

Digital Carbon Management and ESG Greenwashing Risk: A Case Study of BYD's Sustainability Disclosure

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Abstract

This paper explores the effect of digital carbon management on ESG greenwashing in corporate sustainability reporting. The paper uses a qualitative single case research design and preliminary textual analysis based on the text of BYD's 2025 Sustainability Report. The results indicate that digital carbon management can lessen the risk of greenwashing through increase in data traceability, disclosure specificity, carbon accounting capability, embedding of governance, and readiness for verification. BYD's iDi Carbon Chain platform is an example of a pathway to transparency, achieved by organizational carbon management, product carbon footprint accounting and compliance reporting. However, the analysis also shows that symbolic sustainability narratives remain central in ESG communication. The paper thus seeks to show that the anti-greenwashing effect of digitalisation is not self-evident. It is dependent on the embedding of digital tools in external standards and board-level governance and verification mechanisms.

Keywords

ESG disclosure, greenwashing risk, digital carbon management, sustainability reporting, new energy vehicles

1. Introduction

1.1 Research Background

Environmental, social and governance (ESG) disclosure has emerged as a critical means for companies to convey their sustainability plans, environmental impact and governance obligations to investors, regulators, consumers and other stakeholders. Christensen, Hail and Leuz [1] state that sustainability reporting has the potential to mitigate information asymmetries between a company and outsiders. However, the usefulness of information reported in sustainability reports depends on the credibility, comparability and decision usefulness of the information disclosed. The global survey carried out by KPMG [2] also indicates a shift from voluntary sustainability reporting to a normal part of corporate life. This implies that ESG disclosure isn't just supposed to be a communication tool, it should be a way for companies to show accountability.

However, the rapid growth of ESG reporting has also intensified concerns about greenwashing. Delmas and Burbano [3] describe greenwashing as a situation in which firms present a positive environmental image while their actual environmental performance may not fully support such claims. Lyon and Montgomery [4]

further conceptualize greenwash as a broad category of potentially misleading environmental communication, including selective disclosure, vague claims and symbolic language. In this regard, the disclosure of ESG can have an informational role as well as a role to legitimize the strategy. In Suchman's legitimacy theory [5], the author also argues that companies can obtain social legitimacy by turning the information they communicate to the public into socially acceptable information.

This is especially topical when considering the new energy vehicle industry. Many new energy vehicle companies are seen as inherently linked to environmental transition as their products advance the transition towards electrification of transport and carbon reduction. But this “green” brand also can lead to increased stakeholder expectations. For these companies, ESG credibility is not only about the ESG impact of their products and services, but about how transparent their operations and supply chains are, as well as their carbon accounting systems and sustainability governance.

1.2 Case Selection and Research Question

BYD provides an interesting use case to explore this relationship. BYD is a leading Chinese new energy vehicle company with business segments of automobiles, electronics, new energy and rail transit and is headquartered in Shenzhen. In 2025, more than 4.6 million new energy vehicles were sold, and the company's 2025 Sustainability Report shows that it has reduced the carbon footprint by an estimated 46.6 million tonnes in comparison with the carbon footprint of traditional fuel vehicles within the scope of the Sustainability Report; it also indicates that the company has consumed 7.29 billion kWh of clean electricity and invested RMB 2.04 billion in environmental protection in 2025 [6]. These disclosures form a bedrock to discuss the connection between substantive ESG evidence and symbolic sustainability communication.

Digital carbon management could be one solution to the greenwashing risk. There are several options available to companies to enhance the traceability, specificity and verifiability of ESG information through digital platforms, automated data collection and carbon accounting tools and product carbon footprint systems. However, going digital doesn't make greenwashing risk go away. Digital tools can likewise contribute to the development of a more compelling sustainability story from companies, a more complex visual reporting and more appealing ESG communication. Therefore, digital carbon management may have a dual effect. It can reduce greenwashing risk by strengthening evidence-based disclosure, but it may also coexist with symbolic ESG storytelling.

This paper asks how does digital carbon management influence ESG greenwashing risk in corporate sustainability disclosure? The study does not claim that BYD engages in greenwashing. Instead, it uses BYD as an exploratory case to understand how digital carbon management may reshape the relationship between ESG disclosure credibility and greenwashing risk. The central argument is that digital carbon management reduces greenwashing risk when it is supported by data traceability, external standards, governance structures and verification mechanisms, while symbolic ESG narratives remain important in corporate sustainability communication.

2. Literature Review

This section reviews three streams of research that are relevant to the study: ESG disclosure and greenwashing, digital transformation and ESG disclosure, and reporting standards, governance and verification. These streams provide the theoretical foundation for the dual-path framework developed in the next section.

2.1 ESG Disclosure and Greenwashing

ESG disclosure is widely expected to improve transparency between corporations and stakeholders. In principle, sustainability reports help stakeholders assess firms' environmental and social impacts, governance systems and long-term risk exposure. However, prior research warns that sustainability reporting may not always produce substantive accountability. Cho, Laine, Roberts and Rodrigue [7] argue that sustainability reports can become organizational facades when firms face contradictory institutional expectations and attempt to manage public impressions. Boiral [8] similarly suggests that some highly rated sustainability reports may reproduce idealized representations rather than fully reflect organizational realities .

The distinction between substantive disclosure and symbolic disclosure is central to greenwashing research. Substantive disclosure provides specific, measurable and verifiable information. Symbolic disclosure relies more heavily on broad values, narratives and future-oriented commitments. Michelon, Pilonato and Ricceri [9] argue that CSR reporting practices, including stand-alone reports, assurance and reporting guidance, do not automatically improve disclosure quality; their effect depends on how firms use them. Hummel and Schlick [10] further show that the relationship between sustainability performance and sustainability disclosure is theoretically ambiguous because voluntary disclosure theory and legitimacy theory imply different reporting incentives.

Greenwashing risk can therefore be considered a disclosure credibility problem. ESG disclosure does not in itself prove the authenticity of ESG. It's not about whether disclosure is general or whether it's detailed, it's about whether disclosure is specific, balanced, comparable and verifiable, and whether there are real governance and performance systems that relate to the disclosure. This paper is an extension of this perspective and explores the potential of digital carbon management as a means to enhance the credibility of disclosures.

2.2 Digital Transformation and ESG Disclosure

Digital transformation has the potential to transform the way ESG data is produced and governed. Digital platforms facilitate the businesses to gather data on the environment from factories, supply chains, product life cycle processes and energy systems. Burritt and Schaltegger [11] stress that sustainability information is more significant if linked to tangible information and management decisions. Based on this logic, digital carbon management can create more value for the management usefulness of ESG disclosure by linking the environmental claims with measurable operational data.

Digital technologies are also facilitating transparency of supply chains. Bai and Sarkis [12] claim that technology like blockchain can enhance the transparency and sustainability assessment of the supply chain, making it more traceable and boosting the confidence of the stakeholders. This paper does not specifically address blockchain, but the principle is the same: digital systems are better suited to make data more traceable, auditable and comparable in order to significantly improve the transparency of the situation. Digital carbon management could thus be a disclosure infrastructure of interest for companies with extensive manufacturing processes and global value chains.

But digitalization can also lead to a more complex communication situation. The ESG reports are becoming more and more visual, structured and narrative. The claims of sustainable products can be more convincing with digital communication, but not necessarily more verifiable. However, the connection between digital transformation and ESG greenwashing risk should not be taken for granted. The digitalization can have a positive effect on data quality but can also enhance the symbolic communication. This tension is the impetus behind the framework of dual-paths in this paper.

2.3 Reporting Standards, Governance and Verification

Reporting standards and governance systems contribute to the credibility of the ESG disclosure. According to Ioannou and Serafeim [13] mandatory sustainability reporting can have an impact on the disclosure practices and orientation to social responsibility of a firm. Global Reporting Initiatives (GRI) Standards are based on the principles of accuracy, balance, clarity, comparability and verifiability [14]. The orientation of sustainability disclosures and climate disclosures towards investors is echoed in the ISSB's IFRS S1 and IFRS S2 [15]. These frameworks facilitate the consistency of ESG reporting in terms of language and structure.

In the case of carbon related disclosure, verification is especially critical. ISO 14064-1 specifies the requirements and guidelines for quantifying and reporting GHGs for an organization and ISO 14067 specifies the requirements and guidelines for quantifying the GHGs of a product [16, 17]. Digital carbon management systems aligned with such standards can enhance the credibility of carbon data by providing more structure and verifiability. But it's not just standards alone. These should be part of internal governance systems, external verification processes and meaningful scrutiny by stakeholders.

3. Conceptual Framework

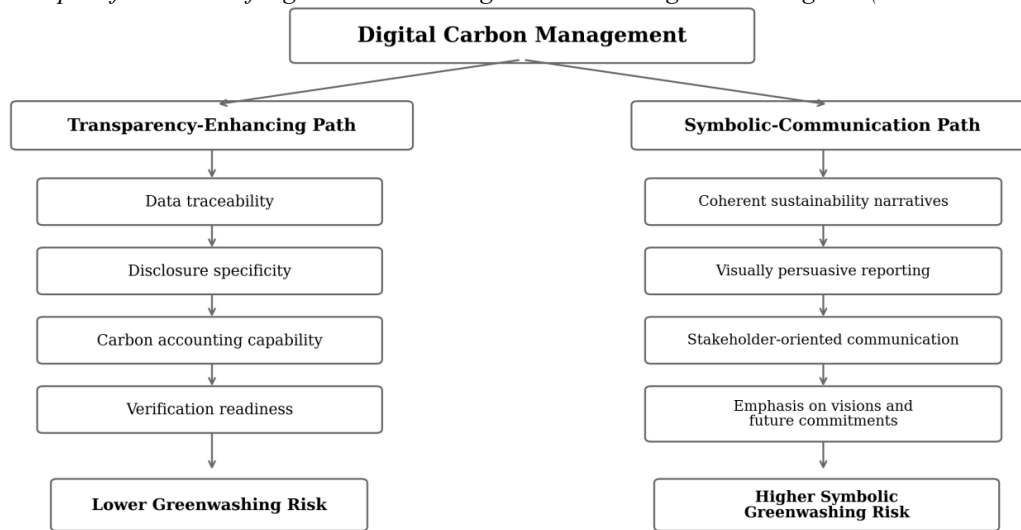
This section develops a dual-path framework that links digital carbon management to ESG greenwashing risk. The framework explains why digitalization may both strengthen disclosure accountability and support symbolic communication.

3.1 A dual-path Perspective

The first one is the transparency-enhancing path. Digital carbon management can mitigate the risk of greenwashing by enhancing data traceability, specificity of disclosures, carbon accounting capacity and preparedness for verification. This route is based on using digital tools to assist with accountability as they enable measurable evidence of environmental claims. The second one is the symbolic-communication path. Digital ESG communication can contribute to bolstering corporate legitimacy as it renders ESG communication more coherent, persuasive and visually appealing for stakeholders. As part of this route, digital instruments can also be used alongside symbolic disclosure if the reporting focuses on visions, values and commitments rather than on measurable performance.

The question isn't really whether symbolic narratives exist or not, but rather whether there is any evidence that balances the symbolic narratives. Corporate reporting is mostly symbolic storytelling, as the companies have to share values, missions and long-term strategies. When symbolic communication is however not correlated with measurable performance, it can be an additional risk for greenwashing. Thus, the trustworthiness of digital ESG disclosure hinges on the balance between the intensity of the narrative and the specificity of the evidence.

Figure 1: Dual-path framework of digital carbon management and ESG greenwashing risk (Author's own illustration)



3.2 Propositions

Based on the dual-path framework, this study develops three propositions that guide the textual analysis of BYD's sustainability disclosure.

Proposition 1: Digital carbon management reduces ESG greenwashing risk by improving the traceability, specificity and verifiability of environmental disclosure.

Proposition 2: Digitalized ESG communication may increase symbolic greenwashing risk when narrative intensity exceeds evidence-based disclosure.

Proposition 3: The greenwashing-reducing effect of digital carbon management is stronger when digital disclosure is supported by external standards, board-level governance and third-party verification.

These propositions are not tested through causal econometric methods in this study. Instead, they provide a conceptual framework for interpreting preliminary textual evidence from BYD's sustainability disclosure.

4. Methodology

This section explains the research design, data source, coding scheme and scoring method used to analyze the case. The study is designed as an exploratory qualitative case study with preliminary textual evidence.

4.1 Research Design and Data Source

The research design of this study is a qualitative single-case research, using preliminary textual analysis. A single-case design is suitable as the research purpose is exploratory, aimed at gaining an understanding of the representation of digital carbon management in sustainability disclosure and how it could be associated with ESG greenwashing risk. BYD is chosen as an information-rich case, as it is a front runner in the new energy vehicle sector, has high sustainability visibility and provides a specific digital carbon management platform.

The main source of data is BYD's Sustainability Report 2025. The report covers the time frame from 1st January 2025 to 31st December 2025. The report is acceptable for textual analysis as it has substantive as well as symbolic aspects. Substantive elements involve carbon emission information, utilization of clean electricity, environmental investments, zero carbon industrial parks, green factories, governance structures and references to ISO related carbon accounting. There are symbolic elements like the visions of 'cooling the Earth by 1 degree Celsius', three green dreams and the DREAMS sustainability concept. The study is not intended to provide verification of BYD's environmental performance. Rather, it considers how disclosure attributes can enhance or diminish greenwashing risk.

4.2 Coding Scheme and Scoring Method

There are five categories for coding the texts. The categories aim to differentiate between disclosure that is backed by evidence and symbolic sustainability communication. A summary of the coding scheme is provided in Table 1. The keyword hits listed in Table 3 were created via a text extraction and keyword matching procedure using Python, to make the keyword-assisted stage replicable. PyMuPDF (fitz) was used to convert the PDF report to machine-readable text, and category-specific keyword lists were applied to the text. Since the source report is mainly a Chinese language document, both the English and the Chinese equivalent of the key words were included. The counts were not used to provide independent statistical evidence, but to inform the identification of the textual presence of appropriate themes and to inform qualitative coding.

Table 1: Coding scheme for preliminary textual analysis

Code	Category	Definition	Examples in the BYD case
A	Digital carbon management	Disclosure related to digital carbon platforms, automated accounting, carbon data monitoring and product carbon footprint systems.	iDi Carbon Chain; automated carbon data calculation; product carbon footprint accounting.
B	Substantive ESG disclosure	Quantified or evidence-based ESG information, including emissions, energy use, investment, targets and performance indicators.	Clean electricity use; environmental investment; Scope 1 and Scope 2 emissions; carbon intensity.
C	Standards and verification	References to reporting standards, ISO certification, third-party verification or external compliance mechanisms.	GRI; ISSB; ESRS; ISO 14064; ISO 14067; assurance mechanisms.
D	Governance embedding	Texts showing ESG governance structures, board oversight, committees, internal control or accountability mechanisms.	Board responsibility; Strategic and Sustainability Committee; ESG Management Committee.
E	Symbolic ESG narrative	Broad sustainability language, vision statements, legitimacy claims and corporate identity narratives.	Three green dreams; cooling the Earth by 1 degree Celsius; DREAMS concept.

In addition, the study applies an interpretive disclosure specificity score. The purpose of this score is not to produce a statistically representative measure, but to provide a transparent way to compare different types of disclosure. The scoring system is shown in Table 2.

Table 2: Disclosure specificity score

Score	Meaning	Greenwashing-risk implication
0	Pure symbolic narrative with no concrete action or data.	Higher symbolic ambiguity.
1	Action description exists, but without quantitative evidence.	Some substantive content, but limited verifiability.

Score	Meaning	Greenwashing-risk implication
2	Quantitative evidence is provided, but external verification or governance linkage is limited.	Lower ambiguity, but credibility still depends on scope and method.
3	Quantitative evidence is supported by standards, certification, verification or governance mechanisms.	Stronger evidence base and lower greenwashing risk.

5. Case Background

This section presents the case background of BYD and explains why its sustainability disclosure provides a useful setting for analyzing digital carbon management and greenwashing risk.

5.1 BYD and the New Energy Vehicle Industry

BYD describes itself as a technology-driven company committed to green development and innovation. The company was established in 1994 and now the company is based in Shenzhen. It operates in the automotive industry, electronics, new energy and rail transportation and is listed both in Hong Kong and in Shenzhen. The report describes a company which combines electric mobility, renewable energies, storage and technological solutions within a larger sustainability plan: BYD.

The new energy vehicle industry is closely related to carbon reduction and transportation electrification, which are key aspects of ESG research. But, when this link occurs it can be dangerous because it gives the appearance of legitimacy. Automatic labelling of new energy vehicle companies as green, could also make stakeholders less aware of operational emissions and supply chain risks, battery recycling, resource usage and manufacturing impacts. Thus, disclosures on sustainability at this sector should not only concern the environmental value of the products, but also evidence on organizational carbon management and governance.

5.2 BYD Sustainability Disclosure

BYD's 2025 Sustainability Report emphasizes formal standardization. It states that it has been prepared based on the Hong Kong Stock Exchange ESG Reporting Code and Shenzhen Stock Exchange sustainability reporting guidance, and is consistent with ESRS, GRI Standards, ISSB IFRS S1 and IFRS S2, SDGs and ISO IWA 48:2024. This means that it sits in a number of domestic and international disclosure frameworks.

The report also highlights the reporting principles such as materiality, quantification, balance and consistency. Furthermore, it also mentions GRI principles including accuracy, balance, clarity, comparability, completeness and sustainability context, as well as timeliness and verifiability. The principles are also pertinent to greenwashing risk, as they directly tackle recognised weaknesses of the symbolic disclosure, such as low verifiability, selective reporting and vagueness.

5.3 iDi Carbon Chain Platform

The iDi Carbon Chain digital carbon management platform is a key component of BYD's sustainability reporting. The report says that the platform was created to meet the needs of the digital and intelligent transformation of corporate carbon management. It emphasizes carbon modules of an organization and of products and facilitates monitoring operational carbon emissions, accounting for product life cycle carbon footprints, automated calculation of vehicle carbon data, compliance reporting on an international scale, etc. [6].

The report also claims that BYD adopted the iDi Carbon Chain platform to do intelligent data statistics and calculation on greenhouse gases, and that the platform passed the ISO14064 certification. It also says that the platform was ISO 14067 certified with regards to accounting the product carbon footprint. These assertions are important as they take ESG disclosure beyond a generalised sustainability story into a more data-centric approach to carbon management.

6. Textual Analysis and Preliminary Evidence

This section strengthens the empirical component of the paper by moving beyond a small set of representative examples. The analysis treats BYD's 2025 Sustainability Report as a structured disclosure text

and examines it through systematic qualitative coding, keyword-assisted evidence mapping and interpretive disclosure specificity scoring. The purpose is not to prove whether BYD engages in greenwashing, but to evaluate how different types of disclosure may reduce or leave residual ESG greenwashing risk. In line with the conceptual framework, the analysis distinguishes transparency-enhancing evidence from symbolic sustainability communication.

6.1 Coding Procedure and Keyword-assisted Screening

The textual analysis is based on a three-step qualitative procedure that is assisted by Python. First, the PDF version of BYD's 2025 Sustainability Report was converted into machine-readable text by using PyMuPDF (fitz). Second, Python keyword matching was used with five category-specific keyword lists to the extracted text. The categories have been listed according to the coding scheme: Digital carbon management; substantive environmental metrics; standards and verification; governance embedding; and symbolic sustainability narratives. Third, the textual segments located were qualitatively interpreted and scored using the disclosure specificity scale (0 – 3). The higher the score, the more evidence, stronger connections to standards or verification, and stronger governance support are found in the disclosure.

The number of keywords is employed as a screening tool and not as a statistical test. The list of keywords was tightened as this would otherwise overcount very broad terms like data, platform or sustainability, as general reference. Some terms are common in more than one section and translation equivalents may be found in a variety of forms; the count should be considered as suggestive of the visibility of a theme, rather than as a precise measure of the quality of disclosure. The use of Python in screening, however, enhances the transparency of the text analysis process as the evidence selection procedure becomes more explicit and replicable.

Table 3: Keyword-assisted textual screening of BYD's 2025 Sustainability Report

Analytical category	Main keywords used for screening	Keyword hits	Interpretation
Digital carbon management	iDi Carbon Chain; digital carbon management; intelligent carbon management; automated carbon calculation; product carbon footprint; organizational carbon management	123	The stricter Python screening shows that digital carbon management is a visible but focused theme, supporting the analysis of carbon data infrastructure rather than broad digital rhetoric.
Substantive environmental metrics	carbon emission; carbon reduction; clean electricity; green electricity; environmental investment; zero-carbon park; green factory; Scope 1; Scope 2; carbon neutrality	275	Environmental metrics are strongly represented, suggesting that the report contains measurable disclosure rather than only general sustainability claims.
Standards and verification	ISO 14064; ISO 14067; GRI; ISSB; ESRS; TCFD; third party; assurance; certification; verification	416	Verification- and standards-related language is highly visible, supporting the argument that formal standards are central to disclosure credibility.
Governance embedding	board; Strategic and Sustainability Committee; ESG Management Committee; risk management; internal control; performance assessment; remuneration; training	390	Governance-related language is prominent, indicating that ESG disclosure is repeatedly connected with oversight, accountability and incentive mechanisms.
Symbolic sustainability narratives	green dreams; cooling the Earth by 1 degree Celsius; DREAMS; vision; mission; responsibility; shared value; green innovation	414	Symbolic and legitimacy-oriented narratives remain highly prominent, supporting the symbolic-communication path in the conceptual framework.

Note. Keyword hits were generated through a Python-based keyword-assisted textual screening procedure using the extracted text of BYD's Chinese-language 2025 Sustainability Report. The keyword list included both English terms and Chinese equivalents, but the table reports English labels only. The counts are used only to guide qualitative coding and should not be interpreted as independent statistical evidence.

6.2 Evidence of Transparency-enhancing Disclosure

BYD's iDi Carbon Chain platform is the best proof of the transparency-enhancing route. The report describes the platform as a digital carbon management infrastructure and not a communications platform. It's

said to enable organizational carbon management and product carbon modules, operational carbon emission monitoring, product life cycle carbon footprint accounting, automated vehicle carbon data calculation and international compliance reporting.

There are two reasons why this evidence is significant. First, it takes digitalization and makes it carbon accounting capable. The platform is not only used to present ESG information, but also to collect, calculate and manage carbon-related data. Secondly the platform is connected to the external standards. The report mentions a platform that is certified to ISO 14064 and ISO 14067 for better readiness in verification. Thus, iDi Carbon Chain platform evidence is that digital carbon management can help mitigate the risk of greenwashing through enhanced traceability and verifiability.

But this conclusion should be noted with caution. The fact that there is a digital platform does not mean that all environmental claims are fully verified. Instead, it indicates that BYD is building a disclosure infrastructure that is capable of more evidence-based ESG disclosure.

Detailed textual evidence and disclosure specificity scores are provided in Appendix A to support the interpretation of the transparency-enhancing and symbolic-communication paths.

6.3 Quantified Environmental Disclosure and Specificity

BYD's report contains multiple quantified environmental indicators. These include clean electricity use, environmental protection investment, carbon emissions, carbon intensity, green factories, zero-carbon parks and carbon reduction estimates [6]. These quantified indicators improve disclosure specificity because they allow stakeholders to evaluate ESG claims through measurable information. Compared with broad statements such as a general commitment to green development, quantified indicators reduce ambiguity and make the disclosure more comparable over time.

Nevertheless, quantified disclosure does not automatically eliminate greenwashing risk. Numbers can create a perception of objectivity, but their credibility still depends on reporting boundaries, calculation assumptions, data sources and verification mechanisms. For example, carbon reduction estimates depend on comparison baselines and usage assumptions. Therefore, the textual evidence suggests a reduction in symbolic ambiguity, but not the complete removal of greenwashing risk.

6.4 Governance Embedding and Accountability Mechanisms

The report provides evidence that carbon management is embedded in governance structures. BYD describes a climate governance architecture involving the board of directors, the Strategic and Sustainability Committee, the ESG Management Committee, the ESG Sustainability Department and ESG personnel within business groups and divisions. This structure indicates that sustainability disclosure is connected to internal governance rather than remaining only a public communication exercise.

The report also mentions that climate-related information is distributed to the board members, that board members and management receive training on climate change and that sustainability performance indicators are tied to the remuneration of the executive and senior managers. This is because, incentive alignment increases the relationship between disclosure and the accountability of the managers. Governance embedding has a moderating effect from a greenwashing-risk perspective. Carbon data connected to board oversight, risk management, internal reporting and performance incentives will be more likely to mitigate greenwashing risk in digital carbon management.

6.5 Symbolic Sustainability Narratives and Legitimacy Building

The report also has a powerful symbolic sustainability story. There is also recurring language used to mark identity building which include concepts like the three green dreams, DREAMS, cooling the Earth by 1 degree Celsius, green innovation, responsibility and shared value. These can be expressions in a positive way. Symbols narratives are frequently used as a method of communicating values, mission and long-term strategic orientation in corporate sustainability reports.

But when symbolizations are not complemented by quantifiable proof, they do have relevance in the context of the risk of greenwashing. The BYD case demonstrates that there can be both symbolic and

substantive disclosure. On the other hand, the report assures evidence-based disclosure via carbon data, ISO-related standards, product carbon footprint accounting and governance structures. It also, however, applies potent legitimacy-building narratives in building a green corporate identity. This is a finding that corroborates the symbolic-communication path as digital ESG communication can lead to increased corporate legitimacy due to the more coherent and convincing sustainability narratives.

6.6 Disclosure Boundary and Residual Greenwashing Risk

There are also disclosure limitations that remain, with a more critical reading of the report. First, there is not a complete coverage of the environmental KPI boundary for all overseas bases and sales stores. This boundary disclosure is transparent, but also indicates that this data on the environment cannot be interpreted as a full global operational footprint. Second, other information related to climate change transactions, for example costs and revenues from carbon trading, is not reported because of business sensitivity. Third, a number of carbon-related disclosures are tied to standards and verification, but not all environmental disclosures are created equal and not all are equally assured by a third party.

These restrictions are not to be interpreted as greenwashing by BYD. Instead, they illustrate why the paper should refer to greenwashing risk, rather than greenwashing behavior. The textual evidence indicates that digital carbon management can lead to a reduction of the risk of greenwashing, but that risks persist in cases of incomplete disclosure boundaries, assumptions or verification coverage.

Table 5: Pathway-level synthesis of the textual analysis

Pathway	Supporting evidence	Risk-reduction mechanism	Residual concern
Transparency-enhancing path	iDi Carbon Chain; ISO 14064/14067; Scope 1 and Scope 2 emissions; clean electricity use; climate governance; ESG-linked remuneration	Improves traceability, specificity, carbon accounting capability, governance embedding and verification readiness.	Disclosure still depends on boundary, calculation method and assurance coverage.
Symbolic-communication path	Three green dreams; DREAMS; cooling the Earth by 1 degree Celsius; responsibility and shared value language	Strengthens corporate legitimacy and communicates sustainability identity.	Symbolic narratives can increase ambiguity when not sufficiently anchored in measurable evidence.
Overall implication	The report contains both substantive evidence and symbolic narratives.	Digital carbon management can reduce greenwashing risk when linked to standards, governance and verification.	Digitalization should not be treated as automatically anti-greenwashing.

7. Discussion

This section discusses the theoretical and practical implications of the findings. It explains how the BYD case contributes to the literature and what it suggests for companies, regulators and investors.

7.1 Digitalization is Not Automatically Anti-greenwashing

The BYD case suggests that digitalization should not be treated as inherently anti-greenwashing. Digital carbon management can minimise the risk of greenwashing if it enhances data traceability, carbon accounting and readiness to analyse and verify carbon impact of products. But digitalized ESG communication can also help to make sustainability narratives more convincing. The difference lies in the fact that digital tools are being used mainly for data governance or impression management.

This distinction enables to reconcile two strands in the literature. On the other hand, research in the field of sustainability accounting underscores the need to have measurable environmental information to use in decision making [11]. However, greenwashing and legitimacy research make it known that sustainability reports can also serve to manage stakeholder perception. Both mechanisms can occur at the same time as illustrated in the BYD case. The symbolic sustainability narrative remains influential in terms of legitimacy, and digital carbon management can enhance accountability.

7.2 From ESG Storytelling to ESG Accountability

A key theoretical implication of this study is the shift from ESG storytelling to ESG accountability. ESG storytelling refers to the use of narratives, visions and values to communicate sustainability identity. ESG accountability refers to the provision of specific, measurable, comparable and verifiable evidence. Effective sustainability disclosure needs both, but the balance matters. Storytelling without accountability creates greenwashing risk. Accountability without narrative may be technically accurate but less understandable to stakeholders.

Digital carbon management can help bridge this gap. It allows companies to support sustainability narratives with carbon data, product footprint results, automated calculations, governance processes and external standards. In BYD's case, the iDi Carbon Chain platform provides a mechanism through which carbon claims can be connected to operational data and compliance reporting [6]. The platform therefore represents more than a technological tool. It is a potential accountability infrastructure.

7.3 Practical Implications

The findings have practical implications for firms in the new energy vehicle industry. First, companies need to not just try to build their brand on their product level green identity. It is important to remember that although EVs have the potential of helping to decarbonize transportation, stakeholders' demands for information regarding manufacturing emissions, supply chain effects, resource utilization and recycling are also growing. Second, companies need to invest in digital carbon management systems that are connected to recognized standards and internal governance. Third, there need to be clear and open techniques, data limits, and verification procedures, to accompany sustainability stories.

The results indicate that regulators and investors should consider not only the length and quality of the narrative of an ESG report, but also the specificity of the evidence, in determining the extent of ESG disclosure. Some questions to consider: Are the boundaries of reporting clear? Is there any correlation between carbon data and methodologies? Do the products have their carbon footprints calculated? Is there external evidence? Are the board members on board? Are there any management incentives for targets? These questions can be used to identify substantive disclosure from symbolic communication.

8. Conclusion

This paper focused on the impact of digital carbon management on ESG greenwashing risks concerning corporate sustainability disclosure. The study used BYD's Sustainability Report 2025 as an exploratory case and came up with a dual-path framework, adopting a preliminary text analysis approach. When digital carbon management is able to increase the traceability of data, disclosure specificity, the ability to account for carbon, readiness to embed into governance and readiness for verification, the findings indicate that there may be a reduced risk of greenwashing. The transparency-enhancing pathway is evident in BYD's iDi Carbon Chain platform, which is linked to organizational carbon management, product carbon footprint accounting, automated carbon data calculation, international compliance reporting and ISO-related standards.

The study makes three contributions to works. Secondly, it adds to greenwashing research the perspective on the production and verification of ESG information, not just the mere disclosure of sustainability information by firms. Second, it contributes to the research on digital transformation by demonstrating that digitalization can have a dual effect, on the one hand making it possible to control and report on decision-making processes, and on the other hand symbolically communicating decisions. Third, it introduces a pragmatic analytical framework to evaluate the credibility of ESG disclosures using coding categories and specificity scores.

There are also some limitations to the study. Firstly, it is a single case study on BYD, thus the findings are not generalizable. Second, analysis is primarily based on corporate sustainability disclosure, which does not necessarily represent the real ESG performance. Thirdly, the textual analysis is preliminary and not based on large scale computational text analysis. Future studies can be expanded by comparing several new energy vehicle companies, using third-party ESG ratings and applying quantitative textual analysis methods to systematically explore the connection between digital carbon management and greenwashing risk.

The limitations aside, the research offers some practical guidelines for corporate ESG governance. It recommends that companies transition from ESG storytelling to ESG accountability, by connecting sustainability storytelling with data systems, governance, external standards and verification. This is particularly relevant for new energy vehicle companies as a green product identity is not enough to prove ESG credibility. Digital carbon management can help diminish the risk of 'greenwashing' if it is not just a communication tool, but a real governance and accounting tool.

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Appendix. Detailed textual evidence and disclosure specificity scores

Table A1: Detailed textual evidence and disclosure specificity scores

Evidence item	Code / score	Evidence summarized from the report	Analytical interpretation
Reporting boundary	B/C; 2	The report discloses that economic and social KPIs cover the group, while environmental KPIs cover operating sites under BYD's operational control and exclude overseas bases and sales stores.	Boundary disclosure improves transparency, but the exclusion of overseas bases and sales stores should be treated as a limitation for global environmental assessment.
Reporting standards	C; 3	The report follows HKEX and SZSE requirements and refers to ESRS, GRI, ISSB IFRS S1/S2, SDGs and ISO IWA 48.	Multi-framework alignment supports formal comparability and reduces purely symbolic ambiguity.
Reporting principles	B/C; 3	The report states principles including materiality, quantification, balance, consistency, accuracy, comparability, completeness and verifiability.	These principles directly address common sources of greenwashing risk such as vagueness and selective disclosure.
Board approval	D/C; 3	The board supervises the report and states responsibility for the authenticity, accuracy and completeness of the content.	Board-level approval strengthens accountability for sustainability disclosure.
iDi Carbon Chain	A/C; 3	The platform supports organizational carbon management, product carbon footprint accounting, automated carbon data calculation and compliance reporting.	This is the strongest evidence of the transparency-enhancing path.
ISO 14064 and ISO 14067	C; 3	The report states that the iDi Carbon Chain platform passed ISO 14064 and ISO 14067 certification.	External standards improve verification readiness and carbon accounting credibility.
Clean electricity use	B; 2	The report discloses 7.29 billion kWh of clean electricity use.	Quantified evidence improves specificity, but its interpretation still depends on procurement boundary and accounting method.
Environmental investment	B; 2	The report discloses RMB 2.04 billion in environmental protection investment.	Quantified financial input supports substantive disclosure, but input data does not directly prove environmental outcome.
Scope 1 and Scope 2 emissions	B/C; 3	The report discloses Scope 1 and Scope 2 emissions for the automobile sector and related carbon intensity indicators.	Scope-based disclosure increases measurability and comparability.
Carbon intensity target	B/D; 3	The report states a target to reduce operational carbon emission intensity by 50% by 2030 from a 2023 baseline.	A time-bound quantitative target strengthens accountability.
Climate governance	D; 3	The report describes a climate governance structure involving the board, Strategic and Sustainability Committee, ESG Management Committee and ESG personnel in business units.	Governance embedding links digital carbon management to organizational accountability.
ESG-linked remuneration	D; 3	The report states that sustainability indicators are linked to 10% of executive and senior management remuneration, with climate indicators accounting for more than 40% of ESG indicators for ESG-related executives.	Incentive alignment strengthens the credibility of ESG governance.
Green vision narratives	E; 0-1	The report uses concepts such as the three green dreams, DREAMS and cooling the Earth by 1 degree Celsius.	Symbolic narrative supports legitimacy but requires evidence-based anchoring.
Withheld climate transaction data	B/C; 1-2	Some carbon trading-related cost and income information is not disclosed due to business sensitivity.	This shows residual information asymmetry and should be discussed as a disclosure limitation.

Note. The specificity score is interpretive: 0 = symbolic narrative only; 1 = action description without quantitative evidence; 2 = quantitative evidence with limited verification or boundary detail; 3 = quantitative evidence supported by standards, certification, governance or verification mechanisms.

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Conflicts of Interest

The authors declare no conflict of interest.

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