

The Economics of Tailings Accountability: Corporate Disclosure and Long-Term Mining Liabilities in Ghana

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Abstract

This study examines the nature, extent and comprehensiveness of corporate disclosure on sustainable mine tailings management among Gold Fields, AngloGold Ashanti, Newmont and Perseus Mining in Ghana between 2019 and 2025. Using a qualitative exploratory design and documentary content analysis, publicly available corporate disclosures were coded in NVivo with a Sustainable Mine Tailings Management Disclosure Index covering ten technical, environmental, social, emergency and financial accountability dimensions. Of 179 evidence records identified, 174 were retained for comparative analysis. Transparency and public disclosure, governance and accountability, monitoring and independent assurance, closure and rehabilitation, and TSF design and lifecycle management dominated reporting. Disclosure also became increasingly formalised, standards-aligned and facility-specific following the introduction of the Global Industry Standard on Tailings Management. However, financial responsibility and long-term liabilities, community engagement and emergency preparedness remained comparatively underrepresented. The findings identify a technical-social-economic accountability imbalance: mining companies increasingly disclose how tailings facilities are technically governed and assured, but provide substantially less visibility regarding the allocation and financing of long-term liabilities and community-related risks. Increased disclosure therefore does not necessarily eliminate information asymmetry across economically consequential accountability dimensions. More comprehensive facility-level reporting of closure obligations, financial assurance, emergency preparedness and stakeholder exposure would strengthen the economic usefulness and accountability value of sustainable tailings disclosure.

JEL classification: M14; Q32; Q56; G32

1 Introduction

Mining is an important source of mineral resources required for industrial production, infrastructure development, energy systems, and technological advancement. However, mineral extraction and processing generate substantial volumes of mine waste. Some mine waste may contain reactive or potentially harmful materials that can be released when rock is mined, crushed, exposed, and dispersed through air and water, potentially affecting receiving environments (IGF 2021). Among the various forms of mine waste, tailings are particularly important because they are generated in large quantities and commonly require long-term containment and management. Tailings are finely ground residual materials remaining after valuable minerals have been separated from ore. Their management involves engineering, environmental, social, economic, and governance considerations that can extend throughout the operational life of a mine and beyond closure (Dold 2008; Jones and Boger 2012).

Tailings storage facilities (TSFs) can contain large volumes of water and fine-grained materials and may present physical and chemical risks to surrounding environments and communities. Research has documented contamination, acid mine drainage, contaminant migration, and ecosystem degradation associated with tailings storage and failure (Kossoff et al. 2014; Rana et al. 2022; Tabelin et al. 2022).

These risks make safe TSF design, operation, monitoring, water management, and long-term management important components of sustainable mining. The potential consequences of tailings failures have also increased attention to governance, risk management, transparency, and accountability. Gold Fields (2019), for example, describes external engineering oversight, peer review, independent audits, Engineer of Record reviews, formal risk assessments, and corporate-level risk management in its approach to TSF management.

The sustainability debate surrounding tailings has expanded beyond containment and risk reduction toward lifecycle management, resource recovery, reuse, and circular-economy approaches. A lifecycle perspective is important because TSFs can remain environmental liabilities after mining ends (Adiansyah et al. 2016, 2017; Cacciuttolo and Atencio 2023). Lèbre and Corder (2015) advocate industrial ecology principles in mining waste management, while Machiels et al. (2021) highlight approaches combining remediation with resource recovery. More recent research demonstrates potential applications of tailings in metal recovery and construction and cementitious materials (Di Maria et al. 2024; Campbell et al. 2025; Feng et al. 2025). Tailings management is also increasingly recognised as a governance issue involving technical oversight, risk assessment, monitoring, accountability, emergency preparedness, closure, and transparency (Crous and Marais 2025; Picarelli 2025). Sustainable tailings management therefore requires attention to technical, environmental, social, governance, closure, and long-term accountability across the facility lifecycle.

The increasing complexity of tailings management has made corporate disclosure and transparency important. Mining companies operate under scrutiny from regulators, investors, local communities, employees, civil society organizations, and other stakeholders. Sustainability reports, annual reports, environmental impact statements, and technical reports provide mechanisms through which companies communicate environmental responsibilities, risks, and management practices. Such disclosures can provide information on tailing related risks, environmental monitoring, water management, emergency preparedness, closure, community engagement, and resource recovery. However, the existence of corporate reporting does not necessarily mean that tailings information is comprehensive, consistent, or transparent. Companies may disclose detailed information in some areas while providing limited information in others, and disclosure should not be treated as evidence of actual operational performance (Crous and Marais 2025).

From a mineral-economics perspective, uneven tailings disclosure is also an information problem. Tailings facilities create obligations that may extend beyond production into closure, rehabilitation and post-closure periods, while failures can impose costs on firms, governments, communities and other stakeholders. Mineral Economics research emphasizes both the unusually long time horizon of mining liabilities and the importance of sufficient financial resources and assurance for closure and post-closure obligations (Hodge et al. 2022; Hodge and Brehaut 2023). Where reporting makes technical controls highly visible but provides limited information on financial assurance, closure obligations and long-term liabilities, stakeholders may be unable to evaluate fully how tailings-related costs and risks are allocated. Corporate disclosure is therefore economically relevant not only as a legitimacy mechanism

but also as a means of reducing information asymmetry around potentially material mining liabilities (Healy and Palepu 2001).

This issue is particularly relevant to Ghana. Ghana has a long history of mining, and gold mining remains an important component of the country's mineral sector. IGF (2021) identifies TSFs as an important part of Ghana's mine-waste management landscape and reported 21 TSFs in the country within the context examined by its 2021 case study. Ghana also has a regulatory and policy framework governing environmental management and mine waste. The Minerals and Mining Act 2006 (Act 703) requires mineral-right holders to obtain necessary approvals and permits for the protection of natural resources, public health, and the environment and to comply with relevant environmental regulations. The Act also provides for prescribed records and reports and public access to relevant records, documents, and reports subject to confidentiality requirements.

The Minerals and Mining (Health, Safety and Technical) Regulations 2012 (L.I. 2182) provide specific technical requirements for TSFs, including hazard classification, embankments, impoundments, discharge systems, safety arrangements, monitoring, engineering design and construction, plans and audits, commissioning, and discontinuance. Regulations 274–286 address rehabilitation and mine closure, including closure planning and closure of TSFs. The Minerals and Mining Policy of Ghana similarly identify water and air pollution, mine-waste disposal, decommissioning, reclamation, monitoring, post-mining opportunities, sustainable livelihoods, community participation, and restoration of mined-out lands as relevant environmental and social considerations. These requirements provide a contextual benchmark for examining corporate disclosure.

Corporate documents from Ghana demonstrate that information relevant to sustainable tailings management can be disclosed across different document types. The Akyem Gold Mining Project Final Environmental Impact Statement (2008) provides information on closure and decommissioning of the TSF, stakeholder consultation, landform stability, ecosystem re-establishment, water quality, public safety, biodiversity, legal compliance, drainage control, topsoil replacement, revegetation, and post-closure monitoring. Gold Fields (2019) reports governance, engineering oversight, independent auditing, risk management, closure, and transparency, including information on Tarkwa and Damang. These documents demonstrate the range of information that can potentially be disclosed but do not establish that companies disclose the same information with the same level of detail.

Existing literature provides substantial knowledge on tailings failures, environmental contamination, engineering management, rehabilitation, closure, and resource-recovery potential (Kossoff et al. 2014; Rana et al. 2022; Tabelin et al. 2022; Machiels et al. 2021; Cacciuttolo and Atencio 2023; Di Maria et al. 2024). Research on reprocessing and valorisation further shows that tailings can be converted into secondary resources, although this literature remains primarily concerned with technical feasibility rather than corporate accountability (Adrianto et al. 2022, 2023; Campbell et al. 2025; Feng et al. 2025; Li et al. 2025; Keskin et al. 2026). By contrast, comparatively less attention has been directed toward how mining companies communicate the multiple dimensions of sustainable tailings management through

corporate reporting. Crous and Marais (2025) examined TSF reporting transparency among major international mining companies, but a systematic Ghana-focused assessment remains limited. The gap is therefore not an absence of tailings information, but the absence of a multidimensional assessment of how comprehensively and consistently companies disclose governance, design and lifecycle management, risk and safety, monitoring and assurance, environmental performance, emergency preparedness, closure, communities and stakeholders, transparency, and long-term financial responsibility.

The unresolved issue is therefore not simply whether mining companies disclose tailings information, but whether increasing technical transparency is accompanied by equivalent disclosure of the economic responsibilities associated with tailings management. Research in Mineral Economics shows that mining sustainability governance increasingly depends on regulatory and voluntary mechanisms for risk assessment, reporting, due diligence and accountability (Franken and Schütte 2022), while closure and post-closure adequacy depends explicitly on long-term financial capability and assurance (Hodge and Brehaut 2023). Recent work further demonstrates the economic relevance of integrating closure and environmental costs directly into strategic mine planning (Oliveros-Sepúlveda et al. 2026). Yet these strands do not establish whether corporate tailings reporting provides balanced visibility across technical controls, community exposure, emergency responsibilities and long-term financial liabilities. Limited visibility of closure obligations, financial assurance, emergency consequences and community exposure can therefore preserve important information asymmetries even where technical reporting becomes increasingly sophisticated. A systematic Ghana-focused assessment of this disclosure asymmetry remains limited, creating a specific gap at the intersection of tailings governance, corporate disclosure and mineral economics.

Legitimacy Theory provides the theoretical foundation for this assessment. Organisations depend on social acceptance and are expected to operate consistently with prevailing societal values and norms (Campbell 2000; Deegan 2002). This perspective is especially relevant to mining because environmental disturbance, waste generation, water impacts, and community concerns can create persistent legitimacy pressures (Hilson and Murck 2000; Dold 2008; Jones and Boger 2012). Corporate environmental disclosure can signal responsiveness to these expectations (Deegan and Gordon 1996; Buhr 1998; Campbell 2000), although reported information may be selective and should not be treated as equivalent to independently verified environmental performance (Boiral and Henri 2017; Diouf and Boiral 2017). For mine tailings, disclosure of governance, risk controls, monitoring, emergency preparedness, closure, stakeholder engagement, and financial responsibility can therefore be interpreted as a mechanism through which companies communicate responsible management and seek organisational legitimacy.

Legitimacy Theory is complemented here by an economic-accountability and information-asymmetry perspective. Legitimacy Theory explains why firms may make tailings-management practices visible in response to societal and institutional expectations, whereas information-asymmetry theory explains why the composition, credibility and completeness of disclosure matter to external decision makers (Healy and Palepu 2001). If technical governance, monitoring and conformance are reported more extensively

than closure funding, financial assurance, long-term liabilities or community exposure, an increase in disclosure volume may coexist with persistent uncertainty about the distribution of tailings-related costs. This concern is consistent with evidence that long-term mining obligations can extend well beyond operations and require adequate financial capability and assurance (Hodge et al. 2022; Hodge and Brehaut 2023). The combined perspective therefore distinguishes disclosure quantity from the economic completeness of accountability.

Against this background, the aim of this study is to examine the nature, extent, and comprehensiveness of corporate disclosure on sustainable mine tailings management among selected mining companies operating in Ghana using qualitative content analysis. The study specifically examines disclosure concerning: (i) tailings governance and accountability; (ii) TSF design and lifecycle management; (iii) risk identification and safety management; (iv) monitoring, inspection and independent assurance; (v) environmental management and performance; (vi) emergency preparedness, response and recovery; (vii) closure, rehabilitation and post-closure management; (viii) affected communities and stakeholder engagement; (ix) transparency and public disclosure; and (x) financial responsibility and long-term liabilities.

The study is significant because it shifts attention from an exclusively technical and environmental view of tailings management toward the composition of corporate accountability. It treats sustainable mine tailings disclosure as a multidimensional construct and applies the Sustainable Mine Tailings Management Disclosure Index (SMTMDI) to assess the breadth and comprehensiveness of Ghana-related corporate disclosures. This provides mining companies with evidence on underreported accountability dimensions, offers regulators and policymakers a basis for improving facility-level reporting comparability, and extends sustainability disclosure research by examining whether increased transparency is balanced across technical, environmental, social, emergency, and financial domains.

Accordingly, the study makes three contributions relevant to mineral economics. First, it treats tailings disclosure as information about the allocation of long-duration environmental and closure liabilities rather than solely as sustainability communication, responding to Mineral Economics scholarship on long-term mining liabilities and closure financial capability (Hodge et al. 2022; Hodge and Brehaut 2023). Second, it tests whether greater standards-based transparency is balanced across technically auditable and economically consequential accountability domains, complementing work on regulatory and voluntary mining-risk governance (Franken and Schütte 2022). Third, it develops the concept of a technical-social-economic accountability imbalance to explain how disclosure can mature while important information on financial responsibility, emergency consequences and stakeholder exposure remains sparse.

The study is guided by four research questions: (1) What are the dominant dimensions of sustainable mine tailings management disclosed by selected mining companies operating in Ghana? (2) How do disclosure patterns differ across the selected companies? (3) How did corporate tailings disclosure

evolve between 2019 and 2025? and (4) What disclosure gaps are evident across technical, environmental, social, emergency, transparency, and financial accountability dimensions?

2 Methodology

2.1 Research Design

This study adopted a qualitative exploratory research design using documentary research and qualitative content analysis to examine corporate disclosure of sustainable mine tailings management among mining companies operating in Ghana. The approach was appropriate because the study examined the nature, extent, and comprehensiveness of information contained in corporate documents rather than operational performance. Qualitative content analysis enables systematic identification, classification, and interpretation of recurring themes within textual documents (Dold 2008; Jones and Boger 2012; Crous and Marais 2025).

2.2 Data Collection

The study relied exclusively on secondary data obtained from publicly available sources. Corporate documents included sustainability reports, annual reports, environmental reports, environmental impact statements, and technical reports on TSFs published by mining companies operating in Ghana. Supporting documents included the Minerals and Mining Act 2006 (Act 703), the Minerals and Mining (Health, Safety and Technical) Regulations 2012 (L.I. 2182), the Minerals and Mining Policy of Ghana, the IGF Mine Waste Management Case Study, the IGF Tailings Management and Reprocessing Governance report, Gold Fields' Management of Tailings Storage Facilities report, and the Akyem Gold Mine Environmental Impact Statement. These documents provided the regulatory, corporate, and contextual basis for the assessment framework.

2.3 Sampling Procedure

Purposive sampling was employed to select the mining companies for analysis. Companies were included if they operated large-scale mining projects in Ghana, owned or managed TSFs, and published publicly accessible sustainability or annual reports containing environmental or tailings-related information. The selected reports were downloaded from official corporate websites and government repositories and organised by company, reporting year, and document type. The final analysis covered Gold Fields, AngloGold Ashanti, Newmont, and Perseus Mining and the period 2019–2025.

2.4 Development of the Sustainable Mine Tailings Management Disclosure Index (SMTMDI)

The SMTMDI was developed from internationally recognised standards, Ghanaian mining legislation, and literature on sustainable mine tailings management. The coding framework comprised ten themes: transparency and public disclosure; tailings governance and accountability; monitoring, inspection and independent assurance; closure, rehabilitation and post-closure management; TSF design and lifecycle

management; risk identification and safety management; environmental management and performance; affected communities and stakeholder engagement; financial responsibility and long-term liabilities; and emergency preparedness, response and recovery. These themes provided a consistent basis for identifying and comparing corporate disclosures.

For analytical transparency, the ten SMTMDI dimensions were treated as disclosure categories rather than as measures of operational sustainability performance. Evidence was assigned to a dimension only when the text contained substantive information corresponding to that category; generic sustainability statements without tailings-specific content were not treated as evidence of comprehensive tailings disclosure. Reference counts therefore indicate the concentration and breadth of disclosed evidence, not the quality, safety or financial performance of a company or facility.

2.5 Data Analysis

Data analysis was conducted using NVivo. All documents were imported into the software, and relevant text segments were coded into predefined thematic nodes. The analysis combined qualitative content analysis and thematic analysis to identify recurring disclosure patterns, differences among companies, and changes across the 2019–2025 period. Word-frequency queries, matrix coding, and exploration cluster analysis were used to support thematic interpretation. The coding produced evidence records that were screened before comparative analysis.

2.6 Reliability and Ethical Considerations

A coding protocol was developed, and the same disclosure framework was applied across all documents to enhance consistency. The coding process was reviewed repeatedly to minimise researcher bias and improve interpretation. Because the study used only publicly available documents, no human participants were involved, and issues of confidentiality and informed consent did not arise. All documentary sources were acknowledged, and the analysis was conducted objectively.

Because the analysis is interpretive, reliability was addressed through consistent application of the predefined codebook, repeated review of coded passages and comparison of coding decisions across companies, years and document types. No inference is made from coding frequency alone. A formal intercoder reliability coefficient was not used as evidence in this study; this is acknowledged as a methodological limitation and provides a clear avenue for replication using independent coders.

3 Results

3.1 Overview of the Thematic Findings

The thematic analysis identified ten themes across 179 evidence records extracted from the sustainability disclosures of Gold Fields, AngloGold Ashanti, Newmont and Perseus Mining between 2019 and 2025. Following coding and evidence screening, 174 references were retained for the comparative analysis. As shown in Table 3, transparency and public disclosure was the most frequently

coded theme, with 40 references across all four companies. This was followed by tailings governance and accountability (32 references), monitoring, inspection and independent assurance (30 references), closure, rehabilitation and post-closure management (22 references), and TSF design and lifecycle management (18 references). Together, these five themes accounted for 142 of the 174 coded references (81.6%), indicating a strong concentration of corporate disclosure around governance, technical oversight, lifecycle management and transparency.

In contrast, comparatively fewer references addressed environmental management and performance, affected communities and stakeholder engagement, financial responsibility and long-term liabilities, and emergency preparedness. The distribution therefore reveals an uneven disclosure structure in which technical and governance-related aspects of tailings management receive substantially greater reporting attention than social, financial and emergency-response dimensions.

Table 1
Overall thematic coding results

Theme	References	Companies represented	General interpretation
Transparency and Public Disclosure	40	Gold Fields; AngloGold Ashanti; Newmont; Perseus Mining	Most prominent
Tailings Governance and Accountability	32	Gold Fields; AngloGold Ashanti; Newmont; Perseus Mining	Very prominent
Monitoring, Inspection and Independent Assurance	30	Gold Fields; AngloGold Ashanti; Newmont; Perseus Mining	Very prominent
Closure, Rehabilitation and Post-Closure Management	22	Gold Fields; AngloGold Ashanti; Newmont; Perseus Mining	Prominent
TSF Design and Lifecycle Management	18	Gold Fields; AngloGold Ashanti; Perseus Mining	Prominent
Risk Identification and Safety Management	13	Gold Fields; AngloGold Ashanti; Newmont; Perseus Mining	Moderate
Environmental Management and Performance	9	Gold Fields; AngloGold Ashanti; Newmont; Perseus Mining	Moderate
Affected Communities and Stakeholder Engagement	4	Gold Fields; AngloGold Ashanti; Newmont	Limited
Financial Responsibility and Long-Term Liabilities	4	AngloGold Ashanti; Perseus Mining	Limited
Emergency Preparedness, Response and Recovery	2	Gold Fields; Perseus Mining	Very limited
Total	174	Four companies	

3.2 Cross-Company Patterns in Sustainable Tailings Disclosure

The matrix coding analysis shows both convergence and variation in sustainable tailings disclosure across Gold Fields, AngloGold Ashanti, Newmont and Perseus Mining. As presented in Fig. 1, governance and accountability, monitoring and assurance, closure and rehabilitation, environmental performance, and transparency and public disclosure appear across all four companies, indicating a common core of tailings-related reporting. However, the frequency and emphasis of these themes differ considerably, suggesting distinct corporate disclosure priorities rather than a uniform reporting approach.

Perseus Mining recorded the highest coding density (52 references), followed by Gold Fields (49), AngloGold Ashanti (44) and Newmont (29). More importantly, the matrix reveals strong cross-company concentration in technical governance and transparency, while community engagement, financial responsibility and emergency preparedness remain sparsely disclosed. This pattern indicates convergence around technical accountability but continued unevenness in the broader social and financial dimensions of sustainable tailings management.

3.3 Evolution of Tailings Disclosure from 2019 to 2025

The longitudinal analysis reveals three phases in the evolution of corporate tailings disclosure (Table 2). The 2019 pre-Global Industry Standard on Tailings Management (GISTM) baseline was characterised by existing disclosures on governance, engineering review, monitoring and closure, although reporting was less standardised. From 2020 to 2022, disclosure shifted towards standards-based practices following the introduction of GISTM, with greater attention to gap assessments, consequence classification, Engineers of Record (EoR), independent review and implementation planning. From 2023 to 2025, reporting became more institutionalised, reflected in conformance-related disclosure, clearer accountability structures, facility-level information, independent assurance and Ghana-specific engineering and regulatory developments. This progression indicates a shift from general tailings-management disclosure towards more structured, standards-aligned and verifiable reporting.

Table 2
Longitudinal evolution of corporate tailings disclosure

Period	Disclosure stage	Dominant characteristics
2019	Pre-GISTM baseline	Governance, engineering review, monitoring and closure
2020–2022	Standards transition	GISTM alignment, gap assessment, consequence classification, EoR systems and implementation planning
2023–2025	Institutionalisation	Conformance reporting, facility-level disclosure, independent assurance and explicit accountability

The progressive movement from established but less standardised practices in 2019 towards GISTM-driven alignment and, subsequently, more institutionalised disclosure. The pattern suggests that GISTM served as an important reference point for increasing the structure, specificity and comparability of corporate tailings reporting across the study period.

3.4 Ghana-Specific Tailings Management Disclosure

The Ghana-specific evidence confirms that disclosure extends beyond corporate-level policies to operational tailings practices (Table 5). Gold Fields reports technical reviews, facility modifications, water management and rehabilitation at Tarkwa and Damang. AngloGold Ashanti provides lifecycle evidence from Iduapriem and Obuasi, particularly concerning TSF construction, closure and rehabilitation. Perseus Mining provides the most detailed facility-level disclosure at Edikan, covering

design, monitoring, risk assessment, incidents, water treatment and future TSF development. Newmont's Ghana-related disclosure for Ahafo and Akyem is comparatively more standards-oriented, with emphasis on GISTM alignment, environmental management and closure. These differences demonstrate variation in the depth and operational specificity of Ghana-focused disclosure across the four companies.

Table 3
Major Ghana-specific tailings management disclosures

Company	Ghana operations	Distinctive evidence
Gold Fields	Tarkwa; Damang	Technical reviews, TSF modifications, water management and rehabilitation
AngloGold Ashanti	Iduapriem; Obuasi	Beposo construction, Greenfields closure, and Kokoteasua and Pompura rehabilitation
Newmont	Ahafo; Akyem/Ahafo North	GISTM alignment, closure planning and environmental management
Perseus Mining	Edikan	TSF inventory, audits, dam-break analysis, incident reporting, facility raises, water treatment and new TSF planning

Gold Fields and AngloGold Ashanti combine technical governance with lifecycle and closure reporting, while Newmont places greater emphasis on standards and transparency. Perseus Mining provides comparatively detailed operational evidence on design, monitoring and risk at Edikan. Overall, the findings show that global tailings commitments are increasingly reflected in Ghana-specific disclosures, although the level of facility-specific detail remains uneven across companies.

3.5 Disclosure Gaps and the Technical-Social Imbalance

The thematic distribution (Table 6) reveals substantial asymmetry in the maturity of tailings disclosure across accountability dimensions. Technical governance and risk accounted for 93 coded references, while transparency and compliance contributed a further 40. Environmental and lifecycle issues accounted for 31 references. In contrast, communities and stakeholder engagement and financial responsibility generated only four references each, while emergency preparedness generated two. This pattern indicates that corporate reporting is substantially more developed around technical control, assurance and standards alignment than around the social, financial and community-protection dimensions of sustainable tailings management. This distribution indicates that disclosure is considerably more developed in technically auditable areas than in broader social, emergency and financial accountability

The financial-accountability result is particularly notable for a mineral-economics interpretation. Only four coded references addressed financial responsibility and long-term liabilities, despite the potential for tailings obligations to persist through closure and post-closure periods. This matters because closure and post-closure can carry substantial costs and require sufficient financial resources and

assurance to prevent liabilities from being transferred to governments, society or the environment (Hodge and Brehaut 2023). The contrast between extensive technical-governance disclosure and sparse financial-liability disclosure therefore indicates that greater visibility of facility management is not necessarily matched by equivalent visibility of how long-term tailings costs are funded, allocated or ultimately borne.

Table 4
Technical versus broader accountability dimensions

Disclosure dimension	Main themes	References	Relative prominence
Technical governance and risk	Governance, design, monitoring, risk	93	Very high
Transparency and compliance	Public disclosure, GISTM alignment	40	Very high
Environmental and lifecycle	Environmental management, closure	31	Moderate–high
Social accountability	Communities and stakeholders	4	Low
Financial accountability	Long-term liabilities	4	Low
Emergency and community protection	Preparedness and response	2	Very low
<i>Note: Reference counts indicate the concentration of coded disclosure and do not represent corporate sustainability performance.</i>			

Figure 2 reinforces the uneven distribution of disclosure. Technical governance, transparency and lifecycle management are comparatively well represented, whereas social accountability, financial responsibility and emergency preparedness remain substantially less visible. The findings therefore identify a technical-social disclosure imbalance, defined here as the disproportionate visibility of technical and procedural accountability relative to social, community-protection and long-term financial accountability.

3.6 Integrated Patterns in Tailings Disclosure

The comparative findings show that corporate tailings disclosure in Ghana became increasingly formalised, standards-aligned and facility-specific between 2019 and 2025. This pattern is reinforced by the word-frequency analysis in Fig. 3, where terms such as “closure,” “review,” “GISTM,” “planning,” “independent,” “standard,” “assurance,” “design,” “monitoring,” and “governance” were prominent. The concentration of these terms supports the thematic evidence that corporate reporting is primarily framed around technical governance, standards compliance, assurance and lifecycle management.

Note

Word size represents relative frequency within the coded disclosure evidence after removal of common and contextually redundant terms.

The cluster analysis provides further evidence of this pattern. As shown in Table 7 and Fig. 4, governance and accountability was most closely associated with monitoring and assurance (Jaccard similarity = 0.145) and closure and rehabilitation (0.137). Monitoring and assurance was also associated with transparency and disclosure (0.122), while design and lifecycle management clustered with closure and rehabilitation (0.115). These relationships indicate an interconnected technical-accountability structure in which governance is communicated alongside assurance, lifecycle management and transparency.

Table 5
Strongest thematic similarities in coded tailings disclosures

Theme A	Theme B	Jaccard similarity
Governance and accountability	Monitoring and assurance	0.145
Governance and accountability	Closure and rehabilitation	0.137
Monitoring and assurance	Transparency and disclosure	0.122
Design and lifecycle	Closure and rehabilitation	0.115
Governance and accountability	Transparency and disclosure	0.112
Transparency and disclosure	Risk and safety	0.109
<i>Note: Jaccard coefficients measure similarity in word usage between coded themes. The analysis is exploratory and does not indicate statistical association or causal relationships. The complete pairwise similarity matrix is provided in the supplementary material.</i>		

The dendrogram further distinguishes a relatively connected technical-accountability core comprising governance, monitoring and assurance, transparency, design, closure and risk management. By contrast, community and stakeholder engagement, financial responsibility and emergency preparedness show weaker lexical similarity with this core. The low absolute similarity coefficients also indicate that the themes remain conceptually distinct despite these relationships.

Taken together, the thematic, frequency and cluster analyses reveal a consistent pattern. Corporate tailings disclosure has developed most strongly around technical control, governance, assurance and standards alignment, while community engagement, emergency preparedness and long-term financial responsibility remain comparatively peripheral. The findings therefore identify a persistent technical-social disclosure imbalance in sustainable tailings reporting.

4 Discussion

The findings reveal a marked transformation in corporate tailings disclosure in Ghana between 2019 and 2025. Three results are particularly salient. First, disclosure became increasingly formalised, standards-aligned and facility-specific following the introduction of GISTM. Second, governance, monitoring, independent assurance and transparency formed a dominant technical-accountability core. Third, this development was asymmetric, with community engagement, emergency preparedness and long-term financial responsibility remaining comparatively peripheral. These findings support evidence of a broader “transparency turn” in tailings governance (Kemp et al. 2021; Kemp et al. 2024; Crous and Marais 2025), while demonstrating that disclosure maturity can develop unevenly across accountability domains.

4.1 GISTM and the Institutionalisation of Tailings Disclosure

The longitudinal findings position GISTM as an important inflection point in corporate tailings reporting. While the 2019 disclosures already addressed governance, engineering review, monitoring and closure, reporting after 2020 increasingly incorporated consequence classification, Engineers of Record, gap assessments, independent assurance, conformance and facility-level information. This temporal shift closely corresponds with GISTM's integrated requirements for governance, technical risk, affected communities, emergency response and public disclosure (UNEP 2020).

The observed change represents more than an increase in disclosure volume. It suggests progressive institutionalisation of a common reporting architecture through which companies demonstrate alignment with internationally recognised tailings-management expectations. This interpretation is consistent with Kemp et al. (2021), who characterise emerging tailings governance as a potential “transparency turn,” and Crous and Marais (2025), who document improvements in facility-level transparency following GISTM. Importantly, the present study does not establish a causal effect of GISTM. Rather, the temporal and thematic alignment indicates that the increasing standardisation of Ghana-related disclosure coincided with its introduction and implementation.

The Ghana evidence adds an important operational dimension to this literature. Increasingly specific disclosures concerning Tarkwa, Damang, Iduapriem, Obuasi and Edikan indicate movement from broad corporate commitments towards facility-linked reporting of governance, engineering, assurance and closure. This suggests that the institutionalisation of tailings disclosure operates not only through corporate policy commitments but increasingly through the visibility of individual facilities and their management practices.

4.2 Technical Accountability as the Dominant Disclosure Logic

Despite this progression, disclosure maturity is concentrated primarily within technically auditable dimensions. Governance, design, risk management, monitoring and assurance accounted for 93 coded references, while transparency contributed a further 40. The word-frequency analysis similarly

foregrounded “closure,” “review,” “GISTM,” “independent,” “assurance,” “design,” “monitoring” and “governance.” The exploratory cluster analysis further identified modest thematic proximity between governance and monitoring/assurance, governance and closure, and monitoring/assurance and transparency. Together, these patterns indicate a technical-accountability disclosure logic centred on control, verification, lifecycle management and procedural conformity.

This emphasis is consistent with GISTM's requirements for risk classification, senior accountability, independent review and public disclosure (UNEP 2020), as well as heightened scrutiny of governance and professional oversight following major tailings failures (Kemp et al. 2021). However, greater technical visibility should not be equated with superior tailings performance. Transparency can improve information availability without necessarily ensuring substantive accountability or safer outcomes (Kemp et al. 2021). Crous and Marais (2025) similarly identify improvements in tailings transparency alongside continuing weaknesses in non-technical dimensions of disclosure.

The findings should therefore be interpreted as differences in disclosure breadth and specificity rather than rankings of corporate or facility performance. This distinction is important because sustainability reports represent organisational accounts of tailings management rather than independent verification of operational outcomes. The results instead show how corporate responsibility is made visible: predominantly through standards, engineering systems, independent assurance and procedural control.

4.3 The Technical-Social Disclosure Imbalance

The most consequential finding is the asymmetric development of accountability across disclosure domains. Technical governance and risk accounted for 93 coded references, compared with only four for communities and stakeholder engagement, four for financial responsibility, and two for emergency preparedness. This disparity is particularly significant because GISTM conceptualises responsible tailings management more broadly, incorporating affected communities, human rights, environmental protection, emergency response and public transparency alongside technical safety (UNEP 2020).

The limited visibility of these broader dimensions suggests that the institutionalisation of tailings disclosure remains incomplete. Kemp et al. (2024) similarly identify limited experience with local public disclosure and continuing hesitancy in communicating disaster risk, while Crous and Marais (2025) find that improvements in transparency have not eliminated weaknesses in community-oriented and non-technical reporting. The Ghana evidence extends these findings by demonstrating that such asymmetry is visible at the country and facility levels.

Financial accountability presents a parallel concern. Tailings liabilities can extend across operation, closure, rehabilitation and post-closure periods, yet financial responsibility remained marginal in the analysed disclosures. This finding is consistent with arguments that conventional tailings governance provides insufficient visibility into the long-term monetary and externalised consequences of tailings risks and failures (Burritt and Christ 2021). The limited reporting of these liabilities suggests that technical lifecycle disclosure is not necessarily accompanied by equivalent financial accountability.

Viewed through legitimacy theory, these patterns point to what this study conceptualises as selective institutionalisation. Sustainability disclosure can support organisational legitimacy by signalling responsiveness to societal and institutional expectations (Deegan 2002; Hahn and Kühnen 2013). In the present context, technically auditable practices such as engineering oversight, monitoring, assurance, conformance and governance have become highly visible, whereas community exposure, emergency preparedness and long-term liabilities remain substantially less represented. Corporate legitimacy may therefore be constructed more readily around demonstrable technical competence and procedural conformity than around broader and potentially more contested dimensions of accountability.

This interpretation qualifies the assumption that greater transparency necessarily represents uniformly mature sustainability disclosure. Instead, the findings suggest that disclosure maturity is multidimensional and can develop asymmetrically across accountability domains. Technical and procedural reporting may become highly institutionalised while social, emergency and financial accountability remains comparatively underdeveloped. This distinction strengthens Kemp et al.'s (2021) caution that a transparency turn should not automatically be equated with substantive accountability.

The study therefore advances the literature beyond documenting increased tailings transparency. Its central contribution is the identification of a technical-social disclosure imbalance, defined here as the disproportionate visibility of technical and procedural accountability relative to social, community-protection and long-term financial accountability. This extends emerging international evidence on the limits of tailings transparency (Kemp et al. 2021; Kemp et al. 2024; Crous and Marais 2025) by demonstrating how such imbalance manifests within Ghana's mining sector.

The economic implication is that technically mature reporting can coexist with incomplete visibility of the financial incidence of tailings risk. Investors, regulators and affected communities may receive increasingly detailed information on governance structures, monitoring and assurance while receiving comparatively little information on closure funding, financial assurance, long-term liabilities and the allocation of costs arising from adverse events. Such gaps are economically consequential because disclosure can reduce information asymmetry only to the extent that decision-relevant obligations are made visible (Healy and Palepu 2001), while mining closure scholarship stresses that long-term obligations require credible financial capacity and assurance (Hodge and Brehaut 2023). In this sense, the observed disclosure imbalance can preserve information asymmetry about who is expected to finance tailings obligations over the facility lifecycle.

This matters because the economic burden of tailings management is intertemporal and potentially distributive. Mining projects can generate environmental, social and financial obligations over unusually long time horizons, including closure and post-closure (Hodge et al. 2022), and recent Mineral Economics research explicitly integrates closure and environmental costs into strategic mine-planning decisions (Oliveros-Sepúlveda et al. 2026). Costs may therefore arise during operation, closure, rehabilitation and post-closure, and insufficiently transparent financial responsibility can make it difficult to distinguish liabilities internalised by mining firms from risks that may ultimately be transferred to

public institutions or local communities. The finding that financial responsibility generated only four coded references therefore represents more than a reporting gap; it identifies a weakly visible component of the economic architecture of tailings accountability.

4.4 Economic Implications of Asymmetric Tailings Disclosure

4.5 Theoretical Implications

This study contributes to sustainability disclosure research by demonstrating that increased transparency does not necessarily produce balanced accountability. While disclosure can support organisational legitimacy by signalling responsiveness to external expectations (Deegan 2002; Hahn and Kühnen 2013), the findings show that such responsiveness may be unevenly distributed across disclosure domains.

The combined framework also extends the argument from legitimacy to information quality. A company may satisfy visible expectations for technical conformance and still leave economically material questions unresolved. Accordingly, disclosure maturity should be assessed by whether reporting reduces uncertainty across the full distribution of technical, environmental, social and financial responsibilities, rather than by disclosure volume alone.

The study therefore extends legitimacy-based explanations from disclosure volume to accountability composition. It conceptualises selective institutionalisation as a condition in which externally legitimised disclosure practices become strongly embedded in technically auditable domains while socially and financially consequential dimensions remain comparatively less visible. The technical-social disclosure imbalance consequently demonstrates that disclosure maturity should be evaluated not only by how much companies report, but also by which dimensions of accountability their reporting makes visible. Drawing together the empirical and theoretical findings, Fig. 5 conceptualises tailings disclosure as a process of asymmetric institutionalisation in which technically auditable accountability has become more strongly embedded than broader social, emergency and financial accountability.

This study therefore identifies a persistent technical-social disclosure imbalance in which advances in technical and procedural transparency have not been matched by equivalent social, emergency and financial accountability. Conceptually, the findings demonstrate that disclosure maturity can develop asymmetrically across accountability domains. Sustainable tailings reporting should therefore be evaluated not only by the volume of information disclosed, but by how comprehensive disclosure represents technical, environmental, social, emergency and long-term financial responsibilities.

4.6 Practical and Policy Implications

For mining companies, technical and GISTM-aligned reporting should be complemented by consistent facility-level disclosure of community exposure, stakeholder engagement, emergency preparedness, closure obligations and long-term financial liabilities. Such integration would better reflect GISTM's broader conception of tailings accountability (UNEP 2020; Kemp et al. 2021).

For Ghanaian regulators, more standardised facility-level disclosure requirements could improve comparability across operators and reduce inconsistencies associated with voluntary reporting. Standard setters should similarly strengthen the integration of social, emergency and financial accountability with technical conformance, particularly given continuing gaps in non-technical tailings disclosure (Kemp et al. 2024; Crous and Marais 2025). This would move corporate tailings reporting beyond demonstrating technical compliance towards more comprehensive accountability.

For mineral-sector governance, this suggests that facility-level reporting templates should connect engineering and conformance information with the economic dimensions of responsibility. Comparable disclosure of closure provisions, financial assurance mechanisms, expected post-closure obligations and responsibility for emergency costs would help stakeholders assess whether long-term tailings risks are financially internalised or potentially shifted beyond the operating company. This recommendation is consistent with Mineral Economics research emphasizing both the role of regulatory and voluntary sustainability governance (Franken and Schütte 2022) and the need for adequate financial assurance to meet closure and post-closure obligations (Hodge and Brehaut 2023).

4.7 Limitations and Future Research

This study has several limitations. First, the analysis is based on publicly available corporate sustainability disclosures and therefore evaluates reported practices rather than independently verified tailings performance. Second, differences in report length, reporting architecture and disclosure granularity may influence coding frequencies across companies. Third, the study focuses on four major mining companies operating in Ghana between 2019 and 2025, which limits generalisation to smaller operators or other mining jurisdictions. Future research could triangulate corporate disclosures with regulatory records, community perspectives and facility-level environmental data. Comparative studies across African mining jurisdictions could also examine whether the technical-social disclosure imbalance identified here persists under different regulatory and institutional conditions.

Future research should also link disclosure evidence to audited financial statements, mine-closure provisions, financial-assurance arrangements and facility-level risk classifications. Such triangulation would permit a more direct test of whether sparse financial disclosure reflects limited public reporting, limited recognition of liabilities, or differences in the underlying economic exposure of individual operations.

5 Conclusion

This study examined how Gold Fields, AngloGold Ashanti, Newmont and Perseus Mining disclosed sustainable mine tailings management in Ghana between 2019 and 2025. Reporting became more formalised, standards-aligned and facility-specific, particularly following GISTM, with governance, monitoring, assurance, transparency, design and closure forming a dominant technical-accountability core. Yet community engagement, emergency preparedness and financial responsibility remained markedly less visible. The study therefore identifies a technical-social-economic accountability

imbalance: increasing technical transparency has not been matched by equivalent disclosure of the long-term financial and distributive consequences of tailings risk. This matters for mineral economics because mining obligations can extend beyond production into closure and post-closure and require credible financial capacity and assurance (Hodge et al. 2022; Hodge and Brehaut 2023). The findings show that disclosure maturity should be judged not simply by reporting volume or standards alignment, but by whether technical, environmental, social, emergency and financial responsibilities are made comparably visible. More integrated facility-level reporting of closure obligations, financial assurance, community exposure and emergency responsibilities would improve the economic usefulness of tailings disclosure and support more comprehensive accountability in mineral development.

Declarations

Author Contribution

B.G.A. contributed to conceptualization, methodology, investigation, data curation, formal analysis, visualization, and writing the original draft. U.O. contributed to conceptualization, methodology, validation, formal analysis, writing the original draft and reviewing and editing the manuscript. B.A.G. contributed to conceptualization, methodology, validation, supervision, project administration, and reviewing and editing the manuscript. E.O.-G. contributed to conceptualization, investigation, data curation, validation, and reviewing and editing the manuscript. All authors reviewed and approved the final manuscript.

Data Availability

The data supporting the findings of this study were derived from publicly available corporate, regulatory, and policy documents. The coded dataset generated and analysed during the study has been uploaded in the supplementary folder.

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Figures

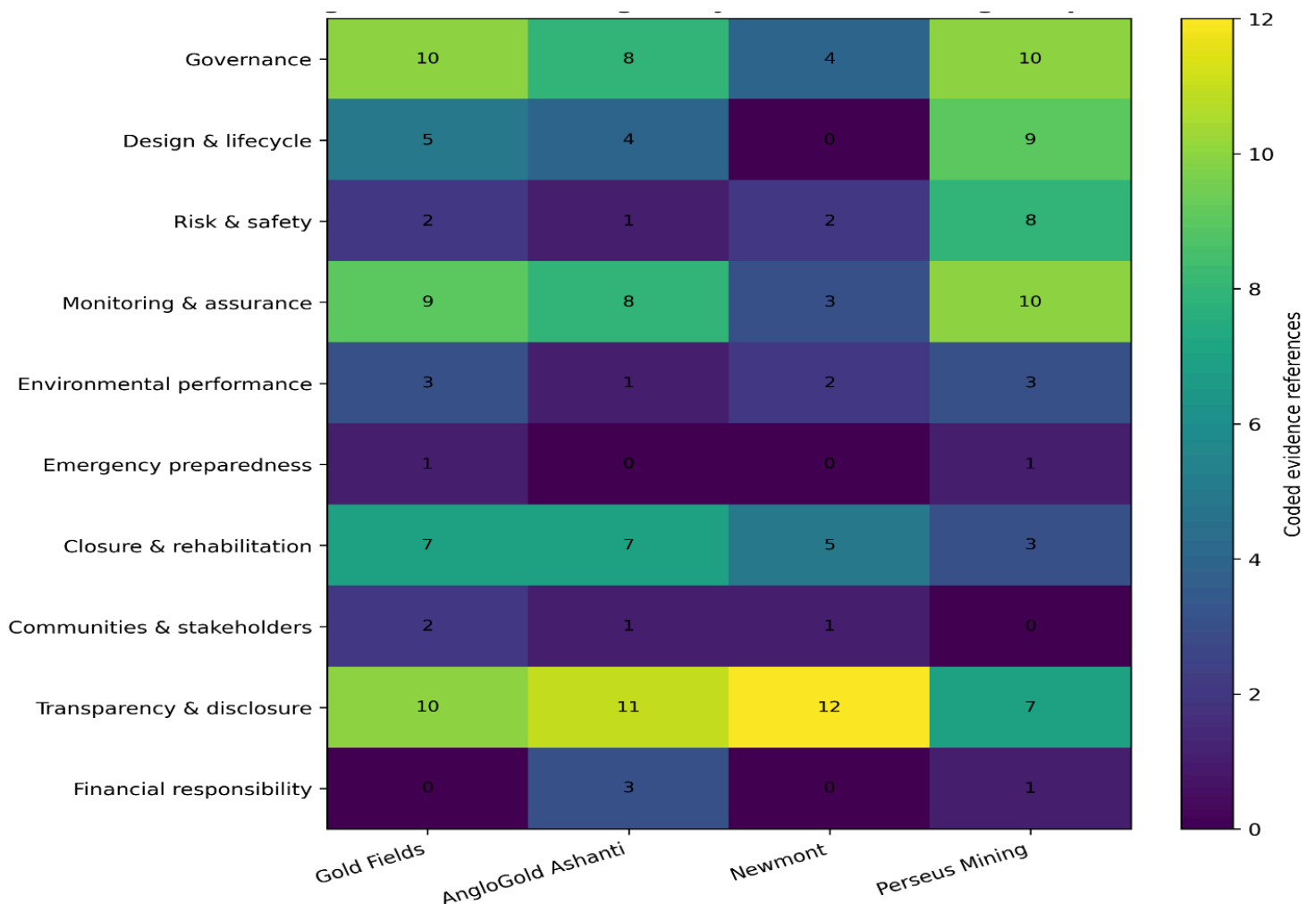


Figure 1

Matrix coding heatmap of sustainable tailings disclosure across mining companies

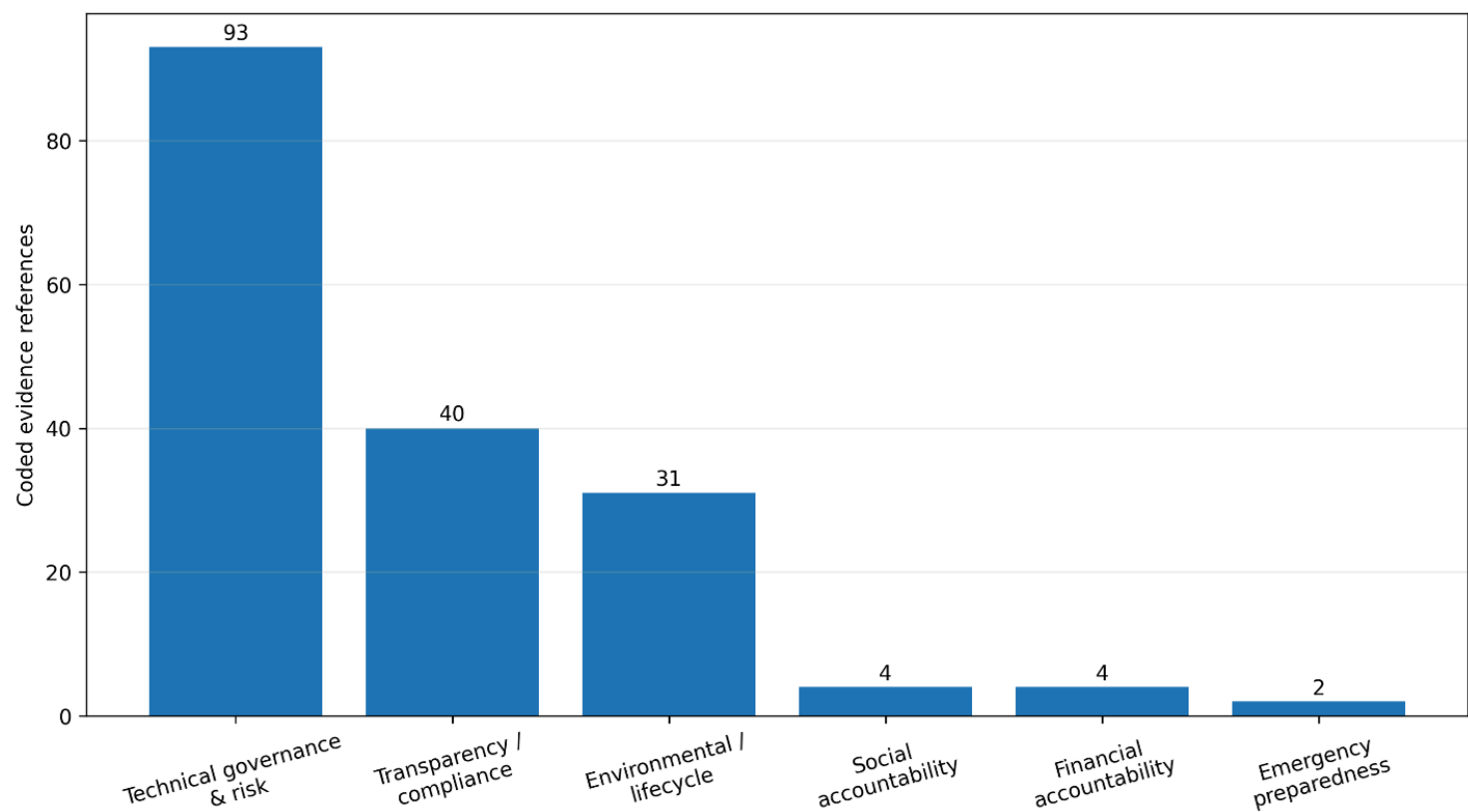


Figure 2

Technical-social disclosure imbalance in sustainable tailings reporting



Figure 3

Word frequency cloud of coded tailings disclosure evidence

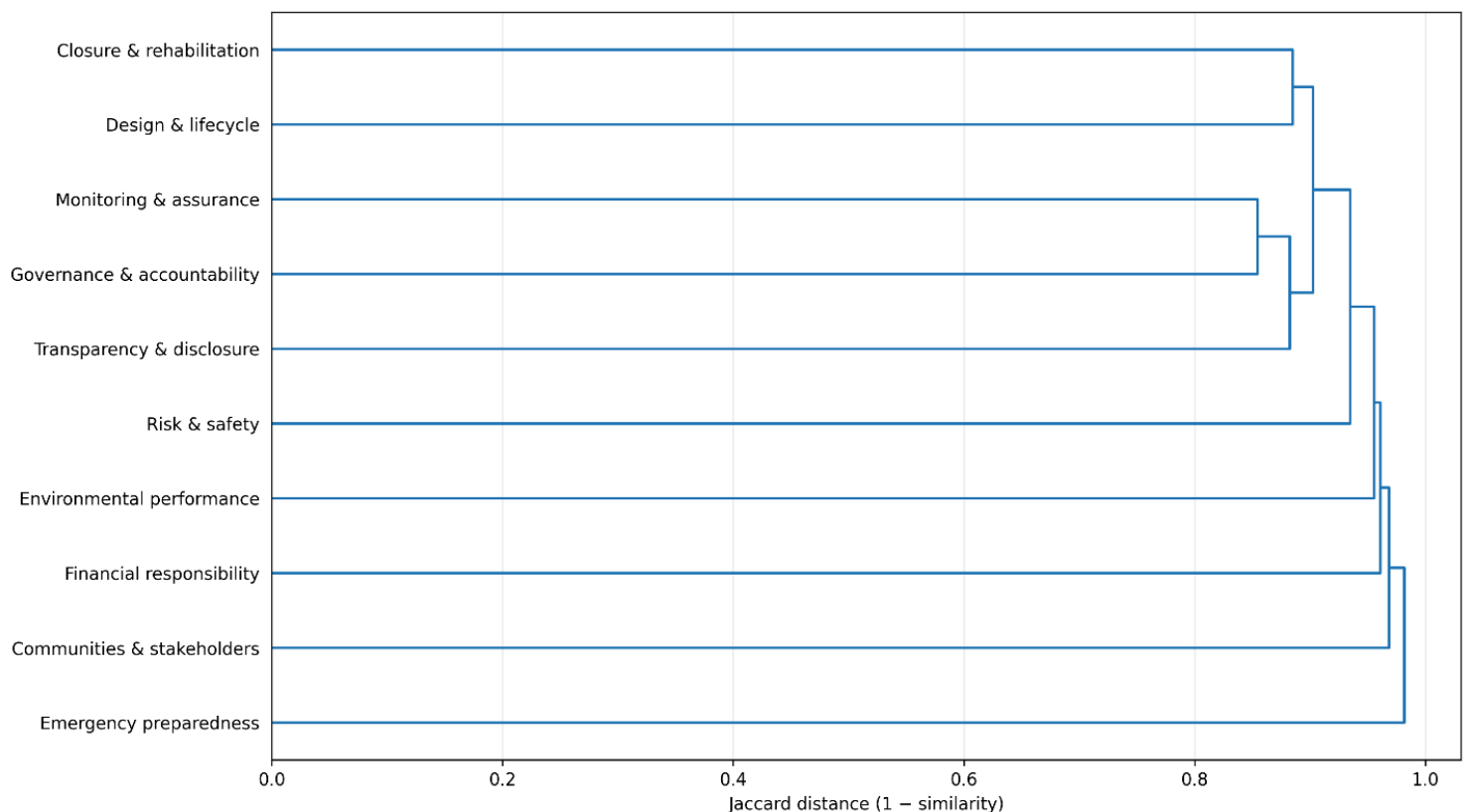


Figure 4

Cluster analysis of themes by word similarity

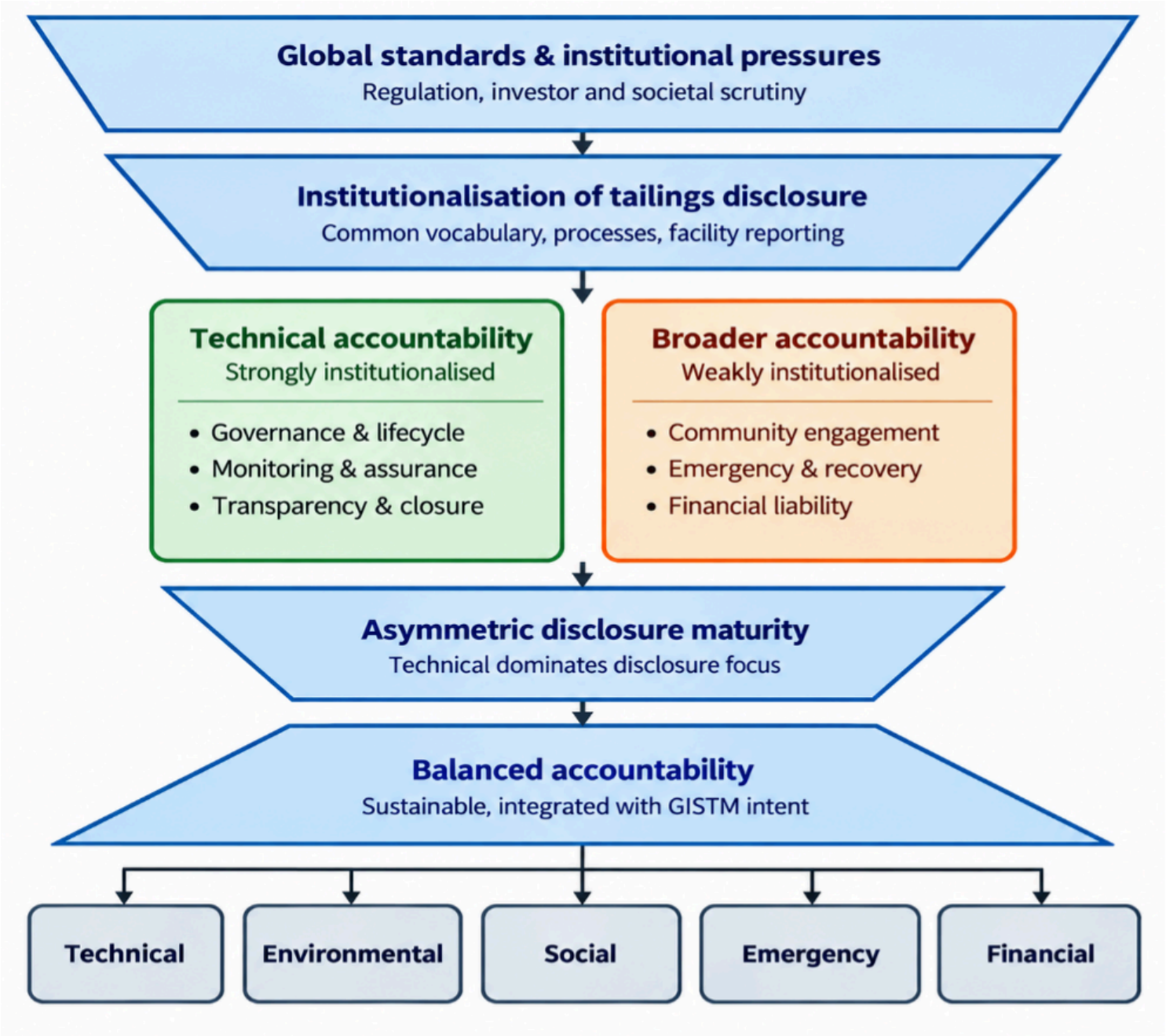


Figure 5

Emergent framework of asymmetric institutionalization in sustainable tailings disclosure

Supplementary Files

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- [GhanaTailingsSustainabilityReportsCodingDatasetCorrected.xlsx](#)
- [GhanaTailingsRegulatoryTechnicalBenchmarkDocumentsComplete.xlsx](#)