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Predicting Bankruptcy of Companies Using Altman's Z-score model

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Introduction

- In today's business, companies face financial challenges due to global events, rules, customer changes, tough competition, and economic swings. Predicting and preventing bankruptcy is key for long-term success and survival.
- With advancements in technology, we now have different ways to guess if a company might go bankrupt. One powerful tool in this area is the Altman Z-Score. It helps check how healthy a business is financially and figures out if it might have trouble and go bankrupt.
- This study aims to comprehensively assess the bankruptcy risk of companies by employing three different versions of Altman's Z-Score model: Z, Z1, and Z2.

Problem Statement

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- **Q1-** How effective is Altman's Z-Score in predicting bankruptcy, and what are the comparative strengths of its different versions?
- **Q2-** How do liquidity, profitability, efficiency, market value, and net worth differ between bankrupt and non-bankrupt companies in our study using the modified Altman model? and how does t-test analysis enhance our understanding of these differences?
- **Q3-** Can K-means clustering effectively classify companies in Finance, Pharmacy, and Technology as distressed, in a gray zone, or safe between 2000 and 2018?

Data Collection

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- **Sources & Time Frame:** Bloomberg & Yahoo Finance (2000-2020)
- **Institutions:** 42 (Pharma: 13, Financial: 17, Tech: 12)
- **Data Types: Financial Statement**

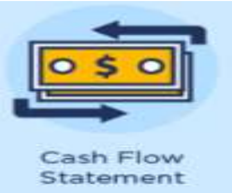
  Financial statement shows you where a company's money came from, where it went and where it is now.

- **Balance Sheet**

  Snapshot of a company's financial position

- **Income Statements**

  Shows if a company made money or had losses by summarizing income and expenses over a period.



- **Cash Flow Statements**

  Tracks cash flow, assessing how a company manages money in operations, investments, and financing.

Methodology: Financial Ratios

- A financial ratio is a simple number that helps us understand a company's financial health.
- Liquidity (X_1)
  - "Liquidity" refers to how easily assets can be converted to cash, indicating a company's financial flexibility.
  - $X_1 = \dfrac{\text{Working Capital is assets minus liabilities for short-term financial health}}{\text{Total Assets represent everything a company owns}}$
- Profitability (X_2)
  - "Profitability" measures how well a company generates profit relative to its assets
  - $X_2 = \dfrac{\text{Retained Earnings is the cumulative profit kept by a company after paying dividends}}{\text{Total Assets}}$
- Efficiency ($X_{3/5}$)
  - "Efficiency" gauges how effectively a company uses its assets to generate earnings.
  - $X_3 = \dfrac{\text{EBIT is a measure of a company's operating profitability}}{\text{Total Assets}}$
  - $X_5 = \dfrac{\text{Total Revenue is a measure of a company's operating profitability}}{\text{Total Assets}}$
- Market Value(X_4)
  - The "Market Value" assesses the relationship between a company's market value of equity and its total liabilities, providing insights into market perceptions.
  - $X_4 = \dfrac{\text{Market Value of Equity is the current market worth of a company's ownership shares}}{\text{Total Liabilities}}$
- Net Worth (X_6)
  - "Net Worth" is the residual value of a company's assets after deducting its liabilities.
  - $X_6 = \dfrac{\text{Book Value is the net value of a company's assets, minus liabilities, as recorded in its financial statements}}{\text{Total Liabilities}}$

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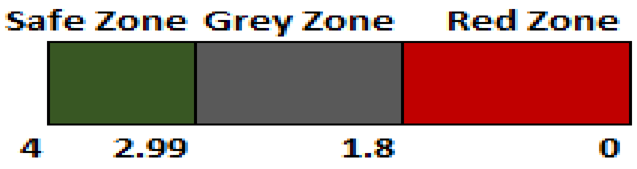
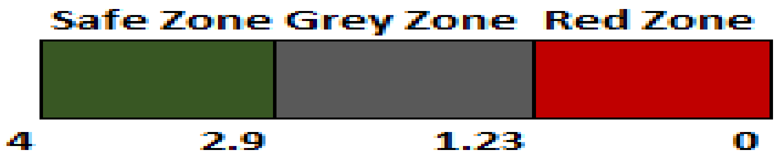
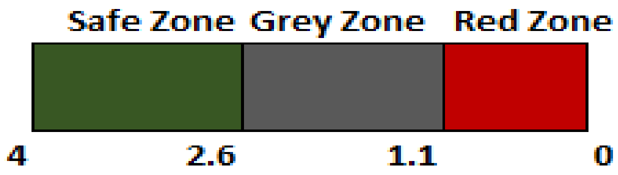
Methodology: Altman Z-Score Analysis

The Altman Z-Score in finance, is a financial health check that helps predict if a company might face bankruptcy. This study employed three versions of Altman's Z-Score model to predict company bankruptcies within the Finance, Pharmaceutical, and Technology sectors.

The Altman Z -Score Five-Financial Ratios for a Public Manufacturing Firms	The Altman Z_1-Score Five-Financial Ratios for a Private Manufacturing Firms	The Altman Z_2-Score Four-Financial Ratios for a Private Non-Manufacturing Firms
Ratios: Liquidity (X_1), Profitability (X_2), Efficiency (X_3 and X_5), Market Value(X_4)	**Ratios:** Liquidity (X_1), Profitability (X_2), Efficiency (X_3 and X_5), Net Worth(X_6)	**Ratios:** Liquidity (X_1), Profitability (X_2), Efficiency (X_3), Net Worth(X_6)
Altman Z-Score Formula: $\text{Z-Score}=1.2X_1+1.4X_2+3.3X_3+0.6X_4+0.999X_5$	**Altman Z_1-Score Formula:** $\text{Z-Score}=0.717X_1+0.847X_2+3.107X_3+0.42X_4+0.998X_5$	**Altman Z_2-Score Formula:** $\text{Z-Score}=6.56X_1+3.26X_2+6.72X_3+1.05X_6$
Interpretation: 	**Interpretation:** 	**Interpretation:** 

Data Visualization : Pharmacy and Technology sectors categorized into 'Safe', 'Gray', and 'Distress' Zones

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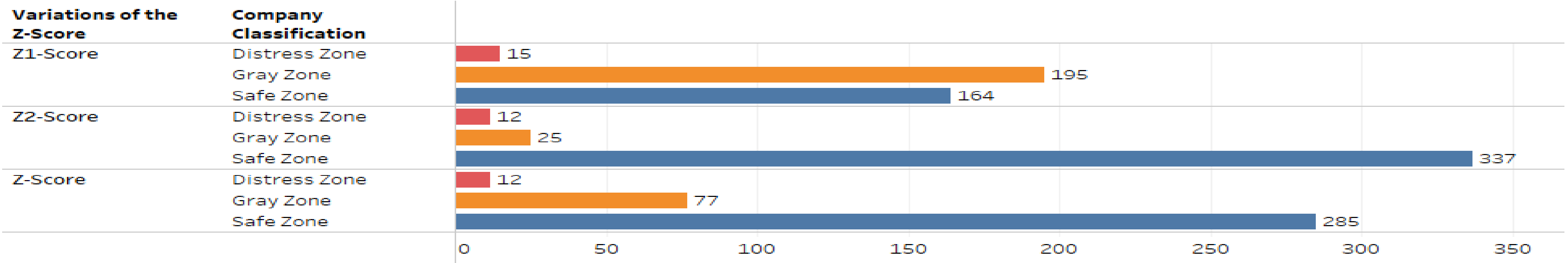
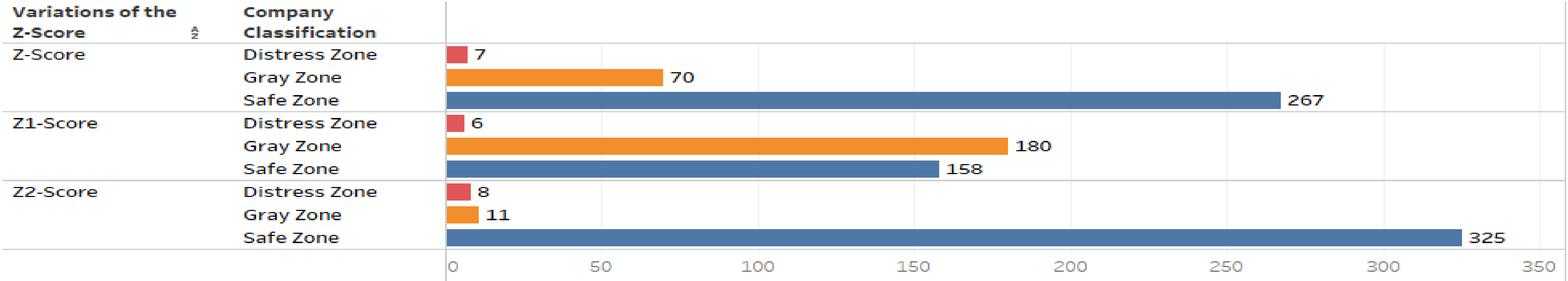
- In our study, we precisely classified **Pharmacy Sector** companies into 'Safe,' 'Gray,' and 'Distress' Zones. The 'Distress' Zone indicates the probability of companies facing bankruptcy, while 'Safe' and 'Gray' signify companies with no discernible bankruptcy risk.



- In our study, we precisely classified **Technology Sector** companies into 'Safe,' 'Gray,' and 'Distress' Zones.



Data Visualization : Financial sector categorized into 'Safe', 'Gray', and 'Distress' Zones

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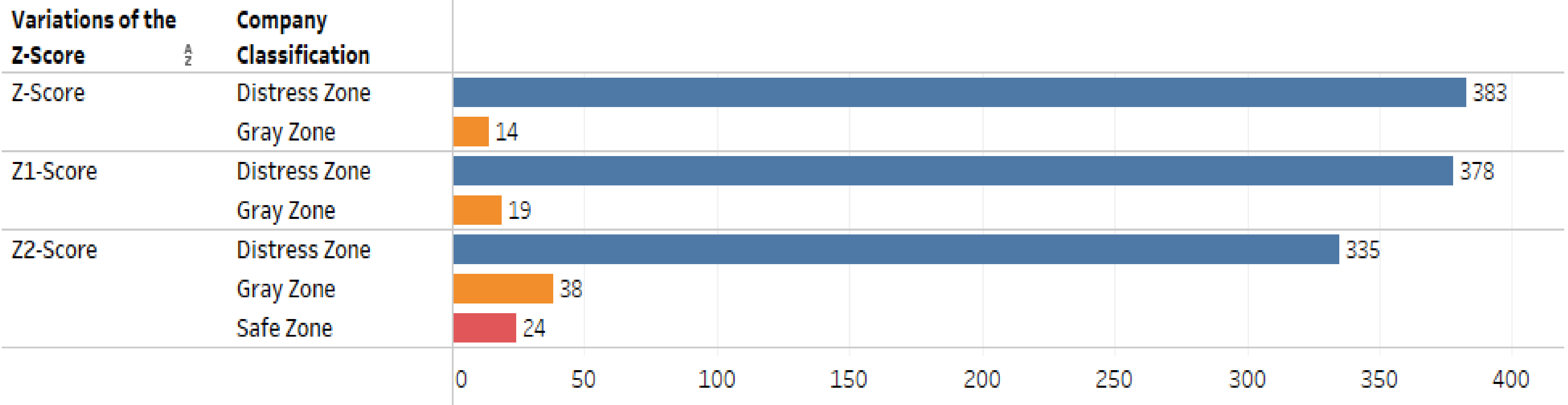
- **Financial Sector -** using the Z-Score was not accurate.
- **The financial industry's complexity and constant changes** make any single model, like the Z-Score, inadequate. Relying solely on **the Z-score may not be suitable for assessing the financial sector.**
- **A combination of various financial metrics and tools is necessary for a comprehensive understanding of its overall health and risks**



Methodology: Illustration of the Entire Model

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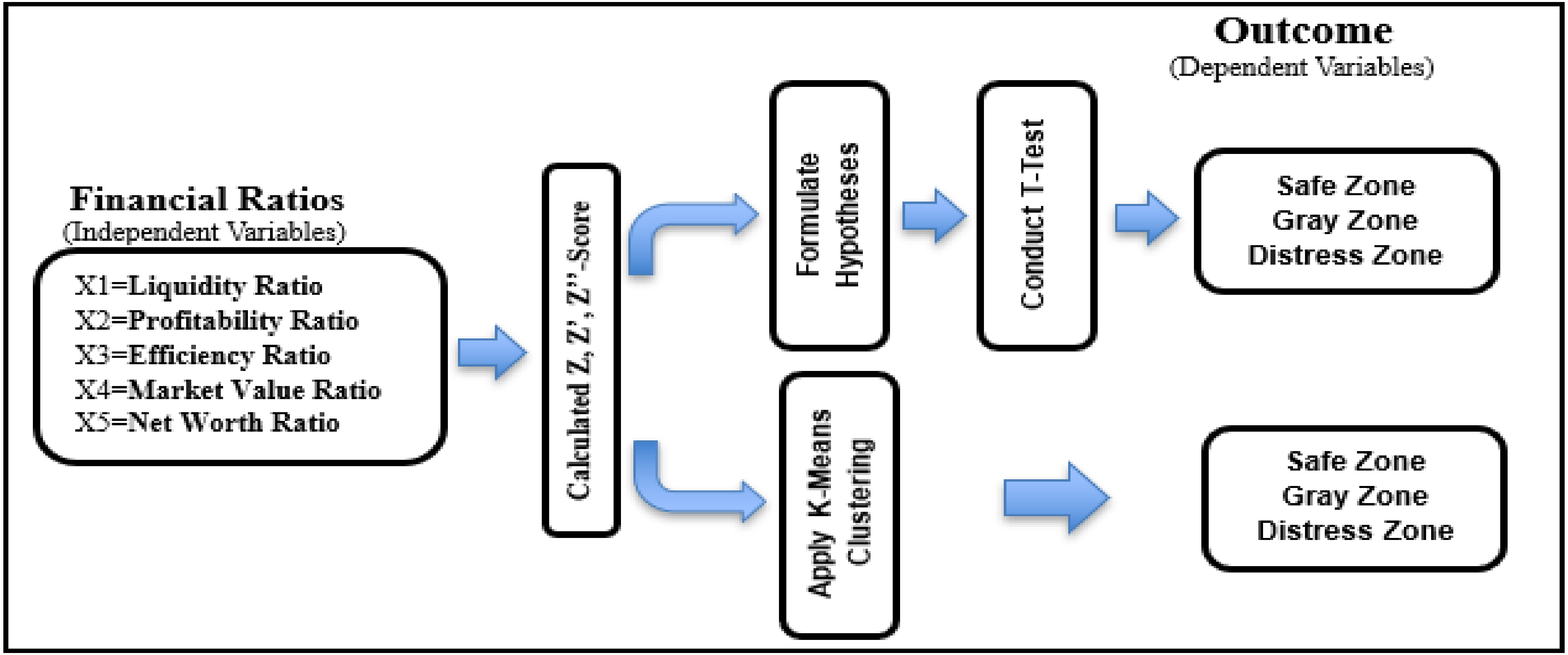

Hypothesis Testing with T-Test and Altman's Z-Score

- A statistical test used to compare the means of two groups of data. Hypothesis testing uses two hypotheses: the Null Hypothesis (H_0), suggesting no significant difference, and the Alternative Hypothesis (H_1 or Ha), proposing a significant difference.
- Hypothesis 1-2-3-4-5: The Liquidity/ Profitability/ Efficiency/ Market Value / Net Worth ratio will be a substantial predictor in the bankruptcy prediction model for companies within the pharmacy, and technology sectors.
- In our study, we conducted bivariate analysis using the modified Altman model to compare financial variables between bankrupt and non-bankrupt companies.

- If the p-value is less than or equal to alpha ($p \leq \alpha$), you reject the null hypothesis.
- If the p-value is greater than alpha ($p > \alpha$), you fail to reject the null hypothesis.

Typical values for alpha (α) in hypothesis testing are 0.05 (5%).

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T-Test Analysis: Financial Variations in Bankrupt and Non-Bankrupt Companies

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In our study, t-tests showed significant financial differences between bankrupt and non-bankrupt companies. However, Z-Score liquidity had no significant difference ($p = 0.06$) in the pharmacy sector, and Z-Score profitability, market value, and efficiency showed no significant differences ($p = 0.06$, $p = 0.28$, $p = 0.71$, respectively) in the technology sector.

Pharmacy Sector

	Altman variables	Bankrupt	Non-Bankrupt	T-Statistic	P-Value
Z Score	Liquidity ratio(X1)	362	12	1.87	0.06
	Profitability ratio(X2)	362	12	5.79	0.00
	Efficiency ratio(X3)	362	12	5.70	0.00
	Market Value ratio(X4)	362	12	2.17	0.03
	Efficiency ratio(X5)	362	12	2.46	0.01
Z1 Score	Liquidity ratio(X1)	359	15	4.16	0.00
	Profitability ratio(X2)	359	15	7.45	0.00
	Efficiency ratio(X3)	359	15	4.99	0.00
	Net Worth ratio(X6)	359	15	3.15	0.00
	Efficiency ratio(X5)	359	15	2.78	0.01
Z2 Score	Liquidity ratio(X1)	362	12	9.09	0.00
	Profitability ratio(X2)	362	12	8.05	0.00
	Efficiency ratio(X3)	362	12	4.43	0.00
	Net Worth ratio(X6)	362	12	4.90	0.00

Technology Sector

	Altman variables	Bankrupt	Non-Bankrupt	T-Statistic	P-Value
Z Score	Liquidity ratio(X1)	362	12	3.01	0.00
	Profitability ratio(X2)	362	12	1.88	0.06
	Efficiency ratio(X3)	362	12	5.60	0.00
	Market Value ratio(X4)	362	12	1.08	0.28
	Efficiency ratio(X5)	362	12	-0.37	0.71
Z1 Score	Liquidity ratio(X1)	359	15	3.43	0.00
	Profitability ratio(X2)	359	15	2.33	0.02
	Efficiency ratio(X3)	359	15	3.55	0.00
	Net Worth ratio(X6)	359	15	2.31	0.02
	Efficiency ratio(X5)	359	15	1.64	0.10
Z2 Score	Liquidity ratio(X1)	362	12	8.07	0.00
	Profitability ratio(X2)	362	12	5.92	0.00
	Efficiency ratio(X3)	362	12	2.61	0.01
	Net Worth ratio(X6)	362	12	3.30	0.00

Methodology: K Means Clustering

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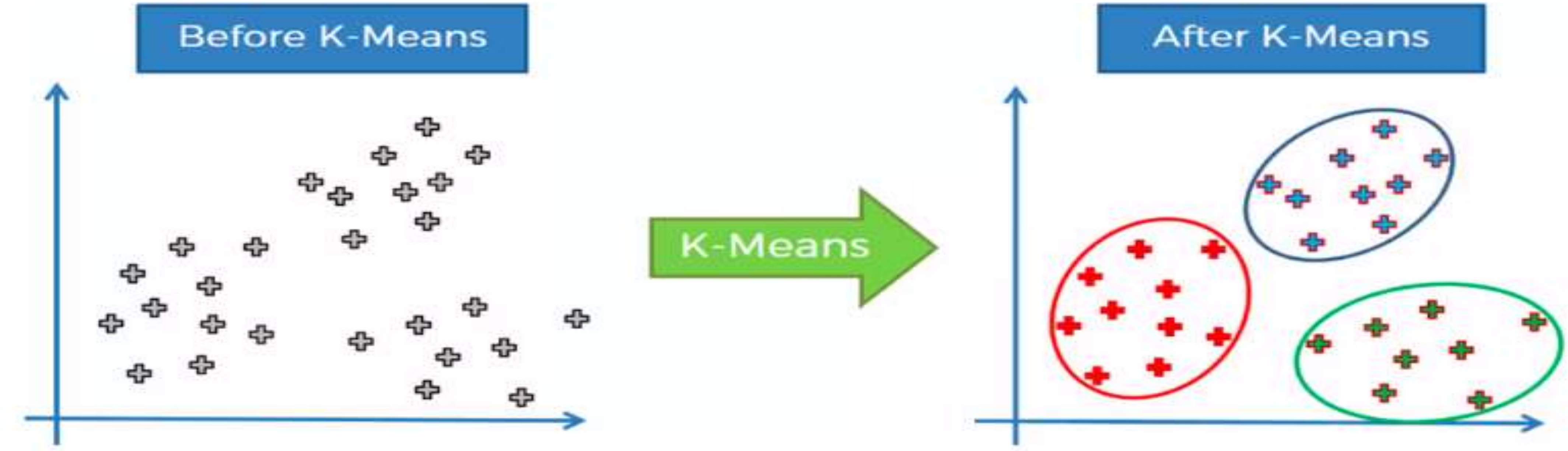
- The K-Means algorithm is a machine learning technique used for clustering, which is the process of grouping similar data points together.
- The K-Means algorithm, a significant clustering technique, adeptly organizes data, categorizing companies into three groups: distress zone, gray zone, and safe zone. These results offer an additional tool for predicting bankruptcies within the pharmacy, a



Data Visualization : Pharmacy and Technology sectors categorized into 'Safe', 'Gray', and 'Distress' Zones using K-Mean Clustering

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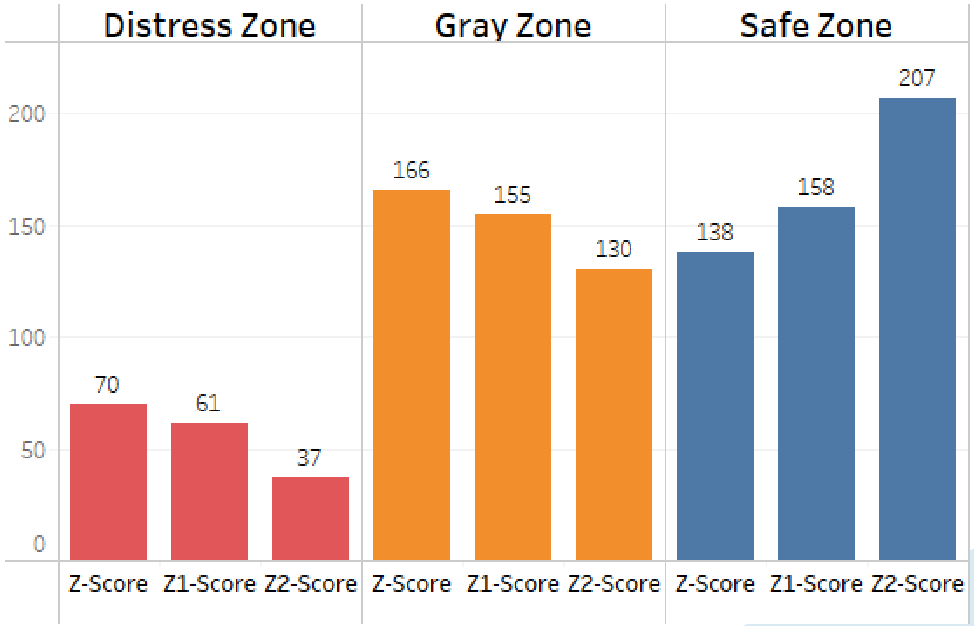
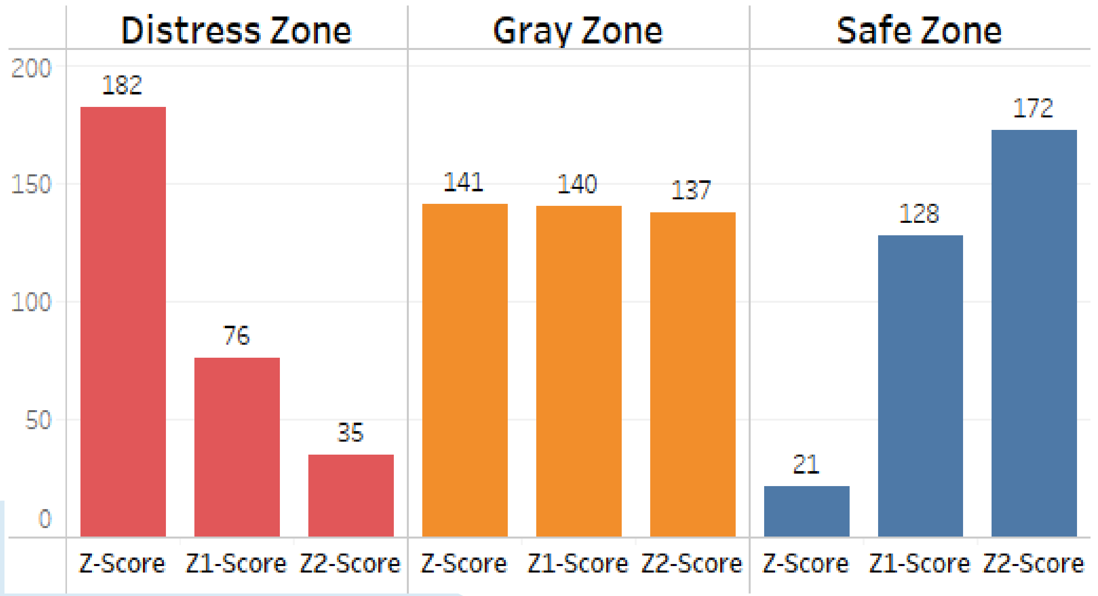
- Pharmacy Sector companies correctly categorized into 'Safe,' 'Gray,' and 'Distress' Zones using K-Mean Clustering

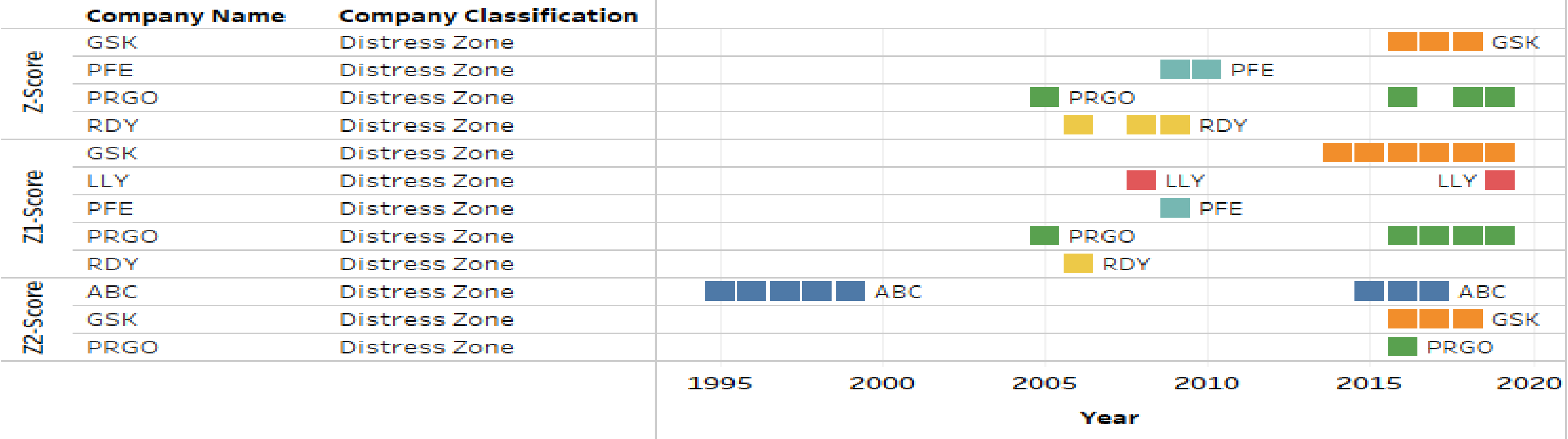


Technology Sector companies correctly categorized into 'Safe,' 'Gray,' and 'Distress' Zones using K-Mean Clustering



Result: Bankruptcy Risk Analysis (1995-2020) with Z-Scores in Pharmacy Sector

- Our study reveals bankruptcy risk predictions in the Pharmacy Sector from 1995 to 2020, precisely identifying companies at potential risk using Z-Score, Z1-Score, and Z2-Score individually.
- **Z-Score:** GSK [1], PRGO [2], PFE [3], RDY
- **Z1-Score:** GSK [1], PRGO [2], PFE [3], RDY, LLY [6]
- **Z2-Score:** GSK [1], PRGO [2], ABC



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Factors Influencing Companies' Financial Challenges: Case Studies of GSK, PRGO, and Pfizer in Pharmacy Sector

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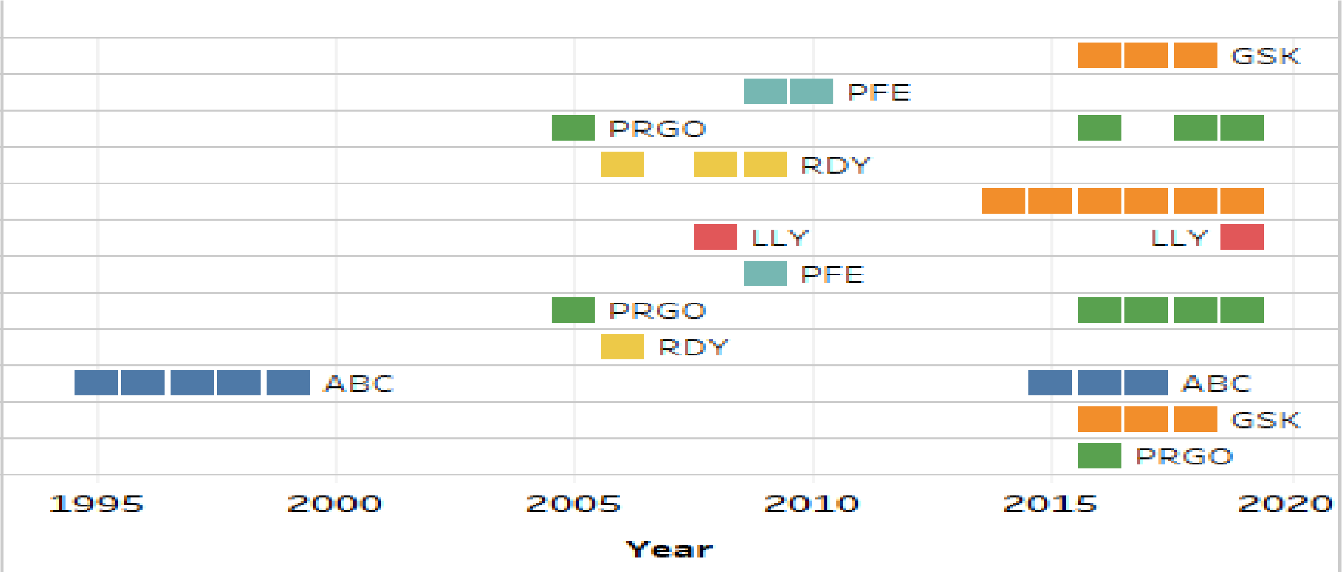
- In 2014, GSK faced a $492 million fine in China for bribing doctors. The U.S. government checked if they broke the law under the Foreign Corrupt Practices Act. This hurt GSK's reputation and kept them under scrutiny in the U.S [1].
- PRGO faced financial issues, including failed acquisitions, declining earnings, and increased debt. Non-GAAP metrics and executive compensation problems contributed to overvaluation and a significant stock value decline [2].
- Between 2008 and 2010, Pfizer (PFE) struggled due to the financial crisis, economic downturn affecting healthcare, generic competition, pipeline challenges, and integration costs from acquisitions [3].

	Company Name	Company Classification
Z-Score	GSK	Distress Zone
	PFE	Distress Zone
	PRGO	Distress Zone
	RDY	Distress Zone
Z1-Score	GSK	Distress Zone
	LLY	Distress Zone
	PFE	Distress Zone
	PRGO	Distress Zone
	RDY	Distress Zone
Z2-Score	ABC	Distress Zone
	GSK	Distress Zone
	PRGO	Distress Zone



Result: Bankruptcy Risk Analysis (1990-2020) with Z-Scores in Technology Sector

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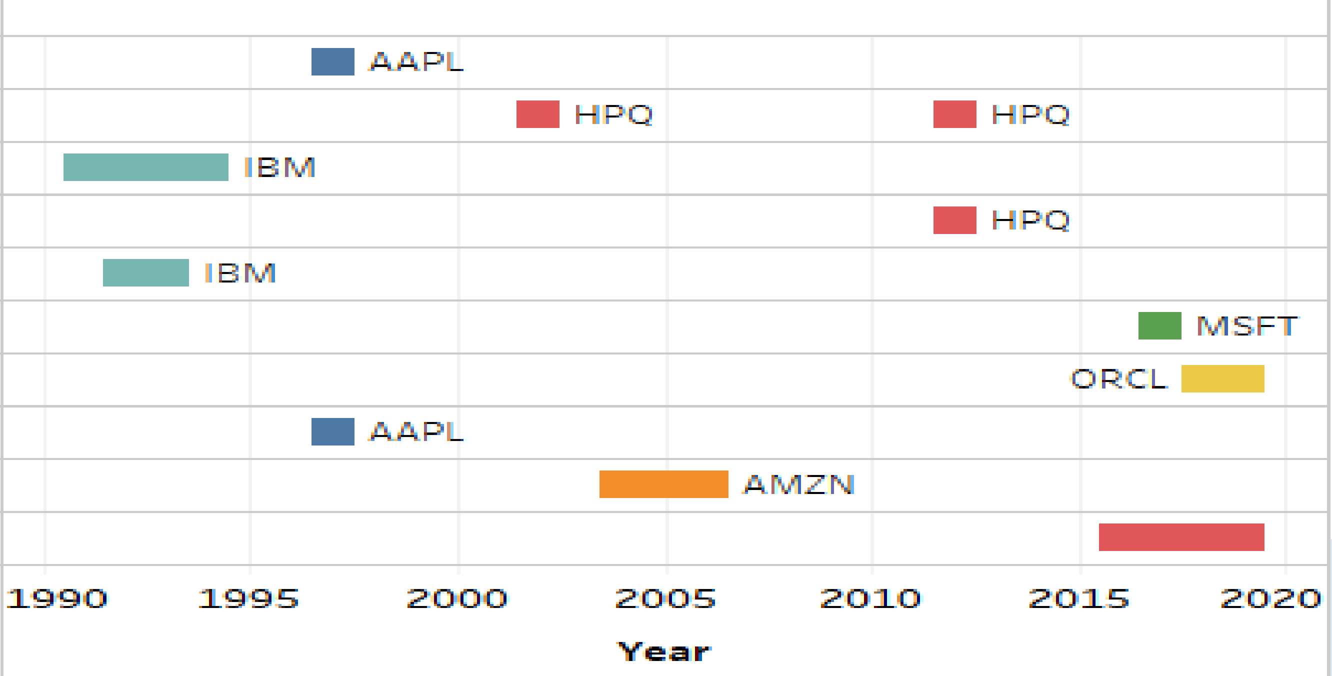
- Our study reveals bankruptcy risk predictions in the Technology Sector from 1990 to 2020, precisely identifying companies at potential risk using Z-Score, Z1-Score, and Z2-Score individually.
- **Z-Score:** HPQ[4], AAPL [5], IBM [7],
- **Z1-Score:** HPQ [4], MSFT [8], IBM [7], ORCL
- **Z2-Score:** HPQ [4], AAPL [5], AMZN

	Company Name	Company Classification
Z-Score	AAPL	Distress Zone
	HPQ	Distress Zone
	IBM	Distress Zone
Z1-Score	HPQ	Distress Zone
	IBM	Distress Zone
	MSFT	Distress Zone
	ORCL	Distress Zone
Z2-Score	AAPL	Distress Zone
	AMZN	Distress Zone
	HPQ	Distress Zone



Factors Influencing Companies' Financial Challenges: Case Studies of HP, Apple, and IBM in Technology Sector

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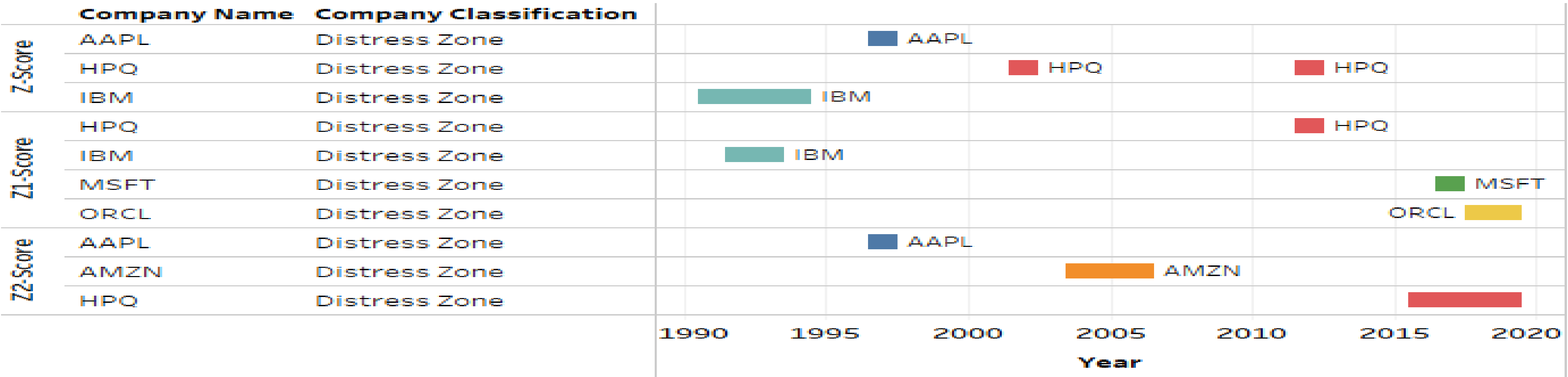
- HP faced turmoil from 2010 to 2021 due to its 2011 acquisition of Autonomy. Accounting irregularities at Autonomy led to over $5 billion in write-downs in 2012, triggering shareholder lawsuits. The fallout continued into 2021, posing ongoing challenges for HP [4].
- Apple faced challenges from 1995 to 2000 with competition, strategic errors, high-end product focus, declining stock, layoffs, and innovation gaps. Steve Jobs' return in 1997 and new consumer-oriented products, like the iMac, sparked the company's revival [5].
- Between 1990 and 1995, IBM faced challenges from changing technology, loss of PC market share, financial losses, and shifting customer dynamics. Strategic shifts, including a focus on cost management and new leadership, played a key role in IBM's recovery [7].



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Result

- Our study reveals that Altman's Z-score is effective for predicting success in technology and pharmacy sectors. However, it falls short in the finance sector. As a solution, our project recommends exploring new tools tailored specifically for the finance sector.

Future Work

- Our project suggests improving the Altman's Z-score for financial sector. This improvement will help make our predictions even smarter in the future.

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Thank you for your attention!

Any Questions / Comments