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Maturity of Managing ESG Aspects vs. Supply Chain Resilience

Keywords: ESG; climate crisis; resilience; company; supply chain

JEL: M10; Q01; Q54

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Abstract

Theoretical background: Resilience is one of the most desirable attributes of enterprises and supply chains in the volatile, uncertain, complex and ambiguous (VUCA) business environment. The theory of dynamic capabilities provides a theoretical foundation for building enterprise and supply chain resilience. The ESG concept has the potential to enhance business resilience to climate crisis on an evolutionary transformation path derived from maturity models.
Purpose of the article: The article aims to assess the maturity of managing ESG aspects in the process approach in enterprises and supply chains, and to examine the relationship between ESG management maturity and the perceived resilience of enterprises and supply chains to the climate crisis, based on survey data collected from company representatives.
Research methods: The article presents results of the research carried out within the project titled "The quality of management of ESG aspects vs. resilience to crises. Enterprises – financial institutions – local

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government units," at the Institute of Corporate Finance and Investment in the SGH Warsaw School of Economics, in 2023. The authors compress the results of the literature review, and the qualitative survey conducted among 100 companies listed on the Warsaw Stock Exchange, included in the WIG20, mWIG40 and sWIG80 stock exchange indices.

Main findings: The incorporation of ESG aspects into business process management is developing in two perspectives: internal in the enterprise and external in the supply chain. The factors determining the maturity of integration of ESG aspects into the management of business processes in enterprise and supply chain are as follows: goals, roles and responsibilities, business relationships, technologies and effects. The highest level of the maturity of managing ESG aspects characterizes companies listed in the WIG20 stock exchange index. The impact of the integration of ESG aspects into the management of business processes on the resilience of supply chains against the climate crisis is positive.

Introduction

Businesses suffer more and more often from disruption risks in the volatile, uncertain, complex and ambiguous (VUCA) environment (Bennett & Lemoine, 2014). Supply chains (SCs) are impacted by numerous challenges, which are increasingly threatening risks (e.g., economic-driven demand shocks, natural disasters, climate change, pandemics, corruption, terrorism, cyber-attacks) (Manners-Bell, 2018). Supply chain resilience (SCRES) is on the agenda of academia and business like never before (Ivanov, 2024). Researchers highlight the critical need for enhancing operational and financial resilience within SCs against climate change impacts (Cao et al., 2024; Nnaji et al., 2024). The climate crisis, related among others to the loss of biodiversity, depletion and increase in prices of natural resources, and the problem of greenhouse gas emissions, is one of the today's most prominent challenges resulting in consequences for companies and SCs. Climate changes are ranked at the top positions among global risks being characterized by long-term severity (World Economic Forum, 2024).

The ESG concept was designed for sustainable transformation of the economy. The Corporate Sustainability Reporting Directive (2022) introduces the obligation of corporate sustainability reporting in accordance with the European Sustainable Reporting Standards, taking into account double materiality analysis considering impact and financial issues with regard to the enterprise and its value chain. It is worth noting, that the ESG concept is not only a performance measurement system, but it provides strategic value for companies prioritizing sustainable development as their primary strategy for growth (Truant et al., 2024). Nnaji et al. (2024), based on the literature review, argue that ESG as a regulatory framework responds to the call for the supportive role of policy and regulatory frameworks for enhancing SCRES against the backdrop of climate change. Furthermore, ESG is gaining a strategic importance in the continuum of managers' efforts to actively manage sustainability risks in SCs. The implementation of ESG aspects is a process that requires changes in business models of enterprises and SCs and moreover, the improvement can take place continuously to achieve higher levels of maturity in this regard.

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Although existing research has addressed the factors enhancing SCRES and the benefits of ESG performance in this context, studies on the detailed pathways through which ESG aspects can be incorporated into business process management remain scarce. Furthermore, the explanation how the advancement of ESG-driven supply chain transformation promotes SCRES is still unclear. Therefore, conducting a more systematic and comprehensive study to fill this research gap and explore the links between the maturity of integration of ESG aspects and SCRES is particularly important.

The article aims to assess the maturity of managing ESG aspects in the process approach in enterprises and SCs, and to examine the relationship between ESG management maturity and the perceived resilience of enterprises and SCs to the climate crisis, based on survey data collected from company representatives. While the authors present the results of empirical research conducted in one country, a detailed description of the research procedure and results provides a basis for conducting similar empirical analyses in other countries and their comparison.

The authors' considerations are organised as follows. The Literature review section is dedicated to SCRES and the connection between ESG and supply chain management (SCM). The next section describes the research methodology focusing on the survey conducted in 2023. Then, the authors present the assessment of maturity factors determining the overall maturity of integration of ESG aspects into the management of business processes in enterprise and SC as well as its impact on the companies' and SCRES. The discussion includes the authors' remarks in the light of the literature and contributions of the presented study to the existing body of knowledge. Theoretical and managerial implications, research limitations and future research ideas conclude this paper.

Literature review

Dynamic capabilities theory as a theoretical foundation

Changes in the business landscape of the 21st century are becoming increasingly dynamic, and businesses are exposed to rising turbulence facing economic, environmental, and social challenges. Therefore, companies need to develop dynamic capabilities to survive, remain competitive, and grow. Their development lies at the core of contemporary companies' success or failure (Wang & Ahmed, 2007). The theory of dynamic capabilities refers to the capacities of companies to sense and shape opportunities and threats, to seize opportunities and to maintain competitiveness through enhancing, combining, protecting and reconfiguring the company's intangible and tangible assets, when necessary (Teece, 2007, p. 1319). The purpose of the dynamic capabilities approach is to explain the sustainability of competitive advantage in rapidly changing contexts (Kurtz & Varvakis, 2016). The theory of

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dynamic capabilities provides a theoretical foundation for conceptualization, operationalization and measurement of resilience (Chowdhury & Quaddus, 2017; Pu et al., 2023; Stadtfield & Gruchmann, 2024) and better understanding of the corporate resilience building process (Joussen et al., 2025).

Supply chain resilience and its types

SCRES is defined as "the ability of the system to return to its original state or move to a new, more desirable state after being disturbed" (Christopher & Peck, 2004, p. 2). Panomarov and Holcomb (2009), using the multidisciplinary perspective, define SCRES as "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" (p. 131). In the light of definitions of SCRES, the following four phases are distinguished: readiness, response, recovery, and growth (Hohenstein et al., 2015). Linnenluecke (2017) used the term "resilience" to describe a company that can respond and recover faster or identify and develop more unusual ways of doing business under threat situations than others. SCRES is also explained as the "capability of a supply chain to develop the required level of readiness, response, and recovery capability to manage disruptions risks, get back to the original state or even a better state after disruptions" (Chowdhury et al., 2019, p. 659). It is worth noting that SCRES refers to "a function of an organization's situational awareness, the identification and management of key vulnerabilities and the ability to successfully react in a complex, dynamic and interconnected environment" (Nascimento, 2021, p. 79). SCRES is a multidimensional concept operationalized by elements (Hohenstein et al., 2015), enhancers (Blackhurst et al., 2011), competencies (Wieland & Wallenburg, 2013), capabilities (Jüttner & Maklan, 2011; Pettit et al., 2013) or factors (Pires Ribero & Barbosa-Povoa, 2018). We use the following elements to detail the SCRES concept: robustness, adaptability, redundancy, agility, flexibility, and resourcefulness (Gemra et al., 2024, p. 23).

Gu and Huo (2017) distinguished the three dimensions of resilience: supplier, internal, customer, and revealed that internal resilience positively influences supplier and customer resilience. Internal and external attitudes are complementary and should be integrated in a strategic holistic approach in today's business. Wieland and Durach (2021) articulate two major perspectives of SCRES: adaptation and transformation. The internal character of resilience concentrates on the single company's capability, whereas the external facet focuses on relationships within supply chain management (Münch & Hartmann, 2023). Moreover, there are two main SCRES strategies: "reactive" referring to building a capability required to react after a disruption takes place, recover and learn during a disruption, and furthermore grow in a post-disruption phase and "proactive" aiming at building a capability desirable to anticipate and be ready in a pre-disruption phase, limit the influence, defend against or achieve disruption avoidance (Ocicka & Brzeziński, 2026).

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Maturity of ESG integration

Our approach is based on definitions and derived from frameworks of maturity models of SCM (Baraniecka, 2016). Firstly, defining SCM as the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders (Lambert et al., 1998, p. 1), we adopted the extended perspective of business process management within a SC of mutual dependencies between the company and its business partners (suppliers and customers). The examination of business process management in the perspective of SCs, not only single companies, is obvious in the network economy. Secondly, we developed internal and external scopes of integration of ESG aspects and identified key factors in the ESG-driven management of business processes. Internal integration increases the maturity from the enterprise integration to the corporate excellence within the internal value chain, whereas external integration is developed through partner collaboration, value chain collaboration and full network connectivity (Poirier & Quinn, 2004, p. 26). We operationalized the maturity of integration of ESG aspects into the management of business processes in enterprise and supply chain through the following factors: goals, roles and responsibilities, relationships, technologies and effects.

SCRES vs. ESG aspects

The ESG concept is a regulatory framework in the light of the EU obligatory documents that builds the backbone of the transformation of businesses and economies towards sustainable development. Based on the results of the systematic literature review, Agrawal et al. (2024) reported that the ESG concept has prominently emerged from the corporate to academic field in 2018. Previous publications often present interdependencies between ESG aspects and SC sustainability, SC finance, and SC risk (Agrawal et al., 2024; Baid & Jayaraman, 2022; Das, 2024). In comparison, fewer publications address the relationship between ESG and SCRES. According to Huiskamp et al. (2021, p. 1765), climate resilient companies develop robustness towards physical climate change impacts and transform their business models or value chains towards a net-zero economy. Adana et al. (2023) argue that enterprises which understand direct correlation between SCRES and business sustainability will be more agile and steady during uncertain times. Stan et al. (2023) propose a model for measuring SC performance incorporating ESG factors. Tsoulfas (2024) contends that companies can address vulnerabilities and develop stronger SCs by adopting ESG. Truant (2024) reveals the relevant role of both practitioners and policymakers in implementing the ESG in SCs. Lin and Li (2025) argue that strengthening SCRES and enhancing ESG performance both contribute to sustainable corporate growth. Yuan et al. (2025) proved empirically that strong ESG performance positively influences SCRES. Similar findings were presented by Yang and Wang (2026), these authors additionally revealed that ESG performance stronger enhances SCRES in private enterprises compared to state-owned

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ones. No publication has been identified taking into consideration the maturity of ESG integration within SCM and presenting the relationship between ESG maturity and SCRES. Cruz and Matos (2023) focus on the ESG maturity, however, these authors shed light on other aspects and present "a new and innovative software as a service framework" (p. 2610). Oliveira et al. (2024) also refer to the term of ESG maturity but operationalize it by referring to ESG performance.

Research methods

The study covered companies included in the WIG20, mWIG40 and sWIG80 indices listed on the Warsaw Stock Exchange. Data were collected between 4 and 27 December 2023 using a structured questionnaire administered in a mixed CATI/CAWI mode by a professional research agency with access to the database of listed entities.

The survey was addressed to randomly selected companies, and respondents were representatives responsible for areas related to sustainable development, ESG, investor relations, SCM, operations, or risk management. A total of 100 valid responses were obtained out of a population of 140 companies, which allows for statistical inference with a maximum estimation error of approx. ±5% at a 95% confidence level.

To analyse relationships between qualitative variables, the Chi-square test of independence was applied, supplemented where necessary by exact or Monte Carlo procedures due to sample size considerations. The strength of associations was assessed using Phi and Cramer's *V* coefficients. For ordinal or quantitative variables, Spearman's rho coefficient was used. Table 1 includes characteristics of respondents taking part in the survey. Table 2 presents the characteristics of the enterprises participating in the survey.

Table 1. Characteristics of respondents

			Group of enterprises			Total
			WIG20	mWIG40	sWIG80	
What is your position in the company?	1. Director	N	6	7	14	27
		%	40.0	33.3	21.9	27.0
	2. Member of the Board	N	3	4	11	18
		%	20.0	19.0	17.2	18.0
	3. Manager	N	6	10	39	55
		%	40.0	47.6	60.9	55.0
Total		N	15	21	64	100
		%	100.0	100.0	100.0	100.0
Cramer's *V*	0.126	3.175[a]	4	0.529	0.543[b]	
Ratio	worth	Chi-square	df	p	*p* Monte Carlo	

a – the calculated statistic may not meet the condition of the minimum expected number, therefore, for this eventuality, a test is also carried out using the exact method or Monte Carlo. In this case, if the "p" value is calculated based on the Monte Carlo method, it is additionally marked with the letter b.

Source: Authors' own study.

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The financial characteristics of the surveyed companies (Table 2) are presented to illustrate the structural diversity of the sample and ensure its representativeness in terms of company size and economic potential.

Table 2. Characteristics of enterprises participating in the study

Characteristic	Group of enterprises																	
	WIG20					mWIG40					sWIG80					Total	
	Average	Median	Average rank	N	Standard deviation	Average	Median	Average rank	N	Standard deviation	Average	Median	Average rank	N	Standard deviation	Average	Median
Number of company employees	11,368.73	9,281.00	87.80	15.00	9,518.46	2,304.05	707.00	54.07	21.00	3,545.19	703.91	316.50	40.59	64.00	1,214.21	2,639.66	554.50
Number of group employees	25,101.67	25,071.00	92.00	15.00	16,225.76	3,260.10	2,038.00	54.60	21.00	3,723.90	1,368.42	737.50	39.43	64.00	1,660.85	5,325.66	1,263.50
Active consolidated	150,715,455.93	82,877,172.00	90.27	15.00	152,003,533.56	22,593,792.29	4,111,956.00	59.48	21.00	52,241,249.17	4,037,712.75	837,963.00	38.23	64.00	18,956,423.69	29,936,150.93	1,463,490.00
Individual assets	109,564,389.07	47,995,000.00	89.67	15.00	122,734,752.94	21,100,704.29	2,784,643.00	60.90	21.00	51,314,541.89	3,498,687.64	557,369.50	37.91	64.00	18,321,337.14	23,104,966.35	940,820.00
Consolidated sales revenues	38,776,882.00	17,370,100.00	91.00	15.00	67,951,853.40	4,956,347.38	2,834,701.00	57.24	21.00	6,049,131.03	1,922,055.20	1,007,231.00	38.80	64.00	2,817,716.50	8,087,480.58	1,544,385.50
Unit sales revenues	28,413,295.47	14,066,703.00	89.60	15.00	50,033,294.44	3,079,596.24	1,468,398.00	59.33	21.00	3,458,305.73	982,071.52	376,479.50	38.44	64.00	1,656,002.77	5,537,235.30	958,811.00

Source: Authors' own study.

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Results

This section presents a summary of the responses to the six questions necessary to define and assess the maturity level of companies in the regard of integration of ESG aspects into the management of business processes in enterprise and SC. The 5-point Likert scale is used in each question.

Table 3. Summary of answers to the question "Does the company take into account ESG goals in business process management?"

Level of maturity	Number of companies	Group of companies			Total
		WIG20	mWIG40	sWIG80	
1	N	0	0	2	2
	%	0.00	0.00	3.10	2.00
2	N	0	0	1	1
	%	0.00	0.00	1.60	1.00
3	N	1	7	21	29
	%	6.70	33.30	32.80	29.00
4	N	2	9	24	35
	%	13.30	42.90	37.50	35.00
5	N	12	5	16	33
	%	80.00	23.80	25.00	33.00
Total	N	15	21	64	100
	%	100.00	100.00	100.00	100.00
Kendall's tau-c	-0.237	0.081	-2.941	0.003	0.003[c]
ratio	value	standard error	approximate *T*	*p*	*p* Monte Carlo

1 – there is a lack of consideration of ESG goals in business process management
2 – ESG goals are taken into account in the management of selected business processes in the company
3 – ESG goals in business process management are consistent and defined in the company's development strategy
4 – ESG goals are taken into account in the management of selected business processes in the company's supply chain
5 – ESG goals are integrated in the management of business processes within the company's end-to-end supply chain
c – the "p" value is calculated using the Monte Carlo method

Source: Authors' own study.

Table 3 presents the distribution of responses to the question concerning the consideration of ESG goals in business process management. This section provides a summary of the responses to the six questions used to define and assess the maturity level of companies with regard to the integration of ESG aspects into the management of business processes in enterprises and SC. A 5-point Likert scale was applied in each question. The vast majority of respondents claim that the companies they represent take into account ESG goals in some way in managing business processes – 98%, while 2% of respondents have a different opinion. The most common answer is: "ESG goals are taken into account in the management of selected business processes in the company's supply chain" – 35%.

Table 4 contains answers to the question "Who in your company and supply chain plays a leading role and is responsible for integrating ESG aspects in business process management?" In the answers to this question, the appropriate persons were

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mentioned by 99% of representatives of companies listed on the WSE. A certain tendency can also be observed, which indicates that a larger company in terms of the WIG index has a higher level of maturity in the discussed aspect. The indication of the company's management staff and partners in the SC concerns 66.7% of respondents of the surveyed WIG20 companies.

Table 4. Summary of answers to the question "Who in the company and the supply chain plays a leading role and is responsible for integrating ESG aspects in business process management?"

Level of maturity	Number of companies	Group of companies			Total
		WIG20	mWIG40	sWIG80	
1	N	0	0	1	1
	%	0.00	0.00	1.60	1.00
2	N	0	0	1	1
	%	0.00	0.00	1.60	1.00
3	N	1	4	25	30
	%	6.70	19.00	39.10	30.00
4	N	4	11	22	37
	%	26.70	52.40	34.40	37.00
5	N	10	6	15	31
	%	66.70	28.60	23.40	31.00
Total	N	15	21	64	100
	%	100.00	100.00	100.00	100.00
Kendall's tau-c	-0.274	0.076	-3.608	<0.001	<0.001[c]
ratio	value	standard error	approximate *T*	*p*	*p* Monte Carlo

Kendall's tau-c = -0.274; $p < 0.001$; *p* Monte Carlo < 0.001

1 – the roles and responsibilities for ESG integration into business process management are not defined
2 – leaders/managers of selected business processes/functions/departments are responsible for ESG integration into business process management
3 – the company's top management staff is responsible for ESG integration into business process management
4 – leaders/managers of selected business processes/functions/departments in the company as well as in its supply chain partners are responsible for ESG integration into business process management
5 – the company's and its supply chain partners' top management staff is responsible for ESG integration into business process management
c – the "p" value is calculated using the Monte Carlo method

Source: Authors' own study.

The next question (Table 5) concerns the implementation of ESG objectives in business process management. It turns out that the implementation of ESG goals in business process management covers, to a varying extent, the vast majority of surveyed companies – 97%, but a much more developed and professional procedure applies to larger companies in the meaning of the WIG index. The answer "ESG goals are integrated in the management of business processes within the company's end-to-end supply chain" is indicated by more than half of the representatives of companies listed on WIG20 – 53.3%. This is a value significantly higher than in the case of companies listed on mWIG40 (19%) and sWIG80 (26.6%).

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Table 5. Summary of answers to the question "Does the company implement ESG goals in business process management?"

Level of maturity	Number of companies	Group of companies			Total
		WIG20	mWIG40	sWIG80	
1	N	0	0	3	3
	%	0.00	0.00	4.70	3.00
2	N	0	0	2	2
	%	0.00	0.00	3.10	2.00
3	N	0	4	24	28
	%	0.00	19.00	37.50	28.00
4	N	7	13	18	38
	%	46.70	61.90	28.10	38.00
5	N	8	4	17	29
	%	53.30	19.00	26.60	29.00
Total	N	15	21	64	100
	%	100.00	100.00	100.00	100.00
Kendall's tau-c	-0.246	0.074	-3.31	0.001	0.002[c]
ratio	value	standard error	approximate *T*	*p*	*p* Monte Carlo

Kendall's tau-c = -0.246; $p = 0.001$; p Monte Carlo = 0.002

1 – business process management is carried out without purposefully incorporating ESG aspects
2 – ESG goals are implemented in the management of selected business processes in the company
3 – ESG goals in business process management are consistent and implemented in the development of the entire company
4 – ESG goals are implemented in the management of selected business processes in the company's supply chain
5 – ESG goals are integrated and implemented in the management of business processes within the company's end-to-end supply chain
c – the "p" value is calculated using the Monte Carlo method

Source: Authors' own study.

Taking into account the development of internal and external cooperation in the supply chain to include ESG aspects in business process management, 95% of respondents indicated the engagement and actions in this regard (Table 6). The lack of consideration of ESG goals in business process management concerns 5% of companies surveyed. Smaller companies are associated with a lower level of management maturity in this aspect. It is particularly noteworthy that only representatives of companies listed on mWIG40 and sWIG80, in addition to answers "4" and "5," which indicate a higher degree of cooperation, also selected answers characterized by a lower degree of cooperation or its absence.

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Table 6. Summary of answers to the question "Does the company develop internal and external cooperation in the supply chain to include (integrate) ESG aspects in business process management?"

Level of maturity	Number of companies	Group of companies			Total
		WIG20	mWIG40	sWIG80	
1	N	0	1	4	5
	%	0.00	4.80	6.30	5.00
2	N	0	0	3	3
	%	0.00	0.00	4.70	3.00
3	N	0	5	17	22
	%	0.00	23.80	26.60	22.00
4	N	2	9	27	38
	%	13.30	42.90	42.20	38.00
5	N	13	6	13	32
	%	86.70	28.60	20.30	32.00
Total	N	15	21	64	100
	%	100.00	100.00	100.00	100.00
Kendall's tau-c	-0.318	0.077	-4.121	<0.001	<0.001[c]
ratio	value	standard error	approximate *T*	*p*	*p* Monte Carlo

1 – there is a lack of cooperation within the company and in the supply chain for integrating ESG aspects into business process management
2 – internal cooperation between certain (selected) business functions/departments for integrating ESG aspects into business process management
3 – internal cooperation in cross-functional teams for integrating ESG aspects into business process management
4 – the company's cooperation with selected partners in the supply chain for integrating ESG aspects into business process management
5 – the company's cooperation with partners in the supply chain and other groups of external stakeholders (e.g., NGOs, local government institutions, financial institutions) for integrating ESG aspects into business process management
c – the "p" value is calculated using the Monte Carlo method

Source: Authors' own study.

As for the next question (Table 7), the majority of respondents stated that at least technologies supporting the inclusion (integration) of ESG aspects in the management of selected business processes in the company's SC are used (69%), while 2% of respondents stated that the technologies used support the inclusion (integration) of ESG aspects in the management of selected business processes. Additionally, representatives of larger companies perceive a higher level of maturity in the discussed scope.

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Table 7. Summary of answers to the question "Does the company use technologies to incorporate (integrate) ESG aspects into business process management?"

Level of maturity	Number of companies	Group of companies			Total
		WIG20	mWIG40	sWIG80	
1	N	0	0	0	0
	%	0.00	0.00	0.00	0.00
2	N	0	0	2	2
	%	0.00	0.00	3.10	2.00
3	N	0	6	23	29
	%	0.00	28.60	35.90	29.00
4	N	7	9	24	40
	%	46.70	42.90	37.50	40.00
5	N	8	6	15	29
	%	53.30	28.60	23.40	29.00
Total	N	15	21	64	100
	%	100.00	100.00	100.00	100.00
Kendall's tau-c	-0.223	0.073	-3.042	0.002	0.005[c]
ratio	value	standard error	approximate *T*	*p*	*p* Monte Carlo

Kendall's tau-c=-0.223; p=0.002; p Monte Carlo=0.005
1 – there is a lack of technologies supporting the integration of ESG aspects into business process management in the company and supply chain
2 – technologies support the integration of ESG aspects into the management of selected business processes in the company
3 – technologies support the integration of ESG aspects into business process management in the entire company
4 – technologies support the integration of ESG aspects into the management of selected business processes in the company's supply chain
5 – technologies support the integration of ESG aspects into business process management in the company's entire supply chain
c – the "p" value is calculated using the Monte Carlo method

Source: Authors' own study.

Answering the last question, all respondents claim that the companies they represent measure the effects of incorporating ESG aspects into business process management to a varying degree. The most common answer is: "Assessment and measurement of the effects of integrating ESG aspects into the management of selected business processes, achieved in cooperation with selected partners in the supply chain" – 40%.

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Table 8. Summary of answers to the question "At what level does the company achieve and measure the effects of incorporating (integration) of ESG aspects into business process management?"

Level of maturity	Number of companies	Group of companies			Total
		WIG20	mWIG40	sWIG80	
1	N	0	0	0	0
	%	0.00	0.00	0.00	0.00
2	N	0	1	0	1
	%	0.00	4.80	0.00	1.00
3	N	1	7	21	29
	%	6.70	33.30	32.80	29.00
4	N	5	8	27	40
	%	33.30	38.10	42.20	40.00
5	N	9	5	16	30
	%	60.00	23.80	25.00	30.00
Total	N	15	21	64	100
	%	100.00	100.00	100.00	100.00
Kendall's tau-c	-0.143	0.081	-1.771	0.077	0.072[c]
ratio	value	standard error	approximate *T*	*p*	*p* Monte Carlo
Cramer's *V*	0.249	12.362[a]	6	0.054	0.052[b]
ratio	value	standard error	approximate *T*	*p*	*p* Monte Carlo

1 – not achieving or not measuring of effects of the integration of ESG aspects into business processes
2 – assessment and measurement of the effects of integrating ESG aspects at the level of management of selected business processes in the company
3 – assessment and measurement of the effects of integrating ESG aspects into business process management at the company management level
4 – assessment and measurement of the effects of integrating ESG aspects into the management of selected business processes, achieved in cooperation with selected partners in the supply chain
5 – assessment and measurement of the effects of integrating ESG aspects into the management of selected business processes, achieved in cooperation with supply chain partners and other groups of external stakeholders (e.g., NGOs, local government institutions, financial institutions)

Source: Authors' own study.

Table 9 summarizes empirical data for the entire sample of surveyed companies. It is worth noting that the average levels of maturity of the six factors building the maturity of integration of ESG aspects into the management of business processes do not differ significantly and all are rated close to the value of 4.00. The aggregate maturity of the integration of ESG aspects into the management of business processes in enterprise and SC achieved the value of 3.81.

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Table 9. The assessment of maturity of the integration of ESG aspects into the management of business processes in enterprise and supply chain

Element of the ESG Management Maturity Model	Factors	A five-point Likert scale*					Total	Average value
		1	2	3	4	5		
Integration of ESG aspects into the management of business processes in enterprise and supply chain	Goals defined	2%	1%	29%	35%	33%	100%	3.96
	Roles and responsibilities	1%	1%	30%	37%	31%	100%	3.96
	Goals implemented	3%	2%	28%	38%	29%	100%	3.88
	Relationships	5%	3%	22%	38%	32%	100%	3.89
	Technologies	0%	2%	29%	40%	29%	100%	3.96
	Effects	0%	1%	29%	40%	30%	100%	3.99

Source: Authors' own study.

The Spearman's rank correlation coefficient for the relationship between the maturity of integration of ESG aspects into the management of business processes in enterprise and supply chain and the enterprise resilience to climate crisis has reached the value of 0.895. As a result, the study proved that there is positive relationship between the maturity of ESG management in the presented scope and the enterprise resilience against the climate crisis. Due to the inclusion of six factors derived from SC maturity models, it can also be concluded that the supply chain resilience rises with the increase of the ESG maturity.

Discussion

The implementation of ESG concept is currently mostly determined by regulations. We are aware of the discourse in academia and practice on the relationship between ESG framework and corporate value, corporate financial performance, and investor ratings (among others in studies and articles of Chen et al., 2023; Friede, 2015; Halbritter & Dorfleitner, 2015; Landi & Sciarelli, 2019). The ESG is most closely related to reporting issues in sustainable development, therefore most of empirical studies is focused on its role in finance and investment management. To add value to the ongoing debate, we devote our attention to operational activities of businesses, addressing the need to operationalize the ESG regulatory framework in the scope of business process management. In our opinion it is necessary to cover all three types of business activities: financial, investment and operational ones for the sustainable transformation of business models. Moreover, rising sustainability risks intensify the necessity to incorporate environmental, social and government aspects in supply chains. Li et al. (2025) also emphasized that clarifying these issues is essential for companies in the context of operations to improve the SC viability.

The proposed framework for the assessment of the maturity of integration of ESG aspects into the management of business processes in enterprise and SC took into account internal and external perspectives of integration. It was based on the

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following factors: goals, roles and responsibilities, relationships, technologies and effects. Similar dimensions and factors were included in the maturity models of supply chain management that have been presented in the literature so far (Baraniecka, 2016). However, we designed an original approach to the assessment of the maturity of integration of ESG aspects into the management of business processes, addressing the need for a theoretical framework supporting companies in managing the ESG-driven transformation of business models. Sincorá et al. (2023) proved that companies developing mature management of business processes will be better able to positively influence organizational resilience and manage supply chains less fragile and more adaptable to changes.

We propose a process-based approach to management of ESG maturity and complement the outcome-based concepts focused on ESG performance presented by other authors. The presented approach is significantly different both theoretically and in terms of application from those previously presented in the literature. Based on theoretical foundations, we defined pathways for the development of ESG integration into key elements of SC management, providing economic businesses with a *modus operandi* for the transformation of SCs for sustainable development. Additionally, we have shown that ESG maturity is associated with SCRES to the climate crisis. The results of our empirical study suggest a strong positive relationship between the declared level of ESG embeddedness in business process management and the perceived resilience of enterprises and SCs against the climate crisis. We probably present the first empirical results addressing this research problem in the process-approach and providing theoretical and practical insights how the SCRES against climate change impacts can be enhanced through integrated managing of ESG aspects. Previous publications in this topic were either conceptual in their nature or based on the ESG performance concepts (e.g., Deng & Karia, 2025; Wang et al., 2024; Xu et al., 2024).

Methodological robustness and limitations

The study adopts a quantitative survey-based research design aimed at identifying patterns of ESG maturity and its relationship with SCRES. The applied methodology is appropriate for exploratory analysis of emerging managerial phenomena, particularly in areas where empirical evidence is still developing.

To strengthen methodological robustness, several design choices were applied. First, the sample included companies listed in major stock exchange indices (WIG20, mWIG40, sWIG80), which ensures coverage of firms representing different scales of market capitalization and operational complexity. Second, respondents were selected based on their professional competence in areas directly related to the research topic, including ESG management, sustainability strategy, investor relations, and SCM. Third, multiple statistical techniques were applied to verify relationships between variables, including chi-square tests, Spearman's rho coefficients, and measures of association strength such as Phi and Cramer's *V*.

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Nevertheless, several methodological limitations should be acknowledged. First, the cross-sectional and survey-based nature of the research does not allow for causal inference, and the identified relationships should be interpreted as associative rather than causal. Second, as the data were collected using a single questionnaire instrument, the risk of common-method bias cannot be fully eliminated. However, the inclusion of both factual and evaluative questions, as well as the selection of knowledgeable respondents, partially mitigates this risk.

Third, the study is limited to publicly listed companies operating on the Polish capital market, which may restrict the external validity of the findings. Future research should consider longitudinal designs, cross-country comparisons, and multivariate modelling techniques to further strengthen inferential power.

As data were collected using a single survey instrument, common-method bias may influence the magnitude of observed correlations. Although the study design included respondents with professional expertise in relevant domains, future research could apply multi-source data collection or statistical techniques such as Harman's single-factor test. The high correlation coefficient may also partially result from conceptual proximity between ESG maturity and resilience-oriented management practices, as both constructs reflect organizational capability development.

Conclusions

The article presents the framework for assessing the maturity of integration of ESG aspects into the management of business processes in enterprise and SC. We use the precise factors (goals, roles and responsibilities, relationships, technologies and effects) derived from the theory on maturity models of SCM. The surveyed companies take into account and implement ESG goals above all internally and in the management of selected business processes in SCs, that reveals the existing potential to increase the ESG maturity in the end-to-end SC. The evaluation of the effects of integrating ESG aspects remains within the scope of selected business processes. According to roles and responsibilities, the relatively highest ESG maturity characterizes companies listed in the WIG20. They more often play the role of focal companies in SC structures and lead SC reconfiguration projects aiming at sustainability. The companies cooperate mainly internally or with selected SC partners in managing business processes in line with ESG aspects. The surveyed companies use technologies supporting the ESG transformation of business processes, however, mostly in managing selected processes. The results of the study indicate a strong positive relationship between the declared maturity of ESG integration and the self-assessed resilience to the climate crisis.

We believe that we contribute to the evolution of the research field and the future-oriented discourse on the ESG-driven transformation of business models of companies and SCs. Our study provides both theoretical and practical contributions to the literature. We developed a theoretical framework of the ESG maturity within enterprise

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and supply chain management, highlighting how ESG aspects can be integrated into business processes management. We also investigated the link between this aspect of the ESG maturity and resilience to climate crisis. Businesses can use the proposed framework on their development path towards the excellence in managing ESG aspects in the process-oriented approach. As the important objectives, the companies need to improve SCs visibility and advance collaboration with SC links in ESG management. Furthermore, there is also still uncovered potential of open collaboration with various stakeholders (e.g., NGOs, local government institutions, financial institutions). Moreover, businesses should exploit the synergies between sustainable (green) and digital transformation of business models in a more effective way.

Although we are confident that the study adds value to the literature, it is not without limitations. First of all, we presented research results according to only one of the elements of the ESG Management Maturity Model in enterprises that was developed by researchers within the project titled "The quality of management of ESG aspects vs. resilience to crisis. Enterprises – financial institutions – local government units." Subsequent publications prepared by members of the project team will complete this status and be complementary to this paper. Secondly, we measured the maturity of integration of ESG aspects into the management of business processes at one point of time, without a dynamic perspective of comparing enterprises' performance in the examined business field. The cyclical research will address this limitation in the future. Moreover, it is desirable to continue the research and compare the maturity of ESG management of listed companies on an international scale.

The results should be interpreted with caution due to the applied methodological approach, which is primarily based on descriptive and bivariate analyses. Although statistically significant associations were identified, the study does not establish causal relationships. Future research should incorporate multivariate models and control variables to provide deeper explanatory insights.

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