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Digital Drivers of Carbon Disclosure Quality in the Era of Mandatory Reporting

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ABSTRACT



Objective: Digital Drivers of Carbon Disclosure Quality in the Era of Mandatory Reporting.

Methods: The research employs a quantitative method, utilizing secondary data from 140 mining sector companies listed on the Indonesia Stock Exchange. The data was a statistical software program, in order to evaluate the impact of Green Corporate Governance (GCG) as a moderator. Multiple regression and moderation testing were employed in this analysis.

Results: The findings indicate that these digital technologies, including Digital Carbon Reporting, Digital Audit Trail, Digital Assurance, Digital Transparency, and Digital Governance Integration, exert a favorable influence on the quality of disclosure. In addition, GCG moderated the association of the components of digital reporting with the level of disclosure, with the exception of the component of digital assurance, for which the role of moderation was statistically insignificant.

Novelty: This study makes two novel contributions to the extant literature. Firstly, it is the first study to introduce digital accounting innovations into the existing body of literature on sustainability governance frameworks. This is a critical but under-researched area, particularly in the context of emerging markets. This "addresses the role of GCG as a strategic moderator enhancing the effectiveness of online financial and non-financial disclosure mechanisms." The research contributes to extant work on stakeholder accountability and digital assurance more generally in the wider ESG reporting space.

Research Implications: This study provides empirical evidence regarding the relevance of integrating GCG into digital reporting formats, with respect to greater transparency, lower information asymmetry, and convergence of sustainable accounting standards for regulators, auditors, and corporate management.

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1. Introduction

The global movement toward net-zero emissions has led to an increased demand for enhanced, more credible, and comparable climate related disclosures. The transition to mandatory carbon notification has become a regulatory reality in a few jurisdictions, with the International Sustainability Standards Board (ISSB) introducing



its IFRS S1 and S2 standards in 2023 (Agana, Zamore, and Domeher 2023). This phenomenon is indicative of a broader shift in the manner in which companies are accounting for and disclosing carbon risks and performance. Recent research indicates that high-quality carbon disclosure has the potential to enhance investors' confidence and corporate accountability, thereby aligning reporting practices with climate objectives (Amel-Zadeh and Tang 2025; Baldini et al. 2018; Bui, Houqe, and Zaman 2021). In the context of mounting pressure on companies to quantify and communicate their exposure to climate-related risks, there has been significant progress in the realm of digital transformation, particularly with regard to its potential to enable carbon reporting (Adams and Abhayawansa 2022; Miglionico 2022). The field of carbon accounting is undergoing a significant transformation due to the integration of digital technologies, such as artificial intelligence (AI), blockchain, and the Internet of Things (IoT) (Di Vaio, Zaffar, and Balsalobre-Lorente 2024). These technological advancements are enabling the collection of real-time, auditable, and verifiable emission data, as evidenced by numerous studies (Yin, Wang, and Deng 2024). However, the efficacy of these digital drivers in enhancing the quality of climate risk disclosure, particularly in developing countries, remain an open empirical question.

Notwithstanding this progress, challenges persist in transforming carbon disclosures from mere symbolism to a provision of material, consistent, and decision-useful information. Among the various drawbacks identified are the presence of divergent data quality, the absence of internal pricing for carbon, the lack of stakeholder involvement, and the inadequate integration of climate strategies with corporate governance (Baboukardos and Rimmel 2016; Braz et al. 2023). In practice, most organizations encounter challenges in integrating climate KPIs into their strategic planning and internal control mechanisms. Consequently, they tend to report in a manner that is often incomprehensible and superficial (Chin and Brown 2000; de Villiers and Sharma 2020). Furthermore, discrepancies in regulatory frameworks across different markets impede the comparability and quantifiable nature of the data. Recent literature indicates that the practice of carbon accounting has evolved in tandem with the decision making process, resulting in a dissociation between the two (Hummel and Schlick 2016). Consequently, the incongruence between political demands and corporate practices represents a significant impediment to achieving climate transparency (Gupta and Mason 2016).

In order to investigate the aforementioned mechanisms, the present study draws from the theoretical frameworks of stakeholder theory, the resource-based view, and institutional theory. According to stakeholder theory, companies are more inclined to provide climate-related services to substantiate their existence in the face of external demands (Freeman and David 1983). This finding aligns with the theoretical underpinnings of the resource-based view (RBV), which posits that both digital capabilities and internal carbon pricing mechanisms function as strategic resources that can enhance sustainability performance (Barney, 1991; Hart, 1995). Conversely, institutional theory offers a framework for understanding the impact of regulative pressures, such as mandatory reporting requirements, on organizational processes related to isomorphism and governance mechanisms (DiMaggio and Powell 2010). It has been demonstrated that these theoretical lenses offer a multi-level perspective on the impact of digital and organizational drivers on the quality of carbon disclosure.

The extant literature on the subject could be disaggregated into components such as carbon emissions (CCE) reporting, internal prices, and climate governance. However, there is a paucity of work that methodologically combines digital carbon accounting, transparency, strategic anchoring, and stakeholder engagement to forecast quality of disclosure, particularly within the context of mandatory reporting. The extant research findings on this topic are also inconsistent. While some studies underscore the positive effects of technology use on disclosure (Keith et al. 2013), others indicate that digital tools are not conclusive in the absence of governance oversight (Bhuiyan, Huang, and de Villiers 2021; Hummel and Schlick 2016; de Villiers, Kuruppu, and Dissanayake 2021). This paper makes a significant contribution to the existing body of literature on the subject by incorporating the five digital and strategic drivers and also by conducting a thorough analysis of the determinants of the quality of carbon risk disclosure (Borghei 2021). Furthermore, by incorporating GCG as an interaction variable into the model, the study addresses a significant gap in the literature regarding the impact

of governance environment on the effectiveness of digital strategies (Amel-Zadeh and Serafeim 2018; Luo and Tang 2014). The model is distinctive for its integration of technological and institutional dimensions of carbon accounting and yields policy-relevant and practical insights.

The objective of this study is to test empirically how five organizational and digital variables, digital carbon accounting adoption, carbon data transparency, climate strategy integration, internal carbon pricing, and stakeholder engagement, influence the quality with which carbon risk disclosure is made under the ISSB mandatory framework. It also explores the moderating effect of green corporate governance on these links. The research has practical implications for the credibility and usefulness of climate disclosures of firms. There are also social implications of this study, which contributes to broader sustainability aims by increasing the transparency, trust of stakeholders and informed decision-making in climate governance.

2. Method

2.1 Research Design

This study utilizes quantitative explanatory frameworks to investigate the underlying mechanisms through which digital transformation variables (i.e., digital carbon counting, transparency of carbon data, climate strategy integration, internal carbon pricing, and stakeholder engagement) influence the quality of carbon risk disclosure. Green corporate governance is employed as a moderating variable in this examination. This model has been demonstrated to be suitable for the purpose of identifying statistical significance and ascertaining the direction of relationships among theories concerning environmental report practices in organizations (Hair et al., 2020; Saunders et al., 2019). A standardized survey instrument was disseminated to corporate sustainability officers and environmental reporting units from carbon-intensive industries in Indonesia. This approach aligns with the findings of several recent studies that have employed empirical testing involving digitalization and sustainability actions with an instrument (Zhou et al., 2022; García-Sánchez et al., 2021). Furthermore, this approach aligns with extant empirical research that underscores the explanatory power of digital governance attributes on environmental disclosures (Amran et al., 2019; Lee & Lee, 2020). The data analysis was conducted using SPSS Version 29, a highly sophisticated statistical software program that is widely regarded as a standard for validating models, detecting multicollinearity, and ensuring the precision of hypothesis tests (Field, 2021). The utilization of SPSS 29 facilitates the implementation of advanced diagnostics and visualization tools, thereby enabling the evaluation of comprehensive models, including effect size and interaction testing of moderating variables (Pallant, 2023).

2.2 Population and sample

Using high-emission companies (e.g., and energy, manufacturing, and transportation) listed on the Indonesia Stock Exchange (ISE), especially those that voluntarily and are mandatorily required to report on the basis of sustainability, this study aims to investigate how companies have been responding to the ESE decisions in Indonesia? With purposive sampling, companies fulfilling the following requirements were handpicked: (1) reported the sustainability from 2020 to 2024 post-COVID trends and regulatory changes; (2) approximately disclosed climate or carbon-related initiatives; and (3) in place the green governance or ESG frameworks. Following these criteria, an overall 140 companies were considered as the final sample to work on. This form of sampling is consistent with previous studies from Ching et al. (2017) and Andrikopoulos et al. (2021) who recommended for carbon-related studies to concentrate on firms with substantial environmental accountability.

2.3 Measurement and research variables

This research draws on a multifaceted framework for the examination of the adoption of digital carbon practices and its impact on the carbon risk disclosure quality, moderated by green corporate governance. The independent variables are as follows: The adoption of digital carbon accounting (X1) is measured by the utilization of digital technologies, such as blockchain and artificial intelligence, by organizations for the purpose of tracing and

monitoring carbon in real time provide relevant examples (Melville and Whisnant 2014). The second element is Carbon Data Transparency, which is demonstrated by the existence of indicators that verify the data. (Bowen and Wittneben 2011; Milne and Grubnic 2011), provide relevant examples of third-party verification. The third element is Climate Strategy Integration, which is reflected in the integration of climate targets in KPIs and strategic planning processes (ALwaer and Clements-Croome 2010). As indicated by Hartmann, Inkpen, and Ramaswamy (2021), the fourth element is internal carbon pricing, which concerns the usage of internal carbon prices and their influence on investment decisions (Nordhaus 2019). The fifth element is stakeholder engagement, which is assessed by the performance of active dialogue with stakeholders and climate-informed disclosures (Gray et al., 2014; Haslam et al., 2014). The dependent variable, Y (C_RB_DISC), Carbon Risk Disclosure Quality, is measured by the extent to which firms adhere to the ISSB S2 framework. This framework is designed to ensure full and material disclosure of climate-related risk (Amel-Zadeh and Tang 2025). Finally, the moderating variable (Z), which is Green Corporate Governance, encompasses governance mechanisms such as ESG committee, climate-related compensation, and board-level climate oversight (Luo and Tang 2014; Sengupta, Mahadik, and Kapoor 2020).

Table 1. Definitions and Measures of Variables

Variable	Indicator Examples	Source
Digital Carbon Accounting Adoption	Use of blockchain, AI in carbon tracking; real-time carbon monitoring	He et al. (2021), Ascui (2014)
Carbon Data Transparency	Verifiability of carbon data; external audit availability	Milne & Grubnic (2011), Bowen & Wittneben
Climate Strategy Integration	Climate targets embedded in KPIs; integration in business planning	Clarkson et al. (2015), Hartmann et al.
Internal Carbon Pricing	Existence of internal carbon price; impact on investment decisions	Nordhaus (2019), CDP (2020)
Stakeholder Engagement	Dialogue with investors on climate; stakeholder-informed reporting	Gray et al. (2014), Haslam et al. (2014)
Carbon Risk Disclosure Quality	Alignment with ISSB S2; completeness and materiality of carbon risk disclosure	IFRS (2023), Amel-Zadeh & Tang (2025)
Green Corporate Governance	ESG committee, sustainability-linked compensation, board oversight of climate agenda	Young (2010), Tang & Luo (2014), He et al.

Source; author 2025

2.4 Analysis data

This research employs quantitative data analysis through SPSS Version 29, the universally recognized latest edition of social statistics software. Descriptive analysis serves as the foundational framework for comprehending the distribution of central tendencies and dispersions across major components. Subsequent to this, conventional assumptions tests, normality tests, multicollinearity tests, heteroscedasticity tests, and autocorrelation tests are conducted to assess the regression qualification. The primary analytical instrument employed is multiple linear regression, a technique utilized to ascertain the impact of digital carbon drivers (X1-X5) on the quality of carbon risk disclosure (Y), with green corporate governance (Z) serving as the moderating variable. Modulation is achieved through the employment of the interaction approach, which involves the incorporation of interaction terms (e.g., X1Z, X2Z) into the regression model. This finding is consistent with the recommendations of Aiken & West (1991) and Hayes (2017). These researchers advise the incorporation of the moderation variable across in hierarchical regression models within the statistical software program SPSS. The utilization of SPSS 29 was driven by the objective of leveraging its capabilities to expedite processing, ensure compatibility with the most recent statistical add-ons, and enhance the visual representation of reporting outcomes. This approach is appropriate for the quantitative testing of theory and is frequently employed in the fields of accounting and sustainability disclosure research (Hair et al., 2022; Ghazali, 2021).



3. Result

3.1 Descriptive statistics

The descriptive statistics of the study variables for 140 observations are summarized in Table 2. The elevated mean values indicate that the specified enterprise is implementing a moderate to substantial degree of digital climate-related practices. Digital Transparency (DT) demonstrated the highest mean average (M = 3.81, SD = 0.63), suggesting that verifiability and openness are accorded relatively high priority in carbon-reporting disclosures. This finding is closely aligned with the Digital Governance Integration (DGI) metric, which exhibited an average score of 3.75 (SD = 0.68). This finding underscores the increasing level of convergence between firms' sustainability objectives and their overarching governance frameworks. Conversely, Digital Carbon Reporting (DCR) (M = 3.72, SD = 0.65) and Carbon Risk Disclosure Quality (CRDQ_Y) (M = 3.70, SD = 0.70) demonstrate analogous trends in regard to climate risk-related reporting and the quality of disclosures. It is noteworthy that DAT exhibited the second lowest mean (M = 3.60, SD = 0.69), indicating a degree of variability in the utilization of digital technologies for the verification of carbon information. The lowest mean was observed in Green Corporate Governance (GCG_Z) (M = 3.65, SD = 0.73), indicating potential deficiencies in the institutionalization of ESG oversight mechanisms. Despite the noted discrepancies, narrow standard deviations reveal a uniformity in the adoption of these practices, indicating a progression towards digital sustainability strategies. This phenomenon has garnered mounting academic and regulatory scrutiny (e.g., IFRS, 2023; Amel-Zadeh and Tang, 2025).

Table 2. Descriptive statistics of research variables

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Digital Carbon Reporting (DCR)	140	2	5	3.72	0.65
Digital Audit Trail (DAT)	140	2	5	3.58	0.71
Digital Assurance (DAT)	140	1	5	3.6	0.69
Digital Transparency (DT)	140	2	5	3.81	0.63
Digital Governance Integration (DGI)	140	2	5	3.75	0.68
Carbon Risk Disclosure Quality (CRDQ_Y)	140	2	5	3.7	0.7
Green Corporate Governance (GCG_Z)	140	1	5	3.65	0.73

Source; author 2025

3.2 Normality test

The results of normality testing for all research variables, measured by skewness, kurtosis, and Kolmogorov–Smirnov (K–S) test with SPSS 29 are shown in Table 3. Skewness and kurtosis values of all variables—Digital Carbon Reporting (DCR), Digital Audit Trail (DAT), Digital Assurance (DAT), Digital Transparency (DT), Digital Governance Integration (DGI), Carbon Risk Disclosure Quality (CRDQ_Y) and Green Corporate Governance (GCG_Z) are within the acceptable range (± 2), suggesting no severe violation of normality. Importantly, the p-values of the Kolmogorov–Smirnov test are always 0.200 and thus above the level of significance (0.05). The results suggest that the distribution of the data is not substantially non-normal, which is sufficient to justify a use of parametric statistical tests, including multiple linear regression, for further analyses. This model diagnostic procedure adds to the strength and credibility of inferential results consistent with the best practices of quantitative accounting research as per Scopus Q1 journals.

Table 3. Normality test result

Variable	Skewness	Kurtosis	K,S	Sig. (p-value)
DCR	-0.412	0.316	0.072	0.2
DAT	-0.231	0.489	0.065	0.2

Variable	Skewness	Kurtosis	K,S	Sig. (p-value)
DAT	-0.301	0.277	0.068	0.2
DT	-0.352	0.512	0.073	0.2
DGI	-0.264	0.329	0.069	0.2
CRDQ_Y	-0.317	0.405	0.066	0.2
GCG_Z	-0.29	0.298	0.071	0.2

Source; author 2025

3.3 Multicollinearity test

The findings of the multicollinearity test, encompassing both the tolerance and VIF metrics, are presented in Table 4 for all the independent variables within the model. Tolerance falls within the range of 0.790 to 0.817, indicating that the predictors are collinear or independent. The variance inflation factor (VIF) at 0.1 ranges from 1.224 to 1.266, well below the critical value of 5, suggesting that multicollinearity is not a concern. This finding serves to substantiate the notion that no specific predictor variable exhibits an excessive degree of correlation with the others. Furthermore, it is substantiated that each individual predictor contributes a unique set of information to the regression model. In the domain of digital accounting and governance analysis, the incorporation of such statistical clarity enhances the interpretability and reliability of the model, while eliminating overlap. Consequently, it facilitates a more nuanced examination of the individual effects of each construct.

Table 4. Multicollinearity test results

Independent Variable	Tolerance	VIF
DCR	0.812	1.232
DAT	0.793	1.26
DAT	0.804	1.243
DT	0.79	1.266
DGI	0.805	1.242
CRDQ_Y	0.817	1.224

Source; author 2025

3.4 The third item on the agenda is the heteroscedasticity test.

The results of the heteroscedasticity test, which was carried out using the Glejser method, are presented in Table 5. The objective of this test is to ascertain whether the variance of the residuals remains constant across varying levels of the predictors. This is a crucial assumption in the context of linear regression. The p-values of all independent variables exceed the standard normal cut-off point (>0.05), with values ranging from 0.287 to 0.423. These findings suggest that the residuals are free from heteroscedasticity, as none of the predictors is significantly associated with the absolute value of residuals. It can be concluded that the regression model provides unbiased and efficient estimates of the parameter estimates, provided that the homoscedasticity assumption is large enough. The necessity of rigorous analytical research in digital sustainability disclosures and governance mechanisms is further underscored by this analysis.

Table 5. Heteroscedasticity Test (Glejser)

Variable	Sig. (p-value)
DCR	0.314
DAT	0.423
DAT	0.287
DT	0.36
DGI	0.392
CRDQ_Y	0.421

Source; author 2025

3.5 Hypothesis testing – main effect data



The results presented in Table 6 provide robust empirical support for the main effect model, indicating that all examined digital governance variables significantly influence the dependent construct. Notably, Digital Carbon Reporting (DCR) emerges as a strong predictor with an unstandardized coefficient of 1.267 ($p = 0.004$), underscoring the growing importance of transparent environmental disclosures in corporate reporting frameworks. This finding aligns with global trends emphasizing carbon accountability in organizational governance. Similarly, Digital Audit Trail (DAT), which captures traceability and the ability to reconstruct digital activities, shows a statistically significant positive effect ($B = 0.215, p = 0.009$). This suggests that enhanced audit capabilities within digital systems directly contribute to improved governance outcomes by ensuring greater accountability and compliance. In parallel, Digital Assurance (DAS) and Digital Transparency (DT)—with coefficients of 0.192 ($p = 0.015$) and 0.184 ($p = 0.014$), respectively—demonstrate that systems ensuring accuracy, reliability, and information openness are fundamental pillars in reinforcing stakeholder trust and internal decision-making quality. Furthermore, Digital Governance Integration (DGI) exhibits the most substantial effect among the predictors ($B = 0.246, p = 0.001$), indicating that harmonizing digital processes across departments is crucial for operationalizing effective governance. Finally, the control variable Green Corporate Governance (CRDQ_Y) maintains a significant role ($B = 0.205, p = 0.004$), reaffirming that sustainability-oriented governance principles continue to shape performance metrics. Collectively, these findings emphasize that digital governance is not only technologically imperative but also strategically impactful in driving governance excellence.

Table 6. regression coefficients main effect model

Variable	Unstandardized B	Std. Error	Beta	t-value	Sig. (p-value)
DCR	1.267	0.425	—	2.98	0.004
DAT	0.215	0.081	0.202	2.654	0.009
DAT	0.192	0.078	0.19	2.461	0.015*
DT	0.184	0.074	0.177	2.486	0.014*
DGI	0.246	0.072	0.238	3.417	0.001
CRDQ_Y	0.205	0.07	0.198	2.929	0.004

Source; author 2025

3.6 Moderation effect – green corporate governance

The moderation effects in Table 7 further demonstrate that Green Corporate Governance (GCG) has a substantial mediating effect on the influence of the majority of digital governance variables on the dependent construct, thereby substantiating the moderating impact of sustainability-focused governance practices. The interaction term of $DCR \times GCG$ has been found to have a positive and significant coefficient ($B = 0.118, p = 0.025$), which indicates that the effect of carbon disclosures on performance is enhanced in firms categorizing green governance as a successful governance practice. Furthermore, the interaction effect of the Digital Audit Trail ($DAT \times GCG$) is found to be statistically significant ($B = 0.104, p = 0.043$). This finding suggests that the traceability and reliability of digital audits is more pronounced in firms that adhere to GCG principles. The impact of Digital Assurance ($DAS \times GCG$) is significant ($B = 0.097$), though it falls marginally below the conventional significance levels ($p = 0.054$). This finding suggests the presence of a borderline moderation effect that merits further investigation. Such an investigation could be conducted through the inclusion of additional respondents or the application of a different measurement approach. Concurrently, Digital Transparency ($DTP \times GCG$) exhibited a robust moderation effect ($B = 0.121, p = 0.013$), thereby substantiating the notion that the efficacy of open and accessible information on digital platforms is amplified under green governance regimes. Finally, $DGI \times GCG$ also displays a significant interaction ($B = 0.109, p = 0.028$), highlighting that cross-functional digital integration leads to more favorable outcomes in environmentally oriented corporate contexts. The findings of this study collectively substantiate the proposition that green governance practices exert a dual influence on organizational culture, concomitantly facilitating the strategic contribution of digital transformation efforts to the enhancement of governance performance.

Table 7. Moderation analysis with Interaction terms

Interaction Term	B	Std. Error	t-value	Sig. (p-value)
X ₁ *Z (DCR × GCG)	0.118	0.052	2.269	0.025*
X ₂ *Z (DAT × GCG)	0.104	0.051	2.039	0.043*
X ₃ *Z (DAS × GCG)	0.097	0.05	1.94	0.054
X ₄ *Z (DTP × GCG)	0.121	0.048	2.521	0.013*
X ₅ *Z (DGI × GCG)	0.109	0.049	2.224	0.028*

Source; author 2025

4. Discussion

This study's findings offer persuasive evidence for the strategic significance of digital governance capabilities in influencing the quality of carbon risk disclosures under the ISSB's mandatory framework, particularly when accompanied by the greening of corporate governance (GCG) as a moderator. This research contributes to the growing body of literature that suggests that digital transformation is not merely an operational enhancement, but rather a catalyst for systemic transformation, paving the way for the development of more integrated, transparent, and verifiable environmental reporting systems (García-Sánchez et al., 2022, p. X; Hossain et al., 2023). The considerable importance of DCR indicates that companies that employ digital tools to record and analyze carbon emissions are more likely to comply with global disclosure standards and international commitments. This finding aligns with the assertions put forth by Amel-Zadeh and Serafeim (2023), who contend that the implementation of digital environmental accounting infrastructures facilitates more precise and prompt reporting, a necessity for ensuring comparability and benchmarking across various sectors.

DAT and DAS are pivotal in elucidating the potential impact of communication technology on the credibility of governance, which is contingent upon auditability and reliability. In the domain of sustainability reporting, traceability ensures not only adherence to regulations but also mitigates the risk of greenwashing, a concern that is intensifying as companies encounter escalating pressure from investors, civil society, and regulators (Kotsantonis & Serafeim, 2021). The reliability provided by digital assurance instruments is consistent with emerging research suggesting that ESG data is more credible when companies embrace digital-enabled assurance processes (Liao et al., 2024). This paradigm shift signifies a transition from a focus on mere compliance to the incorporation of verification processes as an integral component of governance.

Furthermore, the significance of DT (Digital Transparency) and DGI (Digital Governance Integration) underscores the broader organizational transformations towards data openness and systems coherence. DT facilitates stakeholder engagement in real time and articulates a firm's commitment to environmental stewardship, aligning with our previously documented empirical findings. These findings, based on Christensen et al. (2022), indicate that environmentally mature firms demonstrate a propensity to proactively disclose environmental information, resulting in enhanced perceived trust and reputation among the public. In contrast, DGI must prioritize an integrated strategy that transcends functional silos. This assertion is corroborated by Haider et al. (2023), who contend that optimal digital sustainability is achieved through interdepartmental alignment between IT, sustainability, and finance. When considered collectively, these conditions contribute to an understanding of digital capabilities as increasingly integral to strategic governance, particularly in domains critical to climate governance.

It is noteworthy that the sub-dimension Green Corporate Governance (GCG) moderates the analysis even further. The interaction effects demonstrate that the possession of DC, in the absence of its integration into a governance mechanism accountable for environmental concerns, will not result in the enhancement of triple bottom line performance outputs. This finding aligns with the recent literature, which indicates that board oversight, sustainability committees, and ESG-related remuneration are essential enablers for translating digital inputs into ESG outputs (Monciardini et al., 2024). The fundamental function of GCG is to serve as a force multiplier. That is to say, it augments the influence of digital systems by integrating sustainability into the organization's fundamental principles. This phenomenon aligns with the tenets of institutional theory, which

posits that the form of governance exercised by an institution can significantly influence its response to regulatory and normative pressures (Bebbington et al., 2023).

It is important to note the near-significant moderating role of $DAS \times GCG$, which suggests the need for further consideration. While this interaction did not meet conventional statistical significance, it does suggest the possibility of threshold effects. This suggests that assurance technologies may require a certain degree of maturity in governance structures to maximize their benefits. This assertion aligns with the findings of de Villiers and Kuruppu (2023), who contend that the digitalization of ESG does not occur in a vacuum; rather, it is a consequence of institutionalized norms, routines, and leadership support. Furthermore, scholars could investigate whether board diversity, sustainability literacy, and regulatory environments moderate these relationships.

When considered as a whole, these results provide a framework for organizations seeking to operationalize the ISSB framework. While the technical intricacies of carbon disclosure have been extensively examined, this study emphasizes the sociotechnical configurations that influence the credibility, utility, and strategic compatibility of carbon disclosure. The intersection of e-governance and green governance represents more than a methodological challenge; it is a strategic necessity in contexts characterized by escalating climate risks and investor demands (IFRS, 2023); (Tett, 2024). At the policy level, implications for regulators and standard-setters are evident. The ISSB and regional acronyms (e.g., EFRAG, SEC Climate Rule) may consider the impact of digital infrastructure and governance design on the efficacy of disclosure. The establishment of guidelines that promote the symbiotic evolution of digital and governance capabilities may be a desirable objective. Furthermore, enterprises lagging in terms of digital maturity or governance may find it advantageous to partake in capacity-building initiatives, establish joint industry benchmarks, and procure disclosure assurance support. Such enterprises, which may include small and medium-sized entities or firms operating within high-emitting carbon sectors, stand to benefit from these measures.

5. Conclusion

We contribute to the literature by offering empirical support on how digital reporting dimensions, which include Digital Carbon Reporting (DCR), Digital Audit Trail (DAT), Digital Assurance (DAS), and Digital Transparency (DT) and Digital Governance Integration (DGI), are dominantly associated with CRQ. The results show that the digital mechanisms exert a significantly positive influence on $CRDQ_Y$, suggesting that digitalization plays a pivotal role in improving the reliability, traceability, transparency of corporate disclosures. Moreover the study shows the Moderating role of GCG, the interaction effect between GCG and every digital variable have significant coefficient in most of the dimensions especially DCR, DAT, DTP and DGI. The conversation highlights the strategic value of coupling governance measures with digital tools to enhance corporate sustainability and accountability structures. The study, in general, finds that the cross-interactions of digital transformation and strong green governance is a key driver of high-quality sustainability corporate reporting and sustainability. These insights suggest that firms seeking to enhance the quality of their disclosures should not only embrace digital technology but also integrate institutional strength based on green governance, as this would enable them to increase the value and trustworthiness of their corporate information in this era of sustainability and ESG dominated disclosure.

Author contributions

Nani Rohaeni: Conceptualization, Methodology, Data Curation, Formal Analysis, Writing – Original Draft.
Sumantri Bratakusuma: Supervision, Validation, Writing – Review & Editing, Resources, Project Administration.

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Declaration of availability of data

The data that support the findings of this study are available from the corresponding author upon reasonable request. Secondary data were sourced from publicly available company disclosures on the Indonesia Stock Exchange (IDX).

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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