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Review

Navigating the Challenges of Environmental, Social, and Governance (ESG) Reporting: The Path to Broader Sustainable Development

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Abstract: The ascent of environmental, social, and governance (ESG) reporting has established itself as a global standard in financial markets, reflecting a paradigm shift toward corporate sustainability. Despite this, persistent concerns surround the quality of ESG reporting and its tangible impact on Sustainable Development (SD). To address the imperative transition toward a broader SD agenda within the ESG reporting framework, this study delves into contemporary issues and challenges associated with ESG reporting. It emphasizes the scarcity of interdisciplinary expertise across diversified fields, which is a crucial element for establishing robust reporting mechanisms capable of encompassing the multifaceted nature of sustainability. To address this, ESG reporting should extend beyond its company-centric focus, adapting traditional accounting systems to more effectively incorporate evolving ESG disclosure demands. This adjustment will facilitate a transparent portrayal of environmental and social impacts. The Social and Environmental Accounting (SEA) framework presents a structured approach to facilitate this transformation. This study underscores key SEA aspects that will shape future research, including enhancing data accuracy, standardizing sustainability metrics, evaluating the influence of ESG reporting on stakeholders, and refining disclosure formats.

Keywords: social and environmental accounting; ESG; sustainability accounting; sustainability reporting; sustainable development; interdisciplinary



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1. Introduction

The global emphasis on sustainability is unmistakable, with companies worldwide recognizing the significance of environmental, social, and governance (ESG) issues encapsulated by the term “ESG”. Scientists assert that investments in ESG can significantly impact a company’s financial outlook because economic strength is closely related to sustainable development and ESG [1]. The concept of ESG criteria was initially introduced in the 2006 United Nations Principles for Responsible Investments (PRI) report, which emphasized integrating ESG criteria into financial assessments [2]. Additionally, ESG ratings have become critical indicators of a company’s sustainability, reflecting its commitment to environmental, social, and governance issues [1]. Despite the growing traction of ESG reporting,

the sustainability academic community remains skeptical about its ability to drive the transformative changes necessary to remain within 1.5 °C levels, casting doubt on whether these disclosures inadvertently divert attention from core sustainability imperatives [3–5].

The speech delivered by the chair of the International Accounting Standards Board (IASB) on 2 April 2019 includes a cautionary note:

“We should not exaggerate expectations of sustainability reporting as agents for change. Let us not forget that full transparency did little to curb excess in corporate remuneration. Similarly, we should not expect sustainability reporting to be effective in inducing companies to prioritize the planet over profit. Greenwashing was rampant. Therefore, I strongly believe that the most promising strand of sustainability reporting comprises standards that focus on investors and the impact of sustainability issues on the company’s future returns. This is the type of sustainability reporting that will fit well with our Management Commentary Practice Statement, rather than reporting that focuses primarily on a company’s contribution to the public good” [6].

Sustainable investments have gained popularity, with total global assets allocated for sustainable investing strategies growing from USD 13.3 trillion in 2012 to USD 35.3 trillion in 2020 [7,8]. Similarly, in the green bond market, investments have increased from USD 2.6 billion in 2012 to USD 257.7 billion in 2019 [9,10]. In 2021, 84% of asset owners globally implemented considerations for sustainable investment, rising from 53% in 2018 [11]. Asian markets, in particular, are keen on advancing sustainability agendas [12]. These trends have led to the establishment of ESG reporting as a new market standard. Can the rising trends in sustainable investments and ESG reporting ensure a just transition towards a more sustainable, resilient, and inclusive economy? How should the existing ESG information disclosure space evolve to align with the broader agenda of sustainable development? There is a growing concern that ESG is increasingly being used as a greenwashing tool, with companies utilizing ESG initiatives primarily for superficial reputational benefits rather than genuinely addressing environmental, social, and governance challenges. This misuse of ESG not only undermines the credibility and effectiveness of the framework but also hampers progress towards meaningful sustainability outcomes within the constraints imposed by planetary boundaries.

Environmental crises, such as global warming, greenhouse gas emissions, and the overexploitation of natural resources, are increasingly being attributed to various global industries [13]. These industrial activities not only pose a significant risk to the natural environments, biodiversity, and health of living organisms but also threaten their long-term survival. Given these challenges, key ESG performance indicators (KPIs) have emerged as measures for assessing and communicating the sustainability practices of industries [14]. They provide a comprehensive view of a company’s non-financial performance, covering aspects such as environmental impacts, social relations, and corporate governance [14]. The main goal is to guide investors toward more sustainable and socially responsible investment choices. Although companies often showcase their ESG KPIs to demonstrate readiness for climate change risks, it is essential for them to acknowledge that these risks extend beyond their immediate operations. The emphasis should shift from a narrow focus on self-preservation to a broader commitment to the planet’s sustainability aligned with the 17 UN Sustainable Development Goals (SDGs).

ESG or sustainability reporting on KPIs by corporate entities serves a dual purpose: ‘transparency’, critical for investors, and ‘performance improvement’, critical for entities [15]. ESG Risk Ratings (or ESG scores), calculated based on reported KPIs, measure a company’s exposure to industry-specific material climate risks and its efforts to address these risks. Independent organizations, such as Bloomberg, Refinitiv, and Morgan Stanley Capital International issue ESG ratings based on surveys or questionnaires, in addition to the KPIs released by each company. The individual E, S, and G pillar scores and overall ESG score indicate that a company is engaging in sustainable operations and overall functioning [14]. ESG is often touted as a framework for socially responsible investing

that promotes sustainability and encourages corporations and organizations to adopt sustainable practices. However, if the underlying KPI data informing these ESG ratings are questionable, the ratings themselves risk becoming meaningless and can potentially misguide sustainable investment efforts.

Investors use ESG reporting to make effective capital allocation decisions, while firms use it to gain information about effective sustainability risks, opportunities, and management control [15,16]. These goals manifest in a positive feedback loop (Figure 1) and are expected to lead to a sustainable form of capitalism over time [17]. This implies that the flow of money from investors can allow entities to innovate for growth and productivity (with risks and opportunities managed) without negatively affecting people and the planet. With various investment-screening mechanisms enacted on a large scale, only entities that are closely aligned with the sustainable development agenda will be allowed to grow. When implemented transparently, this scenario encourages stakeholders, including consumers and governments, to influence entities' actions. Thus, the desired positive outcomes can be achieved by controlling for corporate impact. This is referred to as the "ESG dream". Unfortunately, such outcomes have not been realized, and the impact of ESG measurement and reporting has been oversold [17].

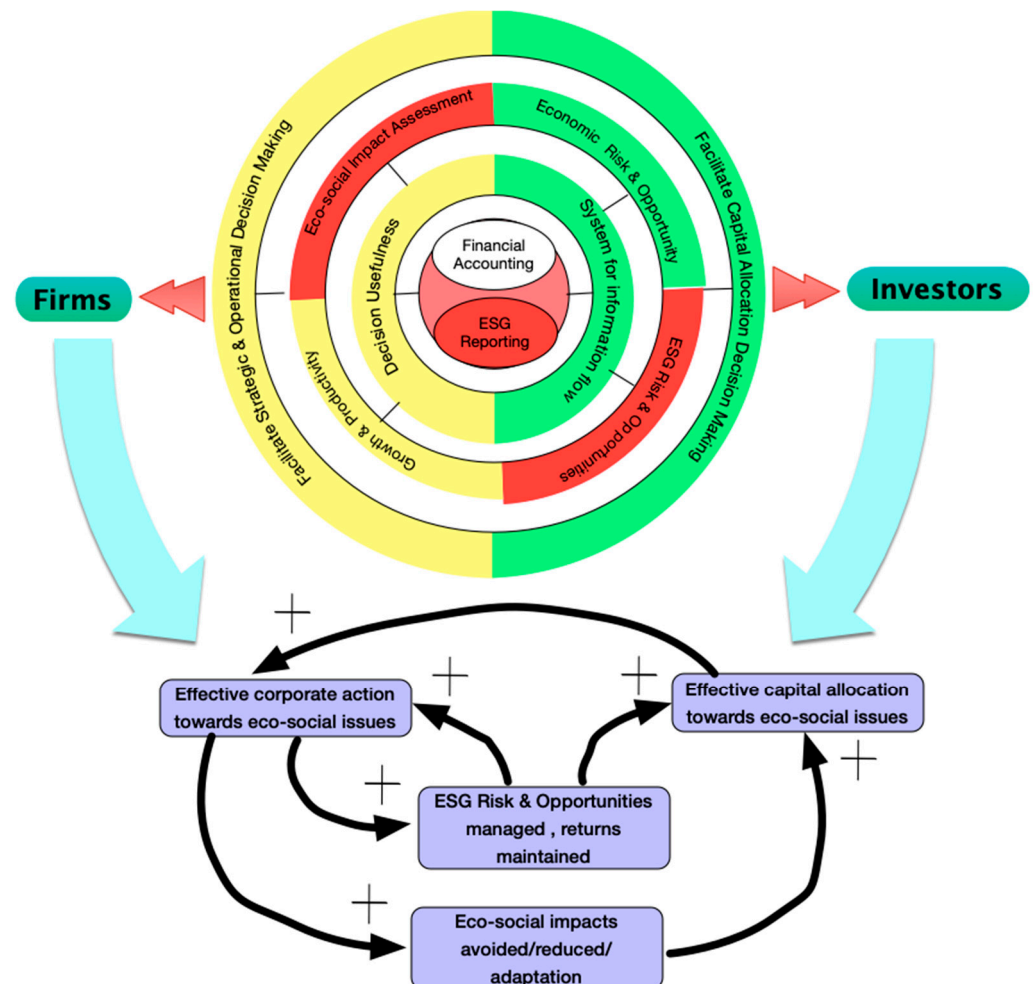


Figure 1. ESG Dream: Financial accounting and ESG-reporting paradigm currently in action. The implementation of this ESG Dream is a weakly reinforced feedback loop due to certain challenges that primarily enable the sustainability of corporates rather than the achievement of just, equitable, and sustainable societies. A (+) sign means a change in the influencing variable will produce a change of the same direction in the target variable.

Researchers have broadly agreed on the ineffectiveness of ESG reporting in contributing to society's sustainability goals and addressing environmental challenges [16,18–23]. Concerns about this inefficacy are heightened by empirical studies revealing greenwashing and a focus on reputation in non-financial disclosures [24–31]. Stakeholder activism is driving companies to adopt “green” initiatives and embrace ESG practices, enhancing both ESG and financial performance [32]. This reflects a broader societal trend where industries are witnessing a growing awareness of greener practices and ESG principles as consumers actively seek environmentally friendly products that align with their values and positively impact a company's financial performance [33]. However, the future form of ESG reporting's contribution to sustainable development remains unclear, necessitating a global framework to prevent fragmentation, improve comparability, and simplify complexities in ESG disclosure [34].

Evaluating the role of corporate disclosures in fostering societal sustainable development is imperative for several reasons. Firstly, a narrow focus on corporate sustainability perpetuates global concerns that demand collective action beyond conventional business practices, leaving critical issues unresolved [35]. Secondly, given the pressing need for swift transitions towards sustainability in a world facing socioeconomic challenges and uncertainties precipitated by climate change, corporations are expected to contribute positively to people, the planet, and profitability [36]. Third, corporate entities play a significant role in shaping the planet's future. As Levin points out, while governments are traditionally expected to address matters pertaining to the common good, their ability to tackle such challenges independently is becoming increasingly limited, particularly as public resources dwindle in developed nations [37,38]. Furthermore, there is a conspicuous concentration of wealth among only a few corporations [39,40]. Consequently, ensuring corporate accountability towards the well-being of both people and the planet before prioritizing profits becomes imperative. Fourth, ESG reporting, while ostensibly promising, carries an inherent risk of creating an illusion [41]. It has the potential to divert public attention towards the semblance of an effective solution, which in reality may serve as a distraction [42]. These considerations have motivated our pursuit of understanding and assessing the genuine significance of ESG reporting in the context of sustainable development for all rather than merely accepting its instrumental role in perpetuating the status quo of “business as usual”.

Academically, the role of non-financial disclosures for sustainable development has been extensively discussed for over five decades under the umbrella of Social and Environmental Accounting (SEA) scholarship [43]. Research within SEA primarily focuses on promoting sustainable practices, enhancing corporate accountability, and advancing social justice [43]. SEA encompasses procedures for gathering and organizing data to inform both internal and external stakeholders about an organization's impact on communities and the environment. It is referred to by various terms, such as green accounting, resource accounting, economic accounting, or integrated accounting, emphasizing responsible management and the sustainable utilization of natural resources [44,45]. This field covers diverse research areas, including management accounting for social and environmental concerns, sustainable development accounting, accounting for social accountability, human rights, biodiversity, and examining the relationships between Corporate Social Performance (CSP), Corporate Social Disclosure (CSD), and Corporate Financial Performance (CFP) [46].

In the early nineties, SEA scholarship actively engaged in interdisciplinary efforts to address social and ecological concerns. However, this momentum waned by the early twenties, with sustainability reporting dominating research more focused on the impact of sustainability on corporations than evaluating the impact of corporate entities on sustainable development [21]. The recent literature has scarcely explored the role of ESG in sustainable development, with notable exceptions including Abela (2022) [47] and Busch et al. (2016) [48]. A positive development is the introduction of the Double Materiality principle for corporate disclosures, requiring companies to disclose not only how sustainability matters affect their own performance but also how the companies themselves impact sustainability matters [49]. Moving in a similar direction, this paper envisions the

future of ESG reporting research for innovation and operationalization in this socially, environmentally, and economically intertwined space.

This paper presents an alternate narrative to contemporary ESG reporting, envisioning ESG evolution beyond the entity level and its contribution towards broader goals, as reflected in the UN SDGs and Planetary Boundaries (PBs). To operationalize this possibility, we argue for interdisciplinary frameworks at the intersection of ecology, engineering, and social sciences under the purview of SEA scholarship.

2. Positioning ESG Reporting for Sustainable Development

Over the last two decades, there has been a notable increase in both sustainability reporting and sustainable investing [50–52]. However, the alarming trend of rising carbon emissions and environmental degradation has accelerated in recent years [17]. Social inequality has reached unprecedented levels. In the 1980s, the wealthiest 1% of the world's population had 28% of the total wealth, but by 2017, they had 33%, while the bottom 75% had stagnated at approximately 10% [53]. Planetary risks are higher and more volatile than before. The PBs define the social and human aspects that are safe within certain environmental limits. Humanity has already transgressed a safe operating space for four out of nine planetary boundaries [54]. Species are becoming extinct at unprecedentedly accelerated rates [55], and the planet's average surface temperature is expected to rise by 1.5 °C by 2041, accompanied by increasing episodes of extreme weather conditions (i.e., heat waves, floods, cyclones, and rising sea levels) globally [56]. These challenges, reflected in the United Nations Sustainable Development Goals, Human Development Index reports, the World Wildlife Fund's Living Planet Index reports, and Planetary Boundaries, require outcomes at local, regional, national, and global scales. Julian Agyeman's framework on just sustainabilities encapsulates the societal vision towards which we call for the repositioning of ESG reporting. Agyeman clarified the idea of sustainable societies, describing it as an approach in which extensive questions regarding social needs, welfare, and economic opportunity are integrally related to the environmental limits imposed by supporting ecosystems [57].

These escalating challenges related to environmental degradation, social inequality, and planetary risks underscore the urgency of repositioning ESG reporting within the broader context of achieving sustainable societies, as envisioned by Agyeman's framework of "just sustainabilities". This entails a holistic approach that integrates social, economic, and environmental dimensions to address pressing issues. ESG reporting is no longer just a corporate obligation; it is a powerful mechanism driving sustainable development. Companies positioning ESG reporting at the core of their operations and strategies can significantly contribute to addressing the world's most pressing challenges while ensuring their long-term viability. By setting clear objectives, emphasizing transparency and accountability, integrating sustainability into business strategies, measuring impacts, engaging with stakeholders, and fostering innovation, businesses can harness the true potential of ESG reporting to create a more sustainable and equitable future for all. In doing so, they will become not only contributors to sustainable development but also leaders in the global movement towards a better world.

3. Identifying the Challenges in Reporting and Pathways for Future

The initial step in recognizing the transformative impact of ESG reporting within a broader SD agenda involves understanding the current challenges associated with reporting. This section, therefore, delves into the challenges of ESG reporting from both investor and entity perspectives.

3.1. Challenges of ESG Reporting

Firms report and establish disclosures to maintain their social licenses while striving to maximize shareholder value. However, at the entity level, they encounter four categories of challenges in ESG reporting: Behavioral, Data Credibility, Methodological, and Contextual

challenges. Table 1 provides a detailed list of the challenges in each category along with relevant literature references.

Table 1. Challenges in ESG reporting.

Challenge Category	Description	Literature References
Behavioral challenges	Short-term focus due to economic pressure	[58]
	Reputational-risk-influenced decisions	[27,28,31,59,60]
	Powerful-stakeholder-influenced decisions	[26,61,62]
Data-based challenges	Fear of revealing excessive information	[63]
	Data acquisition, treatment, and validation cost	[64,65]
	Data normalization challenges	[66,67]
	Inconsistent reporting by firms	[1,67]
Methodological challenges	Lack of historical data availability, missing data	[66,67]
	Reporting challenges for multiple businesses (i.e., conglomerates)	[68]
	Neglected considerations for impact interconnectedness	[69,70]
	Unclear boundaries for the reporting entity (issue of scope-3)	[71,72]
	Lack of appropriate quantitative measures (especially for social issues)	[73]
	Challenges in entity-level science-based target derivation	[74]
	Lack of metrics for positive impact creation	[75,76]
Contextual challenges	Lack of rebound considerations (i.e., the effect of derived changes in consumption and production on sustainability improvements)	[77–79]
	Lack of time and spatial variance consideration	[70,80]
	Varying consumer attitudes towards the environment and social issues	[81,82]
	Varying materiality of topics	[83–85]
	Complex and expanding regulatory landscape (i.e., multiple standards)	[86]
	Uncertain, dynamic environment with social and ecological risks	[37,87]
	Lack of clear consensus on sustainability definition	[88]
	Interdisciplinary and transdisciplinary knowledge requirements	[65,89]

Behavioral resistance accentuates challenges in governance, including pressures faced by entity management, hindering their ability to impartially assume responsibility for environmental and social issues. Data credibility challenges include operational issues for entities such as concerns about the cost of in-depth data collection, a lack of data sharing across the value chain, and unclear standards for data handling. These methodological challenges highlight the technical limitations of different impact valuation accounting methodologies for various environmental and social issues. In a recent study conducted by the Organisation for Economic Co-operation and Development (OECD) based on different rating providers, a comparison of individual E-pillar scores with the overall ESG score was observed to have both high and low correlations. The main reason for this result is that rating providers adopt different methodologies to evaluate each ESG parameter [90]. Providers also prioritize different ESG factors, with some focusing more on environmental issues and others focusing on financial materiality or social governance measures. ESG disclosures lack persistent datasets, leading to potentially controversial results [91].

Contextual challenges arise mainly from the complex adaptive nature of socio-ecological-economic systems, characterized by heterogeneity, interconnectedness, and emerging global

patterns. These systems present dynamic problem spaces with incomplete knowledge at the entity level, resulting in ambiguity, uncertainty, and ignorance [92].

3.2. Seeking Future Pathways for ESG Reporting

While increased data availability, standardization, and technological progress may address some data-related and methodological challenges in the future [93], behavioral and contextual challenges remain significant barriers to targeted reporting for SD. Entities face behavioral issues related to the concept of “maintaining a social license to operate,” where the intention is to operate sustainably while fulfilling the fiduciary duty of maximizing shareholders’ wealth. The trap in this framing is that the “maintenance of a social license” becomes instrumental in supporting the intention “to operate,” rather than becoming an aim itself. Therefore, people and the planet prioritize profit. Given the current global challenges, we assert that the vision of a socially just and sustainable society demands a new framework for social contracts. Levin et al. (2020) [37] and Ricart and Rey (2022) [35] revealed a direction towards the notion of purpose-driven corporations beyond business as usual. However, the sort of social contract framing that can come out of this to drive change at a mass scale remains an open question.

In addition to a sense of purpose, entities are motivated to move beyond “business as usual” by contextual challenges that necessitate organized efforts at a systemic level. Levin et al. (2020) [37] highlighted the need for collective action and coordination among various stakeholders, including individuals, businesses, financial institutions, NGOs, and governments. The challenges of limited resilience and high uncertainty due to socio-economic threats persist, even if entities focus on building resilience through adaptation. Williams et al. (2021) [94] proposed that when resilience is narrowly interpreted as an organizational variable, important cues from other spatial scales are overlooked, leading to a decline in cross-scale resilience. Scholarship in industrial ecology addresses the same challenge for entities by accounting for complexities across resource, production, and consumption systems, thereby revealing sustainability problems at spatial and temporal scales. Subsequently, engineering scholarship can produce solutions and systems for these problems via innovation and technological applications. Finally, the social science field provides a framework within which these problems and solutions can be evaluated and implemented to target societal and sustainable ends.

4. Seeking Innovation: ESG Reporting for Sustainable Development

ESG reporting is compelled by various factors, including the mandatory non-financial disclosure and reporting stipulated by regulations and directives. For instance, companies with over 500 employees are obligated to disclose non-financial risks and opportunities based on their business models [95]. In addition, we believe that the evolution of ESG disclosure systems should occur at the intersection of ecology, engineering, and social sciences. This raises the crucial question of establishing an interdisciplinary framework to facilitate the progression of concepts like ESG disclosure, aiding entities in addressing the complex challenges of (un-) sustainability known as “Wicked Problems” with “Wicked Solutions”. We argue that the innovation of such an interdisciplinary framework can find its foundation in the field of SEA scholarship.

Positioning of SEA Scholarship for Sustainable Development

SEA, an active research area, primarily focuses on the social and environmental impacts of organizations and accounting [21,88,96]. Despite this, SEA scholarship has the potential to catalyze social change, extending its influence beyond the entity level [97,98]. The recent literature also reflects a shift in accounting scholarship from an “entity-centered” to a “problem-centered” focus [21,43,99–101]. This shift prompted us to investigate whether SEA can offer a framework for constructing integrated accounting systems for SD. We posit four reasons supporting the design, construction, and implementation of such systems

through collaborative research between the science and engineering communities within SEA scholarship, aiming to regulate capitalist behaviors within eco-social constraints.

Firstly, SEA scholarship is increasingly recognizing the complexities associated with SD [21,43,65,96,101–105]. This recognition of complexity and the acceptance of incomplete knowledge have led to calls for interdisciplinary [21] and transdisciplinary research [65] in accounting. There has also been a transition from accounting-based to accountability-based systems, ensuring contextual justice for vulnerable and neglected societal groups [18,43,106]. These trends bolster our hypothesis that SEA scholarship is poised to facilitate science-based constraints in collaboration with other disciplines within complex adaptive social–economic–ecological systems.

Secondly, SEA scholarship involves practices, procedures, institutional arrangements, and bodies of knowledge [103,107]. While there is interdisciplinary work in organization management and environmental engineering [108], efforts have not reached a critical mass with which to observe measurable changes towards SD. SEA scholars' engagement with other fields, such as governmentality [109,110], sustainability science [21], complex systems thinking, and political economy [111], is evident. However, greater convergence between these disciplines is necessary to achieve meaningful progress toward SD goals. Recent arguments by Feger et al. (2019) [100] advocate for accounting research to adopt scientific models and methods from biodiversity conservation sciences, illustrating the type of engagement we are calling for. SEA scholarship can provide the framework with which other disciplines can provide information on what to account for, how to account for it, how to govern, and, ultimately, how accountability is discharged towards human and non-human species.

Thirdly, significant advancements in industrial ecology and systems engineering have been made regarding what to account for and how to account for it. Finkbeiner et al. (2014) [112] indicated that Life Cycle Assessment (LCA) approached mainstream concerns. Various standards, methodologies, types of LCAs, case studies, databases, and software products have been developed to perform these assessments [112]. On the application front, single-dimensional LCAs by the name of footprints, such as carbon footprints, are already used extensively at the organizational level. Footprint methodologies, including carbon, water, nitrogen, ecological, economic, ethical, and social methods, have been created [113]. Integrating these advancements with participative decision-making frameworks from sustainability science [21] can lead to the development of impact assessment and valuation protocols [114], which can then be embedded in traditional financial accounting systems. However, the question of how to conduct this integration of eco-social impact valuations with financial accounting statements remains open for future research.

Lastly, the role of technology, particularly the exponential rise of digitalization and advancements in technologies such as the Internet of Things (IoT), Big Data, Blockchain, and Artificial Intelligence, can accelerate the innovation cycle for entities. Imagining accounting systems augmented with inventories of satellite images, photographic evidence, historical maps and accounts, industrial-geographic impact information, local community feedback, and media information illustrates the corresponding potential. These systems can support entities of any type (public or private) and size (SME, MNC, NGO, and Non-profit) in undertaking sustainability innovation and competing effectively. Questions regarding automated impact assessment techniques and tool development have been raised [115]. While technology plays a critical role in security and integrity, issues such as data leaks, reliability, and high energy consumption require further research. Decentralized database technologies like distributed ledger technology (DLT), commonly known as blockchain, can address these concerns, ensuring security through authorization-control-based features while providing transparency via audit trails. For a primer in this direction, refer to the work of Saberi et al. (2019) [116], who make an excellent case for how distributed ledger technology can be used to maintain sustainability dimensions in a supply chain network.

The convergence of these factors provides a unique opportunity for scholars from different disciplines to collaborate, build, and operationalize accounting systems addressing

the urgent issues of global sustainability and contemporary gaps in ESG reporting systems. Accounting systems targeting SD can offer alternatives to the prevailing ineffective ESG disclosure narrative.

5. Limitations, Future Outlook, and Conclusions

Throughout this article, we have explored the motivations for change in the realm of ESG reporting, recognizing the imperative of transitioning towards SD. However, our viewpoint is somewhat constrained, as we have yet to address the necessary conditions for entities to embrace a purpose-driven, cooperative role in this transformation. Efforts in this direction will lead to the derivation of rules surrounding the externality-based social and environmental accounts of entities, bringing justice to the forefront of the required changes for SD. Only after such efforts are made can eco-social-economically integrated accounting and reporting systems for SD be conceived of to allow for an equitable distribution of growth within planetary limits. This proposed “to be” state of the ESG dream must be explored urgently by researchers. The key themes for future research, considered in conjunction with designing ESG reporting and accounting systems for SD, include the following:

- The integration of social and environmental impacts with financial accounting;
- Indirect impacts on a company’s value chain, including social and environmental implications, such as Scope 3 GHG emissions;
- Assessing and enhancing supply chain resilience to withstand and adapt to shocks due to transition risks, such as carbon taxes, and physical risks, such as extreme weather events;
- Governance frameworks for operating integrated accounting systems for SD;
- The role of technology in the future of reporting systems;
- The spatial contextualization of data and methodological needs for the impact valuation of social and environmental topics;
- The future roles and transitional needs of auditors and accountants;
- Educational reform with regard to preparing future accountants and auditors with sustainability knowledge for ESG-focused reporting systems.

In addition to the challenges of viewing the world through an accounting and reporting lens, there is a shortage of talent with interdisciplinary skill sets in ecological sciences, engineering, project management, and social sciences research. This talent shortage serves as a significant obstacle to achieving sustainable development. To address this market need, it is necessary to redesign finance and engineering curricula to incorporate interdisciplinary training. If the goal is sustainable development, the social contract’s inadequacies must be amended, and entities must take a purpose-driven transformative role. The current market-driven ESG reporting regime needs to align with the vision of “just sustainabilities” and move beyond its limited focus on a company’s own sustainability and risk-centered growth.

To accomplish this, we propose an adjustment of traditional accounting systems to reflect the futuristic and evolved state of ESG disclosure systems. This operationalization requires the convergence of ecological sciences, engineering, and social sciences research. It is imperative to establish frameworks that facilitate such research and to train a workforce equipped with interdisciplinary skill sets to meet the market’s demand for such talent. These endeavors are expected to enhance the credibility and effectiveness of reporting and accounting systems, shaping the trajectory of sustainable finance and advancing global sustainability objectives. Transitioning towards the ESG “to-be” state holds the promise of fostering just, equitable, and sustainable societies across local, regional, national, and global scales—an urgent and collective endeavor for our shared future.

The development and verification of solutions to wicked problems like the one we are currently facing requires a systematic and iterative approach. By applying principles of industrial ecology, we can model and test ESG disclosure systems in a systematic manner through case studies, taking into account the complex relationships between materials, energy, and specific firms and making sure that there are no unintended consequences. Moreover, since there is always room for improvement when it comes to addressing wicked

problems, we must continually review and refine ESG disclosure systems, taking into account new information, emerging trends, and changing contexts, to ensure that they are effective and sustainable over time.

In conclusion, ESG reporting is motivated by a multifaceted landscape of various factors. Foremost among these is the growing demand from stakeholders, including investors, customers, and employees, for transparency regarding a company's environmental and social impacts. Stakeholders seek to align themselves with businesses that demonstrate responsible practices. Moreover, ESG reporting serves as a risk-management tool. Companies recognize that neglecting environmental and social concerns can lead to financial and reputational risks, including legal liabilities and regulatory fines. Conversely, proactive ESG efforts can yield a competitive advantage by fostering innovation, cost savings, and efficiency improvements. Regulatory compliance is compelling, with many regions mandating ESG reporting. A long-term perspective on value creation encourages ESG reporting, as it fosters sustainability and resilience. Ethical and moral obligations further motivate organizations to minimize their negative impacts and uphold strong governance standards. Alignment with global goals, such as the UN SDGs, indicates a commitment to addressing critical global challenges. ESG reporting also enhances reputation and brand value, leading to increased customer loyalty. In essence, ESG reporting has become a vital tool with which businesses can exhibit their dedication to sustainability, responsible governance, and long-term value generation in a changing world.

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