

Material Environmental Issues for Indian Pharmaceutical Companies and their Perspectives: A Descriptive Study using Semantic Clustering

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ABSTRACT

Material issues of corporate entities convey important information on the sustainability issues that a company views as important and as such, they form a vital part of sustainability reporting. One such sustainability framework, the Business Responsibility and Sustainability Report (BRSR) requires Indian companies, that fulfil certain criteria to make it mandatory for them to report, to declare which ESG issues they deem to be material to them. Additionally, they must also report on their perspective to each issue. The existing literature, which has focused on a myriad of issues concerning material issues and materiality assessments in the larger field of sustainability has done so on sustainability reporting frameworks other than the BRSR, leaving a gap in the literature, which this study aimed to address. By semantically clustering the material environmental issues of the top ten pharmaceutical companies in the NIFTY Pharma Index, this study attempted to identify the environmental issues that pharmaceutical companies perceive as material to them. This study also examined the differences in the proportion of the issues among companies and across years. In addition, the perspective with which pharmaceutical companies view these material issues were also described in this study. With semantic clustering, the study identified eight clusters of material environment issues, with sustainable supply chain being the most frequent topic, followed by energy management, environmental sustainability, water management, waste management, environment, health, and safety and anti-microbial resistance. While the difference in proportion of the material issues were insignificant across years, they were found to be significantly different among companies, with

all material environmental issues, except energy management, being viewed by the pharmaceutical companies as a risk with negative financial implications.

Keywords: *Materiality, Pharmaceutical Industry, Semantic Clustering, Environmental Sustainability*

1. INTRODUCTION

People have always needed transparency from companies in which they have a stake (Walker, 1931). With financial reports, stakeholders can learn about a company's financial affairs. Sustainability reports, like financial reports, provide information about a company's activities. However, as the name suggests, sustainability reports inform stakeholders about issues pertaining to sustainability (Sachs & Sachs, 2021). In other aspects, sustainability reporting draws plenty from financial reporting, such as the auditing of financial information being homologous to the activity of assurance in sustainability reporting (Larrinaga & Bebbington, 2021). For environmental sustainability, where everyone is a stakeholder, companies' reporting forms a crucial part of the entire picture surrounding the environment.

However, sustainability reporting suffers from a lack of standardisation (Sachs & Sachs, 2021; Siew, 2015; Thijssens et al., 2016), which hinders credibility (Lock & Seele, 2016) and leads to selective reporting (Macellari et al., 2021; Megura & Gunderson, 2022; Stacchezzini et al., 2016). One way this is being resolved is by using sustainability reporting frameworks. Popular frameworks include the Global Reporting Initiative (GRI) Standards, the Integrated Reporting (<IR>) Framework, and the Business Responsibility and Sustainability Report (BRSR), which is used in India.

The BRSR has been the current form of sustainability reporting in India since 2021-2022, and has been made mandatory by the Securities and Exchange Board of India (SEBI) for the top 1000 publicly listed companies by market capitalisation from the financial year 2022-2023 (Securities and Exchange Board of India, 2021b). The BRSR is the successor to the Business Responsibility Report (BRR), which was also created by SEBI. This reporting framework is a result of the need for sustainability reporting being recognised in the "National Guidelines on Responsible Business Conduct" (Ministry of Corporate Affairs, Government of India, 2018). Before the BRSR, Indian companies have been taking up the practice of sustainability reporting voluntarily (Nayak & Kayarkatte, 2021). However, the

BRSR is mandatory for certain companies and requires external assurance, providing advantages over voluntary frameworks.

An important facet of sustainability reporting is materiality assessment (Jørgensen et al., 2022; Ngu & Amran, 2024). Materiality assessment is meant to relay information to stakeholders as to what is important (or as the term suggests, “material”) to the company (Calabrese et al., 2016; Garst et al., 2022; Jørgensen et al., 2022; Taubken & Feld, 2018). Thus, materiality assessment provides space to companies to identify sustainability issues that are important to them and provides an avenue for qualitative differences within the standardised structure that sustainability reporting frameworks bring.

The avenues of differences in this regard open up a problem on the issues which are important to companies and sectors over time. This study delves into questions surrounding materiality assessment for Indian pharmaceutical companies and, by extension, its pharmaceutical sector. The pharmaceutical industry, like every other industry, has adverse impacts on the environment (Wollensack et al., 2022) and is one of the top contributors to greenhouse gas emissions within the health system (Booth et al., 2023; Richie, 2021). Although it is under threat from changing global trade conditions, the Indian pharmaceutical sector has a vital place in the world (Begum & Muthulakshmi, 2024), touted as ‘the pharmacy of the developing world’ (Plahe & McArthur, 2021). Given the standing of the Indian pharmaceutical industry within the pharmaceutical industry in general, the question of which environmental issues are viewed as material to it, as revealed by companies in the BRSR, becomes a pertinent question to pursue.

2. LITERATURE REVIEW

Studies in the literature surrounding the questions of materiality assessment have tackled a myriad of issues but have done so around a limited set of frameworks, namely the GRI and <IR> frameworks in non-Indian contexts (Calabrese et al., 2016, 2019; Machado et al., 2021; Padilla-Garrido et al., 2024; Setia et al., 2024; Torelli et al., 2020). There is therefore, a need to understand the issue of material assessment under the BRSR for Indian companies.

Materiality assessment has been the topic of a multitude of industries, both separately (Guix et al., 2019) and together (Gill et al., 2025). Furthermore, studies focus more on the concept (Oll et al., 2025) and the process of materiality assessment (Guix et al., 2019; Padilla-Garrido et al., 2024) and have not treated the outcomes of materiality assessments of a sector. On sustainability reporting by pharmaceutical

companies, the literature has addressed materiality in different contexts (Miettinen, 2024). More generally, the literature on sustainability issues in the pharmaceutical industry has focused on sustainable supply chains (Shashi, 2022), raw material usage (Wollensack et al., 2022), and carbon emissions (Booth et al., 2023; Richie, 2021). Thus, the question of the outcomes of materiality assessments, that is, material issues, in the pharmaceutical sector in India remains to be addressed.

3. OBJECTIVES

The objectives of the study are centred on the content of materiality assessments on environmental issues made by Indian pharmaceutical companies. More specifically, they are as follows:

- To find topics that are materially important in the ambit of environmental sustainability for Indian pharmaceutical companies.
- To describe the perspective of Indian pharmaceutical companies on their self-identified material issues pertaining to environmental sustainability.

4. METHODOLOGY

Data Sources

The list of Indian pharmaceutical companies used in this study are constituents of the NIFTY Pharma Index as on 29th August 2025. The index consists of 20 companies, but the weights of the companies that comprise the index are not evenly distributed. For this study, we considered the top ten companies, which make up 79.13% of the weight of the index. The selected companies, along with their weights in the NIFTY Pharma Index, are listed in TABLE 1.

TABLE 1: Companies selected for the study

Sl. No.	Company Name	Weight
C01	Sun Pharmaceutical Industries Ltd.	21.99%
C02	Cipla Ltd.	11.43%
C03	Divi's Laboratories Ltd.	9.96%
C04	Dr. Reddy's Laboratories Ltd.	9.81%
C05	Lupin Ltd.	5.86%
C06	Torrent Pharmaceuticals Ltd.	4.76%
C07	Laurus Labs Ltd.	4.29%
C08	Glenmark Pharmaceuticals Ltd.	3.70%
C09	Aurobindo Pharma Ltd.	3.68%

C10	Alkem Laboratories Ltd.	3.65%
	Total	79.13%

Source: NSE Indices, 2025

The Business Responsibility and Sustainability Report (BRSR) of the companies selected for this study will be accessed to understand the companies' material issues and how these issues are viewed by companies (whether as risk or opportunity and whether having negative or positive financial implications). The time period of this study is from the financial year 2022-23, that is the first year of the BRSR being mandatory for a large set of companies, to the financial year 2024-25.

Only those issues that pertain to the environment or are inclusive of the environment were considered for this study. Hence, out of all the material issues that a company might have identified, this study is concerned with the subset of material issues that can be classified as issues related to the environment. This selection was based on whether an issue or its relevant discussions consisted of terms related to the environment, natural resources, or sustainability.

Tools Applied

For the first objective, semantic clustering will be applied to club similar meaning terms, that is, similar material issues together (Kuhn et al., 2007). To achieve the clusters, the pandas, scikit-learn, and sentence-transformers Python libraries were used to generate the clusters (Pedregosa et al., 2011; Reimers & Gurevych, 2019; The pandas development team, 2025). A comma-separated values (CSV) file was created that contained all the material issues identified in a column, with their corresponding attributes (company, year, whether seen as risk or opportunity, and implications). The file and the column containing the material issues were then loaded, and the "all-MiniLM-L6-v2" embedding model was used to convert the phrases containing the material issues into vectors, with those issues which have similar meanings remaining closer to each other (Yin & Zhang, 2024). Thereafter, K-means clustering was applied to create the clusters, with the number of clusters not being specified and therefore defaulting to eight; the seed was set arbitrarily at 42 to ensure reproducibility, and a representative phrase for each cluster was set using NumPy(Harris et al., 2020). A frequency table of the material issues is reported, along with the percentage of the issue relative to the total number of environment-related material issues raised. By describing material issues in this manner, differences across years and among companies can be identified. Testing differences across years would be carried out based on the observed and expected frequencies, and using either the Chi-square test or Fisher's exact test using R

version 4.5.1 (R Core Team, 2025). If neither test is found to be appropriate, Fisher's exact test with a simulated p-value (based on 2000 replicates) will be used. The same technique was applied to the differences in material topics across companies. The following null hypotheses were proposed:

H0a: There is no difference in proportion of material issues across years

H0b: There is no difference in proportion of material issues among companies

With regards to the second objective on the perspectives towards material issues, there are two questions to consider. First, it is the question of whether a material issue is viewed as a risk, an opportunity, or both. The second question is whether companies view the financial implications of material issues positively, negatively, or both. In both questions, the approach was to explore the clusters of material issues. This exploration would constitute using descriptive statistics, looking into the frequencies and proportions of perspectives towards each cluster of material issues during the period of this study.

5. FINDINGS

Material Issues

The clusters obtained using Python libraries and statements are presented in TABLE 3. The Python output uses whole numbers to enumerate clusters; however, in TABLE 3 and the rest of this study, natural numbers have been used to label clusters along with the prefix 'M'. Hence, Cluster 0 in the output is Cluster M1 here, Cluster 1 in the output is Cluster M2 here and so on.

TABLE 3: Clusters of Material Issues

Cluster	Representative Phrase	Frequency	Relative Frequency
M1	Sustainable supply chain	21	19.44%
M2	Water management	15	13.89%
M3	Climate change	15	13.89%
M4	Energy management	16	14.81%
M5	Waste management	15	13.89%
M6	Anti-microbial resistance	5	4.63%
M7	Environmental sustainability	16	14.81%
M8	Environment, health and safety	5	4.63%
Total		108	100.00%

Source: Authors' calculations

As shown in TABLE 3, we find eight clusters, which is the default value of the K-means cluster function. A total of 108 material issues were identified by the selected Indian pharmaceutical companies. The results reveal that sustainable supply chains are the most discussed environmental material issues among Indian pharmaceutical companies. This was followed by the clusters of environmental sustainability and energy management, with both clusters having a frequency of 16. The issues of water management, climate change, and waste management closely followed with 15 instances each. Lastly, the clusters of anti-microbial resistance and environment, health and safety had five instances each.

TABLE 4 shows the observed and expected frequencies (expected frequencies in parentheses) of the material issues across the years. Because the expected frequencies of 11 out of the 24 categories were less than five, Fisher's exact test was applied, and a p-value of 0.9963 was found, implying that the null H_{0a} cannot be rejected.

TABLE 4: Observed and Expected Frequencies of Material Issues across Years

Cluster	Representative Phrase	2022-23	2023-24	2024-25	Total
M1	Sustainable supply chain	6 (5.83)	7 (7.19)	8 (7.97)	21
M2	Water management	4 (4.17)	5 (5.14)	6 (5.69)	15
M3	Climate change	3 (4.17)	5 (5.14)	7 (5.69)	15
M4	Energy management	7 (4.44)	5 (5.48)	4 (6.07)	16
M5	Waste management	3 (4.17)	5 (5.14)	7 (5.69)	15
M6	Anti-microbial resistance	1 (1.39)	2 (1.71)	2 (1.90)	5
M7	Environmental sustainability	5 (4.44)	6 (5.48)	5 (6.07)	16
M8	Environment, health and safety	1 (1.39)	2 (1.71)	2 (1.90)	5
	Total	30	37	41	108

Source: Authors' calculations

TABLE 5: Observed and Expected Frequencies of Material Issues across Years

	C01	C02	C03	C04	C05	C06	C07	C08	C09	C10	Total
M1	3 (1.8)	3 (1.4)	0 (2.1)	2 (2.3)	4 (2.9)	0 (1.2)	0 (0.6)	3 (1.9)	3 (2.7)	3 (4.1)	21
M2	0 (1.3)	0 (1.0)	3 (1.5)	1 (1.7)	2 (2.1)	3 (0.8)	0 (0.4)	0 (1.4)	3 (1.9)	3 (2.9)	15

M3	3 (1.3)	1 (1.0)	2 (1.5)	1 (1.7)	1 (2.1)	0 (0.8)	0 (0.4)	3 (1.4)	1 (1.9)	3 (2.9)	15
M4	0 (1.3)	0 (1.0)	0 (1.6)	5 (1.8)	1 (2.2)	3 (0.9)	0 (0.4)	1 (1.5)	3 (2.1)	3 (3.1)	16
M5	0 (1.3)	1 (1.0)	3 (1.5)	3 (1.7)	3 (2.1)	0 (0.8)	0 (0.4)	1 (1.4)	1 (1.9)	3 (2.9)	15
M6	0 (0.4)	0 (0.3)	0 (0.5)	0 (0.6)	2 (0.7)	0 (0.3)	0 (0.1)	0 (0.5)	3 (0.6)	0 (1.0)	5
M7	3 (1.3)	2 (1.0)	3 (1.6)	0 (1.8)	0 (2.2)	0 (0.9)	0 (0.4)	2 (1.5)	0 (2.1)	6 (3.1)	16
M8	0 (0.4)	0 (0.3)	0 (0.5)	0 (0.6)	2 (0.7)	0 (0.3)	3 (0.1)	0 (0.5)	0 (0.6)	0 (1.0)	5
Total	9	7	11	12	15	6	3	10	14	21	108

Source: Authors' calculations

TABLE 5 illustrates the contingency table for the material issue clusters and companies of the study, with the observed frequencies and expected frequencies (in parentheses). This table reveals important information on how many and which environmental issues individual companies have deemed material. We find that company C10 (Alkem) has the highest number of environmental issues as material to them, and company C07 (Laurus) has the least number of material environmental issues. Owing to the small expected frequencies and the large number of categories, we used simulated p values to test H_{0b} and with the default setting of 2000 replicates in the Fisher's exact test in R, the p-value was found to be less than 0.001 and therefore the null H_{0b} was rejected. Therefore, not only are there differences in the total number of material issues identified by companies, but their proportions are also not similar across companies. TABLE 6 provides a summary of the results of the null hypotheses tests.

TABLE 6: Results of Null Hypotheses Tests

Hypothesis	p-value of Fisher's exact test	Result
H0a: There is no difference in proportion of material issues across years	0.9963	Failed to reject
H0b: There is no difference in proportion of material issues among companies	< 0.0010	Rejected

Source: Authors' calculation

Perspectives on Material Issues

Material environmental issues are overwhelmingly viewed as risks by the pharmaceutical companies selected in this study, as depicted in TABLE 7. At the cluster level, four material issues were viewed as risks, three material issues were viewed as both risk and opportunity, and only one material issue, M5 (Energy management), was viewed as an opportunity.

TABLE 7: Perspective on Material Issue Cluster

Cluster	Representative Phrase	Risk	Opportunity	Both	Total
M1	Sustainable supply chain	9	2	10	21
M2	Water management	11	4	0	15
M3	Climate change	5	2	8	15
M4	Energy management	3	7	6	16
M5	Waste management	10	1	4	15
M6	Anti-microbial resistance	5	0	0	5
M7	Environmental sustainability	13	0	3	16
M8	Environment, health and safety	5	0	0	5
Total		61	16	31	108

Source: Authors' calculations

TABLE 8: Financial Implications of Material Issue Cluster

Cluster	Representative Phrase	Negative	Positive	Both	NA	Total
M1	Sustainable supply chain	9	1	10	1	21
M2	Water management	12	3	0	0	15
M3	Climate change	5	3	7	0	15
M4	Energy management	2	9	5	0	16
M5	Waste management	7	4	4	0	15
M6	Anti-microbial resistance	4	0	0	1	5
M7	Environmental sustainability	15	0	1	0	16
M8	Environment, health and safety	5	0	0	0	5
Total		59	20	27	2	108

Source: Authors' calculations

TABLE 8 presents the perspectives on the financial implications of each material issue cluster. With more risks in TABLE 7, it follows that more implications would be negative, which is precisely what is evident. Only cluster M5 (Energy management) is the only material issue cluster that has more instances where its financial implications are viewed as positive. All other material issue clusters are viewed as having negative financial implications for the business.

6. CONCLUSION

The findings of the study cluster the environmentally material topics identified by the top ten Indian pharmaceutical companies in the NIFTY Pharma index for the three years 2022-2023 to 2024-2025. Using semantic clustering, the material issues identified by the companies during the study period were grouped into eight clusters. The most prominent material issue identified by companies pertained to a sustainable supply chain, followed by energy management and environmental sustainability, and water management and waste management. Two clusters are tied at the bottom of the clusters: anti-microbial resistance and environmental health and safety. These results can help in understanding what issues companies in the pharmaceutical companies deem to be material to them and which issues are not. Furthermore, stakeholders can view whether the material environmental issues identified by the pharmaceutical sector align with their concerns about the environment and its degradation caused by the activities of the pharmaceutical sector. In this regard, this study adds to the literature on material issue identification (Papafloratos et al., 2023). In addition, the study also reveals that while the proportion of instances of material issues remains more or less the same over the three-year period, it varies significantly when comparing companies.

Regarding the perspective on material issues, we found that only energy management is viewed as an opportunity and understood as an issue which could have positive financial implications. All other material issue clusters are mostly seen as risks and are thought to have negative financial implications, exhibiting a sense of pessimism from pharmaceutical companies in recognising their environmentally material issues. Environmental issues, as viewed by pharmaceutical companies in India, are risks to their sustainability. The findings of this study therefore aptly identify material issues in the Indian pharmaceutical sector and the inherent pessimism with which most material issues are viewed by companies in the sector.

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