Integration of ESG Criteria in the Procurement of Indirect Materials in European Companies

Marcel Graf (marcel.graf@htwk-leipzig.de)
Hochschule für Technik, Wirtschaft und Kultur, Leipzig, Germany

Holger Mueller (holger.mueller.scm@htwk-leipzig.de)
Hochschule für Technik, Wirtschaft und Kultur, Leipzig, Germany

Irene Dooley (irene.dooley@stud.htwk-leipzig.de)
Hochschule für Technik, Wirtschaft und Kultur, Leipzig, Germany

Falk Eiling (falk.eiling@unite.eu)
Unite, Leipzig, Germany

Abstract

This paper investigates the sourcing and supplier management for indirect materials and aims to quantify the additional effort required to incorporate ESG criteria into procurement processes and examines the role of digitalization in facilitating this integration. Through a quantitative survey targeting procurement decision-makers across Europe, the research identifies that integrating ESG standards typically increases sourcing and supplier management efforts by approximately 20%. Furthermore, the findings indicate a positive correlation between the degree of digitalization and the presence of comprehensive ESG strategies, suggesting that advanced digital tools can enhance efficiency and transparency in procurement activities. Despite significant progress in larger companies, many small and mid-sized enterprises remain in early stages of ESG integration, relying heavily on non-task-specific tools. This study underscores the critical need for digital transformation to effectively address complex ESG requirements and improve long-term competitiveness in procurement functions.

Keywords: ESG-criteria, indirect material

Introduction
The procurement landscape is undergoing profound change, driven by numerous crises, stricter regulatory requirements and increasing sustainability requirements. Procurement departments are no longer acting solely as cost managers, but are increasingly taking on roles as risk, volatility and sustainability managers. At the centre of this transformation is the integration of environmental, social and governance (ESG) criteria - a concept that encompasses aspects such as climate protection, resource consumption, social working conditions and ethical corporate governance in addition to traditional economic assessment criteria (Bogaschewsky and Möller, 2024). For example, in a global survey, 81% of companies stated that ESG criteria are currently important or very important when selecting suppliers (Thomson Reuters Institute, 2024). Another survey found that more

than 70% of the companies surveyed worldwide decide to leverage procurement in order to deliver their sustainability goals. A significant proportion of companies incorporate ESG metrics into procurement processes such as the selection of new suppliers and commissioning of suppliers (Ecovadis and Accenture, 2024, 13, 22).

Simultaneously, the broadening of the decision criteria gives rise to potential conflicts of interest. The assessment of the price-performance ratio of procured goods must now be supplemented by additional sustainability dimensions, with the procurement risk being given due consideration (Morton, 2024, p. 285). This increased administrative effort, which is further intensified by extended reporting obligations and more intensive monitoring of the supply chain, presents companies with additional challenges (Bogaschewsky and Möller, 2024, pp. 45–46). With regard to regulatory requirements, the business community repeatedly argues that such requirements would result in restrictions on global competitiveness (Industrie- und Handelskammer Düsseldorf, 2023). However, various studies and research show that alignment based on ESG criteria improves competitiveness in the long term (Kotsantonis *et al.*, 2016, p. 13; Schmidt, 2023, pp. 120–121) and that ESG disclosure can have a positive impact on corporate reputation and financial performance (Gao *et al.*, 2022, p. 4002; Truant *et al.*, 2024, p. 7) as well as the firm's risk profile (Schmidt, 2023, pp. 123–124).

In the area of procurement, positive effects can be attributed in particular to increased transparency in the supply chain, which is achieved through improved communication and cooperation with partners and counteracts information asymmetries (Gualandris *et al.*, 2021, p. 805; Truant *et al.*, 2024, p. 7). However, specific effects, e.g. on operational efficiency, are still partially unexplored (Truant *et al.*, 2024, p. 7)

In research and practice, the focus is often on the procurement of direct materials due to their direct influence on the end product and cost-saving potential (Boer *et al.*, 2003, p. 911; Vos *et al.*, 2016, p. 4614). However, indirect materials, which are often characterised by a substantial quantity of - albeit frequently low-volume - procurement processes and a wide supplier base, possess considerable potential and present complex organisational and procedural challenges for purchasing (Nadeesh *et al.*, p. 377; Schiele *et al.*, 2023, p. 6). Nevertheless studies in the area of indirect materials are mostly associated with an efficient operational purchase-to-pay process (Nadeesh *et al.*, p. 377). The effort involved in upstream basic processes such as the search, selection and management of suppliers has not yet been analysed in depth for indirect materials - either without or with consideration of ESG requirements. This leads to the first research question: *What process-related effort is required to integrate ESG criteria in sourcing and supplier management for indirect materials?*

The success of integrating ESG criteria into procurement processes is contingent on a number of factors, including technological and organisational framework conditions. The degree of digitalisation in particular has been identified as a key factor in efficiently meeting complex requirements and securing competitive advantages (Zhou and Liu, 2023, p. 6; Lu *et al.*, 2024, pp. 365–366).

Digital solutions, including the utilisation of generative artificial intelligence (large language models), robotic process automation (RPA) and autonomous negotiations (chatbots), have the potential to enhance the efficiency with which Environmental, Social and Governance (ESG) standards can be implemented.

Moreover, these technologies are likely to be essential for the effective management of data volumes. Digital technologies such as the digital product passport or blockchain are even considered a prerequisite for managing the transformation to a circular economy (Walden *et al.*, 2021, p. 1720).

This leads to the second research question: *To what extent is there a connection between a high degree of digitalisation and the integration of ESG criteria in the procurement of indirect materials?*

Procurement process landscape for indirect materials

Indirect procurement encompasses goods that do not directly contribute to the final product. In addition to services—which are not further considered in this discussion—this category includes a wide range of items such as office supplies, IT accessories, tools, and operating materials. While production materials are centrally planned based on customer orders or demand forecasts, the need for indirect materials arises in a decentralized manner within individual departments. Although the overall demand for a specific product category can be estimated using historical consumption data, accurately predicting individual procurement needs remains nearly impossible. These needs arise on a situational basis, for instance, due to the failure of a tool or the depletion of consumable materials such as copier paper.(Gebauer and Segev, 2000, p. 109; Nadeesh *et al.*, p. 377)

The design of procurement processes varies across organizations and is influenced by structural and organizational factors. Consequently, several generic process models exist, differing in terms of their scope and level of detail. For the purposes of this study, the procurement landscape illustrated in Figure 1 is used as the foundational framework.

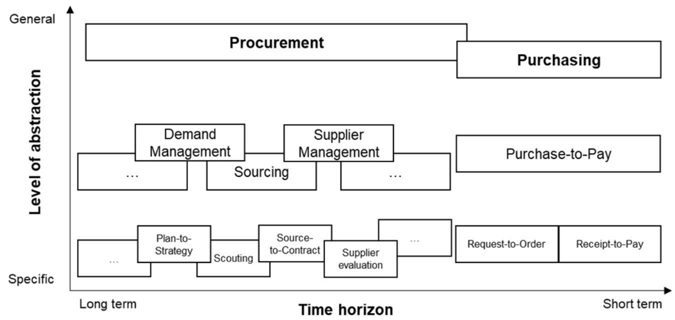

Figure 1: Classification system for procurement terminology (own illustration)

The terms with the highest level of abstraction are *procurement* and *purchasing*. The term *procurement* is sometimes used synonymously to refer both to strategic purchasing and to the entire procurement process (Kaufmann, 2002, pp. 9–13). Procurement differs from Purchasing in its strategic focus and includes, among other things, demand management, sourcing, and supplier management (Jahns, 2005, pp. 349–358; Kaufmann, 2002, pp. 9–13).

Demand management encompasses the plan-to-strategy process (Hofbauer and Kececioglu, 2023, p. 8). In this process, management develops strategies for markets, suppliers, and product groups based on demand forecasts. The strategy is then operationalized in a demand description, which forms the starting point for sourcing. The focus of the subsequent investigation is the initiation of a sourcing process, also known as *Source-to-Contract*. This process includes all steps, from identifying suppliers and selecting suitable providers to concluding contracts (Vollmer *et al.*, 2021, p. 41; Hofbauer and Kececioglu, 2023, p. 8). Depending on the product group, this may involve concluding framework agreements, integrating into electronic catalog systems, or negotiating contracts for complex procurement items. In addition to sourcing, supplier management plays a central role. It encompasses all actions aimed at managing and integrating suppliers with the goal of best supporting the company's strategy (Helmold, 2023, p. 145; Grün and Brunner, 2019, pp. 200–211).

The term *purchasing* is commonly associated with operational order processing, which is primarily decentralized within the purchase-to-pay process (Jahns, 2005, pp. 349–358; Kaufmann, 2002, p. 9). Operational order processing encompasses all steps from material selection and approval to placing orders with suppliers, receiving goods, and completing invoice processing and payment (Bogaschewsky, 2019, pp. 145–147). This process is governed by contracts established during the sourcing phase and managed within the framework of supplier management. The resulting process map, which outlines the analysis of indirect material procurement and defines the scope of this study, is presented in Figure 2.

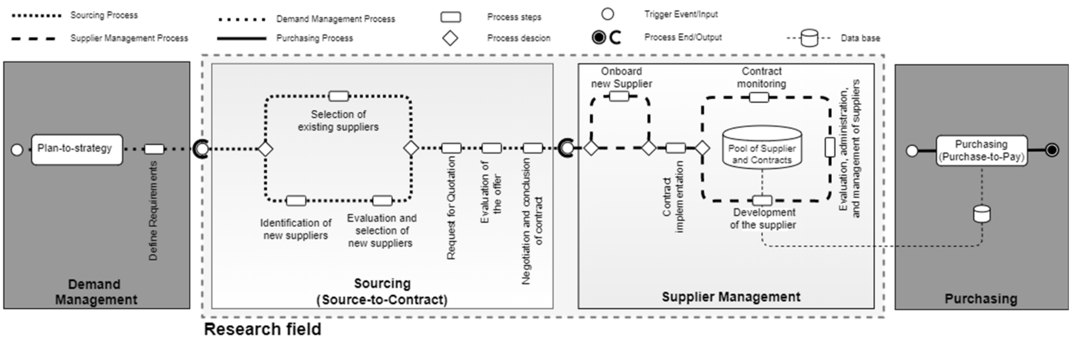

Figure 1: Process landscape for indirect materials

Research process: data collection, sample description and analysis

Research design and data collection

This study follows a quantitative research design, conducted through a standardized online survey using the Unipark tool. Data collection took place between July and October 2024 and targeted procurement decision-makers in European companies. The objective was to gather both general company and procurement data, as well as specific insights into sourcing and supplier management processes. The survey primarily employed structured questions with predefined response options (e.g., Likert scales and multiple-choice questions), supplemented by open-text fields for capturing process times to provide a more detailed understanding of operational workflows.

To ensure a representative sample, the questionnaire was translated into eight languages and distributed through various channels. In addition to invitations via professional networks such as LinkedIn groups and industry associations, targeted email invitations were sent to selected companies. The study explicitly focused on companies with headquarters or subsidiaries in Europe.

Data analysis and validation

Prior to the main data collection, extensive pretests were conducted with procurement and sustainability experts to ensure the clarity and validity of the questionnaire. Following data collection, various statistical validation methods were applied to assess the reliability and accuracy of the data. The Pearson correlation coefficient was used to identify potential duplicate entries (Reh, 2017, pp. 165–168). Additionally, erroneous records and outliers were removed using the interquartile range method to ensure a valid data set for analysis.

For data evaluation, classical descriptive methods such as frequency distributions and mean calculations were employed. Given the right-skewed distribution of process time data, the median was used instead of the arithmetic mean, as the latter would be distorted by extreme values (Reh, 2017, p. 9). The median is more robust to outliers, making it particularly relevant for analysing open-text responses, where the likelihood of erroneous entries is higher.

Sample description
After data cleaning, the final sample consists of 181 European companies, representing a diverse range of industries and company sizes.

A total of 18 countries were included in the survey, though a regional concentration is evident: 46.4% of participants are based in Germany, suggesting a higher survey distribution in German-speaking regions. Other major participant groups originate from Italy (12.7%), Spain (10.5%), Belgium (6.6%), and Austria (6.1%). No single industry was dominant in the sample. The largest subgroups include companies from manufacturing (mechanical and plant engineering: 9.9%; metalworking and processing: 9.4%; automotive industry: 8.3%), the service and IT sectors (transport and logistics: 7.2%; IT consulting and services: 7.2%), and trade (4.5%).

Regarding indirect procurement volume, approximately 62% of companies report a procurement volume of less than €100 million, while 11% indicate a volume exceeding €1 billion. On average, 36.4% of total procurement volume is allocated to indirect materials. Additionally, more than 70% of companies have fewer than 10 full-time equivalent (FTE) years dedicated to managing indirect procurement, with a median of approximately 3 FTE years.

More than 70% of surveyed companies employ over 1,000 people, meaning they are typically directly subject to ESG regulations. Meanwhile, 60% of companies with fewer than 1,000 employees report being indirectly affected by ESG requirements due to customer demands. To facilitate further analysis, companies were categorized into three groups based on their number of employees:

- **Small**: < 1.000 employees (29,3%)
- **Mid-Size**: 1.000–9.999 employees (43,1%)
- **Large**: > = 10.000 employees (27,6%)

The study participants predominantly consist of experienced procurement professionals. Approximately 60% hold leadership positions in procurement, while 25% work as operational buyers or procurement analysts. An additional 15% are employed in sustainability management with direct relevance to procurement. This high level of expertise ensures that the collected data provides well-founded and practice-oriented insights into current procurement and ESG practices.

Empirical analysis

Sourcing effort
The level of effort required in the sourcing process is primarily influenced by the annual number of sourcing cases conducted. Each sourcing case results in a new contract, which, in the context of indirect materials, typically covers a category or an entire commodity group. Two-thirds of the surveyed companies establish a monetary threshold for initiating a sourcing case, with a median value of €13,750. This threshold varies depending on company size: smaller companies tend to set lower limits, whereas medium and large companies implement slightly higher ones. Companies that do not define a fixed monetary threshold nevertheless consider the financial scope and potential cost savings as key decision-making factors when initiating a sourcing process. The frequency of sourcing cases conducted each year is closely correlated with company size. On average, small companies report 12 sourcing cases per year, mid-sized companies 30, and large companies 150. The estimated time required for a sourcing process is approximately 18

hours, with larger companies generally investing more time than their small and mid-sized counterparts, see Table 5.

Table 1: Drivers and process times in sourcing

Driver	Full Dataset			Small			Mid-size			Large		
	mdn	Q1	Q3	mdn	Q1	Q3	mdn	Q1	Q3	mdn	Q1	Q3
Threshold in (€)	13.750	5.000	50.000	10.000	10.000	15.000	24.000	5.000	50.000	20.000	10.000	50.000
Number of sourcing cases	50	10	400	12	5	50	30	10	200	150	50	350
Proportion of new suppliers (%)	20,0	10,0	50,0	20,0	10,0	47,5	20,0	10,0	50,0	20,0	10,0	50,0
Process	**Full Dataset**			**Small**			**Mid-size**			**Large**		
h per sourcing case	mdn	Q1	Q3	mdn	Q1	Q3	mdn	Q1	Q3	mdn	Q1	Q3
Selection of existing suppliers	1,0	0,9	4,0	1,0	0,5	5,0	1,0	1,0	3,0	1,0	0,5	4,0
Sourcing a new supplier	8,0	3,0	20,0	9,5	3,0	20,0	8,0	3,0	18,5	8,0	4,0	21,0
Sourcing RFQ	12,0	4,0	26,0	9,0	3,0	20,0	9,5	4,0	21,0	14,0	6,5	37,5
Total time sourcing (h per sourcing case)	18,0	6,1	42,0	16,2	5,0	38,2	16,6	6,2	40,2	20,7	8,7	49,2

Supplier management effort

The primary factor influencing supplier management effort is the number of suppliers a company oversees. Small companies typically manage approximately 65 suppliers in the procurement of indirect materials, mid-sized companies 450, and large companies 1,000. The average annual time effort per supplier is estimated at seven hours, with larger companies reporting a significantly greater overall effort compared to small and mid-sized firms. A comprehensive analysis of absolute resource allocation indicates that supplier management requires substantially greater resource utilization than the sourcing process.

Table 2: Drivers and process times in supplier management

Driver	Full Dataset			Small			Mid-size			Large		
	mdn	Q1	Q3	mdn	Q1	Q3	mdn	Q1	Q3	mdn	Q1	Q3
new suppliers in the onboarding process per year	30	10	100	10	5	30	35	15	85	50	12	150
suppliers to be maintained per year	300	50	1.050	65	30	245	450	115	1.500	1.000	250	2.500
suppliers being subject to systematic monitoring and evaluation per year (%)	10,0	5,0	30,0	10,0	5,0	31,5	10,0	5,0	20,0	20,0	4,5	50,0
suppliers going through a supplier management process per year (%)	5,0	1,0	12,5	5,0	0	20,0	5,0	1,0	10,0	5,0	1,25	25,0
Process	**Full Dataset**			**Small**			**Mid-size**			**Large**		
h per supplier	mdn	Q1	Q3	mdn	Q1	Q3	mdn	Q1	Q3	mdn	Q1	Q3
Supplier onboarding	3,0	1,0	8,0	5,0	2,0	24,8	2,0	1,0	5,0	7,0	2,0	20,0
Contract implementation	5,0	2,0	15,0	5,0	2,0	11,3	5,0	2,0	10,0	5,0	2,0	23,0
Contract monitoring	2,0	1,0	10,0	2,0	1,0	8,0	2,0	1,0	5,8	2,8	1,0	5,8
Evaluation,administration and management of suppliers	3,0	1,0	8,5	3,0	1,5	9,5	2,0	1,0	6,0	4,0	1,0	8,0
Supplier development	5,0	1,0	10,0	5,0	2,0	10,0	4,0	1,0	10,0	4,0	1,5	16,0
Total time for supplier management – (h per supplier)	7,0	2,7	35,2	6,2	2,3	19,8	3,7	2,2	15,9	13,4	3,3	51,6

Integration of an ESG strategy

The incorporation of ESG criteria into the procurement of indirect materials indicates that companies make only minor distinctions among the three ESG dimensions. Strategies and guidelines are generally developed in a holistic and integrated manner. 43.9% of the surveyed companies have implemented an overarching ESG strategy for the procurement of indirect materials. An additional 39.9% have introduced individual initiatives but have yet to establish a fully developed strategy. In contrast, 16.2% have not yet formulated a strategy or explicit guidelines in this area.

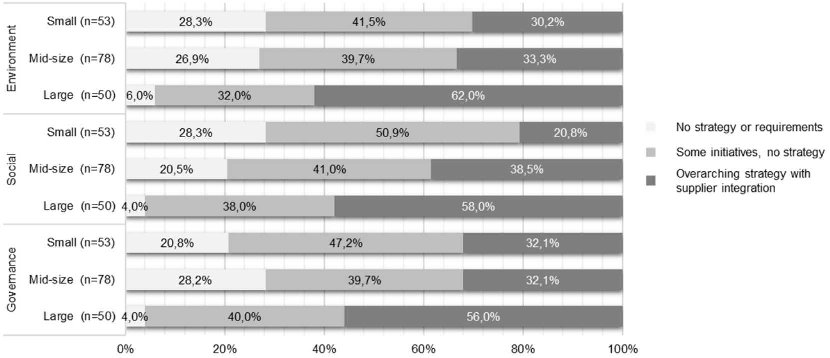

Figure 2 – Integration of an ESG strategy in small, mid-sized and large companies

An analysis of company size reveals distinct differences in the adoption of ESG strategies (see Figure 3). Depending on the ESG dimension, 56–62% of large companies have implemented an overarching strategy, while only 4–6% have yet to establish one. In contrast, small and mid-sized companies demonstrate a significantly lower prevalence of overarching ESG strategies. This disparity is particularly pronounced in the social dimension, where only approximately 21% of small companies have adopted an overarching strategy.

Companies that currently incorporate ESG criteria into the procurement of indirect materials—or will be required to do so in the near future—estimate an average increase of 20% in process effort, spanning activities such as supplier search, selection, and development. The additional effort attributed to sourcing is 18.8%, while supplier management requires an increase of 20.6%. No significant differences were observed concerning company size.

Correlation between ESG strategy and degree of digitalisation

The degree to which companies have adopted digital technologies in the procurement of indirect materials varies significantly. Only 15% of companies have fully integrated digital processes, while 45% utilize task-specific digital tools. In contrast, approximately 40% rely solely on non-task-specific tools, such as spreadsheet applications (e.g., Excel).

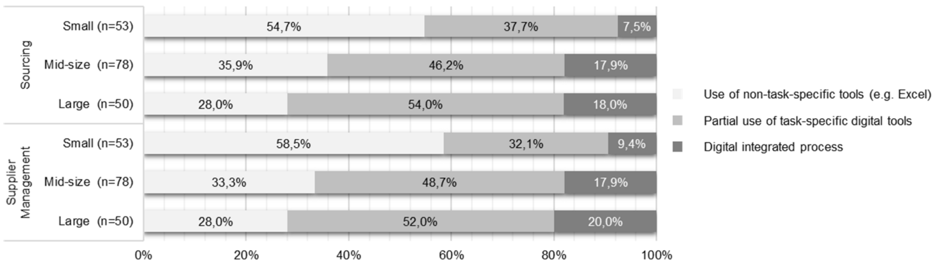

Figure 3 – Use of digital tools in small, mid-sized and large companies for sourcing and supplier management

As illustrated in Figure 4, large and mid-sized companies exhibit similar levels of digitalization. In these companies, the partial adoption of digital tools is most prevalent, followed by the use of non-task-specific applications. Fully integrated digital processes have been implemented in only about one in five large and mid-sized companies. In contrast, small companies demonstrate significantly lower levels of digitalization, with non-task-specific tools being the most commonly used.

The data reveal a clear correlation between a higher degree of digitalization and the presence of a comprehensive ESG strategy, see Figure 5. However, the direction of causality was not examined.

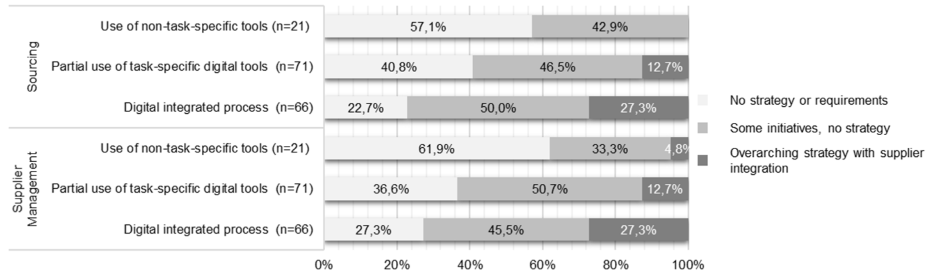

Figure 4 – Correlation between the existence of an ESG strategy and the use of digital tools for sourcing and supplier management

New technologies are recognized as playing a pivotal role in meeting ESG requirements in the procurement of indirect materials. Survey results indicate that 80% of companies consider sustainability tools to be relevant in supporting ESG compliance. Notably, risk management tools received even stronger approval, with an endorsement rate of 84%. Other technologies identified as important include platform-as-a-service solutions (73%), generative AI (61%), predictive analytics (61%), and robotic process automation (RPA) (58%). In contrast, chatbots for autonomous negotiations (50%) and blockchain solutions with smart contracts (46%) were perceived as comparatively less relevant.

Among companies that regard sustainability tools as relevant, 35.9% have already implemented them, while 39.3% are in the planning phase. The remaining 24.8% have either only vague concepts or no concrete plans for their adoption.

Findings

The results indicate that the additional effort required for integrating ESG criteria into sourcing and supplier management currently averages around 20%, with no noticeable differences between companies of varying sizes. This thus answers Research Question 1. The significant additional effort in key areas of indirect material procurement must be taken into account when allocating resources within companies. However, whether digitalization can or has already contributed to a reduction in manual effort remains unclear based on the present study and requires further investigation.

Furthermore, the data suggest a positive correlation between the degree of digitalization and the presence of a comprehensive ESG strategy in the procurement of indirect materials, thereby addressing Research Question 2. However, the results do not allow for a causal interpretation that a high degree of digitalization is necessarily a prerequisite for the implementation of ESG criteria. Nevertheless, the identified additional effort strongly suggests such a connection. These findings align with the results of Fang, who demonstrated that advancing digitalization—particularly with regard to governance and social aspects—improves ESG scoring at the corporate level (Fang *et al.*, 2023, p. 12). Thus, the use of digital tools is identified as a key factor in meeting the complex requirements in the ESG domain. Additionally, the study by Bag, confirms that digital technologies in the procurement process not only increase efficiency but also save resources and enhance transparency (Bag *et al.*, 2020, p. 11).

The results also suggest that many companies are still in the early stages of integrating ESG criteria into their indirect procurement processes. While large companies have made considerable progress, medium-sized and small companies -whether directly or indirectly impacted by regulatory requirements- are showing only initial efforts. Given the potential alleviation of regulatory pressure through the proposed OMNIBUS I and OMNIBUS II initiatives by the European Union, it remains to be seen to what extent widespread progress can be achieved in the coming years (European Commission, 2025a, p. 1, 2025b, p. 1).

Regardless of ESG integration, it must be noted that a large number of companies continue to rely on general, non-task-specific tools such as Excel. The study did not investigate the actual potential of digitalisation within individual companies. However, the reliance on heavily manual processes appears justifiable only in very small companies. Especially considering the increasing use of modern technologies, such as those in risk management or sustainability tools, it is essential that core processes are digitally integrated to avoid creating even more siloed solutions.

Conclusion

The study provides fundamental data on sourcing and supplier management for the procurement of indirect materials and quantifies the additional time effort required due to regulatory requirements in the area of sustainability. This offers companies a valuable foundation for evaluating and optimizing their procurement activities, as well as raising awareness about the importance of digitalization as a key factor for enhancing efficiency and long-term competitiveness. The findings highlight that without digital support, efficiently implementing complex ESG requirements is scarcely achievable.

However, the study has certain limitations. The anonymized web survey does not allow for direct verification of responses, the sample size is limited for detailed subgroup analyses (e.g., industry-specific differences), and the country composition (46.4% German companies) does not provide a fully representative distribution for a Europe-wide study. Future research should build on these results and also analyse the contribution of sustainability strategies to corporate success, to emphasize that such measures should not be seen merely as additional efforts to meet regulatory requirements but also as a catalyst for sustainable corporate development.

References

Bag, S., Wood, L.C., Mangla, S.K. and Luthra, S. (2020), "Procurement 4.0 and its implications on business process performance in a circular economy", *Resources, Conservation and Recycling*, Vol. 152, pp. 1–14.

Boer, L. de, Holmen, E. and Pop-Sitar, C. (2003), "Purchasing as an organizational design problem: the case of non-product-related items and services", *Management Decision*, Vol. 41 No. 9, pp. 911–922.

Bogaschewsky, R. (2019), "Entwicklung und Bedeutung der Digitalisierung in Einkauf und SCM", in Obermaier, R. (Ed.), *Handbuch Industrie 4.0 und Digitale Transformation: Betriebswirtschaftliche, technische und rechtliche Herausforderungen*, 1st ed. 2019, pp. 139–164.

Bogaschewsky, R. and Möller, J. (2024), "Nachhaltigkeitsrisiken in der strategischen Beschaffung", in Fröhlich, E. and Jamal, Y. (Eds.), *CSR und Beschaffung*, *Management-Reihe Corporate Social Responsibility*, Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 31–67.

Ecovadis and Accenture (2024), *Sustainable Procurement Barometer 2024: Transforming Procurement Into a Strategic Sustainability & Resilience Partner*.

European Commission (2025a), *DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directives (EU) 2022/2464 and (EU) 2024/1760 as regards the dates from which Member States are to apply certain corporate sustainability reporting and due diligence requirements*.

European Commission (2025b), *REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Regulations (EU) 2015/1017, (EU) 2021/523, (EU) 2021/695 and (EU)*

2021/1153 as regards increasing the efficiency of the EU guarantee under Regulation (EU) 2021/523 and simplifying reporting requirements.

Fang, M., Nie, H. and Shen, X. (2023), "Can enterprise digitization improve ESG performance?", *Economic Modelling*, Vol. 118, pp. 1–15.

Gao, H., He, J. and Li, Y. (2022), "Media spotlight, corporate sustainability and the cost of debt", *Applied Economics*, Vol. 54 No. 34, pp. 3989–4005.

Gebauer, J. and Segev, A. (2000), "Emerging technologies to support indirect procurement: two case studies from the petroleum industry", *INFORMATION TECHNOLOGY AND MANAGEMENT*, Vol. 1 1/2, pp. 107–128.

Grün, O. and Brunner, J.-C. (2019), "Beschaffung", in Kummer, S., Grün, O. and Jammernegg, W. (Eds.), *Grundzüge der Beschaffung, Produktion und Logistik*, *wi - wirtschaft*, 4., aktualisierte Auflage, Pearson, Hallbergmoos, pp. 133–225.

Gualandris, J., Longoni, A., Luzzini, D. and Pagell, M. (2021), "The association between supply chain structure and transparency: A large-scale empirical study", *Journal of Operations Management*, Vol. 67 No. 7, pp. 803–827.

Helmold, M. (2023), *Wettbewerbsvorteile entlang der Supply Chain sichern*, Springer Fachmedien Wiesbaden, Wiesbaden.

Hofbauer, G. and Kececioglu, S. (2023), *Digitalisation of the Source-to-Contract Process: Evaluation and Proof of Concept, Arbeitsberichte - Working Paper*, Ingolstadt.

Industrie- und Handelskammer Düsseldorf (2023), "Das Lieferkettengesetz - Ergebnisse einer IHK-Umfrage", available at: https://www.ihk.de/duesseldorf/aussenwirtschaft/lieferkettengesetz/das-lieferkettengesetz-ihk-umfrage-5821342 (accessed 28 March 2025).

Jahns, C. (2005), "Supply Controlling", *Controlling*, Vol. 17 No. 6, pp. 349–358.

Kaufmann, L. (2002), "Purchasing and Supply Management - A Conceptual Framework", in Hahn, D. and Kaufmann, L. (Eds.), *Handbuch Industrielles Beschaffungsmanagement: Internationale Konzepte - Innovative Instrumente - Aktuelle Praxisbeispiele*, 2., überarbeitete und erweiterte Auflage, Gabler Verlag, Wiesbaden, s.l., pp. 3–33.

Kotsantonis, S., Pinney, C. and Serafeim, G. (2016), "ESG Integration in Investment Management: Myths and Realities", *Journal of Applied Corporate Finance*, Vol. 28 No. 2, pp. 10–16.

Lu, Y., Xu, C., Zhu, B. and Sun, Y. (2024), "Digitalization transformation and ESG performance: Evidence from China", *Business Strategy and the Environment*, Vol. 33 No. 2, pp. 352–368.

Morton, A. (2024), "Nachhaltige Transformation im Einkauf in der vertikalen Landwirtschaft (vertikales Farming)", in Fröhlich, E. and Jamal, Y. (Eds.), *CSR und Beschaffung*, *Management-Reihe Corporate Social Responsibility*, Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 279–299.

Nadeesh, S., Mylvaganan, R. and Siddappa, S., "A Multi-Step Recommendation Engine for Efficient Indirect Procurement", in IEEE (Ed.), *2015 IEEE International Advance Computing Conference (IACC)*, pp. 377–380.

Reh, E. (2017), *Chemometrie: Grundlagen der Statistik, Numerischen Mathematik und Software Anwendungen in der Chemie*, De Gruyter, Berlin, Boston.

Schiele, H., Buchholz, W. and Delke, V. (2023), "Differentiating Between Direct and Indirect Procurement: Roles, Skills and Industry 4.0", *International Journal of Procurement Management*, Vol. 16 No. 1, pp. 1–30.

Schmidt, R.C. (2023), "ESG in der Unternehmensbewertung", in Behringer, S. and Follert, F. (Eds.), *Unternehmensbewertung und ökonomische Analyse*, Springer Fachmedien Wiesbaden, Wiesbaden, pp. 115–132.

Truant, E., Borlatto, E., Crocco, E. and Sahore, N. (2024), "Environmental, social and governance issues in supply chains. A systematic review for strategic performance", *Journal of Cleaner Production*, Vol. 434, pp. 1–13.

Vollmer, M., Bode, C. and Burkhart, D. (2021), "Die Einkaufsfunktion 2030: Wie Trends und disruptive Technologien die Zukunft des Einkaufs verändern", in Bogaschewsky, R. (Ed.), *Einkauf und Supply Chain Management*, *ZfbF-Sonderheft*, 76/21, Springer Gabler, Wiesbaden, Heidelberg, pp. 37–58.

Vos, F.G., Schiele, H. and Hüttinger, L. (2016), "Supplier satisfaction: Explanation and out-of-sample prediction", *Journal of Business Research*, Vol. 69 No. 10, pp. 4613–4623.

Walden, J., Steinbrecher, A. and Marinkovic, M. (2021), "Digital Product Passports as Enabler of the Circular Economy", *Chemie Ingenieur Technik*, Vol. 93 No. 11, pp. 1717–1727.

Zhou, H. and Liu, J. (2023), "Digitalization of the economy and resource efficiency for meeting the ESG goals", *Resources Policy*, Vol. 86, p. 104199.