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Research Article

# The relationship between SMEs' perception of global risks and sustainable innovation: The case of Türkiye[1]

## KOBİ'lerin küresel risk algısı ve sürdürülebilir inovasyon ilişkisi: Türkiye örneği

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## Abstract

This study examines associations among global risk perceptions, institutional pressures, and sustainable innovation in Turkish SMEs engaged in international trade. Data were collected through an online survey conducted between 7 December 2024 and 20 March 2025, and 342 complete responses were analyzed. The measurement model was assessed using confirmatory factor analysis, and parallel multiple mediation was estimated in jamovi using 5,000 bias-corrected bootstrap resamples. Bootstrap confidence intervals excluded zero for the indirect associations of social and environmental risk perceptions with sustainable innovation through normative pressure. Indirect effects through regulatory and cognitive pressure were not statistically significant. Social and environmental risk perceptions had positive total associations with sustainable innovation, whereas the total association of geopolitical risk perception was not significant. Geopolitical risk received the highest mean score and environmental risk the lowest. The findings provide limited evidence consistent with an indirect role of normative pressure, but the cross-sectional design does not establish causal mechanisms. The results indicate a need for carefully evaluated institutional support for sustainability-oriented innovation in SMEs.

**Keywords:** Institutional Theory, Sustainable Innovation, Global Risk Perception

**JEL Codes:** D81, O31, L26

## Öz

Bu çalışma, uluslararası ticaret yapan Türkiye'deki KOBİ'lerin küresel risk algıları, kurumsal baskılar ve sürdürülebilir inovasyon arasındaki ilişkileri incelemektedir. Veriler, 7 Aralık 2024 ile 20 Mart 2025 tarihleri arasında çevrim içi anket yoluyla toplanmış ve 342 eksiksiz yanıt analiz edilmiştir. Ölçüm modeli doğrulayıcı faktör analiziyle değerlendirilmiş; paralel çoklu aracılık analizi jamovi'de 5.000 yanlılığı düzeltilmiş bootstrap örneklemi kullanılarak gerçekleştirilmiştir. Bootstrap güven aralıkları, sosyal ve çevresel risk algılarının normatif baskı üzerinden sürdürülebilir inovasyonla dolaylı ilişkileri için sıfırı dışlamıştır. Düzenleyici ve bilişsel baskı üzerinden dolaylı etkiler istatistiksel olarak anlamlı değildir. Sosyal ve çevresel risk algılarının sürdürülebilir inovasyonla toplam ilişkileri pozitifken jeopolitik risk algısının toplam ilişkisi anlamlı değildir. Jeopolitik risk en yüksek, çevresel risk ise en düşük ortalamaya sahiptir. Bulgular, normatif baskının dolaylı rolüyle uyumlu sınırlı kanıt sunmakta; kesitsel tasarım nedensel mekanizmalar kurulmasına izin vermemektedir. Sonuçlar, KOBİ'lerde sürdürülebilir inovasyona yönelik kurumsal desteklerin dikkatle değerlendirilmesi gerektiğine işaret etmektedir.

**Anahtar Kelimeler:** Kurumsal Teori, Sürdürülebilir İnovasyon, Küresel Risk Algısı

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## Introduction

The philosophy that if there is a problem, there is also a solution has historically driven humanity to struggle for survival in nature and to innovate in this direction (Günay & Çalık, 2019). Innovation is broadly defined as the development of a novel product or service, or the differentiation of an existing one for commercialization (Klewitz & Hansen, 2014; Yorgancılar, 2011). Today, however the innovation literature emphasizes that businesses consider not only economic concerns but also social and environmental dimensions. In today's world, where global risks are increasing, the importance of sustainable innovation efforts for businesses to remain competitive is emphasized (Çalık, 2021; Demirel, 2024; World Economic Forum, 2024).

The literature emphasizes the urgency of SMEs involvement in achieving sustainable development. Across OECD countries, SMEs account for approximately 99% of all firms (Wildnerova et al., 2024). In the context of the Turkish economy, according to KOSGEB data, as of 2023, SMEs constitute 99.7% of total enterprises, 70.6% of employment, and 31.6% of total exports (KOSGEB, 2024). While SMEs are widely regarded as the backbone of the global economy, their collective activities also have a substantial environmental footprint, contributing to greenhouse gas emissions, waste generation, and resource consumption (Wildnerova et al., 2024; Zhang et al., 2022). In the global risk environment, the sustainable innovation capabilities of SMEs have become an important competitive factor. In studies conducted, sustainable innovation stands out in firms gaining a competitive advantage (Bos-Brouwers, 2010; Boons et al., 2013; Piñera-Salmerón et al., 2023). The literature emphasizes the sensitivity of SMEs to financial and environmental risks, while the OECD suggests that sustainable innovation strategies can reduce this sensitivity (Asgary et al., 2020; Sinani & Zilja, 2025).

According to the 2024 Global Risks Report by the World Economic Forum, which includes perspectives from experts in academia, business, government, international organizations, and civil society, technological and societal risks such as disinformation, cyber insecurity, and societal polarization are expected to intensify over the next decade. At the same time, the environmental dimension of global risks is becoming increasingly apparent. Biodiversity loss, extreme weather events, and natural resource scarcity are defined as systemic threats that could potentially have serious consequences for the global economy. In an era characterized by increasing economic uncertainties and geopolitical tensions, the report highlights the growing interconnectedness and cascading effects of global risks across economic, social, political, and environmental systems (WEF, 2024). Since the 2008 global financial crisis, there has been an increasing body of literature indicating a slowdown in globalization and a stagnation in trade and foreign direct investments (e.g., Mariotti, 2024). Recently, the literature increasingly discusses the weakening of international institutions (see Witt, 2019), the reversal of globalization, international trade protectionism, and the restructuring of global value chains (Baldermann et al., 2026; Baur & Flach, 2023; Witt et al., 2023; Zahoor et al., 2023), the technology cold war, and the multipolarity of the world economy (Tung et al., 2023).

The convergence of environmental, social, and geopolitical risks necessitates different approaches for businesses to identify, assess, and mitigate supply-chain vulnerabilities in their supply chains (Kazan & Uzun Kocamış, 2024). A large part of the literature has focused on the global risk perception and risk management of multinational enterprises. SMEs are an important part of global supply chains, and considering today's market, they increasingly face similar international challenges as larger firms (Ruzzier et al., 2006). In an environment where global risks are increasing, the lack of studies examining the relationship between SMEs' risk perception and sustainable innovation efforts is particularly noticeable. While prior studies indicate that global risks negatively affect innovation activities (e.g., Krammer & Kafouros, 2022; Nadeem et al., 2020; Qian & Qiu, 2023; Rehman et al., 2023; Thakkar et al., 2009), contrasting research highlights that firms evaluate identical risk environments in distinct ways and emphasizes the crucial role of innovation in managing these risks (Aragón-Correa et al., 2008; Bach et al., 2025; Chatterjee et al., 2022; Sinani & Zilja, 2025; Vieira et al., 2023). This suggests that strategic decision-making in firms is significantly driven by how organizations approach the concept of risk. Consequently, understanding how individuals perceive uncertainty within an unstable global order and navigate through it has become increasingly vital (Deirmentzoglou et al., 2025). Furthermore, empirical research demonstrates that awareness regarding the nature and consequences of risk serves as a critical element in both mitigating supply chain risks (Adeseun et al., 2018) and responding effectively to incoming threats (Hauser, 2022).

Alongside these dynamics, the literature heavily the determinative role of countries' institutional environments and external institutional pressures on firm's innovation performance (Chen et al., 2018; D'Ingiullo & Evangelista, 2020; Durst & Leyer, 2022; Romanello et al., 2022; Singh et al., 2025) and has shown that external institutional pressures have significant positive effects on innovation (Carfora et

al., 2021; Ketata et al., 2015). However, some studies point out the lack of an institutional context in innovation (e.g., Martínez-Román et al., 2019). According to institutional theory, multilevel institutional structures shape and constrain firm behaviour. Global supply chains are influenced by multiple actors, including governments, businesses, and other organizations (Herold & Marzantowicz, 2023). From an institutional theory perspective, heightened perceptions of global risks may increase SME decision-makers' attention to regulatory, normative, and cognitive demands in their environment, which may subsequently shape firms' sustainable innovation responses.

Although environmental innovation research has gained momentum in Türkiye (e.g., Yıldız Çankaya & Sezen, 2015; Gelmez & Ergen Işıklar, 2025; Kazdal et al., 2025; Kuzgun & Gözükara, 2023; Oğul, 2022; Şenocak & Bursalı, 2018; Ünsal & Gövdere, 2023), studies examining the environmental, social, and economic dimensions of sustainable innovation simultaneously remain limited. More importantly, little is known about how globally exposed Turkish SMEs translate their perceptions of geopolitical, environmental, and social risks into sustainable innovation responses. The institutional mechanisms underlying this relationship also remain underexplored.

From the perspective of institutional theory, it is considered important to examine the role of external pressure elements in the sustainable innovation efforts of SMEs in a global risk environment. This gap indicates an important research area that could contribute to both institutional theory and sustainable innovation research.

In line with this purpose, the research seeks to answer the following questions:

Q1: How does the global risk perception of SMEs affect their sustainable innovation performance?

Q2: Is there a mediating role of institutional external pressure elements (regulatory, normative, and cognitive) in the relationship between SMEs' perception of global risk and their sustainable innovation performance?

This study examines the direct associations between the global risk perceptions—geopolitical, environmental, and social—of SMEs engaged in international trade in Türkiye and their sustainable innovation performance. It also tests the mediating role of regulatory, normative, and cognitive institutional pressures using GLM-based mediation analysis.

This study aims to contribute to the sustainable innovation literature by examining the environmental, social, and economic dimensions of product and process innovation among SMEs engaged in international trade. By testing the mediating role of regulatory, normative, and cognitive institutional pressures across multiple global risk dimensions, the study also contributes to institutional theory.

## Literature review

Increasing geopolitical, environmental, social, and economic issues worldwide have brought sustainability to the forefront. While governments, nongovernmental organizations and consumers emphasize sustainability in every field, the idea of transforming challenges into business opportunities and new markets has garnered interest in the business world (Bos-Brouwers, 2010; Boons et al., 2013).

The term "sustainability" is interpreted in various ways, ranging from an intergenerational philosophical position to a multidimensional term for business management. Early sustainability initiatives tended to focus on environmental issues, but over time, a three-dimensional approach to sustainability (i.e., environmental, economic, and social) has been increasingly adopted (Ahi & Searcy, 2013). Sustainability-focused innovation involves making deliberate changes in an organization's products, processes, or practices with the aim of creating and realizing social and environmental value, while also serving economic returns (Boons et al., 2013; Çalık, 2021). Following Calik and Badurdeen (2016), sustainable innovation performance is conceptualized as a firm's ability to generate economic benefits while simultaneously producing positive environmental and social outcomes through successfully implemented product, process, and system innovations. The literature on innovation studies emphasizes the determinative role of countries' institutional environments and external institutional pressures. Three classifications are proposed related to the motivation for adopting institutional practices: regulatory, cognitive and normative. Regulatory isomorphism arises from both formal and informal pressures exerted by other parties on which an organization is dependent, as well as from the expectations of the society in which it operates. Cognitive isomorphism is a process in which an organization attempts to imitate another organization it perceives as more successful; this process is often driven by uncertainty and a lack of direction in its own environment. Normative isomorphism, on the other hand, stems from professionalization; that is, it is the common struggle of a professional group to define the working conditions and methods of its members (Dillard et al., 2004).

Studies examining the impact of external institutional pressures on innovation performance have produced mixed findings in the literature. For example, in the study by Romanello et al. (2022) comparing Chinese and Italian firms, while Italian firms primarily shape their opportunities through product innovation, their Chinese counterparts develop opportunities mainly thru networks embedded in the local institutional context. The study shows that regulatory, cognitive, and normative institutions strongly influence the process (Romanello et al., 2022). Similarly, in the study conducted by Chen et al. (2018), which sampled the top 100 publicly traded companies in China from 2008 to 2014, the findings indicate that both regulatory and normative pressures have significant positive effects on corporate green innovation (Chen et al., 2018). The findings of Carfora et al. (2021) study on the determinants of environmental innovations supporting the sustainable development of SMEs show that, among internal factors, firm's environmental awareness, company personnel, and capabilities are influential, while among external factors, norms and regulations have an impact. Additionally, the expectation of improving economic and environmental performance also plays an important role. It has been shown that monetary and fiscal incentives are not significant (Carfora et al., 2021). Based on survey data obtained from 165 3PL (third-party logistics) providers in China by Chu et al. (2018), empirical results show that customer pressure and competitive pressure significantly push 3PL providers to adopt green innovation, but so far, regulatory pressure has not affected such innovation (Chu et al., 2018).

In the study by Ketata et al. (2015), who empirically tested the role of internal capabilities and the environment of firms in sustainable innovation for over 1,100 companies in Germany, it was found that firms engaged in sustainable innovation activities focus on sustainable innovation activities that provide resource and energy savings, followed by activities that improve health and safety and reduce environmental stress. According to the findings of the study, regulatory pressure has a significant positive impact on sustainable innovation participation, while public funding does not have a significant effect (Ketata et al., 2015).

Taken together, prior findings suggest that institutional pressures do not influence innovation uniformly. Normative pressures show relatively consistent positive associations with environmental and sustainable innovation, cognitive and regulatory pressures vary across organizational and national contexts. This mixed evidence supports examining each perceived institutional pressure separately as a potential mechanism linking SMEs' global risk perceptions to sustainable innovation performance.

**Geopolitical risks and sustainable innovation**

Geopolitical risks stem from political instabilities across international borders, trade disputes, and regulatory shifts. Tariffs, trade restrictions, and sanctions can disrupt supply chains, escalate costs, and hinder market access. Furthermore, political instability and regulatory uncertainties adversely impact supply chain compliance and operational efficiency (Kazan & Uzun Kocamış, 2024).

According to the 2024 Global Risks Report by the World Economic Forum, ongoing supplyside pressures and demand uncertainty can contribute to persistent inflation and high interest rates. In such a situation, SMEs will be particularly vulnerable to slowing growth (WEF, 2024). Geopolitical disruptions can generate geoeconomic consequences—including trade restrictions, supply shortages, inflationary pressures, and financing uncertainty—that constrain SMEs' innovation capacity. In the past decade, financial economists and practitioners have recognized the significance of economic uncertainty on firms' innovations (Rehman et al., 2023). Uncertainties in supply and demand, the degree of market globalization, increasingly shorter product and technology life cycles, and the growing use of production, distribution, and logistics partners have led to small and medium sized enterprises (SMEs) involved in the supply chain being exposed to greater economic risks due to complex international supply network relationships (Thakkar et al., 2009). Additionally, regional wars and conflicts also increase economic risks for SMEs. For example, it is stated that the insecurity created by conflicts such as wars and explosions in the Middle East and North Africa (MENA) region has a negative and strong impact on sales and productivity, and this effect is more pronounced for small and medium sized enterprises (SMEs) (Mirza et al., 2021). Qian and Qiu (2023) found in their study examining the economic consequences of the changing international supply chain with political risk that international purchasing decreased with political risk and that political risk could reduce capacity utilization, expected sales, and research and development activities (Qian & Qiu, 2023).

Studies on geopolitical risks indicate that geopolitical risks such as international terrorism, religious conflicts, and trade wars negatively affect SMEs (Baur & Flach, 2023; Naradda Gamage et al., 2019; Sinani & Zilja, 2025). The literature emphasizes the negative effects of political instability on firms' innovation (Krammer & Kafouros, 2022; Nadeem et al., 2020; Rehman et al., 2023). It also reveals that terrorism has negative effects on innovation (Nadeem et al., 2020; Qian & Qiu, 2023). In measuring

innovation in companies, R&D and patents are used; however, some studies emphasize the recent rise of techno-nationalism and indicate that patents cause inequalities in certain countries. Sinani and Zilja (2025) found that deteriorating diplomatic relations discourage the foreign investments of international high-technology SMEs. However, this relationship varies according to firms' innovation capabilities, measured through patents, and the scope of their international diversification.

Investigating how individuals perceive and navigate uncertainty within an unstable global environment through the lens of attitudes, subjective norms, and perceived behavioral control, Deirmentzoglou et al. (2025) demonstrate that geopolitical risks significantly shape entrepreneurial dynamics. Specifically, these risks alter resource accessibility, reshape market conditions, and serve as a catalyst for innovation in response to heightening uncertainty. Although geopolitical turmoil imposes substantial barriers—including supply chain disruptions, inflationary pressures, and investment volatility—it concurrently generates strategic opportunities, particularly within technology-intensive sectors (Deirmentzoglou et al., 2025).

Examining organizational adjustments to external constraints, Hauser (2022) investigated how small and medium-sized enterprises (SMEs) respond to coercive economic measures such as trade control regulations, embargoes, and sanctions across a sample of 289 SMEs. The findings indicate that SMEs execute proportional strategic adaptations to regulatory pressures; however, the deployment of these organizational responses relies heavily on decision-makers being thoroughly informed and aware of existing regulatory frameworks (Hauser, 2022). Complementing this focus on organizational awareness, Adeseun et al. (2018) evaluated risk perception across organizational hierarchies within the UK agri-food sector, concluding that a comprehensive awareness of both the nature and consequences of risk is critical for mitigating supply chain vulnerabilities (Adeseun et al., 2018).

Similarly, in a qualitative study conducted between November 2019 and June 2020 across 28 firms in nine sectors within the UK—amid Brexit preparations, escalating US-China trade tensions, and the COVID-19 pandemic—Roscoe et al. (2022) revealed that managerial decision-making logic is constrained by three core environmental ecosystem conditions: (1) the perceived intensity of institutional pressures, (2) the relative mobility of suppliers and supply chain assets, and (3) the perceived severity of disruption risks. Consequently, intense regulatory pressure and persistent geopolitical instability exert uniform effects on firms within the same sector, driving convergent strategic approaches to supply chain design (Roscoe et al., 2022).

To test the mediating role of external institutional pressures in the relationship between geopolitical risk perception and innovation performance among Turkish SMEs, the following hypotheses are proposed:

H1: Regulatory pressures (RP) mediate the impact of geopolitical risk perception (GPR) on the sustainable innovation performance (SI) of SMEs.

H2: Normative pressures (NP) mediate the impact of geopolitical risk perception (GPR) on the sustainable innovation performance (SI) of SMEs.

H3: Cognitive pressures (CP) mediate the impact of geopolitical risk perception (GPR) on the sustainable innovation performance (SI) of SMEs.

**Environmental risks and sustainable innovation**

Environmental risks encompass threats originating from both natural and anthropogenic environmental factors. Natural disasters—such as earthquakes, hurricanes, floods, and wildfires—can severely disrupt supply chain infrastructure and transportation networks. Furthermore, climate shifts adversely affect resource availability, logistical transport, and manufacturing processes, while potential resource scarcities escalate operational costs and induce severe disruptions in procurement and production (Kazan & Uzun Kocamış, 2024).

Sustainable innovation efforts are of great importance in the management of environmental risks. In their study aimed at determining the impact of biodiversity risk on firm performance, Bach et al. (2025) reveal the role of product innovation in mitigating the negative effect of biodiversity risk on firm performance (Bach et al., 2025). Similarly, in a study conducted by Aragón-Correa et al. (2008) on 108 SMEs in the automotive repair sector in Southern Spain, they found that SMEs implemented various environmental strategies ranging from reactive regulatory compliance to proactive pollution prevention and environmental leadership (Aragón-Correa et al., 2008).

Grounded in institutional theory, Daddi et al. (2020) investigated the influence of coercive, normative, and mimetic pressures on corporate climate change mitigation and adaptation strategies. Employing econometric modeling—specifically multivariate regression—on a survey dataset of 487 Italian

manufacturing firms, their empirical findings revealed that perceived normative and mimetic pressures heighten a firm's climate sensitivity. This internal sensitivity, in turn, significantly increases the likelihood of adopting both mitigation and adaptation strategies. The study contributes to institutional scholarship by clarifying how external pressures drive corporate climate action and highlighting the mediating role of internal organizational factors between external institutional pressures and corporate climate responses (Daddi et al., 2020).

Focusing on executive dynamics and risk perception, Liao et al. (2025) analyzed Chinese A-share listed firms from 2012 to 2023, finding that firm risk perception positively moderates the relationship between star CEOs and environmental innovation. Examining the nuanced effects of risk awareness across organizational scales, Bao and Zhang (2026) demonstrated that climate risk perception enhances the quantity of green innovation more effectively in large enterprises, whereas it fosters the quality of green innovation more prominently in small firms. Similarly, Liao et al. (2026) identified a statistically significant positive effect of climate risk perception on digital innovation across organizations.

Conversely, regarding risk prioritization within emerging markets, Asgary et al. (2020) demonstrated that small and medium-sized enterprises (SMEs) in Türkiye perceive global risks differently than respondents to the World Economic Forum survey. Specifically, while global economic and geopolitical risks represent major sources of concern for Turkish SMEs, environmental risks rank at the bottom of their strategic priorities (Asgary et al., 2020).

To test the mediating role of external institutional pressures in the relationship between environmental risk perception and innovation performance among Turkish SMEs, the following hypotheses are proposed:

H4: Regulatory pressures (RP) mediate the impact of global environmental risk perception (GER) on the sustainable innovation performance (SI) of SMEs.

H5: Normative pressures (NP) mediate the impact of global environmental risk perception (GER) on the sustainable innovation performance (SI) of SMEs.

H6: Cognitive pressures (CP) mediate the impact of global environmental risk perception (GER) on the sustainable innovation performance (SI) of SMEs.

**Social risks and sustainable innovation**

Social risks stem from organizational and societal disruptions, including labour-rights violations, human rights violations, and deteriorating community relations, which directly threaten corporate reputation and operational continuity (Kazan & Uzun Kocamış, 2024). Grounded in the WEF's (2024) Global Risks Framework, global threats operate within a systemic, interconnected network of mutual reinforcement (WEF, 2024). Although the report formally categorizes phenomena such as societal polarization and involuntary migration as societal risks, and cyber threats alongside misinformation/disinformation as technological risks, their extensive socio-cognitive ramifications and profound societal impacts justify their operationalization under a unified 'global social risk' construct within the scope of this study

Historically examined primarily through sociological and demographic lenses (Beets & Willekens, 2009), forced migration and geopolitical realignments have evolved into central research topics within strategic management and international business. Recent empirical research underscores that forced migration movements significantly shape international trade dynamics (Poot & Strutt, 2010), entrepreneurial ecosystems, corporate human resource strategies, and global value chains (Minbaeva et al., 2025). Concurrently, technological cold wars and the rapid proliferation of generative AI tools have exacerbated the mass dissemination of misinformation and disinformation (Tung et al., 2023). In the context of sustainability, fake news generates "infodemics" that distort risk perceptions, manipulate public sentiment against green technologies, and undermine climate policies (Earnshaw et al., 2020; Foxwell-Norton & Konkes, 2021, as cited in Vasist & Krishnan, 2023). This pervasive cognitive manipulation increases societal friction and introduces high unpredictability into corporate strategic decision-making.

Despite the growing severity of these systemic disruptions, critical research gaps remain regarding how social risk perceptions influence the sustainable innovation performance of small and medium-sized enterprises (SMEs). Some studies show that innovation is positively related to social and environmental performance and that R&D enhances economic performance. However, technological turbulence negatively affects the adoption of sustainable innovation (Zhang et al., 2022).

To test the mediating role of external institutional pressures in the relationship between social risk perception and innovation performance among Turkish SMEs, the following hypotheses are proposed:

H7: Regulatory pressures (RP) mediate the impact of global social risk perception (GSR) on the sustainable innovation performance (SI) of SMEs.

H8: Normative pressures (NP) mediate the impact of global social risk perception (GSR) on the sustainable innovation performance (SI) of SMEs.

H9: Cognitive pressures (CP) mediate the impact of global social risk perception (GSR) on the sustainable innovation performance (SI) of SMEs.

## Method

This section includes how the study was conducted, data collection tools, the research design, and analysis methods.

### Data collection

In this study, the population of the research consists of SMEs engaged in international trade registered with the Union of Chambers and Commodity Exchanges of Türkiye. Due to constraints in accessing a complete directory of all international trading SMEs in Türkiye, an accessible sampling frame of 8,000 companies was identified through available contact records. An online survey was administered between 7 December 2024 and 20 March 2025. After invalid or undeliverable email addresses were excluded, 410 companies voluntarily responded to the survey. The principles used to define SMEs in Türkiye are determined by the "Regulation on Small and Medium-Sized Enterprises." At the time of data collection, Turkish regulations defined SMEs as enterprises employing fewer than 250 persons and having either annual net sales revenue or a financial balance sheet total not exceeding TRY 500 million (KOSGEB, 2024). To reduce confidentiality concerns and encourage participation, financial information was not collected. Therefore, SME eligibility was operationalized using employment size because the financial criteria could not be verified. Respondents selecting the predefined categories “1–10,” “11–50,” or “51–250 employees” were retained, whereas those selecting a category above 250 employees were excluded. Because exact employee counts were unavailable within the “51–250” category, it was not possible to determine whether any firm employed exactly 250 persons. The inability to verify the financial criteria and this ambiguity arising from the grouped response format are acknowledged as limitations of the study. 342 met the operational SME eligibility criterion and were retained for the final analysis.

### Survey design

Before designing the survey, the literature on global risks, corporate external pressure factors and sustainable innovation was examined with special emphasis on scales and key indicators used in previous studies.

The first section of the survey consisted of six questions aimed at determining the demographic characteristics of SMEs (Table 1).

**Table 1:** Demographic Characteristics of the Sample

| **Region** | **N (342)** | **% of Total** | **Sektor** | **N (342)** | **% of Total** |
|---|---|---|---|---|---|
| Aegean Region | 45 | 13.2% | Automotive | 16 | 4.7% |
| Black Sea Region | 4 | 1.2% | Chemistry | 16 | 4.7% |
| Central Anatolia | 93 | 27.2% | Construction | 10 | 2.9% |
| Marmara Region | 163 | 47.7% | Electrical-electronics | 14 | 4.1% |
| Mediterranean | 22 | 6.4% | Food | 23 | 6.7% |
| Southeastern Anatolia | 15 | 4.4% | Furniture | 47 | 13.7% |
| **Firm age** | **N (342)** | **% of Total** | Logistics | 9 | 2.6% |
| 1-10 years | 101 | 29.5% | Machinery | 48 | 14.0% |
| 11-20 years | 88 | 25.7% | Metal | 37 | 10.8% |
| 21 and above | 153 | 44.7% | Plastic | 35 | 10.2% |
| **Number of employees** | **N (342)** | **% of Total** | Textiles | 50 | 14.6% |
| 1-10 | 88 | 25.7% | Others | 37 | 10.8% |
| 11-50 | 141 | 41.2% | **Respondent role** | **N (342)** | **% of Total** |
| 51-250 | 113 | 33.0% | Expert | 113 | 33.0% |
| **International trade activity** | **N (342)** | **% of Total** | Founder | 28 | 8.2% |
| Both | 170 | 49.7% | Manager | 192 | 56.1% |
| Export | 154 | 45.0% | Senior Executive | 9 | 2.6% |
| Import | 18 | 5.3% | | | |

Table 1 summarizes the demographic and organizational profile of the sampled firms (N = 342). Geographically, nearly half of the participants operate in the Marmara Region (47.7%), followed by Central Anatolia (27.2%) and the Aegean Region (13.2%). In terms of organizational maturity, well-established enterprises operating for 21 years or more constitute the largest group (44.7%), while firms aged 1–10 years represent 29.5%. Regarding firm size, small and medium-sized enterprises dominate the sample, with 41.2% employing 11–50 individuals and 33.0% employing 51–250 individuals. Notably, the dataset demonstrates strong international trade exposure, as 49.7% of the respondents engage in both import and export activities, and 45.0% focus primarily on exports. The sample covers a broad industrial spectrum, led by textiles (14.6%), machinery (14.0%), furniture (13.7%), and metal manufacturing (10.8%). Finally, respondent positions are overwhelmingly held by informed decision-makers, with mid-level managers comprising 56.1% and experts accounting for 33.0%, thereby strengthening the informational reliability of strategic perception measures.

The second section comprised 10 items selected from the World Economic Forum's Global Risks Report 2024 to assess SME decision-makers' perceptions of risks relevant to their firms' international trade and supply-chain activities. The questions have been coded as geopolitical, social, and environmental risks (Table 2). Participants indicated the extent to which each listed risk affected their firms' international trade activities.

WEF (2024) emphasizes that global risks are interconnected and may generate cascading effects across economic, environmental, geopolitical, societal, and technological domains. For the purposes of the present study, the ten selected risk items were organized into three analytical dimensions. Economic and geopolitical items were grouped under geopolitical risk perception because international conflict, trade restrictions, sanctions, and their immediate geoeconomic consequences are closely intertwined in the international operations of SMEs. Technological risks with predominantly societal and organizational consequences, including misinformation, disinformation, and cyber insecurity, were examined together with societal risks under global social risk perception. Climate-related changes, biodiversity loss, extreme weather events, and resource scarcity formed the environmental risk dimension. This study-specific classification does not reproduce the original WEF taxonomy; rather, it provides a parsimonious operationalization of the selected risks in relation to SMEs' international trade and supply-chain activities. The empirical adequacy of this grouping was subsequently examined through the study's measurement analyses.

**Table 2:** Global Risks

| Global Risks | Risk Type | Codes |
|---|---|---|
| 1-Social polarization | Social Risk | GSR1 |
| 2-Political risks | Geopolitical Risk | GPR1 |
| 3-Extreme weather events | Environmental Risk | GER1 |
| 4-Decrease in biodiversity | Environmental Risk | GER2 |
| 5-Cyber insecurity | Social Risk | GSR2 |
| 6-Interstate armed conflicts | Geopolitical Risk | GPR2 |
| 7-Economic recession | Geopolitical Risk | GPR3 |
| 8- Forced migration | Social Risk | GSR3 |
| 9-Misinformation and disinformation | Social Risk | GSR4 |
| 10-Natural resource shortages | Environmental Risk | GER3 |

**Source:** Created by the author based on the 2024 Global Risk Perception survey data from the World Economic Forum

In the third section, the Sustainable Innovation (SI) scale originally developed by Calik and Badurdeen (2016) and validated in Turkish by Çalık (2021) was adopted. The instrument comprises 34 items evaluated on a 5-point Likert scale. Since the Turkish version of the scale had already been validated for manufacturing enterprises in Türkiye by Çalık (2021), no additional language adaptation or translation process was required. The scale operationalizes sustainable innovation under two main dimensions: sustainable product innovation (SPt) and sustainable process innovation (SPs). In the scale of sustainable product innovation (SPt), the three fundamental dimensions of sustainability are considered: economic (SPtEco), environmental (SPtEnv) and social (SPtSo). Similarly, in the scale of sustainable process innovation (SPs), the three fundamental dimensions of sustainability are economic (SPsEco), environmental (SPsEnv) and social (SPsSo) (Çalık, 2021; Calik 2024).

In the fourth section of the survey, participants were asked to respond to 12 items concerning corporate external pressure factors identified through the literature review (Table 3). Respondents evaluated the extent to which each factor affected their business under the following instruction: "The factors listed below affect our company's international trade activities." The external institutional pressure items were adapted from Saeed and Kersten (2019), Sarrakh et al. (2020), and Zimon et al. (2020). Their conceptual grouping drew on Scott's (2014) discussion of the regulative, normative, and cultural-cognitive pillars of institutions.

Participants in the survey were asked to respond to all questions using a 5-point Likert scale: 1: Strongly disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly agree.

**Table 3:** External Pressure Elements

| External Pressure Factor | Institutional Pressure Dimension | Codes |
|---|---|---|
| Government regulations/laws | Regulatory Pressure | RP1 |
| Regional and international regulations | Regulatory Pressure | RP2 |
| Incentives | Regulatory Pressure | RP3 |
| Professional trade associations | Regulatory Pressure | RP4 |
| Media/press | Normative Pressure | NP1 |
| Public pressure (social groups) | Normative Pressure | NP2 |
| Consumer organizations | Normative Pressure | NP3 |
| NGO pressure | Normative Pressure | NP4 |
| Supplier pressure | Cognitive Pressure | CP1 |
| Customer pressure | Cognitive Pressure | CP2 |
| Reputation/image | Cognitive Pressure | CP3 |
| Competitor pressure | Cognitive Pressure | CP4 |

**Source:** Adapted by the author based on Saeed & Kersten (2019), Sarrakh et al. (2020), and Zimon et al. (2020).

**Research model**

Building on institutional theory, the proposed research model examines the relationships between SME decision-makers' perceptions of global risks and their firms' sustainable innovation performance. Global risk perceptions comprise geopolitical risk perception (GPR), including selected geoeconomic items; environmental risk perception (GER); and global social risk perception (GSR), including selected socio-technological items. Sustainable innovation performance (SI) encompasses sustainable product innovation (SPt) and sustainable process innovation (SPs). The three dimensions of perceived institutional pressure—regulatory (RP), normative (NP), and cognitive (CP)—are specified as parallel mediators. GPR, GER, and GSR were entered simultaneously as predictors of each of the three parallel

mediators (RP, NP, and CP). SI was modeled as a function of these three mediators and all three risk-perception dimensions; no serial ordering among the mediators was specified.

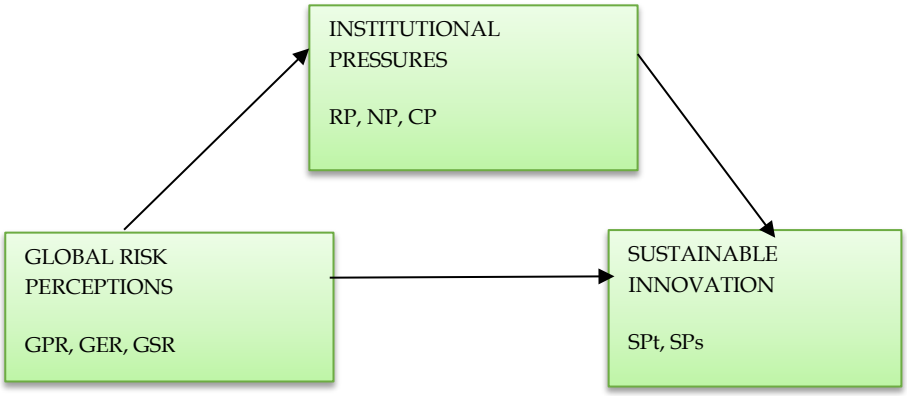


**Figure 1:** Research Model

**Source**: Created by the author.

## Data analysis

In this study, the jamovi statistical analysis software was used to analyze the survey data. Exploratory group comparisons were conducted to examine whether global risk perceptions and sustainable innovation dimensions differed according to selected firm and respondent characteristics. Univariate normality was evaluated through skewness and kurtosis analyses. A two-stage analytical procedure was followed (Anderson & Gerbing, 1988). First, confirmatory factor analysis (CFA) was used to examine the specified factor structure. Internal consistency was assessed using Cronbach's alpha, McDonald's omega, and composite reliability (Hair et al., 2010), while convergent validity was evaluated using average variance extracted (AVE; Fornell & Larcker, 1981). Following the measurement-model assessment, SI was calculated as the unweighted arithmetic mean of its 34 product and process innovation items, including SPtSo16. All 342 cases had complete scores for the variables in the mediation model. Hypotheses were tested using GLM-based parallel mediation with 5,000 bootstrap resamples to estimate direct, indirect, and total effects (Hayes, 2018). For the predictors in these regression equations, variance inflation factors calculated from the observed scores ranged from 1.73 to 2.45.

### Group comparisons across firm and respondent characteristics

Group comparisons covered geographical region, firm age, firm size, industry sector, international trade activity, and respondent role. Nine outcomes were examined for each grouping variable, yielding 54 exploratory omnibus tests. Because group sizes were unequal, Welch's one-way ANOVA was used. The 54 omnibus p values were adjusted as one family using the Holm procedure. Games–Howell comparisons were also computed for outcomes with unadjusted omnibus $p < .05$; because none of these omnibus tests remained significant after Holm adjustment, the pairwise comparisons were not used to draw inferential conclusions.

**Table 4:** Exploratory Welch group comparisons before and after Holm adjustment

| Grouping variable | Outcome | Welch's F ($df_1$, $df_2$) | Unadjusted p | Holm-adjusted p |
|---|---|---|---|---|
| Firm age | No outcomes with unadjusted p < .05 | - | All p > .05 | All adjusted p = 1.000 |
| Region | GPR | 3.094 (5, 25.9) | .0255 | 1.0000 |
| Region | SPtEco | 4.699 (5, 25.5) | .0036 | .1919 |
| Firm size | SPtSo | 3.377 (2, 204) | .0361 | 1.0000 |
| Firm size | SPsEnv | 3.082 (2, 204) | .0480 | 1.0000 |
| Firm size | SPsSo | 5.191 (2, 205) | .0063 | .3285 |
| Sector | GER | 2.260 (11, 83.9) | .0182 | .9292 |
| Sector | SPtSo | 2.125 (11, 82.8) | .0270 | 1.0000 |
| Activity | SPsEnv | 3.561 (2, 47.4) | .0362 | 1.0000 |
| Activity | SPsSo | 3.270 (2, 45.9) | .0470 | 1.0000 |
| Role | GSR | 3.063 (3, 32.4) | .0418 | 1.0000 |
| Role | GER | 5.176 (3, 32.1) | .0050 | .2634 |
| Role | SPtEco | 2.949 (3, 33.2) | .0469 | 1.0000 |

**Note:** Six grouping variables and nine outcomes were examined, yielding 54 Welch omnibus tests. The table presents the 12 outcomes with unadjusted p < .05 and a summary row for firm age, for which no unadjusted p was below .05. No omnibus test remained significant after Holm adjustment across all 54 tests. Games–Howell comparisons were treated as exploratory and are not presented as significant findings after adjustment.

Across the 54 exploratory group comparisons, 12 Welch omnibus tests yielded unadjusted p values below .05. None remained significant after the Holm adjustment across the full test family (Table 4). Accordingly, the nominal group differences and associated Games–Howell comparisons do not provide evidence of demographic differences after correction for multiple testing.

**Descriptive statistics**

Descriptive statistics showed that the study variables had medium to high levels overall. The perception of geopolitical risk showed the highest average score (M= 4.27, SD= 0.77), suggesting that SMEs perceive geopolitical risks at a relatively high level. Normative pressure showed the lowest average score (M = 2.88, SD = 1.19), indicating a relatively lower normative institutional impact.

Skewness values ranged from −1.43 to 0.18, and kurtosis values ranged from −0.96 to 2.13. These values do not suggest marked univariate departures from normality (see Table 5).

**Table 5:** Descriptive Statistics of Study Variables (N = 342)

| Variable | M | SD | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| GSR | 3.62 | 0.90 | 1.00 | 5.00 | -0.611 | 0.244 |
| GER | 3.53 | 0.94 | 1.00 | 5.00 | -0.331 | -0.432 |
| GPR | 4.27 | 0.77 | 1.00 | 5.00 | -1.430 | 2.130 |
| RP | 3.71 | 0.94 | 1.00 | 5.00 | -0.587 | -0.165 |
| NP | 2.88 | 1.19 | 1.00 | 5.00 | 0.183 | -0.961 |
| CP | 3.58 | 1.02 | 1.00 | 5.00 | -0.622 | -0.201 |
| SPt | 3.46 | 0.90 | 1.00 | 5.00 | -0.292 | -0.248 |
| SPs | 3.64 | 0.92 | 1.00 | 5.00 | -0.509 | -0.030 |

**Note:** GSR = Global Social Risk; GER = Global Environmental Risk; GPR = Geopolitical Risk; RP = Regulatory Pressure; NP = Normative Pressure; CP = Cognitive Pressure; SPt = Sustainable Product Innovation; SPs = Sustainable Process Innovation. N = 342 for all variables. Missing values = 0.

**Measurement model and confirmatory factor analysis (CFA)**

The 56-item, 12-factor measurement model was examined using confirmatory factor analysis with maximum likelihood estimation. SPtSo16 was retained: its standardized loading was 0.679 in this model. Model fit was $\chi^2(1418) = 3314.00$, $p < .001$, $\chi^2/df = 2.34$, SRMR = 0.0516, RMSEA = 0.0625 (90% CI [0.0598, 0.0653]), CFI = 0.871, and TLI = 0.860 (Table 6). The SRMR and RMSEA values indicated comparatively better fit than the CFI and TLI values; accordingly, overall measurement-model fit was interpreted cautiously (Hu & Bentler, 1999; Marsh et al., 2004).

**Table 6:** Fit Indices for the Measurement Model

| Test for Exact Fit | | | Fit Measures | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | RMSEA 90% CI | |
| $\chi^2$ | df | p | CFI | TLI | SRMR | RMSEA | Lower | Upper |
| 3314.00 | 1418 | <.001 | 0.871 | 0.860 | 0.0516 | .0625 | 0.0598 | 0.0653 |

**Internal consistency and scale reliability analysis**

Internal consistency and convergent validity were assessed using Cronbach's alpha, McDonald's omega, Composite Reliability (CR), and Average Variance Extracted (AVE) (Table 7). Most constructs met the conventional reliability benchmark of 0.70. GSR yielded marginally lower coefficients (α = .695, ω = .699, and CR = .698), which closely approached the recommended level. The reliability coefficients of the remaining constructs ranged from acceptable to excellent (Hair et al., 2019).

The AVE values exceeded .50 for NP, CP, SPtEco, SPtEnv, SPtSo, SPsEco, SPsEnv, and SPsSo, supporting convergent validity for these dimensions. GER (AVE = .471), GPR (AVE = .466), and RP (AVE = .484) produced AVE values slightly below .50, although their CR values exceeded 0.70. These results provide partial support for their convergent validity. In contrast, the comparatively low AVE obtained for GSR (.367) indicates limited convergent validity and suggests that this dimension should be interpreted cautiously. Overall, the findings support the internal consistency of most dimensions but provide varying levels of evidence for convergent validity. For constructs with AVE values slightly below 0.50 (GSR, GER, GPR, and RP), composite reliability exceeded 0.70, supporting internal consistency. Nevertheless, the lower AVE values indicate some limitations in convergent validity; therefore, the measurement model was interpreted with caution (Fornell & Larcker, 1981; Lam, 2012). Overall, the refined measurement model demonstrated adequate reliability and construct validity.

**Table 7:** Reliability Indices

| Construct / Dimension | Items (k) | Cronbach's α | McDonald's ω | Composite Reliability (CR) | Average Variance Extracted (AVE) | Evaluation |
|---|---|---|---|---|---|---|
| GSR | 4 | 0.695 | 0.699 | 0.698 | 0.367 | CR≈0.70 |
| GER | 3 | 0.727 | 0.730 | 0.727 | 0.471 | CR>0.70 |
| GPR | 3 | 0.723 | 0.726 | 0.723 | 0.466 | CR>0.70 |
| RP | 4 | 0.792 | 0.797 | 0.787 | 0.484 | CR>0.70 |
| NP | 4 | 0.915 | 0.917 | 0.917 | 0.733 | AVE>0.50 |
| CP | 4 | 0.816 | 0.819 | 0.818 | 0.532 | AVE>0.50 |
| SPtEco | 3 | 0.870 | 0.878 | 0.878 | 0.708 | AVE>0.50 |
| SPtEnv | 11 | 0.941 | 0.943 | 0.943 | 0.601 | AVE>0.50 |
| SPtSo | 5 | 0.878 | 0.881 | 0.881 | 0.597 | AVE>0.50 |
| SPsEco | 3 | 0.891 | 0.902 | 0.905 | 0.762 | AVE>0.50 |
| SPsEnv | 9 | 0.951 | 0.952 | 0.952 | 0.689 | AVE>0.50 |
| SPsSo | 3 | 0.886 | 0.889 | 0.887 | 0.725 | AVE>0.50 |

**Correlation analysis and discriminant validity**

Relationships among latent variables and discriminant validity were systematically evaluated using the Fornell and Larcker (1981) criterion. To establish discriminant validity, the square root of the Average Variance Extracted (√AVE) for each latent construct should exceed its inter-construct correlations with all other dimensions in the measurement model (Fornell & Larcker, 1981; Hair et al., 2019).

**Table 8:** Latent Factor Correlations and Square Roots of AVE

| Construct | GSR | GER | GPR | RP | NP | CP | SPtEco | SPtEnv | SPtSo | SPsEco | SPsEnv | SPsSo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GSR | **0.606** | | | | | | | | | | | |
| GER | 0.895 | **0.686** | | | | | | | | | | |
| GPR | 0.926 | 0.669 | **0.683** | | | | | | | | | |
| RP | 0.447 | 0.395 | 0.377 | **0.696** | | | | | | | | |
| NP | 0.564 | 0.566 | 0.332 | 0.689 | **0.856** | | | | | | | |
| CP | 0.462 | 0.434 | 0.392 | 0.740 | 0.709 | **0.729** | | | | | | |
| SPtEco | 0.293 | 0.289 | 0.179 | 0.306 | 0.329 | 0.323 | **0.841** | | | | | |
| SPtEnv | 0.320 | 0.315 | 0.171 | 0.254 | 0.332 | 0.231 | 0.728 | **0.775** | | | | |
| SPtSo | 0.317 | 0.239 | 0.245 | 0.266 | 0.146 | 0.201 | 0.615 | 0.714 | **0.773** | | | |
| SPsEco | 0.308 | 0.297 | 0.162 | 0.252 | 0.291 | 0.233 | 0.697 | 0.751 | 0.718 | **0.873** | | |
| SPsEnv | 0.355 | 0.361 | 0.186 | 0.252 | 0.304 | 0.205 | 0.671 | 0.856 | 0.773 | 0.850 | **0.830** | |
| SPsSo | 0.288 | 0.222 | 0.252 | 0.247 | 0.172 | 0.225 | 0.541 | 0.630 | 0.807 | 0.616 | 0.718 | **0.851** |

As shown in Table 8, the Fornell–Larcker criterion was clearly not met for six construct pairs: GSR–GER, GSR–GPR, RP–CP, SPtEnv–SPsEnv, SPsEco–SPsEnv, and SPtSo–SPsSo. For SPtSo–SPsEnv, both values appear as .773 in the table; unrounded estimates indicate a marginal exceedance (correlation = .772712; square root of AVE for SPtSo = .772688). The matrix reconstructed from the unrounded latent-factor correlations was not positive semidefinite (minimum eigenvalue = −.009396). Consequently,

discriminant validity cannot be claimed for all dimensions, and conclusions involving the highly correlated constructs require caution. The factor estimates and model specification require further methodological evaluation before the measurement model is treated as fully validated.

**Testing the hypotheses**

A parallel multiple mediation analysis was conducted using 5,000 bias-corrected bootstrap resamples. The indirect effect of environmental risk perception on sustainable innovation through normative pressure was positive and statistically significant (B = .039, SE = .022, β = .042, 95% BC CI [.002, .095]), supporting H5. Similarly, the indirect effect of social risk perception on sustainable innovation through normative pressure was significant (B = .043, SE = .024, β = .044, 95% BC CI [.002, .108]), supporting H8. In accordance with bootstrap mediation literature (Hayes, 2018; Preacher & Hayes, 2008), 95% Bias-Corrected Bootstrap confidence intervals serve as the primary test. All remaining indirect-effect confidence intervals included zero; therefore, H1–H4, H6, H7, and H9 were not supported (Table 9).

The total effects of social risk perception (B = .199, β = .204, p = .009) and environmental risk perception (B = .166, β = .178, p = .008) on sustainable innovation were positive and statistically significant, whereas the total effect of geopolitical risk perception was not significant (B = −.038, β = −.033, p = .631). None of the direct effects remained statistically significant after the mediators were included. Overall, the findings indicate small but statistically detectable indirect effects of social and environmental risk perceptions on sustainable innovation through normative pressure.

**Table 9:** Testing the Hypotheses

| Hypothesis | Path | SE | β | B | p | %95 BC bootstrap CI | Result |
|---|---|---|---|---|---|---|---|
| H1 | GPR ⇒ RP ⇒ SI | 0.0118 | 0.0106 | 0.0122 | 0.300 | [ -0.0050, 0.0553] | Not supported |
| H2 | GPR ⇒ NP ⇒ SI | 0.0118 | -.0105 | -0.0121 | 0.308 | [ -0.0619, 0.0063] | Not supported |
| H3 | GPR ⇒ CP ⇒ SI | 0.0097 | 0.0022 | 0.0025 | 0.795 | [ -0.0178, 0.0348] | Not supported |
| H4 | GER ⇒ RP ⇒ SI | 0.0098 | 0.0110 | 0.0104 | 0.293 | [ -0.0041, 0.0427] | Not supported |
| H5 | GER ⇒ NP ⇒ SI | 0.0216 | 0.0420 | 0.0394 | 0.069 | **[ 0.0022, 0.0954]** | **Supported** |
| H6 | GER ⇒ CP ⇒ SI | 0.0114 | 0.0032 | 0.0030 | 0.794 | [ -0.0246, 0.0314] | Not supported |
| H7 | GSR ⇒ RP ⇒ SI | 0.0121 | 0.0131 | 0.0128 | 0.290 | [ -0.0050, 0.0539] | Not supported |
| H8 | GSR ⇒ NP ⇒ SI | 0.0241 | 0.0444 | 0.0434 | 0.073 | **[ 0.0021, 0.1078]** | **Supported** |
| H9 | GSR ⇒ CP ⇒ SI | 0.0114 | 0.0031 | 0.0030 | 0.795 | [ -0.0189, 0.0359] | Not supported |

**Note:** Indirect effects were evaluated using 95% bias-corrected bootstrap confidence intervals based on 5,000 resamples. An indirect effect was considered statistically significant when its bootstrap confidence interval excluded zero. The reported p values are based on asymptotic z tests and were not used as the primary criterion for evaluating the mediation hypotheses. B denotes the unstandardized effect, and β denotes the completely standardized effect.

The component paths of the parallel mediation model are presented in Table 10.

**Table 10:** Component Paths in the Parallel Mediation Model

| Path | B | p |
|---|---|---|
| a: GPR → RP | .157 | .061 |
| a: GER → RP | .133 | .048 |
| a: GSR → RP | .164 | .043 |
| a: GPR → NP | −.116 | .236 |
| a: GER → NP | .376 | < .001 |
| a: GSR → NP | .414 | < .001 |
| a: GPR → CP | .161 | .069 |
| a: GER → CP | .190 | .008 |
| a: GSR → CP | .190 | .028 |
| b: RP → SI | .078 | .222 |
| b: NP → SI | .105 | .053 |
| b: CP → SI | .016 | .795 |
| c′: GPR → SI | −.040 | .611 |
| c′: GER → SI | .114 | .079 |
| c′: GSR → SI | .140 | .072 |

**Note:** B values are unstandardized regression coefficients. Each mediator was regressed on GPR, GER, and GSR simultaneously. The b and c′ paths were estimated in the SI equation containing all three mediators and all three risk-perception scores. The p values in this table refer to individual regression paths; the indirect effects in Table 9 were evaluated using bootstrap confidence intervals.

## Discussion

Group comparisons across firm and respondent characteristics yielded some unadjusted differences, but none remained statistically significant after Holm adjustment across the 54 tests. Therefore, the results do not provide sufficient evidence of differences by region, firm age, firm size, sector, international trade activity, or respondent role. No inferential conclusions were consequently drawn from the unadjusted omnibus or Games–Howell results.

Descriptive results indicated that geopolitical risk perception had the highest mean, whereas environmental risk perception had the lowest. This pattern is consistent with Asgary et al. (2020), who reported that Turkish SMEs assigned greater importance to economic and geopolitical risks and ranked environmental risks comparatively lower. The total effects of social and environmental risk perceptions on sustainable innovation were positive and statistically significant, whereas the total effect of geopolitical risk perception was not statistically significant. One possible interpretation is that perceiving a risk as severe does not necessarily correspond to a stronger sustainable innovation response. Explanations involving defensive responses, resource allocation, or operational continuity remain tentative because these mechanisms were not directly measured.

Bootstrap confidence intervals excluded zero for the indirect effects of environmental and social risk perceptions on sustainable innovation through normative pressure. These findings are consistent with indirect associations involving perceived pressures from the media, public and social groups, consumer organizations, and NGOs. Such external stakeholders may increase the visibility of sustainability concerns and strengthen societal expectations. This pattern is broadly consistent with studies linking institutional and stakeholder pressures to environmental and sustainable innovation (Chen et al., 2018; Carfora et al., 2021). Given the cross-sectional and self-reported nature of the data, however, these results should not be interpreted as establishing causal mechanisms.

Statistically significant indirect effects were not identified through regulatory or cognitive pressure. This finding does not establish that normative pressure was stronger or more effective than the other mediators because differences among the indirect effects were not directly tested. Under the operationalization used in this study, indirect effects involving formal rules, international regulations, incentives, professional associations, suppliers, customers, competitors, and reputation concerns were not statistically supported. Overall, the evidence for mediation was limited to the indirect associations of environmental and social risk perceptions through normative pressure, and the remaining hypothesized indirect effects were not supported.

## Conclusions

Geopolitical risk was perceived as the most severe global risk by internationally active Turkish SMEs. However, the estimated direct, indirect, and total associations between geopolitical risk perception and sustainable innovation were not statistically significant. In contrast, the estimated total associations of social and environmental risk perceptions with sustainable innovation were positive and statistically significant.

Bootstrap confidence intervals excluded zero for the indirect associations of social and environmental risk perceptions with sustainable innovation through normative pressure. Statistically significant indirect effects were not identified through regulatory or cognitive pressure. These results provide limited evidence consistent with an indirect role of normative pressure in the two specified pathways. Because differences among the indirect effects were not formally tested, the findings do not establish that normative pressure was stronger or more effective than the other mediators.

Overall, the findings suggest that the associations between global risk perceptions and sustainable innovation vary according to the risk dimension and the examined indirect pathway. The cross-sectional and self-reported nature of the data prevents causal conclusions concerning how risk perceptions, institutional pressures, and sustainable innovation influence one another.

Recommendations based on the results

- Managerial recommendation: SME managers should consider environmental and social risks when planning product development, operational improvements, supply-chain management, and sustainability initiatives.
- Institutional recommendation: The media, public and social groups, consumer organizations, and NGOs may contribute to the visibility of sustainability concerns by sharing reliable information, raising awareness, and communicating stakeholder expectations to SMEs.
- Policy recommendation: Policymakers may consider developing and evaluating targeted financial incentives, technical assistance, accessible green-finance instruments, and capacity-building programs designed to support sustainability-oriented innovation in SMEs.
- Environmental recommendation: Because environmental risks received the lowest perception score, awareness and technical support programs should explain their potential operational, financial, and supply-chain implications for SMEs.

**Research limitations and future research directions**

First, the measurement model did not establish convergent and discriminant validity equally across all dimensions. Although the SRMR and RMSEA indicated reasonable absolute fit, the CFI and TLI indicated limited incremental fit. GSR showed borderline composite reliability (CR = 0.698) and low average variance extracted (AVE = 0.367), while several construct pairs failed the Fornell–Larcker criterion. In addition, the matrix reconstructed from the reported latent-factor correlations was not positive semidefinite. Findings involving highly correlated constructs should therefore be interpreted cautiously. Future studies should refine the measurement structure and validate it using independent samples.

Second, the cross-sectional design does not permit definitive causal conclusions or an assessment of changes in risk perceptions over time. Longitudinal studies should examine how changes in the global risk environment are associated with institutional pressures and sustainable innovation over time.

Third, the use of convenience and voluntary-response sampling limits the generalizability of the findings to all SMEs in Türkiye. Future studies should employ probability-based sampling and conduct adequately powered sectoral and regional comparisons.

Fourth, SME eligibility was operationalized using grouped employment-size categories because financial information was not collected. Consequently, the financial criteria in the official SME definition could not be verified, and the "51–250 employees" category did not allow firms employing exactly 250 persons to be identified separately. Future research should collect exact employee numbers and the financial information required to verify SME eligibility.

Fifth, all variables were measured using self-reported data collected through the same questionnaire, which raises the possibility of common-method variance. Future research could combine survey responses with objective innovation indicators, environmental performance data, or qualitative interviews.

Finally, the global risk dimensions were adapted from the WEF framework and consolidated into three study-specific categories. Future studies could examine economic and technological risks as separate dimensions and test alternative classifications of global risks.

**Peer-review:**

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The author has no conflict of interest to declare.

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**Ethical Statement:**

Ethical approval for this study was granted by the Ethics Committee of Istanbul Gedik University at its meeting held on 29 November 2024 (Meeting No. 2024/11; Application/Barcode No. 359985). The official notification of the decision was issued on 3 December 2024. Data collection was conducted between 7 December 2024 and 20 March 2025. No data, including pilot data, were collected before ethics committee approval.

**Informed Consent Statement:** Informed consent was obtained from all participants before their participation in the study.

**Data Availability Statement**:

The data supporting the findings of this study are not publicly available because the dataset contains potentially identifiable organizational and respondent information and is subject to confidentiality and ethical restrictions. Requests for access to a suitably anonymized dataset may be considered by the author upon reasonable request, subject to the conditions of the ethics approval and informed consent.

**Declaration of AI-Assisted Tool Use**:

During the preparation and revision of this manuscript, the author used OpenAI's ChatGPT and Google Gemini to assist with language refinement and the review of the presentation and interpretation of statistical results, and QuillBot for language refinement. These tools were not used to collect or generate data or to conduct the statistical analyses. All AI-assisted content was critically reviewed and verified against the statistical outputs and relevant literature by the author, who accepts full responsibility for the final content of the manuscript.

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