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Predictive Analysis of Financial Distress in Pharma Sector: A Quantitative Approach using Altman's Z-Score Model

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Abstract

The research intends to evaluate the financial health of selected pharmaceutical companies and assess its risk of insolvency or bankruptcy by employing Altman's Z-score Model, a globally recognized tool for detecting corporate insolvency.For this study, the sample selection was determined by market capitalization, encompassing 10 companies representing various market caps: large, mid, small, and micro-cap enterprises. The research spanned from April 1st, 2015, to March 31st, 2022, covering a duration of 8 years. Altman's Z-score model served as the analytical tool for data analysis. The findings revealed that the majority of Indian pharmaceutical companies were in a safe or healthy financial zone. Medico Remedies Limited, Venus Remedies Limited, Brooks Laboratories Limited, Bafna Pharmaceutical Limited, SMS Life Science India Private Limited, Mangalam Drugs and Organics, and Take Solutions Limited were positioned in the grey zone. However, they had the potential to avoid bankruptcy through effective management decisions such as a focus on improving operational efficiency, reducing debts, and diversifying revenue streams. Conversely, companies such as Wockhardt Ltd., Nectar Lifescience Ltd., Lyka Lab Ltd., and Wanbury were in the bankruptcy zone as they showed signs of significant financial distress. The study uncovered a predominantly positive outlook, indicating that the majority of large, mid-sized, and small pharmaceutical companies in India are financially robust. However, attention is urgently needed to address potential financial risks in the Micro Pharmaceutical sector. In summary, the Indian pharmaceutical industry demonstrates overall financial strength. Policymakers must enact tailored policies to strengthen the Micro Pharmaceutical sector's financial resilience, promoting its economic contribution. Investors should target strategic investments in innovative risk-mitigation initiatives within the sector. Pharmaceutical stakeholders need collaborative efforts to address financial vulnerabilities, ensuring sustained growth. Academicians and researchers must delve into the sector's financial dynamics to inform evidence-based solutions and decision-making.

Keywords: *Altman Z-Score, Financial Distress, Financial Performance, Indian Pharmaceutical Industry, Prediction, Risk Mitigation.*

INTRODUCTION

The Indian pharmaceutical industry stands as a cornerstone of global healthcare, renowned for its provision of affordable generic drugs and vaccines. Evolving into a thriving sector with a compound annual growth rate (CAGR) of 9.43% over the past nine years, it now ranks third in pharmaceutical production by volume worldwide. Comprising segments such as generic drugs, over-the-counter medications, vaccines, and contract research, the industry boasts the largest number of US Food and Drug Administration (USFDA)-compliant manufacturing facilities and commands 8% of the global active pharmaceutical ingredient (API) market. With its significant contribution to global vaccine and generic drug supply, India has earned the moniker "pharmacy of the world (Wickneswary et al., 2024)." Contributing around 1.72% to the country's Gross Domestic Product (GDP), the pharmaceutical sector plays a pivotal role in India's economic landscape. As the sector continues to expand, projections indicate its pivotal role in the global pharmaceutical market, with an estimated value of US$ 130 billion by 2030, further solidifying India's position as a key player in healthcare innovation and accessibility (Chowdhury et al., 2022a).

The Indian pharmaceutical industry has witnessed significant growth, with projections indicating a market size of US$ 65 billion by 2024 and an impressive US$ 130 billion by 2030. Contributing approximately US$ 50 billion to the global market, with over US$ 25 billion from exports, India ranks among the top destinations for biotechnology and pharmaceuticals globally. This growth is fuelled by a compound annual growth rate (CAGR) of 6-8% during FY18 to FY23, driven by both export and domestic market expansion. With India emerging as

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a key player in biosimilars, APIs, and medical devices, the industry is poised for further expansion, solidifying its position as a powerhouse in the global pharmaceutical landscape (Barman et al., 2023).

The global economy heavily relies on India's pharmaceutical industry, evident from its position as a top-ten sector for foreign investment and as the 12th largest exporter of medical goods globally. With exports reaching over 200 countries, including critical markets like the USA and Europe, India's pharmaceutical exports ensure widespread access to essential medicines, including generic drugs that constitute 20% of global exports by volume. During emergencies like the COVID-19 pandemic, India's rapid supply of hydroxychloroquine to 114 countries highlighted its crucial role in global health security. Sustaining India's pharmaceutical growth is vital for meeting global healthcare needs and ensuring economic stability worldwide.

The Indian government has implemented various initiatives to bolster the pharmaceutical sector, emphasizing innovation, accessibility, and self-reliance. Through schemes such as the National Medical Devices Policy and the Scheme for Development of Pharma Industry, efforts are directed towards fostering growth and quality enhancement. Additionally, initiatives like the Ayushman Bharat Digital Mission aim to revolutionize healthcare delivery, while significant budget allocations demonstrate a commitment to research, development, and pandemic response. These proactive measures underscore India's dedication to advancing its pharmaceutical industry, ensuring global health security, and promoting domestic manufacturing capabilities.

Thus, amidst the rapid expansion and pivotal role of the Indian pharmaceutical industry in global healthcare, there arises a critical need to assess and predict financial distress within this dynamic sector. The increasing reliance on India's pharmaceutical products underscores the importance of ensuring the sector's financial stability, as any disruptions could have far-reaching implications for global health security and economic stability. Therefore, the present research aims to employ Altman's Z-Score Model to analyze financial indicators within the Indian pharma industry, with the goal of identifying potential risks and mitigating strategies. By shedding light on the financial health of pharmaceutical companies in India, this research seeks to provide valuable insights for stakeholders, policymakers, investors, and academia, facilitating informed decision-making and fostering the sustained growth and resilience of this vital sector.

REVIEW OF LITERATURE

In the realm of financial analysis, Altman's Z-Score model stands as a timeless beacon, illuminating the path towards understanding corporate bankruptcy and financial distress (Puspita et al., 2023; Molla, 2022). Developed by Edward I. Altman, a professor of finance at New York University, this model emerged in 1968, a product of an era marked by economic turbulence and the need for robust predictive tools (Sethi & Mahadik, 2024; Campobasso & Boscia, 2023; Altman, 1968). Altman's pioneering work sought to distill the complex dynamics of financial health into a concise framework, providing clarity amidst uncertainty (Salina et al., 2024; Khalil et al., 2023).

At its core, the Z-Score model comprises a set of financial ratios that capture different dimensions of a company's solvency, profitability, and liquidity (Kamran & Saleem, 2023, Altman, 1968). These ratios, consisting financial elements such as retained earnings, working capital, and earnings before interest and taxes, are meticulously calibrated to reflect the underlying risk factors contributing to financial distress (Abdullah et al., 2023; Jones, 2023; Nareswara & Dewiyanti, 2023; Altman et al., 2017; Altman et al., 2014).

Since its inception, Altman's Z-Score model has found widespread application across industries and sectors, serving as a trusted compass for investors, creditors, and policymakers alike (Campobasso & Toma, 2023; Mugo, 2021; Rengaswamy, 2016). Its utility lies in its ability to generate a single numerical score, categorizing companies into distinct risk categories and enabling stakeholders to make informed decisions with confidence (Can, 2023; Pathmanathan et al., 2022).

Researchers around the globe have embraced Altman's framework, conducting rigorous analyses to evaluate its efficacy and applicability in diverse contexts (Ramalingam et al., 2024). Studies by (Azam et al., 2023; Jagannathan et al., 2023; Jones, 2023; Qiu et al., 2020; Jones et al., 2017; Jones, 2017) have underscored the model's robustness in predicting corporate bankruptcy, highlighting its role as a valuable risk assessment tool.

Moreover, the model's versatility extends beyond corporate finance, with studies exploring its effectiveness in assessing the financial health of banks (Salina et al., 2024; Azam et al., 2023; Hamid et al., 2023; Khawaja, 2023; Ntawumenyumunsi & Maringa, 2022; Elia et al., 2021; Joshi, 2020) and companies in specific industries like manufacturing and mining (Mukherjee & Chakraborty, 2016; Rao & Rao, 2017). These investigations have yielded insights into the model's nuanced performance across different sectors and regions, enriching our understanding of its strengths and limitations (Al Amin, 2023; Cındık & Armutlulu, 2021; Saha, 2021; Saputri & Krisnawati, 2020). For instance, Numerous researchers (Islam & Fakir, 2023; Puspita et al., 2023; Ramana et al., 2023; Nimbalkar & Marisetty, 2022) have utilized Altman's Z-Score model to forecast financial distress within the cement industry across various countries, yielding diverse research outcomes. Several researchers (Rahman & Acharya, 2022; Sareen & Sharma, 2022; Swalih et al., 2021; Baciu et al., 2020) have applied Altman's Z-Score model to predict financial distress within the automobile industry across different regions, each offering unique insights and findings. Researchers (Goh et al., 2022; Lestari et al., 2021; Lewaru & Loupatty, 2021) have shown considerable interest in using Altman's Z-Score model to assess the financial health of the tourism and hospitality industry in different regions, unveiling a spectrum of outcomes.

Amidst the current of scholarly investigation, numerous scholars (Nengsih, 2024; Azam et al., 2023; Sapari, & Sunardi, 2023) have directed their focus towards the metals and mining sector, employing Altman's Z-Score model to gauge financial stability and anticipate potential distress, unveiling a plethora of insights and conclusions. In the realm of retail and e-commerce, a multitude of researchers (Ika et al., 2021; Kolte et al., 2021; Muzani & Yuliana, 2021) have delved into the application of Altman's Z-Score model, unraveling insights into financial stability and distress within this dynamic sector.

Altman's Z-Score model embodies the convergence of rigorous scholarship, practical relevance, and enduring impact (Reinwald et al., 2023). Its legacy endures as a testament to the power of financial analysis in navigating the complexities of corporate finance and safeguarding against financial distress (Abidin et al., 2023). This legacy extends beyond traditional sectors, as the application of Altman's Z-Score model has diversified into various industries, including pharmaceuticals (Ratnasari et al., 2024; Acharyya, 2023; Azam et al., 2023; Pratiwi et al., 2023; Pravin & Dhabaliya, 2023; Nayem, 2022). In assessing the financial health of companies within this sector, Altman's model has proven instrumental (Arnu & Nugraha, 2024; Jagannathan et al., 2023).

Azam et al. (2023) evaluated the financial well-being of five chosen Indian pharmaceutical companies by employing Altman's Z-Score model from 2019 to 2023. Findings revealed varied financial positions, with Divis Laboratories Ltd. and Cipla Ltd. maintaining safety, while Zydus Lifescience Ltd. and Torrent Pharmaceutical Ltd. showed moderate stability. Notably, Abbot India Ltd. stood out with robust financial health, emphasizing the importance of prudent financial management in navigating the pharmaceutical sector's complexities (Annathurai et al., 2023). Pravin and Dhabaliya (2023) employed Altman's Z-score model to predict financial difficulties in the pharmaceutical sector, using data from the top five companies listed on the Bombay Stock Exchange from 2017-2018 to 2021-2022. Secondary data analysis was conducted, revealing an average Z-score exceeding 4.5, signifying a satisfactory financial position for the sector, crucial for stakeholders and society alike. Acharyya (2023) addressed the necessity for companies to anticipate financial troubles post-2008 crisis by examining selected drug manufacturers' financial difficulties using Altman's "Z" Score Model over a 12-year period (2010–2011 to 2021–2022). Utilizing secondary data of 11 selected NSE listed Pharma companies and Altman's methodology, it revealed the pharmaceutical sector's overall good financial health, emphasizing the importance of early identification of financial distress for effective corporate governance (Ifedi et al., 2024). Ansari et al. (2023) analyzed financial distress in the Pakistani pharmaceutical sector over a decade, focusing on five companies listed on the Pakistan Stock Exchange. The study examines the effectiveness of identifying financial distress through Altman's Z-score model. Analyzing data from 2006 to 2016, the study found Abbot, Glaxo, and Wyeth to be generally stable, while Ferozsons and Highnoon showed signs of potential distress, emphasizing the importance of timely intervention to prevent insolvency. Pratiwi et al. (2023) predicted bankruptcy among pharmaceutical companies listed on the Indonesia Stock Exchange (2019-2021) using Altman (Z-Score) and Grover (G-Score) methods. Altman identified 6 healthy and 3 distressed companies, while Grover classified all 9 as financially healthy, achieving 77.7% and 100% accuracy respectively. The findings emphasized the crucial role of precise financial prediction models for risk management, especially

during economic challenges like the Covid-19 outbreak. Ratnasari et al. (2024) compared Altman Z-Score and Grover models in predicting bankruptcy among 2018-listed pharmaceutical companies on the Indonesia Stock Exchange. Using purposive sampling, both models effectively forecasted financial distress (Osman et al., 2024). Altman Z-Score model demonstrated higher accuracy (86.67%) than Grover model (55.56%), underscoring its superior predictive ability.

Existing literature reveals limited studies on the application of Altman's Z-Score model in the Indian pharmaceutical industry, despite extensive research across various industries and regions (Jye et al., 2022). Additionally, while some studies have focused on predicting financial distress, they often examine only a few companies rather than providing a comprehensive analysis across different market capitalizations (Jing et al., 2023). The present study addresses this research gap by focusing specifically on the Indian pharmaceutical industry and considering a broader sample size across different market capitalizations. By evaluating 40 companies across Large, Medium, Small, and Micro market capitalizations, the study provides a comprehensive analysis of financial distress prediction, offering insights into the sector's overall stability and risk management strategies (Chawdhury et al., 2022b). This approach enhances the understanding of financial dynamics within the pharmaceutical industry, contributing valuable insights for investors, policymakers, and industry stakeholders.

RESEARCH AIM AND METHODOLOGY

Research Aim

The study endeavours to assess the financial performance of selected Indian pharmaceutical companies and predict potential financial distress utilizing the Altman Z-Score model.

Research Design

This study employs five distinct financial ratios to calculate Altman's Z-score, aimed at predicting the financial distress of Indian pharmaceutical companies over a specific period. Through quantitative analysis, the research adopts a Descriptive Research Design.

Sources and Types of Data

The research relied on secondary data sources, accessing company-specific financial data from the Top Stock Research website (www.topstockresearch.com).

Population, Sample and Sampling Method

The Indian pharmaceutical industry encompasses a diverse array of over 250 units. To ensure comprehensive representation, this study targets all active pharmaceutical companies in India, stratified into four market capitalization categories: large, medium, small, and micro. Employing a stratified random selection approach, ten companies were sampled from each category, resulting in a total of forty Indian pharmaceutical firms listed on the Bombay Stock Exchange, selected based on their market capitalization (Haque & Srivastava, 2014).

Table 1: Indian Pharmaceutical Companies Based on Market Capitalization

S. No.	Company Name	BSE security code	Status	Market Capitalization (Rs In Crores)
1	Sun Pharmaceutical Industries Limited	524715	Large	296,653.78
2	Cipla Limited	500087	Large	97,289.76
3	Dr Reddy's Laboratories Limited	500124	Large	93,283.99
4	Lupin Limited	500257	Large	56,747.15
5	Aurobindo Pharma Limited	524804	Large	60,468.86
6	Divis Laboratories Limited	532488	Large	97,941.98
7	Torrent Pharmaceutical Limited	500420	Large	71,029.54
8	Zydus lifescience	532321	Large	65,383.33
9	Alkem Laboratories Limited	539523	Large	59,434.57
10	Ajanta Pharmaceutical Limited	532331	Large	23,697.96
11	Wockhardt Ltd.	532300	Mid	5,979.49

12	Natco Pharma Ltd.	524816	Mid	13,875.64
13	Granules India Limited	532482	Mid	9,464.50
14	Marksans Pharma Ltd.	524404	Mid	7,336.72
15	Alembic Pharmaceutical Limited	533573	Mid	15,053.79
16	Pfizer limited	500680	Mid	19,236.92
17	Suven Life Science Limited	530239	Mid	17,873.01
18	Larus Lab Limited	540222	Mid	20,736.71
19	Caplin Point laboratories limited	524742	Mid	9,636.88
20	Eris Lifesciences Limited	540596	Mid	11,910.20
21	Shilpa Pharmaceutical Limited	530549	Small	3,189.97
22	Kilitch Drugs	524500	Small	529.11
23	Gufic Bioscience limited	509079	Small	3,123.64
24	RPG Lifesciences Limited	532983	Small	2,201.09
25	Indoco Remedies Ltd.	532612	Small	3,630.26
26	Morepen Laboratories Limited	500288	Small	2,373.36
27	Bliss GVS Pharma Ltd.	506197	Small	1,328.82
28	Medico Remedies Limited	540937	Small	733.16
29	Lincoln Pharma limited	531633	Small	1,284.71
30	Nectar Lifescience Limited	532649	Small	674.13
31	Lyka Lab	500259	Micro	405.02
32	Venus Remedies Limited	526953	Micro	505.47
33	Brooks Laboratories	533543	Micro	312.34
34	Bafna Pharmaceutical Limited	532989	Micro	241.29
35	Alpa Laboratories	532878	Micro	217.74
36	Albert David Limited	524075	Micro	558.39
37	SMS Lifescience India private Limited	540679	Micro	155.62
38	Wanbury	524212	Micro	428.51
39	Mangalam Drugs and Organics	532637	Micro	156.46
40	Take solutions Limited	532890	Micro	340.99

(Source: Authors data compilation)

Note: Data was retrieved on 16 December 2023 from https://www.moneycontrol.com/stocks/marketinfo/marketcap/bse/pharmaceuticals.drugs.html

Table 1 depicts the descriptive characteristics of the selected companies.

Period of the Study

The study conducts an analytical examination of the financial performance of specific Indian pharmaceutical firms over the past eight years, spanning from April 1st, 2015, to March 31st, 2022-23. By analyzing financial performance trends over this period, valuable insights into the industry's dynamics are garnered, offering a comprehensive understanding of its trajectory.

Tool for Data Analysis

Altman's Z-score model, developed by Edward I. Altman in the late 1960s, is employed to evaluate a company's financial health and assess its risk of bankruptcy. Utilizing various financial ratios, the Z-score model predicts the probability of a company facing bankruptcy within a specified time period.

The Z-score's value is calculated as follows:

Z-Score is equal $1.2(X_1) + 1.4(X_2) + 3.3(X_3) + 0.6(X_4) + 1.0(X_5)$

Where,

X_1 = Net Working Capital to Total Assets.

X_2= Retain Earning to Total Assets.

X_3= Operating Profit to Total Assets.

X_4= Market Capitalization to Total Liabilities.

X_5= Total Turnover to Total Assets.

A higher Z score indicates a better financial situation and a lesser chance of bankruptcy.

Examining the proportions employed in this model:

Total Assets/Net Current Assets (X1): This ratio evaluates a company's capacity to repay its immediate liabilities. An increasing ratio suggests improving liquidity, while a decrease may indicate excessive short-term debt burden.

Total Assets/Retained Earnings (X2): This ratio gauges the proportion of profits reinvested into the business. A decreasing ratio suggests a higher reliance on borrowing to finance assets, while a higher ratio indicates efficient utilization of retained earnings for asset funding.

Total Assets/Operating Profit (X3): This ratio assesses a company's operational efficiency in generating income with available resources. It reflects the relationship between operating profit, financial profit, and total assets utilized during the fiscal year, providing insights into the company's ability to generate profits or revenue.

Market capitalization/total debt (X4): This ratio represents the relationship between a company's stock market value and its total book debt in its capital structure. It indicates the maximum decline in the organization's assets before its liabilities exceed its assets, potentially leading to bankruptcy.

Total Sales/Total Assets (X5): This ratio illustrates a business's efficiency in generating profits from its assets. A higher ratio indicates greater efficiency, as it signifies that the business is generating more revenue per dollar of assets.

Table 2: Altman's Financial Health Guideline

Z-score	Zone	Results
Below 1.8	Bankruptcy zone	Financially weak or high probability of bankruptcy
1.8 to 2.99	Grey zone	warning of possible bankruptcy but Company can avoid bankruptcy through management decisions, improving operational efficiency
Above 2.99	Healthy zone	Financially healthy or low probability of Bankruptcy

(Source: Altman, 1968)

Table 2 outlines the financial health criteria based on the Z-score derived from the equation. A Z-score below 1.8 predicts business insolvency, requiring immediate attention to financial aspects to prevent bankruptcy. Scores falling in the grey zone (1.8 to 2.99) suggest management interventions can rescue the business. A Z-score exceeding three indicates robust financial health, implying minimal risk of bankruptcy in the near future. Investors may utilize these scores to inform their decisions on buying or selling company shares, opting to divest from firms with Z-scores below 1.8 and invest in those with scores of three or higher.

Data Analysis and discussion

The Altman Z-Score of 10 Selected Large Cap. Indian Pharmaceutical Companies

Table 3: Z-score of Large Cap. Indian pharmaceutical companies

Altman Z-Score Model										
Name of the Company	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**Mean Z score**	**Zone**
Sun Pharmaceutical Industries Limited	8.53	7.01	4.81	5.18	4.47	6.38	8.97	7.84	6.65	Healthy Zone
Cipla Limited	4.65	5.56	5.23	5.14	4.96	8.38	11.02	10.02	6.87	Healthy Zone
Dr Reddy's Laboratories Limited	6.25	4.61	3.84	5.41	6.26	7.21	6.29	7.93	5.98	Healthy Zone
Lupin Limited	5.58	5.14	3.23	3.14	3.04	4.68	3.61	3.41	3.98	Healthy Zone
Aurobindo Pharma Limited	5.58	6.32	4.31	4.19	3.42	5.21	4.85	3.43	4.66	Healthy Zone
Divis Laboratories Limited	29.12	15.41	23.22	28.23	28.89	42.22	46.02	29.89	30.38	Healthy Zone
Torrent Pharmaceutical Limited	4.62	3.9	2.12	2.92	3.01	3.75	4.28	4.95	3.69	Healthy Zone
Zydus life science	6.62	5.32	4.41	3.21	2.73	4.15	3.08	5.79	4.41	Healthy Zone
Alkem Laboratories Limited	8.54	10.86	7.74	7.37	7.09	7.43	7.44	7.69	8.02	Healthy Zone
Ajanta Pharmaceutical Limited	29	36.96	21.28	14.93	12.85	10.77	10.99	9.97	18.34	Healthy Zone

(Source: Authors' Analysis)

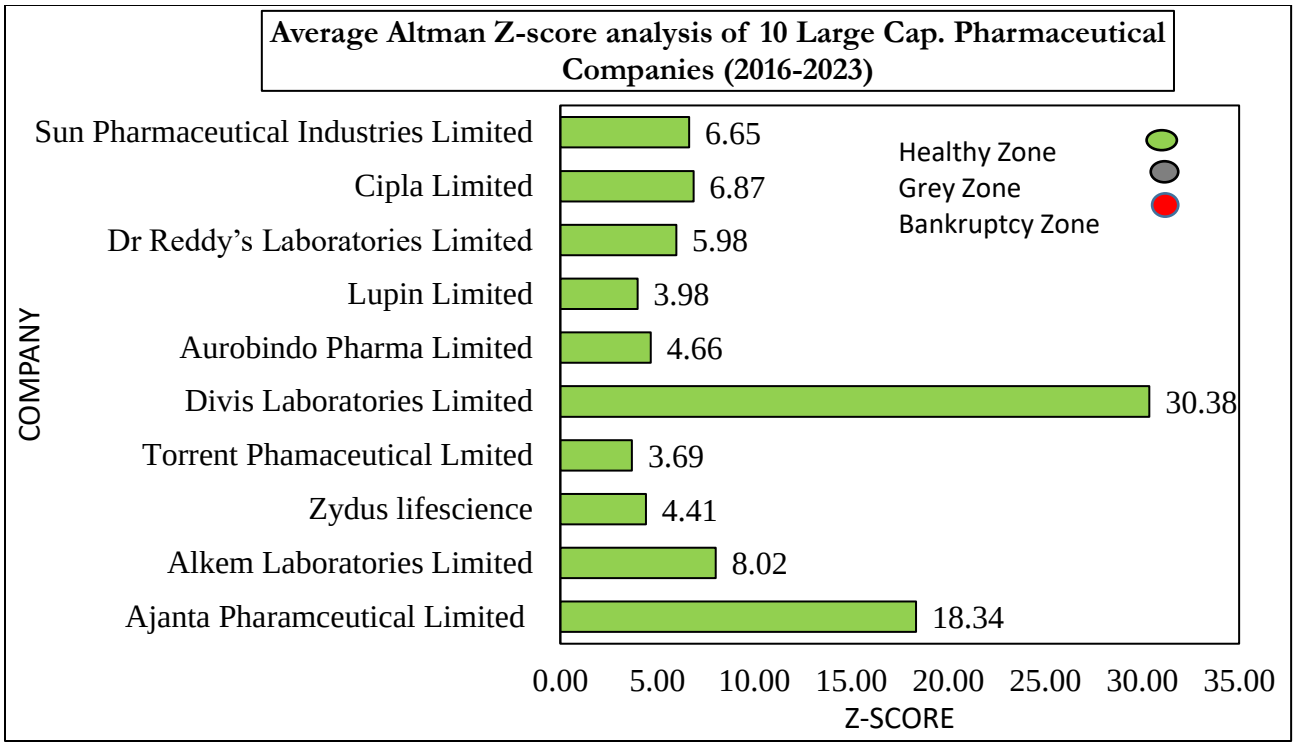

Figure 1: Bar graph of Average Altman Z-score Analysis of 10 selected large cap. Indian Pharmaceutical companies for the financial period of 2016-2023

(Source: Authors' Analysis)

Table 3 and Figure 1 present the Altman Z-Score analysis of ten prominent Indian pharmaceutical companies with large market capitalization. The findings unveil a consistently positive financial outlook and minimal risk of bankruptcy. Each company, including Sun Pharmaceutical Industries, Cipla Limited, Dr. Reddy's Laboratories, Lupin Limited, Aurobindo Pharma Limited, Divis Laboratories Limited, Torrent Pharmaceutical Limited, Zydus Lifescience, Alkem Laboratories Limited, and Ajanta Pharmaceutical Limited, demonstrates Z-Scores within the Healthy Zone, indicating robust financial health and reduced bankruptcy risk.

Sun Pharmaceutical Industries maintains a stable Z-Score of 6.65, reflecting enduring financial strength. Similarly, Cipla Limited, Dr. Reddy's Laboratories, Lupin Limited, and Aurobindo Pharma Limited exhibit steady Z-Scores, affirming their financial stability. Divis Laboratories Limited stands out with remarkably high Z-Scores of 30.38, indicating exceptional financial health. Torrent Pharmaceutical Limited, Zydus Lifescience, and Alkem Laboratories Limited maintain consistent Z-Scores within the Healthy Zone, demonstrating sound financial positions (Narayanan et al., 2023). Ajanta Pharmaceutical Limited, despite minor fluctuations, generally maintains Z-Scores suggesting stable financial health.

Overall, the Altman Z-Score analysis underscores the financial robustness of these large-cap Indian pharmaceutical companies, with all companies surpassing the threshold for healthy financial status. Notably, Divis Laboratories (Z-score: 30.38) and Ajanta Pharmaceutical (Z-score: 18.34) exhibit notably high Z-Scores, reflecting exceptionally strong financial health, while the mean Z-Score for each company reinforces the overall healthy financial status.

The Altman Z-Score of 10 selected Mid Capital Indian Pharmaceutical Companies

Table 4: Z-score of Mid Cap. Indian pharmaceutical companies

Altman Z-Score Model										
Name of the Company	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**Mean Z score**	**Zone**
Natco Pharma Ltd.	10	16.1	15.43	9.96	8.75	15.53	11.48	10.55	12.23	Healthy Zone
Granules India Limited	3.73	3.99	2.52	2.9	3.6	5.26	4.49	4.34	3.85	Healthy Zone
Marksans Pharma Ltd.	6.72	5.92	5.5	5.35	4.31	6.51	5.3	6.75	5.80	Healthy Zone
Alembic Pharmaceutical Limited	12.03	12.21	5.84	5.19	4.38	9.08	6.74	5.42	7.61	Healthy Zone
Pfizer limited	8.92	8.46	7.95	12.04	13.14	16.32	13.84	14.49	11.90	Healthy Zone
Caplin Point laboratories limited	3.77	16.52	22.56	20.12	10.34	14.77	16.79	11.93	14.60	Healthy Zone
Eris Lifesciences Limited	3.77	3.57	13.21	15.79	14.53	21.84	18.04	4.97	11.97	Healthy Zone
Wockhardt Ltd.	3.1	2.07	1.63	1.27	0.623	1.63	1.04	1.07	1.55	Bankruptcy zone
Suven Life Science Limited	11.69	10.69	11.19	36.25	2.82	24.35	62.87	39.25	24.89	Healthy Zone
Larus Lab Limited	1.81	4.39	3.41	2.66	2.54	5.92	7.17	4.69	4.07	Healthy Zone

(Source: Authors' Analysis)

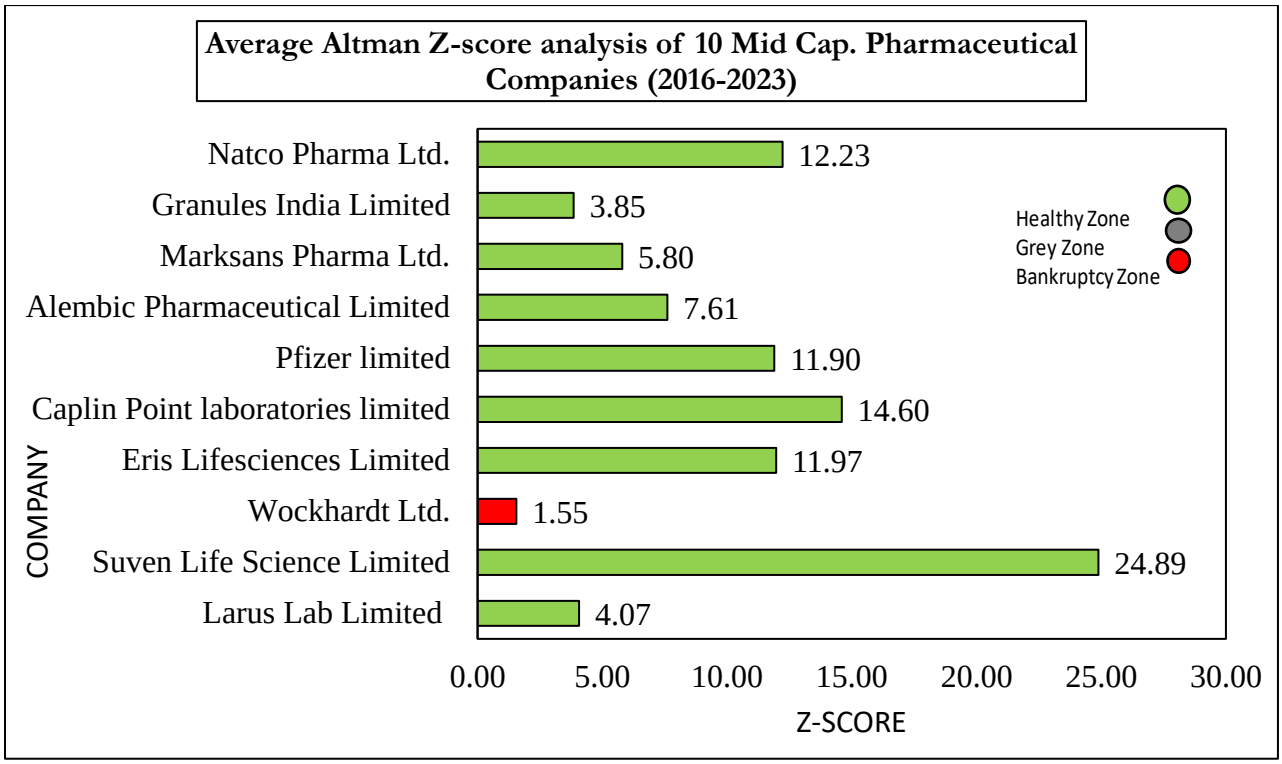

Figure 2: Bar graph of Average Altman Z-score Analysis of 10 selected mid capital Indian Pharmaceutical companies for the financial period of 2016-2023.

(Source: Authors' Analysis)

Table 4 and Figure 2 provide a comprehensive analysis of the Altman Z-Score for ten mid-cap Indian pharmaceutical companies spanning from 2016 to 2023. The companies namely Suven Life Science Limited, Caplin Point Laboratories Limited, Natco Pharma Ltd., Eris Lifesciences Limited and Pfizer Limited consistently exhibit robust financial health, with their respective Z-Scores viz. 24.89, 14.60, 12.23, 11.97, 11.90 consistently placing them in the Healthy Zone, indicating a lower risk of bankruptcy. Specifically, Granules India Limited, Larus Lab Limited and Marksans Pharma Ltd. maintain steady Z-Scores viz. 3.85, 4.07 and 5.80 respectively, reflecting their stability and financial strength (Kaur et al., 2022). Alembic Pharmaceutical Limited and Pfizer Limited showcase consistently strong Z-Scores, affirming their solid financial positions and sustained performance (Fei et al., 2024). However, Wockhardt Ltd. raises concerns with consistently low Z-Scores i.e.

1.55, suggesting potential financial distress and necessitating vigilant monitoring by stakeholders. Overall, the analysis underscores the financial resilience of most mid-cap pharmaceutical companies while highlighting the importance of proactive risk management, particularly for companies showing signs of instability (Francis et al., 2023).

The Altman Z-Score of 10 selected Small Cap. Indian Pharmaceutical Companies

Table 5: Z-score of Small Cap. Indian pharmaceutical companies

Altman Z-Score Model										
Name of the Company	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**Mean Z score**	**Zone**
Gufic Bioscience limited	3.88	4.92	4.98	4.07	2.54	5.51	8.89	4.04	4.85	Healthy Zone
Kilitch Drugs	4.5	4.16	5.87	9.74	4.43	1.84	3.72	3.17	4.68	Healthy Zone
Indoco Remedies Ltd.	6.98	4.97	3.97	3.48	3.78	4.87	6.23	5.37	4.96	Healthy Zone
Morepen Laboratories Limited	2.78	2.61	3.09	2.45	2.12	4.03	4.45	4.91	3.31	Healthy Zone
Bliss GVS Pharma Ltd.	4.78	4.2	5.86	7.59	4.83	4.96	4.27	4.16	5.08	Healthy Zone
Necter Lifescience Limited	2.03	2.04	1.61	1.61	1.73	1.26	1.82	1.58	1.71	Bankruptcy zone
Medico remedies limited	1.66	1.33	1.36	1.55	1.75	2.37	2.54	11.31	2.98	Grey Zone
Lincoln Pharma Limited	4.17	5.25	4.55	5.37	4.86	6.23	6.69	8	5.64	Healthy Zone
Shilpa Pharma Limited	8.19	8.08	7.24	5.67	3.36	2.69	3.18	1.76	5.02	Healthy Zone
RPG Lifesciences Limited	5	7.05	4.85	5	4.63	7.41	9.53	9.61	6.64	Healthy Zone

(Source: Authors' Analysis)

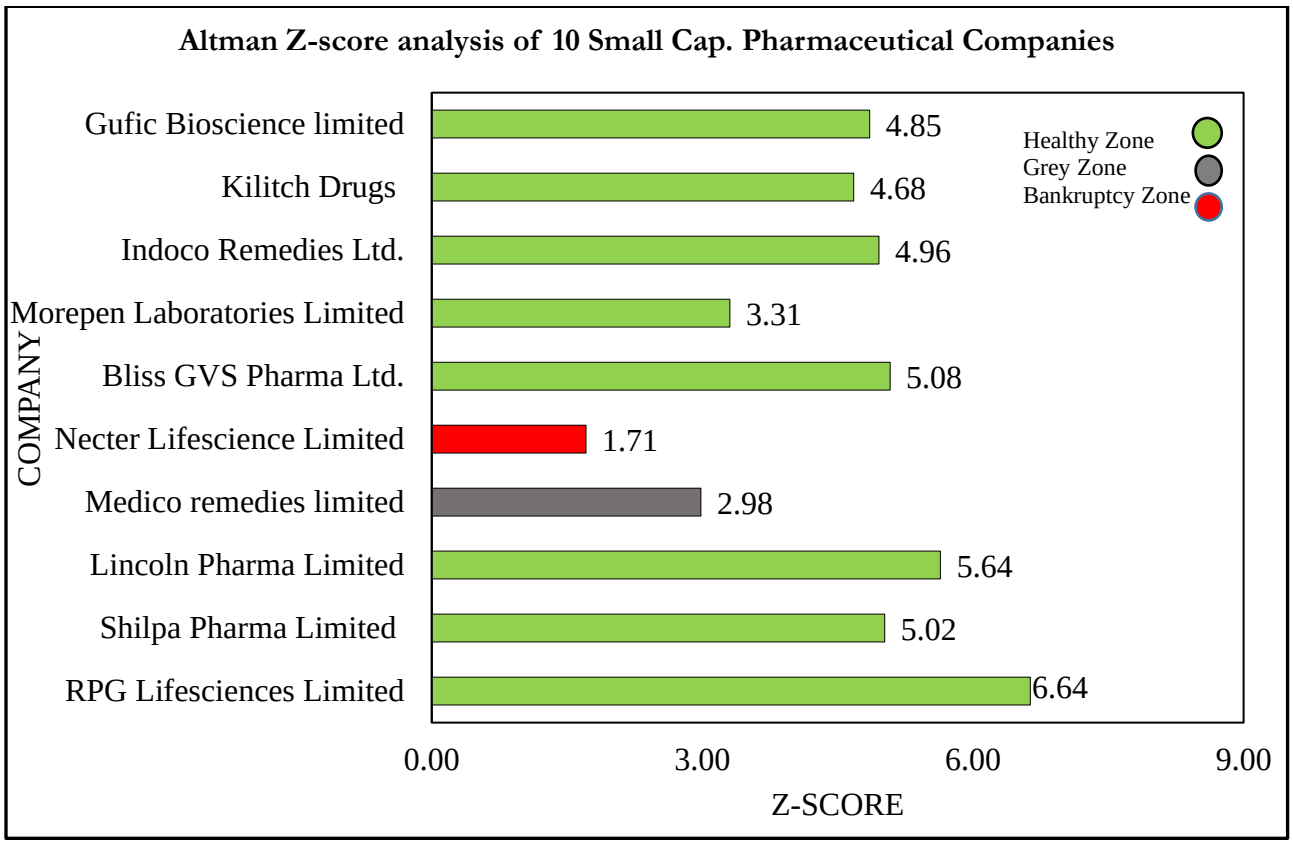

Figure 3: Bar graph of Average Altman Z-score Analysis of 10 selected Small Capital Indian Pharmaceutical companies for the financial period of 2016-2023.

(Sources: Authors' Analysis)

Table 5 and Figure 3 present a thorough evaluation of the Altman Z-Score analysis for ten small-cap Indian pharmaceutical companies from 2016 to 2023. Notably, Gufic Bioscience, Kilitch Drugs, Indoco Remedies, Morepen Laboratories, Bliss GVS Pharma, Lincoln Pharma, Shilpa Pharma, and RPG Lifesciences consistently

demonstrate robust financial health, boasting Z-Scores firmly in the Healthy Zone, indicating a significantly reduced risk of bankruptcy. With mean Z-Scores of 4.85, 4.68, 4.96, 3.31, 5.08, 5.64, 5.02, and 6.64 respectively, these companies underscore their financial stability. Conversely, Nectar Lifescience's placement in the Bankruptcy Zone with a Z-Score of 1.71 and Medico Remedies Limited's position in the Grey Zone with a Z-Score of 2.98 hint at potential financial challenges, warranting meticulous scrutiny.

The Altman Z-Score of 10 Micro-Cap. Indian Pharmaceutical Companies

Table 6: Z-score of Micro Cap. Indian pharmaceutical companies

Altman Z-Score Model										
Name of the Company	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**Mean Z score**	**Zone**
Lyka Lab	1.55	0.74	-0.57	-0.4	-1.09	-0.44	2.66	2.49	0.62	Bankruptcy zone
Venus Remedies Limited	1.73	1.82	1.19	0.91	1.23	3.14	3.97	3.58	2.20	Grey Zone
Brooks Laboratories	4.14	5.53	1.93	1.23	0.59	1.23	1.73	2.11	2.31	Grey Zone
Bafna Pharmaceutical Limited	0.4	0.14	-0.27	-0.91	-0.55	6.85	7.2	3.07	1.99	Grey Zone
Alpa Laboratories	2.95	3.95	3.75	3.23	2.7	3.41	5.01	4.8	3.73	Healthy Zone
Albert David Limited	2.91	3.6	3.65	4.42	3.79	3.24	3.99	4.37	3.75	Healthy Zone
SMS Lifescience India private Limited	0.56	2.5	3.04	2.99	2.24	1.98	2.61	2.67	2.32	Grey Zone
Wanbury	0.334	0.447	-1.17	-0.98	0.40	-0.47	1.53	0.91	0.12	Bankruptcy zone
Mangalam Drugs and Organics	1.79	1.3	1.34	0.972	0.891	3.29	2.96	4.53	2.13	Grey Zone
Take solutions Limited	3.81	4.74	5.13	3.66	2.05	0.68	0.9	1.99	2.87	Grey Zone

(Source: Authors' Analysis)

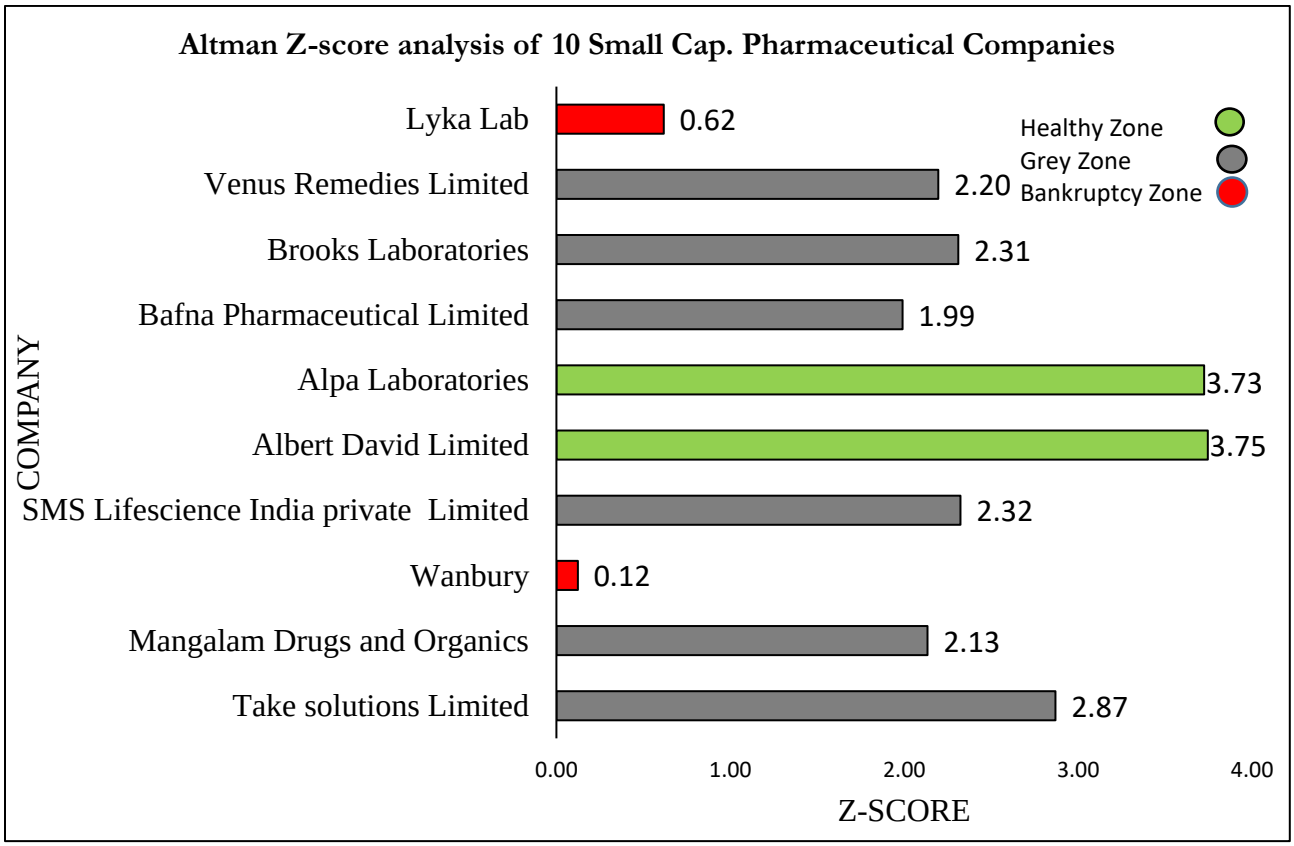

Figure 4: Bar graph of Average Altman Z-score Analysis of 10 Micro cap. Indian Pharmaceutical companies for the financial period of 2016-2023.

(Source: Authors' Analysis)

Table 6 and Figure 4 depict the Altman Z-Score analysis for ten micro-cap Indian pharmaceutical companies from 2016 to 2023, offering insights into their financial health and bankruptcy risk. Alpa Laboratories and Albert David Limited consistently maintain Healthy Zone Z-Scores, with mean scores of 3.73 and 3.75, reflecting stable financial positions. Conversely, Lyka Lab and Wanbury consistently falls into the Bankruptcy Zone with a Z-Score of 0.62 and 0.12 respectively, indicating high financial distress risk. Venus Remedies Limited (Z-score: 2.20), Brooks Laboratories (Z-score: 2.31), Bafna Pharmaceutical Limited (Z-score: 1.99), SMS Lifescience India Private Limited (Z-score: 2.32), Mangalam Drugs and Organics (Z-score: 2.13), and Take Solutions Limited (Z-score: 2.87) exhibit Grey Zone Z-Scores, suggesting potential financial challenges and warranting close scrutiny. This analysis highlights varying financial health among micro-cap pharmaceutical companies, urging stakeholders to monitor those facing higher risks of financial distress.

Discussion on Results and Implications

DISCUSSION

The Altman Z-Score model categorizes companies into different financial health zones based on their calculated Z-Scores. A Z-score exceeding 2.99 places a company in the Healthy Zone, indicating a sound and steady financial situation. The Grey Zone, with Z-Scores ranging from 1.81 to 2.99, suggests a slight chance of financial difficulty, emphasizing the need for careful financial management decisions. A Z-Score lower than 1.81 categorizes a company in the Bankruptcy Zone.

All selected Large Capital Pharmaceutical Companies, including Sun Pharmaceutical Industries Limited, Cipla Limited, and others, are in the healthy zone, with Z-scores of 3 or higher. This typically indicates that all the companies are financially healthy and less likely to face financial distress. Notably, Divis Laboratories Limited stands out with an exceptionally high Z-score of 30.38, significantly higher than the rest of the selected Large Cap. companies. These results align with findings from similar studies (Ratnasari et al., 2024; Acharyya, 2023; Azam et al., 2023; Jagannathan et al., 2023; Pravin & Dhabaliya, 2023).

All selected Mid-Capital Pharmaceutical companies are in the healthy zone except for Wockhardt Ltd., whose average Z-Score is 1.55, indicating a high risk of bankruptcy and insolvency (Haque et al., 2024).

Among the Small Capital Pharmaceutical Companies, 8 Companies are in the healthy zone, indicating financial stability. However, Medico Remedies Ltd. is in the Grey Zone, with an average Z-Score of 2.98, suggesting potential financial challenges. With an average Z-score of 1.71, Nectar Lifesciences Ltd. is vulnerable to insolvency as it falls into the Bankruptcy Zone.

Among all selected Micro Capital Pharmaceutical companies, Alpa Lab. Ltd., and Albert David Limited have average Z-scores of more than 3, indicating financial stability (Ying et al., 2023). Others, such as Venus Remedies Ltd. and Brooks Laboratories Ltd., fall into the Grey Zone, suggesting potential financial challenges (Lee et al., 2023).

Using the Altman Z-Score methodology, investors can make well-informed judgments regarding their investment portfolios. Out of the 40 firms examined, 30 fall within the Healthy Zone, 7 in the Grey Zone, and 4 in the Bankruptcy Zone. This comprehensive breakdown enables investors to thoroughly evaluate risk and potential returns.

Managerial Implications

The findings from the Altman Z-Score analysis provide essential guidance for pharmaceutical company management to navigate financial challenges and optimize operational performance (Malnaad et al., 2022). For instance, companies with Z-scores above 2.99, such as Cipla Limited, Aurobindo Pharma Limited, Sun Pharmaceutical Industries Limited, Divis Laboratories Limited, Torrent Pharmaceutical Limited, Dr Reddy's Laboratories Limited Natco Pharma Ltd., Pfizer limited, Alpa Laboratories, Indoco Remedies Ltd. and others, exhibit robust financial health, indicating stability and resilience in the face of economic fluctuations (Adetayo et al., 2022). These companies can capitalize on their strong financial position to pursue strategic investments in research and development, expand their product portfolio, or explore new markets with confidence.

Conversely, companies like Wockhardt Ltd., Necter Lifescience Limited, Lyka Lab and Wanbury, with Z-scores below 1.81, face heightened risks of bankruptcy and insolvency. For such companies, immediate corrective actions are imperative, including debt restructuring, operational streamlining, and divestment of non-core assets, to restore financial viability and sustain long-term growth.

For companies that are found in the Grey Zone, such as Medico Remedies Ltd., Venus Remedies Ltd., Brooks Laboratories, Mangalam Drugs and Organics and others, proactive financial planning and risk management strategies are essential to mitigate potential financial challenges (Jiayuan et al., 2018). These companies should focus on improving operational efficiency, optimizing working capital management, and diversifying revenue streams to enhance financial resilience and navigate uncertain economic conditions effectively.

Transparent communication with stakeholders, including investors, customers, and regulators, is critical for maintaining trust and confidence amidst financial uncertainties (Wan et al., 2023). Management should provide regular information regarding company's financial performance, strategic initiatives, and risk mitigation measures to reassure stakeholders and foster long-term relationships. Overall, leveraging the insights from the Altman Z-Score analysis enables pharmaceutical companies to make informed decisions, mitigate financial risks, and position themselves for sustainable growth in a dynamic market environment.

Implications for Investors

Investors leverage the Altman Z-Score method to categorize companies into Healthy, Grey, or Bankrupt groups, aiding in assessing investment risks and potential returns accurately. In the context of the study, companies like Sun Pharmaceutical Industries Limited and others, with Z-scores above 2.99, fall into the Healthy Zone, indicating stability and growth potential for long-term investment strategies. Conversely, companies like Wockhardt Ltd., with Z-scores below 1.81, are classified in the Bankrupt Zone, signaling high risk and typically being avoided by investors.

For Grey zone companies, such as those identified in the study like Venus Remedies Ltd., Brooks Laboratories Ltd. And others, investors may adopt more cautious approaches. These companies may have potential for improvement, but they require close monitoring and diversified investment strategies to mitigate risks. By understanding these classifications and aligning their investment strategies accordingly, investors can optimize their portfolio's performance while minimizing exposure to potential financial distress.

Implications for Creditors

Using Altman Z-Score analysis, long-term creditors gain valuable insights for making well-informed decisions on loan approvals and setting appropriate interest rates. As an illustration, companies like Sun Pharmaceutical Industries Limited, categorized in the Healthy Zone with Z-scores above 2.99, signify lower default risks, offering favorable terms for long-term loans. Conversely, companies like Wockhardt Ltd., in the Bankruptcy Zone with Z-scores below 1.81, indicate higher default risks, prompting long-term creditors to proceed cautiously or avoid extending significant credit altogether (.

Short-term creditors, such as suppliers, can tailor their credit terms based on the financial health of pharmaceutical companies (Bin et al., 2022). For example, dealing with companies like Sun Pharmaceutical Industries Limited, in the Healthy Zone, assures suppliers of timely payments and may enable them to offer more favorable credit terms. However, companies like Wockhardt Ltd., categorized in the Bankruptcy Zone, signal higher risks of default, prompting suppliers to implement stricter credit monitoring and diversify their customer base to mitigate potential losses (Yu et al., 2023).

Policy Implications

Regulatory bodies and policymakers can use the findings from the Altman Z-Score analysis to develop targeted policies and regulations to support the pharmaceutical industry's financial health and stability (Ahmed et al., 2024). For instance, regulators can implement measures to enhance transparency and disclosure requirements, ensuring that pharmaceutical companies deliver timely and accurate financial information to each stakeholder (Sirajuddin et al., 2023). Moreover, regulatory oversight can help identify and address systemic risks within the

industry, such as companies with Z-scores indicating a high risk of bankruptcy, to safeguard public health interests and maintain market stability.

Government policies aimed at promoting access to finance for pharmaceutical companies, particularly SMEs, can stimulate industry growth and innovation. Initiatives such as government-backed loan guarantee programs or tax incentives can incentivize financial institutions to extend credit to pharmaceutical companies, enabling them to invest in research and development, expand production capacity, or upgrade manufacturing facilities. Additionally, policies that encourage industry collaboration and capacity-building initiatives can strengthen the overall resilience and competitiveness of the pharmaceutical sector, fostering innovation and sustainable growth in the long run.

CONCLUSION AND FUTURE SCOPE

CONCLUSION

A company's financial well-being significantly impacts its overall performance and often guides crucial decision-making processes. Among the arsenal of tools available for predicting insolvency and assessing financial health is Altman's Z-Score model (Umesh et al., 2023). The present work seeks to compare, assess, and forecast the financial performance of selected pharmaceutical companies operating in India. The findings paint a largely optimistic picture, with the majority of Indian pharmaceutical firms comfortably positioned within the safe or healthy zone according to the Altman Z-Scores. However, companies categorized in the Grey Zone, such as Medico Remedies Ltd., Venus Remedies Ltd., and Brooks Laboratories Ltd., among others, have the potential to avoid bankruptcy through strategic management decisions (Haibao & Haque, 2023). These businesses must prioritize initiatives aimed at enhancing operational efficiency, reducing debt burdens, and diversifying revenue streams to bolster their financial stability and transition into the Healthy Zone (Wai et al., 2024). Conversely, entities like Wockhardt Ltd., Nectar Lifescience Ltd., Lyka Lab Ltd., and Wanbury find themselves in the Bankruptcy Zone or displaying concerning signs of financial distress (Senathirajah et al., 2024). Urgent action is imperative for these companies, necessitating measures such as debt restructuring, stringent cost-cutting measures, and the establishment of strategic partnerships to stabilize their financial footing and prevent insolvency (Haque et al., 2022). In summary, while most large, mid-sized, and small pharmaceutical companies in India enjoy favorable financial health, immediate attention is warranted for the Micro Pharma sector to address potential financial risks (Mien et al., 2023).

Future Scope and Limitations

The study's scope is confined to the years 2016-2023 and solely focuses on financial data from Indian pharmaceutical firms, limiting its generalizability to other time periods, industries, and regions (Wahab et al., 2024). Future research could extend the analysis period, incorporate qualitative methodologies, and explore cross-sectoral and cross-country comparisons to enhance the study's robustness and applicability (Senathirajah et al., 2023). Additionally, expanding the dataset to include a more diverse sample of companies and industries would provide deeper insights into global industry trends and potential synergies between different segments (Rana et al., 2023). These enhancements would address the study's limitations and contribute to a more comprehensive understanding of the financial dynamics within the pharmaceutical sector and beyond.

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