ECONOMETRIC ANALYSIS OF CEMENT COMPANIES IN AN EMERGING MARKET: A SUSTAINABILITY OUTLOOK

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Abstract

Cement plays a crucial role in India's infrastructure projects and contributes significantly to the nation's gross domestic product (GDP) and employment. India's urbanization relies heavily on this sector as the world's second-largest producer of cement. Given its economic importance, understanding and assessing financial health and predicting the likelihood of default by these companies are critical for stakeholders. This study investigates various financial ratios, assesses their significance, and explores their relationship with the Altman Z-score, a financial ratio used to predict the probability of a company's bankruptcy. Recent corporate practices show a growing trend toward incorporating corporate social responsibility (CSR) reporting and sustainable growth rate (SGR) reporting into mandatory disclosures. These metrics are strategically used to improve public perception, build stakeholder trust, and convey a company's reliability and operational performance. This study further explores the potential impact of CSR and SGR on bankruptcy risk, assessed using the Altman Z-score. Empirical analysis within the Indian cement industry reveals that, at present, CSR and SGR factors may not have a significant effect on financial distress. This study contributes significantly to the understanding of the financial health of the Indian cement industry while examining the evolving roles of CSR and SGR. It provides a nuanced perspective by empowering stakeholders to identify financial and non-financial indicators of stability. It also emphasizes the critical need for holistic assessment methodologies in the ever-evolving corporate landscape.

Keywords: Financial Health, Financial Ratios, Altman Z-Score, Corporate Social Responsibility, CSR Reporting, Sustainable Growth Rate, SGR, Cement Industry India

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1. INTRODUCTION

Cement is a fundamental building block of infrastructure projects such as roads, bridges, ports, and buildings (Miller, 2020). India is the second-largest cement producer in the world after China (Mishra et al., 2022). India's rapid urbanization and infrastructure expansion rely heavily on cement for construction. It is a significant source of employment, directly and indirectly, providing jobs in the manufacturing, logistics, construction, and allied sectors (Kukreja et al., 2020). India's cement

industry is critical for economic growth, infrastructure development, job creation, and industrial progress (Chandrika, 2020; Shaban et al., 2022). Its significance extends beyond construction materials, impacting multiple facets of the economy, and contributing to India's overall development trajectory (Kukreja et al., 2020). The market size of India's cement industry reached 3.96 billion tonnes in the year 2023 and is expected to touch 5.99 billion tonnes by 2032, exhibiting a compound annual growth rate (CAGR) of 4.7% during 2024–2032. Overall cement demand is believed to have grown by 8.8% to 420 MnT in FY2024 (Dalmia Bharat Limited, 2023). Industry growth and output directly impact the overall economic and industrial output of the country.

The cement industry stimulates growth in various ancillary sectors, such as steel, chemicals, machinery, and equipment suppliers, further enhancing industrial development and creating a broader economic impact (Balaji et al., 2022). Cement plants are often located in rural or semi-urban areas, providing investment and employment opportunities to these regions. This helps balance the regional development across the country. Cement production contributes to exports, generating foreign exchange earnings for the country, particularly through clinker exports and finished cement products (Sankaran et al., 2020). This industry fosters technological advancements and innovations in manufacturing processes, environmental sustainability, and efficiency, thereby contributing to India's industrial and technological growth (Ighalo & Adeniyi, 2020). Although cement production can have environmental challenges, the industry has been focusing on sustainable practices, including alternative fuels, energy efficiency, and reducing carbon emissions, aligning with global environmental goals (Dhar et al., 2020).

The Indian cement industry has experienced steady growth over the past decade, driven by infrastructure development (Mudgal & Chellasamy, 2024; Adhikary, 2024). Leading companies such as UltraTech Cement, Ambuja Cements, ACC, JK Cement, and Shree Cement reported significant increases in revenues and profits, reflecting their financial stability. However, smaller players such as Heidelberg, Sagar, Mangalam, and Udaipur Cement face financial constraints due to rising raw material costs and competition (Sathiya & Palaniammal, 2024). This led to declining revenues, mounting losses, and increased debt burdens, pushing several companies into bankruptcy and contributing to the issue of non-performing assets (NPAs) in Indian commercial banks (McCarthy & Amoasi-Andoh, 2020; Lavina & Salathiyan, 2023). In this context, assessing the financial soundness and predicting the likelihood of default for companies has become critical for stakeholders. Tools such as the Altman Z-score, which measures a firm's credit strength and bankruptcy risk, play a pivotal role in evaluating corporate insolvency (McCarthy & Amoasi-Andoh, 2020; Zatira & Puspitasari, 2020; Vibhakar et al., 2023; Verma, 2023). Consequently, companies are compelled to implement effective credit management strategies to maintain financial health and avoid debt traps (Asamoah & Puni, 2021; Ershad et al., 2021; Blessing & Sakouvogui, 2023; Hartomo, 2024).

The existing literature indicates that numerous studies have used both fundamental and technical analysis methodologies to investigate cement companies. These studies focused on financial performance indicators. The demand-supply dynamics of the Indian cement industry were significantly influenced by factors such as increasing urbanization, transportation, and housing. Post-COVID-19, additional factors contributed to the growth of this industry. Furthermore, various government schemes and ongoing urbanization trends indicate that companies in this sector require careful examination. Moreover, the analysis of opportunities and challenges that have emerged from infrastructure development policies and investments has been regarded as highly significant from a research perspective. This highlights the importance of evaluating the performance of the cement companies operating in India. It became crucial to assess not only their financial health but also how their social initiatives contributed to creating a sustainable environment and growth. Recent corporate practices have shown a growing trend to incorporate CSR and SGR reporting into mandatory disclosures. The objectives of this study were to calculate the financial ratios of selected cement companies in India to assess their financial health and analyze their overall performance based on key financial metrics. It aimed to examine the relationship between these financial ratios and the Altman Z-score (Hartomo, 2024), a critical indicator of financial stability. Additionally, the study sought to evaluate the significance of CSR reporting in relation to the Altman Z-score and investigate the correlation between the SGR and the Altman Z-score. These objectives were designed to provide comprehensive insights into the financial and social performances of the selected companies.

The literature reveals a gap in studies that comprehensively integrate financial performance metrics with social responsibility and sustainability indicators in the Indian cement industry. While previous research primarily focused on financial ratios and macroeconomic impacts, limited emphasis has been placed on exploring the relationship between financial health indicators, such as the Altman Z-score, and sustainability metrics, such as corporate social responsibility (CSR) and sustainable growth rate (SGR) reporting.

This underscores the importance of evaluating financial stability and sustainable growth indicators. This study investigates various financial ratios, assesses their relevance, and explores their relationship with the Altman Z-score. Additionally, it examines whether CSR and the SGR significantly influence bankruptcy risk.

The rest of the paper is structured as follows. Section 2 reviews the relevant empirical literature, Section 3 identifies the research gap, Section 4 outlines the variables and methodology used to assess financial distress, Section 5 presents the analysis and findings, Section 6 discusses the findings in the context of existing literature, and Section 7 concludes the study with recommendations.

2. LITERATURE REVIEW

Increasing urbanization, transportation, and housing have impacted the demand-supply dynamics of the Indian cement industry (Nandamuri et al., 2017).

Post-COVID many factors such as environmental, social, and governance (ESG) and CSR are becoming important criteria for creating a positive image of the company (Elghamrawi, 2023). CSR and sustainable reporting are structured frameworks that focus on ESG factors. These frameworks incorporate variables that go beyond traditional financial metrics, highlighting the organization's performance in sustainability and ethical governance (Baran & Woznyj, 2021; Baran et al., 2022). By integrating these variables, organizations not only address regulatory and societal expectations but also align themselves with global standards of sustainable development and responsible business practices (Al Fadli, 2020; Kandpal et al., 2024). These reports are voluntary and highlight the company's commitment to ethical behavior, sustainable practices, social welfare, and economic development through job creation and fair trade (Poudyal & Adhikari, 2021; Mudgal & Chellasamy, 2024; Adhikary, 2024).

The SGR is the maximum growth rate that a company can sustain without increasing debt or equity capital (Vibhakar et al., 2023). Although the SGR is not directly linked to ESG, ESG considerations can influence a company's ability to achieve sustainable growth. Companies that adopt environmentally sustainable practices (e.g., reducing carbon emissions, minimizing resource consumption, and using renewable energy) may lower operational costs over time. This efficiency can improve profitability and free up resources that can be reinvested for growth, potentially enhancing a company's SGR. In this context, it is crucial to examine the influence of CSR and SGR on the financial stability of cement companies, particularly considering infrastructure development policies and investments.

Understanding the financial health (Malik & Handono, 2019; Zatira & Puspitasari, 2020; Ershad et al., 2021) and sustainability of cement companies are important for various stakeholders, including investors, policymakers, and regulators (Panigrahi, 2019; Naik et al., 2020; Chouhan et al., 2021; Poudyal & Adhikari, 2021). The existing literature indicates that studies on cement companies primarily use fundamental and technical analysis to assess their performance (Shahriari, 2020; Naushad, 2021; Goh et al., 2022; Taufik et al., 2023; Vibhakar et al., 2023). The performance serves as a key indicator of the attractiveness and survival prospects of these companies (Lazarides, 2017).

As most studies used financial performance indicators (Heriyanto et al., 2021; Nawaz et al., 2020), financial ratios play a crucial role in assessing the health of a company, providing insights into its financial performance and stability (Lazarides, 2017; Olayinka, 2022; Blessing & Sakouvogui, 2023; Fikri & Yolanda, 2023; Kamal, 2024). Ratios such as liquidity ratios (e.g., current ratio, quick ratio) assess a company's ability to meet short-term obligations (Sareen & Sharma, 2022). Profitability ratios (e.g., return on assets and return on equity) measure the efficiency of generating profits from investments and assets. Debt ratios (e.g., debt-to-equity ratios) assess financial leverage and risk. These ratios helped stakeholders, including investors and creditors, evaluate the company's financial health and monitor its overall financial well-being and sustainability (Asamoah & Puni, 2021; Nimbalkar & Marisetty, 2022).

Recent studies, like Chouhan et al. (2021), have affirmed the Altman Z-score's efficacy in forecasting financial distress, where higher scores signify enhanced financial health and reduced bankruptcy risk (Swalih et al., 2021). Legitimacy theory posits that businesses must conform to societal norms to ensure sustainability (Burhan & Rahmanti, 2012; Schmelzer, 2013). CSR and sustainability reporting supported this theory by advising companies to surpass legal obligations (Carroll, 2016). The Indian Companies Act, 2013 mandates CSR spending, underscoring its important role in determining CSR effectiveness.

Several studies have investigated the link between CSR activities and financial stability by incorporating these factors into the Altman Z-score model (Destriwanti et al., 2022; Galant & Zenzerović, 2023). However, the research findings on this relationship vary, including mixed, positive, negative, and null results. Positive correlations were the most prevalent (Lu & Abeysekera, 2014; Wang & Shen, 2016; Bartolacci et al., 2020; Velte, 2024; van Beurden & Gössling, 2008). This suggests that CSR initiatives can enhance a company's financial performance (Kozarevic & Piric, 2022). However, the existing evidence on the relationship between CSR and bankruptcy risk at the global level is inconclusive, necessitating further research (Swalih et al., 2021). Literature suggested that Most studies indicate a negative correlation between socially responsible governance and bankruptcy risk (Cooper & Uzun, 2019; Pizzi et al., 2020). The studies by Onyiri (2014) and Shah et al. (2022) emphasized the enhancement of Z-score accuracy by incorporating the SGR. Additionally, the Securities and Exchange Board of India (SEBI, 2021) mandated Business Responsibility and Sustainability Reporting (BRSR), quantifying companies' ESG initiatives into measurable scores.

3. RESEARCH METHODOLOGY

This study uses a positivist research approach to identify the key financial indicators predictive of financial distress within the cement industry. The quantitative research design consisted of an empirical analysis of 14 cement companies listed on the National Stock Exchange of India. The secondary data, sourced from Bloomberg Terminal, consisted of a panel of 98 observations from 2017 to 2023. Microsoft Excel was used for data visualization and R-software for panel data analysis techniques to explore the trends and relationships from the collected data.

3.1. Study variables

The Altman Z-score is based on financial ratios such as liquidity, profitability, leverage, and solvency. It provides a quantitative assessment of a company's financial health, complements qualitative analysis, and helps in making informed decisions. The Z-score allows for a comparative analysis across companies within the same industry or sector. It helps stakeholders understand how a company's financial risk profile compares with its peers, highlighting its relative strengths and weaknesses. Creditors and

lenders use the Altman Z-score to assess credit risk when extending loans or credit lines to companies. Hence, Z-scores were calculated and companies were analyzed by applying various data visualization tools (Hofer et al., 2023). The financial ratios used to calculate the Altman Z-score were as follows:

- Working capital / Total assets (*X1*);
- Retained earnings / Total assets (*X2*);
- Earnings before interest and taxes (EBIT) / Total assets (*X3*);
- Market value of equity / Total liabilities (*X4*);
- Sales / Total assets (*X5*).

In addition to the above-mentioned variables, this study explored the phenomenon with two additional variables: CSR coded as *X6* and SGR coded as *X7*. Variable *X6* was a dichotomous indicator, capturing whether a company had proper CSR reports available in the public domain. This variable reflects an organization's compliance with globally recognized CSR standards. It also helped map the organizational commitment to disseminating these reports in a stakeholder-accessible format. Variable *X7* represents a company's SGR and was derived from the Bloomberg database from 2017 to 2023. It offers longitudinal insights into a company's sustainability trajectory. This approach allows for a nuanced analysis of both CSR engagement and sustainability growth trends.

3.2. Model specification

This study aimed to assess the financial health of companies by employing a methodology based on the Altman Z-score, with modifications to enhance its applicability. The revised Z-score formula is as follows:

$$Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 0.999X5 + X6 + X7 \quad (1)$$

where *Z* represents the dependent variable and *X1* to *X7* serve as independent variables. This study utilized panel data analysis to examine the dynamic relationships among these variables over time. This analytical approach leverages the combined benefits of time-series and cross-sectional data. It provides deeper insights and more robust inferences, particularly when examining the interplay of financial health indicators (Neves et al., 2023). The Z-score enabled comparative inquiry of companies within the same industry, offering stakeholders a valuable perspective on financial risk profiles, including key strengths and weaknesses. This tool is widely used by creditors and lenders to estimate credit risk and evaluate a company's likelihood of avoiding financial distress (Hofer et al., 2023). A higher Z-score indicates financial stability and a reduced risk of bankruptcy.

Unlike simpler models such as Beaver's univariate analysis, the Altman Z-score integrates multiple financial ratios to capture various dimensions of financial health, including profitability, liquidity, solvency, and operational efficiency. Its multivariate structure improves the predictive accuracy by considering the interdependence of these factors. Since its development in 1968, the Z-score has undergone extensive validation across diverse datasets, industries, and geographies, making it a reliable tool in different regulatory and economic contexts.

Considering the time-series and cross-sectional components of the dataset, panel data analysis was deemed more appropriate than ordinary least squares (OLS). Panel data analysis offers significant advantages by addressing issues such as correlated error terms, which are common in OLS, and allowing for better control of unobservable variables. This approach is particularly effective for studying dynamic relationships over time, capturing both cross-sectional and temporal dimensions. The analysis employed both fixed effects (FE) and random effects (RE) models to account for individual-specific characteristics. The FE model controls for time-invariant variables that might otherwise bias the results, while the RE model assumes that these characteristics are uncorrelated with the explanatory variables. The Hausman test was used to select the most appropriate model for the data to ensure accurate and meaningful results. This comprehensive application of panel data analysis facilitates a nuanced understanding of the financial health of companies and their interconnections.

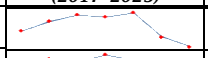
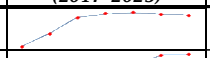
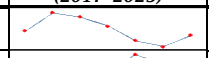
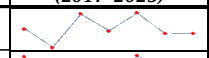
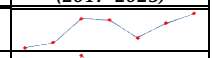
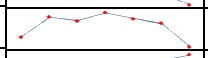
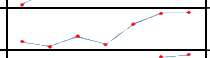
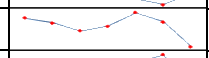
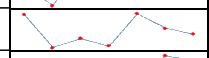
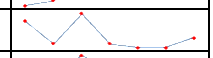
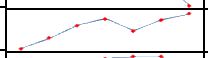
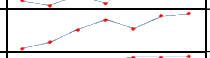
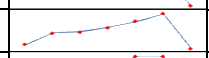
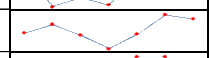
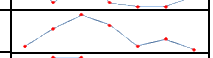
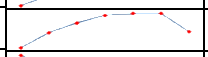
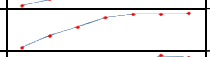
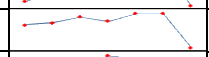
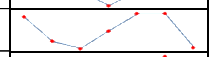
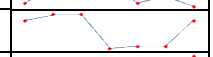
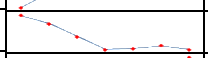
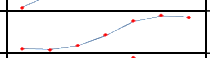
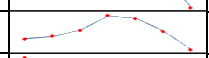
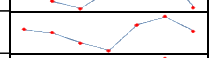
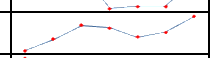
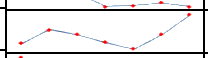
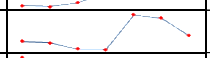
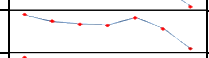
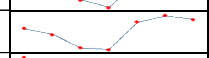
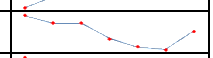
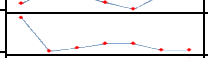
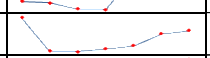
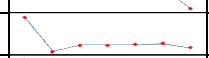
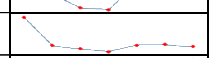
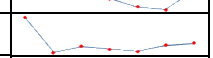
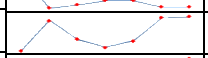
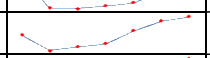
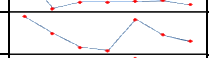
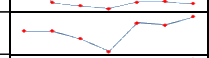
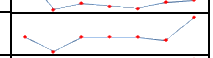
4. ANALYSIS AND FINDINGS

4.1. Analysis of Altman Z-score

The period considered for the study was seven years (i.e., from 2017 to 2023), and the sample size was 14 listed cement companies in India. Excel sparklines were found to be suitable for analyzing trends because they summarized data into small, simple visualizations, making it easy to observe patterns over time. Their seamless integration into cells along with data allows for efficient comparison and quick analysis without cluttering the worksheet.

Table 1 depicts the trend analysis of the above ratios across the 14 selected companies, where the negative markers are denoted by red. Except for the working capital to total assets ratio (*X1*), all other ratios were positive, highlighting the fact that it required a deeper examination to infer further.

Table 1. Trend analysis of financial ratios in Altman Z-scores

SN	Company	X1 — Trend (2017–2023)	X2 — Trend (2017–2023)	X3 — Trend (2017–2023)	X4 — Trend (2017–2023)	X5 — Trend (2017–2023)
1	Star Cement					
2	Shree Cement					
3	Ambuja					
4	ACC					
5	BirlaCorp					
6	India Cement					
7	Grasim					
8	Dalmia					
9	JK Laksmi					
10	Ramco					
11	JKCement					
12	Prism					
13	Heidelberg					
14	Orient Cement					

Source: Authors' compilation.

The *X1* is crucial for assessing a company's financial health, particularly in terms of its ability to meet short-term obligations and efficiently sustain operational activities. The use of MS Excel color scales was found to be appropriate for analyzing data because they apply gradient or contrasting colors to cells based on their values, making it easy to identify patterns, trends, and outliers. This visual indication enhances the interpretability of large datasets by highlighting their relative differences at a glance. The dark green color in Table 2 represents a higher ratio, which indicates a conservative approach with ample liquidity for day-to-day operations. A low ratio suggests a higher proportion of assets tied up in long-term investments, which could impact short-term liquidity. From Table 2, it can be inferred that Star Cement, Shree Cement, Ambuja, and ACC managed their working capital efficiently. Whereas Heidelberg and Dalmia were getting better at managing their working capital compared to their total assets.

Table 2. Comparative analysis of working capital to total asset ratio (2017–2023)

SN	Company	X1 (2017)	X1 (2018)	X1 (2019)	X1 (2020)	X1 (2021)	X1 (2022)	X1 (2023)
1	Star Cement	0,2377	0,2945	0,3311	0,3197	0,3447	0,2059	0,1498
2	Shree Cement	0,1158	0,1805	0,1673	0,1945	0,1740	0,1593	0,0849
3	Ambuja	0,0268	0,0624	0,1075	0,1306	0,0892	0,1282	0,1496
4	ACC	0,0581	0,1232	0,1655	0,2002	0,2073	0,2073	0,1272
5	BirlaCorp	0,0877	0,0781	0,0635	0,0488	0,0499	0,0528	0,0487
6	India Cement	-0,0446	0,0011	-0,0157	-0,0425	-0,0668	-0,0157	0,0524
7	Grasim	0,1189	-0,0106	0,0046	0,0207	0,0204	-0,0039	-0,0060
8	Dalmia	0,0335	0,1042	0,0595	0,0406	0,0561	0,1100	0,1131
9	JK Laksmi	-0,0411	-0,0823	-0,1072	-0,0865	-0,0003	0,0400	0,0435
10	Ramco	-0,0854	-0,0733	-0,0837	-0,0751	-0,0838	-0,0817	-0,0823
11	JKCement	0,0310	0,0607	0,0619	0,0480	0,1242	0,0749	0,0596
12	Prism	-0,1019	-0,1225	-0,0819	-0,0388	-0,0389	-0,0871	-0,1507
13	Heidelberg	-0,1187	-0,0777	-0,0096	0,0340	0,0275	0,1231	0,0986
14	Orient Cement	-0,0519	-0,0634	-0,0178	0,0007	0,0005	-0,0905	-0,0468

Source: Authors' compilation.

The retained earnings to total assets ratio (*X2*) provides insight into a company's financial health, profitability, and long-term sustainability. A high ratio indicates that the company has been profitable over time and has retained a significant portion of its earnings, rather than distributing it as dividends. This suggests a strong internal generation of funds and signifies financial stability and a strong equity base. This may make a company more resilient to economic downturns and less reliant on external financing. To analyze the study data, MS Excel data bars were used, as they represent the value of each cell as a horizontal bar, allowing for quick comparison of magnitudes within a range. This further helps identify trends, variations, and outliers without the need for additional charts. From Table 3, it can be inferred that Star Cement, ACC, Dalmia, JK Laksmi, Heidelberg, and Orient Cement had significant and consistent growth in their retained earnings to total assets ratio. This helped them build investor confidence and potentially led to higher market valuations. Furthermore, Shree Cement, Ambuja, BirlaCorp, JKCement, and Prism exhibited moderate growth, with some fluctuations. In contrast, India Cement, Grasim, and Ramco showed either low growth or declining trends, indicating potential areas of concern.

Table 3. Comparative analysis of the retained earning to total asset ratio (2017–2023)

SN	*Company*	*X2 (2017)*	*X2 (2018)*	*X2 (2019)*	*X2 (2020)*	*X2 (2021)*	*X2 (2022)*	*X2 (2023)*
1	Star Cement	0,42962	0,55710	0,71536	0,75336	0,76646	0,74972	0,73640
2	Shree Cement	0,23573	0,22018	0,25257	0,22705	0,29414	0,32786	0,33119
3	Ambuja	0,03011	0,05192	0,09486	0,13062	0,09884	0,14414	0,15192
4	ACC	0,37313	0,41742	0,45013	0,48714	0,49773	0,49773	0,50129
5	BirlaCorp	0,03735	0,03517	0,04535	0,07588	0,11614	0,13179	0,12693
6	India Cement	0,06209	0,06125	0,05819	0,05794	0,07560	0,07372	0,06480
7	Grasim	0,05257	0,01661	0,01634	0,01885	0,02250	0,03511	0,03849
8	Dalmia	0,14192	0,07237	0,08978	0,10394	0,15997	0,20257	0,22288
9	JK Laksmi	0,04268	0,05168	0,05838	0,09798	0,17671	0,23474	0,25851
10	Ramco	0,02900	0,03021	0,02698	0,02213	0,02154	0,01788	0,01412
11	JKCement	0,08393	0,11499	0,11579	0,12997	0,17749	0,18889	0,17530
12	Prism	0,03364	0,04285	0,05855	0,09008	0,11581	0,12450	0,10628
13	Heidelberg	0,10122	0,12197	0,15601	0,20254	0,26170	0,31398	0,29341
14	Orient Cement	0,08600	0,09511	0,10512	0,12954	0,20027	0,29540	0,30082

Source: Authors' compilation.

The EBIT to total assets ratio (*X3*) is a valuable metric for assessing a company's ability to generate earnings from its asset base. A high ratio generally indicates good asset utilization and profitability, whereas a low ratio may point to inefficiencies or profitability challenges. This ratio is useful for investors, analysts, and management when evaluating and comparing the performance of companies. From Table 4, with MS Excel data bars for visualization, it was concluded that Star Cement, Ambuja, ACC, and JK Laksmi showed strong performance until recent declines. Heidelberg and Orient Cement exhibited strong growth until 2022. The consistent growth until recent years indicated strong management and operational efficiency but needed to address recent declines. Shree Cement, BirlaCorp, and JKCement showed moderate improvements with some fluctuations and India Cement, Ramco, Dalmia, and Prism showed declining trends, with India Cement and Prism showing negative returns in recent years. These fluctuating and declining trends highlight the need for strategic adjustments to enhance profitability and asset utilization. Companies that had previously exhibited consistent growth, but were experiencing recent declines, indicated a requirement to address operational inefficiencies.

Table 4. Graphical comparative analysis of EBIT to total asset ratio (2017–2023)

SN	Company	X3 (2017)	X3 (2018)	X3 (2019)	X3 (2020)	X3 (2021)	X3 (2022)	X3 (2023)
1	Star Cement	0,11709	0,15990	0,14956	0,12812	0,09469	0,08146	0,10771
2	Shree Cement	0,11628	0,10391	0,08532	0,09653	0,13025	0,10658	0,04669
3	Ambuja	0,05241	0,07429	0,07676	0,08573	0,09706	0,11188	0,04561
4	ACC	0,08547	0,08999	0,10541	0,09430	0,11395	0,11395	0,02935
5	BirlaCorp	0,03788	0,04298	0,05379	0,08082	0,07497	0,05148	0,01863
6	India Cement	0,05591	0,03928	0,03194	0,02904	0,04880	0,02148	-0,03160
7	Grasim	0,08886	0,04616	0,05413	0,05426	0,05458	0,05622	0,05053
8	Dalmia	0,07227	0,05015	0,03145	0,02764	0,06860	0,04785	0,03958
8	JK Laksmi	0,03795	0,04401	0,04789	0,11200	0,13493	0,12272	0,09332
10	Ramco	0,13045	0,11424	0,09075	0,08200	0,10482	0,06747	0,04657
11	JKCement	0,07942	0,08617	0,07997	0,10834	0,12485	0,09997	0,06456
12	Prism	0,03303	0,05021	0,07354	0,04740	0,05335	0,03307	-0,00446
13	Heidelberg	0,07464	0,10352	0,14156	0,15009	0,13903	0,11421	0,05124
14	Orient Cement	0,01962	0,06095	0,06127	0,08345	0,14538	0,16827	0,07568

Source: Authors' compilation.

The market value of the equity to total liabilities (*X4*) ratio is a valuable metric for assessing a company's financial stability, risk, and investor confidence. It is crucial for investors, creditors, and managers to make informed financial and strategic decisions. A high ratio suggests a strong, stable company with low financial risk, whereas a low ratio indicates potential financial weakness and higher risk. The MS Excel data bars in Table 5 indicate that companies with consistently high ratios, such as Shree Cement, Star Cement, Ambuja, and ACC, demonstrated strong financial stability and investor confidence. Several companies, such as JKCement and Heidelberg, have shown steady improvements, suggesting successful strategies to enhance financial stability. Companies, such as Dalmia and Grasim, experienced significant fluctuations, indicating periods of financial instability.

Table 5. Graphical comparative analysis of the market value of equity to total liabilities (2017–2023)

SN	Company	X4 (2017)	X4 (2018)	X4 (2019)	X4 (2020)	X4 (2021)	X4 (2022)	X4 (2023)
1	Star Cement	6,7292	5,0320	8,0421	6,5216	8,1767	6,2801	6,3226
2	Shree Cement	17,1607	9,0350	11,2908	9,4407	17,5302	13,8998	12,3397
3	Ambuja	4,7452	5,2791	4,5894	3,7587	4,6518	5,8983	5,5995
4	ACC	6,0502	5,1295	4,8573	5,5253	6,1857	6,1857	4,8905
5	BirlaCorp	0,8886	0,8100	0,5908	0,4337	0,9872	1,1667	0,8472
6	India Cement	0,8695	0,7749	0,5593	0,5364	0,9753	1,0785	1,0167
7	Grasim	2,2591	0,5562	0,3696	0,2043	0,5785	0,6324	0,5017
8	Dalmia	2,5849	2,5849	1,9310	0,9198	3,2325	3,0754	3,7658
9	JK Laksmi	1,4590	1,4849	1,1383	0,6630	1,6026	1,6462	2,5169
10	Ramco	4,8927	5,5850	4,7339	2,3570	4,1367	2,7779	2,3139
11	JKCement	1,3922	1,5846	1,4180	1,3061	3,6336	2,6414	2,6139
12	Prism	1,3576	1,4156	1,1790	0,3203	1,4191	1,1928	1,0411
13	Heidelberg	1,9583	2,1711	2,6992	2,1748	3,9171	3,4141	3,0314
14	Orient Cement	1,4199	1,4909	0,8639	0,5141	1,3303	2,5932	1,7694

Source: Authors' compilation.

The sales to total assets ratio (*X5*) is known as the asset turnover ratio. It helps assess how efficiently a company uses its assets to generate sales. This ratio indicates the effectiveness of the company's asset management. From Table 6 with MS Excel color scales, it was inferred that most companies showed stable or slightly improved ratios. This suggests a general trend towards better asset management in the cement industry. Companies such as JK Lakshmi, Prism, and Orient Cement have shown strong improvements in asset utilization, reflecting effective operational strategies. In contrast, India Cement and Grasim showed declining trends, indicating potential inefficiencies and a need for operational improvements.

Table 6. Graphical comparative analysis of sales to total assets (2017–2023)

SN	Company	X5 (2017)	X5 (2018)	X5 (2019)	X5 (2020)	X5 (2021)	X5 (2022)	X5 (2023)
1	Star Cement	0,61	0,64	0,79	0,78	0,67	0,76	0,82
2	Shree Cement	0,77	0,65	0,81	0,65	0,63	0,63	0,68
3	Ambuja	0,61	0,66	0,70	0,67	0,61	0,63	0,60
4	ACC	0,87	0,90	0,90	0,74	0,75	0,75	0,87
5	BirlaCorp	0,45	0,50	0,56	0,55	0,51	0,53	0,60
6	India Cement	0,51	0,48	0,48	0,42	0,39	0,38	0,45
7	Grasim	0,57	0,27	0,32	0,30	0,28	0,33	0,35
8	Dalmia	0,46	0,41	0,46	0,46	0,46	0,45	0,53
8	JK Laksmi	0,57	0,73	0,85	0,84	0,89	0,91	0,99
10	Ramco	0,56	0,62	0,63	0,53	0,46	0,45	0,55
11	JKCement	0,72	0,77	0,70	0,67	0,67	0,70	0,73
12	Prism	1,02	1,06	1,12	0,97	0,89	0,95	1,10
13	Heidelberg	0,71	0,73	0,78	0,77	0,74	0,79	0,83
14	Orient Cement	0,65	0,76	0,86	0,84	0,83	1,03	1,02

Source: Authors' compilation.

For a deeper understanding of the phenomenon, these five financial ratios, which indicate a company's financial health, are used in an equation to calculate the Altman Z-score. These Z-scores provide a single score indicating the level of financial distress. The equation for manufacturing firms is as follows:

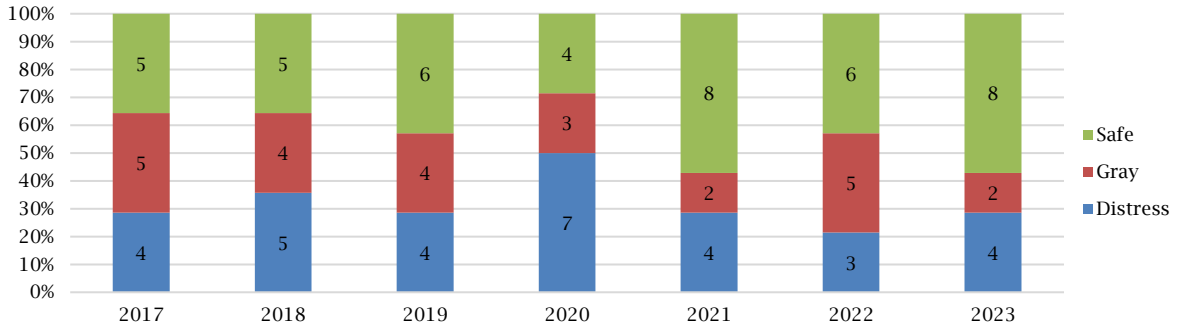
$$Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + 0.999X5 \quad (2)$$

These Z-scores were used to determine the zones of discrimination using the criteria suggested by Altman:

- $Z > 2.99$ — "safe" zone;
- $1.81 < Z < 2.99$ — "gray" zone;
- $Z < 1.81$ — "distress" zone.

The companies included in this study were categorized into different zones based on the distribution criteria outlined by the Altman Z-score. Figure 1 below shows the distribution of the companies across these zones.

Figure 1. Distribution of sample companies based on Altman Z-score during the study period



Source: Authors' compilation.

Figure 1 highlights the negative impact of the COVID-19 lockdown on the cement industry, with an increase in the number of companies in financial distress. However, a positive recovery trend was observed post-lockdown starting in 2021, with a significant increase in the number of companies entering the "safe" zone. The data revealed that four companies — ACC, Ambuja, Shree Cement, and Star Cement — remained consistently in the "safe" zone throughout the seven-year study period. In contrast, BirlaCorp and India Cement were in distress for all seven years, whereas Grasim was in distress for the past six years.

Post-COVID lockdown, Dalmia Cement and Heidelberg moved from the "gray" zone to the "safe" zone. A deeper investigation showed that in the last decade, Dalmia Cement consistently made substantial investments to increase its production capabilities and broaden its presence across various regions. In FY2019, they completed corporate restructuring to become a single listed entity, which gave them the power to enhance capacity. In FY2023, they enjoyed a leading market position in the highly attractive East, Northeast, and South regions of the country. The company's focus on developing its scale, strengthening its brand, utilizing digital technology, and prioritizing sustainability positioned them favorably to take advantage of future growth opportunities (Dalmia Bharat Limited, 2023). In the past ten years, they have experienced a threefold increase in capacity corresponding to 3X EBITDA, 2X EPS, and 5X Sales Revenue. Aggressive

yet sustainable growth has enabled them to emerge as the 4th largest cement player in India (Dalmia Bharat Limited, 2023).

In the case of Heidelberg Cement India, the group placed sustainability at the core of the business. While increasing the cement capacity in Central India in FY2020, they started working on a sustainable future by investing in Solar Power Projects. Over the years, they have benefited from research and development initiatives at the Heidelberg Materials Group, resulting in carbon footprint reduction and product quality enhancement. Their commitment to circular economy principles led them to optimize resource utilization and minimize waste, thus minimizing the ecological impact (Indian Companies Act, 2013).

Table 7. Trend analysis of Altman Z-score during the study period

Year	Gracim_ AZScore	ACC_AZ Score	Dalmia_AZ Score	JK_Laksmi_ AZScore	Ramco_AZ Score	BirlaCorp_AZ Score	JKCement_AZ Score	Prism_AZ Score	India Cement_AZ Score	Star Cement_AZ Score	Shree Cement_AZ Score	Ambuja_AZ Score	Heidelberg_ AZScore	Orient Cement_AZ Score
2017	2,49	5,36	2,66	1,59	3,88	1,34	1,97	1,88	1,25	5,92	11,92	3,98	2,13	1,14
2018	0,82	5,02	2,66	1,75	4,31	1,35	2,24	1,99	1,17	5,32	6,94	4,53	2,46	1,64
2019	0,82	4,99	2,14	1,66	3,71	1,32	2,05	2,06	1	7,59	8,43	4,3	3,08	1,93
2020	0,73	5,3	1,48	1,66	2,16	1,33	2,06	1,41	0,88	6,56	7,18	3,88	2,9	1,73
2021	0,93	5,79	3,11	2,57	3,23	1,65	3,67	2,04	1,17	7,38	12,2	4,26	3,94	1,63
2022	1	6,42	3,03	2,71	2,27	1,72	2,98	1,85	1,19	6,1	9,98	5,19	3,81	2,42
2023	0,91	4,76	3,53	3,24	2,02	1,48	2,86	1,69	1,12	6,19	8,81	4,72	3,35	3,49

Source: Authors' compilation using MS Excel sparklines tools.

Table 7 shows that JK Lakshmi and Orient Cement had an impressive upward movement, demanding a deeper analysis of their assets and performance. Various reports have shown that JK Lakshmi Cement Ltd. blended the core of its business with sustainable goals and, at the same time, stepped on the accelerator to be future-ready. They focused on value-added products, creating the best out-of-waste, blended cement, and sustainable technologies. On the digital front, there was fast-paced innovation in the development and implementation of mobile apps, Enterprise Resource Planning (ERP) solutions, Internet of Things (IoT), and so on, to integrate business across the value chain. While exercising a zero discrimination and equal opportunity organization as per the United Nations Human Rights, they were finding innovative ways to keep all stakeholders connected and engaged. From 2017 to 2023, they almost doubled their total capacity from 8.6 Mn MT to 14 Mn MT, which justified their steady growth. Similarly, Orient Cement has also undertaken steady capacity expansion, with digitalization as a driver of growth and efficiency. The company consistently enhanced its operational efficiency through various measures, such as optimizing thermal and electrical energy, circular economy initiatives, co-processing of waste materials as alternative fuels and raw materials, and switching to renewable energy resources.

4.2. Analysis of Z-score, SGR, and CSR relationship

The relationships presented in Table 8 through the correlation matrix provide valuable insights into the interactions among the variables. The results indicated that the Z-score exhibited a very strong positive correlation with *X4* and strong positive correlations with *X1* and *X2*. CSR demonstrated a strong negative correlation with *X2* and a moderate negative correlation with *X1*, whereas SGR showed a moderate positive correlation with *X3*. In addition, *X1* and *X2* were strongly positively correlated, indicating a tendency to move together. Most other correlations were weak or very weak, suggesting minimal relationships between the variable pairs. Furthermore, CSR was negatively correlated with all variables that influenced the Altman Z-score.

Table 8. Correlation matrix of variables

Variables	AZScore	CSR	SGR	X1	X2	X3	X4	X5
AZScore	1.00							
CSR	-0.18	1.00						
SGR	0.23	-0.06	1.00					
X1	0.66	-0.31	0.15	1.00				
X2	0.65	-0.53	0.28	0.75	1.00			
X3	0.49	-0.27	0.58	0.36	0.46	1.00		
X4	0.98	-0.11	0.19	0.58	0.52	0.42	1.00	
X5	0.23	-0.21	0.16	-0.05	0.35	0.30	0.13	1.00

Source: Authors' compilation.

4.3. Analysis of model validation

Further analysis was performed using R statistical software. It uses the pooled least squares model (PLM) test, which is typically used to assess the appropriateness of a pooled model in a panel data analysis. Because the data are cross-sectional and have time-series components, complex models such as FE or RE should be employed. This helps in testing heterogeneity across entities. However, to make the final determination between FE and RE, a Hausman test is often conducted to confirm whether random effects are uncorrelated with the regressors.

PLM test-FE model results are as follows in Table 9. PLM test-RE model results are shown in Table 10.

Table 9. FE model

Variables	*Estimate*	*Std. Error*	*t-value*	*Pr(> |t|)*	*Significance*
XCSR	-0.1895	0.1133	-1.6724	0.0985	.
XSGR	-0.0026	0.0056	-0.4723	0.6381	
XX1	1.8669	0.4650	4.0149	0.0001	***
XX2	1.1776	0.4023	2.9271	0.0045	**
XX3	2.0928	0.9446	2.2156	0.0297	*
XX4	0.5968	0.0181	33.0014	< 2.2e-16	***
XX5	1.3573	0.2859	4.7478	0.0000	***

*Note: Sig. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.*
Source: Authors' compilation.

Test results — Output in R

Total sum of squares: 55.918
Residual sum of squares: 2.4458
R-squared: 0.95626
Adj. R-squared: 0.9449
F-statistic: 240.487 on 7 and 77 df, p-value: < 2.22e-16
CSC is significant at 90% CI
SGR is not significant
X1, *X4*, *X5* are significant at 99.9%
X2 at 99% and *X3* at 95%

Inference

As per Table 9, CSR is significant at a 90% confidence interval (CI) but SGR is not significant whereas *X1*, *X4*, and *X5* significant at 99.9% and *X2* at 99% and *X3* at 95%.

Table 10. RE model

Variables	*Estimate*	*Std. Error*	*z-value*	*Pr(> |z|)*	*Significance*
(Intercept)	0.0962	0.1075	0.8943	0.3711	
XCSR	0.0379	0.0682	0.5551	0.5788	
XSGR	-0.0051	0.0049	-1.0518	0.2929	
XX1	2.1385	0.3592	5.9529	0.0000	***
XX2	1.1144	0.2394	4.6552	0.0000	***
XX3	2.4213	0.7499	3.2287	0.0012	**
XX4	0.5992	0.0082	72.7475	< 2.2e-16	***
XX5	1.0562	0.1404	7.5246	0.0000	***

*Note: Sig. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.*
Source: Authors' compilation.

Test results — Output in R

Total sum of squares: 389.15
Residual sum of squares: 2.9679
R-squared: 0.99237
Adj. R-squared: 0.99178
Chisq: 11710.8 on 7 df, p-value: < 2.22e-16

Inference

As per Table 10, CSR and SGR are not significant whereas *X1*, *X2*, *X4*, and *X5* are significant at 99.9% and *X3* at 99%.

The above results show that the RE model had a higher R-squared value (R-sq ~ 0.99) than the FE model (R-sq ~ 0.95). A higher value of Adj. R-square indicates that the RE model is more appropriate. This further required careful inspection and statistical evidence in terms of the Hausman test to understand which model would fit the data best.

Null hypothesis (H_0): The random effects model is consistent, meaning that there is no correlation between the regressors and the individual effects.

Alternative hypothesis (H1): The random effects model is inconsistent, and the fixed effects model should be used instead.

The results of the Hausman test in R software are as follows:

> phtest(random1,fixed1)

Hausman test results:

data: Y ~ X
chisq = 11.605, df = 7,
p-value = 0.1143
Alternative hypothesis: One model is inconsistent.

The test results yielded a p-value of 0.1143, which exceeded the significance threshold of 0.05. Consequently, the H_0 cannot be rejected, indicating that insufficient evidence suggests that the RE model is inconsistent. Based on this result, it can be concluded that the RE model provided a better fit for the data.

The results further highlight that the CSR and SGR variables were not statistically significant in the model. This observation is notable when there is increasing emphasis on CSR reporting. While CSR is a commendable initiative and should be encouraged, it appears to have a limited direct impact on the financial performance or trustworthiness of companies, at least within the Indian context.

5. DISCUSSION

The findings of this study provide valuable insights into predictors of financial distress and operational efficiencies within the Indian cement industry.

The analysis highlights the importance of key financial ratios in assessing a company's financial stability and its predictive power in determining the likelihood of bankruptcy.

This study identified five key financial indicators that significantly influence the financial health of companies in the cement sector. Working capital/total assets (*X1*), retained earnings/total assets (*X2*), the market value of equity/total liabilities (*X4*), and sales/total assets (*X5*) were found to have a strong positive association with financial stability. These ratios collectively underscore the importance of liquidity, profitability, financial leverage, and asset utilization in mitigating financial distress. Furthermore, EBIT/total assets (*X3*), though statistically significant at the 95% confidence interval, reiterate the role of operational efficiency in sustaining financial health.

Interestingly, despite the growing emphasis on CSR and the SGR as components of corporate image-building and stakeholder trust, the analysis revealed no statistically significant impact of these variables on a company's likelihood of financial distress. This suggests that, within the Indian cement industry, CSR and SGR practices, while valuable for reputation and broader stakeholder engagement, do not directly influence a firm's capacity to manage financial challenges.

Firm-specific analysis reveals notable trends in financial performance and stability. Companies such as Star Cement, Shree Cement, Ambuja, and ACC demonstrated exemplary working capital management, and robust financial health, and bolstered investor confidence. Improvements in retained earnings-to-total-assets ratios among firms, such as Star Cement, ACC, Dalmia, JK Lakshmi, Heidelberg, and Orient Cement, further supported their financial resilience. However, India Cement, Grasim, and Ramco exhibited declining trends in retained earnings, signaling potential vulnerabilities.

The data also highlight operational fluctuations within the sector. While firms like JK Lakshmi, Prism, and Orient Cement showed improved asset utilization, companies such as India Cement and Grasim experienced inefficiencies, indicating areas needing operational reforms. These trends suggest that, despite the overall sector's progress toward better financial management, certain firms require targeted interventions to address declining performance metrics.

These findings contribute to the understanding of financial health determinants in the Indian cement industry. They highlight that while CSR and SGR practices enhance corporate reputation, their direct financial implications remain limited in this context. These results underscore the need for companies to prioritize operational efficiency, liquidity management, and asset utilization to maintain financial stability and investor trust. Future research could explore the longitudinal impacts of CSR and SGR on financial outcomes or investigate their significance in other industrial sectors to provide a comparative perspective.

6. CONCLUSION

This study confirms the importance of strong financial ratios in assessing the stability and performance of Indian cement companies. By using the Altman Z-score, a widely recognized metric, this study provides insights into the likelihood of financial distress, such as profitability, leverage, and liquidity. While the Z-score offers a reliable measure of financial health, the study cautioned against over-reliance on this single metric, as it may not account for the diverse factors influencing a company's overall stability and growth path. Indian cement companies have increasingly embraced CSR initiatives and sustainable development goals (SDGs), showcasing their commitment to ethical practice and long-term value creation. However, the study found that factors such as CSR and the SGR did not directly impact the likelihood of financial distress, as determined by traditional financial metrics. In addition, the integration of non-financial metrics such as CSR and SGR in corporate reporting reflects a broader trend where stakeholders prioritize ESG considerations. Over time, these factors may gain prominence in the evaluation of a company's trustworthiness and resilience. This study underscored the continued relevance of traditional financial metrics, such as the Altman Z-score, while highlighting the need for a more holistic approach that includes social and environmental dimensions. It also acknowledged the limitations in its scope, as the findings are specific to the Indian cement industry and may not be generalizable to other sectors. Future research could enhance the robustness of this type of study by incorporating qualitative methods, exploring additional control variables, and examining larger or more diverse samples across multiple industries. A comprehensive approach that integrates financial and nonfinancial factors is essential to better understand company stability and sustainability in a dynamic business environment.

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