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AN APPLIED MODEL FOR ESG/CSRD COMPLIANCE IN MANUFACTURING ENTERPRISES

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Abstract
The Corporate Sustainability Reporting Directive (CSRD) and the European Sustainability Reporting Standards (ESRS) require manufacturing enterprises to integrate environmental, social and governance (ESG) considerations into their strategies, processes and information systems. This paper systematises the existing scientific and applied literature on the subject, covering the regulatory framework (including the 2025–2026 "Omnibus" simplification package), the theoretical foundations of the research field, the methodology of double materiality assessment and the models of organisational ESG maturity, with a focus on the specifics of the manufacturing sector. Based on the reviewed literature, a four-layer applied compliance model is proposed – regulatory positioning, double materiality assessment, data and digital infrastructure, and organisational maturity – which is illustrated through an example of a medium-sized manufacturing enterprise. The paper concludes with practical guidelines for the phased implementation of the model and outlines gaps in the research.

Keywords: ESG, CSRD, ESRS, double materiality, maturity model, manufacturing enterprises, compliance.

INTRODUCTION

The CSRD and the resulting ESRS have substantially changed the non-financial reporting requirements for enterprises in the European Union by extending the range of obliged entities, introducing the principle of double materiality and requiring assurance of the reported information [1, 2]. For manufacturing enterprises – characterised by intensive consumption of energy and raw materials, complex supply chains and significant exposure to Scope 3 indicators – the application of these requirements poses specific organisational, methodological and technological challenges [3, 4].

The aim of this paper is threefold: (1) to systematise the existing literature on ESG/CSRD compliance in the manufacturing context; (2) to propose a synthesised applied model derived from the reviewed literature and to illustrate it through a specific example of a manufacturing enterprise; and (3) to formulate practical guidelines for the phased implementation of the model, useful for managers and sustainability specialists in manufacturing organisations.

REVIEW METHODOLOGY

The review was prepared as a narrative review of recent academic and applied literature (2023–2026), including peer-reviewed articles, book chapters, regulatory guidance of the European Commission and EFRAG, as well as analyses by leading consulting and law firms. The search covered four thematic areas corresponding to the structure of the paper: the regulatory framework of CSRD/ESRS and the Omnibus package; theoretical frameworks explaining the adoption of ESG practices; the methodology of double materiality assessment; and models of organisational and digital ESG maturity, including those specific to the manufacturing sector and to small and medium-sized enterprises (SMEs). Given the rapid regulatory dynamics in 2025–2026, priority was given to the most recent sources.

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REGULATORY FRAMEWORK: FROM NFRD TO CSRD/ESRS AND THE OMNIBUS PACKAGE

CSRD and ESRS – essence and scope

The CSRD extends the scope of the preceding Non-Financial Reporting Directive (NFRD) by introducing an obligation for detailed disclosure of ESG aspects based on the principle of double materiality – a simultaneous assessment of the enterprise's impact on the environment and society and of the financial risks and opportunities arising from ESG factors [1, 5]. The Directive requires ESG considerations to be integrated into the business model and strategy of the enterprise, rather than merely filling in reporting indicators [6].

In the context of the manufacturing sector, the literature highlights several specific exposure factors: a high environmental footprint due to energy and raw-material intensity; complex multi-tier supply chains that make the tracing and validation of ESG data difficult; growing expectations of transparency from investors, regulators and customers; and regulatory pressure related to achieving climate targets [3, 4]. The main challenge remains the collection of high-quality data, especially for Scope 3 emissions, which depend on supply-chain partners using different reporting formats and standards [3].

Simplification through the Omnibus package (2025–2026)

In February 2025, the European Commission presented the Omnibus package aimed at reducing the administrative burden, affecting simultaneously the CSRD, the Corporate Sustainability Due Diligence Directive (CSDDD) and the EU Taxonomy [7, 8]. The main change is a significant narrowing of the scope of obliged entities – according to various estimates, the number of enterprises subject to mandatory reporting decreases by approximately 80–90%, the threshold for large enterprises being raised to more than 1000 employees and a net turnover above EUR 450 million, while listed SMEs are removed from the scope [9–11].

In addition to narrowing the scope, the directive introduces a "value chain cap", which limits the ability of large reporting enterprises to request detailed ESG information from smaller partners beyond the scope of the voluntary SME standard [9, 12]. In parallel, EFRAG published a draft of simplified ESRS, aimed mainly at simplifying the double materiality assessment through a so-called "information materiality filter" and the possibility of a top-down approach [13–15]. These changes are directly relevant to manufacturing enterprises, since many of them – especially second- and third-tier suppliers – move from the status of directly obliged entities to the status of entities providing data under a contractual (rather than regulatory) obligation towards their customers.

Transposition in Bulgaria and the countries of Central and Eastern Europe

The transposition of the CSRD in the Central and Eastern European (CEE) Member States is proceeding unevenly [16]. Surveys by law firms indicate that Bulgaria finalised the initial transposition through amendments to the Accountancy Act, introducing an obligation to publish a consolidated sustainability report in Bulgarian within 12 months after the end of the financial year, with the provisions following the directive without significant national deviations [16, 17]. In February 2025, the Bulgarian Parliament adopted amendments postponing by one year the start of the reporting period for certain categories of enterprises [18]. Member States have until 19 March 2027 to transpose the Omnibus provisions, which creates additional regulatory uncertainty for the medium-term planning of enterprises [12].

THEORETICAL FOUNDATIONS OF RESEARCH ON ESG COMPLIANCE

Systematic literature reviews identify stakeholder theory and institutional theory as the dominant conceptual frameworks in research on ESG measurement and reporting, complemented by legitimacy

theory [19, 20]. Stakeholder theory emphasises the responsibility of the enterprise towards a broad range of stakeholders and explains why enterprises invest in sustainable production practices beyond strict compliance with regulatory requirements [20].

Institutional theory explains the adoption of ESG practices as a result of regulatory, normative and cognitive pressure from the institutional environment, which is particularly relevant for explaining the homogenisation of compliance practices among enterprises within the same regulatory regime [20]. A study of the Chinese manufacturing sector combines the two theories in a single framework, explaining how ESG policies affect cleaner production practices through both stakeholder engagement and institutional pressure [21]. Conceptual reviews distinguish between "compliance-oriented", "legitimacy-oriented" and hybrid approaches to the governance of sustainability reporting, noting that formal compliance with technical standards does not automatically guarantee legitimacy in the eyes of stakeholders [22].

DOUBLE MATERIALITY ASSESSMENT: METHODOLOGY AND CHALLENGES

Double materiality combines the impact perspective (impact materiality) and the financial perspective (financial materiality) [5, 23]. The EFRAG guidance (Implementation Guidance 1) describes a four-step process: analysis of the business model, value chain and stakeholders; generation of a list of potential impacts, risks and opportunities (IROs) based on the reference list in ESRS 1, Appendix AR 16; assessment of impact and financial materiality against threshold values; and consolidation of the results into a list of material topics [24, 25].

The consulting and professional literature describes persistently recurring practical difficulties: the lack of specific guidance for setting threshold values; the need to analyse a wide range of topics with equal depth even when they are clearly not material; difficulties in comparing impacts of a qualitatively different nature; and challenges in ensuring data quality [15, 23, 26]. In response, the draft simplified ESRS (2025) introduces the possibility of a direct conclusion on materiality or non-materiality based on the business model, without a detailed IRO analysis for clearly material or non-material topics [13, 14, 26].

MODELS OF ORGANISATIONAL MATURITY AND READINESS FOR ESG COMPLIANCE

General ESG maturity models

The applied literature describes ESG maturity as a spectrum, usually structured in four stages – from a reactive and fragmented approach, through a compliance stage, to a stage of strategic integration in which ESG practices are fully embedded in the business strategy, operational risk management and corporate culture [27]. Most organisations remain between the compliance stage and the strategic integration stage, the main obstacle to progress being the lack of reliable and structured data rather than a lack of ambition [27].

Integration between digital transformation (Industry 4.0) and ESG maturity

Existing Industry 4.0 maturity models focus mainly on technological and process capabilities and rarely address directly the regulatory and reporting dimensions of ESG [28]. Critical reviews point out that only a small proportion of these models take into account the specific constraints of SMEs in terms of organisational and competence resources [28]. In response to this gap, integrated frameworks have been proposed, such as the "Digital Sustainability Maturity Framework", which links Industry 4.0 maturity, digital capabilities, ESG maturity and measurable sustainability outcomes in a single cause-and-effect structure [28], as well as the ESG-CMM (ESG Capability Maturity Model), which extends traditional process maturity models with parameters

such as risk management, compliance, resilience to disruptions and organisational learning from incidents [29]. A study of SME cases in Quebec found that higher digital maturity is associated with an evolution from a purely compliance-oriented approach towards more integrated and strategic ESG practices [30].

Specific models for small and medium-sized enterprises

The literature underlines the need for simplified self-assessment tools adapted to the resource constraints of SMEs. An "agile readiness model" for the decarbonisation of manufacturing SMEs has been proposed and validated through case studies with industrial partners from developed and developing economies [31]. A key conclusion is that a local manufacturing enterprise can use a basic framework to move beyond simple environmental compliance towards identifying cost-saving opportunities through energy efficiency and waste reduction, before progressing to higher levels of strategic ESG integration [31].

SPECIFICS OF THE MANUFACTURING SECTOR

A systematic thematic review covering the period 2020–2024 found significant gaps in readiness to apply the ESRS – only about 37% of EU enterprises are fully prepared, with large enterprises (about 68%) considerably ahead of medium-sized ones (about 23%) [32]. The manufacturing sector shows relatively higher readiness (in the range of about 58–72%) compared with sectors such as retail, hospitality and technology (about 28–34%), probably owing to the longer history of environmental regulation in manufacturing [32].

Studies show that alignment between circular economy principles and ESG criteria brings potential long-term financial benefits, improved reputation and better regulatory compliance, but also substantial barriers – high initial investment costs, regulatory fragmentation and the complexity of global supply chains [33]. In parallel, research on manufacturing enterprises has found a positive relationship between the adoption of intelligent manufacturing practices, digital transformation and ESG performance [34, 35], which supports the thesis that the technological modernisation of production processes creates the data infrastructure needed for reliable ESG reporting.

SYNTHESISED APPLIED COMPLIANCE MODEL

Based on the reviewed literature, a four-layer applied model is proposed, summarised in Table 1.

Table 1. *Four-layer applied model for ESG/CSRD compliance in manufacturing enterprises*

Layer	Focus	Main activities	Ref.
1. Regulatory positioning	Status of the enterprise under CSRD / Omnibus	Periodic check of thresholds; classification as directly obliged entity or contractual data provider	[9, 12]
2. Double materiality	Identifying material IROs	Analysis of business model and value chain; assessment of impact and financial materiality	[24, 25]
3. Data and digital infrastructure	Collection, validation and aggregation of ESG data	Integration with ERP/MES; Scope 3 tracking; digital data-quality layer	[28, 35]
4. Organisational maturity	Positioning on an ESG / capability maturity model	Self-assessment; gap identification; prioritisation of initiatives in a cycle	[27, 29]

It is precisely the combination of the four layers – rather than the separate application

of each of them – that emerges in the literature as a prerequisite for sustainable (reproducible over time) compliance, as opposed to one-off, project-oriented efforts to prepare a sustainability report.

ILLUSTRATIVE EXAMPLE OF APPLICATION IN A MANUFACTURING ENTERPRISE

To illustrate the practical application of the model, an illustrative example (hypothetical, generalised from typical practices in the literature) is presented below for a medium-sized manufacturing enterprise – a producer of metal components for mechanical engineering, with about 300 employees, one production site and a network of about 40 suppliers of raw materials and semi-finished products. The example does not describe a specific real enterprise but serves to demonstrate the logic of the four-layer model.

Layer 1 – Regulatory positioning. The enterprise does not meet the new Omnibus thresholds (fewer than 1000 employees and a turnover below EUR 450 million) and is therefore not a directly obliged entity under the CSRD. However, it is a second-tier supplier of a large European automotive component manufacturer, which is a directly obliged entity. As a result, the enterprise receives contractual requests for ESG data from its customer, limited in scope by the value chain cap to information corresponding to the voluntary SME standard. The conclusion of the analysis is that the enterprise does not prepare its own ESRS report but must build the capability to provide structured ESG data on request.

Layer 2 – Materiality assessment (in simplified form). Although not formally obliged, the enterprise conducts a simplified materiality analysis based on its business model in order to determine which topics are relevant to the customer's requests and to its own risk profile. The following were identified as likely material: energy consumption and emissions from own operations (Scope 1 and 2); working conditions and safety in production; management of metalworking waste; and supplier selection and evaluation practices. Topics such as biodiversity were assessed as non-material given the nature of the activity.

Layer 3 – Data and digital infrastructure. The audit of available data shows that the enterprise has an ERP system for production planning, but lacks integrated tracking of energy consumption by production line and has no systematic register of ESG information from suppliers. The enterprise introduces: (a) an energy consumption monitoring module connected to the existing metering points; (b) a short structured supplier questionnaire aligned with the voluntary SME standard, sent once a year; and (c) a centralised register consolidating internal data and data received from suppliers.

Layer 4 – Organisational maturity. A self-assessment against a simplified ESG maturity model positions the enterprise at the beginning of the "compliance" stage – individual initiatives exist (energy monitoring, documented safety procedures), but there is no integrated ESG strategy and no regular review cycle. The priority gaps identified are: no designated internal sustainability officer; no annual cycle for reviewing customer requests and materiality; and limited capacity to respond if the main customer's requirements expand in future years. Based on this assessment, an improvement plan with a 12–18-month horizon was defined, including the appointment of a responsible person, the introduction of an annual review cycle and the gradual extension of the digital layer beyond energy monitoring.

IMPLEMENTATION GUIDELINES

Based on the reviewed literature and the illustrative example above, the implementation of the model in a manufacturing enterprise can follow an eight-step roadmap, summarised in Table 2. The roadmap is applicable both to enterprises that are directly obliged entities under the CSRD and to enterprises participating as suppliers in the value chain

of such an entity.

Table 2. *Eight-step roadmap for implementing the applied model in a manufacturing enterprise*

Step	Name	Content	Indicative horizon
1	Regulatory screening	Applicability of CSRD/ESRS and role of the enterprise in the value chain (directly obliged entity / data provider)	1–2 months
2	Project governance	Internal owner (e.g. sustainability manager or committee) with representatives of production, quality, finance and procurement	in parallel with step 1
3	Double materiality assessment	Business model and value chain analysis; IRO list; stakeholder consultation; material topics	2–4 months
4	Data availability audit	Mapping of existing systems (ERP/MES/energy monitoring) against required ESRS indicators; gap identification	1–3 months
5	Data and digital layer	Introduction/adaptation of ESG data collection tools; supplier request protocols; integration with existing systems	3–6 months
6	Maturity self-assessment	Positioning against a selected ESG/capability maturity model; priority gaps by dimension	1 month
7	Sustainability report	Disclosures under relevant ESRS sections; internal review; preparation for independent assurance	2–3 months
8	Continuous improvement	Annual update of materiality, maturity review and adjustment of the digital layer to regulatory changes	ongoing, annual cycle

Additional guidelines arising from the reviewed literature:

– **Proportionality to the size of the enterprise:** SMEs and smaller suppliers should apply simplified versions of each layer (e.g. a top-down approach to the materiality assessment) instead of copying methodologies developed for large, directly obliged entities.
– **Integration rather than duplication of systems:** the digital layer should build on the existing ERP/MES systems instead of introducing a parallel reporting infrastructure, in order to limit the operational burden.
– **Managing customer requests in the value chain:** enterprises that are not directly obliged entities should monitor the scope of the voluntary SME standard and the value chain cap in order to avoid providing information beyond the necessary minimum.
– **Regulatory monitoring:** given the ongoing changes to the Omnibus package and the simplified ESRS, a regular (e.g. semi-annual) review of the applicable thresholds and requirements is recommended until they are finally stabilised.
– **Cyclicality:** all four layers should be treated as a recurring rather than a one-off process, synchronised with the annual reporting and audit cycle.

CONCLUSION

The literature review shows that the research field of ESG/CSRD compliance in the manufacturing sector is actively developing but remains fragmented in several respects. First, the regulatory framework is undergoing substantial change (the Omnibus package and the simplified ESRS), which means that a significant part of the earlier literature, prepared against the original 2023 version of the ESRS, needs to be reconsidered in the light of the new thresholds and simplified methodologies. Second, the literature on maturity models is divided between studies focusing solely on digital/Industry 4.0 maturity and studies focusing solely on ESG maturity, while integrated frameworks are relatively new

and still poorly validated empirically beyond individual case studies. Third, the specific context of the CEE countries, including Bulgaria, is represented mainly in legal and consulting literature, while academic empirical research on the readiness and practices of local manufacturing enterprises remains limited.

The four-layer model and the illustrative example presented in this paper aim to offer a working starting point for practical implementation, but require empirical validation in real manufacturing contexts. Directions for future research include: (1) empirical validation of integrated digital-ESG maturity models in different national and sectoral contexts, including CEE countries; (2) investigation of the effect of the new Omnibus thresholds on the practices of second- and third-tier suppliers in the value chain of manufacturing enterprises; and (3) development and testing of applied, SME-specific tools for self-assessment of ESG readiness, adapted to the limited resources of these enterprises.

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