

Transparent Chemistry: Sustainability Reporting and Employee Safety Disclosures in Chemical Manufacturing — Conceptual Foundations, Frameworks, and SDG Case Alignment

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Abstract

Chemical manufacturing combines complex industrial processes with high environmental and occupational risks. As stakeholders demand greater transparency, sustainability reporting and explicit employee safety disclosures have become essential mechanisms for accountability, regulatory compliance, and stakeholder trust. This article conceptually examines sustainability reporting practices in chemical manufacturing, highlighting frameworks such as the Global Reporting Initiative (GRI 403), ISO 45001, and the Triple Bottom Line. The paper reviews recent literature, outlines a secondary-data methodology for empirical analysis, introduces key models, and illustrates alignment with Sustainable Development Goals (SDGs) through a composite case study. Findings underscore that reporting quality (metrics, targets, assurance) is more consequential than mere presence of disclosures. The study concludes with implications for practice, policy, and research gaps in linking disclosure practices to tangible safety outcomes.

Keywords: Sustainability reporting, Employee safety, Chemical manufacturing, GRI 403, ISO 45001, Triple Bottom Line, Occupational health and safety, ESG, SDGs

1. Introduction

The chemical manufacturing sector is among the most vital yet risk-intensive industries in the global economy. It contributes significantly to national GDPs through the production of pharmaceuticals, fertilizers, plastics, petrochemicals, and a wide range of industrial inputs that underpin modern life¹. However, the same processes that create economic value also introduce substantial environmental and occupational risks, including toxic exposures, hazardous waste, chemical leaks, explosions, and long-term ecological degradation².

Sustainability reporting has emerged as a global standard for communicating corporate performance beyond financial metrics. Organizations are increasingly required to disclose their environmental, social, and governance (ESG) impacts to stakeholders, including regulators, investors, employees, and local communities³. Within this paradigm, employee safety disclosures represent the “social” dimension of ESG, linking operational transparency to occupational health and safety (OHS) practices⁴.

Employee safety reporting is not merely a compliance exercise but a strategic tool for accountability and trust-building. Frameworks such as the Global Reporting Initiative (GRI 403), the International

¹ *International Council of Chemical Associations (ICCA). (2023). The global chemical industry: Enabling sustainable development*

² *World Health Organization (WHO). (2021). Preventing occupational and environmental risks in chemical industries*

³ *KPMG. (2022). The Time Has Come: The KPMG Survey of Sustainability Reporting 2022.*

⁴ *Global Reporting Initiative (GRI). (2018). GRI 403: Occupational Health and Safety 2018.*

Organization for Standardization (ISO 45001), and Sustainability Accounting Standards Board (SASB) guidelines provide standardized indicators on lost-time injury rates, occupational illnesses, near-miss reporting, and safety training⁵. These frameworks help ensure comparability and reliability of reported data, while also aligning corporate practices with international labor standards and human rights principles.

In the chemical sector specifically, sustainability and safety disclosures carry heightened significance. This is due to the sector's history of catastrophic industrial accidents such as the Bhopal Gas Tragedy (1984, India), the Tianjin Port Explosions (2015, China), and numerous incidents investigated by agencies like the U.S. Chemical Safety Board (CSB)⁶. Such events have underscored the reputational, financial, and human consequences of inadequate safety systems and opaque reporting practices.

The shift toward integrated reporting reflects recognition that financial performance is interdependent with social responsibility and environmental stewardship⁷. For chemical manufacturers, effective disclosure of safety metrics not only mitigates reputational risk but also aligns with Sustainable Development Goals (SDGs), particularly:

- SDG 3: Good health and well-being,
- SDG 8: Decent work and economic growth,
- SDG 12: Responsible consumption and production, and
- SDG 13: Climate action⁸.

Despite these advances, challenges persist. Reporting quality remains inconsistent across geographies, with variations in assurance, comparability, and integration of process safety indicators (e.g., hazard analyses, near-miss data and process incident rates). Scholars argue that disclosures often prioritize compliance-driven metrics rather than proactive, culture-based indicators of safety performance⁹. Thus, this paper positions sustainability reporting and employee safety disclosures as conceptual cornerstones for responsible chemical manufacturing, it explores theoretical underpinnings, reporting frameworks, models, and case study illustrations to clarify how firms can strengthen accountability while advancing global sustainability objectives.

2. Objectives Of The Study

- Clarify the conceptual relationship between sustainability reporting and employee safety disclosures in chemical manufacturing.
- Review key reporting frameworks (GRI 403, ISO 45001, ISSB/SASB).
- Synthesize recent literature on ESG, safety disclosures, and corporate performance.
- Present a secondary-data methodology suitable for empirical research.
- Introduce relevant conceptual models (Triple Bottom Line, safety maturity, HAZOP).
- Provide a case study linking reporting practices with SDGs.
- Identify research gaps and propose recommendations for practice and policy.

⁵ International Organization for Standardization. (2018). ISO 45001:2018 — Occupational health and safety management systems.

⁶ U.S. Chemical Safety Board (CSB). (2025). Incident Report Rule Form.

⁷ International Integrated Reporting Council (IIRC). (2021). Integrated Thinking & Reporting Framework.

⁸ United Nations. (2015). Transforming our World: The 2030 Agenda for Sustainable Development.

⁹ Podrecca, M., Molinaro, M., & co-authors. (2024). *The impact of ISO 45001 on firms' performance: An empirical analysis*. CSR and Environmental Management.

3. Literature Review

3.1. Evolution and current state of sustainability reporting: Sustainability reporting has shifted from voluntary narrative disclosures to increasingly structured, indicator-based frameworks that emphasize materiality, comparability and third-party assurance. The Global Reporting Initiative (GRI) remains the dominant, widely adopted standards set, and its Topic Standard for Occupational Health and Safety (GRI 403) has been a major driver for more consistent OHS disclosure since its 2018 update (effective for reports published from 2021 onward). Recent updates to the GRI architecture and the consolidation of investor-facing standards under bodies such as the ISSB reflect a convergence toward more standardized disclosure expectations across environmental, social, and governance (ESG) domains—making social topics (including employee safety) more visible to investors and regulators.

3.2. Occupational health & safety (OHS) disclosures - practice and trends: Corporate OHS disclosures typically cover both lagging indicators (injuries, fatalities, lost-time rates) and an increasing set of leading indicators (training hours, near-miss reports, safety observations, hazard analyses). Several studies and industry reviews of corporate sustainability reports have shown that large firms and leaders in high-risk sectors are more likely to publish metric-based OHS data and to reference standards such as ISO 45001 and GRI 403. ISO 45001—published in 2018 and adopted progressively since—provides a standardized management-system approach (Plan-Do-Check-Act) to occupational safety; recent empirical work suggests ISO 45001 certification correlates with improved organizational performance metrics, including productivity and profitability, although effects vary by industry and context. (Empirical ISO study; large-scale 2024 analysis).

3.3. Reporting quality and firm outcomes (evidence on value and performance): The empirical literature on the relationship between ESG disclosure quality and firm financial/operational performance is mixed but growing. Several robust studies indicate that higher-quality ESG disclosures can be associated with improved access to capital, lower cost of capital, or better stakeholder trust; however, other studies find weaker or context-dependent effects—particularly when disclosures are unverified or when “green washing” is present. Recent empirical analyses (including panel regressions and firm-level studies) underscore the importance of separating disclosure presence from quality (measurability, targets, assurance) when assessing outcomes.

3.4. Chemical industry specifics — process safety and reporting needs: The chemical manufacturing sector is unique in combining routine occupational hazards and potential high-consequence process safety events (releases, fires, explosions). Industry-specific disclosures therefore often need to include process-safety metrics (process safety incidents, PSM/HAZOP usage, near-miss analyses) and hazardous-waste management indicators (e.g., GRI 306). Sector reviews emphasize that meaningful disclosure for chemical firms must go beyond simple injury counts to include process-safety management practices and evidence of hazard analysis. Regulatory and oversight agencies continue to highlight gaps in process safety reporting. For example, the U.S. Chemical Safety and Hazard Investigation Board (CSB) and national incident reporting systems periodically release data showing upticks and clusters of chemical incidents, underlining that better public data and more transparent firm reporting are needed for external benchmarking and research.

3.5. Near-miss reporting and leading indicators — why they matter: Academic and industry studies consistently identify near-miss reporting and leading-indicator programs as central to preventing major incidents. Systematic near-miss management, coupled with analysis and organizational learning, reduces the probability of repeated failures and catastrophic events—both in practice and as an observable disclosure practice that signals a mature safety culture. Studies on near-miss systems and process-safety learning synthesized across chemical and process industries show tangible improvements where near-miss programs are robust.

3.6. Assurance, materiality and double materiality in social disclosures: The literature emphasizes that assurance (independent verification) substantially increases the credibility of safety disclosures. Materiality—both single (financial) and double materiality (impact on

society/environment)—is now commonly used in frameworks and in corporate disclosure policy to justify social and OHS reporting. Studies note that many firms claim alignment with frameworks (GRI/ISSB/SASB) but vary widely in how materiality is assessed and disclosed; robust materiality processes and clear linkages to strategy are recommended best practices.

3.7. Evidence gaps and methodological challenges in the literature: Key methodological challenges found across studies include heterogeneity in reporting formats (narrative vs. metric), inconsistent assurance scopes, and limited public availability of high-granularity process-safety data—especially outside the U.S. and EU. Several recent literature reviews call for: (a) longitudinal designs to test causality between improved disclosure and safety outcomes; (b) standardized, sector-specific indicators for process safety; and (c) cross-country comparative work to account for regulatory and cultural moderators.

4. Research Methodology (Secondary Data Framework)

This study adopts a conceptual and secondary-data approach suitable for an initial theoretical article or preparatory stage before empirical analysis.

4.1 Data sources

- Public sustainability reports (annual sustainability/CSR reports) of chemical manufacturing firms.
- Regulatory filings and safety incident reports (national chemical safety boards, environmental agencies).
- Framework documents (GRI Standards, ISO 45001 text, SASB/ISSB industry briefs, UN SDG indicators).
- Industry association white papers and media reports for triangulation.

4.2 Sampling

- Select a purposive sample of chemical manufacturers (global and regional) representing different sizes and product mixes.
- Timeframe: last 3–5 reporting cycles to assess trends (preferably consistent with data availability).

4.3 Data extraction and coding

- Create a codebook to extract: disclosure presence (yes/no), disclosure depth (narrative vs. metric), key safety metrics (TRIR, LTIFR, near-miss reporting, process safety incidents), targets, verification/assurance statements, and alignment with SDG targets.
- Use content analysis (quantitative and qualitative): count indicators, score quality (e.g., 0–3 scale for completeness), and thematic coding for narrative elements.

4.4 Analysis

- Descriptive statistics for disclosure prevalence and quality scores.
- Cross-tabulation versus firm characteristics (size, region, ownership).
- Conceptual mapping of disclosure attributes to SDGs and management standards.
- Limitations: secondary data may vary in comparability and reporting cycles; assurance levels differ; some data may be proprietary.

5. Core Concepts And Models

This section presents models and conceptual tools that structure thinking about sustainability reporting and safety disclosures in chemical manufacturing.

5.1 Triple Bottom Line (Elkington, 1997): Framework emphasizing simultaneous consideration of People (social), Planet (environmental), and Profit (economic). In chemical manufacturing: People = employee safety, community health, Planet = emissions, effluent, waste management and Profit = sustainable operations, risk management, long-term viability.

5.2 Materiality and Double Materiality: Financial materiality assesses whether an issue affects the firm's value. Double materiality (increasingly influential) adds societal/environmental materiality: issues that matter to stakeholders even if short-term financial impact is limited. For chemical firms, employee safety is often double material.

5.3 GRI & Sector Supplements: GRI Standards provide indicators for occupational health and safety (e.g., GRI 403) and sector guidance for extractive and manufacturing industries. Use them to structure disclosures and validate content.

5.4 ISO 45001 (Management System Model): Plan–Do–Check–Act cycle applied to occupational health and safety: policy, hazard identification, objectives, competence/training, operational controls, monitoring, incident investigation, continual improvement.

5.5 Process Safety and HAZOP: Process Hazard Analysis (PHA) methods such as HAZOP (Hazard and Operability Study), LOPA (Layer of Protection Analysis) are core technical risk-management tools in chemical plants; disclosures about their use signal technical rigor.

5.6 Safety Maturity Model: Maturity scales (reactive → compliant → proactive → generative) assess organizational culture toward safety. Reporting that shows near-miss learning, leading indicators, and employee participation indicates higher maturity.

6. Composite Case Study: Chem-Safe Industries - Aligning Reporting With Sdgs

6.1 Company profile: Chem-Safe Industries (fictional) - mid-sized specialty chemical manufacturer with three plants producing intermediates for agrochemicals and polymers.

6.2 Disclosure practice (high level)

- Publishes annual Sustainability Report aligned to GRI Standards (including GRI 403 on OHS).
- Discloses safety metrics: Total Recordable Incident Rate (TRIR), Lost Time Injury Frequency Rate (LTIFR), number of process safety incidents, near-miss reports and training hours per employee.
- Provides independent assurance over selected indicators (e.g., LTIFR, emissions).

6.3 Management systems

- ISO 45001 certified across two plants.
- Uses HAZOP and LOPA for process design; maintains PSM (Process Safety Management) registers.
- Implements leading indicators: safety observations, near-miss closeout time, safety training completion rates.

6.4 Mapping to SDGs

- **SDG 3 (Good Health & Well-being):** reduction in TRIR and LTIFR; occupational health programs and medical surveillance.

- **SDG 6 (Clean Water & Sanitation):** wastewater treatment and reduction in hazardous effluent.
- **SDG 8 (Decent Work & Economic Growth):** safe working conditions and training; no child/forced labor; decent wage reporting.
- **SDG 9 (Industry, Innovation & Infrastructure):** investment in safer process technologies and modernization.
- **SDG 12 (Responsible Consumption & Production):** waste reduction, circular streams for solvents, and transparent hazardous waste reporting.
- **SDG 13 (Climate Action):** emissions reduction targets and energy efficiency programs.

6.5 Outcomes and lessons

- Transparently reporting near misses and corrective actions improved employee trust and reduced repeated incidents.
- Assurance of safety metrics bolstered stakeholder confidence and aided contract negotiations with multinational customers requiring supplier safety standards.
- Remaining gaps: deeper disclosure on contractor safety, supply-chain chemical hazards, and quantitative linkage between safety investments and financial performance.

7. Practical Recommendations And Implications

The analysis of sustainability reporting and employee safety disclosures in chemical manufacturing yields several practical implications for different stakeholders:

For Managers and Corporate Leaders:

1. Prioritize quality over quantity of reporting: Focus on measurable, assured indicators such as near-miss reporting, safety training hours, and process-safety incidents rather than only publishing basic injury or fatality data.
2. Integrate safety into strategic planning: Align occupational health and safety (OHS) objectives with broader ESG and corporate sustainability goals.
3. Adopt structured frameworks: Implement GRI 403, ISO 45001, and other recognized standards to ensure standardized, transparent, and comparable disclosures.
4. Foster a proactive safety culture: Encourage reporting of hazards and near misses, and use findings to continuously improve processes, reducing the likelihood of major incidents.
5. Leverage disclosures for stakeholder trust: High-quality, verified reports can enhance investor confidence, employee engagement, and public reputation.

For Policymakers and Regulators:

1. Promote harmonized reporting standards: Establish sector-specific requirements that balance global frameworks (GRI, ISSB) with local legal obligations.
2. Encourage leading-indicator disclosure: Mandate or incentivize reporting beyond lagging metrics, including near-miss management and process-safety audits.
3. Support independent assurance mechanisms: Develop guidelines for third-party verification to improve transparency and credibility of OHS disclosures.
4. Link reporting to SDG performance: Encourage firms to explicitly connect their disclosures to Sustainable Development Goals, creating measurable societal impacts.

1. Focus on longitudinal and cross-country studies: Examine causal relationships between safety disclosures, ESG outcomes, and financial performance.
2. Develop standardized measurement tools: Create validated metrics for process safety, near-miss reporting, and cultural safety maturity to allow benchmarking across the chemical sector.

By implementing these strategies, chemical manufacturing firms can not only comply with global sustainability expectations but also contribute to safer workplaces, improved operational efficiency, and broader societal benefits.

8. Discussion And Conclusion

This study explored the conceptual link between sustainability reporting and employee safety disclosures within the chemical manufacturing industry. By examining global frameworks, reviewing literature, and illustrating case alignment with the Sustainable Development Goals (SDGs), the paper highlights how disclosure practices go beyond compliance to become a **strategic necessity** for firms operating in high-risk sectors.

The review demonstrates that quality of disclosure—through completeness, assurance, and inclusion of leading indicators such as near-miss data—is far more valuable than the **mere** presence of reporting. When firms adopt structured frameworks like GRI 403 or ISO 45001, they not only improve internal safety culture but also strengthen investor confidence, employee trust, and regulatory goodwill. Furthermore, integrating safety disclosures with sustainability reports positions chemical companies as active contributors to global development agendas, particularly SDG 3 (health and well-being), SDG 8 (decent work), SDG 12 (responsible production), and SDG 13 (climate action).

However, gaps remain. Current disclosures often emphasize lagging indicators (injury and fatality rates) while neglecting process safety, near-miss management, and cultural dimensions of safety performance. There is also wide variability in disclosure assurance and comparability across regions. Addressing these gaps requires collaboration between regulators, standard-setting bodies, and industry stakeholders to develop harmonized global benchmarks for chemical safety reporting.

In conclusion, sustainability reporting and employee safety disclosures are not optional add-ons but foundational components of responsible chemical manufacturing. They provide transparency, mitigate reputational and operational risks, and align firms with global sustainability commitments. Future research should employ longitudinal and cross-country **analysis** to evaluate how disclosure practices influence both safety outcomes and financial performance over time. For practitioners, the challenge lies in moving from compliance-driven reporting to a culture of proactive transparency, ensuring that the chemical industry evolves as a safer, more sustainable contributor to economic and social development.

9. Research Gaps & Future Directions

- Empirical causal studies linking disclosure quality to actual safety outcome improvements are limited.
- Cross-country comparisons are needed to understand how regulation and culture influence disclosure behavior.
- The role of digitalization (IoT sensors, real-time monitoring) in producing verifiable leading indicators for disclosure requires more study.
- Supply-chain chemical safety disclosure (beyond direct operations) is nascent and worth deeper exploration.

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