

How will AI text generation and processing impact sustainability reporting? Critical analysis, a conceptual framework, and avenues for future research

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Purpose: The ability of generative AI tools such as ChatGPT to produce convincing, human-like text has major implications for the future of corporate reporting, including sustainability reporting. As the importance of sustainability reporting continues to grow, we critically analyse the benefits and pitfalls of automated text generation and processing.

Design/approach/methodology: We develop a conceptual framework to delineate the field, assess the implications, and form the basis for the generation of research questions. We use Alvesson and Deetz's critical framework, considering insight (a review of literature and practice in the field), critique (consideration of the influences on the production and use of non-financial information, and the implications for assurers of such information) and transformative redefinition (considering the implications of generative AI for sustainability reporting and proposing a research agenda).

Findings: We highlight the implications of generative AI for sustainability accounting, reporting, assurance, and report usage, including the risk of AI facilitating greenwashing, and the importance of more research on the use of AI for these matters.

Originality: We critically analyse the potential use of AI for sustainability reporting, construct a conceptual framework to delineate the field, and develop a research agenda.

Keywords: *Sustainability reporting, Artificial intelligence (AI)*

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1. INTRODUCTION

The huge media interest in ChatGPT, an AI ‘assistant’ which produces human-like text via a simple user-friendly chat interface, has highlighted the capabilities of AI to a larger audience. While some critics have dismissed ChatGPT as error-prone and lacking in creativity, AI technology continues to advance at pace and its performance is only likely to improve over time¹. Such AI is already being used to present management information, write sections of corporate reports, provide assurance on corporate reports and analyse large volumes of text-based data for insights to inform investment strategies (FRC, 2019). This poses interesting questions for the future of sustainability reporting. Whereas traditional annual reports are subject to reporting standards and need to balance financial information with narrative disclosures, sustainability reporting contains more text and allows for considerably more management discretion (Adams & Abhayawansa, 2022). Much of the information provided is narrative and qualitative, and is provided by organisations voluntarily, in some cases aligning with global voluntary reporting initiatives such as reporting on the UN SDGs (Adams et al., 2020).

Sustainability reporting has grown significantly as companies seek (and are potentially pressured) to provide information to a variety of stakeholders about the non-financial drivers and impacts of their performance. Text generation and analysis is therefore of particular interest for sustainability reporting, where accusations and occurrences of greenwashing are growing (Lyon & Montgomery, 2015) and evidence has shown that managers select to disclose social and environmental factors that are likely to positively impact their share price (De Villiers & van Staden, 2011). Greenwashing threatens the accuracy and reliability of sustainability

¹ ChatGPT version 3.5 was trained on 175 billion parameters, whereas ChatGPT 4 is based on a rumoured trillion parameters, and is multi-modal rather than uni-modal (Heaven, 2023)

reporting by creating a difference between a company's disclosure to stakeholders and their actions, undermining corporate accountability (Moodaley & Telukdarie, 2023).

AI assistants such as ChatGPT are trained on data from multiple sources. Considering the prevalence of greenwashing, this training data set presumably includes 'greenwashed' sustainability information alongside more factually accurate accounts of performance. ChatGPT may therefore replicate 'greenwashed' content and style if tasked to write sections of sustainability reports (a point which we demonstrate later in our paper). However, AI could be harnessed beneficially to check narrative information against other sources, offering potential checks and balances against practices such as greenwashing. As sustainability reporting aims to improve trust and transparency between managers and stakeholders, it is important to consider and reflect on the current and potential use of AI throughout the sustainability reporting process and the impacts that this might have in future. Therefore, the research question we address in this paper is: How will AI text generation and processing impact sustainability reporting?

We structure our conceptual paper according to the Alvesson and Deetz (2000) critical analysis framework. This framework is widely used in management research and has been used in similar critical accounting studies (De Villiers & Sharma, 2020). For instance, it helps to understand and critically analyse cases with power imbalances and has been used in accounting research for this purpose (De Villiers and Dimes, 2022). Critical management research used this framework to argue that many researchers are stuck in an evaluator trap (Dumay and Garanina, 2013). The framework proposes three stages of critical analysis: insight, critique, and transformative redefinition. The first stage of the framework, 'insight', requires a detailed investigation of the phenomena of interest. We review the current literature on AI and non-financial reporting, proposing a simple conceptual framework of management, reporting, assurance and use of non-financial information to situate our subsequent discussion and

suggestion of future research avenues. The second stage of the framework, ‘critique’, considers the conditions (such as power, social and cultural influences and ideologies) that affect how actors understand and order the world (Alvesson & Deetz, 2000, p104). In our paper we use AI and human-generated text samples to inform our discussions on the influences of AI on producers, assurers and users of sustainability information and what future challenges may arise in the field. The third stage of the framework, ‘transformative redefinition’, recognises the importance of a ‘call to action’. Without such a call to action, ‘insight’ and ‘critique’ remain academic constructs (Alvesson & Deetz, 2000). We provide insights into the current use of non-financial reporting and AI in Section 2, illustrating our key points with AI and human-generated text samples of the CEO report sections of sustainability reports. Informed by the sustainability accounting literature, we develop a framework that considers four of the key aspects embedded in NFR: management information, external reporting, report assurance and report use (Busco et al., 2017; Carungu et al., 2021; Farooq & De Villiers, 2017). In Section 3, for each aspect of our framework, we consider the existing and potential contribution of AI (both positive and negative) in terms of sustainability reporting and narrative information. We critique the potential uses for AI in these four stages, considering likely future developments and their implications. We conclude in Section 4 by using the ‘transformative redefinition’ concept to propose how researchers could address emerging issues in this critical stream of literature on accounting innovations (Arnaboldi et al., 2017; Gray et al., 2014; Lee and Tajudeen, 2020; Lombardi and Secundo, 2021; Sutton et al., 2016).

2. INSIGHT

2.1 Developments in sustainability reporting

Reporting on sustainability has become mainstream, with an estimated 80% of companies worldwide providing sustainability-related information (KPMG, 2020). Sustainability

investing grew tenfold in the US between 2018 and 2020 alone (S&P, 2021), and high-profile fund managers and investment banks have declared their commitment to investing in companies with sufficient sustainability disclosures (Dunn, 2021). Investors are becoming more interested in non-financial information, particularly as the disclosure of such information has been associated with higher firm values (Cahan et al., 2016) and a reduced cost of capital (Dhaliwal et al., 2011).

To date, organisations have provided sustainability voluntarily, but there is increasing interest in the mandating of such information. Mandatory reporting would be likely to introduce more standardised reporting formats and therefore improve comparability, although discretion would still be likely in terms of narrative commentary made by management. Both the existence and the threat of future mandates can also lead to changes in the type of sustainability information that managers voluntarily provide (De Villiers & van Staden, 2011). Many other factors are also at play. For example, larger organisations provide more CSR information (Chan et al., 2014) and smaller ones provide less (Satta et al., 2014), possibly seeing less need to differentiate themselves from competitors (Eccles & Krzus, 2010).

Environmental activists and others have recently raised concerns about corporate deception, sometimes entrenched in rhetoric within narrative statements. With a mix of circumstantial evidence, these accusations of deception reveal concerted lobbying, political and corporate cronyism, and large corporations' instrumental use of media (Vogel, 1989). The rise of terms such as “greenwash” and “bluewash” (originally referring to untrue claims concerning the United Nations compact, and now referring to social and community matters more broadly) mirror an increasing apprehension that some organisations ingeniously manage their reputations with the public, financial community, and regulators, and wide range of stakeholders by deflecting attributions of fault, disguising the nature of problems or allegations,

reattributing blame, and seeking to appear in a leadership position from a sustainability perspective (Abhayawansa & Adams, 2022; Laufer, 2003).

This practice of making false or misleading claims about the sustainable benefits of a product, service, or entire organisation can be particularly harmful when corporate sustainability reports are used as a means to misinform stakeholders into thinking they are making a positive impact on the environment and society. Conversely, it can also generate detrimental effects for organisations that are making genuine efforts to reduce their sustainable footprint and attempting to communicate these efforts through their reporting.

2.2 Developments in AI – text generation and analysis

AI can be used to generate text in a variety of applications and can be trained to generate original narratives. AI can be also used to generate news articles based on a given set of facts or data. Moreover, AI-powered chatbots use text generation to respond to user queries in a conversational manner and can consequently create beneficial implications in terms of sustainability engagement and interaction among different stakeholders within and among organisations. AI can be used to translate text from one language to another. However, the quality of the generated text depends on the training data quality and the AI model's complexity. The quality of generated text also depends on the nature of the prompts given. In terms of narrative sections, the more diverse and high-quality the training data, the more sophisticated the model and the more knowledgeable the human actor, the better AI can generate text that is coherent, grammatically correct, and semantically meaningful. Another feature of AI is adaptation, where machines learn through movement, taking cues from sensation, and developing situational awareness (Kar et al., 2022).

Not only can AI generate text, it can also analyse it. Although processing narrative data to gain insights can be challenging due to the proliferation of reporting formats and the increasing amount of text, it is increasingly important, as quantitative data is insufficient for stakeholders to make decisions (Lewis & Young, 2019). Natural language processing (NLP) techniques (a subset of machine learning) are increasingly used by researchers to gain insights from disclosures made by managers on many topics, including sustainability (El-Haj et al., 2020; Li, 2010).

The use of AI is growing rapidly in accounting practice as advanced by academic research. Gray et al. (2014) investigated the productivity of AI research in accounting and argued that both research and practice use of AI had waned since the late 1990s. Following this research stream, Sutton et al., (2016) reconsider a broader view of AI centric versus expert systems centric. They show how AI research in accounting has continued to steadily increase over the past 30 years. Accounting research has explored the use, implications and impact of AI within different contexts and perspectives. For instance, Lee and Tajudeen (2020) explored the use and impact of AI-based accounting software among organisations in Malaysia. They highlight how the use of AI-based accounting software has accelerated productivity, improved efficiency, enhanced customer service, supported flexible working styles, and increased process governance. Damerji and Salimi (2022) conducted a study involving an examination of individual students' perceptions of technology readiness and technology adoption.

Lombardi and Secundo (2021) highlight how digital technologies and corporate reporting (both financial and non-financial) have largely been researched separately and call for more research on their intersection. While their review predates the widespread awareness of AI developments heralded by ChatGPT, they highlight the importance of considering digital transformation and automation across the lifecycle of the reporting process, from information production to consumption. This is highly relevant for sustainability reporting. However,

organisations may make business-centred decisions on digitalisation, threatening the process of sustainability reporting (Niehoff, 2022). Moodaley and Telukdarie (2023) also highlight a lack of literature reviews that relate to the intersection of non-financial reporting (sustainability reporting in particular) and AI. However, the authors note that several research papers (Kang et al., 2020; Ning et al., 2021) have used AI technology (in particular NLP) to analyse the large quantities of complex narrative information typically found in sustainability reports (Louche et al., 2021). This has also been extended to include references to the UN SDGs (Amel-Zadeh et al., 2021).

2.3 AI vs human-generated text

To reflect on the current sophistication of AI-generated text, we input the following command into ChatGPT:

“Create a 500-word CEO report to shareholders for the sustainability report of a fictional energy company Energize Co. The report should contain qualitative and quantitative data. Please also include reference to specific sustainability KPIs and recognised initiatives eg GRI.”

We chose a short CEO report as our illustration for two key reasons. Firstly, CEO reports summarise the content of sustainability reports and reflect the attitude and ethos of management in a relatively short piece of text. For this reason, we considered the CEO report as one of the narrative sections most likely to be a candidate for greenwashing by management. Secondly, at the time of writing, ChatGPT only currently produces text rather than detailed charts and diagrams that usually form a major part of sustainability reports (Mäkelä & Laine, 2011). We therefore wanted to focus on a text-heavy section of a sustainability report rather than consider the multiple data points and references necessary for a comprehensive report. The output is shown in Appendix 1. Several aspects of this report are notable. Firstly, the report is predominantly positive, with few mentions of any negative aspects of performance. Other than

bland statements such as ‘we are committed to continued improvement’ there is little to suggest that there are any negatives in the sustainability performance of this organisation. This is possibly because the reports it is trained on contain predominantly positive messages from internet examples (although OpenAI has not revealed the source training data for ChatGPT). Secondly, while the ChatGPT text sounds convincing, some statements, for example: ‘We have also been recognized as a GRI-checked organisation’ are inaccurate. The Global Reporting Initiative (GRI) is a set of globally recognised sustainability standards (globalreporting.org, 2023), but there is no such thing as a ‘GRI-checked organisation’, or any organisation that would provide such assurance.

In Appendix 2, we show for comparison BP’s 2021 CEO report at the beginning of their sustainability report (BP, 2021), containing both positive and negative information about performance and more company-specific details. It is clear to see that further refinement of the ChatGPT commands (for example providing ChatGPT with company-specific data) and human editing could serve to reduce the difference between Appendix 1 and Appendix 2, making the difference between AI and human-generated text indistinguishable². Using a reverse engineering approach, we asked ChatGPT what kind of prompt and writing style would produce the ‘real’ output in Appendix 2. ChatGPT responded that a suitable prompt would be:

“Write a company update letter highlighting the implementation of a new sustainability strategy, recent achievements, and future goals. Address the letter to the company's stakeholders, including employees, shareholders, customers, and partners. Emphasize the

² To see if the difference in language was distinguishable, we input both texts into GPTZero, software that claims to correctly identify AI-generated text (<https://gptzero.me>). This correctly identified Appendix 1 as likely to have AI-generated text and Appendix 2 less likely, citing the difference as associated with sentence complexity (simpler sentences being more likely to be generated by AI). Whereas Appendix 1 (the AI text) scored 69.7 for average perplexity (the measure of the randomness of the text) and 99.2 for burstiness (the measure of the variation in perplexity), the BP report (Appendix 2) scored much higher results: 241.5 for average perplexity and 519.5 for burstiness.

importance of sustainability, resilience, and safety while discussing the company's response to recent events and its commitment to supporting humanitarian efforts. Highlight the progress made in greening the company's operations, increasing capital expenditure in transition growth businesses, and setting new net-zero aims. Discuss specific initiatives related to emissions reduction, methane measurement, and renewable energy. Conclude the letter by expressing gratitude for the support and reiterate the company's dedication to delivering the strategy and achieving sustainability goals.”

When asked to describe the writing tone in the body of text in Appendix 2, ChatGPT responded:

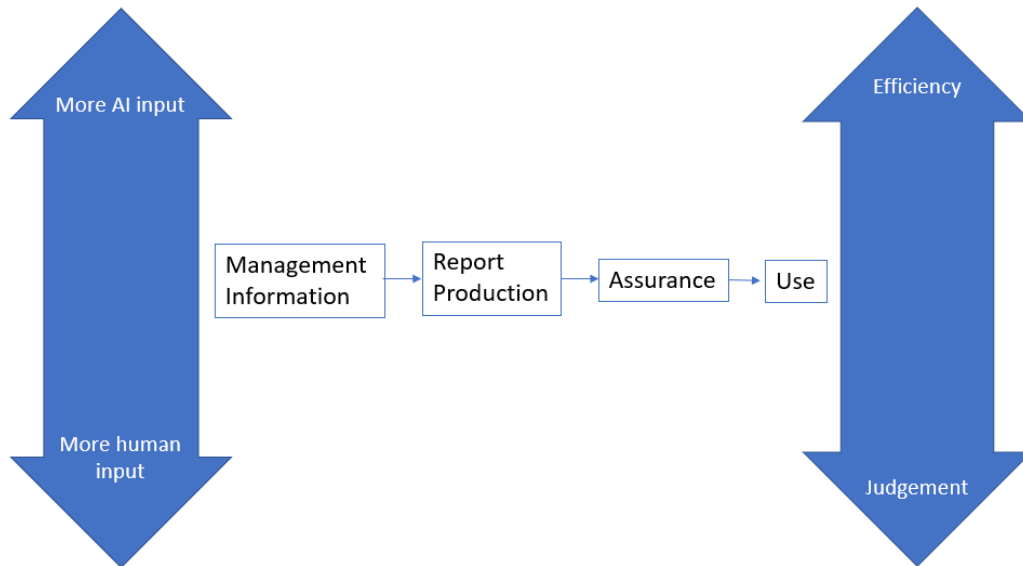
“The writing tone in the body of text can be described as formal, informative, and introspective. The author uses a professional and respectful tone while addressing the readers as valued stakeholders. The language is clear and concise, conveying important information and strategic decisions. There is a sense of reflection and self-assessment as the author acknowledges past incidents and emphasizes the need for improvement in certain areas. The tone also carries a sense of determination and commitment to sustainability, resilience, and safety, with the author expressing confidence in the company's ability to navigate challenges and achieve its goals. Throughout the text, there is a sense of appreciation for the readers' support and a call for their continued backing.”

ChatGPT’s comments on BP’s report reveal not only a sound grasp of language nuance, but also a strong appreciation of the audience for such reports. We include Appendix 1 and 2 and the comments from ChatGPT above as illustrations of how close ChatGPT is to being able to replicate genuine company output with sufficient prompt engineering.

2.4 Conceptual framework

We consider reporting to be a four-stage process encompassing management information systems, external reporting, assurance and subsequent use (by investors and others). We follow other literature reviews in the sustainability field which also consider four stages of corporate reporting – see for example Busco et al. (2017), Carungu et al. (2021) and Farooq and De Villiers (2019). We present our framework in Figure 1. We consider a broad range of corporate information users and consider whether such advances would influence them, rather than focusing only on investors. A 2019 report by the Financial Reporting Council (FRC) considered three aspects of corporate reporting to be affected by AI: production, distribution and consumption (FRC, 2019). Whereas the FRC report focuses on the potential for AI in each of the categories (and provides a roadmap for how to achieve this potential), our paper also considers the risks associated with AI in each category and introduces other potential influences over producers and consumers. The two arrowheads at the left of the framework allow us to consider different scenarios – maximum AI (where management information is produced and converted into an external report using AI, reviewed by an AI-informed board, assured by AI techniques and then analysed by AI analysts who make decisions) and minimum AI (which reimagines a time before AI existed, and all text was written by humans). In reality, current practices sit somewhere between these scenarios (FRC, 2019), but they are useful to reflect on when considering the potential of AI across all stages of the reporting process. The two arrowheads at the right of the framework consider the major benefit of more AI (efficiency) compared to the major benefit of more human involvement (judgement). We consider the balance and trade-offs between these benefits in our subsequent discussion.

Figure 1: *Conceptual Framework for assessing the implications of AI for Sustainability Accounting, Reporting, Assuring, and Usage*



Source: Developed by the authors, and adapted from Busco et al. (2017), Carungu et al. (2021), and Farooq and De Villiers (2019).

3 CRITIQUE

3.1 Management information

Efficiency

Most large organisations have a vast amount of management information to analyse, and AI tools are already being used to automate routine and time-consuming tasks to improve efficiency. The use of AI to automate tasks and analyse large amounts of data is likely to increase, particularly as this will improve organisational efficiency and optimise decision-making by reducing human error. AI can analyse and interpret information faster than humans, and minimise the risk of bias, provided there are human overrides in exceptional cases or where judgement or choice needs to occur (FRC, 2019). Accordingly, Alvesson and Deetz (2000) emphasize the role of communication and discourse in shaping organizational efficiency. AI-generated text introduces a new layer of communication, potentially altering how sustainability information is presented and understood. Examining the language, tone, and style of AI-

generated reports becomes crucial to understanding how they convey meaning and influence stakeholders' perceptions.

Judgement

Although managers have long used both financial and non-financial information for internal decision-making, with the Balanced Scorecard a popular example of this in practice (Ferreira & Otley, 2009), inputs into this system come from different sources with varying levels of reliability. Financial information tends to dominate decision-making as it is perceived as being more reliable than non-financial information (particularly by the finance function) (Akbas et al., 2021). As sustainability information is more fragmented than financial information, usually being held on separate systems to the main accounting system (Robertson & Samy, 2015), AI may be able to finally provide an integrated solution for combining financial and non-financial management information, an area which many organisations struggle with (Gibassier et al., 2018). One positive outcome of AI developments could therefore be an increasing perception of reliability of sustainability information among managers, something that could help to promote sustainability agendas internally. However, AI systems learn from existing data, which may carry social and cultural biases (Alvesson and Deetz, 2000). These biases could inadvertently be embedded in the AI-generated sustainability reports, perpetuating existing inequalities and overlooking important perspectives. For instance, the AI might prioritize certain metrics or sustainability priorities that align with dominant cultural values, potentially sidelining alternative viewpoints.

3.2 Report production

Efficiency

New technologies have already impacted the corporate reporting process, with traditional paper-based annual reports increasingly replaced or supplemented with interactive digital versions of the same information. Organisations also use social media tools to disseminate corporate information, both financial and non-financial (Lombardi & Secundo, 2021). Formats such as XBRL, increasingly used in accounting and auditing, allow for more standardisation and offer increasing transparency and comparability.

Judgement

Some consider corporate reports completely produced by AI to be a way off yet, requiring management to trust in the technology (FRC, 2019), particularly as they will be held accountable for the content. However, there are clear opportunities for managers to use AI to ghostwrite report sections, editing the final results (Farooq & De Villiers, 2019). This, however, requires managers to have sufficient knowledge about sustainability data and reporting to exercise judgement. Within this context, Alvesson and Deetz (2000) highlight the importance of recognizing how corporate reporting and discourse reflect and perpetuate ideologies. In the case of AI-generated sustainability reporting, the design and programming of AI systems may involve choices that could be influenced by underlying ideologies or value judgments. The AI might inherently promote certain sustainability ideologies over others, affecting how organizations and stakeholders perceive and prioritize sustainability initiatives.

3.3 Assurance

3.3.1 Board

Efficiency

The board has a monitoring function, ensuring that managers remain accountable to their stakeholders. AI can be a valuable resource for board members as they navigate the complex and rapidly evolving field of sustainability reporting. For example, board members can use AI to access relevant information and data on a wide range of topics, including sustainability, ESG performance, and corporate governance. This can help them make informed decisions and better understand the organisational sustainability strategy and performance. AI can also provide board members with insights and expertise on various sustainability-related topics, including best practices and emerging trends in the field. Furthermore, AI can assist board members in their decision-making process by providing relevant data and analysis to support their discussions and debates on sustainability-related topics. In the context of AI-generated sustainability reporting, power dynamics are crucial to consider (Alvesson and Deetz, 2000). The use of AI-generated text could potentially centralize power in the hands of those with technological expertise, while marginalizing the perspectives and voices of other stakeholders. Power can manifest in decisions about which data to include or exclude, how metrics are prioritized, and the overall shaping of the sustainability narrative.

Judgement

There are already cases of AI-assisted boards (Burridge, 2017), and emerging discussions around whether or not a board could comprise of AI board members, or even a single member (FRC, 2019). This is particularly relevant considering the emergence of non-traditional organisations such as decentralised autonomous corporations, able to operate without humans. These new forms of corporation could herald completely new forms of corporate governance.

Hilb (2020) provides an overview of the potential impact of AI on corporate governance, considering a range of implications from assisted intelligence (where AI makes the board more efficient in governance) through to autopoietic intelligence, where the governance of an organisation is not only entirely automated, but also self-evolving. The legal ramifications of this in terms of the personal liability of the directors of limited liability companies are still poorly understood and under-researched. These developments will impact not only sustainability reporting, but all forms of corporate reporting. Moreover, stakeholders may resist the adoption of AI-generated reporting if they perceive it as reinforcing power imbalances or neglecting certain sustainability aspects (Alvesson and Deetz, 2000). Conversely, AI could bring about positive changes by providing more comprehensive and timely information, enabling data-driven decision-making for sustainability initiatives.

3.3.2 Auditors

Efficiency

Whereas traditional audit procedures involved sampling large numbers of transactions in order to form an opinion, AI, with its ability to analyse vast quantities of data at speed, now allows for verification of transactions in their entirety. AI can also be used to test compliance with certain standards and accounting rules. This adds additional assurance and frees up time for the more judgemental reporting areas (FRC, 2019). Real-time reporting can use big data techniques to make audit decisions given particular organisational and environmental contexts (Gepp et al., 2018). The integration of artificial intelligence and blockchain could form a system for advanced continuous audits (Han et al., 2023). Consistently, organizations must consider who bears responsibility for the content generated by AI systems. Ethical concerns can arise if AI generates misleading or inaccurate sustainability information, potentially undermining the trust of stakeholders (Alvesson and Deetz, 2000).

Judgement

The assurance of non-financial information, including sustainability information has lagged behind developments in assurance of financial reporting, largely because non-financial reporting is voluntary and less relied on by investors (Farooq & De Villiers, 2019; Farooq & De Villiers, 2020). Yet developments in AI highlight the need for more assurance of such information, particularly as efficiency gains in reporting are likely to lead to an increased volume of sustainability reports.

3.3.3 Regulators

Efficiency

AI may assist regulators in ensuring that organisations comply with sustainability and ESG-related regulations. For example, AI can provide information on the requirements for sustainability reporting and help regulators evaluate the accuracy and completeness of sustainability reports submitted by organisations. Moreover, AI can also support regulators in their enforcement efforts by providing relevant data and analysis to support investigations and enforcement actions. AI can clearly and concisely explain complex sustainability-related regulations and help communicate the regulator's stance on these issues.

Judgement

Regulation is an outcome of the nexus between market forces, ethical ideals and legal controls (Puxty et al., 1987; Ryan et al., 2007). Regulators aim to protect investors by reducing systemic risk, ensuring that markets are fair, efficient and transparent (IOSCO, 2021). Regulators are expressing increasing concern about greenwashing. Within this context, they could use AI to access relevant information and data on a wide range of topics, including recent regulatory sustainability developments. Although AI may provide regulators with insights and

expertise on various sustainability-related topics, including best practices and emerging trends in the field, regulators will need to cross-check that information by engaging with different stakeholders, including investors, customers, and the public, on sustainability-related topics.

3.4 Use

Efficiency

Investors already analyse narrative information provided by corporations using large language models. The focus of investors is on the security and performance of their investment, and investors are likely to have the funds and skills to invest in AI to process data from organisations in order to give themselves an advantage. Investors and data providers consider AI a potential solution to the current challenges of collecting data from numerous sources, collating the data and providing useful recommendations based on it (FRC, 2019), and are probably the most advanced users of AI in our framework. Other stakeholders for sustainability information in corporate reports are many and varied. They include employees, customers, environmentalists and others (including silent stakeholders such as future generations). Their information needs vary, and they are likely to have significantly less money and time to spend analysing vast quantities of corporate information.

Judgement

‘Sustainable’ investing is big business, with flows into ‘ESG’ investments reaching \$51.1 billion in the US in 2020 (S&P, 2021). Yet the extent of greenwashing in the investment industry has highlighted how many funds are guilty of falsely promoting the ‘green’ credentials of their products (Mooney & Flood, 2021). In recognition of this, activists may pressure firms to include certain types of disclosures (Uysal & Tsetsura, 2015). Divestment campaigns have become a feature in the Environmental, Social and Governance (ESG) investing landscape (Fletcher & Stubbington, 2021), and stakeholder pressure to invest or divest can be exacerbated

by media pressure (Grosser, 2016; Shipilov et al., 2019). These trends indicate that non-investor stakeholders are scrutinising corporate information more closely. AI-generated sustainability reporting introduces the potential for encoding specific ideologies into the reporting process. The choices made during the design and programming of AI systems are influenced by underlying values and perspectives. This can lead to AI-generated reports that inherently prioritize certain sustainability ideologies over others. For instance, an AI system might emphasize quantitative metrics over qualitative indicators, favoring a technocentric approach to sustainability that might not align with all stakeholders' values. Such biases can limit the scope of sustainability initiatives and fail to address the diversity of cultural and ethical perspectives (Alvesson and Deetz, 2000). Additionally, stakeholders might have limited ability to question or challenge the information presented by AI systems, further reinforcing power imbalances.

4 TRANSFORMATIVE REDEFINITION: FUTURE RESEARCH AVENUES

The framework and analysis in the preceding section highlight the many opportunities and threats posed to sustainability reporting by AI. In this section, we set out a research agenda to explore these issues more deeply, structuring our agenda around the four main process areas of the conceptual framework: management information, report production, report assurance and use. We also consider a broad all-encompassing research category that explores overarching issues generated by the framework. Alvesson and Deetz consider this final stage of their critical approach, the 'transformative redefinition', the key to moving academic debate forward into action.

4.1 Management information

Open AI applications such as ChatGPT represent a critical research topic, which calls for further investigation from different perspectives. Management accounting researchers have multiple avenues ahead, and AI may reactivate interest in exploring the use - and related implications - of AI in terms of management information. It will be crucial to understand the underlying rationales and logics behind AI. Hence, research on the following topics is warranted:

- Management accounting practices in relation to management information, systems, and disclosure, and particularly how AI may enhance organisational efficiency, optimise decision-making, and reliability of sustainability-related information.
- The role of managers and management accountants in supporting the use and relevance of AI for sustainability reporting.
- The views of managers on AI and the embedded changes, challenges and opportunities in their working practices.
- How management accounting aspects, practices and mechanisms organisations need to be leveraged to enjoy AI's benefits.
- How AI may support current management systems in place within organisations, and what the long-term implications would be.
- The effects and relationship among different stakeholders involved in adopting AI, and the related organisational tensions.
- The accountability of AI for sustainability reporting, and particularly who is accountable? Does accountability remain with managers? If so, will they be wary of the use of AI? May AI improve organisational accountability?

- Critically evaluating the accuracy and reliability of information generated by AI for sustainability reporting.
- Examining the adoption and impact of AI, including the benefits and challenges faced by organisations and the role of stakeholders in shaping the use of these technologies.
- Understanding the limitations of AI in generating management information, including the challenges of data availability and quality, the limitations of natural language processing, and the limitations of machine learning algorithms.

Researchers could use a broad array of quantitative, qualitative, and mixed research methods to approach these topics, such as surveys/interviews of practitioners, software surveys, field- and case studies along with secondary data analysis (De Villiers et al., 2019; Molinari & De Villiers, 2021).

4.2 Report production

Accounting researchers should take the lead in undertaking extensive research on the potential implications of AI for report production and related disclosure and reporting activities, mechanisms, and practices. Arguably, there are multiple questions that may be interesting to further investigate, such as:

- Can AI ghost-write entire reports? Which sections does it fare better with, and why?

Moreover, AI further boosts sustainability accounting researchers to explore current sustainability challenges in-depth. For instance, the increasing levels of greenhouse gases in the atmosphere due to human activities are a major driver of climate change. The information and communications technology industries are responsible for a relatively large share of global greenhouse gas emissions. To this end, it is crucial to have access to factual information in discussing how to reduce our footprint such that we can prioritize our efforts to address those

issues that yield the biggest carbon savings. Environmental costs can come in various guises, for instance water usage, soil contamination, air pollution. Future research can consider the environmental impact of ChatGPT through the lens of carbon footprint. Particularly, when determining the carbon footprint of a machine learning model, if one can distinguish between the carbon footprint from training the model, the carbon footprint from running inference with the model once it has been deployed, and the total life cycle carbon footprint of a model (Ludvigsen, 2022). Regardless of the scope, it would be interesting to know how to account for and report the carbon footprint of any model the amount of electricity it consumes, and the carbon intensity of this electricity. Within this context, several research avenues remain open, driven by factual queries, such as:

- Can predictive analytics be used, such as the scenario planning required around climate change?

Accounting scholars will be also motivated in exploring the accuracy and reliability of reports generated by AI. This could include the analysis of the model's performance on real-world datasets, as well as the development of metrics to evaluate the quality of the generated reports. Additionally, the research could explore how the models can be fine-tuned and trained to ensure that their output is trustworthy and meets the needs of its intended audience.

Sustainability accounting researchers may be interested in focusing on the development and evaluation of AI algorithms and models, such as ChatGPT, that are designed to generate non-financial reports based on input data and natural language questions. The research could also explore how these models can be integrated into sustainability disclosure and evaluate their effectiveness in terms of efficiency, accuracy, and quality of the generated reports.

Ethical and privacy concerns and implication of using AI models within reports remain to research in-depth. This could include the assessment of the impact of AI-powered report generation on human jobs, as well as the development of guidelines and best practices for ensuring the security and confidentiality of sensitive data. Additionally, the research could explore the potential of AI models to bias in the report generation process and the development of methods to mitigate this risk.

4.3 Assurance

Recent development on AI generates multiple assurance-related questions that need further research in line with the growth in demand for NFR assurance, which has resulted in the emergence of a number of different sustainability assurance standards (Farooq & De Villiers, 2020). Globally recognized standard-setters include – for instance - IAASB and AccountAbility (Perego, 2009). The scope and focus of the standards issued by these organisations varies considerably and there is potential that AI may affect the use– and maybe update - of these standards in combination. AI could imply advancing knowledge about assurance, the organisation, and sustainability (Adams & Evans, 2004). AI may support in addressing past critics arguing that traditional financial audit methodologies constitute a bureaucratic verification of quantifiable data unsuitable for the qualitative nature of sustainability (Perego & Kolk, 2012). Instead, assurance practitioners are encouraged to experiment with the use of AI and find more suitable approaches.

Sustainability reporting assurance research should focus on the potential of ChatGPT and other AI models to support the assurance process for sustainability reports. This could include the analysis of how the technology can streamline the data collection and analysis process and support the evaluation of the reliability and accuracy of sustainability reports.

Finally, sustainability reporting is a complex area as it combines quantitative and qualitative data, as well as assurance over materiality assessment and stakeholder engagement processes (De Villiers et al., 2017). Thus, AI may trigger multiple research questions, such as:

- How do regulators currently detect greenwashing?
- Are boards informed enough about AI? If so, how?
- What are the governance implications of AI?
- How is AI viewed by boards and directors?
- AI in audit procedures – are decisions about such as materiality and risk better than human judgement?
- When do auditors intervene and why?

4.4 Use

The use of AI presents multiple implications that need further research. For instance, as advanced by Open AI, research could focus on understanding the factors that influence user acceptance and adoption of ChatGPT and other AI models. This could include an analysis of user attitudes towards AI technology, as well as an evaluation of the impact of different design and deployment strategies on user adoption. Furthermore, accounting scholars could investigate for ChatGPT and other AI models to introduce bias and discrimination into both preparers and users of NFR. The research could explore the sources of bias, as well as the impact of these biases on different stakeholders. The research could also include the development of methods to mitigate these risks and ensure the equitable treatment of all users.

Future research could focus on the need for user education and awareness about ChatGPT and other AI models. This could include the development of educational materials and training

programs to help users understand the technology and its capabilities, as well as the impact of these programs on user engagement and adoption.

Multiple research queries remain open for further investigation, including:

- Can AI be detected in reports? Does it matter? Is it already being used?
- What are investors' perceptions and what will be the managers' perceptions?
- Are there any ethical and legal ramifications for managers if text is incorrect?
- How do other users access corporate non-financial information?

4.5 Other research considerations

In addition to the questions raised above, the use of AI introduces other potential research questions for academic research and debate, including:

- **Reporting language.** Although ChatGPT and other similar AI assistants can operate and are trained on many different languages, research could be conducted into how effective translation is across different languages, and how significant this might be for sustainability reporting.
- **Detection of AI.** Many different software solutions claim to be able to 'detect' AI use. We provide an example of this in Section 2. How useful might this be to corporate report preparers and users? Do any of them use such software already, and if so, why and how?

- **Perceptions of AI.** Much of the recent commentary around AI has centred on certain industries or applications of ChatGPT, notably journalism, marketing and academia. The perceptions of AI in the field of corporate reporting have not really been discussed, and insights from actors across the entire process, from report production to use, would be insightful. Research questions could explore whether or not AI increases or decreases information asymmetry.
- **Different research methods** could be used to generate insights into the field. For example, experiments could be conducted to see how the perception of actors changes the more or less AI-generated content is used in corporate reporting, or whether or how concerned actors might be able to detect its use without detection software.

This research agenda will help to explore the potential benefits of chatbots and processing technologies for sustainability reporting. Within this context, some general research topics may include the development of a comprehensive framework for the use of AI in non-financial reporting, including guidelines for data collection, analysis, presentation, and communication. Assessing the accuracy and reliability of AI-generated information is a paramount. Therefore, future research could focus on evaluating the accuracy and reliability of information generated by chatbots and other processing technologies, such as machine learning, natural language processing, computer vision, data preprocessing etc., and on developing methods to reduce bias and error in the information presented. Exploring the limitations of AI in depth is essential for providing a comprehensive understanding of the benefits of AI. Additional limitations include, for instance, data dependence. AI models heavily rely on the quality, quantity, and diversity of data used during the training process. Insufficient or biased data can lead to inaccurate or unfair predictions. AI models may also struggle to handle situations where the data is scarce or unavailable. Many AI algorithms, especially deep learning models, require significant

computational power and resources to train and run effectively. This limitation can be a barrier for individuals or organizations with limited access to high-performance hardware. AI models are often considered black boxes as their decision-making process can be challenging to interpret and explain. This lack of transparency raises concerns, particularly in critical applications such as healthcare where understanding the model's reasoning is crucial. While AI models trained on large datasets can perform well in specific domains, they may struggle to generalize to new and different tasks or environments. Investigating the privacy and security implications of AI-generated sustainability information is needed to understand how to cope with these criticalities, including the protection of sensitive information and the mitigation of potential risks.

Table 1. *Summary of findings and future research directions*

<i>Sustainability reporting stage</i>	<i>Management Information Systems</i>	<i>Reporting</i>	<i>Assurance</i>	<i>Use</i>
<i>Opportunities with AI</i>	Improvements in efficiency of data gathering. Potential to provide more balanced (financial and non-financial) information for decision-making.	Speed of analysis, and development of new reporting mechanisms.	AI-augmented analysis and assurance processes, increasing time for human judgement.	Speed of analysing large quantities of corporate data for insights.
<i>Challenges with AI</i>	Potential dominance of certain information types (eg financial information) as it is easier to process.	Increased threat of greenwashing.	Challenge to traditional models of corporate governance. Challenges associated with assurance of sustainability-related information.	Investor-focused perspectives on sustainability reporting will dominate as they have more resources to invest in AI than other stakeholders.
<i>Future research avenues</i>	Impact of AI on management accounting practices, processes and perceptions.	Impact of AI on different reporting types and the emergence of new types of reporting.	Models for assurance of sustainability-related information. Considerations of corporate liability in the face of AI developments.	User perceptions of AI-generated sustainability reporting information.

Source: Developed by the authors.

5 CONCLUSION

As awareness of AI-generated text and text analysis software enters the mainstream, our paper critically considers the benefits and risks of such applications for the future of sustainability reporting. We develop a conceptual framework showing four key stages of non-financial reporting: management information, reporting, assurance and use. This framework forms the basis for critical analysis of the potential uses of AI in sustainability reporting and for the generation of research questions, many of which we outline in our paper.

We asked ChatGPT our research question: ‘How will AI text generation and processing impact non-financial reporting?’. The response was as follows:

“The use of AI for text generation and processing has the potential to significantly impact the future of non-financial reporting in several ways:

- 1. Increased efficiency and accuracy: AI-powered text generation and processing can automate and streamline the process of producing non-financial reports, reducing the risk of errors and inconsistencies. This can lead to more accurate, consistent, and up-to-date reports being produced in a timely manner.*
- 2. Enhanced data analysis: AI can process vast amounts of data and perform complex analysis to support non-financial reporting, providing a more comprehensive view of an organisation's sustainability and social impact.*
- 3. Improved transparency and accountability: AI can support the collection and reporting of non-financial data, such as environmental, social and governance (ESG) data, making it easier for organisations to communicate their impact to stakeholders.*
- 4. New insights and perspectives: By leveraging AI to analyse vast amounts of data and identify patterns and trends, organisations can gain new insights into their operations and the impact they have on society and the environment.*

However, the use of AI in non-financial reporting also raises some concerns. One of the challenges is ensuring the quality and reliability of AI-generated data and reports, particularly when it comes to ESG data. Additionally, there is a need to address potential biases in AI models and ensure that they are representative of diverse perspectives and voices.

In conclusion, while the use of AI has the potential to greatly improve the efficiency and accuracy of non-financial reporting, it is important to address these challenges to ensure that the information generated and processed by AI is of high quality and reliable.”

Following our critical analysis of the field, we agree with some aspects of ChatGPT's own assessment of its potential, in particular points 1 and 2 – its potential to improve efficiency and enhance data analysis. Our paper indicates that the use of Open AI and other advanced processing technologies has the potential to revolutionise non-financial reporting by improving the efficiency, accuracy, and accessibility of information (Kar et al., 2022). This can reduce the burden on organisations and improve the timeliness of information. AI can also help organisations to better analyse and interpret non-financial data, leading to more accurate and reliable reporting (Heaven, 2023). This can increase the credibility and transparency of non-financial reporting and help organisations to identify and address sustainability challenges. Increased accessibility is another key positive implication of AI as it can make non-financial information more accessible to stakeholders by providing easy-to-understand and interactive information. This can increase engagement and understanding of non-financial information and help organisations to better communicate the impact of their sustainability initiatives (Moodaley and Telukdarie, 2023). While our example of a fictional energy company highlights weaknesses in the data used, this could easily be overcome through the use of organisation-specific data, more accurate prompts and some human editing. Management information and reporting systems could be enhanced and streamlined significantly through the use of AI (Lombardi and Secundo, 2021). We also agree with point 4 – that AI may be able to analyse vast amounts of data, providing insights that humans are unable to and putting this into a global context.

Where we disagree is for point 3 – an improvement in transparency and accountability. It is this specific weakness that is highlighted in our paper. Processing technologies, such as machine learning, natural language processing, computer vision, data preprocessing etc, are only as good as the data they are trained in and may be prone to bias and error if the training data is not diverse or comprehensive enough. This can result in inaccurate or misleading

information being presented. This can reduce transparency and increase the risk of information being misinterpreted or misused (Han et al., 2023). Automated text generation software cannot be held accountable for anything and does not care how stakeholders are likely to use the information it provides. Our AI-generated example shows that AI may perpetuate greenwashing if trained on sets of organisational data that themselves only provide positive accounts of performance relating to sustainability (Kar et al., 2022). While comparability may be improved, ultimately an organisation's managers still need to be accountable to their stakeholders. Yet developments in AI also mean that the traditional corporate model may develop, and entirely new autonomous corporations emerge (Gepp et al., 2018). We therefore highlight assurance and ethics as the research area in need of most attention as AI develops. ChatGPT mentions this in terms of data quality and reliability, but not in the context of the ultimate purpose of non-financial reporting – to provide relevant and accurate information which stakeholders can use to make decisions (Arnaboldi et al., 2017).

Appendix 1: ChatGPT-generated CEO report for a fictional energy company

Dear Shareholders,

I am pleased to present to you the sustainability report for Energize Co for the year 2022. At Energize Co, we are committed to delivering sustainable energy solutions that meet the needs of our stakeholders, including our shareholders, customers, employees, and the communities in which we operate. This report provides an overview of our sustainability performance and progress, and I am proud to share that we have made significant advancements in key areas this past year.

First, I would like to report on our progress against our sustainability KPIs. In 2022, we were able to reduce our carbon emissions by 8% compared to the previous year, surpassing our target of a 5% reduction. This was achieved through a combination of efficiency improvements in our operations, an increased use of renewable energy sources, and our ongoing efforts to reduce waste. Our energy mix has also shifted towards cleaner sources, with 60% of the energy we generated coming from renewable sources, compared to 55% in 2021.

In addition to reducing our carbon footprint, we have also been working to promote sustainable communities through our investment in renewable energy projects. In 2022, we invested \$100 million in wind and solar projects that will provide clean energy to over 50,000 households, while also creating new jobs and boosting local economies.

We are also proud to report that we have received recognition from leading sustainability organisations for our efforts. In 2022, Energize Co was included on the Dow Jones Sustainability Index for the first time, reflecting our commitment to sustainable business practices. We have also been recognized as a GRI-checked organisation, demonstrating our commitment to transparency and reporting on our sustainability performance.

In terms of employee engagement, we have made progress in creating a culture of sustainability within our organisation. In 2022, we launched a new employee engagement program focused on sustainability, which has received positive feedback and high participation rates. We have also continued to provide training and development opportunities for our employees, including workshops and training sessions on sustainability and environmental issues.

Despite these successes, we also recognize that there is still much work to be done. We are committed to continued improvement, and in the coming year, we will be setting new sustainability targets and developing new initiatives to build on our progress to date.

In conclusion, I would like to express my gratitude to all of our stakeholders, including our shareholders, for their continued support. I am confident that, together, we can continue to drive sustainable growth and create long-term value for all of our stakeholders.

Sincerely,[Your Name],

Chief Executive Officer, Energize Co

Appendix 2: BP's CEO foreword for their 2021 sustainability report (BP, 2021)

Rooting our new strategy in sustainability

Purpose is a company's north star. In recent weeks, our purpose has guided bp's response to the military aggression in Ukraine. It has helped us to fundamentally rethink our position in Russia – and drives us to support the humanitarian efforts in the region. As I write this letter, our thoughts remain with everyone affected by what is happening.

Sustainability, resilience and safety

As well as embedding sustainability across our strategy, we designed it to be resilient across a wide range of scenarios. As recent events heighten uncertainty and global energy security concerns, we are positioned to help keep the energy flowing that the world desperately needs. We do this recognizing that nothing is more important than safety. While we have seen some improvements in our safety performance over the past year, tragically a bp contractor died in an accident at our Castellon refinery in Spain. We have more work to do to eliminate accidents and injuries so that everyone goes home safe to their loved ones every day. Nothing is more important.

Leaning into greening

The strategic progress we have made so far, and the pace at which society has been moving on sustainability, has given us confidence to accelerate the greening of bp. We now expect that by 2025, more than 40% of our capital expenditure will be in our transition growth businesses, and around 50% by 2030. We have also increased our net zero aims. On aim 1, we are now aiming to cut our operational emissions in half by 2030 (up from 30-35%). And on aim 3 (covering the lifecycle emissions for the energy products we sell) we now aim to reduce carbon intensity to net zero by 2050 or sooner – up from 50% – and have increased the volume of emissions covered by this aim, which now includes physically traded sales of energy products.

Uniquely among our peers, we are aiming to be net zero across operations, production and sales.

Diversifying and decarbonising

We have a lot more to learn, but our experience so far is that our purpose – reimagining energy for people and our planet – can help us diversify and decarbonize bp and at the same time create real value and returns for our shareholders. What does that mean in practice? It means that by doubling down on five transition growth engines where we have real strengths – bioenergy, convenience, EV charging, renewables and hydrogen – we can grow as a company and at the same time advance towards our aim of net zero on the products we sell (aim 3). Or take our aim 4, which is to install methane measurement at all our major oil and gas processing sites by 2023. While we work towards that, our methane intensity has come down by more than 40% since 2019 (from 0.12 to 0.07%). This includes reduced operational methane emissions, and more bp-produced gas available to sell to our customers. And at our Gelsenkirchen sites in Germany, we have reduced our Scope 2 emissions by more than half-a-million tonnes in 2021 (in line with aim 1), helped by our trading team’s long-term arrangement to purchase renewable energy.

Focused on delivery

With our direction set, and the major organisational changes behind us, we are now fully focused on delivering our strategy and the sustainability aims that underpin it. Thank you for your support and challenge – it has been vital. We could not have made this progress so far without you – and look forward to your continued backing. Thank you.

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