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GREEN TRANSFORMATION AND ORGANIZATIONAL RESILIENCE IN THE PACKAGING INDUSTRY: CHALLENGES AND BARRIERS

Natalia KOZIK-KOŁODZIEJ

Kraków University of Economics; kozikn@uek.krakow.pl, ORCID: 0000-0001-6787-2573

Purpose: The purpose of this paper is to examine the role of organizational resilience in the green transformation of the packaging industry, with particular emphasis on barriers that limit the pace and effectiveness of this process.
Design/methodology/approach: This study draws on an examination of academic literature, regulatory documents, and sectoral reports related to sustainable development and the circular economy.
Findings: The study identifies key barriers to the green transition: the high costs of innovative materials and technologies, limited availability of alternative raw materials, infrastructural shortcomings in recycling, regulatory uncertainty, and the risk of greenwashing. SMEs, which numerically dominate the industry yet operate with constrained financial, technological, and human resources, are particularly vulnerable to these challenges. Such limitations reduce their adaptive capacity and may lead to market concentration in favor of larger players, thereby weakening the overall resilience of the sector.
Practical implications: Overcoming barriers to ecological transformation requires coordinated actions: investment in innovation and infrastructure, supportive regulatory frameworks, and promotion of digital solutions. For business practice, this means that green transformation should be perceived not only as a compliance burden but also as a strategic opportunity to strengthen resilience and competitiveness.
Social implications: The successful implementation of sustainable packaging solutions can reduce environmental risks, foster consumer trust, and support the transition toward a circular economy, thereby contributing to broader societal goals of sustainability and climate mitigation.
Originality/value: This paper contributes to the debate on organizational resilience by linking it explicitly with the green transformation of the packaging industry. It provides a comprehensive overview of sector-specific barriers and emphasizes the strategic importance of resilience as both a precondition and an outcome of ecological transition. The study is particularly relevant to policymakers, industry practitioners, and scholars interested in sustainability management.
Keywords: organizational resilience; green transformation; sustainable packaging; packaging industry; barriers.
Category of the paper: General review.

1. Introduction

Contemporary organizations operate in an environment characterized by high dynamics of change, uncertainty, and increasing regulatory and social pressure. In particular, companies from resource-intensive industries, such as the packaging sector, face the necessity of adapting to new realities related to climate transition, sustainable development requirements, and disruptions in global supply chains (Bocken et al., 2014; Geissdoerfer et al., 2017; Niero, Hauschild, 2017). These conditions require not only incremental improvements in efficiency but also profound organizational and technological transformations that redefine existing business models.

Packaging plays a key role in the modern economy, serving multiple functions simultaneously: protective, logistical, marketing, and informational. It secures products during transport and storage, extends their shelf life, and provides consumers with essential information on quality, safety, and sustainable origin (Wikström et al., 2019; Chan, 2022). Particularly in the food and pharmaceutical industries, packaging is a prerequisite for ensuring health safety and reducing losses, which would be significantly higher without proper protection (Alamri et al., 2021; Lv et al., 2025). At the same time, from a market perspective, packaging is increasingly perceived as a carrier of innovation and a tool for building competitive advantage (Nordin, Selke, 2010). This wide range of functions makes the packaging sector one of the most strategic areas of the modern economy, but also one of the most exposed to environmental and regulatory pressures.

The packaging industry is among the most strategic areas of the contemporary economy. According to estimates, its global value reached approximately USD 1080 billion in 2024 and may grow to USD 1452 billion by 2032, with an average annual growth rate (CAGR) of 3.9% (Fortune Business Insights, 2024). Eurostat (2023) reports that in the European Union, around 84 million tons of packaging were placed on the market in 2021, of which nearly 41% consisted of paper and cardboard, 19% of plastics, 19% of glass, and 16% of metals. While recycling rates in the EU are relatively high (averaging around 65%), they differ significantly across materials: over 80% for paper and metals, about 75% for glass, but only 40% for plastics (Eurostat, 2023). These figures highlight the growing regulatory and market pressure for the packaging sector to evolve toward a circular economy and climate neutrality.

A key process defining modern management in the packaging sector is the green transition, understood as the implementation of strategies and technologies leading to climate neutrality, minimization of environmental impact, and resource circularity. In light of strategies such as the European Green Deal, Fit for 55, and the Packaging and Packaging Waste Regulation (PPWR), the role of packaging companies is becoming not only productive but also transformative (European Commission, 2022). At the same time, increasing importance is attached to organizational resilience, understood as the ability to flexibly and proactively

respond to disruptions, unpredictable changes, and crisis situations. As Duchek (2020) points out, organizational resilience is not merely a passive survival capability but an active process of learning, adaptation, and innovation. Particularly in the packaging sector, exposed to fluctuations in raw material prices, legislative changes, and consumer pressure, combining resilience with green transition is emerging as a key strategic challenge.

Although sustainable packaging, circular economy practices, and organizational resilience have been widely discussed in the literature, these issues are typically examined separately. Existing studies tend to focus either on environmental innovations and eco-design solutions, or on resilience from a general management or supply chain perspective. Relatively little attention has been paid to how the green transition in the packaging sector specifically shapes companies' adaptive capacity and what structural, technological, and regulatory barriers may limit this process. This fragmentation reveals a research gap concerning the integrated analysis of sustainability transformation and organizational resilience at the sectoral level.

The aim of this article is to analyze the challenges associated with the green transition in the packaging sector and their impact on organizational resilience. The study adopts a qualitative, review-based approach grounded in the analysis of scientific literature, policy documents, and industry reports to synthesize existing knowledge and identify critical determinants of adaptation. The remainder of the paper is structured as follows. Section 2 presents the theoretical background and literature on sustainable packaging and resilience. Section 3 describes the research methodology. Section 4 presents the results of the analysis in the form of identified challenges and barriers. Section 5 discusses the findings in relation to existing studies and outlines implications for theory and practice, followed by conclusions.

2. Organizational Resilience and Ecological Transformation in the Packaging Industry

In contemporary contexts, organizational resilience is emerging as a key capability enabling not only survival but also the development of firms under conditions of disruption and external pressures. It is defined as the ability of a company to effectively anticipate disturbances, cope with them, and adapt rapidly. Resilience is conceptualized as a complex, dynamic meta-capability encompassing both the ability to respond to sudden crises and to learn and evolve as a result (Linnenluecke, 2017; Duchek, 2020; Hillmann, Guenther, 2021).

Duchek (2020) identifies three stages of the resilience process: anticipation, coping, and adaptation. Together, these enable organizations to function effectively in uncertain and turbulent environments. Both cognitive capabilities (e.g., risk analysis) and behavioral capabilities (e.g., implementing change) play a central role, pointing to the necessity of a comprehensive approach to resilience management (Williams et al., 2017). Resilience should

not be understood as a one-time reaction to crisis, but rather as a dynamic process of learning, reorganization, and the strategic use of available resources and knowledge.

The literature distinguishes between two complementary types of organizational resilience: planned resilience and adaptive resilience. Planned resilience refers to the deliberate design of structures, procedures, and strategies intended to protect the organization from disruption. This is a systemic approach, focused on risk identification and the preparation of contingency plans (Linkov, Palma-Oliveira, 2017; Barasa et al., 2018). An example in the packaging sector is the adjustment of production processes to comply with EU regulations requiring that all packaging be fully recyclable by 2030. Companies that invest in alternative materials, recovery technologies, and modernization of production lines in advance are demonstrating planned resilience. In contrast, adaptive resilience refers to an organization's ability to flexibly respond to sudden, unpredictable events. Its essence lies in rapid learning, improvisation, and the reorganization of resources in response to crises (Barasa et al., 2018). A good example from the packaging sector was the set of measures undertaken during the COVID-19 pandemic, which forced a rapid increase in the production of unit and hygienic packaging, reconfiguration of supply chains, and the introduction of additional product safety measures. In practice, both types of resilience – planned and adaptive – complement one another, forming the foundation of long-term resilience in the packaging sector.

New approaches to building organizational resilience highlight the importance of integrating three key areas: digitalization, security, and innovation. Tarapata and Woźniak (2022) refer to these as the "organizational resilience triangle", which constitutes the basis for ensuring business continuity and adaptive capacity. Digitalization enables the streamlining of operational processes, more effective data management, and faster responses to disruptions through technologies such as ERP systems, artificial intelligence, and predictive analytics. Security, encompassing both physical and cyber domains, is critical for minimizing the risk of failures, crises, or data loss. Innovation, in turn, paves the way for new business models, the implementation of ecological solutions, and the development of products tailored to market needs.

The packaging industry is currently one of the most innovative and digitally advanced sectors of manufacturing. Increasingly, solutions from the fields of smart packaging and connected packaging, based on digital technologies such as IoT sensors, QR codes, and blockchain-based tracking systems, are being adopted. These technologies enable monitoring of product life cycles, improved supply chain security, and greater transparency for consumers (Towards Packaging, 2025). The digitalization of production processes, data management, and logistics has become a fundamental tool for strengthening organizational resilience, allowing for faster disruption detection and more efficient resource utilization. At the same time, the packaging sector demonstrates a high degree of innovativeness. According to the European Patent Office (2021), packaging accounted for approximately 6% of all bioplastics-related innovations between 2010 and 2019. Companies in the sector allocate

an average of 3% of their revenues to research and development (R&D), exceeding the rates observed in many other manufacturing industries (Damodaran, 2025). Industry reports also forecast dynamic growth in these segments: Grand View Research (2023) projects the smart packaging market to grow at a CAGR of 6.2% between 2024 and 2030, while Mordor Intelligence (2025) predicts the green packaging market will expand at a CAGR of 7.37% over the 2025-2030 horizon.

3. Sustainable Packaging and Green Transformation as the Foundation of Organizational Resilience

The ecological transformation of the packaging industry currently constitutes one of the key processes shaping the competitiveness and long-term stability of enterprises. Changing legal regulations, increasing societal pressure and consumer expectations, as well as global challenges associated with the climate crisis and limited resource availability, position the packaging sector at the core of the green transformation. Its central element is sustainable packaging, which functions both as an instrument for achieving environmental goals and as a source of competitive advantage and organizational resilience.

The concept of sustainable packaging has evolved alongside the development of regulations, technologies, and stakeholder expectations. As noted by Kozik (2018), definitions proposed by industry organizations such as the European Organization for Packaging and the Environment and the Sustainable Packaging Alliance identify five areas constituting the idea of sustainable packaging (Figure 1):

- environment – minimizing the negative impact of packaging across its life cycle,
- society – meeting the needs of users,
- economy – optimizing the costs of production, distribution, and end-of-life management,
- time – accounting for long-term environmental consequences for future generations,
- development – supporting innovation and the competitiveness of enterprises.

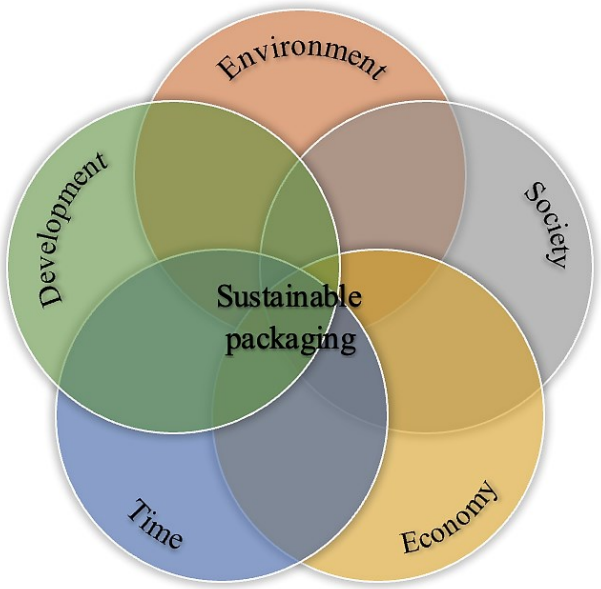

Figure 1. Five Core Areas of Sustainable Packaging.

This concept is not static; it is dynamically evolving in response to new technologies, regulations, and market needs. Packaging development is a continuous, dynamic process, open to new solutions, without the possibility of achieving a single universal end model. In this sense, sustainable packaging aligns with the logic of innovation while simultaneously reinforcing the need to build organizational resilience: companies must be capable of flexible responses, continuous learning, and adaptation in order to maintain competitiveness in a volatile market environment (Kozik, 2018).

In this context, ESG strategies are gaining importance as they structure corporate activities and strengthen adaptive capacity. Research shows that organizations pursuing consistent environmental, social, and governance strategies are better able to anticipate regulatory, environmental, and reputational risks (Broadstock et al., 2021; Wang et al., 2023). Within the packaging industry, EU regulations – particularly the proposed Packaging and Packaging Waste Regulation (PPWR) – play a pivotal role, as they will enforce significant sectoral changes, compelling firms to adapt to new legal and environmental requirements. This necessitates strategic flexibility, the ability to adjust technological processes, business models, and stakeholder communication to a dynamically shifting regulatory environment. Companies that treat regulations not as barriers but as catalysts for transformation thereby gain long-term resilience and competitive advantage.

A particularly significant element in this process is the circular economy, within which the reduce-reuse-recycle (3R) model plays a central role, enabling resource consumption reduction, extension of product and material lifecycles, and minimization of waste. From the perspective of organizational resilience, the implementation of 3R principles strengthens not only environmental efficiency but also operational stability – by reducing dependence on unstable raw material supplies and fluctuating material prices, while lowering the risk of production

interruptions (Zapłata et al., 2024). Thus, the circular economy becomes not only an instrument of environmental protection but also a source of strategic resilience and adaptive flexibility for enterprises.

Ecological transformation, understood as the transition toward a low-emission, circular, and ESG-compliant economy, represents both a challenge and an opportunity for the packaging sector. Its effective implementation requires risk anticipation, operational flexibility, and strategic adaptability – competencies that lie at the very foundation of organizational resilience. Industry analyses indicate that green strategies enhance flexibility and innovativeness, thereby strengthening firms' resilience (Ayming, 2024). At the same time, they enable the creation of new sources of competitive advantage based on reputation, customer trust, and stakeholder loyalty (Bojewska, 2024). Investments in innovations in the field of sustainable packaging not only reduce environmental risks but also build the foundations for long-term development in a dynamic and evolving environment.bles, figures and formulas – continuous numbering in the text.

4. Methods

This study adopts a qualitative, exploratory research design based on desk research and a narrative literature review. Such an approach is appropriate for conceptual and review-oriented studies that aim to synthesize dispersed knowledge, identify patterns, and systematize complex phenomena rather than to test hypotheses through quantitative or experimental methods. Given the multidimensional and evolving nature of sustainable packaging and organizational resilience, an integrative analysis of academic, regulatory, and sectoral sources allows for a comprehensive understanding of both theoretical developments and practical constraints.

The research process relied exclusively on secondary data. The empirical material consisted of three main categories of sources:

1. peer-reviewed academic publications concerning organizational resilience, sustainable development, circular economy, and sustainable packaging,
2. regulatory and policy documents at the European and international levels, including strategies, directives, and regulations shaping the environmental obligations of the packaging sector (e.g., the European Green Deal and the Packaging and Packaging Waste Regulation – PPWR),
3. sectoral reports, statistical databases, and market analyses prepared by public institutions and industry organizations (e.g., Eurostat, consulting reports, and industry outlooks).

The selection of materials followed purposive and relevance-based criteria. Sources were included based on their topicality, scientific credibility, direct relevance to the research objective, and their contribution to understanding environmental, technological, and organizational determinants of the packaging sector's green transition. Particular attention was paid to recent publications and documents reflecting current regulatory and market conditions. The review was not conducted according to a formal systematic review protocol; instead, it followed a flexible, iterative search and selection process typical of narrative reviews, enabling the inclusion of diverse and context-specific evidence.

The collected materials were analyzed using qualitative document analysis and thematic content analysis. First, key concepts and recurring themes were identified, including definitions of sustainable packaging, regulatory pressures, technological constraints, cost barriers, and organizational resilience mechanisms. Second, the evidence was compared and synthesized to categorize the main challenges and barriers affecting the sector. Finally, relationships between sustainability-oriented practices and organizational resilience were interpreted to develop an integrated conceptual framework explaining how green transformation influences firms' adaptive capacity.

This methodological approach enables a holistic and interdisciplinary perspective and facilitates the integration of insights from different types of sources. However, it also has limitations. As a narrative and non-systematic review, the study may involve a degree of subjective interpretation and selection bias. Moreover, the analysis is based on secondary data and does not include primary empirical research. Therefore, the findings should be understood as analytical and conceptual contributions rather than statistically generalizable results.

5. Challenges and Barriers in the Green Transformation of the Packaging Sector – Results

The green transformation in the packaging industry is a complex process, requiring enterprises to implement technological innovations while continuously adapting to rapidly changing regulations and growing market expectations. The analysis of the reviewed sources indicates the presence of multiple barriers that affect the pace and scope of this transformation. However, organizations face a range of barriers that significantly hinder the development of organizational resilience. The most important include high implementation costs of new solutions, limited availability of alternative raw materials, technological and infrastructural barriers, regulatory uncertainty, and the risk of greenwashing.

One of the key challenges is the cost of implementing sustainable solutions, such as biodegradable materials, recovery systems, and investments in research and development. Alternative raw materials, such as PLA and PHA, are still characterized by higher production

costs and limited scale – particularly compared to conventional plastics – which significantly restricts their adoption (Naser et al., 2021; Gundlapalli, Ganesan, 2025). PLA and PHA require further technological improvements and adequate infrastructure to become economically competitive and widely used in packaging applications. A lack of economies of scale – stemming from insufficient production volumes – renders their prices unstable and supply chains vulnerable to disruptions. The limited number of suppliers and low-quality standardization of bio-based materials further increase costs and operational risks for packaging producers (Shah, Gangadeen, 2023; Börner, Zinn, 2024). At the value chain level, additional costs arise from the integration and harmonization of activities with subcontractors, recyclers, and transport companies, complicating systemic implementation of the circular economy (Cerqueira-Streit et al., 2023; Stumpf et al., 2023).

Traditional bioplastics also often fail to meet visual, hygienic, or durability requirements comparable to conventional plastics (Abe et al., 2021), limiting their application in industries with stringent quality standards. Moreover, their deployment requires costly investments in infrastructure, restructuring of production processes, and adaptation to evolving regulations and standards, which places a particular burden on SMEs (Brendzel-Skowera, 2021; Schwarz, 2023). As a result, the introduction of bioplastics is often perceived as a costly and high-risk process that demands strategic vision and adaptive change management (Cerqueira-Streit et al., 2023; Stumpf et al., 2023).

High capital expenditures are also associated with the development of chemical recycling technologies and closed-loop material systems (McKinsey & Company, 2019), which, although promising, remain economically unviable in the short term. Additionally, compostable or biodegradable packaging often ends up in mixed waste streams because local facilities lack composting chambers or installations adapted for safe decomposition (Kaiser et al., 2018; European Environment Agency, 2023; U.S. Environmental Protection Agency, 2021). The absence of clear standards for compostability – for instance, differences between home and industrial composting – creates confusion among both producers and consumers, leading to mismanagement of packaging waste (European Parliament, 2023; U.S. Environmental Protection Agency, 2021).

Another major barrier in the packaging industry's green transformation is the set of technological and infrastructural limitations associated with recycling. A large proportion of packaging, especially in the food sector, has multilayered structures (e.g., plastic-aluminum laminates), which makes sorting, separation, and processing significantly more challenging (Schmidt et al., 2022). In practice, this means that despite sustainable design initiatives, many packages are not effectively recycled. The lack of standardized sorting systems, variations in waste management infrastructure across countries, and limited availability of advanced installations such as chemical recycling plants, result in a significant share of packaging still ending up in landfills or incineration. Furthermore, despite rapid technological progress,

chemical recycling processes remain costly and inaccessible to many SMEs (European Environment Agency, 2024).

A further challenge lies in adapting to shifting legal frameworks. Although the European Union has introduced multiple legislative initiatives – such as the Packaging and Packaging Waste Regulation (PPWR) and the Single-Use Plastics Directive (SUP) – their interpretation and implementation vary significantly across member states. Some countries have adopted stricter regulations, while others still lack appropriate implementing measures. This inconsistency creates regulatory uncertainty, complicating investment planning and long-term strategic development in sustainable packaging. Producers often operate under legal instability, unsure which packaging formats will remain compliant in the future, which discourages investment in innovation (Geissdoerfer et al., 2017; Forest.fi, 2023; Baker McKenzie, 2025). Another complication is the fragmented and unclear implementation of Extended Producer Responsibility (EPR). While EPR in theory requires producers to assume full responsibility for packaging lifecycles, in practice systems are inconsistently applied, and settlement mechanisms across operators and industries lack transparency. The absence of harmonized eco-modulation fees means that environmentally friendlier solutions are not always rewarded with lower costs (OECD, 2021). For firms operating across multiple European markets, divergent national regulations increase compliance costs and hinder the adoption of standardized international solutions. The lack of regulatory stability and predictability reduces companies' willingness to make long-term environmental investments, thereby weakening the effectiveness of the industry's ecological transition.

An increasingly important challenge in the green transformation process is the growing risk of greenwashing – hat is, practices that create the appearance of environmental responsibility without substantive changes to production or waste management. With rising consumer awareness and pressure from regulators and investors, many companies intensify their environmental communication, but such claims are not always supported by verifiable data or audited indicators. Ambiguous labels such as "eco", "bio", or "environmentally friendly", which are neither standardized nor certified, often mislead consumers. Research shows that consumers can quickly detect inconsistencies in brand messaging, leading to declines in trust, reputation, and sales (Delmas, Burbano, 2011; Lavuri, 2022; Wang, 2023). The problem is exacerbated by the lack of consistent regulations on environmental claims. Although the EU is preparing the Environmental Claims Directive (so-called "green claims"), clear verification requirements are not yet in place. As a result, firms may employ green marketing slogans without providing objective evidence (European Commission, 2025). Such practices undermine consumer trust in the entire sector and distort fair competition, as companies genuinely investing in sustainable solutions may be disadvantaged against those engaging in greenwashing. To counteract these risks, companies should adopt transparent environmental communication strategies based on measurable indicators (e.g., CO_2 emissions, recycled material share, biodegradability) and established standards such as ISO 14021, the EU Ecolabel,

or ESG reporting, which ensure independent verification and comparability of data (Szopik-Depczyńska et al., 2022).

SMEs are particularly vulnerable to the negative effects of these barriers, as they make up the majority of firms in the EU (Eurostat, 2024). In Poland, for example, around 90% of enterprises in plastics processing are SMEs, which often operate with limited resources and have lower capacity to invest in innovations, recycling technologies, or alternative materials (Poland Insight, 2025). High costs of implementing innovative materials, limited access to external financing, and the lack of internal R&D departments mean that smaller firms are frequently unable to meet regulatory requirements or quickly adapt to new technologies (Brendzel-Skowera, 2022). Consequently, SMEs may be more exposed to supply chain disruptions and raw material price fluctuations, directly impacting their operational resilience. Moreover, their lack of production scale hinders the ability to establish partnerships with bioplastic or recyclate suppliers, who typically require large and stable orders. SMEs therefore face greater difficulty in building resilience, particularly in anticipating disruptions, ensuring operational stability, and adapting to regulatory changes. This increases the risk of marginalization of smaller firms in the green transformation process and fosters market concentration in favor of larger players capable of absorbing high innovation costs. Ultimately, structural inequalities may weaken the resilience of the entire sector, as excessive dependence on large corporations reduces diversity and flexibility in responding to crises.

Overall, the identified barriers can be grouped into economic, technological, infrastructural, regulatory, and reputational categories. These categories summarize the key challenges documented in the reviewed sources.

6. Discussion

The results of this study provide a comprehensive view of the barriers affecting the green transformation of the packaging sector and their implications for organizational resilience. While previous research has examined sustainable packaging, circular economy adoption, and resilience independently, this analysis integrates these perspectives, highlighting how sector-specific constraints influence firms' adaptive capacity and long-term stability (Geissdoerfer et al., 2017; Niero, Hauschild, 2017). Unlike earlier studies, this paper offers a holistic perspective that considers economic, technological, regulatory, and reputational factors simultaneously.

One key insight is that the green transition is not merely a technical or environmental challenge but also a strategic and organizational one. Although sustainable packaging and circular models are widely recognized for their potential to reduce environmental impacts and generate competitive advantage (Bocken et al., 2014; Kozik, 2018), their implementation

involves substantial costs, infrastructure gaps, and regulatory uncertainty. These constraints can limit firms' investment capabilities, slow innovation, and restrict strategic planning, particularly for resource-constrained SMEs. In this sense, sustainability initiatives can simultaneously serve as drivers of resilience and as sources of vulnerability, depending on organizational context and capabilities.

The findings largely align with previous research on sectoral barriers. High costs and limited availability of bio-based materials, underdeveloped recycling infrastructure, and fragmented regulatory systems have been documented as obstacles to circular packaging practices (Kaiser et al., 2018; European Environment Agency, 2023; OECD, 2021). This study extends the literature by showing that when these barriers interact, they reduce operational flexibility, adaptive capacity, and ultimately the resilience of firms and the sector as a whole (Duchek, 2020; Linnenluecke, 2017).

SMEs emerge as a particularly critical focus. Despite their numerical dominance in the European packaging sector, they are disproportionately affected by the costs and risks of green transformation. Limited financial and technological resources, together with weaker bargaining power in supply chains, constrain their capacity to adopt alternative materials and implement innovative solutions (Brendzel-Skowera, 2022). If smaller firms are unable to adapt, market concentration may increase, reducing diversity and flexibility at the sectoral level. This, in turn, has broader implications for resilience across the entire industry. Supporting SMEs through targeted policy interventions, knowledge transfer, and access to innovation is therefore essential for maintaining sectoral stability.

The reputational dimension also plays a significant role in shaping resilience. The prevalence of greenwashing, as highlighted in the results, illustrates that organizational credibility and transparency are as important as operational and technological capabilities. Companies that fail to provide verifiable evidence of their environmental performance risk eroding consumer trust, undermining brand stability, and limiting long-term resilience (Delmas, Burbano, 2011; Lavuri, 2022). Transparent, evidence-based communication and adherence to recognized standards such as ISO 14021 or ESG reporting are therefore critical components of resilient green strategies.

Overall, the study suggests that organizational resilience and green transformation are interdependent processes. Firms that actively invest in innovation, digitalization, and circular solutions enhance their capacity to anticipate disruptions and adapt to change. Resilience emerges not only as a reactive response to crises but also as a proactive capability that allows firms to leverage sustainability as a source of long-term competitive advantage (Hillmann, Guenther, 2021).

From a practical perspective, these findings underline the need for coordinated investments in infrastructure, regulatory alignment, and support mechanisms, particularly for SMEs. Without systemic measures, the pace and effectiveness of the green transition remain constrained. From a scientific perspective, the study highlights the value of integrating sectoral,

technological, and organizational perspectives to understand the dynamics of sustainable transformation.

These insights provide the foundation for the study's conclusions on how resilience strategies can facilitate green transformation, emphasizing that addressing structural barriers while strengthening adaptive capabilities is essential for ensuring the long-term sustainability, stability, and competitiveness of the packaging sector.

7. Conclusions

The green transformation of the packaging sector is a complex and multifaceted process, shaped by regulatory pressures, technological challenges, market dynamics, and societal expectations. This study demonstrates that economic, infrastructural, and institutional barriers – such as high costs of innovative materials, limited recycling infrastructure, regulatory fragmentation, and reputational risks – directly influence firms' adaptive capacity and long-term organizational resilience.

Organizational resilience emerges as a critical enabler of the green transformation. Companies that invest strategically in innovation, digitalization, and circular economy practices are better equipped to respond to uncertainty, anticipate disruptions, and maintain competitiveness. SMEs, which dominate the sector in terms of numbers but often operate with limited resources, face particular challenges. Supporting smaller firms through policy interventions, knowledge transfer, and improved access to innovation is essential to maintain industry diversity and overall sectoral resilience.

From a practical perspective, these findings underscore the importance of coordinated actions, including investment in infrastructure, harmonization of regulatory frameworks, and promotion of transparent, evidence-based environmental communication. Scientifically, future research should investigate the effectiveness of specific resilience strategies, ESG practices, and digital technologies in enabling successful green transformation.

Overall, the study confirms that green transformation and organizational resilience are mutually reinforcing processes. Addressing structural barriers while strengthening adaptive capabilities is crucial for ensuring the long-term sustainability, stability, and competitiveness of the packaging sector.

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