European Journal of Business and Management Research
Vol 9 | Issue 5 | September 2024
ISSN 2507-1076

RESEARCH ARTICLE

Anticipation of Efficacy of the Natural Gas Distribution Companies in Bangladesh: An Evaluation Regarding Z-Score Model

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ABSTRACT

The energy and power sectors are crucial for developing the financial and socio-economic sectors of underdeveloped countries like Bangladesh. Effective gas distribution can positively impact the supply chain, power sectors, fertilizers, CNG stations, industries, and commercial users. The study's main goal is to evaluate the overall efficacy and predict the stability and soundness of the five selected Bangladeshi natural gas distribution companies. The secondary data of ten years from annual reports have been taken purposively from selected companies and analysed with the help of SPSS Version 24. The study finds that SGCL and JGDSL's risky financial positions depend on borrowing funds, and the rest of TGTDCL, PGCL, and KGDCL have better positions. The study also reveals significant differences in the value Z-score among the companies and performance. All companies, except KGDCL, have poor productivity and operating efficiency, indicating inefficient expense management. To improve financial health, companies should maintain sufficient current assets and pay liabilities, maintain a consistent sales margin, manage costs and expenses, overcome operational problems, evaluate projects, establish policies for maintaining a safe financial position, and report financial statements based on FRC instructions.

Keywords: Altman Z-score, Financial distress, Financial solvency, Profitability.

Submitted: July 11, 2024

Published: September 18, 2024

10.24018/ejbmr.2024.9.5.2466

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1. Introduction

Nowadays, the business world is running through collaboration and competition in the global market. Because of the higher level of global market competition, without performance evaluation and continuous monitoring, the company will not be able to face global challenges and sustain itself in the market in the long run (Baran *et al*., 2016; Chan & Qi, 2003; Collin, 2003; Erdogan *et al*., 2015; Üçüncü *et al*., 2018). The evaluation process reflects a company's effectiveness and sustains when financial performance is determined accurately. Financial performance evaluation is crucial to achieving investment objectives, particularly boosting revenue in a competitive market for manufacturing business operations (Abdel-Basset *et al*., 2020) and becoming a vital tool for managerial decisions (Gazi *et al*., 2022). According to Elgazzar (2013), performance measurement is required to implement methods for maximizing productivity, efficiency, and effectiveness. Performance evaluation compares and interprets current and past performance with standard performance (Debasish, 2006; Varkkey & Dessler, 2018). Financial performance indicates business profitability in a fundamental sense (Green, 1978). To assess a company's current position and potential for future success, it is crucial to consider its business success as well as its liquidity, leverage, operations efficiency, and comparative performance relationships. Financial analysis is conducted to assess organizational viability, stability, and profitability. Financial analysis is the act of accurately creating a relationship between the balance sheet and income statement to determine the organizational strengths and weaknesses of an organization (Khan & Jain, 2008; Pandey, 2011; Parveen & Mohideen, 2014; Üçüncü *et al*., 2018). Financial statement analysis is a component of business analysis. Business analysis is the evaluation of a company's prospects and risks to make business decisions about equity and debt valuation, credit risk assessment, earnings predictions, audit testing, compensation negotiations, and other decisions

(Subramanyam & Wild, 2014) and capital structure, costs, revenues, and consequent profit margins have an impact on organizational performance (Al Dalayeen, 2016).

Performance and financial health are crucial factors for individuals, banks, governments, auditors, creditors, owners, employees, management, society, stakeholders, etc., in making their decisions (Ahmed & Alam, 2015; Altman *et al*., 2017; Dhamelia, 2021; Emre & Serdar, 2023; Kertapati *et al*., 2004; Lifschutz & Jacobi, 2010; Milašinović *et al*., 2019; Mostofa *et al*., 2016; Shetty & Shetty, 2020; Verlekar & Kamat, 2019). Rating agencies, managers, investors, auditors, creditors, lenders, stakeholders, and the country's economy highly depend on the accurate forecasting of the organizational financial crisis (Alaka *et al*., 2018; Emre & Serdar, 2023).

There was a long time of debate among planners, administrators, managers, economists, and academicians on how to quantify the performance of public organizations (Asaduzzaman *et al*., 2015) because the main objectives were concerned with the welfare of the public, not generating income. Natural gas distribution companies in Bangladesh are public limited companies controlled by the Bangladesh Oil, Gas, and Mineral Corporation (Petrobangla) under the Ministry of Power, Energy, and Mineral Resources (Petrobangla, 2021). So, there is a debate in the gas sector of Bangladesh as to why that organization generates profit. The golden age of Jute Mills Corporation, Bangladesh Textile Mills Corporation, and Bangladesh Sugar Mills Corporation shaped the history of Bangladesh. All these public bodies are so weak in a financial position that are not operated successfully, and every year a huge amount of loss is incurred from those organizations (Hossain *et al*., 2021; Hossain *et al*., 2006; Islam *et al*., 2013). So it is time to measure of financial health (Chakraborty, 2017) of the natural gas distribution company for sustain in the competition. The financial performance, financial stability, and the chance of bankruptcy are determined by the Z-score model (Bushra & Mishra, 2015). The Z-score model is the most used model based on accounting data and easy applicability (Emre & Serdar, 2023; Milašinović *et al*., 2019; Verlekar & Kamat, 2019). Poor decision is the main cause of corporate failure (Bushra & Mishra, 2015). Policymakers and investors can get early warnings about solvency. Early warning indicators are sought after for financially troubled organizations. The sooner the trouble is identified, the more effectively a remedy may be implemented to turn in the right truck (Svabova *et al*., 2020). Future development depends on the analysis, trend, and prediction of the financial position and interpretation of the result (Svabova *et al*., 2020). The Altman Z-Score model is a widely accepted model to predict financial distress in international contests (Altman *et al*., 2017). Although the effectiveness of the Altman model depends on the economic environment and operating industry (Georgiev & Petrova, 2020), Altman's Z score approach is still useful for identifying failing businesses before they go bankrupt (Barboza *et al*., 2017; Cındık & Armutlulu, 2021), the prediction 70%–80% is accurate (Altman *et al*., 2017; Shetty & Shetty, 2020), and bankruptcy is predicted prior one year of collapse (Ahmed & Alam, 2015; Kim, 2007). Natural gas sectors contributed more than 63% of total commercial energy uses in Bangladesh (Bangladesh Economic Review 2021, 2021). In Bangladesh, 71% of electricity is generated from natural gas (Bangladesh Economic Review 2020, 2020). The failure and distress of the gas distribution highly affected the supply chain of gas and, consequently, on power sectors, fertilizers companies, CNG stations, industry production, commercial users, and domestic users across the country. So, the study is undertaken by the researcher to assess the overall efficacy and anticipate the stability and soundness of the selected natural gas distribution companies in Bangladesh. This study is important from both the organization's point of view as well as the economic point of view.

2. Literature Reviews

Altman Z-score model was first introduced in 1968 to measure financial performance and predict the financial distress of companies. Subsequently, this model was improved to cope with the new situation and predict accurate results. For the development of conceptual framework and literature, different research studies were reviewed. Some of the important works are as follows:

Kertapati *et al*. (2004) explained that the success of a company had direct or indirect effects on management, shareholders, the government, customers, suppliers, and other stakeholders. Ratio analysis is a common financial performance measurement technique, with five variables being crucial for its development. Bandyopadhyay (2006) created a bankruptcy model for the Indian company sector based on MDA, using factors such as liquidity, leverage, solvency, productivity, turnover, solidity, and other nonfinancial variables. The financial performance of Indian automobile companies listed on the Bombay Stock Exchange (BSE). The manufacturing model of Altman's Z-score was applied, revealing that all companies except Tata (Grey Zone) are sound in a position with no chance of bankruptcy (Bushra & Mishra, 2015). Risk management activities are integrated within risk management activities, and the banking industry faces risks that need to be addressed. Altman's Z-Score model has been used to predict bank failures, with the model accurately predicting failure up to two years ahead of distress. However, the original model was found to have limited prediction value and overstated bankruptcy relative to real cases (Chakraborty, 2017). Milašinović *et al*. (2019) highlighted the importance of financial stability preserved from bankruptcy. The modified model has broad use in manufacturing, service, public, and private enterprises. Untwal (2019) examined the suitability of using Altman's bankruptcy model to assess the financial strength of servicing companies of Infosys, finding that for most of the years, Infosys has been operating in a safe zone. Cındık and Armutlulu (2021) predicted financial distress in Turkey companies using four models: Altman Z-score, Revised Altman Z-score, Quadratic discriminant analysis, and Random Forest machine learning. Random Forest produced 100% of the findings for publicly listed companies, but other models revealed that private companies

performed better than publicly traded ones. Dhamelia (2021) explained that financial analysis and financial statements are tools for aiding in the future utilization of organizations' assets. The Z-score model, which Altman devised to forecast a company's financial health, is a set of financial measures that helps investors, managers, auditors, creditors, and CEOs make wise decisions by accurately predicting financial performance. Altman *et al*. (2017) used the modified Z-score model to evaluate multinational banks' insolvency and company distress. The model, developed in 1983, was 75% accurate and could be increased to 90% by including more factors and nation estimations. Kittur (2019) investigated the effectiveness of the Altman model in Indian banking sectors, finding it more suitable for testing financial performance during the distress period. Verlekar and Kamat (2019) highlighted the impact of a single bank's collapse on national and global economies, with the original model showing limited prediction value and overstating bankruptcy. Shetty and Shetty (2020) assessed Yes Bank's performance using the Altman Z Score model, finding it did not accurately predict the bank's bankruptcy. Ntawumenyumunsi and Maringa (2022) found bankruptcy problems were primarily related to increasing demand deposits, quasi-money, and treasure bill holding. Emre and Serdar (2023) concluded that the Z-score model is suitable for assessing a company's financial performance and serving as a predictor for making long-term judgments about a publicly traded company's worth.

In Bangladesh, Chowdhury and Barua (2009) analyzed the financial distress of the Z category share of the Dhaka Stock Exchange using Altman Z-score and found that 90% of companies were experiencing financial difficulties due to inadequate management capability and inefficient operational activities. Most Bangladeshi companies do not use Altman's Z-scores. Masum and Johora (2012) assessed the performance of four Bangladeshi ceramic industries using the Z Score approach, finding weak liquidity and difficulty meeting existing liabilities. Jahur and Quadir (2012) identified reasons for Bangladeshi SMEs' financial difficulties, including rate of adequacy, sales patterns, debt, and management competencies. Fund management, resource mobilization, inadequate reporting systems, low productivity and profitability, and management succession are the main reasons for the financial crisis. Hasan and Khanam (2013) highlighted the need for improved long-term solvency, liquidity, and productivity in Bangladesh's state-owned general insurance companies. Hossain and Moudud-Ul-Huq (2014) found that 48% of enterprises were in the "grey" zone, and only 20% were in a secure position of the cement industries in Bangladesh. Ahmed and Alam (2015) examined the financial standing of fifteen banks in Bangladesh using the Altman Z Score model. The findings indicated that most banks were distressed, although the trend was improving. Hamid *et al*. (2016) predicted the financial position of 15 non-bank financial institutions in Bangladesh using the Altman Z score model (1983). Results indicated that most companies lay in the distress zone despite their outstanding local and global market performance. Researchers suggested regulatory authorities, researchers, and stakeholders should be watchdogs on company performance. Mostofa *et al*. (2016) evaluated the financial performance of 25 Bangladeshi banks using the Altman model to predict financial crises. They used indicators like leverage, activity, profitability, solvency, and market value ratios. The profitability ratio showed significant volatility. Sina *et al*. (2020) used the Altman Z-score to determine the illness of Bangladeshi garment industries, finding a negative correlation between the five Z-score ratios. Factors found included working capital management inefficiencies, resource misallocation, idle capacity, and low activity levels.

In the previous study, there was no study related to performance evaluation and predicting financial health conditions in the natural gas distribution companies (publicly traded) carried out by applying the Z-score model, so the scope will open to conducting research.

3. Methods and Methodology

There are six natural gas marketing companies in Bangladesh operating their activities across the country. To measure the performance of the financial position and find out the financial distress, five companies were selected purposively Titas Gas Transmission and Distribution Company Ltd., (TGTDCL), Jalalabad Gas Transmission and Distribution System Limited (JGDSL), Pashchimanchal Gas Company Limited (PGCL), Karnaphuli Gas Distribution Company Limited (KGDCL), and Sundarban Gas Company Limited (SGCL) based on geographical location, year of establishment and area coverage. Secondary data are used to carry out the research. ten years, from 2012–13 to 2021–22, have been considered in this study, and data have been collected from annual reports, audit reports from selected companies, articles from online publications, etc. With the help of SPSS Version-24, the gathered data has been analyzed. The accounting and statistical tools like ratios, Z-score, mean, standard deviation, coefficient of variation, ANOVA single factors, regression analysis, and correlation analysis are applied to uncover the problems and prospects of natural gas marketing companies in Bangladesh.

4. Hypothesis of the Study

- Ho_1 = There is no significant difference among Bangladesh's natural gas marketing companies regarding liquidity (X1).
- Ho_2 = There is no significant difference among Bangladesh's natural gas marketing companies regarding past profitability (X2).
- Ho_3 = There is no significant difference among Bangladesh's natural gas marketing companies regarding profitability (X3).
- Ho_4 = There is no significant difference among Bangladesh's natural gas marketing companies regarding Leverage (X4).
- Ho_5 = There is no significant difference among Bangladesh's natural gas marketing companies regarding the Altman Z-score.

5. Performance Evaluation Based on Altman's Z Score

The Z-score model, which Altman developed in 1968 (Altman *et al*., 2017), is a multiple discriminatory analysis of financial statements used to measure performance, predict financial distress, and help investors make suitable and accurate decisions (Bushra & Mishra, 2015). Firstly, it was only applicable to publicly traded companies. The five variables in the model are liquidity, profitability, leverage, solvency, and activity ratios (Altman, 1968). The authors then created a new model (Z') in 1983 with a wider variety of applications in private-public, manufacturing-non-manufacturing businesses. A new model (Z") with four variables apart from asset turnover was introduced in 1995 in response to an issue with the private firm database (Altman *et al*., 2017). Details of the evaluation systems of the Altman Z-score model are as follows:

- *Publicly traded Companies* (Altman, 1968):

$$Z = 0.012X1 + 0.014X2 + 0.033X3 + 0.006X4 + 0.999X5 \quad (1)$$

where *X1* is Working capital over total Assets (a measure of liquidity), *X2* is Retained Earnings over total Assets (a measure of reinvested earnings and past profitability), *X3* is EBIT over total Assets (a measure of profitability), *X4* is Market/Book value of equity over total liabilities (a measure of leverage), *X5* is Sales over total Assets (a measure of efficiency/activity).

- *Private manufacturing Companies* (Altman, 1983; Altman *et al*., 2017):

$$Z' = 0.717X1 + 0.847X2 + 3.107X3 + 0.420X4 + 0.998X5 \quad (2)$$

- *Private non-manufacturing servicing companies* (Altman, 1983):

$$Z = 6.56X1 + 3.26X2 + 6.72X3 + 1.05X4 \quad (3)$$

where the value of the *Z-score* is less than 1.10 (Distress), 1.10 to 2.60 (grey zone), and more than 2.60 (safe zone) (Cındık & Armutlulu, 2021; Kittur, 2019), this model is appropriate for the natural gas distribution companies in Bangladesh. The value of *Z* (servicing companies)' is treated as a dependent variable, whereas *X1* (Liquidity), *X2* (Profitability), *X3* (Productivity), and *X4* (Leverage) are treated as independent variables. *X5* is deducted to reflect the minimum effects of industry impact (Cındık & Armutlulu, 2021).

6. Analysis and Findings

Based on the collected data and applied tools, analysis and findings are as follows:

$$X1 = \frac{Net\ Current\ Assets/working\ capital\ (CA - CL)}{Total\ Assets} \quad (4)$$

The ratio of the company's total assets held to its working capital is shown by *X1*. This ratio (*X1*) shows the company's ability to pay its present debts; the greater the value, the greater the ability to pay off debts. The ratio allows for the evaluation of a company's financial difficulty (Knežević *et al*., 2019). On the other hand, a lower ratio denotes greater discomfort and the burden of huge liabilities (Untwal, 2019). Greater current asset holdings are a sign of financial health and the ability of the business to meet its obligations with its available cash. Normally, continual operational losses of any organization represent the reducing the percentage of the company that indicates a distressed position (Altman, 2013; Chakraborty, 2017).

It can be seen from Table I that PGCL and KGDCL had an overall negative ratio over the research period from 2012–13 to 2017–18, with an overall mean of 0.01. The ratio has been trending downward and upward over the year but has been able to reach positive levels from 2018–19 to 2021–2022. At the same time, TGTDCL and SGCL were able to maintain this ratio's favorable status in 2012–13. JGTDSL was maintaining positive ratios except from 2015–16 to 2017–18. However, if a business invests in a lucrative venture, it maintains a low current asset, and in such circumstances, it is acceptable to have a low value of this ratio. All the company's SD values were higher than Sample (0.02), indicating less homogeneity of the concern variable, according to the larger standard deviation. The performance of gas companies is determined by the mean values of the ratios; in this case, TGTDCL (0.15) exhibits the highest performance, while PGCL and KGDCL (0.01) exhibit the lowest. Since in ANOVA single factor, calculated F value 3.07* is greater than the table value (2.58), the null hypothesis is rejected at a 5% level of significance [result hypothesis-1]. Thus, there is a notable variation in the liquidity position of natural gas distribution companies in Bangladesh.

$$X2 = \frac{\text{Retained Earnings}}{Total\ Assets} \quad (5)$$

X2 measures the leverage (Ahmed & Alam, 2015) and profitability of the company (Chakraborty, 2017; Untwal, 2019). It indicates the amount of profit reinvested in the company, which means capital is financed from its resources (Milašinović *et al*., 2019). The value of the ratios depends on the age and unallocated earnings of the company. The ratio value of the new company is comparatively lower in comparison to the old company. The low value represents a high dependency on financing on the borrowings (Milašinović *et al*., 2019; Untwal, 2019).

It can be seen from Table II that KGDCL had the highest value (0.43), subsequently followed by TGTDCL (0.38), PGCL (0.34), JGTDSL (0.33) are greater than the sample mean value (0.31) and SGCL (0.05) is the lowest value. It indicates that the profitability and profit reinvestment capacity of KGDCL is better than other natural gas distribution companies and that they are able to finance their investment from their sources. The ratio of X2 is lower in the SGCL because this company is newly established in Bangladesh. It was found that SGCL has to borrow funds to operate the business. All the company's SD values were higher than Sample (0.02), indicating less homogeneity of the concern variable, according to the larger standard deviation. At the 1% significance level, the null hypothesis

TABLE I: X1: Net Working Capital/Total Assets

Years	TGTDCL	JGTDSL	PGCL	KGDCL	SGCL	Mean	ANOVA single factor
2012–2013	0.14	0.07	−0.03	−0.17	0.02	0.01	3.07*
2013–2014	0.13	0.02	−0.01	−0.12	0.01	0.01	
2014–2015	0.11	0.03	−0.01	−0.18	0.04	0.00	
2015–2016	0.08	−0.03	−0.02	−0.17	0.02	−0.02	
2016–2017	0.11	−0.12	−0.09	−0.20	0.03	−0.05	
2017–2018	0.09	−0.03	−0.05	−0.01	0.07	0.01	
2018–2019	0.13	0.01	0.03	0.10	0.18	0.09	
2019–2020	0.22	0.06	0.09	0.25	0.03	0.13	
2020–2021	0.27	0.11	0.14	0.29	0.01	0.16	
2021–2022	0.24	0.09	0.04	0.30	0.13	0.16	
Mean	0.15	0.02	0.01	0.01	0.05	0.05	
SD	0.06	0.07	0.07	0.21	0.06	0.08	

Source: Data are compiled from published records of companies.
Note: *, ** consecutively statistically significant at 5% and 1% level, where table value = 2.58.

TABLE II: X2: Retained Earnings/Total Assets

Years	TGTDCL	JGTDSL	PGCL	KGDCL	SGCL	Mean	ANOVA single factor
2012–2013	0.41	0.37	0.19	0.43	0.00	0.28	61.07**
2013–2014	0.44	0.37	0.24	0.40	0.00	0.29	
2014–2015	0.46	0.37	0.29	0.42	0.01	0.31	
2015–2016	0.41	0.34	0.30	0.41	0.02	0.30	
2016–2017	0.44	0.30	0.31	0.40	0.03	0.30	
2017–2018	0.37	0.28	0.38	0.48	0.07	0.31	
2018–2019	0.35	0.29	0.37	0.46	0.09	0.31	
2019–2020	0.32	0.33	0.43	0.50	0.11	0.34	
2020–2021	0.33	0.35	0.48	0.49	0.08	0.35	
2021–2022	0.32	0.27	0.43	0.32	0.13	0.29	
Mean	0.38	0.33	0.34	0.43	0.05	0.31	
SD	0.05	0.04	0.09	0.05	0.05	0.02	

Source: Data are compiled from published records of companies.
Note: *, ** consecutively statistically significant at 5% and 1% level, where table value = 2.58.

is rejected because the computed F value (61.07) in the ANOVA single factor is higher than the table value (2.58) [result in hypothesis-2]. So, there is a significant difference between the past profitability of natural gas distribution companies.

$$X3 = \frac{Earnings\ before\ Interest\ and\ Tax\ (EBIT)}{Total\ Assets} \quad (6)$$

Before interest and taxes are paid, *X3* calculates asset productivity and profitability (Ahmed & Alam, 2015; Chakraborty, 2017; Knežević *et al*., 2019; Milašinović *et al*., 2019). This ratio also indicates the operating efficiency of the company (Mostofa *et al*., 2016). The ability of a company's assets to generate profits determines its ability to survive, and this ratio is a useful tool for forecasting business failure (Ahmed & Alam, 2015; Chakraborty, 2017; Untwal, 2019).

It can be seen from Table III that the overall highest productivity and operating efficiency of KGDCL (0.25), subsequently followed by PGCL (0.10), JGTDSL (0.06), TGTDCL (0.04) and SGCL (0.04) whereas the mean value (0.10). It is found from the analysis that the productivity of all companies except KGDCL is not satisfactory at all and indicates that all the expenses are not efficiently maintained by the management of the organizations, although the SD value of this ratio of JGDSL (0.01), PGCL (0.02) is lower than the Sample (0.03), indicating high homogeneity of the concern variable, according to the larger standard deviation. The null hypothesis is rejected because the calculated F value (14.16**) in the ANOVA single factor is greater than the table value (2.58) [result hypothesis-3]. So, there is a significant difference in the profitability of the natural gas distribution companies.

$$X4 = \frac{Book\ value\ of\ Equity\ capital}{Total\ Liabilities} \quad (7)$$

X4 denotes the financial leverage of the company (Untwal, 2019). The high ratio signifies the low financial risk of the company. If the value of equity capital is less than the total liabilities, it indicates the company is insolvent (Chakraborty, 2017).

It can be seen from Table IV that the leverage of SGCL (0.17) and JGDSL (0.63) indicate that the financial position of these companies is risky, and they depend on borrowing funds. However, the position is better for the companies TGTDCL (0.98), PGCL (0.98), and KGDCL (0.85) compared with the mean value (0.72). All the company's SD values were higher than Sample (0.06), indicating less homogeneity of the concern variable, according to the larger standard deviation. Due to the computed F value in the ANOVA single factor (27.30**) being higher than the table value (2.58), the null hypothesis is rejected [result for hypothesis-4]. So, there is a significant difference in the leverage position among the natural gas distribution companies.

TABLE III: X3: EBIT/Total Assets

Years	TGTDCL	JGTDSL	PGCL	KGDCL	SGCL	Mean	ANOVA single factor
2012–2013	0.11	0.07	0.07	0.63	0.00	0.18	14.16**
2013–2014	0.11	0.07	0.11	0.30	0.00	0.12	
2014–2015	0.08	0.07	0.11	0.27	0.01	0.11	
2015–2016	0.03	0.05	0.08	0.19	0.02	0.08	
2016–2017	0.03	0.04	0.07	0.14	0.01	0.06	
2017–2018	0.01	0.05	0.08	0.17	0.06	0.08	
2018–2019	0.02	0.06	0.11	0.16	0.08	0.08	
2019–2020	0.01	0.07	0.13	0.15	0.09	0.09	
2020–2021	0.01	0.08	0.12	0.14	0.08	0.09	
2021–2022	0.01	0.07	0.10	0.34	0.09	0.12	
Mean	0.04	0.06	0.10	0.25	0.04	0.10	
SD	0.04	0.01	0.02	0.15	0.04	0.03	

Source: Data are compiled from published records of companies.
Note: *, ** consecutively statistically significant at 5% and 1% level, where table value = 2.58.

TABLE IV: X4: Book Value of the Equity Capital/Total Liability

Years	TGTDCL	JGTDSL	PGCL	KGDCL	SGCL	Mean	ANOVA single factor
2012–2013	1.32	0.81	0.69	0.74	0.01	0.72	27.30**
2013–2014	1.39	0.80	0.79	0.68	0.15	0.76	
2014–2015	1.42	0.76	0.88	0.72	0.15	0.79	
2015–2016	0.99	0.66	0.88	0.71	0.16	0.68	
2016–2017	1.15	0.55	0.82	0.68	0.15	0.67	
2017–2018	0.80	0.49	1.12	0.94	0.18	0.71	
2018–2019	0.73	0.52	0.94	0.85	0.19	0.65	
2019–2020	0.64	0.61	1.15	1.01	0.19	0.72	
2020–2021	0.66	0.64	1.40	1.32	0.22	0.85	
2021–2022	0.65	0.46	1.12	0.85	0.30	0.67	
Mean	0.98	0.63	0.98	0.85	0.17	0.72	
SD	0.32	0.13	0.21	0.20	0.07	0.06	

Source: Data are compiled from published records of companies.
Note: *, ** consecutively statistically significant at 5% and 1% level, where table value = 2.58.

The Altman's Z-scores for each company, as determined by the tools mean, standard deviation, and coefficient of variations (CV) for the period under consideration, are compared in Table V to show the descriptive statistics of Bangladesh's natural gas distribution companies. While the mean values of the ratios determine the performance of the companies, the wider the range and standard deviation, the less consistent the concern variable is. It was discovered that the mean of Altman's Z-score was below standard for SGCL (1.01) and laid down in the stress zone (standard >2.60), JGDSL (2.29), and laid down in the grey zone and all the other companies namely KGDCL (4.04), TGTDCL (3.55), and PGCL (2.86) are laid down in safe zone within. The computed F value (14.10) in the ANOVA single factor is higher than the table value (2.58), which leads to the rejection of the null hypothesis [result hypothesis-5]. Thus, there is a significant difference Z-value of the natural gas distribution companies.

The R square, adjusted R square, and standard error, regression, and residual F-statistics model included variables of the selected natural gas distribution companies, and overall, they are illustrated in Table VI.

From Table VII, in the regression analysis, the value of the Z-score is treated as the dependent variable, whereas X1 (Liquidity), X2 (Profitability), X3 (Productivity), and X4 (Leverage) are considered as independent variables. From Table VII, it is noted that the value of the Z_T score depends on the regression coefficient 0.75 (X1), 0.71 (X2), and 0.64 (X3) at a 1% level of significance for the TGTDCL where the VIF (Variance Inflationary Factor) are found in the acceptable region of multicollinearity (Tables I–V). Moreover, a one unit increase in X1, X2, and X3 will positively impact the dependent variable Z score with an increase of 0.75, 0.71, and 0.64 units, respectively. It is found that leverage (equity to debt ratio) has no significant relation to the performance of Z value.

The value of the Z_J score depends on the regression coefficient 0.83 (X1) and 0.41 (X4) at a 1% level of significance for the JGTDSL where the VIF (Variance Inflationary Factor) is found in the acceptable region of multicollinearity (Tables I–V). Moreover, one unit increase of X1 and X4 will positively impact the dependent variable Z-score with an increase of 0.83 and 0.41 units, respectively. It is found that Profitability (Retained earnings to total assets) and Productivity (EBIT/TA) have no significant relation to the performance of Z value.

The value of the Z_P score depends on the regression coefficient 0.51 (X1), 0.48 (X2), and 0.11 (X3) at a 1% level of significance for the PGCL where the VIF (Variance Inflationary Factor) is found in the acceptable region of multicollinearity (Tables I–V). Moreover, one unit increase of X1, X2, and X3 will positively impact the dependent variable Z-score with an increase of 0.51, 0.48, and 0.11 units, respectively. It is found that leverage (equity to debt

TABLE V: Altman Z-Score the Selected Natural Gas Distribution Companies in Bangladesh

Z-score = (6.56X1) + (3.26X2) + (6.72X3) + (1.05X4)							
Years	TGTDCL	JGTDSL	PGCL	KGDCL	SGCL	Mean	ANOVA single factor
2012–2013	4.35	3.02	1.65	5.32	0.14	2.90	14.10**
2013–2014	4.49	2.64	2.23	3.23	0.24	2.57	
2014–2015	4.28	2.67	2.58	2.72	0.51	2.55	
2015–2016	3.15	1.91	2.31	2.26	0.52	2.03	
2016–2017	3.59	1.01	1.73	1.66	0.53	1.70	
2017–2018	2.65	1.59	2.68	3.64	1.27	2.37	
2018–2019	2.88	1.94	3.11	4.13	2.17	2.85	
2019–2020	3.18	2.60	4.12	5.38	1.34	3.32	
2020–2021	3.59	3.02	4.73	5.83	1.15	3.66	
2021–2022	3.36	2.46	3.49	6.22	2.20	3.55	
Mean	3.55	2.29	2.86	4.04	1.01	2.75	
SD	0.64	0.66	1.01	1.59	0.75	0.93	
CV	18.00	28.66	35.16	39.38	74.09	39.06	

Source: Data are compiled from published records of companies.
Note: *, ** consecutively statistically significant at 5% and 1% level. SD: CV:.

TABLE VI: ANOVA Regression Model Fit for the Selected Natural Gas Distribution Companies in Bangladesh

Companies	R square	Adjusted R square	Std. error	Regression	Residual	F.statistics	Model included variables
TGTDCL	0.999	0.998	0.02889	3.647	0.005	1455.933**(3, 6)	X1, X2, X3
JGTDSL	0.998	0.998	0.032	3.846	0.007	1877.516**(2, 7)	X1, X4
PGCL	0.994	0.990	0.09882	9.036	0.059	308.458**(3, 6)	X1, X2, X3
KGDCL	1.00	1.00	0.02564	22.787	0.003	8663.718**(4, 5)	X1, X2, X3, X4
SGCL	0.998	0.997	0.03873	5.019	0.009	1115.427**(3, 6)	X1, X3, X4
Overall	1.00	1.00	0.03026	100.084	0.041	27322.761**(4, 45)	X1, X2, X3, X4

Sources: Derived from table No. 1, 2, 3, 4 & 5 using SPSS version 24.
Note: *, ** consecutively statistically significant at 5% and 1% level and within the first parenthesis indicated the degree of freedom.

TABLE VII: The Regression Coefficient of the Selected Variables of Natural Gas Distribution Companies in Bangladesh

	TGTDCL		JGTDSL		PGCL		KGDCL		SGCL		Overall	
Parameters	β	VIF	*β*	VIF	*β*	VIF	*β*	VIF	*β*	VIF	*β*	VIF
X1 (WC/TA)	0.75**	2.568	0.83**	1.045	0.51**	4.275	0.87**	3.966	0.49**	1.451	0.54**	1.194
X2 (RE/TA)	0.71**	4.704	—	—	0.48**	1.998	0.12**	2.441	—	—	0.32**	5.048
X3 (EBIT/TA)	0.64**	2.455	—	—	0.11**	3.077	0.64**	1.225	0.52**	2.578	0.50**	1.347
X4 (BOE/TD)	—	—	0.41**	1.045	—	—	0.12**	5.855	0.15**	2.285	0.28**	4.755

Note: Calculated from Tables I–V with the help of SPSS version-24; Beta co-efficient are standardized form; *, ** consecutively statistically significant at 5% and 1% level.

ratio) has no significant relation to the performance of Z value.

The value of the Z_K score depends on the regression coefficient 0.88 (X1), 0.11 (X2), 0.64 (X3), and 0.12 (X4) at a 1% level of significance for the KGDCL where the VIF (Variance Inflationary Factor) is found in the acceptable region of multicollinearity (Tables I–V). Moreover, one unit increase of X1, X2, X3, and X4 will positively impact the dependent variable Z-score with an increase of 0.88, 0.12, 0.64, and 0.12 units, respectively.

The value of the Z_S score depends on the regression coefficient 0.49 (X1), 0.52 (X3), and 0.15 (X4) at a 1% level of significance for the SGCL where the VIF (Variance Inflationary Factor) is found in the acceptable region of multicollinearity (Tables I–V). Moreover, one unit increase of X1, X3, and X4 will positively impact the dependent variable Z-score with the increase of 0.49, 0.52, and 0.15 units, respectively. It is found that profitability (X2) has no significant relation to the performance of the Z value.

The value of the Z_o score depends on the regression coefficient 0.54 (X1), 0.32 (X2), 0.50 (X3), and 0.28 (X4) at a 1% level of significance for the overall companies where the VIF (Variance Inflationary Factor) is found in the acceptable region of multicollinearity (Tables I–VI). Moreover, one unit increase of X1, X2, X3, and X4 will positively impact the dependent variable Z-score with an increase of 0.54, 0.32, 0.50, and 0.28, respectively.

From Table VIII, it is noted that X1 (−0.001) has a negative correlation with the z score, whereas X2 (0.618) has an insignificant relation, but X3 (0.883**) and X4 (0.808**) have a significant positive correlation at 1% level of significant for the TGTDCL.

It is found that X1 (0.914**) and X3 (0.957**) have a significant positive correlation at a 1% level of significance for the JGTDSL, whereas X2 (0.634*) has a significant positive correlation at a 5% significant level and X4 (0.585) has an insignificant correlation.

TABLE VIII: Correlations Analysis with Z-Score for Each of its Components

Companies	X1	X2	X3	X4
TGTDCL	−0.001	0.618	0.883**	0.808**
JGTDSL	0.914**	0.634*	0.957**	0.585
PGCL	0.936**	0.899**	0.789**	0.923**
KGDCL	0.810**	0.114	0.311	0.642*
SGCL	0.846**	0.923**	0.903**	0.766**

Note: Calculated from Tables I–V. **Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

For the PGCL, it is observed that all the variables like X1 (0.936**), X2 (0.899**), X3 (0.789**), and X4 (0.957**) have significant positive correlation at a 1% level of significance.

It is estimated that X1 (0.810**) has a significant positive correlation at a 1% level of significance, and X4 (0.642*) has a positive significant level at a 5% level. Rest two variables, X2 (0.114) and X3 (0.311), have a positive insignificant correlation for KGDCL.

It is noted that all the variables like X1 (0.846**), X2 (0.923**), X3 (0.903**), and X4 (0.766**) have a significant positive correlation with Z-score at a 1% level of significance for SGCL.

7. Major Findings

The major findings from the analysis and interpretations are as follows:

1. It has been found that based on liquidity (X1), PGCL and KGDCL have a negative ratio from 2012–2013 to 2017–2018, with a mean of 0.01. However, it shows a downward trend and upward, reaching positive levels from 2018–2019 to 2021–2022. TGTDCL and SGCL maintain favorable ratios, while JGTDSL maintains positive ratios determined by their mean ratio values.
2. KGDCL outperformed other natural gas distribution companies in terms of profitability and reinvestment capacity, with a lower X2 ratio due to its new establishment in Bangladesh, indicating a need for borrowing funds to operate the business.
3. The analysis (X3) reveals that all companies except KGDCL have unsatisfactory productivity and operating efficiency, indicating inefficient expense management. The SD values of JGDSL and PGCL are lower than the sample, indicating high homogeneity of the concern variable.
4. The analysis (X4) explores SGCL and JGDSL's risky financial position depending on borrowing funds, while TGTDCL, PGCL, and KGDCL have better positions, with SD values higher than Sample, indicating less homogeneity.
5. The measurement of Altman's Z-scores for natural gas distribution companies in Bangladesh explained that SGCL and JGDSL are in stress and grey zones, while PGCL, TGTDCL, and KGDCL are in safe zones. The mean values indicate performance, with wider ranges and standard deviations affecting consistency.
6. The study model fitting explores the R square, adjusted R square, and standard error for various companies, which were all within acceptable limits.
7. The regression analysis of a company's performance is based on the Z-score as the dependent variable and the independent variables X1 (Liquidity), X2 (Profitability), X3 (Productivity), and X4 (Leverage). The results show that the Z_T score, Z_J, Z_P, Z_K, Z_S, Z_S, and Z_o scores all have no significant relation to the performance of the Z value. The Z_T score depends on the VIF (Variance Inflationary Factor) in the acceptable region of multicollinearity (Tables I–V)

8. Conclusion

Natural gas and natural gas distribution companies play an important role in Bangladesh's economic development. Performance and financial solvency are important for the development and sustainability of the market in the long run. It is noted that most Bangladeshi natural gas distribution companies are in the safe zone. However, some companies lay in the grey zone, and some companies were in the stress zone, i.e., failed to attain the minimum value of Z-score; although Altman Z-score result prediction is not 100% accurate result but a perquisition may provide regarding bankruptcy. Loans from local and international institutions should be taken carefully, as this will create financial solvency problems in the future. So, it is time to consider the facts; regulatory authorities should monitor the performance and select effective plans and strategies for the companies to ensure to meet the customer's demand and confirm the flow of energy for economic development as well as holding a strong financial position. The model may be applied by management to their current financial planning and decision-making about stakeholders, including suppliers, investors, consumers, and regulatory bodies, for their future interactions with the company.

9. Suggestions and Recommendations

For improving the financial health of the distribution companies in Bangladesh, the following suggestions may be followed:

- All the companies should keep a uniformity of sufficient amount of current assets and pay their current liabilities to improve the current ratios and liquidity position in the standard position.
- The sales margin of gas should be the same for all distribution companies. The strategies should be taken for cost management, expense management, and system loss management to ensure the profitability of the companies.
- Proper steps should be taken to overcome operational problems to increase the level of productivity.
- Projects should be carefully evaluated at the time by borrowing funds from the World Bank, ADB, JICA, or other institutions, and sufficient cash inflows should be ensured after implementing the project to meet the payment.

- To set up the policies to maintain the standard safe financial position for all the natural gas distribution companies engaged in Bangladesh.
- SGCL should focus on liquidity and profitability to attain a safe financial position.
- All companies should report their financial statements based on the instructions given by the Financial Reporting Council (FRC) (Chairman, 2023).

Conflict of Interest

The authors declare that they do not have any conflict of interest.

References

Abdel-Basset, M., Ding, W., Mohamed, R., & Metawa, N. (2020). An integrated plithogenic MCDM approach for financial performance evaluation of manufacturing industries. *Risk Management*, *22*(3), 192–218. https://doi.org/10.1057/s41283-020-00061-4.

Ahmed, T., & Alam, S. (2015). Prediction of financial distress in banking companies of Bangladesh and a need for regulation by FRC. *Cost and Management*, *43*(6), 13–19.

Al Dalayeen, B. (2016). Financial performance appraisal of selected companies in Jordan. *Open Journal of Business and Management*, *5*(1), 131.

Alaka, H. A., Oyedele, L. O., Owolabi, H. A., Kumar, V., Ajayi, S. O., Akinade, O. O., & Bilal, M. (2018). Systematic review of bankruptcy prediction models: Towards a framework for tool selection. *Expert Systems with Applications*, *94*, 164–184.

Altman, E. I. (1968). Financial ratios, discriminant analysis and the prediction of corporate Bankruptcy. *The Journal of Finance*, *23*(4), 589–609.

Altman, E. I. (1983). *Corporate Financial Distress|Altman EI*. New York: John Wiley.

Altman, E. I. (2013). Predicting Financial Distress of Companies: Revisiting the Z-Score and ZETA® models. *Predicting Financial Distress of Companies*, 428–456.

Altman, E. I., Iwanicz-Drozdowska, M., Laitinen, E. K., & Suvas, A. (2017). Financial distress prediction in an international context: A review and empirical analysis of Altman's Z-score model. *Journal of International Financial Management & Accounting*, *28*(2), 131–171.

Asaduzzaman, M., Hamid, M. K., & Asaduzzaman, M. (2015). Financial performance analysis of Lp Gas Ltd. with special reference to govt. restriction on new piped gas connection to households. *International Journal of Business and Technopreneurship*, *5*(1), 49–60.

Bandyopadhyay, A. (2006). Predicting probability of default of Indian corporate bonds: Logistic and Z-score model approaches. *The Journal of Risk Finance*, *7*(3), 255–272.

Bangladesh Economic Review 2020. (October 2020). Tejgaon, Dhaka 1208: Finance division, Ministry of Finance Government of the People's Republic of Bangladesh. https://mof.gov.bd/site/page/44e399b3-d378-41aa-86ff-8c4277eb0990/Bangladesh-Economic-Review-Archive.

Bangladesh Economic Review 2021. (August 2021). Dhaka 1208: Finance division, Ministry of Finance, Government of the People's Republic of Bangladesh. http://mof.gov.bd/site/page/44e399b3-d378-41aa-86ff-8c4277eb0990/Bangladesh-Economic-Review-Archive.

Baran, D., Pasttfytfr, A., & Baranová, D. (2016). Financial analysis of a selected company. *Research Papers Faculty of Materials Science and Technology Slovak University of Technology*, *24*(37), 73–92.

Barboza, F., Kimura, H., & Altman, E. (2017). Machine learning models and bankruptcy prediction. *Expert Systems with Applications*, *83*, 405–417.

Bushra, M., & Mishra, K. (2015). Efficacy of Altman's Z-score to predict financial unassailability: A Multiple Discriminant Analysis (MDA) of select automobile companies in India. *Golden Research Thoughts*, *4*(7), 1–8.

Chairman. (2023). *Financial Reporting Framework: Accounting Formats and Standards Applicable for Statutory Public Authorities & State-Owned Enterprises (M. O. F. B. Finance Division, Trans.) (2023 ed.)*. Dhaka: Financial Reporting Council.

Chakraborty, S. A. (2017). Z-scores: An effective way of analysing banks risks. *Asia Pacific Journal of Research*, *1*(LII), 94–102.

Chan, F. T., & Qi, H. J. (2003). An innovative performance measurement method for supply chain management. *Supply Chain Management: An International Journal*, *8*(3), 209–223.

Chowdhury, A., & Barua, S. (2009). Rationalities of Z-category shares in Dhaka stock exchange: Are they in financial distress risk? *BRAC University Journal*, *VI*(1), 45–58.

Cındık, Z., & Armutlulu, I. H. (2021). A revision of Altman Z-score model and a comparative analysis of Turkish companies' financial distress prediction. *National Accounting Review*, *3*(2), 237–255.

Collin, J. (2003). *Selecting the Right Supply Chain for a Customer in Project Business: An Action Research Study in the Mobile Communications Infrastructure Industry* (pp. 1). Finland: Helsinki University of Technology

Debasish, S. S. (2006). Efficiency performance in Indian banking—Use of data envelopment analysis. *Global Business Review*, *7*(2), 325–333.

Dhamelia, H. (2021). Application of Z-score model for financial health checkup: Case study on selected airways companies. *Vidhyayana—An International Multidisciplinary Peer-Reviewed E-Journal-ISSN 2454-8596*, *6*(6), 1–9.

Elgazzar, S. H. (2013). *Enhancing the Company's Financial Performance of Supply Chain Operations: A Case Study of an Egyptian Manufacturing Company*. University of Huddersfield.

Emre, G.İ., & Serdar, Y. H. (2023). Application of the Altman Z"score model in forecasting the financial position of BIST companies. Финансы: теория и практика, *27*(2), 192–202.

Erdogan, E. O., Erdogan, M., & Ömürbek, V. (2015). Evaluating the effects of various financial ratios on company financial performance: Application in Borsa Istanbul. *Business and Economics Research Journal*, *6*(1), 35.

Gazi, F., Atan, T., & Kılıç, M. (2022). The assessment of internal indicators on the balanced scorecard measures of sustainability. *Sustainability*, *14*(14), 8595. https://doi.org/10.3390/su14148595.

Georgiev, V., & Petrova, R. (2020). Testing the usefulness and predictive power of the adapted Altman Z-score model for bulgarian public companies. *Economics and Computer Science*, *2020*(1), 19.

Green, D. (1978). To predict failure. *Management Accounting*, *7*, 39–45.

Hamid, T., Akter, F., & Rab, N. B. (2016). Prediction of financial distress of non-bank financial institutions of Bangladesh using Altman's Z score model. *International Journal of Business and Management*, *11*(12), 261–270.

Hasan, K., & Khanam, F. A. (2013). Performance evaluation of public sector general insurance company in Bangladesh—A case study on SBC. *European Journal of Business and Management*, *5*(25), 118–124.

Hossain, M. K., & Moudud-Ul-Huq, S. (2014). Analysis of credit-strength of cement industry in Bangladesh. *Management Studies and Economic System*, *1*(2), 97–114.

Hossain, M. M., Nishu, N. S., & Freelance Researcher, M. (2021). State-owned Jute Mills in Bangladesh: Problems and possible way-out. *International Journal of Business and Management*, *16*(4), 63–74.

Hossain, S., Zaman, M., Rabbani, M., & Hossain, M. (2006). Problems and prospect of sugar industry in Bangladesh. *Progress Agric*, *17*(1), 283–293.

Islam, M. M., Khan, A. M., & Islam, M. M. (2013). Textile industries in Bangladesh and challenges of growth. *Research Journal of Engineering Sciences*, *2278*, 9472.

Jahur, M. S., & Quadir, S. N. (2012). Financial distress in Small and Medium Enterprises (SMEs) of Bangladesh: Determinants and remedial measures. *Economia Seria Management*, *15*(1), 46–61.

Kertapati, M. R., Shah, N. R., & Hadi, A. (2004). *Evaluating Company's Performances Using Multiple Discriminant Analysis*. UIBMC Hyatt Hotel Kuantan.

Khan, M., & Jain, P. (2008). *Financial Management Fiveth Edition*. New Delhi: Tata McGraw-Hill Publishing Company Limited.

Kim, B. (2007). Bankruptcy prediction: Book value or market value?. *Paper presented in Korean Insurance Journal, Paper presented at 2007 APRIA Annual Meeting*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1579929.

Kittur, A. H. (2019). *Effectiveness of the Altman Z-Score Model: does the Altman Z-Score Model Accurately Capture the Effects of Non-Performing Assets (NPA) in the Indian Banking Sector? (Bachelor)*. Sweden: Linnaeus University.

Knežević, S., Mitrović, A., Vujić, M., & Grgur, A. (2019). *Analiza finansijskih izveštaja [Financial Statement Analysis]*. Beograd, Srbija: Samostalno izdanje autora.

Lifschutz, S., & Jacobi, A. (2010). Predicting bankruptcy: Evidence from Israel. *International Journal of Business and Management*, *5*(4), 133.

Masum, A. A., & Johora, F. -T. (2012). Performance evaluation of selected ceramic companies of Bangladesh. *Asian Business Review*, *1*(1), 37–48.

Milašinović, M., Knežević, S., & Mitrović, A. (2019). Bankruptcy forecasting of hotel companies in the Republic of Serbia using Altman's Z-score model. *Hotel and Tourism Management*, *7*(2), 87–95.

Mostofa, M., Rezina, S., & Hasan, M. (2016). Predicting the financial distress in the banking industry of Bangladesh: A case study on private commercial banks. *Australian Academy of Accounting and Finance Review*, *2*(1), 45–58.

Ntawumenyumunsi, A., & Maringa, E. (2022). Application of Edward Altman Z score model on measuring financial distress of commercial banks listed on rwanda stock exchange (2015–2019). *The Strategic Journal of Business & Change Management*, *9*(1), 130–146.

Pandey, I. M. (2011). *Financial Management*. Fall 2011 ed. Gangtok, Sikkim: Manipal Technologies Ltd., Published on Behalf of Sikkim Manipal University.

Parveen, M., & Mohideen, O. (2014). A study on financial performance of pharmaceutical company using five power analyses. *International Journal of Business Management & Research (IJBMR)*, *1*(4), 45–50.

Petrobangla. (2021). Annual Report-2021. From Bangladesh Oil Gas and Mineral Resources (Petrobangla). http://www.petrobangla.org.bd/sites/default/files/files/petrobangla.portal.gov.bd/annual_reports/3b3b53fd_e70e_48b8_92af_5be5175204b2/2023-01-31-07-06-99efbacbbfc26604c626ad01eae57322.pdf.

Shetty, P. S., & Shetty, M. R. (2020). Prediction of bankruptcy of a bank through Z-score model—A case study of yes bank. *Journal of Applied Management and Advanced Research*, *2*(1), 45–55.

Sina, M. A., Huda, M. N., Hossain, H., & Sabur, M. A. (2020). Identification of sickness of some selected garment factories in Bangladesh and its remedial measures: An application of Altman's Z-score model. *American Journal of Industrial and Business Management*, *10*(12), 1823.

Subramanyam, K. R., & Wild, J. J. (2014). *Financial Statement Analysis*. 10e ed. Chennai: McGraw Hill Education (India) Private Limited.

Svabova, L., Michalkova, L., Durica, M., & Nica, E. (2020). Business failure prediction for Slovak small and medium-sized companies. *Sustainability*, *12*(11), 4572.

Untwal, N. (2019). Application of Altman Z-score model for non-manufacturing organization with reference to Infosys. *International Journal of Innovative Research in Technology*, *6*(1), 466–468.

Varkkey, B., & Dessler, G. (2018). *Human Resource Management 15th Edition (Revision)*. Pearson Education Limited.

Verlekar, R. P., & Kamat, M. S. (2019). Application and recalibration of Altman Z-score model for forecasting banking Bankruptcy in India. *Wealth: International Journal of Money, Banking & Finance*, *8*(2), 74–86.

Üçüncü, T., Akyüz, K. C., Akyüz, İ., Bayram, B.Ç., & Ersen, N. (2018). Evaluation of financial performance of paper companies traded at BIST with TOPSIS method. *Kastamonu University Journal of Forestry Faculty*, *18*(1), 92–98.