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The Impact of Generative AI on the Perpetuation and Detection of Greenwashing in Sustainability Reports: Insights From an Experiment

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ABSTRACT

Our study, based around an experiment, examines the consequences when generative AI tools are used to create and assess sustainability disclosures. There are two key findings: (1) that generative AI greenwashes sustainability disclosures, with our study participants doing little to mitigate this, and (2) that our study participants viewed AI-generated sustainability disclosures as more positive and credible than real disclosures. Our findings suggest that generative AI can mimic corporate spin, potentially weakening the quality of climate-related communication. We highlight the dangers of overreliance on AI tools for sustainability reporting, provide a replicable experiment and outline a framework showing where human oversight and strategic controls are most needed. We offer practical insights for business leaders, sustainability teams and regulators as generative AI becomes an everyday part of corporate reporting workflows.

1 | Introduction

The majority of companies worldwide provide environmental and social information in their corporate reports, including 96% of G250 companies (KPMG 2024). Such disclosures are becoming mandatory in many jurisdictions, with the formation of the International Sustainability Standards Board (ISSB) and the subsequent introduction of IFRS S1 and S2 a significant global development in standardising this reporting (De Villiers et al. 2024). Although the disclosure of sustainability information is associated with higher firm values (Cahan et al. 2016) and a reduced cost of capital (Dhaliwal et al. 2011), the quality and usefulness of sustainability information have been called into question in several studies (see Hahn and Lülfs 2014; Moneva et al. 2006). Evidence shows that managers selectively disclose positive social and environmental information (Bingler et al. 2023; De Villiers and van Staden 2011) and downplay negative events (Diouf and Boiral 2017). Such selective disclosure undermines efforts to improve transparency in climate-related disclosures and impacts decision-making. As a result, sustainability reports are often perceived as tools to manage impressions (Brennan and Merkl-Davies 2013; Cho et al. 2015; Hooghiemstra 2000) or tools to manage risk (Bebbington et al. 2008), raising ethical concerns about their role in climate governance.

The increasing use of generative artificial intelligence (AI) applications in corporate reporting introduces new complexities. AI is now used across multiple accounting and reporting areas (Yi et al. 2023). AI tools have significant potential to enhance and streamline sustainability reporting processes, which tend to involve more complex and varied sets of data than traditional financial transactions (Zvezdov 2012). However, despite its potential for enhancing sustainability reporting, the use of generative AI may replicate or amplify disclosures intended

to manage impressions (De Villiers et al. 2023; Ray 2023). This is because the output of popular generative large language models (LLMs) such as ChatGPT is based on prediction, with the quality of information generated dependent on three things: the data used to train the model, the model's sophistication and prompts given by human actors (Kar et al. 2022). Subsequently, when sustainability reports produced using AI tools are received by stakeholders, the confident tone associated with many generative AI applications may influence user perceptions of the information provided (Kidd and Birhane 2023). Therefore, our research question aims to explore whether both the production of AI-generated sustainability reports and the interpretation of them by users may serve to perpetuate greenwashing, potentially masking climate-related risks.

To explore this question, we designed an experiment to examine how humans interact with AI-generated content when preparing and using sustainability reports. Our experiment responds to calls for more innovative and transdisciplinary approaches in business research (Guthrie and Parker 2017; Loureiro et al. 2021). We used masters-level research students as a proxy for sustainability report producers and users, following Elliott et al. (2007). The experiment formed part of a series of student assignments on a sustainability accounting research course. Study participants were tasked with producing the CEO report section of a sustainability report using ChatGPT, reflecting on the production process and their findings. In a later exercise, the study participants acted as report users, scoring a series of reports on seven measures from the prior literature. Unknown to them, the reports they had to score contained both real reports and AI-generated reports.

Our findings confirm the potential for generative AI to replicate the positive content and tone of disclosures designed to manipulate audience impressions, supporting conjectures to this effect expressed in the prior literature (De Villiers et al. 2023; Ray 2023). When creating sustainability disclosures, our study participants placed a considerable amount of trust in the ChatGPT output and, in most cases, did not engineer their ChatGPT prompts or edit the output to consider a more balanced view of sustainability performance. In some cases, participants made amendments to the ChatGPT reports that greenwashed them further. We used an adapted version of the Cheap Talk Index developed by Bingler et al. (2023) to score the greenwashing within each report and found the ChatGPT-generated reports to contain more greenwashing than a sample of real reports. When acting as report users in a later exercise, our study participants scored ChatGPT-generated reports as more optimistic, confident and trustworthy than real reports.

Our findings are important in the context of rapid developments in generative AI and growing calls for corporate transparency in respect of climate change. Evidence shows that sustainability information is increasingly important for investment decision-making, and that investors use narrative analysis in their decisions (Cahan et al. 2016; Hartzmark and Sussman 2019). With the value of ESG investments estimated to exceed $40 trillion by 2030 (Bloomberg 2024), greenwashing within sustainability narratives is a major economic, environmental and social concern. We provide a conceptual framework that highlights how AI could perpetuate impression management strategies and what types of human intervention are necessary to counteract this. By designing a replicable experiment using students as participants, we also contribute to the literature on tertiary education, highlighting challenges that arise with teaching in an era of advanced AI (Ballantine et al. 2024; Prather et al. 2023) and issues that face the modern workplace (Loureiro et al. 2021).

The remainder of this paper is structured as follows: Section 2 contains the background and literature review, Section 3 presents the theoretical framework for the study, Section 4 describes the method and data collection, Section 5 presents the findings, Section 6 discusses the findings and Section 7 concludes.

2 | Background

2.1 | Developments in Sustainability Reporting

Organisations are increasingly providing information to a broader group of stakeholders about the impact their decision-making may have on society and the environment (Unerman and Chapman 2014). In addition to reporting on their sustainability and climate-related activities externally, organisations are also increasingly incorporating sustainability into their strategy and seeking to embed low-carbon and climate-resilient practices into their organisations (Engert et al. 2016), including through digital transformation (Guandalini 2022) and the use of climate analytics and emissions tracking technologies. The stakeholders for sustainability information are many and varied. Investors look to sustainability reports for information regarding risks and future returns, which can be influenced by social and environmental issues, including exposure to physical and transition risks associated with climate change. Other stakeholders typically have more direct interests in specific areas of social and ecological impact (such as carbon emissions, biodiversity loss and climate resilience) that feature in sustainability reports. Disclosures aligned with climate-related frameworks such as the Task Force on Climate-related Financial Disclosures (TCFD) aim to improve transparency around climate-related risks and opportunities. Sustainability reporting is complex, requiring a combination of quantitative and qualitative data alongside assurance over materiality assessment. It also requires stakeholder engagement processes to provide relevant and accurate information, which stakeholders can use to make decisions (De Villiers and Maroun 2018).

Sustainability reports are predominantly voluntary and allow considerable management discretion (Adams and Abhayawansa 2022). Even recent developments such as the mandating of sustainability reporting through new reporting standards issued by the ISSB and in developments underway for XBRL (the 'tagging' of disclosures to improve comparability) are unlikely to reduce the considerable leeway managers have in the way they present disclosures, and in the level of disclosure they choose to make beyond that required by the standards. Evidence has shown that managers are selective in the disclosures they make, favouring positive stories and downplaying negative ones (Bingler et al. 2023; De Villiers and van Staden 2011; Diouf and Boiral 2017). The quality and usefulness of the information contained in sustainability reports are therefore debatable (Hahn

and Lülfs 2014; Moneva et al. 2006). Sustainability reports can be used as tools to manage impressions (Brennan and Merkl-Davies 2013; Cho et al. 2015), with the voluntary nature of much of this reporting potentially facilitating this process (Hahn and Lülfs 2014).

2.2 | Greenwashing

Greenwashing is a type of selective disclosure whereby firms mislead stakeholders about their performance to create a false impression of transparency (Delmas and Burbano 2011). Greenwashing has multiple definitions depending on the context (De Freitas Netto et al. 2020) and can relate to both content (included or omitted) and tone of disclosures. Greenwashing presents a major economic, environmental and social problem if greenwashed content attracts investment. ESG investing is valued at $30 trillion, currently representing 25% of global assets under management (Bloomberg 2024). The potential harm caused by greenwashing is twofold: Stakeholders may be misled into thinking they are making a positive impact on the environment and society, and organisations with a genuine commitment to taking action on climate change may be tarnished by the growing cynicism surrounding sustainability disclosures and activities (De Villiers et al. 2023). Research shows that consumers are increasingly cynical about sustainability claims made by organisations (Policarpo et al. 2023), reacting more angrily to firms perceived as greenwashers than to firms who make little attempt to improve their environmental record (Lyon and Maxwell 2011).

2.3 | LLMs and the Potential for Greenwashing in Corporate Reporting

Much research on the use of AI tools in corporate reporting, including sustainability reporting, focuses on how they can improve efficiency. For example, Asif et al. (2023) consider how AI tools can gather and process data from disparate sources, a key development in making sustainability reporting more mainstream and standardised. The use of AI tools to find patterns in datasets has also been highlighted as a potential way of identifying important social and environmental information for decision-making (Chen et al. 2023). The predictive capabilities of AI tools show considerable potential when modelling complex climate-related risks and patterns (Cheong et al. 2022).

Despite the importance of narrative information and disclosures in influencing stakeholder decision-making (Cahan et al. 2016; Hartzmark and Sussman 2019), the use of AI tools in this area has received less research attention to date. This is a concern considering the widespread use of AI tools to present information, draft sections of corporate reports and analyse data for insights to inform investment strategies (FRC 2019). Some studies (see Sætra 2023) have considered how AI tools could help to reduce material misstatements around carbon disclosure by improving estimation processes (e.g., around indirect Scope 3 emissions), thereby improving ESG communication. However, such studies focus on specific disclosures rather than more general voluntary management narratives, which also influence report users.

OpenAI's launch of ChatGPT in late 2022 catapulted the use of LLMs for text production into the mainstream. LLMs can generate coherent and semantically meaningful text for a number of purposes. Their output is based on prediction; these models do not understand what their output means (Roberts et al. 2024). The quality of text generated by LLMs therefore depends on the quality of the data used to train the AI model, the AI model's complexity and the sophistication of the prompts given by human actors (Kar et al. 2022). While the training datasets of popular LLMs such as ChatGPT have not been disclosed, they draw from information available on the internet. It is therefore reasonable to assume that these datasets include examples of both balanced and greenwashed sustainability reports, and that LLMs use a combination of these to produce their output. The technological features of LLMs, combined with their implicit biases, therefore mean that they are likely to perpetuate greenwashing, a point which has been argued in the prior literature (De Villiers et al. 2023; Ray 2023). In addition to their likely perpetuation of greenwashing, LLMs' hallucinations, confident tone and incorporation of human biases may also influence report users (Kidd and Birhane 2023; Ray 2023; Roberts et al. 2024). It is these aspects of LLMs that we aim to explore in this study.

3 | Theoretical Framework and Research Question

As our research focuses on both the production and the interpretation of AI-generated sustainability reports and the human actions taken while producing and interpreting these reports, we consider impression management to be the most appropriate theoretical lens through which to approach our study. Impression management theory focuses on individuals' and organisations' needs to deliberately control the impression that others have of them (Goffman 1959). This idea is consistent with legitimacy theory, which posits that firms use sustainability disclosures to create and maintain the impression that they align with expected social norms (Deegan 2002) and agency theory, which assumes that managers choose to disclose sustainability information (in a way) that will positively impact the value of the firm to maximise their incentive pay (Jensen and Meckling 1976).

When choosing a suitable theoretical framework for our study, we focused on management use of sustainability reports. Managers have been found to use sustainability disclosures as a tool for impression management, carefully selecting the quantity and quality of the information provided and the language and verbal tone used to communicate messages around performance. Merkl-Davies and Brennan's (2007) impression management framework shows that corporate attempts to manipulate usually focus on either the disclosure (quality and quantity) or the presentation (language and verbal tone) of the information provided. The two impression management strategies most commonly used by companies are enhancement (highlighting good performance) and obfuscation (concealing poor performance). Fabrizio and Kim (2019) find that firms use linguistic obfuscation to balance the pressure for more disclosure with the desire to present a positive image to stakeholders. Marquis et al. (2016) find that firms may selectively disclose relatively benign information to create an impression

of transparency while leaving more controversial information undisclosed. Such activities have led to increasing concerns around greenwashing (Lyon and Montgomery 2015; Marquis et al. 2016), as stakeholders struggle to determine the difference between corporate sustainability rhetoric and genuine action (Bellucci et al. 2019; Bini et al. 2017). Prior research on sustainability reporting and impression management has mainly focused either on the report production process (Hahn and Kühnen 2013) or on the use of sustainability reports by stakeholders (Diouf and Boiral 2017; Simnett et al. 2009). Although users can perceive disclosures as impression management (Merkl-Davies and Brennan 2007), there have been calls for more qualitative research on this topic (Diouf and Boiral 2017; Hahn and Kühnen 2013; Tilt 2010).

In the context of rapid developments in AI, our study considers how LLMs may perpetuate impression management strategies through both content and disclosure. As discussed earlier, LLMs are not aware they may be managing impressions; the content they produce is a function of their training, complexity and the sophistication of prompts entered by humans. Yet, if AI tools are already being used in corporate reporting, including sustainability reports, it is important to understand not only what kind of greenwashing such technology may perpetuate but also how this is received and interpreted by human report preparers and users. The key to mitigating the risk of greenwashing is human intervention, either through refined prompts, subsequent editing of content, assurance, tightened rules or negative consequences for managers and directors. These observations therefore lead to our research question:

How do humans interact with AI-generated content when preparing and using sustainability reports?

4 | Data and Method

4.1 | Experiment Design and Participant Selection

To validate our research question, we designed a research project that included an experiment. The participants in the experiment were postgraduate students enrolled in a masters-level research degree in accounting. One of the optional courses on this degree is a sustainability accounting research course. The syllabus of this course covers topics such as reasons for voluntary reporting (considering legitimacy, institutional and agency theories), determinants and consequences of reporting and the assurance of reports. Elliott et al. (2007) find that graduate students (MBA students in particular) are generally a suitable proxy for non-professional investors for experimental studies. Given their background, this group of students was well informed about the purpose of sustainability reporting and had studied critical perspectives on the topic.

The 14 students in the course all independently agreed to participate in this research project. Ethical clearance was gained from the university's research ethics committee. The course lecturer provided data from the course to the research team but did not participate in the data analysis process due to the potential conflict of interest.

4.2 | Research Instrument

During the course, students were given five assignments, all of which were used in the research project. These five assignments are summarised below, with the full assignment instructions provided in Appendix A. The assignments needed to be designed to be genuine assessments as well as meeting the needs of the research project. Assignments A1 and A2 focused on report preparation, whereas Assignments B1 and B2 focused on report use. Assignment C was a critical essay reflecting on the overall findings from the project. The assignments are summarised below, with full details provided in Appendix A.

4.2.1 | Assignments A1 and A2: Preparing Reports (Full Details in Appendix A)

In Assignment A1, students were tasked with using ChatGPT to create a 500-word CEO statement to shareholders to accompany the sustainability report for a fictional forestry company based in New Zealand. The CEO statement section was selected for two reasons: Firstly, it summarises the ethos of the entire report, and secondly, we required a text-heavy section of a sustainability report to analyse ChatGPT's capabilities in terms of text generation. The forestry sector was chosen deliberately as one with positive and negative social and environmental impacts, and a complex connection to climate change (as both a contributor and potential solution to the climate crisis). A fictional company was chosen to ensure that ChatGPT-generated generic sustainability report content which reflecting any underlying biases. The students were asked to submit a series of files containing their full conversation with ChatGPT (all prompts and responses), the original output (termed 'ChatGPT' output), any manual amendments to the output they made subsequently and their final CEO statement (termed 'Human-edited ChatGPT' output).

For Assignment A2, students were asked to reflect on whether their ChatGPT-generated and edited output from Assignment A1 would be suitable for a forestry company in the Hawkes Bay area of New Zealand in 2023. This area experienced devastating flooding in the aftermath of Cyclone Gabrielle in early 2023, which threw the activities of forestry companies, particularly the generation of forestry slash, into the spotlight (McClure 2023). Having established and reflected on the key criteria for sustainability reports in Assignments A1 and A2, students then progressed to the next stage of the research project—use of the reports.

4.2.2 | Assignments B1 and B2: Using Reports (Full Details in Appendix A)

Following Assignment A1, 28 reports were generated by students (14 'ChatGPT' reports and 14 'Human-edited' ChatGPT reports). We added three real reports (termed 'Real') and an additional control report ('ChatGPT Control') to these, giving 32 reports in total. The real reports were selected from three companies operating within the forestry sector of a similar size, scale and complexity to the fictional company that

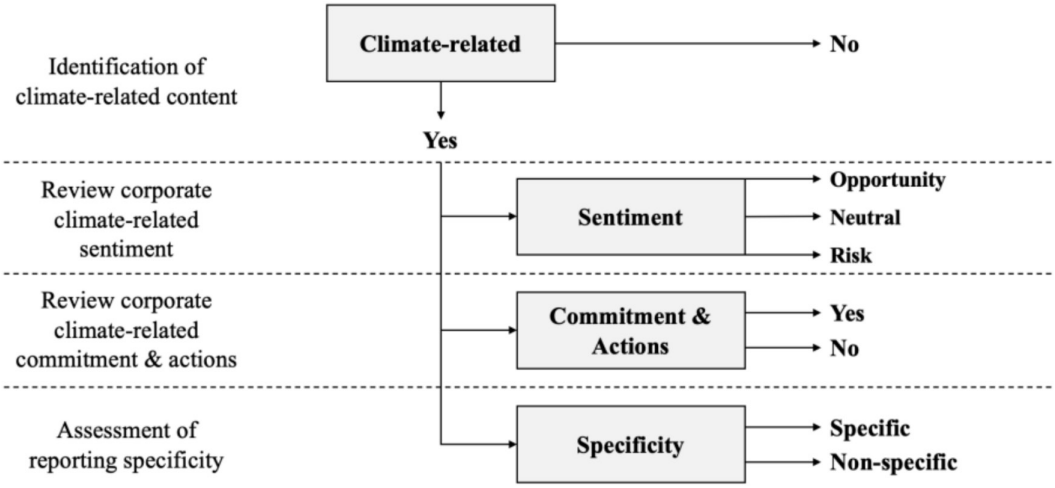

FIGURE 1 | Determination of Cheap Talk from Bingler et al. (2023).

featured in the assignments. The 32 reports were all anonymised (using 32 fake forestry company names generated by ChatGPT) and were converted into the same font and format, eliminating all pictures and specific references to any real events or people.

Students then received 10 of these 32 reports each. All students received the three anonymised 'Real' reports and the 'ChatGPT Control' report. The remaining six reports received were the anonymised 'ChatGPT' and 'Human-edited ChatGPT' reports generated by their peers. No students received their own reports to review. The remainder were allocated evenly across the group so that all reports received an equal number of reviews. Students were asked to score the 10 reports they received against the following seven statements using a 7-point Likert scale:

- Statement 1: 'There is an appropriate balance of qualitative and quantitative information in the report'
- Statement 2: 'There is an appropriate balance of positive and negative information in the report'
- Statement 3: 'A broad range of stakeholders are mentioned in the report'
- Statement 4: 'The report sounds optimistic'
- Statement 5: 'The report sounds confident'
- Statement 6: 'The report sounds trustworthy'
- Statement 7: 'I would invest in this company'

Statements 1–3 relate to the disclosure elements of Merkl-Davies and Brennan's (2007) impression management framework. Although our experiment is based on an extract from a sustainability report (the CEO report), this extract should still contain a balance of qualitative and quantitative information, a balance of positive and negative information and reference to a broad range of stakeholders. Statements 4–6 refer to the presentation of the reports, recognising the importance of language and linguistic tone for how information is analysed and acted upon. Tone, as a rhetorical device, can influence the mood and judgements of an audience (Fisher et al. 2020; Sheafer 2007) and can influence investor decision-making—see Henry and Leone (2016) and Loughran and Mcdonald (2011). Cho et al. (2010) note that worse environmental performers exhibit significantly more optimism and less certainty than their counterparts in their sustainability disclosures. Statement 7 aims for a 'decision-usefulness' measure to determine how investors might react to the reports. While a real investment decision is based on multiple factors (risk appetite, time horizon, ethical stance, etc.), this simple question seemed appropriate to elicit students' overall 'gut feel' towards the CEO extracts and to indicate the potential economic consequences of our study.

Once all students had scored their respective reports, they were given the results of the class scoring exercise and informed of the deception (that some real reports were embedded into the 10 they had each reviewed). The students were then asked to perform statistical analysis (*t*-tests or ANOVA tests) on the results and comment on their analysis.

The final assignment (Assignment C) was a reflective essay where students were asked to consider the implications of the assignments and the results from the scoring exercise in terms of the theories and research papers introduced in the course.

4.3 | Greenwashing Measurement

We used the Cheap Talk Index developed by Bingler et al. (2023) to measure the level of greenwashing in our sample of reports produced by the study participants. This measure has been used to highlight greenwashing in large samples of TCFD disclosures (Bingler et al. 2022). The Cheap Talk measure aligns with impression management theory and is appropriate for our study, as the 'sentiment' aspect of this measure (shown in Figure 1) aligns with the 'presentation' strategy of Merkl-Davies and Brennan's (2007) impression management framework, and the 'commitment and actions' and 'specificity' aspects align well with the 'disclosure' strategy of the framework.

Based on the framework in Figure 1, we identified all paragraphs with climate-related content (1 for yes, 0 for no). For those with climate-related content, we attached a sentiment

(opportunity, neutral or risk), with scores of 1 for opportunity and 0 for neutral or risk. Commitments and actions related to both forward-looking plans and backwards-looking actions regarding climate scored 0 for yes and 1 for no. Specificity refers to commitments and actions that relate to a particular organisation and are tangible and verifiable. Specificity scored 0, and non-specificity scored 1. The higher the score, the higher the cheap talk (greenwashing). As an illustration, the paragraph below from our sample scored 3 (sustainability-related, content relates to opportunity, contains some commitment, but no specificity):

Innovation is an important part of sustainable development. We continuously invest in new technologies and processes that improve our efficiency and reduce our environmental footprint. We have recently implemented a new supply chain management system that allows us to track our products from the forest to the customer, ensuring transparency and accountability throughout the value chain. Additionally, we have also invested in advanced harvesting equipment that minimises waste and reduces the environmental impact of our operations. The use of this technology has enabled us to streamline our operations and reduce our pollution of nature. As a result, we have been able to increase our efficiency and productivity while also reducing our costs and environmental impact.

5 | Findings

5.1 | Levels of Greenwashing and Student Editing/Adjustments

Table 1 shows the difference in means between the Human-edited ChatGPT reports produced by students and the real reports, with the AI-generated reports showing much higher scores for greenwashing.[1]

Table 2A shows the results of a two-sample *t*-test for the difference in means between ChatGPT reports (original AI output) and the Human-edited ChatGPT reports. Table 2B shows the results of a paired *t*-test between the two samples. There was no statistically significant difference between the two, although the mean scores for both samples are still substantially higher than the mean scores for the Real reports presented in Table 1.

When asked to reflect on the quality of the ChatGPT output (in the final part of Assignment A1), Student D commented:

> Some users may have never read the CEO's statement to shareholders, and know nothing about its format and key content, but ChatGPT can quickly search and provide suitable answers to questions, which greatly improves the efficiency of work and study.

This comment was relatively typical and suggests that not only was there a high level of trust in the ChatGPT output but also that students did not search for CEO statement content independently. Only one student did this, Student G. Student G's prompt to ChatGPT included the following guidance for ChatGPT to seek out an actual report to validate the content and tone needed:

> I need to create a one-page 500-word CEO statement to shareholders, which will accompany our sustainability report for 2022. Please create this statement for me. Below I will send you a CEO statement from West Fraser's 2021 Sustainability Report, as inspiration. West Fraser is a global forestry company based in Canada.
>
> (Student G)

When asked to reflect on the content necessary for a sustainability report in a specific context (post-Cyclone Gabrielle) in

TABLE 1 | Difference in greenwashing means between Human-edited and Real reports.

Variable	Obs.	Mean	Std. err.	Std. dev.	95% conf. interval	
Human	14	16.214	1.095	4.098	13.848	18.581
Real	3	7.333	0.667	1.155	4.465	10.202

TABLE 2A | *t*-test for the difference in greenwashing means between ChatGPT and Human-edited reports.

Variable	Obs.	Mean	Std. err.	Std. dev.	95% conf interval	
ChatGPT	14	16.8	1.247	4.828	14.126	19.474
Human-edited	14	16.214	1.095	4.098	13.848	18.581

Note: diff = mean(ChatGPT)—mean(Human-edited); $t = 0.3509$. Ha: diff < 0; Pr(T < t) = 0.6358; Ha: diff != 0; Pr(|T| > |t|) = 0.7284; Ha: diff > 0; Pr(T > t) = 0.3642.

TABLE 2B | Paired *t*-test for difference between ChatGPT and Human-edited reports.

Variable	Obs.	Mean	Std. err.	Std. dev	95% conf interval	
ChatGPT	14	16.714	1.336	5.000	13.828	19.601
Human-edited	14	16.214	1.095	4.098	13.848	

Note: diff = mean(ChatGPT)—mean(Human-edited); $t = 1.3915$. Ha: diff < 0; Pr(T < t) = 0.9063; Ha: diff != 0; Pr(|T| > |t|) = 0.1874; Ha: diff > 0; Pr(T > t) = 0.0937.

Assignment A2, all students identified that the ChatGPT reports they had generated earlier needed more detail and needed to be more balanced. A typical comment is included below:

> The statement is a high-level overview and does not provide specific details on the company's actual sustainability practices and performance. Without concrete information on the company's sustainability efforts, it is difficult to assess the effectiveness of its sustainability initiatives and the extent to which it is reducing its impact on the environment.
>
> (Student C)

Overall, our findings indicate that students did not make significant changes to the ChatGPT output and did not adjust the prompts they entered into ChatGPT when developing their 'Human-edited ChatGPT' sustainability reports. The findings provide evidence that not only are LLMs likely to perpetuate greenwashing (the ChatGPT-generated and edited reports showed far higher levels of greenwashing than the real reports) as predicted but also that human intervention seems unlikely to have any major impact on the level of greenwashing at either the prompt engineering or editing stages of text production.

5.2 | Report Scoring Results

Assignment B1 considered the reports from a user perspective. Students were presented with 10 reports each and scored these according to the seven Statements shown in Section 4.2.

Table 3 shows the sample statistics for the student scores of the 10 reports.

Table 4 shows the results of two-tailed *t*-tests comparing the 'Real' report scores to the 'Human-edited ChatGPT' report scores. Each of the 14 students scored 3 real reports and 3 Human-edited ChatGPT reports, resulting in 42 observations for each sample. Students scored the Human-edited ChatGPT reports higher for an appropriate balance of qualitative and quantitative content than the real reports (a statistically significant result). The other two disclosure-related statements (relating to positive–negative content and stakeholders) did not yield a statistically significant difference. Students scored all of the presentation-related statements higher for the Human-edited ChatGPT reports, with statistically significant results for the ChatGPT reports being more optimistic, confident and trustworthy than the real reports. Despite the students regarding AI-generated reports as more optimistic, confident and trustworthy in tone, this did not lead to more confidence in investing.

TABLE 3 | Descriptive statistics of participants' scores of the 10 reports.

Variable	Obs.	Mean	Std. dev.	Min	Max
Qual_quant balance	140	5.05	1.53	1	7
Positive_negative	140	4.64	1.76	1	7
Stakeholders	140	5.31	1.37	1	7
Optimistic	140	6.11	1.12	1	7
Confident	140	6.09	1.04	2	7
Trustworthy	140	5.82	1.05	2	7
Invest	140	5.26	1.12	1	7

6 | Discussion

Our experiment provides evidence that ChatGPT has the capacity to perpetuate greenwashing through both content and tone and highlights that sustainability report producers and users may not detect it. While other studies have highlighted the possibility that ChatGPT might perpetuate greenwashing (De Villiers et al. 2023; Ray 2023), our study provides empirical evidence to confirm this. In addition, the importance of tone compared to content is notable in our study, supporting Kidd and Birhane's (2023) view that ChatGPT's confident tone can have a considerable influence on users. In Figure 2, we provide a framework that situates our findings in the broader context of the production and use of sustainability reports and use our framework to form the basis of our discussion.

Two key controls need to be in place for AI-generated greenwashing to be detected at the production stage. Firstly, quality checks need to be performed on the content, and the tone to ensure the information provided is accurate and not misleading. In our study, students did not perform these quality control checks as report preparers. Despite the students being well-educated in the content and purpose of sustainability reports, only on later reflection did they realise that the reports they had produced were vague and lacking specificity. Prather et al. (2023) find younger generations more trusting in output from AI technologies, and while our results support this, the issue may extend to other age groups. Recent high-profile media cases have highlighted the risks of overreliance on AI-generated output without fact-checking (Belot 2023).

Another key form of control is incentives. Managers may be incentivised to leave greenwashed content unedited in order to manage their impression with stakeholders. This is particularly the case with tone, which is harder to pinpoint as deliberately misleading. There may also be more practical influences over managerial behaviour, such as a lack of time to check facts or a lack of willingness to disclose specific information for fear of being held to account. The students used as a proxy in our experiment may arguably limit our conclusions here slightly, not being subject to the same pressures and consequences as real CEOs when making disclosures. Nonetheless, their overreliance on AI-generated content across the sample of reports produced highlights the potential for managers to overlook critical quality control checks.

The results from our experiment show that when students proxied as report users, they were more influenced by tone than by content. Our findings support the views of other researchers on the importance of tone to report users (see Henry and Leone (2016) and Huang et al. (2014)). We did not find tone to

TABLE 4 | Comparing two-tailed *t*-tests (Human-edited ChatGPT mean—Real mean).

Variable	Group	Obs.	Mean	Std. err.	Std. dev.	[95% conf.	interval]
Qual_Quant	Human-edited ChatGPT Real	42	5.24	0.23	1.46	4.78	5.69
		42	4.29	0.25	1.63	3.78	4.79
						t	2.8216
					Diff > 0	***p*-value**	**0.0030***
Positive_Negative	Human-edited ChatGPT Real	42	4.86	0.28	1.82	4.29	5.42
		42	4.45	0.26	1.68	3.93	4.98
						t	1.059
					Diff > 0	***p*-value**	**0.1463**
Stakeholders	Human-edited ChatGPT Real	42	5.33	0.20	1.32	4.92	5.74
		42	5.21	0.23	1.51	4.75	5.69
						t	0.3853
					Diff > 0	***p*-value**	**0.3505**
Optimistic	Human-edited ChatGPT Real	42	6.31	0.17	1.09	5.97	6.65
		42	5.76	0.20	1.30	5.36	6.17
						t	2.0867
					Diff > 0	***p*-value**	**0.0200***
Confident	Human-edited ChatGPT Real	42	6.26	0.15	0.99	5.95	6.57
		42	5.76	0.18	1.14	5.41	6.12
						t	2.1430
					Diff > 0	***p*-value**	**0.0175***
Trustworthy	Human-edited ChatGPT Real	42	5.93	0.15	0.95	5.63	6.22
		42	5.52	0.19	1.23	5.14	5.91
						t	1.6859
					Diff > 0	***p*-value**	**0.0478***
Invest	Human-edited ChatGPT Real	42	5.26	0.15	0.99	4.95	5.57
		42	5.07	0.20	1.28	4.67	5.47
						t	0.7645
					Diff > 0	***p*-value**	**0.2234**

*Highly statistically significant ($p < 0.001$).

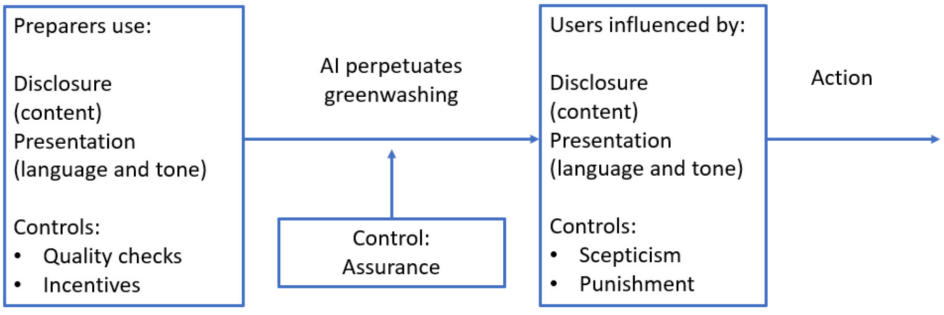

FIGURE 2 | Controls over AI perpetuating greenwashing (authors' elaboration).

influence the investment decision of our study participants, although it was notable that the experiment participants considered the AI-generated reports more trustworthy. Students did not show much scepticism, which was particularly surprising given the focus on critical perspectives in the course overall. It is possible, however, that there is a shared perception amongst report preparers and users that reporting on social and environmental matters is largely a cosmetic exercise with financial issues remaining the priority, as suggested by Solomon et al. (2013).

Preparer (manager) perspectives	Assuror perspectives	User perspectives
To what extent do managers use ChatGPT, other LLMs or AI in general to produce sustainability reports? What are the influences over sustainability report producers that might influence their decisions and actions when producing their reports? What quality checks exist over the production of sustainability reports and who conducts these checks? Are there checks over both content and tone? To what extent do report preparers collaborate in the production of reports, and what influence does this have on the final reports?	What information do assurors check when conducting reviews of climate-related information in sustainability reports? What is the background of sustainability assurors and how does this influence their actions? Can assurance perpetuate greenwashing? Why do companies choose assurance over their sustainability reports? Do the professional scepticism skills of financial auditors translate to sustainability auditing?	What reliance is placed on the assurance of sustainability reports, and by whom? What criteria do different stakeholders use when assessing sustainability reports? Can users detect greenwashing in sustainability reports, and if so, how? What actions do users take if they detect or suspect greenwashing in sustainability reports? How do users display scepticism? Do professional and non-professional investors react differently to greenwashed content? Do investors react differently to greenwashed content compared to other stakeholders? How influential on stakeholder impressions is the CEO report compared to other sections of sustainability reports?

FIGURE 3 | Future research avenues.

Our findings highlight the need for more assurance of corporate sustainability information, particularly as efficiency gains in reporting through the use of AI tools could lead to an increased volume of climate-related disclosures. Given the risks of AI tools perpetuating greenwashing in the production of reports, the risks of it remaining undetected by users, and the growing levels of cynicism around such information, assurance of sustainability information is critical. Whether assurance of the information provided would influence the users and preparers of the reports and their subsequent decisions is an important outstanding research question.

7 | Conclusion

7.1 | Summary of Findings

The results of our study provide evidence that ChatGPT can perpetuate greenwashing through the dual impression management strategies of disclosure (content) and presentation (language and tone). ChatGPT-generated reports produced by our research participants contained significantly higher levels of greenwashing than real reports. Our research participants, who were both interested in and informed about sustainability reporting and corporate actions on climate change, made very few changes to the sustainability reporting content automatically generated by ChatGPT, either through prompt engineering or subsequent manual adjustments to the text. They also (with one exception) failed to review the ChatGPT reports against genuine sustainability reports to assess whether the tone and content were representative. The lack of human intervention and checking by our study participants suggests that if AI tools are used to produce sustainability reports, they could perpetuate greenwashing.

When acting as report users, our study participants scored the AI-generated reports as more optimistic, confident and trustworthy than the real reports. Tone had more influence than content in our sample. However, the students were not any more confident investing in firms with AI-generated reports. This suggests that informed stakeholders can potentially see through the optimism of the tone used by ChatGPT when making investment decisions or alternatively discount such information entirely (as proposed by Milne and Chan 1999). Whether this would also apply to less informed audiences is unclear.

7.2 | Theoretical Contributions

Our experiment responds to calls for research into perceptions of sustainability report quality (Diouf and Boiral 2017) and for more qualitative work on user perspectives on climate-related information (Hahn and Kühnen 2013; Tilt 2010). It also responds to a growing literature on the benefits and limitations of using AI tools for corporate reporting, including sustainability reporting. We provide empirical evidence to support prior research that suggests that AI tools can perpetuate greenwashing (see, for example, De Villiers et al. 2023).

We contribute to impression management theory by highlighting the unchecked influence of tone over content. We integrate our findings with the Merkl-Davies and Brennan's (2007) framework, proposing a new conceptual framework to demonstrate how generative AI can greenwash through both content and tone. Unlike prior studies that examine production or use separately (e.g., Hahn and Kühnen 2013; Diouf and Boiral 2017), our dual-role research design offers unique insights into how impression management flows through the climate-related reporting process. We highlight the

importance of controls at the production and use stages, and how assurance of sustainability information can act as an additional control.

By designing our experiment using students as participants, we also contribute to the tertiary education literature. Our series of assignments used for the experiment provide a novel approach to teaching corporate reporting in an era of advanced AI and provide an example of how AI can be used positively in business education (as proposed by Ballantine et al. 2024). Our paper not only provides a replicable experiment and novel teaching approach but also highlights the danger of student overreliance on technology (Prather et al. 2023), and related challenges when these students then enter the workforce (Loureiro et al. 2021).

7.3 | Practical Implications

As interest in sustainability reports continues to grow and AI tools are increasingly used in corporate reporting activities, our findings support the view of Farooq and de Villiers (2020) that urgent action needs to be taken towards the standardisation and assurance of climate-related disclosures. The current guidelines on sustainability reporting (even the recent introduction of IFRS S1 and S2 by the ISSB) remain relatively high-level and principles-based and give managers considerable discretion in the content and tone of their disclosures. Moves towards mandating XBRL may enhance comparability but do not reduce the ability of managers to choose how they may wish to discuss and interpret their sustainability information for the benefit of users.

We also note that despite rapid concurrent developments in both sustainability reporting and AI, standard-setters are not directly addressing the use of AI tools when producing corporate reports. Our findings suggest that there needs to be more integration of these technologies into reporting frameworks, with emerging opportunities and risks clearly highlighted for both preparers and users.

Our findings are also relevant for managers. While the use of AI tools has ushered in an era of unprecedented change and efficiency, the use of LLM tools comes with specific risks that are relevant to the preparers of any corporate reports, including sustainability reports. Our study shows evidence of overreliance on AI output, a lack of critical thinking from human actors and a willingness to believe in the persuasive nature of AI communications—all of which are worrying factors when managers are producing reports that will be used for investment decision-making. Our new conceptual framework therefore provides a useful reference point for managers when considering the implications of AI use in sustainability reporting, highlighting actions they might take to mitigate risks of greenwashing. In particular, additional quality checks may need to be introduced to ensure that reporting is transparent. Managerial incentives relating to sustainability reporting may also need to be reviewed to ensure that data quality remains of paramount importance. The relative importance of assurance as a control is also a factor for organisations to consider when determining the level of assurance their stakeholders are likely to require over their disclosures.

7.4 | Limitations

Our experiment uses a small sample of masters-level accounting students, which limits generalisability. Our sample's size (14 participants) and age range (under 30) also reduce variability in attitudes toward technology (KPMG 2021). While students are often used as proxies for managers (Elliott et al. 2007), they do not face real-world consequences for their actions. In addition, our focus on the CEO section of sustainability reports (which has been linked to impression management—see Barkemeyer et al. 2014), and our chosen evaluation metrics may limit broader applicability.

7.5 | Future Research Avenues

To support our findings, qualitative research with managers could deepen our understanding of how AI influences impression management in sustainability reporting. Future research could also examine whether older participants are more sceptical of AI-generated content, given younger generations' greater trust in technology (KPMG 2021) and attraction to green purchasing decisions (Lopes et al. 2023). Our study offers a replicable experiment that can be extended to larger and more diverse participant groups to explore variables like age, gender and sustainability reporting knowledge. The experiment could also be adapted to other sections of sustainability reports beyond the CEO section, focusing in particular on the different impacts of quantitative vs. qualitative information around climate change.

As our findings show that AI can perpetuate greenwashing, and that human intervention—largely absent in our study—is essential to mitigate this risk, we propose that future research focuses on the roles of producers, users and assurors (Figure 2) and assesses the effectiveness of human oversight at each stage. Below, we expand our Figure 2 framework to explore ideas for future research into this topical and fast-moving area, presenting these in Figure 3.

Author Contributions

Ruth Dimes: conceptualization, methodology, writing – original draft, project administration, investigation. **Charl de Villiers:** conceptualization, writing. **Paul Denny:** conceptualization, methodology, data curation. **Juho Leinonen:** conceptualization, methodology, data curation.

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Conflicts of Interest

The authors declare no conflicts of interest.

Endnotes

[1] There was no evidence that students were aware of the deceptive nature of the experiment while scoring.

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Appendix A

Student Assignments

Assignment A1 (10 marks, 10% of total grade).

Available from: 5 April. Due by: 12 noon on Friday 14 April.

Create a one-page 500-word CEO statement to shareholders to accompany the sustainability report for a fictional forestry company based in New Zealand using ChatGPT (register and login: https://chat.openai.com/auth/login). You can assume that this is for a large listed forestry company, with 500 employees and export sales of NZ$150 million, derived from operations that include plantation forestry and the sale of timber products. The text for the statement should be generated **only using ChatGPT commands**, with no subsequent editing by you (of Files 1 or 2 mentioned below).

Please upload two files to Canvas, naming the files as follows:

File 1 (Microsoft Word)—A list of your complete conversation with ChatGPT, including all prompts and responses (if you perform this task as one continuous ChatGPT conversation, you can simply copy and paste the prompts and responses into a Word document).

File 2 (Microsoft Word)—A 'clean' final CEO statement in Word (i.e., the final ChatGPT response from your conversation).

Next, edit your File 2 by hand (if you wish) to produce a final CEO report to shareholders that you are happy with. Please upload two further files to Canvas as follows:

File 3 (Microsoft Word)—A version of File 2 showing all tracked changes (if you made any) that you made in Word, with comments stating why you made those changes.

File 4 (Microsoft Word)—A 'clean' version of File 3 with no tracked changes.

Finally, please upload a file with your reflections on the exercise:

File 5 (Microsoft Word)—A 150-word reflection on how you found this exercise.

Marking: Please note that you will receive a full 10 marks for Part A1 of this assignment if all files are loaded onto Canvas as described by the due date.

Assignment A2 (10 marks, 10% of total grade). 500 words, excluding references.

Available from: 15 April. Due by: 9 AM on Wednesday 26 April.

Would your File 4 from assignment Part A1 be suitable as the CEO statement of a forestry company in the Hawkes Bay area of New Zealand in April 2023, given recent events and the opinions expressed by politicians and other commentators? (You can assume as for Part A1 that this is a large listed forestry company, with 500 employees and export sales of NZ$150 million, derived from operations that include plantation forestry and the sale of timber products). Explain your answer with reference to the purpose of sustainability reporting, discussing the theories introduced so far during this course.

Please upload one file to Canvas:

File 6 (Microsoft Word)—Your 500-word commentary.

Marking: Part A2 will be marked using the rubric below:

	Excellent (A)	Good (B)	Satisfactory (C)	Unsatisfactory
Content	The assignment demonstrates an excellent understanding of the topic. The content is accurate and supported by relevant and reliable sources.	The assignment demonstrates a good understanding of the topic. The content is mostly accurate and supported by relevant and reliable sources.	The assignment demonstrates a satisfactory understanding of the topic. The content is generally accurate and supported by some relevant and reliable sources.	The assignment demonstrates a poor understanding of the topic. The content is inaccurate and/or not supported by relevant and reliable sources.
Critical Thinking	The assignment demonstrates excellent critical thinking skills, including analysis, evaluation and synthesis.	The assignment demonstrates good critical thinking skills, including analysis, evaluation and synthesis.	The assignment demonstrates some critical thinking skills, including analysis, evaluation and synthesis.	The assignment lacks critical thinking skills.
Written expression	The assignment is well organised, clear and easy to follow. The assignment is written in an appropriate academic style, and appropriate referencing is used throughout.	The assignment is mostly well organised, clear and easy to follow. The assignment is mostly written in an appropriate academic style with appropriate referencing style.	The assignment is reasonably well organised but not always easy to follow. The assignment is mostly written in an academic style, but referencing is poor.	The assignment is poorly organised, unclear and difficult to follow. It is not written in an appropriate academic style and referencing is poor.

Assignment B1 (10 marks, 10% of total grade).

Available from: Thursday 27 April. Due by: 9 AM on Tuesday 2 May.

You have been provided with 10 CEO reports. Using the marking rubric provided in the Excel file, score these reports based on the criteria provided. Full instructions are provided in the Excel file.

Please upload two files to Canvas:

File 7 (Microsoft Excel)—The Excel file containing your scores for the 10 reports.

File 8 (Microsoft Word)—A 150-word reflection on how you found this exercise.

Excel file details:

For each of the 10 reports allocated to you, score each report relating to the following statements, using the Likert scale below:

7 = *Strongly agree*, 6 = Agree, 5 = *Somewhat agree*, 4 = *Neither agree nor disagree*, 3 = *Partly disagree*, 2 = *Disagree*, 1 = *Strongly disagree*

Statement 1: There is an appropriate balance of qualitative and quantitative information in the report

Statement 2: There is an appropriate balance of positive and negative information in the report

Statement 3: A broad range of stakeholders are mentioned in the report

Statement 4: The report sounds optimistic

Statement 5: The report sounds confident

Statement 6: The report sounds trustworthy

Statement 7: I would invest in this company

Marking: Please note that you will receive a full 10 marks for Part B1 of this assignment if your files are loaded onto Canvas as described by the due date.

Assignment B2 (10 marks, 10% of total grade).

Available from: Wednesday 3 May. Due by 9 AM on Tuesday 9 May.

500 words max, excluding tables.

Review the Excel file on Canvas, which reveals the results from your class peer review of sustainability statements. There are 140 observations in the file (10 reports scored by 14 students). There were a total of 32 reports in the sample, consisting of:

14 ChatGPT reports (your File 2 reports from Assignment 1A).

14 Human-edited ChatGPT reports (your File 4 reports from Assignment 1A).

4 Control reports: 3 of which are from real companies, 1 of which is a ChatGPT control (similar to your File 2).

All students scored the 4 control reports, and the other 6 reports you scored were a mixture from your peer group. You did not score your own reports.

Perform statistical analysis (e.g., *t*-tests or ANOVA tests) on the results and comment on your analysis.

Please upload one file to Canvas:

File 9 (Microsoft Word)—A file containing your statistical analysis and comments.

Marking:

	Excellent (A)	**Good (B)**	**Satisfactory (C)**	**Unsatisfactory**
Statistical analysis	The statistical analysis is accurate and is clearly and professionally presented.	The statistical analysis is mostly accurate and is mostly clearly and professionally presented.	Some of the statistical analysis is accurate, and the work is presented clearly but could be more professional.	The statistical analysis is inaccurate and poorly presented.
Critical Thinking	The assignment demonstrates excellent critical thinking skills, including analysis, evaluation and synthesis.	The assignment demonstrates good critical thinking skills, including analysis, evaluation and synthesis.	The assignment demonstrates some critical thinking skills, including analysis, evaluation and synthesis.	The assignment lacks critical thinking skills.
Written expression	The assignment is well organised, clear and easy to follow. The assignment is written in an appropriate academic style.	The assignment is mostly well organised, clear and easy to follow. The assignment is mostly written in an appropriate academic style.	The assignment is reasonably well organised but not always easy to follow. The assignment is mostly written in an academic style.	The assignment is poorly organised, unclear and difficult to follow. It is not written in an appropriate academic style.

Assignment C (30% of total grade).

Available from: 17 May. Due by: 9 AM on Friday 2 June. 1000 words max, excluding references.

Required:

Critically analyse the results from Parts A and B of this assignment in light of the theories and research articles discussed during this course, discussing the implications of the findings, and what you have learnt while doing Parts A and B, for the future of sustainability reporting and assurance.

Please upload one file to Canvas:

File 10 (Microsoft Word)—A file containing your response to the question above.

Marking: Part C will be marked using the rubric below:

	Excellent (A)	**Good (B)**	**Satisfactory (C)**	**Unsatisfactory**
Content	The assignment demonstrates an excellent understanding of the topic. The content is accurate and supported by relevant and reliable sources.	The assignment demonstrates a good understanding of the topic. The content is mostly accurate and supported by relevant and reliable sources.	The assignment demonstrates a satisfactory understanding of the topic. The content is generally accurate and supported by some relevant and reliable sources.	The assignment demonstrates a poor understanding of the topic. The content is inaccurate and/or not supported by relevant and reliable sources.
Critical Thinking	The assignment demonstrates excellent critical thinking skills, including analysis, evaluation and synthesis.	The assignment demonstrates good critical thinking skills, including analysis, evaluation and synthesis.	The assignment demonstrates some critical thinking skills, including analysis, evaluation and synthesis.	The assignment lacks critical thinking skills.
Written expression	The assignment is well organised, clear and easy to follow. The assignment is written in an appropriate academic style, and appropriate referencing is used throughout.	The assignment is mostly well organised, clear and easy to follow. The assignment is mostly written in an appropriate academic style with appropriate referencing style.	The assignment is reasonably well organised but not always easy to follow. The assignment is mostly written in an academic style, but referencing is poor.	The assignment is poorly organised, unclear and difficult to follow. It is not written in an appropriate academic style and referencing is poor.