Managing ESG Asymmetry with AI-Enabled Knowledge Governance: A Cyber-Systemic Perspective

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Abstract

Socio-economic systems are under growing pressure to provide credible environmental, social, governance (ESG) disclosures and to integrate sustainability into their decision-making processes. Nevertheless, the practice of ESG reporting frequently faces multiple challenges, such as data fragmentation, divergent interpretations, and misaligned purposes among the stakeholders involved. These issues can generate conditions of information asymmetry, reducing the quality of sustainability reporting and performance. This paper sets out a conceptual framework for decoding the role of Artificial Intelligence (AI)-driven knowledge governance in ensuring the balance between ESG information and sustainability management through a cyber-systemic lens based on the Viable Systems Approach (VSA).

The model has been developed by drawing from research on knowledge governance, information asymmetry, cybernetics/system thinking, and AI for organizational decision support. The model proposes a multi-layered representation for connecting ESG data with meaning-making processes, governance mechanisms, and feedback loops. The framework outlines how AI can support traceability, interpretability, and responsible use of ESG information when integrated into appropriate governance structures.

Keywords: ESG reporting; Knowledge governance; Information asymmetry; Artificial Intelligence (AI); Cyber-systemics; Viable systems approach (VSA).

1 Introduction

In recent decades, socio-economic systems have been facing increasing challenges related to the environment, society, and governance. These challenges have placed conventional management methodologies, designed to address complexity, under significant strain. It has been emphasized by numerous experts that sustainability should be regarded as a dynamic, collaborative process influenced by adaptive interactions and feedback loops linking businesses, governments, and knowledge institutions (Saviano *et al*., 2025). Thus, in the context of the rapid spread of new digital technologies, there has been a concomitant increase in the accessibility of ESG information, as well as an escalation in the strategic relevance of that information. Consequently, the real challenge lies not in the 'ownership' of a greater quantity of data, but rather in the interpretation, validation, and integration of this data into decision-making processes (Caputo *et al.,* 2019).

This issue is evident when considering the evolution of ESG disclosure over time. However, ESG reporting practices are frequently affected by inconsistencies in measurement methods, divergent interpretations, and conflicting incentives among employees and external stakeholders (Akerlof, 1970).

Building upon these preliminary reflections, the paper addresses the challenges of ESG reporting by framing it as a matter of knowledge governance within complex systems. Contributing to the existing ESG reporting and AI literature, the paper introduces a cyber-systemic framework grounded in the VSA to demonstrate how artificial intelligence can support effective governance of ESG-related knowledge rather than replacing it. These processes, in turn, require governance mechanisms, such as roles, accountability, controls, incentives, and assurance, to maintain traceability, interpretability, and responsible use over time. In a nutshell, the paper argues that ESG information asymmetry cannot be reduced through AI alone. Rather, AI becomes effective only when embedded within cyber-systemic knowledge governance mechanisms capable of supporting interpretation, accountability, feedback, and organizational learning. Accordingly, this paper addresses the following research question: how can AI-enabled knowledge governance reduce internal and external ESG information asymmetries when interpreted through a cyber-systemic perspective? Following this line, the rest of the paper is structured as follows. In the second section, ESG reporting is presented as a challenge of information asymmetry. The third section provides the theoretical foundations of knowledge governance, information asymmetry, and cyber-systemics/VSA. Section 4 presents the proposed framework. The final section offers a discussion of possible research implications and limitations.

2 Background and problem framing: ESG reporting as an information asymmetry challenge

To decode decision-making processes focused on sustainability, it is necessary to bring together diverse stakeholders who operate both within and beyond the limits of the organization (Cervino & Caputo, 2025). From a broader perspective, sustainability is achieved when stakeholders align their goals, manage expectations, and participate in learning processes driven by feedback (Saviano *et al.,* 2025).

In such a vein, ESG reporting emerges as prime evidence of the multiple hidden connections existing in information management. These reports are affected by multiple information gaps, divergent interpretations, and selected focuses (Caputo *et al*.,2016). A compelling approach to address this challenge is to categorize the ESG information asymmetry into two distinct types: external and internal. On the one hand, the external ESG information asymmetry refers to the discrepancy between the knowledge that organizations possess regarding their sustainability efforts and their impacts, and the understanding that external stakeholders can comprehend and evaluate. On the other hand, the internal ESG information asymmetry is defined as the misalignment of information and interpretations across different units, functions, subsidiaries, and decision-making levels (Del Giudice *et al.*, 2017). From a cyber-systemic viewpoint, these asymmetries point to a fundamental governance challenge by

underlying that the effectiveness of ESG reporting hinges on the system's capacity to handle multiple and divergent information through feedback loops that promote learning and adaptation. From this perspective, a double aim emerges: the need to ensure consistency of ESG knowledge throughout the entire process (from data collection to interpretation, validation, and application) and the coherent information sharing (Saviano *et al.*, 2025). Recent developments in sustainability regulation, including the growing relevance of the Corporate Sustainability Reporting Directive (CSRD) and the European Sustainability Reporting Standards (ESRS), have further increased organizational pressure to ensure transparency, traceability, and accountability in ESG disclosure processes. These evolving regulatory expectations suggest that the challenge of ESG reporting no longer concerns only the quantity of disclosed information, but also the governance mechanisms through which sustainability knowledge is generated, interpreted, and monitored over time. In this context, the growing integration of AI into ESG reporting processes introduces both opportunities and risks related to interpretability, reliability, and organizational accountability, reinforcing the need for governance approaches capable of supporting learning, feedback, and adaptive coordination (Cervino & Caputo, 2025).

3 Methodology

This study adopts a conceptual and interpretative research design grounded in Cyber-systemics and based on the VSA (Beer, 1985; Golinelli, 2010; Espejo & Reyes, 2011). The proposed framework was developed through the integration of four literature streams: ESG reporting and sustainability disclosure, knowledge governance, information asymmetry, and VSA. The paper employs a narrative; theoretical synthesis aimed at identifying conceptual complementarities among these domains. The framework was constructed to explain how AI-enabled governance mechanisms may support the reduction of ESG information asymmetries through monitoring, adaptation, and organizational learning processes (Akerlof, 1978; Barile 2009).

Rather than relying on empirical investigation, the deductive approach allows to develop a preliminary reflection aimed at decoding how knowledge governance in ESG reporting contexts shapes the balance between ESG information and sustainability management.

4 Theoretical foundations

4.1 Knowledge governance and knowledge management

In an era of technological turbulence, knowledge has become a vital resource for the survival of organized entities, especially in contexts of complexity, fluidity, and uncertainty (Saviano & Caputo, 2013; Caputo, 2017).

The pervasive nature of artificial intelligence (AI) is progressively reshaping knowledge management (KM) systems and their associated governance mechanisms, thereby redefining the roles, responsibilities, incentives, and control structures that shape the creation, validation, and sharing of knowledge. Within the broader knowledge movement, knowledge governance offers an emergent view for showing that the evolutionary trajectory from data to information and knowledge is mediated by these critical antecedents.

Indeed, the literature demonstrates that incentive systems play a decisive role in shaping knowledge management behaviours. These systems can potentially promote knowledge-sharing practices or, conversely, generate knowledge-hiding phenomena. The same goes for rethinking roles, responsibilities, and control mechanisms.

4.2 Information asymmetry in organizational and stakeholder contexts

Emerging technologies and the associated changes in governance mechanisms are influencing the dynamics of organizational interactions within their internal and external contexts (Perko, 2021).

In organizational contexts, information asymmetry, studied by agency theory, can influence interactions at the external level concerning informational, cognitive, or value misalignments between the system and its environment (Akerlof, 1978). In such a vein, informational complexity and data fragmentation are primary sources of asymmetry because contemporary organizations must manage ever-growing quantities of information from diverse sources (Caputo *et al*., 2016).
From a systemic perspective, this weakens the structural conditions necessary for potential 'harmony of sounds'. Indeed, not only is information unevenly distributed, but it is also interpreted through different cognitive frameworks, simultaneously increasing the system's level of entropy (Barile, 2009). Furthermore, information asymmetry affects trust, as stakeholders perceive higher informational risk when information is asymmetric or difficult to decode, thereby destabilising interactions over time. Moreover, information asymmetries directly affect the economic and financial dimensions, influencing the cost of capital, and it can also undermine organisational legitimacy. Accordingly, artificial intelligence emerges as a key area for realigning information units, interpretive schemas, and categorical values to mitigate the entropic effects of information asymmetries (Barile *et al*., 2019).

4.3 Cyber-systemics and the Viable Systems Approach (VSA)

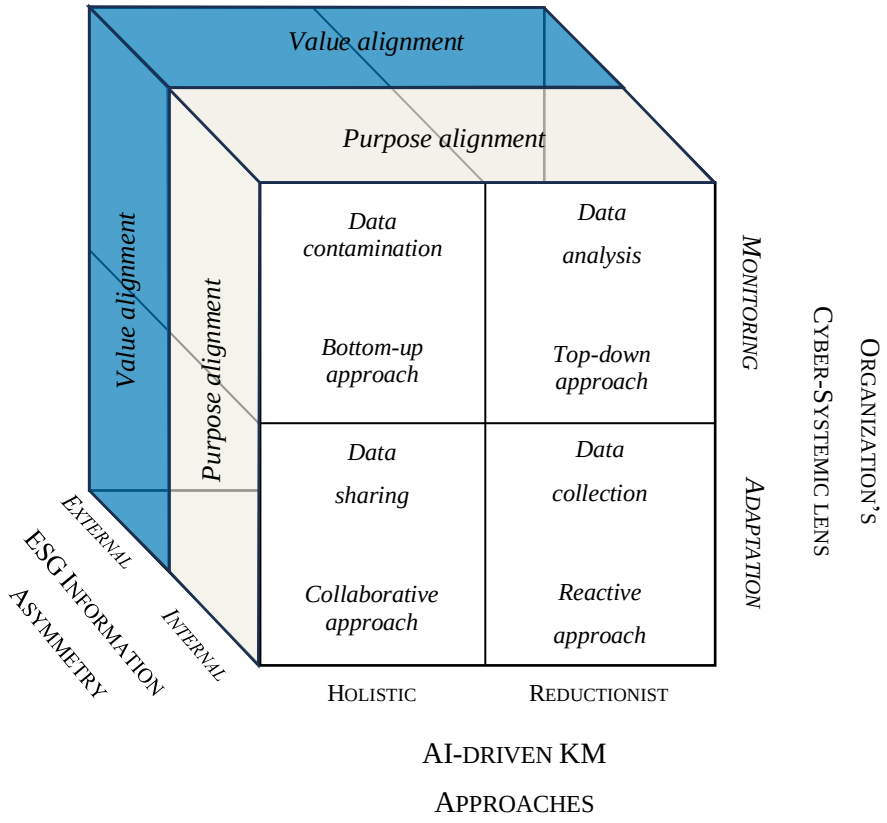
The complexity of the digital era necessitates a cyber-systemic approach to overcome reductionist logic, which still appears to characterize current ESG measurement and reporting processes. Cyber-systemics, based on the VSA (Beer, 1985; Golinelli, 2010; Espejo & Reyes, 2011), offers a framework for analysing the dynamic interactions and emergent behaviours of complex systems. Integrating cybernetics and systems thinking, organizations are viewed as adaptive systems operating through feedback cycles of learning, adaptation, and monitoring, with a focus on both individual and organizational knowledge governance (Perko, 2025).
According to Espejo (2021), learning generates an increase or reduction in the complexity of evolving systems within co-evolutionary circuits, distinguishing between single-loop and double-loop learning. Specifically, systems thinking offers a constructive systemic perspective according to which a system can be considered viable if it "survives, remains cohesive and integral, is homeostatically balanced both internally and externally, and possesses mechanisms and opportunities for growth, learning, development, and adaptation that enable it to become increasingly effective within its environment" (Beer, 1985: 69).
In such a vein, thanks to the contributions of Cyber-Systemics and the VSA, the survival, eidos, isotropy, ethos, and exhaustiveness of a viable system are ensured through its capacity to stimulate information variety, adopt feedback loops, and establish harmonious relationships with organizational contexts and supra-systems. This reduces ESG information asymmetries (Barile & Saviano, 2018).

5 AI for sustainability and reporting: capabilities and risks

The spread of AI is changing the ways in which organizations gather, analyse, and use sustainability-related data for internal decision-making and ESG reporting. AI should not be seen as a simple accelerator for reporting tasks because it can act as a supportive layer that can either lessen or heighten information gaps, depending on its integration into knowledge governance and organizational learning processes (Caputo *et al.*, 2019; Caputo, 2021).
Knowledge graphs and ontology-based methods link diverse indicators and narratives, allowing to illustrate causal relationships, accountability roles, and boundary conditions thanks to the integration with traditional data systems. For example, AI-supported semantic extraction systems may automatically collect ESG-relevant information from supplier documentation, sustainability reports, and operational databases, reducing fragmentation in data gathering processes. Similarly, anomaly-detection algorithms can identify inconsistencies between declared ESG indicators and operational performance metrics, supporting traceability and validation activities. Anomaly detection and pattern

recognition are vital for data quality control. Accordingly, the real question is not whether AI can be used in ESG reporting, but under what governance conditions it can help bridge information gaps while ensuring organizational viability and stakeholder alignment. Figure 1 illustrates a proposed framework that tries to clarify how AI-enabled knowledge governance can impact ESG reporting outcomes.

Figure 1: A cyber systemic conceptual model



Source: Authors' elaboration, www.asvsa.org

The left side of Figure 1 builds upon the idea that ESG reporting faces challenges from both internal and external information asymmetry. Internal asymmetry refers to the misalignment within different parts of an organization, where multiple units produce ESG data based on different logics, priorities, and timelines, with several impacts on the level of coordination costs (Del Giudice *et al.*, 2017). However, external asymmetry highlights the disconnect between an organization's knowledge of its ESG performance and what stakeholders can understand and assess. The issue is made worse by the often intangible and long-term effects of many ESG factors (Akerlof, 1970). The figure separates these two areas because they need different, yet connected, governance strategies showing the importance of AI-driven knowledge management strategies, particularly the reductionist versus holistic approaches. A reductionist AI-driven KM strategy is oriented to increase efficiency and the automation of reporting tasks, emphasizing speed and standardization. In contrast, a holistic AI-driven KM approach sees AI as a socio-technical facilitator for fostering shared understanding. AI tools help weave together diverse pieces of information, but the process of making sense of that information still relies on clear interpretative guidelines and organizational accountability.

The right side of the figure illustrates the organization's cyber-systemic lens, which operates through two main mechanisms: monitoring and adaptation. This is in line with VSA-oriented views that emphasize viability as a dynamic capability, supported by feedback loops and information variety management (Saviano *et al.*, 2017, 2025). Monitoring involves the continuous observation of ESG signals, inconsistencies, and emerging tensions within internal processes and stakeholder expectations. On the other hand, adaptation refers to the organization's ability to adjust its boundaries, indicators, governance responsibilities, and decision-making rules based on the collected feedback. In this context, the figure makes clear that AI is valuable not just for its ability to compute and identify patterns, but also for its role in enhancing cyber-systemic feedback loops. This enables the organization to learn, make corrections, and refine its ESG knowledge practices over time (Saviano *et al*., 2025). The lower section of the figure translates these interpretive layers into four operational knowledge processes where AI capabilities can be used.

The first process is data collection, and it is associated, in the figure, with a reactive approach. In ESG reporting, data collection is often prompted by deadlines, audit requirements, or external pressures, resulting in a fragmented and sporadic compilation. AI-supported semantic extraction and process automation can facilitate a more dynamic and structured gathering of ESG-relevant information. However, in a reductionist view, automation might merely speed up data collection without ensuring interpretative coherence, while in a holistic setup, the same tools can be leveraged to create shared data dictionaries and traceability links.

The second process revolves around data sharing, which requires collaborative working. Digital technologies undoubtedly facilitate information sharing, but research shows that merely transitioning to digital formats is insufficient to guarantee that all involved actors have the same data. Factors like cognitive distance and opportunistic behaviours make people hesitant to share their data (Caputo *et al.,* 2019).

The third process refers to data contamination, which takes a bottom-up approach. Data contamination refers to incomplete, inconsistent, biased, or unreliable ESG data that may distort interpretation and decision-making. In the domain of ESG, contamination should take into consideration multiple phenomena such as missing values, inconsistencies, biased proxies, and unreliable supplier data. Figure 1 emphasizes contamination control as a bottom-up process, highlighting that ensuring data quality and interpretative accuracy cannot rely solely on centralized controls. It demands local knowledge and on-the-ground verification. This aligns with the notion that sustainability outcomes are influenced by micro-level actions and contextual practices (Del Giudice *et al.,* 2017).

The fourth step is data analysis, which takes a top-down approach. When it comes to ESG reporting, data must be synthesized, aggregated, and interpreted to create meaningful indicators. During this phase, AI-driven analytics and decision support can support managers in making decisions able to overcome the reductionist compliance requirements.

The final piece of the puzzle is related to purpose and value alignment. These are the outcomes that help bridge the gaps created by information asymmetry. Purpose alignment focuses on how different actors' intentions and expectations come together around sustainability goals, while value alignment looks at how consistent the criteria are for evaluating ESG performance, both internally and externally. In a nutshell, the model builds upon the three drivers described in Table 1 to show that ESG information asymmetry is not a static problem; it is a dynamic issue arising from mismatches between data, interpretations, and purposes.

Table 1: The drivers of a cyber systemic conceptual model

Model components	Meanings	Role in reducing ESG asymmetry
AI-driven knowledge management	It supports the acquisition, documentation, transfer, creation, and application of sustainability-related information. AI should not be interpreted merely as an automation tool, but rather as a governance-support mechanism capable of shaping how organizations create, integrate, and disseminate sustainability knowledge.	Improve the integration, reliability, traceability, and interpretability of ESG information while reducing fragmentation, cognitive distance, and informational inconsistencies across multiple systems. It enhances the evolutionary path from sustainability data to information and knowledge.
Cyber-systemic lens	Cyber-systemic perspective, interprets organizational entities as adaptive systems continuously which interact with internal and external systems through recursive feedback loops aimed at managing informational variety and reducing entropy within ESG reporting processes.	It supports and stimulates the development of feedback loops, adaptation, and continuous learning mechanisms capable of enhancing the transparency, traceability, and consistency of sustainability disclosures, while reducing ESG data contamination, opportunistic behaviours.
Purpose and value alignment	Within the framework, purpose alignment refers to the harmonization of intentions and sustainability goals, while value alignment concerns the coherence between different evaluative criteria.	When organizational purpose is embedded within governance and decision-making processes, ESG disclosures become more coherent, credible, and contextually relevant. Such alignment fosters shared languages and inter-functional coordination mechanisms, thereby reducing informational fragmentation and opportunistic behaviours.

Source: Authors' elaboration, www.asvsa.org

Thanks to the proposed model, it is possible to underline how AI-driven knowledge management approaches can support the evolution of ESG reports from simple automation to a more integrated way of handling knowledge practices (Saviano *et al*., 2025). This helps explain how AI-enabled governance mechanisms may reduce ESG information asymmetries.

6 Discussions, implications, limitations, and future research agenda

This paper proposes a systemic reflection on the role of knowledge governance in reducing information asymmetries and supporting sustainability-oriented decision-making processes. From a theoretical perspective, the conceptual model contributes to the debate on ESG reporting by highlighting, through the cyber-systemic lens and the VSA, that it cannot be interpreted solely in technical-accounting terms, but rather as a dynamic process of rethinking knowledge governance.

From a managerial perspective, the conceptual framework provides operational guidelines for professionals and organizational stakeholders responsible for managing the increasing complexity of information contexts through feedback loops that promote learning and adaptation (Saviano *et al.*, 2025). The work guides managers on how to organize roles, responsibilities, and accountability mechanisms related to heterogeneous ESG information flows originating from internal units and external stakeholders.

From a regulatory perspective, the proposed framework suggests that regulatory bodies should expand their scope of attention: regulatory attention should progressively expand beyond disclosure content alone to include the quality of the governance mechanisms through which ESG knowledge is generated, interpreted, and monitored (Caputo *et al*., 2016, 2023). The model suggests that regulators may play a crucial role in defining governance-oriented principles aimed at ensuring that AI-supported ESG reporting systems remain transparent, auditable, and consistent with sustainability-oriented accountability objectives.

From a technological perspective, the contribution highlights that AI systems should not be interpreted merely as automation tools aimed at accelerating ESG disclosure activities. Rather, the study encourages technology providers to develop AI-enabled solutions capable of supporting interpretability, governance, organizational learning, and adaptive coordination processes.

In summary, this paper contributes to the literature in three ways. First, it reframes ESG reporting as a knowledge governance challenge rather than merely a disclosure problem. Second, it integrates information asymmetry theory, knowledge governance, and cyber-systemics/VSA into a unified interpretative framework. Third, it conceptualizes AI not as an autonomous decision-maker, but as a governance-support mechanism embedded within organizational learning and feedback processes.

Considering these limitations, future research could adopt comparative case studies to observe governance practices in real-world contexts, survey-based validation to capture the perceptions and experiences of professionals and stakeholders, and design science prototypes to test system functionality and interoperability. Future research activities could develop empirical analyses aimed at observing how AI-enabled knowledge governance concretely operates within ESG reporting processes. Exploratory case studies could investigate how organizations manage the collection, validation, interpretation, and feedback of ESG information through intelligent governance mechanisms, while simultaneously highlighting where AI may create new governance opportunities or risks.

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