Innovation Barriers Improvement Areas Theme

An examination of the findings related to RQ4 revealed that several areas for improvement are crucial for strengthening green innovation practices in the long term. Participants emphasized the need to develop clear strategies and integrate green innovation goals into long-term business plans. The findings show that supply chain harmonization, increased employee engagement, and continuous training activities play a significant role in enhancing the effectiveness of green innovation initiatives. Renewable energy investments and a stable supply of recycled raw materials were also identified as important areas for improvement. Nine codes were created for this theme, including strategy development, supply chain harmonization, sustainability training, regulation monitoring, orientation towards savings-oriented projects, ensuring employee participation, recycling raw material supply, renewable energy investment, and digital tracking systems.

Figure 5 illustrates the main theme "green innovation barriers—improvement areas" and highlights the key areas identified to improve and mitigate barriers to green innovation. The central node represents the overall improvement framework, while the surrounding elements indicate specific improvement areas derived from the qualitative analysis. The numbers in parentheses represent code frequencies, showing how often each area was mentioned by participants.

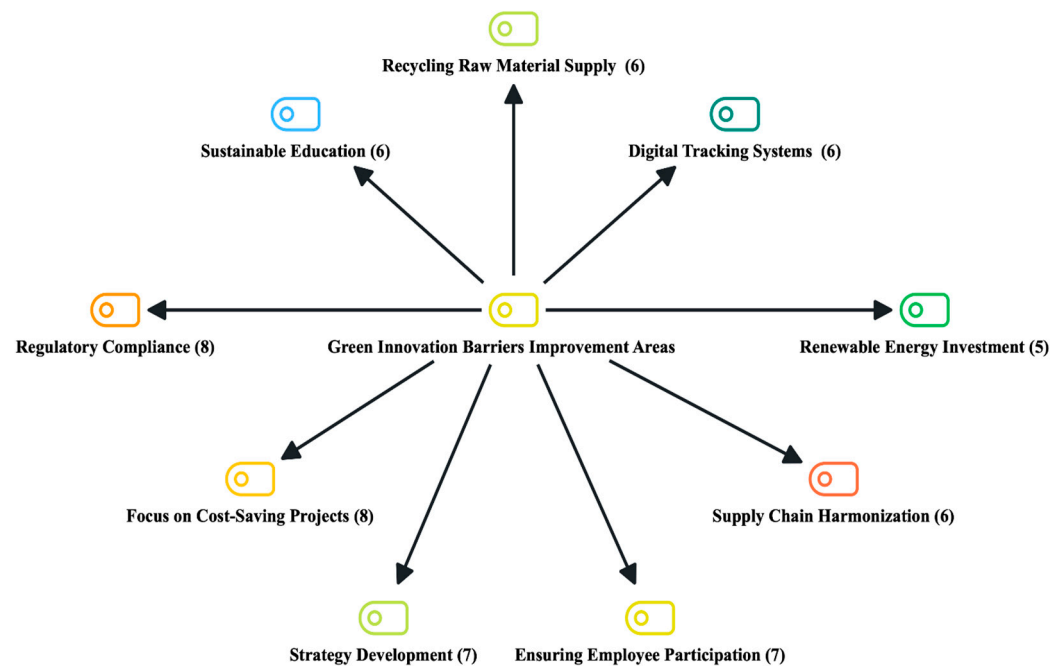


Figure 5. Hierarchical code–subcode display for the green innovation barriers improvement areas theme.

The most frequently emphasized improvement areas are regulatory compliance (8) and focus on cost-saving projects (8), indicating the importance of regulatory alignment and cost efficiency in supporting green innovation. These are followed by strategy development (7) and ensuring employee participation (7). Other important areas include recycling raw material supply (6), digital tracking systems (6), sustainable education (6), and supply chain harmonization (6), reflecting the need for technological, educational, and supply chain improvements. Renewable energy investment (5) also contributes as a supportive improvement area.

Overall, the figure shows that improving green innovation requires coordinated efforts across regulatory, financial, organizational, technological, and supply chain dimensions.

Table 7 shows the distribution of subcodes under the theme “green innovation barriers improvement areas” according to participant roles.

Table 7 displays the frequency and distribution of nine subcodes reflecting suggested areas for improvement to address barriers to green innovation, as identified by participants across various roles. The most frequently mentioned improvement strategies include ensuring employee participation (7) and focus on cost-saving projects (7), followed by supply chain harmonization (6) and regulatory compliance (5).

Aerosol and plastic manufacturing plant managers contributed the highest number of suggestions (19 and 13 codes, respectively), emphasizing their practical insights into the operational implementation of green innovation improvements. Conversely, sustainability-oriented participants highlighted upstream areas such as strategy development, digital tracking systems, and sustainable education.

In total, 49 codes were generated, demonstrating the broad and multidimensional nature of proposed improvement efforts, ranging from policy-level changes to employee engagement and digital transformation initiatives.

Table 7. Detailed results related to the green innovation barriers improvement areas theme.

RQ4	Sustainability and Process Engineer	Sustainability Manager	Aerosol Manufacturing Plant Manager	Plastic Manufacturing Plant Manager	Metal Manufacturing Plant Manager	Total
Strategy Development		1	3	1		5
Supply Chain Harmonization	1	1	3	1		6
Sustainable Education	1		2	1	1	5
Regulatory Compliance		1	2		2	6
Focus on Cost-Saving Projects	1		2	2	2	7
Ensuring Employee Participation			2	3	2	7
Recycling Raw Material Supply	1		1	3		5
Renewable Energy Investment	1		2		1	4
Digital Tracking Systems			2	2	1	5

4.4.1. Strategy Development

The participants stated that strategies for green innovation need to be developed. Participant K10 mentioned the following in relation to this topic:

“Normally, our targets are generally set from the bottom up, but here the strategies are determined by the sustainability team and the CEO. We are developing our strategies. With the setting of climate targets, the processes operate on this science-based targeting principle. We look at the work related to the system and develop strategies linked to these targets. For example, the targets will be announced in 2025. We are working on scenarios related to these targets, looking at what to do and how to start in our factories. We are moving forward by consulting with industry representatives on this issue. Information is gathered from everywhere so that we can establish our targets and strategies. We have to keep up. If we export and import to Europe for leadership, we must comply”. (K10)

4.4.2. Supply Chain Harmonization

The participants stated that comprehensive support from start to finish is essential for the implementation of green innovation strategies and ensuring compliance with this process. Participant K7 emphasized that all stages of the process must be supported:

“First, when making agreements, we set certain criteria with our customers. Agreements are made annually. As a result of the agreement, we divide the desired number of boxes into specific terms within the year, either monthly or quarterly. We produce and ship these orders on time, ensuring they are high-quality, environmentally friendly, and affordable. Now, the promises we have made here bind us. How? At this stage, we are responsible for any energy problems, raw material problems, or processes related to environmental regulations that may arise. There are carbon-related aspects in the production stage. There are carbon regulations. If we do not pay attention to these, if we do not prioritize these projects, if we do not make the materials used recyclable, our commitment will be broken. Therefore, it is important to harmonize the entire process in order to keep our promise to our customers and to prepare our production and our company for the coming years, otherwise it will not be easy to quickly adapt to green production”. (K7)

4.4.3. Sustainable Education

The participants emphasized the need for continuous training. Participant K3, when discussing the topic, mentioned the following:

“We provide training regularly and understand where and what is needed through audits. Especially since we sell abroad, the conditions are determined by European laws, and

resources are documented to comply with these, or customers know what they want and request products according to the rules. Naturally, those who prepare these must always be trained and knowledgeable". (K3)

4.4.4. Regulatory Compliance

The participants mentioned that they must regularly monitor regulations in the packaging production market to always be prepared. Participant K7 discussed the following on this topic:

"Each type of waste has a separate code and specific disposal procedures. We pay particular attention to this. We even have spill trays to prevent chemicals from spilling onto the ground. We don't want them to spill onto the ground. We control all possible points to prevent anything else from mixing with the soil or our rainwater drains. We have systems in place to ensure that no chemicals mix with the rainwater channels. The government comes to us for this, checks us regularly every year, and supports us in this regard. I believe this is also positive in terms of protecting our seas and nature. When our inspectors visited us, they suggested a system specifically for collecting exhaust gases, the RTO system. (Regenerative Thermal Oxidizer (RTO) is an air pollution control system used in industry. It incinerates volatile organic compounds (VOCs), bad odors, and harmful gases emitted from production facilities at high temperatures, rendering them harmless.) The investment for the RTO system was made in 2015, and it is present here in this factory. This allows the exhaust gases to be collected and released into the environment with a 90% reduction in biological levels. Of course, I know this from when I acquired it in 2013 and 2014. At that time, there was a certain amount of support for this". (K7)

4.4.5. Focus on Cost-Saving Projects

The participants stated that projects should be carried out in line with savings plans. Participants K1 and K3 mentioned the following on this subject:

"We have air consumption in the factory. Free air is waste. Free natural gas is waste. We have a unit that controls these. They inspect the factories at certain intervals with advanced devices. They come approximately every three months. For example, a hose burst here. They guide us, point it out. We quickly resolve the issues. Let me give you another example. We recently purchased a box machine. It produces and assembles metal boxes. It has doubled our production. We saved 40% more energy. We don't lubricate it, so we don't harm the environment. Old-style motors use oil. New servo motors don't". (K1)

"We send our recyclables to licensed organizations. These licensed organizations examine the products to see if they are green or not. We also examine whether they send the products they receive to be incinerated or to a warehouse. It is important that they are green in these areas. This way, we start to move towards these cost-saving steps. In fact, if everyone directs their waste or trash in this way, they will realize the savings they can achieve". (K3)

4.4.6. Ensuring Employee Participation

The participants mentioned that ensuring employee participation is a sensitive issue, and that they have achieved faster transformation when receiving support from employees in this regard. Participant K5 mentioned the following:

"We are focused on specific issues. But our priority is to explain our steps to our production workers. We want them to know what they are doing and why, so they can be conscious

and aware. Frankly, I try to instill this in the areas where I have strategic authority. Employees are happy when they see our support for the environment. One day, one of our employees, who was quite old, mentioned a project about how he could save money in his field of work every day. This is very valuable. After we make a change or take a decision, we don't just tell our employees, "This is how it will be"; we talk about how they can save money in their field of work every day. He mentioned a project about how he could save money in his work area every day. This is very valuable. After we make a change or a decision, we don't just tell our employees that this is how it will be; we explain it, we train them, and we clarify it. During a meeting about an energy-saving measure, our employee said, "God bless us, we will bring home halal bread, thank God we are not harming anyone." These things increase trust in the company and commitment to the job. We continue to instill these concepts. We do this not only with our employees, but also with our customers if necessary. Of course, the customers have the final say, but we also share these ideas with them and try to steer them in the right direction". (K5)

4.4.7. Recycling Raw Material Supply

The participants expressed the need to procure raw materials which are suitable for recycling. Participant K5 mentioned the following on this subject:

"We have a recycling facility at K. We established it about five years ago. We only work with it ourselves. It's a very different thing; we're in the early stages. Actually, the facility can process over 1000 tons of material per month. But we can only process about 3 to 5 tons per month. Why are we doing this? We made this investment after the law was passed in the UK. Because in 3 or 5 years, the same law will be implemented in Germany, and maybe in Turkey too. We need to be prepared for that day. Because sourcing recycled material is more expensive. It's not just about paying for the machine. There are many different details. We discovered this situation here as we used 2 tons, 3 tons, 1 ton". (K5)

4.4.8. Renewable Energy Investment

The participants stated that investments into energy sources should be made. Participant K3 mentioned the following on this subject:

"We have a need for solar energy systems (GES), and we also have factories near the sea. Perhaps wind terminals could be established if supported; our country is in a fortunate position in this regard. I mention this with carbon emissions in mind, so as not to harm the environment further; we establish our factories in areas close to customers. Energy is more valuable to us; with support, we will progress more quickly. We are eager". (K3)

4.4.9. Digital Tracking Systems

The participants emphasized the need to develop digital tracking systems. Participant K8 mentioned the following regarding this topic:

"Now automation improves the quality of the final product or the quality of the packaging time. Because, for example, you place the tin cans into the post machine. The operator could place them upside down in the wrong position. This was one of the most common complaints we received at the time. But now, with automation, when I put them in the robot, it doesn't make any mistakes. It ensures that the incoming cans are fed into the machine in the same way. This also improves the quality of the product". (K8)

Figure 6 shows a word cloud generated using MAXQDA 24 qualitative data analysis software to visualize the frequency distribution of codes derived from participant statements. The word cloud was employed as an exploratory and supportive analytical

tool to identify dominant themes within the qualitative dataset following the systematic coding process. A larger font size indicates codes with higher frequency, reflecting a greater prominence in participants' responses, whereas smaller fonts represent less frequently referenced codes.



Figure 6. Code cloud.

Highly mentioned codes such as “regulatory compliance,” “ensuring employee participation,” “focus on cost-saving projects,” and “recycling material quality” appear more prominently, indicating their central role in shaping participants’ perspectives across the interviews. Less frequently occurring codes, including “pre-planning for regulations” and “infrastructure problems,” although smaller in size, contribute to the overall thematic framework and provide contextual depth to the analysis. The word cloud complements the tabulated findings by offering a concise visual synthesis of key priorities and recurring concepts related to green innovation practices.

5. Discussion

5.1. Theoretical Contribution

This qualitative case analysis reveals the critical barriers encountered in the practical implementation of green innovation practices within organizations and solutions for overcoming them, providing both managers and organizations with actionable insights for implementation. The literature review revealed that existing quantitative studies have largely identified such barriers while failing to sufficiently provide solutions that are consistent with field practices. In this context, this study presents quantitative findings which provide a more explanatory answer to the “how” and “why” of green innovation from a management perspective. Several theories are utilized to explain these findings. Furthermore, it is determined that green innovation barriers and solutions consist of a combination of many approaches that explain both the internal and external environment.

This study specifically draws upon the Resource-Based View (RBV) and Natural Resource-Based View (NRBV) frameworks. It emphasizes that green innovation is dependent on internal resources such as financial support, R&D, technical infrastructure, and sustainability, and that obstacles arising from these factors must be overcome through investment. It also reveals that investments represent a significant financial burden. Furthermore, Stakeholder Theory highlights that external pressures related to the market and public opinion, as well as regulatory frameworks, manufacturing sector norms, and supplier–customer needs or expectations, are crucial in determining the pace and direction of innovation and influencing how collaboration and adaptation strategies are implemented.

From an Institutional Theory perspective, this study argues that the institution is shaped by environmental expectations and pressures. This case study also demonstrates that compelling pressures such as government regulations, laws, and standards are prominent, while external mechanisms such as the EU Green Deal and CBAM strategically control the process. Moreover, it reveals that normative pressures play a significant role in the formation of professional rules through education. Regarding imitative pressures, examples are given of the need to follow successful competitors and implement green innovation practices in the face of uncertainty. Within the context of this theory, it is important for companies to maintain a competitive pace of change and innovation and to prioritize green issues, not only in terms of cost and efficiency, but also in response to pressure from stakeholders to protect their reputations. This study considers the Upper Echelons Theory in arguing that strategic decisions in organizations are shaped by the values and experiences of top management [86]. It emphasizes that green innovation requires leaders to assume roles in vision, resource allocation, culture building, and stakeholder coordination. It has also been found that the environmental sensitivity of top management, along with their enhanced awareness of sustainability and long-term perspectives, strongly supports the implementation of green innovation practices. In conclusion, the study provides mechanism-based, contextual, and explanatory theoretical contributions to the literature by answering relevant qualitative questions.

5.2. Contribution to Practice

The results of this study emphasize that employees need to develop knowledge, experience, creativity, and diversity in relevant areas for a company to effectively adopt environmental policies. One of the fundamental problems many companies encounter during the transition to green innovation practices is that, when employees fail to adapt to these practices and changes and thus encounter failure, they respond to any innovation with low motivation and resistance. In this regard, the findings indicate that green innovation practices can be successfully achieved through effective communication from the lower to the upper levels. Changes must be implemented by taking adjustments in human resources practices such as recruitment, selection, workplace training, reward methods, performance management, and employee participation into account. Employee participation significantly contributes to reducing obstacles, and spreading the awareness created among employees to the corporate culture is important for sustainable adaptation. Studies have presented findings related to employee skepticism towards green innovation practices [41,87,88], while others have emphasized employees' lack of training, awareness, and experience; the study of Orji et al. [87] is particularly noteworthy in this regard. Zhu and Sarkis emphasized how barriers and reactions related to low employee motivation and resistance to change can hinder these practices, consistent with the views of this study's participants [89]. Indeed, the example solutions indicate that this situation can be overcome through the right leadership approach. As stated by Tseng et al., the successful implementation of sustainable green innovation practices requires an adequate level of awareness throughout the organization, from top to bottom [15]; this is consistent with the emphasis of the present study's participants regarding this issue.

When examined from an organizational perspective, it is important for the top management and executives to integrate green awareness and consciousness into the organization's goals, objectives, and vision. Furthermore, the most critical element in green innovation practices is the full participation of employees in the process. The aim here is to motivate them, provide the necessary training, and make them part of the system through effective leadership. In green innovation practices, proactive and determined managerial support increases the efficiency of operational activities [26]. In the Turkish manufacturing sector,

lack of awareness and experience, alongside economic inadequacies, are among the biggest drivers of resistance to change.

The results of this study revealed that the success of green innovation practices is not solely the responsibility of businesses; the state also has certain responsibilities in this regard. The participants emphasized that the state can contribute to this transformation through economic incentives such as tax exemptions, and it was observed that a broader perspective on green innovation practices is needed in order to take more concrete steps. At this stage, it is important for the government to provide credit support and incentive mechanisms to overcome financial constraints. Technical consulting services can be obtained from expert engineers sent by the government during the establishment and transformation of innovation investments. To address infrastructural deficiencies, area control must be carried out before industrialization, and appropriate planning must be made, according to efficiency evaluations. R&D inadequacy is one of the most frequently highlighted obstacles in the literature, as clearly stated in the studies of Orji et al., Chien et al., and Ghazilla et al. [3,87,90]. A strategic approach in leadership and decision-making is seen as important for successful green innovation. However, it has been observed that infrastructure and regulation-related obstacles significantly slow down these processes. These obstacles can be overcome by raising awareness through educational activities, providing appropriate incentives, and developing strategic plans.

This theoretical framework reveals the scope of and relationships between the concepts addressed in the study, enabling an examination of their practical implications. According to the analyzed case, the effective use of the approaches in question demonstrates that the research objectives were achieved.

5.3. Limitations of the Study and Recommendations for Future Research

This study focuses on a single firm operating in the packaging sector and highlights the need for sector-specific assessments of green innovation. Green innovation, as a subfield of innovation, should be applied differently depending on the sector, region, country, and field of activity. Therefore, new case studies in different sectors are needed to develop more comprehensive and sector-specific solutions. It is recommended that solution-oriented and management-centric approaches are adopted in future research, rather than focusing on obstacles, particularly to identify critical success factors. Furthermore, the limited number of studies addressing the relationship between environmental leadership and green innovation, and the fact that most existing studies rely on quantitative methods, leads to insufficient explanation of the obstacle–solution mechanisms in the implementation process.

The main limitation of this study is that it focused on a single firm operating in the packaging sector within the context of Turkey, a developing country. Due to its single case study design, its aim is not to perform statistical generalization; however, it does aim to provide analytical and theoretical insights in accordance with a qualitative research approach. The selected company, a large-scale manufacturing enterprise operating under high regulatory pressure and sustainability requirements, is a valuable case study for examining green innovation practices. While the findings are not directly generalizable, they offer transferable, guiding insights for businesses operating in similar sectoral and organizational conditions. In this context, the results should be evaluated considering the organizational and institutional framework examined.

6. Conclusions

In this study, insights gained during interviews with 11 senior executives regarding green innovation practices were classified into four main themes, grouped under the head-

ings of leadership and decision-making in green innovation, barriers to green innovation, fundamental solution areas for barriers, and areas for improving green innovation barriers.

6.1. RQ1-How Do Leadership and Decision-Making Processes Shape the Adoption and Implementation of Green Innovation Practices Within Manufacturing Firms?

As shown by the findings in the theme of leadership and decision-making in green innovation, participants mentioned the impact of leadership and emphasized the integration of decisions made with managerial support into practice. Furthermore, while the importance of top managerial support and the rapid integration of employees was expressed, it was further noted that the leader's vision influenced the organizational culture. These results highlight the importance of a proactive approach, with particular emphasis on the impact of employee motivation.

The findings largely coincide with studies in the existing literature; however, when viewed at the sectoral level, some important differences emerge.

For example, Chan et al. emphasized that environmental awareness is an important factor in the adoption of green practices and that it needs to be reinforced through managerial support [91]. In his study, Ar [92] found that managerial support has a facilitating effect on the implementation of strategies—consistent with the findings of this study, where the participants emphasized the importance of environmentally conscious production and mentioned that managerial support greatly facilitated this process. Similarly, Oktaysoy demonstrated that environmental leadership significantly strengthens green innovation [93]. When considering studies on innovation, Dangelico and Pujari [94] stated that the rapid and effective integration of green innovation practices into decision-making operations increases success—again consistent with the findings of this study, in which the participants also mentioned that green innovation practices reduce errors, prevent waste, and improve quality.

Rennings stated that environmental innovation requires not only a strategic but also a preventive and proactive approach [85], in agreement with the findings of this study. Furthermore, the leadership effect—which is also particularly emphasized in the study of Zhu and Sarkis—was observed to be a strong determinant of employee adoption of green innovation strategies in this study [89]. The low employee motivation and resistance to change highlighted by Zhu and Sarkis were also mentioned as significant barriers by the participants in this research [89]. However, solutions were also proposed to overcome these barriers with the right leadership approach.

6.2. RQ2-What Are the Key Barriers Hindering the Implementation of Green Innovation Practices in Manufacturing Firms Operating in Turkey?

In the theme of barriers to green innovation practices, infrastructure problems, regulatory difficulties, investment payback periods, and employee resistance emerged as key findings. The importance of following international regulations and adapting quickly in this company, which is dominant in export processes, was underscored. When evaluating the costs of investments, the importance of insufficient incentives and support was also noted. It was mentioned that companies having to meet their financing needs with their own resources prolongs the process and slows down the adaptation process. The participants also identified that employee resistance can be overcome through appropriate training and awareness. The lack of customer demand and awareness for green innovative products is also considered a significant obstacle; in particular, the examined manufacturing company stated that they support their customers in this regard, but cannot insist on it as long as there is no demand.

Similar findings have been presented in studies on green innovation barriers. For example, Chen et al. mentioned that insufficient digital transformation and a lack of

technical infrastructure hinder green investments [13]. Similarly, the OECD has stated that the strategies used in green innovation are challenging to implement due to environmental regulations [95]. Similarly, the participants in this study mentioned encountering strict laws, particularly regarding exports to European countries. Furthermore, Rennings emphasized that state support would accelerate investments by providing incentives for businesses [85]. In this line, when expressing their views on state support, participants stressed the need for financial support for green innovation practices in this study. The high cost of raw materials to be used in recycling and their lack of compliance with certain standards were stated as factors hindering green production. As such, the process of aligning with the European Union's environmental policies needs to be planned early, which may provide significant advantages for businesses.

6.3. RQ3-What Basic Solution Areas Are Identified by Senior Managers to Overcome Barriers to Green Innovation Practices?

In terms of fundamental solution areas for obstacles, education and awareness are at the forefront. It was revealed that the company can benefit from solution proposals such as financial support and incentives through planning of its energy investments. Furthermore, it was observed that successes in recycling and energy management are largely related to education and awareness. Among the responsibilities of the state, difficulties were identified in terms of standardization of recycled raw materials and allowing sufficient time for advance planning regarding relevant regulations.

6.4. RQ4-What Improvement Areas Are Perceived as Critical for Strengthening and Sustaining Green Innovation Practices in the Long Term?

In the theme of areas for improvement in green innovation barriers, it was determined that businesses need to develop strategies, align their supply chain processes, strengthen training activities, and increase employee participation. Additionally, prioritizing renewable energy investments was identified as an important area for improvement. Furthermore, in terms of the supply of recycling raw materials, it is recommended that businesses make strategic investments, particularly in order to manage recycling facilities with a future-oriented perspective. It was stated that strengthening the motivation shared between employees and management and involving employees more in the process can be expected to increase corporate belonging, thus enhancing the effectiveness of green innovation practices.

Tseng and colleagues' [15] emphasis on the need for all stakeholders to be fully aware of sustainable green innovation practices is also consistent with the participants' views regarding the supplier awareness and supply chain alignment sub-themes in the present study. Furthermore, Ar [92] determined the mandatory nature of education through online practices and that participants experience a continuous education cycle, thus increasing their self-confidence and facilitating the transition to new practices, in line with the participants' views in the present study.

The participants in this study emphasized the importance of developing strategies to overcome the obstacles that arise, stating that these strategies should be integrated into long-term plans. This is consistent with the findings of Dangelico and Pujari, who mentioned that both internal business integration and overall harmonization are required when planning for integration into supply chain processes [94]. They stated that continuous training is mandatory and that adapting to systemic changes is a critical requirement for businesses; in addition, regular government oversight and monitoring of legal regulations at the international level are important. The participants explained, with various examples, that renewable energy investments can help to reduce environmental damage. These examples are consistent with the study of Chan et al. [91], who stated that both the establishment of

standards and regulations as well as the widespread establishment of facilities for these materials and the expansion of logistics processes are critical for the procurement of recycled raw materials. It was also stated that renewable energy investments need to be supported and relevant incentives increased, and that there are some structural deficiencies in the current system in this regard. Another noteworthy study in the literature has emphasized that green product innovation for biodegradable plastics is a risky and multifactorial process. In this regard, Moshood et al. [96] mentioned that knowing the history of the raw plastic materials affects the production process and stated that the ability to offer environmentally beneficial, high-quality, functional, and reasonably priced products is dependent on public support; these findings are consistent with those of the present study.

As indicated by the research findings, packaging is expected to be subject to stricter rules and greater scrutiny in the near future. Alongside this, qualitative research has revealed that the green product development process is unclear and is variable due to environmental factors. This study helps to explain how and in what way businesses may integrate green innovation to achieve greater sustainability; in particular, many of the obstacles identified can be effectively overcome through proper leadership and decision-making. Furthermore, findings related to strategic direction, resource allocation, culture creation, and stakeholder collaboration were linked to their potential to help in overcoming these obstacles. In terms of management and policy, the study findings yield important implications, particularly for manufacturing firms operating in export-oriented sectors. Managers are encouraged to adopt proactive leadership approaches and strengthen employee engagement, as well as to integrate green innovation strategies into their long-term plans. From a policy perspective, the results highlight the need for consistent regulatory frameworks, early alignment with international environmental standards, and expanded financial incentives to support green investments. The findings of this research provide a valuable foundation for future studies. Further understanding of green innovation dynamics and increased generalizability of the results can be achieved by utilizing larger sample sizes, cross-sector comparisons, or mixed methods approaches.

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Appendix A. Interview Questions

1. What is sustainability and why is it important?
2. Do you think sustainability strategies are effective and why?
3. What are the challenges you face regarding sustainability and what methods do you apply to overcome these challenges?
4. How do you determine your sustainability goals and what do you do to achieve these goals? What resources do you use to raise awareness?
5. How would you define green innovation? How do you evaluate the benefits it provides to your business or organization and the challenges you encounter?
6. What do you think is the contribution of green innovation to your sustainability goals and how does it affect your employees' motivation, way of working, or skills?
7. Can you share the resources or strategies you use to encourage or support green innovation?
8. What are your thoughts on government incentives that encourage green innovation? If you have benefited from them, how do you evaluate the impact of these supports on your business or organization?
9. What challenges have you encountered while utilizing government supports for green innovation? How do you evaluate the contribution of these supports to your sustainability and competitiveness?
10. How do you evaluate the effects of green innovation practices on your business's long-term competitive advantage and corporate reputation?
11. How is the integration of digitalization (IoT, artificial intelligence, big data, etc.) with green innovation realized in your business? What are the effects of this integration on environmental and operational performance?
12. What are the institutional, technical, or cultural obstacles encountered in disseminating green innovation practices in supply chain management?
13. How do you evaluate the role of top management's approach and leadership style to green innovation in the decision-making and implementation of green innovation initiatives in your business?
14. What performance indicators do you use to measure green innovation activities? How do you evaluate the contribution of these indicators to sustainability reporting?
15. What are your views on the effects of green innovation on your business's corporate risk management, regulatory compliance, and reduction of environmental risks?

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