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İSTANBUL AYDIN UNIVERSITY

INSTITUTE OF SOCIAL SCIENCES

ESTIMATING THE PROBABILITY OF BANKRUPTCY USING Z-SCORE AND DISTANCE TO DEFAULT MODEL: AN APPLICATION ON ISE

M.Sc. THESIS

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Master's in Business Administration

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İSTANBUL AYDIN ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ MÜDÜRLÜĞÜ

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3) Jüri Üyesi : Dr. Öğr. Üyesi Özge EREN	.....

Not: Öğrencinin Tez savunmasında **Başarılı** olması halinde bu form **imzalanacaktır**. Aksi halde geçersizdir.

Every challenging work needs self-efforts as well as the guidance of elders, especially who were very close to our heart. My humble effort I dedicate to my sweet and loving father and Mother.

FOREWARD

First and foremost, I would like to thank God Almighty for giving me the strength, knowledge, ability and opportunity to undertake this research study and to persevere and complete it satisfactorily. Without his blessings, this achievement would not have been possible.

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Last but not the least, I thank my family for their trust in me, for their moral support and dedication. I shall dedicate my success to them.

March 2018 **Iftikhar Iftikhar**

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ABBREVIATIONS

AS **:** Annual sales
D **:** Debt
DD **:** Distance to default
DP **:** Default point
E **:** Firms equity
E **:** Firms equity
IBTI **:** Income before tax and interest
IWT **:** Income without tax
KMV **:** Kealhofer, McQuown and Vasicek
PPD **:** Probability of default
R **:** Return rate
RE **:** Retained earnings
SHE **:** Share-holder equity
T **:** Time
TA **:** Total assets
TD **:** Total debt
TE **:** Total equity
V **:** Volatility
WC **:** Working capital

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İFLAS ETME OLASILIKLARINI Z-SKOR VE FİNANSAL SIKINTIYA OLAN UZAKLIK HESAPLAYARAK TAHMİN ETME: BİST'DE AMPiRiK BiR UYGULAMA

ÖZET

2008'den bu yana dünya ciddi bir ekonomik durgunlukla karşı karşıya kalmıştır. Bu küresel kriz, birçok bireysel işletmeyi ve çok uluslu şirketi iflasa sürükledi ve bu da küresel ölçekte önemli sosyal etkilere sebep oldu. Hükümetleri ve finans kurumları, milyarlarca dolarlık borca dönüştüren ekonomiyi teşvik etme girişimi ile asal oranın neredeyse sıfıra indirilmesi, işsizlik oranının artması ve gelir oranlarının düşmesi gerçeğine rağmen. İşletmeler, gelir eksikliği ve nakit akışı düzensizlikleri nedeniyle zor durumda kaldılar. Bu ekonomik serpintinin gerçeklerini anlamak için sayısız fırsat mevcuttur, bunlardan biri iflas tahminlerini incelemektir. Bireysel ve kurumsal sektör için ekonomik krizlerden daha az etkilenmek için iflasın daha ciddi bir şekilde öngörülmesi gerekir.

Bu araştırmanın amacı, bilanço ve yıllık raporlardan elde edilen bilgi ve verilere dayanarak borsadaki Türk şirketlerinin durumunu analiz etmek için iflas tahmin modellerini incelemektir. Bu tez için Altman'ın mali oranlarına dayalı Z-Skoru ve Merton'un DD modeli seçilmiştir. Bu çalışmada, incelenen şirketler Borsa İstanbul Menkul Kıymetler Borsası'nın işlem gören ve 2007 yılından 2016 yılına kadar Türkiye'ye ait finansal olmayan şirketleri temsil etmektedir. Bu çalışmada iflas şansı yüksek olanlarla sağlıklı şirketleri izole etmiştir.

Bu araştırma aynı zamanda iflas konularına ve küresel ekonomiye olan harmonik etkilerine ve aynı zamanda diğer endüstriler için kolayca adapte edilebileceklere genel bir bakış sunmaktadır. Sonuçta, bu şirketler için Z-skor modelinin iflasın tahmininde DD modelinden daha iyi performans gösterdiği gözlemlenmiştir.

Buna ek olarak, bu araştırma, kredi kuruluşlarına, küçük işletmelere, başarısızlıklarını en aza indirmek ve sağlıklı organizasyonlara ve sağlıksız olanlara yatırım yapmak için mevcut operasyonlarını iyileştirmek için daha iyi bir risk yönetimi sağlamaktadır.

Anahtar Kelimeler: *Altman modeli, Finansal sıkıntıya olan uzaklık, İflas gösterge modelleri, Kredi riski, finansal oranlar*

ESTIMATING THE PROBABILITY OF BANKRUPTCY USING Z-SCORE AND DISTANCE TO DEFAULT MODEL: AN APPLICATION ON ISE

ABSTRACT

Since 2008, the world has faced a severe economic recession. This global crisis promoted many individual businesses and multi-national corporations to file for bankruptcy, which has crucial social implications globally. Despite the fact that with the intrusion of governments and financial institutions to encourage the economy that has put corporations in billions of dollar of debt, reduces the prime rate to almost zero, increases unemployment rate as well as a decrease in the income rates. Trades became hesitant for spending due to the instability of jobs and personal financial problems. Businesses face tear due to lack of revenues and cautions of cash flows impact the psychology of investors. Logically, the convolution of this crisis is the matter of responsiveness. A countless opportunity is available to understand the facts of this economic fallout. In other words, it is more reasonable to study bankruptcy prediction because of its relevance. It has become essential to predict the bankruptcy more seriously to avoid or minimize the economic crisis for the individual and corporate sector.

The objective of this research is to examine the performance of bankruptcy prediction models by data analysis to predict the chances of Turkish companies in the stock market based on information and data available from balance sheets and annual reports. The Altman's financial ratios based Z-Score and Merton's DD model has been selected for this thesis. It is hypothesized that these prediction models are quite precise to implement for understudy corporations and to compare these models. The study represents Turkey based non-financial firms that are listed in the main market segment of Borsa Istanbul Stock Exchange (ISE) between the years 2007 to the year 2016. It includes the observations on 10 stock listed businesses to find the effect of above-mentioned model. This study proved to be an appropriate tool and isolate the healthy corporations with those who have high chances of bankruptcy. This research also provides an overview on the subject of bankruptcies and their harmonic effects on the global economy as well as easily adapted for other industries. The result shows the projection that Z-score model clearly outperform in predicting the bankruptcy than DD model. The results of the hybrid model (Z-score) are more even than the other. Research also find many other financial factors influencing in the whole scenario of bankruptcy.

Additionally, this research provides a better risk management to creditors, small businesses to improve their current operations to minimize failure as well as to invest in healthy organizations and short unhealthy ones.

Keywords: *Altman model, Distance to default model, Bankruptcy prediction, Credit risk, financial ratios*

1. INTRODUCTION

Since mid-2007 and afterwards world is facing crucial financial and economic crisis. Most of the world financial and economic badly impacted the economic growth, bankruptcy rates, and unemployment. In the United States and Europe, the rate of high-yield bond and leveraged loans crossed the threshold limits in 2009, which create extreme financial uncertainty and instability for coming years.

More than 230 firms having liabilities of around $100 million filed for bankruptcy protection with combined liabilities of $ 600 Billion under chapter 11 in the United States. More than 40 of these defaults involved firms having more than $ 1 billion in liabilities, with world brand organizations like Capmark Financial group, Nortel Networks, General Motors corporation individually at least $10 billion in terms of liabilities. Undoubtedly, 2009 was marked the highest bankruptcy year in terms of chapter 11 liabilities.

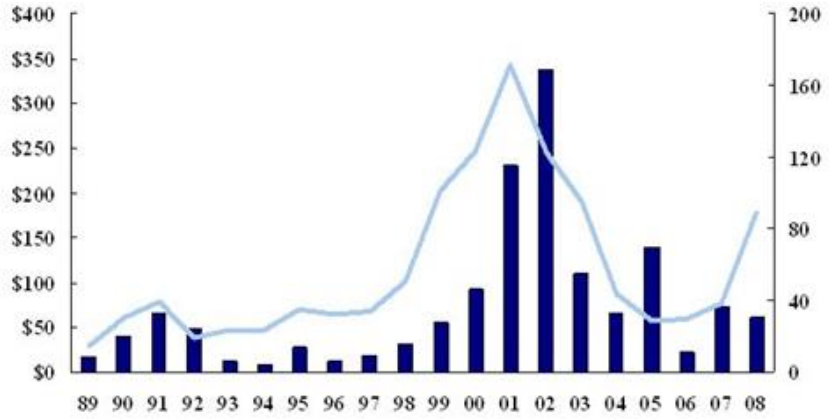

Figure 1.1: Number of filings and Pre-petition Liabilities of Public Companies 1989-2008 (*Minimum $100 million in liabilities*)

Source: NYU Salomon Center Bankruptcy Filings Database

Bankruptcy has become one of the critical issues across the world, influencing the economy of the whole world. It has become crucial to envisage the bankruptcy more utterly to elude the economic catastrophe for individual business and corporate sector. The drive of this research is to study the performance of bankruptcy prediction models, the financial ratios based Z-Score and DD model to give investors an incentive to purchase a bond that is less risky or risk-free. This study will explore the research literature and find some definitions of bankruptcies and its reasons. The research will provide the overview on the subject of bankruptcies and their harmonic effects on the global economy. Then the study will represent the theoretical model, which will be used in research, and will discuss the research design, methodology etc. This study will specifically test the following hypothesis: a. Merton model and Z-Score formula are significantly accurate to imply on Borsa Istanbul Stock Exchange (ISE). b. Null hypothesis. c. Comparing DD model and Z-score model. Last but not least, this research will provide the crux of the whole study, along with findings study will also provide a recommendation, limitations, and suggestion for the new work.

Each year thousands of people and businesses in the world file for bankruptcy because it offers them an opportunity to set up their businesses again in future and get rescued by the law. Whatever the reason is for filing bankruptcy is, bankruptcy is codified in the US under the act of federal law of 1978 (DeSmith, Dodyk, Smith, & Stieg, 2014:18).

Predicting bankruptcy is always crucial for numerous handlers of financial statements. These handlers can be banks, creditors, investors, auditors, regulators, and controllers. Even though bankruptcy models are continuously important, but their usage surges during financial and economic distress. For instance, it is imperative for financial investors to know about the risk of bankruptcy inherent in bond, who is concerned to buy corporate bonds (Lifschutz & Jacobi, 2010:1-2).

This research suggests inspecting how efficiently the Altman Z-score and Merton model can explain corporate bankruptcy in Turkey. Furthermore, the research empirically relates the performance of the Merton model with Altman Z-score model of bankruptcy.

This research suggests inspecting how efficiently the Altman Z-score and Merton model can explain corporate bankruptcy in Turkey. Furthermore, the research empirically relates the

performance of the Merton model with Altman Z-score model of bankruptcy. This research will test the following hypothesis:

H_1: The difference of Merton model and Z-Score is significant.

H_0: The difference Merton model and Z-Score is not significant.

1.1. Statement of the Problem

The focal point of this study is to give the answer of the following questions: What is the impact of Altman Z-score and Merton model on Borsa Istanbul stock listed companies and is there significant difference between these models?

1.2. Purpose of the Study

This study aim at to unveil the capability of the enterprises to withstand against bankruptcy using bankruptcy prediction models and to find how effective the financial strategy of the enterprises is, mainly focusing on these points:

- A brief overview of bankruptcy with general definitions of bankruptcy in the literature and explaining the development in the field with the passage of time. Then elaborating the bankruptcy prediction model mainly focuses on two of them: Altman' Z-score and Merton' model commonly named as DD model.
- After an overview of bankruptcy and prediction models, transitory comparison of Altman's Z-score model with DD model
- Applications of these model on Borsa Istanbul stock listed companies to quantify the difference between these models.

Istanbul Stock Exchange-listed companies are included in the study during the year of 2007-16. This research includes different methodologies, in the start, it uses commonly available bankruptcy prediction approaches, the financial based Z-score model of Altman's and then the Merton's model of DD. Then it will test the relative performance of these models including their forecasting accuracy percentage.

1.3. Significance of Study

The unexpected financial crisis over time leads most of the organization towards bankruptcies and the public losses their millions in financial markets every day. Predicting bankruptcies is one of nutshell topic of modern finance.

This study will prove valuable to investors, shareholders, analysts and especially public sectors who are always interested to know where they should invest their assets so that they find it secure and can increase their asset' value in future. This study will also be useful for further research and considerations on bankruptcies and bankruptcies prediction models.

1.4. Structure of Research

The research of the thesis is organized as follows. Chapter 2 provides the literature review of bankruptcy forecasting models and financial distress situation. The major focus of the review is on Altman's Z-score model and Merton's DD model. Chapter 3 gives an overview of research design and the research methodology, data sample, empirical and mathematical results. Chapter 4 briefs a summary and conclusion of the findings.

1.5. Limitations of Study

As this study is reluctantly relying on the Z-score model and DD model so perhaps, it may be the most important weak point of the thesis. It can also not be denied that this research may have geographical limitations in the sense that the results and finding related to the enterprises listed on ISE might not be directly manageable to other geographic regions. For instance, it may occur that some conditions in the UK (FTSE) are critical for the findings. To elucidate these potential constraints we can test the validity for some of the results on broader stock exchange markets.

2. LITERATURE REVIEW

Literature review, in this chapter, is organized as follows: Initially described the classical definition of bankruptcy. Then review the different concept of bankruptcy from literature and approaches to bankruptcy prediction. Then thoroughly explained Altman's Z-score model of bankruptcy and modifications in the model and Merton's DD model of bankruptcy. In the end, also discussed the advantages and limitations of mentioned models.

The word "Bankruptcy" has been derived from an Italian word 'Banca rotta' a common perception that it was used by a creditor who broke the bench of a trader when he was unable to pay his debt (Depoorter & Cabrillo, 1999:1-3). Although bankruptcy has always been got attention historically after the 1980's it has become more visible and controversial (Jackson, 1985:1-2). The research on financial distress and bankruptcy conducted by Senbet and Seward in 1995 reveals that the dispute on these areas is still unsolved and numerous chances still exist for further research. The financial crisis of 2008-9 exposes this area into public domains when many financial institutions have ruined and rescued by the government (Senbet & Wang, 2012:2)

Traditionally, Bankruptcy law is researched by lawyers not economists but in the recent decades, many research publications have been made on economies of bankruptcy. With the minimum social cost, economists analyze the bankruptcy as the legal instrument to achieve some possible outcomes. Legal instruments theory explains the fairness and equity aspects of bankruptcy (Depoorter & Cabrillo, 1999:1-3).

Research of bankruptcy in view of the empirical evidence means to recognize financial qualities of those organizations that are probably going to petition for bankruptcy and recognize them from those that are most certainly not. The objective of predicting such bankruptcy forecast models is to anticipate which organizations will potentially petition for bankruptcy a couple of years earlier to the genuine recording. The models that foresee

bankruptcy have been developed from the financial ratios usually used in financial statements issued by the organization time to time (Pestalozzi & Timisoara, 2014:17).The literature on bankruptcy models has its roots back to 1930's when first-time financial ratio was used to predict future bankruptcies. That research was conducted on 24 financial based ratios of 29 or more firms to find out the identical attributes of deteriorating firms. These 29 firms paved the path to developing average ratios. These average ratios were compared to the ratio of each firm individually to show that failing firms displays some similar trends. This research results with 8 ratios that were measured good approach of the "growing weakness" of a firm. These ratios were as follows: Net worth of organization to Fixed Assets, fixed assets to total assets, the current ratio, Net worth to total assets, sales total assets, Cash to total assets, Surplus and reserves to total assets and working capital total assets. Bureau of Business Research (BBR) testified that working capital to Asset ratio apparently is more valuable indicator than the current ratio, Regardless of the fact both were found good indicators of weakness.

In 1932, Fitz Patrick studies 13 ratios of effective and unsuccessful organizations. His research results that, in major cases, effective firms shows promising ratios while unsuccessful firms have unfavorable ratios when compared with average ratios or some ratio trends. He stated Net worth to debt ratio and Net profit to net worth as two significant ratios. For organizations with long-term liabilities, he also reported that current ratio and the quick ratio should be placed on less importance zone.

Smith and Winakor (1935) investigated financial ratios of 183 failed firms from an assortment of enterprises in a subsequent review to the BBR's (Bureau of Business Research) 1930 publication. Smith and Winakor found that Working Capital to Total Assets was a much better indicator of financial issues than both Cash to Total Assets and the Current Ratio. They additionally discovered that the Current Assets to Total Assets proportion dropped as the firm moved toward liquidation or bankruptcy. In 1942, Merwin presented three ratios: net working capital to total assets, current ratio and net worth to the total debt. He found these ratios as a substantial sign of business failure. Moreover, he mentioned that as comparing successful firm with futile one, the failed firms shows some weaknesses 4 to 5 years prior to failure (Gissel, Giacomino, & Akers, 2007:3-5).

In Chudson's article entitled as "The pattern of corporate financial structure" direct proves can be found that's the companies can get more long-term debts who have high properties of fixed assets. Additionally, there is no direct relationship witnessed between communal size and debt ratio (Chudson, 1945:15-16). In the article, there is no model and discussion on bankruptcy but the study has been proved quite important for preparing bankruptcy prediction models.

Jackedoff (1962), presented differences between the ratios of lucrative firms with unsuccessful ones. He found that two ratios: current ratio to total assets and working capital to total assets are higher for profitable organizations than unsuccessful organizations. As above studies show than working capital and current ratio are an important one for predicting liquidations but working capital to total asset has proved more useful than others and all these studies provide groundwork for successor studies.

Beaver (1966), used 30 financial ratios and almost 79 companies based on failure and non-failure. The result was relatively amazing. The best factor was working capital to debt ratio, which shows 90 percent correct result. The second ratio was net income to total assets of the organization and the results were 88 percent correct. Most of the researchers focus on multivariate ratios instead of single ratios (Ko, Blocher, & Lin, 1999:73). Up-to-the mid of 1960's single factor ratio was used with almost no progress in the field. First time in 1968's Altman published the multiple ratios study to predict the bankruptcy till used in today's (Gissel, Giacomino, & Akers, 2007:7)

Table 2. 1: Bankruptcy Forecasting Model

Category	Model
Statistical Models	Univariate Multiple discriminant analysis Linear probability Logit model Probit model Cumulative sums
Artificial Intelligence & Expert System model	Recursively decision Trees Neural networks Genetic algorithm
Theoretical model	Balance sheet decomposition Gambler's Ruin theory Cash management theory Credit risk Theories

Source: Altman (2006) & Aziz M. Humaiyon (2006) compilation

2.1. Altman's Z-score Model

In Altman's analysis, the underlying example included sixty-six companies with thirty-three organizations in each group from 1946-65. The Z-score utilizes numerous inputs from corporate financial statements, balance sheets, and income statements to measure the financial prestige of an organization. The sources of info that Altman chose were from those budgetary reports that are one announcing period prior than bankruptcies. The information sources that Altman utilized were twenty-two diverse financial proportions. Altman considered that these financial ratios were wiped out measure impacts. Those proportions were partitioned into five classes: liquidity, benefit or profit, leverage, solvency, and activity. The explanation behind partitioning the information factors in case five classes is spontaneous. These are standard financial classes (Chi, 2012:7-8).

Of the various financial ratios analyzed, five (X_1 to X_5) that really contributed to predicting bankruptcy. Every ratio is allocated with a quantity (weight) in the measure of its comparative contribution. The record - the Z-score - contains the duplication of each of the proportions by the suitable coefficient and expansion of the outcomes. The model, which has

turned out to be standard, indicated high prescient power in regards to which organizations could face financial distress. The following list shows the coefficient and ratios:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.99X_5$$

Where, X_1 is working capital to total assets. X_2 is retained earnings to total assets. X_3 is income before tax and interest to total assets. X_4 is total equity of the organization total debt and X_5 is annual sales to total assets.

If the final value of Z is bigger than 2.99 it means the organization is in the safe zone and there are no chances of bankruptcy. If the value of Z is in between 1.81 to 2.99 it means there are 50% chances of bankruptcy. If the value of Z-score is less than 1.81 it means the organization is going to be bankrupt soon (Altman E. , 1968).

In the course of recent years, many tests have been directed that brought about Altman's bankruptcy prediction model being around 80-90% exact in anticipating the corporate default two years earlier to the documenting under Chapter 11 bankruptcy protection code. In spite of the way that Altman's Z-score is anything but difficult to apply and incorporates different financial ratios, it is additionally criticized for not integrating all important discerning financial ratios (Pestalozzi & Timisoara, 2014:17-19).

As the above Z-score model is limited to stock listed enterprises, so after the publication of original Z-score model academics and researchers created a discussion that how this model could be modified to non-stock companies? So in 1977 Altman modified the previous model for non-stock companies. The modification was implemented just in the fourth ratio where the market value of owner's equity was replaced with a book value of owner's equity. Thus the new model is as following:

$$Z = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.420X_4 + 0.998X_5$$

Classification of bankrupt or safe is also been changed, for this situation if the Z score value is above 2.9, the enterprise is in the safe zone and if below 1.23 it is going to be bankrupt in coming years. The in-between area is a grey zone, having 50% chances of bankruptcy.

The next modification of Z-score is for non-manufacturing firms, where the ratio of annual sales to total assets value is emitted. The new model looks as follow:

$$Z = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4$$

In this case, if the Z-score value is more than 2.6, it indicates that organization has no chances of bankruptcy if, below 1.1, it shows a distress situation for coming years. Between 1.1 and 2.6 is a grey zone where prediction cannot be clearly interpreted (Saeed, 2014:175).

Odipo and Sitati in 2008 applied the Z-score model on Nigerian banking sector and found the reasonable result in their research. The most imperative factor of using the model is that it is quite simple and easy to use, moreover it is a very low cost in its applications (Raymond, Nzewi, & Okoye, 2014:158).

Kpodoh (2009), verified the Z-score model for the communication sector in Ghana. His verdicts proved and verified the strength of the model to predict the business and financial distress. Charles and Goodluck (2009) applied the model using the multivariate technique to find the power of the model and to differentiate between healthy and distress enterprises. The results were quite impressive for the Nigerian market sector.

Hayes, Hodge, and Hughes (2010), applied the model of retailing firms. They hypothesized that the credibility of the model is getting lower as the rapid changing in a business environment. They applied the model over eight pairs for the year 2007-2008 of bankrupt firms versus non-bankrupt to predict the firm's failure and ultimately the accuracy of the model was above 90 percent.

Johansson & Kumbaro (2011) conducted a research with a sample data for 45 enterprises, which filed for bankruptcy in years 2007 to 2010. He used the methodology of multiple discriminant analysis by applying Z-score and found that model has an ability to predict distress situation before the actual bankruptcy.

Mohammad & Soon (2012) conducted a research in Jordan using 71 healthy and 71 non-healthy firms for a period from 1989 to 2009 and extract that model can predict bankruptcy with more accuracy, but it is difficult for the service industry.

2.2. Limitations of the Z-score Model

From the past few decades, after the Z-score model was published, it is considered one of the most reliable tools for prediction bankruptcies and financial distress in a comprehensive diversity of circumstances and markets. Nevertheless, it is also noted that model is not valid for every situation and circumstances and many objections have already been taken over the years. Model or financial firms is quite different from manufacturing firms. It can interpret that Z-score can only be used for bankruptcy predictions if the firm being investigated is analogous to the firms in Altman's samples. Moreover, the model is not suitable for small firms usually having their assets value less than $1 million, as their financial ratios are big different from larger firms, also not suitable for corporations with little or no earnings.

Altman has examined the reliability of model by implementing it on a number of firms regardless of their size, asset values or debt size, the results were quite surprising. He found that it is difficult to handle large firms with the model. A common argument is that financial ratios having a varying nature, having the effect of devaluing statistics by size, so the size effect has been removed. It is then shown in the modified version of the model that it is applicable on firms having their total assets value of more than $25 million and for non-manufacturing firms, this number is above $100 million, that makes it more comparable for public listed companies.

In addition, the model is not compatible with false or local accounting practices (not following IFRS standards). Altman stated that accumulated profits (retained earnings) to total asset ratio show a valuable negativity in the mean value of non-distress firms in the past decades. The model should not be applied to financial organizations due to the fact that firms use off-balance sheet items but it is a known fact that financial firms' shows large impact due to crisis and distress situation, so the financial industry should not be the one, to examine.

Despite the all the fact and figures mentioned above, the Z-score model is still considered most popular and reliable tool to measure financial stability of firms in future. This model widely explains the financial health of organization and possibility of bankruptcy. To strengthen the resulting model can also be complemented with other analytical tools.

2.3. Merton's Distance to Default Model

Rebort Merton proposed a model in 1974 by extending the Black & Scholes model (1973) of option pricing to conceive the credit risk of a firm or organization by illustrating the firm's equity as a call option on its assets and the creditors can be viewed as on short position on the firm's assets. This approach of Merton's raised as "structural approach" because for exhibiting credit risk the whole model trusts upon the capital structure of the organization. The formula is as follows:

$$E = AN(d_1) - N(d_2)(MTL)e^{-rt}$$

where,

$$d_1 = \frac{\left[\ln\left(\frac{S}{k}\right) + \left(r + \frac{\sigma^2}{2}\right)t\right]}{s\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

E is the market equity, A shows the firm assets. t represents time until option exercise (maturity), MTL is the market values of liability, r denotes risk-free interest rate, N denotes cumulative standard normal distribution, e is an exponential term, ln is natural logarithm and σ represent standard deviation of the market.

In the derivative market an option is a most common one. It is an agreement, or an endowment of a contract, which gives option holder (1st party) the right, but not the responsibility to accomplish a stated deal with another party (the option writer) according to specified terms and conditions. It can be implanted into many forms of agreements. For instance, a firm might issue a bond with an option that will allow the company to buy the bonds back in ten years at an agreed price. Most exchange-traded options have shares as their underlying asset but option trade on exchanges (OTC) traded options have a huge variety of underlying assets (bonds, currencies, commodities, swaps, or baskets of assets).

European and American are two kind of options. European Options can be exercised only on the expiry date. European options are valued most of the time using the Black & Scholes option pricing formula. It is a simple equation mentioned below) with a general solution that has become a benchmark in the financial market. American type is an option that can be exercised at any time up to and including the expiry date. There are no general formulas for valuing American options, but a choice of models to approximate the price is available for example Whaley, binomial options model, Monte Carlo and others, although there is no consensus on which is preferable. American options are rarely exercised early. This is because all options have a non-negative time value and are usually worth more unexercised. Owners who wish to realize the full value of their options will mostly prefer to sell them rather than exercise them early and sacrifice some of the time value (Cosma, Galluccio, Pederzoli, & Scaillet, 2016:3-4)

There are two main types of options: calls and puts: Call options deliver the holder the right but not the responsibility to purchase an underlying asset at a certain price the strike price k, for a specified period of time t. If the stock flops to meet the strike price before the termination date, the option expires and becomes insignificant. Financiers buy calls when they consider the share price of the underlying security will rise or sell a call if they think it will fall. Selling an option is also referred to as "writing" an option.

$$C = SN(d_1) - N(d_2)Ke^{-rt}$$

C is called premium of call option, S shows current stock price (price of underlying asset at time 0), t represents time until option exercise (maturity), K is the option strike price (exercise price), r denotes risk free interest rate, N denotes cumulative standard normal distribution, e is an exponential term.

Put options give the holder the right to sell an underlying asset at a specified price (the strike price). The seller or writer of the put option is obligated to buy the stock at the strike price. Put options can be exercised at any time before the option expires. Investors buy puts if they think the share price of the underlying stock will fall, or sell one if they think it will rise. Put buyers - those who hold a "long" - put are either speculative buyers looking for leverage or "insurance" buyers who want to protect their long positions in a stock for the period of time

covered by the option. Put sellers hold a "short" expecting the market to move upward or at least stay stable. A worst-case situation for a put seller is a downward market turn. The maximum profit is limited to the put premium received and is achieved when the price of the underlying asset is at or above the option's strike price at expiration. The maximum loss is unlimited for an uncovered put writer. The formula for Black and Scholes option pricing model is as follows:

$$P = Ke^{-rt}N(d_2) - SN(-d_1)$$

P is called premium of put option, S shows current stock price (price of underlying asset at time 0), t represents time until option exercise (maturity), k is the option strike price (exercise price), r denotes risk free interest rate, N denotes cumulative standard normal distribution, e is an exponential term.

Most of the trading on option is on stock exchange markets. In the United States main markets are the Chicago board option exchanges, the International Securities Exchange, Boston Stock Exchange and the American Stock Exchange. Index options are financial derivatives which are based on stock indices such as the S&P 500 or the Dow Jones Industrial Average. Index options give the investor the right to buy or sell the underlying stock index for a defined time period. Since index options are based on a large basket of stocks in the index, investors can easily diversify their portfolios by trading them. Index options are cash settled when exercised, as opposed to options on single stocks where the underlying stock is transferred when exercised (Hull, 1997:179-190)

Black and Cox (1976), Geske (1977), Longstaff and Schwartz (1995), Leland and Toft (1996) and Collin-Dufresne and Goldstein (2001) extended and modify the model in the traditional way. Ferry (2013) quoted in his paper that this model has become so popular in a current business environment that it is driving prices in the credit market. The main reason for its popularity is that this model uses significant credit market factors as current Asset value and volatility of the firm, debt and debt maturity etc. In the late 1980's, Moody's KMV was the pioneer one who commercializes the bankruptcy prediction model to whom ground work provided by Black & Scholes and Merton model. The DD model is a mathematical deduction, which is built upon the assumptions that an organization can default

over its financial commitments if its assets have less worth than its liabilities (Miller, 2009:2).

The structural model could not get critical fame due to the fact of failing to reconstruct the level of credit spreads that is observed in common practices. However, their performance can be increased as suggested by Hull, Nelken & White (2003), by calculating the spreads which use the dimensions of a traditional approach like outstanding debts, volatility, and instantaneous equity. Gemmill (2002) proved that model performed well in the case of a zero-coupon bond that is used for funding.

Campbell & Taskler (2003) determine that equity volatility helps to explain variation in bond prices. They fit a linear model and explain the important instructive strength of historical volatility if a lot of explanatory variables.

Altman, Brady, Resti & Sironi (2003), examine the association between the probability of default and rate of recovery on the assets and empirically explain this significant relationship. They found recovery rate as a key variable in their research. All the above mentioned finding support the fact the equity market is a key point in default model which cannot be emitted or ignored if the strong alternative is not available. All this research strengthen the structural framework of Merton model of default. The structural model basically uses to find the relative probability of default and credit risk swaps and very fewer researches can be found which supports the approach to find joint probabilities of default for many enterprises. But the issue is quite critical for credit analysis, valuation of credit derivatives and for risk management. Now the credit derivatives are considered the most growing financial tool in the derivative markets (Cathcart & El-Jahel, 2004:1-3).

Lara & Lina (2004) explain the integrated context for the calculation of single and joint probabilities, Moreover, the results are in closed form and can be used to compare with the more complex sweeping statement. They extend that credit quality changes with time and default probabilities have a direct impact on credit analysis and risk management.

The study conducted by Hillegeist (2004) inspects the occurrence of commercial bankruptcy in the United States market, also finds that's the probability of default (POD) conducted by Black & Scholes is more significant than others like Altman (1968) and Ohlson (1980). Not

like the previous study of bankruptcies, which concentrates on determining exactness test to look at model execution, the study utilizes relative data content tests to differentiate about the out-of-sample presentation of every bankruptcy models. By considering a specimen of 78,100 firm-year perceptions and 756 initial liquidations during the period of 1980-2000, log probability proportion tests demonstrate that the probability of default assessed from the structural model contains essentially more data in measuring bankruptcies than any of the bookkeeping based bankruptcy prediction models (Tanthanongsakkun, Pitt, & Treepongkaruna, 2007:5-6)

2.4. Limitations of Merton Model

The leading drawback of this structural model is its implementation. As the rapid changing tradability assumption for business is unrealistic. The parameters used in the calculation are difficult to calculate. One of them is equity volatility, which can be calculated day by day monitoring of the equity data on the stock market. The modern model finds many limitations in the previous model but these itself very complex and computationally incentive.

As the mentioned models, truly rely on external specifications for credit defaults and debt recoveries and do not consider the internal cause of default and distress. This feature can be considered as strength as well as a weakness because these models suffer from a deficiency of economic literature about default probability, they provide more degree of freedom (DOF) in functional selection. This kind of freedom added value to logical controllability and calibration. Relying on the pervious literature it may results good in sample fitting possessions but imperfect in the prediction of bankruptcy. Generally, structural models are quite beneficial for estimating credit risk analysis, risky portfolios and structural modelling, on the other hand, it finds difficulty in calibration limits.

3. RESEARCH METHODOLOGY AND APPLICATIONS

Bankruptcies increased in Turkey to 1112 enterprises in June from 861 companies in May 2017. Bankruptcies in Turkey be an average of 684.24 Enterprises from 1995 up to 2017, reaching an all-time high of 3113 Enterprises in January of 2013 and a record low of 11 Companies in October of 1995. Figure 3.1 illustrates bankruptcy situation in Turkey between years 2007 and 2016.

Figure 3. 1: Turkey Bankruptcy 2007-2016

Source: Tradingeconomic.com

3.1. Selection Criteria and Data Selection

The sample includes Turkey based financial, manufacturing, non-manufacturing firms listed in main stream market of ISE. The primary data source is the Borsa Istanbul Stock exchange with a total number of 561 firms. After studying this research is limited to those firms whose data is available.

For bankruptcy prediction, it raises the need for necessary data to apply Z-score and DD model for firms listed on ISE. For that sample is extracted from manufacturing or non-

manufacturing firms and the models are calculated. The data sample collected for the study is consists of a total 10 public listed organizations, spanning the years 2007 to 2016. This chapter will introduce the data collection processing and final samples. A summary of the data sample is available in the appendix section.

3.2. The Sample Collection Process

This study tested the fiscal data for the years 2006 to 2016, which is a span of 10 years to better understand the circumstances, for those enterprises that have been listed on the ISE for the whole period. As some organizations have been bankrupted so research also selected the data only for the years when these enterprises are listed on ISE. In this regard, study reclaimed market data (financial statements, income statements, cash inflows & outflows) published by ISE officially, most prominently the list changes that gives an overview of all listing, delisting, changes of the listing or name changing. This was quite significant because it gives the research, an overview of these firms for the year 2016, and the delisted firms during this period.

The study used only the annual data for the research due to 2 main reasons, 1st annual data is fulfilling the demand of the thesis research. 2nd quarterly data sometimes do not show the whole impact due to many financial adjustments within the company. Most of the time audited data is included in the study.

To calculate the Z-score and DD, accounting data including balance sheet, income statements are the most important component. This study only collected the concerned data from the financial statements to avoid mishaps and complications and for better understanding the scenarios.

However, this research finds some difficulty in collecting data, some of the data was missing on ISE website but was able to find the data from some other reliable sources. As much data was in the Turkish language it was sometimes difficult to translate but the study is managed with that. The enterprises included in the research is shown in Table 3.1.

Table 3. 1: List of Borsa Istanbul listed Companies

Company Name	Abbreviation
Coca-Cola İçecek Anonim Şirketi	C_1
Dogan Sirketler Grubu Holding AS	C_2
Pinar Sut Mamulleri Sanayii A.S	C_3
Migros Türk Ticaret Anonim Şirketi	C_4
Anadolu EFES Biracilik ve Malt Sanayii Anonim Şirketi	C_5
Yazicilar Holding Anonim Şirketi	C_6
Otokar Otomotiv ve Savunma Sanayi AS	C_7
Petkim Petrokimya Holding A.S	C_8
Arçelik A.Ş	C_9
Akın Tekstil A.Ş	C_{10}

3.3. Accounting-Based Model

Z-score is the formative accounting based model. It was first introduced by Altman (1968) and is used widely as a benchmark in the literature of bankruptcy prediction. By using MDA (multiple discriminant analysis), he chooses the linear combinations from different financial ratios that differentiate between bankrupt and non-bankrupt firms 2 years prior to the bankruptcy.

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.99X_5$$

3.3.1. Parameters for Z-score model

The parameters in the Z-score model included working capital, total asset, retained earnings, income before tax and interest, total equity, total debt ratio and annual sales. The explanation of these parameters has been given below.

3.3.1.1. Working capital to total assets

Working capital to asset ratio is a liquidity ratio, which states the current assets of a firm as a percentage of its total assets. Working capital here is the difference between current assets and liabilities. Current assets maybe the cash and cash equivalents or simply say liquid cash which a firm carry within 1 year including stocks, cash etc. while current liabilities may include account and notes payables or accrued liabilities. A high working capital to total asset ratio means that firm is paying the suppliers on time and firms are generating revenue quicker from raw material. On the other hand, low working capital to asset ratio indicates cash flow problems for the firm. The firm is unable to pay its suppliers, which may destroy its credibility in the market.

$$X_1 = \frac{Working\ Capital\ (WC)}{Total\ Asset\ (TA)}$$

3.3.1.2. Retained earnings to total assets

If a business is generating profit that profit can be paid as dividends to an investor or it can be kept in the business to generate more profit in coming years. So retained earnings are the accumulated profit and losses backed by the business during its commenced trading. The retained earnings to total assets ratio are used to estimate the fraction of total assets backed by the retained earnings of a corporate. The ratio is a gauge of the level to which the business is obtaining its profits and utilizing them to back assets rather of paying out dividends and using loans.

$$X_2 = \frac{Retained\ Earnings(RE)}{Total\ Assets\ (TA)}$$

3.3.1.3. Income before tax and interest on total assets

It is considered one of the most significant factors in Altman's Z-score model. Income before tax and interest to total asset represents the firm's profitability and its assets. It measures the exact productivity of the firm. Data can be obtained from the balance sheet and income statement of annual financial reports.

$$X_3 = \frac{Income\ Before\ Tax\ \&\ Interest(IBTI)}{Total\ Assets\ (TA)}$$

3.3.1.4. Total equity to total debt ratio

The shareholders equity to debt ratio estimates that how much power the organization has to meet its financial obligations in terms of short term and long term liabilities. A higher value of equity to debt ratio means a positive sign for the firm as it indicates that firm has a higher strength to pay its debts.

$$X_4 = \frac{Total\ Equity\ (TE)}{Total\ Debt\ (TD)}$$

3.3.1.5. Annual sales to total assets

The annual sales to total assets ratio estimate the strength of a corporate to produce sales on as small a base of assets as possible. It shows how much effect a firm uses its assets to generate revenue. When the sales to total asset ratio are high, it explains that firm has the power to twist the most conceivable use of a small venture in assets. This can also be easily collected from the balance sheet or income statement.

$$X_5 = \frac{Annual\ Sales\ (AS)}{Total\ Assets\ (TA)}$$

3.4. Market-Based Model

DD prediction model is a market-based model. Conservative market-based model follows the derivative pricing model of Merton and the option pricing of Black and Scholes and derive the DD model, which is applied to accumulative density function. There are two assumptions used in option pricing model: First one is the total firm value which typically follows a Brownian motion and total debt or loss is a discounted bond with maturity T. Option pricing model define the equity of the firm.

$$\mathrm{E} = AN(d_1) - e^{rt}\ MTLN\ (d_2)$$

where E is the value of firm's equity. A is asset value. N is the standard normal distribution, e is the exponential function; MTL is the market value of total liabilities. r is the interest rate and t is maturity time.

3.4.1. Parameters for DD model

The parameters in the Merton' model included: firms' equity, volatility, debt, default point, maturity and rate of return. The explanation of these parameters has been given below.

3.4.1.1. Firms equity

Equity (denoted by E) is basically the amount invested by an enterprise in a business or market, and any accumulated profit. Here equity means the annual market value of equity. Since this study chooses the data after 2007, it does not contain any calculation. Data is directly imported from the financial statement taken from public disclosure platform.

3.4.1.2. Volatility

Volatility (denoted by V) means the fluctuations in the market due to some event. It is calculated from historical equity return data. As the stock price follows the Brownian motion under some assumptions, thus volatility is calculated by the help of following formula.

$$\boldsymbol{\sigma_E} = \frac{\frac{1}{t-1}\,\boldsymbol{\Sigma(u_i - u)^2}}{\sqrt{\boldsymbol{\frac{1}{n}}}}$$

$$u_i = \ln\frac{s_i}{s_i - 1}$$

where t is the time period, s is the stock price and u the log return for time t.

3.4.1.3. Total debt

The total debt (denoted by D) is the sum of short-term and long-term liabilities and can be calculated from the annual report of the firm.

3.4.1.4. The default Point

In the case of Merton model default point (DP) is the sum of short-term liabilities and k times long-term liabilities. Here k is the strike price, which is generally taken as 0.5. However, this default point is based on Turkish companies.

3.4.1.5. Maturity

The maturity (denoted by T) period is taken 1 year in the calculations.

3.4.1.6. Rate of return

The return rate (denoted by r) determines that how much effectively an organization uses the capital investment from shareholders to generate profit. High return rate means more revenue. An organization can compare their return rate with the common stock rate of the same business of its competitors to check the financial health of their firm. Here risk-free return rate data will be directly extracted from ISE.

3.5. Research Methodology

The preceding chapter describes the parameters thoroughly, used to calculate the Altman's model and DD model. In this chapter, first of all, volatility of the market is calculated from the past data during the period on which this study is conducted. Despite taking all the data set for ten companies, here only the two of them were discussed. Remaining are mentioned in Appendix A and B. The outcome of the study will be observed according to the original model developed by Altman in 1968 and according to the DD model. Analysis of the hypothesis will be done by calculating the both models. Analysis of Hypotheses will be done by ranking Z for both acute values: The first category Z-scores greater than 2.99, second category - Z-scores below 1.80. Altman (1968) initiate that this value differentiates best between bankrupt and non-bankrupt firms. Firms in the first group will be classified as stable, while firms in the second category will be classified as being at risk for bankruptcy. Then, the percentage of companies correctly classified and the percentage of companies incorrectly classified will be calculated. The percentage of correctly classified companies will reflect the predictive accuracy of the Altman Model. Similarly, percentage of PPD will

describe the accuracy of DD model. PPD near to 100% means firm is near to bankrupt while on the other hand if PPD is near to 0% means firm is in the stable zone.

3.6. Volatility of Market

The method adopted here to calculate market volatility is simple moving average volatility also known as historical volatility. For that purpose, historical series of closing prices is needed which is recorded from the market on daily basis. Here in the table below is the data are taken from the google for 15 days. Typically, calculation of these values is done on yearly basis. Here the 1st column is showing the dates in which market was open. The 2nd column is showing the closing prices. The 3rd column is showing the daily return or daily log return. The daily log return is the natural log of today closing price divided by the previous day closing price. For instance, if the today closing price of the market is $23 and the previous date closing price was $22.9. The daily log return will be LN (23/22.9). After that variance is calculated from this series of daily log return. The formula for the variance is mentioned below in the equation.

$$\sigma_n^2 = \frac{1}{m-1}\sum_{i=1}^{m}(u_{n-i} - u)^2$$

Here, σ is representing the sample variance. M is number of days which is 15 days for the current example. u_{i-1} is showing the mean of daily log return. Practically the below mentioned formula can also be used for calculation. In this equation m is used instead of m-1 to calculate the population variance. U is representing the daily log return value.

$$\sigma_n^2 = \frac{1}{m}\sum_{i=1}^{m}u_{n-i}^2$$

After calculating the daily variance. The square of this variance is calculated which is known as the daily volatility of the market. In the last annual volatility can be calculated.

Table 3. 2: Closing Price of Stock Market for Company A

Date	Closing Prices	Daily Log Return
2/1/2018	1167.7	0.048966
2/2/2018	1111.9	0.051771
2/5/2018	1055.8	-0.02322
2/6/2018	1080.6	0.03008
2/7/2018	1048.58	0.045918
2/8/2018	1001.52	-0.03556

The standard deviation or market volatility can be calculated from the table by the formula mentioned above, and annualizing that value to calculate the annual volatility.

The selected data in this chapter is for organization C_3 and C_4. We are discussing the result of both models, Z-score, and probability of default shown in Table 3.3 the data of 10 years from 2007 to 2016 is selected and ratios are mentioned. X_1 is the ratio of working capital to total assets. X_2 has retained earnings to total assets, X_3 is income before tax and interest on total assets, X_4 is total equity to total debt and X_5 is annual sales to total assets. These ratios have been calculated by the data obtained from the balance sheets and income statement. The last column in the table represents the value of Z- a score which gives an overview of the prediction of organization's bankruptcy. As discussed in the previous chapter if the value of Z-score is above the 2.99 then the organization is in the safe zone and there are no chances of bankruptcy. If the values lie between 1.8 and 2.99 then organization lies in the gray area there maybe the chances of bankruptcy. While if the organization has a Z-value below 1.8 then it will be bankrupt in the coming years. It can be seen in the last column that most of the values lies in grey and safe zone which means that there are no chances or very little chance of bankruptcy.

Table 3. 3: Z-score Values of Organization C_3

Year	X_1	X_2	X_3	X_4	X_5	Z-score
2016	0.0645	0.2157	0.0682	1.7438	1.1437	2.7831
2015	0.0426	0.2113	0.0765	1.9795	1.1442	2.9198
2014	0.0665	0.2214	0.0650	1.8901	0.9248	2.6540
2013	0.1159	0.2197	0.0698	3.3577	0.8785	3.5612
2012	0.1413	0.2233	0.1002	2.4141	1.1788	3.4284
2011	0.1747	0.2146	0.1332	2.3523	1.0408	3.3914
2010	0.1728	0.2369	0.1341	2.6038	1.0835	3.6166
2009	0.2036	0.2553	0.1486	2.7198	1.0037	3.7175
2008	0.1272	0.3003	0.0200	2.1688	0.2883	2.2258
2007	0.1069	0.2122	0.0377	2.3851	0.2638	2.2422

In Figure 3.2 the graph gives a glimpse of the scenario happened during 10 years. The x-axis of the graph is representing the number of years starting from 2007 and end on 2016. While the y-axis is showing the Z-score values. The graph clearly figures out that in the first 2 years 2006-7 the organization falls in the gray zone but from the years 2008 to onwards the organization is continuously in the save zone while in the last 3 years organization again falls in the mixed zone but not in the distress zone. The average line is also showed in the figure which shows that organization is lying in the safe region. So generally we can say that there are no chances of bankruptcy for the organization.

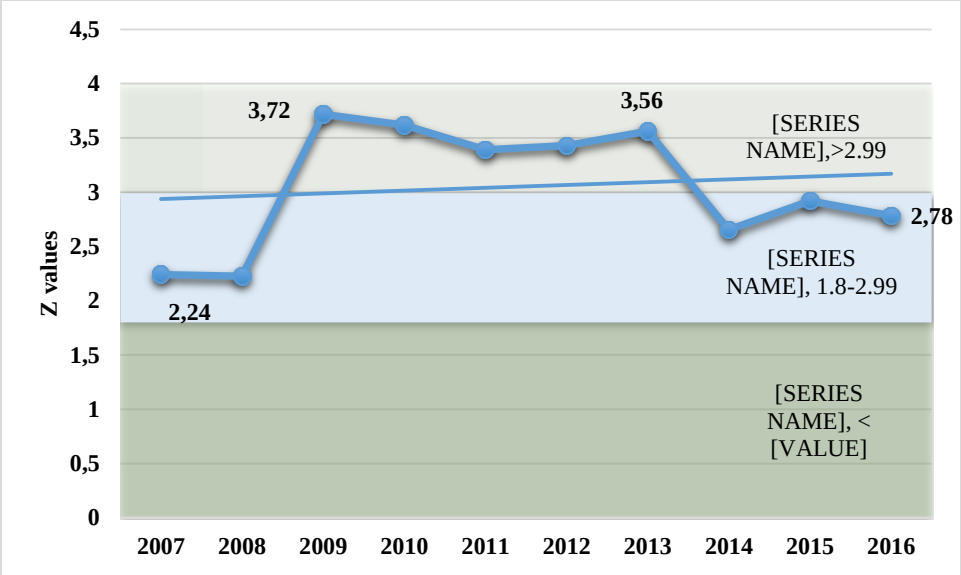

Figure 3. 2: Z-score Values of Organization C_3

Table 3.4 shows the data for the probability of default model for company C_3. This table is showing the natural log return of firm assets to firm equity. The 2nd column is showing the standard deviation or volatility of the market while next column representing the default point of organization and the last column is showing the probability or chances of the organization to fail or bankrupt. Detailed information is mentioned in Appendix A & B.

Table 3. 4: Probability of Default of Organization C_3

Year	V	(u-sigma2/2)t	d_2	PPD
2016	22.38%	0.668	8.075	0.000
2015	26.79%	0.740	7.210	0.000
2014	27.35%	0.760	7.070	0.000
2013	27.78%	0.699	7.346	0.000
2012	22.75%	0.922	10.017	0.000
2011	27.93%	1.226	9.248	0.000
2010	30.34%	1.174	8.671	0.000
2009	40.00%	1.287	6.986	0.000
2008	54.34%	0.294	3.090	0.001
2007	39.03%	0.369	4.737	0.000

Figure 3.3 is the graphical representation of Table 3.4. The x-axis is representing the number of years and the y-axis is for the PPD. As seen in the graph that the organization has zero chances of default from starting year to the end. It shows that probability of default model is

confirming the results mentioned in the Z-score. It is showing that both the models are elaborating the same results and supporting each other.

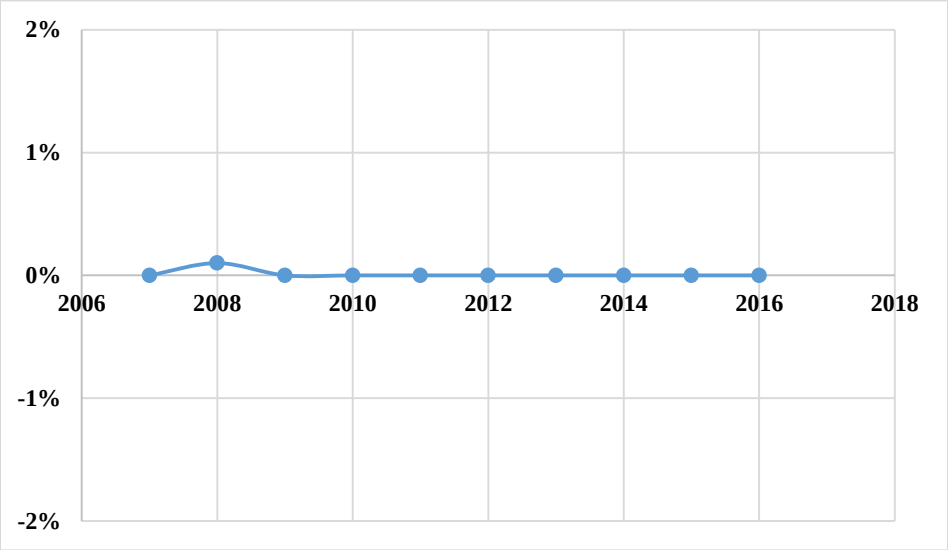

Figure 3. 3: Probability of Default of C_3

Table 3.5 is an illustration of organization C_4. All the parameters are same as mentioned in the above tables. Here the results of ratios are quite different from the previous table. As we see in the first column the working capital to total asset ratio X_1 has negative values or very small values that means the current assets are less than current liabilities causing negative working capital which is the cause of lower z-score value. Similarly for the column 3 in which X_3 ratio is mentioned which means that organization C_4 has very low or negative income as compared to its total assets.

Table 3. 5: Z-score Values of Organization C_4

Year	X_1	X_2	X_3	X_4	X_5	Z-score
2016	-0.124	0.073	-0.036	0.040	1.745	1.586
2015	-0.120	0.088	-0.060	0.098	1.630	1.455
2014	-0.176	0.090	0.033	0.122	1.452	1.534
2013	-0.066	0.087	-0.066	0.099	1.229	1.101
2012	0.006	-0.019	0.023	0.289	1.153	1.371
2011	0.038	0.013	-0.058	0.279	1.050	1.080
2010	0.005	0.005	0.014	0.319	1.143	1.383
2009	0.088	0.024	0.024	0.362	1.011	1.437
2008	0.158	0.222	0.111	1.277	1.752	3.368
2007	0.171	0.226	0.226	1.080	1.694	3.592

Figure 3.4 is the graphical representation of Table 3.5 for the organization C_4. Here a clear glimpse of the table can be seen that in the first 2 years organization was in good state and there were no chances of bankruptcy at all but as 2008 years begin the downfall of the organization had been started and till the end of period 2016 organization was in the continuous state of distress. There was a global economic crisis in the year 2008 which may be one of the reasons for the distress situation of the organization C_4.

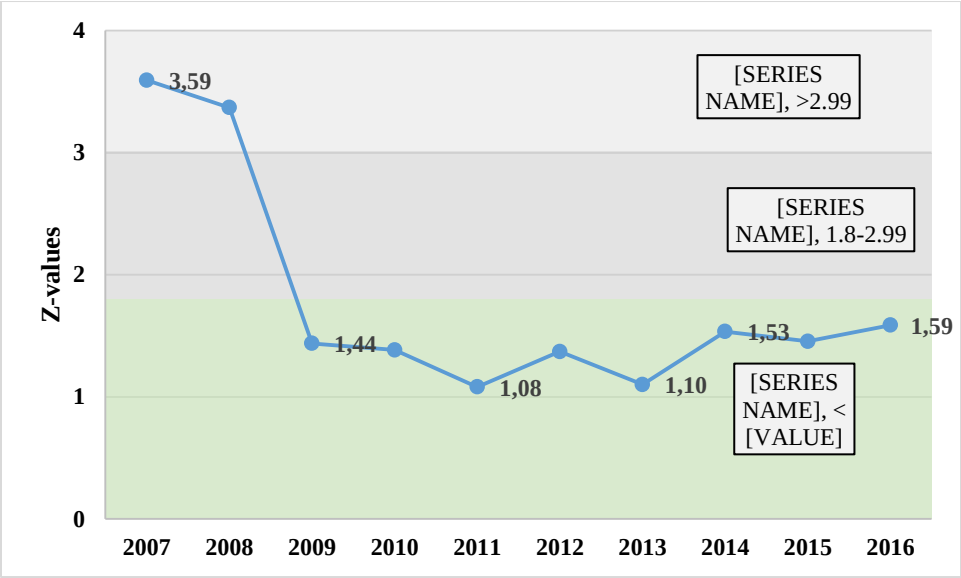

Figure 3. 4: Z-Score Values of Organization C_4

Table 3.6 shows the data for the probability of default for the organization C_4. The first column has quite a different result from the previous example where natural log return of assets to firm equity has large values but here have small values as compared. Similarly, the standard deviation has negative values which have deep impact on the probability of default.

Table 3. 6: Probability of Default of Organization C_4

Year	V	(u-sigma2/2)t	d_1	PPD
2016	20.17%	-4.78	-22.25	0%
2015	29.61%	-7.02	-22.46	0%
2014	29.61%	1.35	5.95	0%
2013	32.09%	5.56	18.77	30%
2012	14.12%	2.03	18.56	80%
2011	30.04%	-8.57	-26.45	100%

2010	43.90%	1.11	3.96	100%
2009	39.67%	2.72	8.63	100%
2008	7.04%	20.57	304.32	100%
2007	25.55%	40.68	162.35	95%

Figure 3.5 shows that in the years 2006-8 organization has no chances or 0 chances of bankruptcy but from the year 2010 organization had 35% chances of default which increase further in the year 2011 up to 85% and after that 100% from the year 2012 to onward. If we compare both models it strength up our theory that both the model are quite supportive of each other.

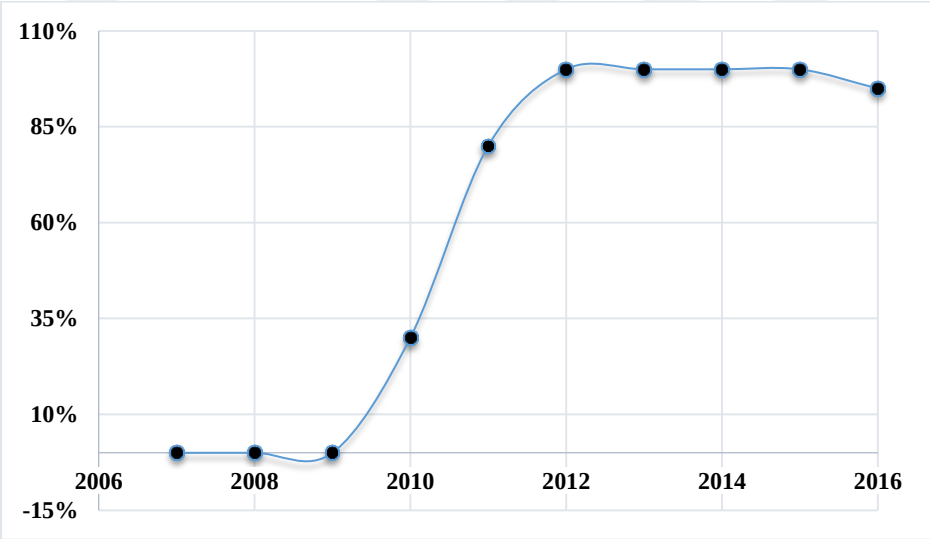

Figure 3. 5: Probability of Default of Organization C_4

Table 3.7 illustrates the Z-score values of all firms Within the period 2007 and 2016

Table 3. 7: Result of Z-score Model

Firm	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
C_1	2.26	1.74	1.59	2.20	2.11	2.42	1.82	1.99	1.77	1.68
C_2	5.47	2.72	2.16	3.70	2.76	1.60	1.53	1.40	1.62	1.78
C_3	2.24	2.23	3.72	3.62	3.39	3.43	3.56	2.65	2.92	2.78
C_4	3.59	3.37	1.44	1.38	1.08	1.37	1.10	1.53	1.45	1.59
C_5	2.23	1.91	2.05	2.21	2.10	2.01	1.98	1.76	1.37	1.49
C_6	0.95	0.91	1.01	0.91	0.57	0.73	3.75	2.54	1.27	1.12

C_7	2.89	1.45	1.72	1.39	1.56	1.43	1.61	1.46	1.39	1.42
C_8	3.53	3.41	2.51	2.85	2.92	2.70	2.25	2.11	2.10	1.92
C_9	1.52	1.61	2.07	1.37	1.43	2.11	2.08	2.15	2.07	2.29
C_{10}	2.20	1.84	2.08	2.95	2.91	2.71	2.34	4.34	4.69	4.49

Table 3. 8: Result of Distance to Default Model

Firm	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
C_1	2.95	10.90	0.00	100.00	8.84	100.00	0.00	0.00	0.00	0.00
C_2	0.92	0.00	0.00	100.00	54.15	100.00	0.05	0.00	0.00	0.00
C_3	0.16	5.27	0.00	0.00	99.95	0.00	0.00	0.00	0.00	0.00
C_4	0.29	0.04	0.00	0.00	0.00	0.00	0.12	0.00	0.00	100.00
C_5	0.37	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_6	1.78	0.06	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.01
C_7	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_8	0.05	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.71
C_9	13.49	0.64	0.10	0.00	0.00	0.00	0.00	100.00	43.37	8.38
C_{10}	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.31	0.11

3.7. Testing Hypothesis

As the sample size is less than 30 so two-tailed t-test is conducted here. The α value here is taken 0.05. n_1 is the sample size of Z-score model which is 10, n_2 is the sample size of DD model which is 10, $H_0 : \mu_z = \mu_p$ is showing the null hypothesis which means that there is no significant difference between Z-score and DD model while $H_1: \mu_z \neq \mu_p$ means there is a significant difference between Z-score and DD model. The degree of freedom d_f is n-1. The steps of independent sample 2 tailed t-test is as follows:

$$H_0 : \mu_z = \mu_p$$

$$H_1: \mu_z \neq \mu_p$$

$$\alpha = 0.05$$

$$d_f = (n_1 - 1) + (n_2 - 1) = 18$$

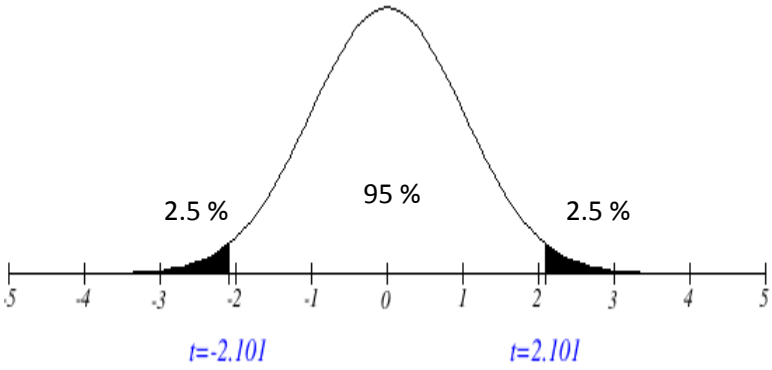

Figure 3. 6: Normal distribution Curve of 2-tailed t-test

$$t = \frac{(\bar{x}_z - \bar{x}_p)}{(\sqrt{(\frac{S_p^2}{n_1} + \frac{S_p^2}{n_2})}}$$

$$S_p^2 = \frac{SS_z + SS_p}{df_1 + df_2}$$

$$df_1 = n_z - 1 = 9$$

$$df_2 = n_p - 1 = 9$$

$SS_z = (0.72)(0.9) = 4.67$

$SS_p = (0.10)(0.9) = 0.09$

$$S_p^2 = \frac{4.67 + 0.09}{9 + 9} = 0.264$$

$$t = \frac{0.72 - 0.10}{(\sqrt{(\frac{0.264}{10} + \frac{0.264}{10})}}$$

$$t = 2.69$$

Decision rule is that if t is less than -2.101 or greater than 2.101, reject the null hypothesis. As t is 2.69 which is greater than 2.101 so reject null hypothesis.

4. CONCLUSION

In this study, 10 organizations in the Turkish stock exchange listed were chosen, in the span of 10 years from 2007 to 2016. Earlier studies available in Turkey were conducted on a single company or in a different economic environment, and therefore it was significant to re-examine the subject on a sample of corporations and the period after economic recession of 2008. This study shows that the predictive capability of the original Altman Model for publicly traded companies is high with respect to bankrupt corporations. However, the model is less efficient in predicting stable companies and gives some misleading information. Use of the Merton Model develops the predictive ability for stable companies and, as a result, the overall predictive ability of the model. For each organization unique set of data is collected from the balance sheet, income statements, and annual reports to meet the requirements of under study models. Data collection process was tracked by the extensive analysis of bankruptcy literature. The result showed that financial and economic data was quite dependent and individually quite a good predictor of bankruptcy. Therefore, it is hypothesized financial variables (ratios) increase the predictive power.

From the section 3.7 a 2-tailed t-test is conducted which reject the null hypothesis which conclude that there was significant difference between Z-score model and DD model, $t = 2.69$, $p > 0.05$

It should be noted that the Altman Z-score Model for manufacturing and non-manufacturing firms is one of the appropriate tool in assessing the risk of bankruptcy for corporates and consequently other evidence, both qualitative and quantitative, must be used to appraise the solvency of corporations. This is usually done in the finance industry as part of management and governing credit risks.

The results of the study are promising because Z-score and DD model can be used to predict economic failure of companies in Turkey, even years prior to bankruptcy. This subject has

been critically important over the past years, following the liquidity distress many Turkish and global companies have confronted.

The most significant gain of the models equated to more advanced ones is its simplicity and the low cost of its application. Using a neutral, quantitative indicator represented by a single number, the credit risk can be estimated. We believe the issue to be of great importance now, in light of the significant growth in recent years in the amount of information companies include in financial statements. The model allows users to focus attention on a single number in an era when we are "flooded" with financial information, when we “cannot see the forest for the trees."

Additionally, the contributions of this study have concrete applications, with respect to economic and social advantages. For stakeholders and investors, bankruptcy prediction develops risk assessment while for vendors, it would be able to get additional time to shelter more sponsoring or recover current actions and operations to escape catastrophe altogether. For financiers, these models can also be used to recognize dynamic and bankrupt companies, serving individuals and corporates to invest in healthy businesses and short unhealthy corporations.

4.1. Limitations

This thesis examined 2 separate accounting bankruptcy predicting models that are quite similar in literature as compared with the current topic. As both of these portrays different financial variable and explain prediction accuracy at different stages but none of them explain financial distress completely.

As studying the literature study can conclude that these model does not provide a satisfactory statistic for failure prediction since both have strengths and weaknesses. Data is selected from historical information and trends. These trends are not included in the prediction model, which makes these models limited itself.

4.2. Future Work

For future research and perfections for bankruptcy prediction, several areas can arise from this work. For example: scrutinizing corporates by additional disintegration by business and geographical sectors. Applying the research methodology to other sectors like social organizations or start-ups where there is always a high chance of bankruptcy. The span of the

research can be increased to get more deep knowledge about the sector. By this amount of useful data can be increased. Data can also be check quarterly to know about hidden circumstances.

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APPENDIX A

Table A.1: Balance Sheet Data for Z-Score Model for Company C_1

Year	WC	TA	RE	TD	TE	NI	IWT	AS
2016	1,635,209,000	10,455,946,000	1,871,626,000	5,458,999,000	4,996,947,000	22,391,000	70,766,000	7,050,245,000
2015	1,136,314,000	8,945,818,000	1,784,483,000	4,804,247,000	4,141,571,000	12,665,300	203,946,000	6,723,866,000
2014	805,944,000	7,201,860,000	1,569,274,000	3,828,828,000	3,373,032,000	34,720,400	432,946,000	5,985,370,000
2013	987,101,000	7,005,775,000	1,165,471,000	4,134,436,000	2,871,339,000	50,216,900	573,977,000	5,186,445,000
2012	946,415,000	4,081,366,000	865,470,000	2,171,230,000	1,910,136,000	38,493,400	480,755,000	3,819,302,000
2011	924,098,000	3,787,577,000	784,529,000	2,117,481,000	1,670,096,000	14,147,300	183,358,000	3,408,583,000
2010	413,245,000	3,014,042,000	656,872,000	1,579,007,000	1,435,035,000	19,837,300	255,260,000	2,753,161,000
2009	48,310,000	2,863,582,000	537,288,000	3,319,640,000	1,269,948,000	16,920,500	215,390,000	2,407,527,000
2008	445,413,000	2,447,347,000	471,914,000	3,393,650,000	1,108,201,000	8,250,700	102,282,000	2,258,096,000
2007	118,523,000	1,677,055,000	439,288,000	2,015,039,000	910,999,000	15,366,500	204,329,000	1,925,906,000

Table A.2: Balance Sheet Data for Merton Model for Company C_1

Year	V	TA	DP	NI	SHE	ER	T
2016	20.24	10,455,946,000	7,439,679,000	22,391,000	4,996,947,000	2.14	1
2015	14.98	8,945,818,000	6,445,389,000	12,665,300	4,141,571,000	1.42	1
2014	14.20	7,201,860,000	5,021,624,000	34,720,400	3,373,032,000	4.82	1
2013	13.08	7,005,775,000	5,294,029,000	50,216,900	2,871,339,000	7.17	1
2012	15.77	4,081,366,000	2,978,901,000	38,493,400	1,910,136,000	9.43	1
2011	14.79	3,787,577,000	2,913,165,500	14,147,300	1,670,096,000	3.74	1
2010	14.68	3,014,042,000	1,928,210,500	19,837,300	1,435,035,000	6.58	1
2009	16.00	2,863,582,000	1,821,663,000	16,920,500	1,269,948,000	5.91	1
2008	36.23	2,447,347,000	1,812,297,500	8,250,700	1,108,201,000	3.37	1
2007	18.96	1,677,055,000	921,627,000	15,366,500	910,999,000	9.16	1

Table A. 3: Balance Sheet Data for Z-score Model for Company C_2

Year	WC	TA	RE	TD	TE	NI	IWT	AS
2016	111,700,000	783,200,000	27,678,899	481,500,000	301,700,000	(21,900,000)	47,400,000	777,400,000
2015	126,500,000	744,800,000	27,908,257	440,600,000	304,200,000	(16,100,000)	34,700,000	595,100,000
2014	177,900,000	687,700,000	26,697,248	396,800,000	291,000,000	(22,500,000)	17,900,000	354,300,000
2013	199,700,000	758,800,000	36,697,248	396,800,000	400,000,000	3,800,000	26,400,000	330,100,000
2012	209,600,000	778,500,000	37,467,890	358,700,000	408,400,000	15,500,000	32,400,000	306,700,000
2011	124,750,000	583,850,000	31,988,606	254,300,000	551,861,394	7,631,500	114,200,000	284,350,000
2010	39,900,000	389,200,000	26,509,321	149,900,000	288,951,600	(237,000)	196,000,000	262,000,000
2009	57,800,000	419,900,000	30,927,541	160,300,000	337,110,200	(343,000)	7,000,000	243,500,000
2008	20,904,000	330,521,000	23,276,269	89,477,000	240,793,000	(753,000)	(9,205,000)	341,353,000
2007	148,770,000	330,521,000	23,355,824	37,724,000	241,616,000	8,833,000	11,120,000	293,417,000

Table A.4: Balance Sheet Data for Merton Model for Company C_2

Year	V	TA	DP	NI	SHE	ER	T
2016	43.71	783,200,000	380,200,000	22,391,000	4,996,947,000	-0.279622063	1
2015	3.28	744,800,000	355,350,000	(16,100,000)	304,200,000	-0.216165414	1
2014	35.44	687,700,000	297,450,000	(22,500,000)	291,000,000	-0.327177548	1
2013	30.56	758,800,000	297,450,000	3,800,000	400,000,000	0.050079072	1
2012	39.76	778,500,000	280,550,000	15,500,000	408,400,000	0.199100835	1
2011	39.76	583,850,000	199,875,000	7,631,500	551,861,394	0.130709943	1
2010	32.57	389,200,000	119,200,000	(237,000)	288,951,600	-0.006089414	1
2009	59.92	419,900,000	124,500,000	(343,000)	337,110,200	-0.008168612	1
2008	60.02	330,521,000	86,830,500.0	(753,000)	240,793,000	-0.022782214	1
2007	35.78	330,521,000	35,875,000.0	8,833,000	241,616,000	0.267244744	1

Table A.5: Balance Sheet Data for Z-score Model for Company C_3

Year	WC	TA	RE	TD	TE	NI	INW	AS
2016	60,257,991	933,593,147	201,405,899	340,254,783	593,338,364	60,019,544	63,675,950	1,067,776,692
2015	37,667,923	883,757,955	186,701,497	296,607,993	587,149,962	62,235,907	67,588,973	1,011,204,645
2014	50,290,416	756,707,671	167,523,627	261,822,993	494,884,678	54,675,379	49,209,984	699,834,316
2013	79,188,052	683,347,439	150,152,970	203,515,223	683,347,439	45,124,178	47,669,138	600,318,493
2012	87,151,923	616,857,752	137,766,514	180,682,060	436,175,692	55,271,283	61,820,443	727,149,364
2011	109,298,347	625,574,137	134,238,876	186,611,243	438,962,894	74,277,964	83,315,661	651,106,918
2010	92,046,787	532,592,717	126,164,232	147,786,886	384,805,831	60,075,624	71,426,332	577,076,728
2009	97,508,856	478,961,667	122,258,847	128,760,148	350,201,519	57,821,619	71,154,811	480,746,723
2008	53,903,651	423,884,402	127,288,582	133,768,189	290,116,213	6,188,690	8,482,810	122,225,706
2007	43,708,146	408,772,717	86,751,941	120,794,753	288,108,223	11,966,293	15,431,057	107,821,376

Table A.6: Balance Sheet Data for Merton Model for Company C_3

Year	V	TA	DP	NI	SHE	ER	T
2016	22.38	933,593,147	298,866,929.50	22,391,000	499,947,000	0.642887581	1
2015	26.79	883,757,955	268,429,754.50	62,235,907	587,149,962	0.704218917	1
2014	27.35	756,707,671	233,898,268.50	54,675,379	494,884,678	0.722542946	1
2013	27.78	683,347,439	178,667,614.00	45,124,178	683,347,439	0.660340193	1
2012	22.75	616,857,752	158,793,961.50	55,271,283	436,175,692	0.89601343	1
2011	27.93	625,574,137	161,023,331.00	74,277,964	438,962,894	1.187356695	1
2010	30.34	532,592,717	124,055,183.50	60,075,624	384,805,831	1.127984332	1
2009	40.00	478,961,667	106,104,407.00	57,821,619	350,201,519	1.207228532	1
2008	54.34	423,884,402	106,045,665.50	6,188,690	290,116,213	0.145999475	1
2007	39.03	408,772,717	93,072,229.50	11,966,293	288,108,223	0.292737076	1

Table A.7: Balance Sheet Data for Z-score Model for Company C_4

Year	WC	TA	RE	TD	TE	NI	IWT	AS
2016	(788,735,000)	6,337,406,000	462,650,000	6,096,249,000	241,155,000	(292,918,000)	(227,111,000)	11,059,224,000
2015	(690,148,000)	5,760,717,000	509,468,000	5,244,731,000	515,986,000	(370,453,000)	(345,984,000)	9,389,829,000
2014	(986,696,000)	5,593,495,000	504,766,000	7,551,894,000	919,166,000	98,506,000	183,998,000	8,122,667,000
2013	(379,942,000)	5,796,635,000	504,766,000	8,402,377,000	830,224,000	463,133,000	(384,717,000)	7,126,925,000
2012	33,410,000	5,624,345,000	(106,548,000)	4,362,269,000	1,262,076,000	88,136,000	128,910,000	6,482,402,000
2011	209,566,000	5,480,964,000	70,541,000	4,285,257,000	1,195,707,000	(369,214,000)	(315,858,000)	5,753,112,000
2010	27,363,000	5,567,345,000	27,960,000	4,220,192,000	1,347,153,000	42,674,000	78,828,000	6,365,124,000
2009	497,628,000	5,648,043,000	137,609,000	4,147,713,000	1,500,330,000	109,614,000	134,546,000	5,711,268,000
2008	458,027,000	2,896,256,000	643,450,000	1,271,872,000	1,624,384,000	261,532,000	321,571,000	5,073,746,000
2007	484,478,000	2,829,725,000	640,479,000	1,360,392,000	1,469,333,000	552,913,000	638,630,000	4,793,359,000

Table A.8: Balance Sheet Data for Merton Model for Company C_4

Year	V	TA	DP	NI	SHE	ER	T
2016	20.17	6,337,406,000	4,708,504,500	(292,918,000)	241,155,000	-4.8049	1
2015	29.61	5,760,717,000	3,985,201,000	(370,453,000)	515,986,000	-7.0633	1
2014	29.61	5,593,495,000	3,695,129,500	98,506,000	919,166,000	1.3044	1
2013	32.09	5,796,635,000	3,663,540,000	463,133,000	830,224,000	5.5119	1
2012	14.12	5,624,345,000	3,118,704,500	88,136,000	1,262,076,000	2.0204	1
2011	30.04	5,480,964,000	2,931,975,500	(369,214,000)	1,195,707,000	-8.6159	1
2010	43.90	5,567,345,000	2,969,086,500	42,674,000	1,347,153,000	1.0112	1
2009	39.67	5,648,043,000	2,795,477,500	109,614,000	1,500,330,000	2.6428	1
2008	7.04	2,896,256,000	1,231,912,500	261,532,000	1,624,384,000	20.5628	1
2007	25.55	2,829,725,000	1,270,219,500	552,913,000	1,469,333,000	40.6437	1

Table A.9: Balance Sheet Data for Z-score Model for Company C_5

Year	WC	TA	RE	TD	TE	NI	IWT	AS
2016	3,322,218,000	25,628,559,000	1,841,842,000	10,811,537,000	14,817,022,000	(40,055,000)	52,964,000	10,420,257,000
2015	2,317,379,000	22,044,090,000	80,543,000	9,470,585,000	12,573,505,000	(137,154,000)	(98,954,000)	10,205,146,000
2014	1,963,695,000	20,113,805,000	4,812,035,000	8,289,866,000	11,823,939,000	(331,554,000)	(263,080,000)	10,079,137,000
2013	1,811,825,000	22,366,984,000	2,203,115,000	8,905,058,000	13,461,926,000	2,852,990,000	2,902,443,000	9,195,773,000
2012	1,682,068,000	11,644,803,000	1,908,080,000	4,858,012,000	6,786,791,000	630,268,000	803,739,000	6,416,835,000
2011	699,410,000	6,420,709,000	1,820,229,000	3,213,829,000	3,206,880,000	359,472,000	464,981,000	4,761,266,000
2010	383,622,000	5,588,831,000	1,601,674,000	2,773,826,000	2,767,088,000	518,441,000	658,552,000	4,168,793,000
2009	568,017,000	5,430,041,000	1,378,290,000	2,695,863,000	2,426,917,000	422,272,000	543,754,000	3,811,076,000
2008	519,766,000	4,975,664,000	1,249,864,000	2,604,776,000	2,009,662,000	288,700,000	355,000,000	3,668,900,000
2007	171,108,000	3,894,467,000	1,001,795,000	1,755,499,000	1,821,553,000	390,100,000	501,500,000	3,030,400,000

Table A.10: Balance Sheet Data for Merton Model for Company C_5

Year	V	TA	DP	NI	SHE	ER	T
2016	32.66	25,628,559,000	14,874,077,000	(40,055,000)	14,817,022,000	-0.1563	1
2015	32.31	22,044,090,000	12,893,296,000	(137,154,000)	12,573,505,000	-0.6222	1
2014	30.86	20,113,805,000	11,167,937,500	(331,554,000)	11,823,939,000	-1.6484	1
2013	37.84	22,366,984,000	11,783,936,000	2,852,990,000	13,461,926,000	12.7554	1
2012	24.63	11,644,803,000	6,227,314,500	630,268,000	6,786,791,000	5.4124	1
2011	33.32	6,420,709,000	4,006,448,500	359,472,000	3,206,880,000	5.5986	1
2010	25.83	5,588,831,000	3,282,141,500	518,441,000	2,767,088,000	9.2764	1
2009	37.32	5,430,041,000	3,299,473,000	422,272,000	2,426,917,000	7.7766	1
2008	49.65	4,975,664,000	3,249,505,500	288,700,000	2,009,662,000	5.8022	1
2007	13.90	3,894,467,000	2,131,816,000	390,100,000	1,821,553,000	10.0168	1

Table A.11: Balance Sheet Data for Z-score Model for Company C_6

Year	WC	TA	RE	TD	TE	NI	IWT	AS
2016	(867,189,000)	9,348,066,000	3,368,005,000	4,877,534,000	4,470,532,000	(378,232,000)	(397,242,000)	3,030,113,000
2015	(286,858,000)	8,840,671,000	3,590,502,000	4,523,454,000	4,317,210,000	(280,005,000)	(325,733,000)	2,592,183,000
2014	929,387,000	6,565,625,000	3,687,730,000	2,097,749,000	4,467,876,000	(26,772,000)	4,205,000	1,989,732,000
2013	1,042,443,000	6,413,198,000	2,519,664,000	1,474,616,000	4,938,582,000	1,401,935,000	1,451,649,000	1,630,694,000
2012	(1,246,247,000)	11,828,296,000	1,652,518,000	8,352,106,000	3,476,190,000	1,023,942,000	1,058,912,000	1,374,737,000
2011	(667,874,000)	9,178,356,000	1,554,186,000	6,641,554,000	2,536,802,000	172,323,000	190,333,000	1,127,689,000
2010	36,795,000	6,652,571,000	1,374,727,000	4,351,479,000	2,301,092,000	277,259,000	292,179,000	1,047,914,000
2009	152,321,000	5,785,347,000	1,181,574,000	3,712,144,000	2,073,203,000	310,991,000	321,544,000	1,022,759,000
2008	213,514,009	4,286,886,374	540,090,593	2,728,389,839	1,230,167,557	242,244,969	255,230,874	900,510,870
2007	263,870,722	3,453,930,807	405,307,313	2,148,064,821	1,051,498,062	156,745,411	177,512,702	810,233,114

Table A.12: Balance Sheet Data for Merton Model for Company C_6

Year	V	TA	DP	NI	SHE	ER	T
2016	34.77	9,348,066,000	6,083,828,000	(378,232,000)	4,470,532,000	-7.755	1
2015	25.14	8,840,671,000	5,898,184,000	(280,005,000)	4,317,210,000	-6.190	1
2014	23.88	6,565,625,000	2,630,568,000	4,205,000	4,467,876,000	0.200	1
2013	40.37	6,413,198,000	1,851,106,500	1,451,649,000	4,938,582,000	9.844	1
2012	22.32	11,828,296,000	8,780,642,500	1,023,942,000	3,476,190,000	12.260	1
2011	20.67	9,178,356,000	7,046,044,000	172,323,000	2,536,802,000	2.595	1
2010	29.42	6,652,571,000	4,627,414,000	277,259,000	2,301,092,000	6.372	1
2009	33.34	5,785,347,000	3,828,476,000	310,991,000	2,073,203,000	8.378	1
2008	41.12	4,286,886,374	2,906,450,944	156,745,411	1,230,167,557	5.745	1
2007	13.79	3,453,930,807	2,306,488,223	156,745,411	1,051,498,062	7.297	1

Table A.13: Balance Sheet Data for Z-score Model for Company C_7

Year	WC	TA	RE	TD	TE	NI	IWT	AS
2016	383,592,724	1,784,267,642	46,131,822	1,541,309,550	242,958,092	69,725,866	68,080,363	1,634,514,698
2015	234,803,269	1,605,062,174	46,011,054	1,359,823,075	245,239,099	7,950,615	87,840,303	1,433,967,887
2014	37,139,866	1,235,552,386	61,119,856	991,225,010	244,327,376	72,771,198	81,783,848	1,231,633,772
2013	128,535,615	1,375,250,156	74,438,113	1,101,980,576	273,269,580	96,561,743	108,248,320	1,401,552,934
2012	146,713,152	1,037,425,120	65,806,705	795,692,260	241,732,860	76,384,978	8,181,794	1,004,492,232
2011	(11,456,042)	854,645,945	63,640,101	641,298,063	213,347,882	54,846,604	61,776,341	890,525,189
2010	68,314,735	635,639,291	59,241,787	462,138,013	173,501,278	20,778,314	20,076,855	517,396,494
2009	74,061,719	537,979,765	47,701,977	364,856,801	173,122,964	33,859,810	35,674,865	503,244,683
2008	(12,111,146)	507,856,412	20,646,577	359,958,821	147,897,591	34,855,400	36,565,736	479,114,855
2007	66,438,282	292,201,541	15,953,643	149,695,424	142,506,117	37,572,934	46,245,842	427,610,628

Table A.14: Balance Sheet Data for Merton Model for Company C_7

Year	V	TA	DP	NI	SHE	ER	T
2016	25.53	1,784,267,642	1,303,824,230	69,725,866	242,958,092	4.524	1
2015	31.47	1,605,062,174	1,072,356,387	7,950,615	245,239,099	0.585	1
2014	30.24	1,235,552,386	813,072,039	81,783,848	244,327,376	8.251	1
2013	51.07	1,375,250,156	885,694,366	108,248,320	273,269,580	0.982	1
2012	23.79	1,037,425,120	664,574,034	76,384,978	241,732,860	9.600	1
2011	33.51	854,645,945	592,154,252	54,846,604	213,347,882	8.552	1
2010	24.00	635,639,291	412,710,107	20,778,314	173,501,278	4.496	1
2009	32.42	537,979,765	326,130,011	33,859,810	173,122,964	9.280	1
2008	52.76	507,856,412	357,733,670	37,572,934	147,897,591	10.438	1
2007	34.18	292,201,541	147,210,182	37,572,934	142,506,117	25.100	1

Table A.15: Balance Sheet Data for Z-score Model for Company C_8

Year	WC	TA	RE	TD	TE	NI	IWT	AS
2016	863,305,199	6,268,527,788	241,912,168	3,199,087,762	3,069,440,026	731,687,346	781,883,244	4,532,590,622
2015	1,183,184,763	5,460,665,328	156,442,236	2,655,281,831	2,805,383,497	639,208,658	573,827,236	4,532,535,969
2014	630,940,495	3,788,257,092	178,181,398	1,604,996,225	2,183,260,867	8,678,766	(61,771,495)	4,132,846,077
2013	487,022,689	3,245,629,905	180,987,490	1,538,124,927	1,707,504,978	48,896,680	53,508,620	4,158,730,152
2012	422,805,649	2,799,356,243	155,168,177	1,135,038,849	1,664,317,394	17,428,618	21,156,071	4,348,910,031
2011	492,681,454	2,671,127,874	113,495,168	968,439,098	1,702,688,776	102,341,325	117,795,725	3,891,322,098
2010	424,105,980	2,375,893,103	(16,589,752)	775,545,652	1,600,347,451	130,084,920	139,932,200	2,909,391,891
2009	288,406,341	2,113,202,978	(130,624,846)	642,940,447	1,470,262,531	114,035,094	64,731,190	2,057,459,379
2008	193,219,867	1,698,292,910	20,633,304	341,700,273	1,256,592,637	(151,258,150)	(157,278,423)	2,320,432,985
2007	333,901,811	1,933,536,147	(45,325,123)	426,050,560	1,507,485,587	67,905,574	67,905,574	2,174,849,627

Table A.16: Balance Sheet Data for Merton Model for Company C_8

Year	V	TA	DP	NI	SHE	ER	T
2016	26.45	6,268,527,788	2,497,864,176.0	731,687,346	3,069,440,026	23.837	1
2015	24.45	5,460,665,328	2,119,835,085.0	639,208,658	2,805,383,497	22.785	1
2014	26.82	3,788,257,092	1,370,882,461.0	8,678,766	2,183,260,867	0.397	1
2013	30.75	3,245,629,905	1,375,757,666.5	48,896,680	1,707,504,978	2.863	1
2012	24.15	2,799,356,243	1,077,141,280.0	17,428,618	1,664,317,394	1.0471	1
2011	31.12	2,671,127,874	904,840,003.0	102,341,325	1,702,688,776	6.0105	1
2010	16.43	2,375,893,103	728,727,209.0	130,084,920	1,600,347,451	8.128	1
2009	29.31	2,113,202,978	604,508,466.0	114,035,094	1,470,262,531	7.756	1
2008	50.22	1,698,292,910	296,507,957.5	(151,258,150)	1,256,592,637	-12.03	1
2007	38.74	1,933,536,147	360,081,006.0	67,905,574	1,507,485,587	4.504	1

Table A.17: Balance Sheet Data for Z-score Model for Company C_9

Year	WC	TA	RE	TD	TE	NI	IWT	AS
2016	3,509,242	14,075,504	2,446,010	10,906,791	6,004,577	1,304,150	1,201,681	16,096,172
2015	4,169,955	13,738,508	1,839,690	9,062,671	4,675,837	892,993	785,121	14,166,100
2014	4,340,954	12,395,005	1,792,999	7,996,307	4,398,698	637,978	731,662	12,514,033
2013	3,575,977	11,410,916	1,521,038	7,274,158	4,138,756	622,695	744,780	11,097,711
2012	2,795,654	10,228,153	1,387,994	6,300,918	3,927,235	546,638	623,060	10,556,861
2011	2,306,145	7,232,975	1,200,381	3,903,454	3,329,521	132,836	161,422	1,699,386
2010	2,406,450	7,321,769	954,525	3,914,025	3,407,734	116,746	144,713	1,486,923
2009	978,292	6,426,658	574,257	3,683,155	2,743,503	503,026	576,443	6,591,895
2008	1,432,599	6,859,801	542,917	4,858,472	2,001,329	6,556	29,121	6,852,289
2007	1,886,906	7,292,944	511,577	6,033,789	1,259,155	16,456	49,154	7,112,683

Table A.18: Balance Sheet Data for Merton Model for Company C_9

Year	V	TA	DP	NI	SHE	ER	T
2016	29.0	14,075,504.00	8,757,440	1,304,150	6,004,577	9.265	1
2015	26.3	13,738,508	7,149,484	892,993	4,675,837	6.500	1
2014	25.8	12,395,005	6,213,555	637,978	4,398,698	5.147	1
2013	41.0	11,410,916	5,683,650	622,695	4,138,756	5.457	1
2012	31.0	10,228,153	5,120,971	546,638	3,927,235	5.344	1
2011	32.7	7,232,975	3,113,197	132,836	3,329,521	1.837	1
2010	35.1	7,321,769	3,128,007	116,746	3,407,734	1.595	1
2009	47.2	6,426,658	6,678,404	503,026	2,743,503	7.827	1
2008	47.0	6,859,801	7,793,223	6,556	2,001,329	0.096	1
2007	35.5	7,292,944	4,418,691	16,456	1,259,155	0.226	1

Table A.19: Balance Sheet Data for Z-score Model for Company C_{10}

Year	WC	TA	RE	TD	TE	NI	IWT	AS
2016	46,025,040	468,814,448	148,512,951	68,446,711	400,367,737	5,534,471	6,139,489	175,818,540
2015	41,449,275	421,124,143	73,148,685	64,130,104	356,994,039	76,973,248	80,875,237	149,261,367
2014	31,258,865	335,825,235	(20,146,184)	56,062,596	279,762,639	93,438,253	96,092,597	128,051,396
2013	17,495,133	241,441,704	(2,358,519)	55,035,075	186,406,629	(18,530,607)	(19,476,794)	122,309,542
2012	28,308,102	254,471,956	(12,266,322)	57,211,217	197,260,739	5,192,843	8,083,939	119,923,742
2011	34,034,035	248,582,871	12,678,612	57,137,950	191,444,921	328,360	(360,621)	166,909,325
2010	20,837,735	242,193,015	(352,296)	51,701,133	190,491,882	(27,149)	2,854,329	145,710,490
2009	15,764,974	158,697,893	1,023,205	58,770,889	99,927,004	(8,644)	850,074	145,937,627
2008	19,298,787	178,378,018	18,073,260	77,066,869	101,311,149	(189,819)	1,316,417	135,960,746
2007	35,593,973	191,295,098	24,866,676	72,744,075	101,300,009	122,477	204,921	156,935,650

Table A. 20: Balance Sheet Data for Merton Model for Company C_{10}

Year	V	TA	DP	NI	SHE	ER	T
2016	53.02	468,814,448	80,513,702.0	5,534,471	400,367,737	1.180	1
2015	37.04	421,124,143	74,689,383.0	76,973,248	356,994,039	18.278	1
2014	43.18	335,825,235	64,486,219.5	93,438,253	279,762,639	27.823	1
2013	47.39	241,441,704	61,622,347.5	(18,530,607)	186,406,629	-7.674	1
2012	46.24	254,471,956	63,808,371.0	5,192,843	197,260,739	2.040	1
2011	42.08	248,582,871	66,943,242.0	328,360	191,444,921	0.132	1
2010	34.41	242,193,015	57,263,261.0	(27,149)	190,491,882	-0.011	1
2009	69.55	158,697,893	62,778,128.5	(8,644)	99,927,004	-0.005	1
2008	57.21	178,378,018	85,782,278.5	(189,819)	101,311,149	-0.106	1
2007	30.00	191,295,098	84,845,013.0	122,477	101,300,009	0.064	1

APPENDIX B

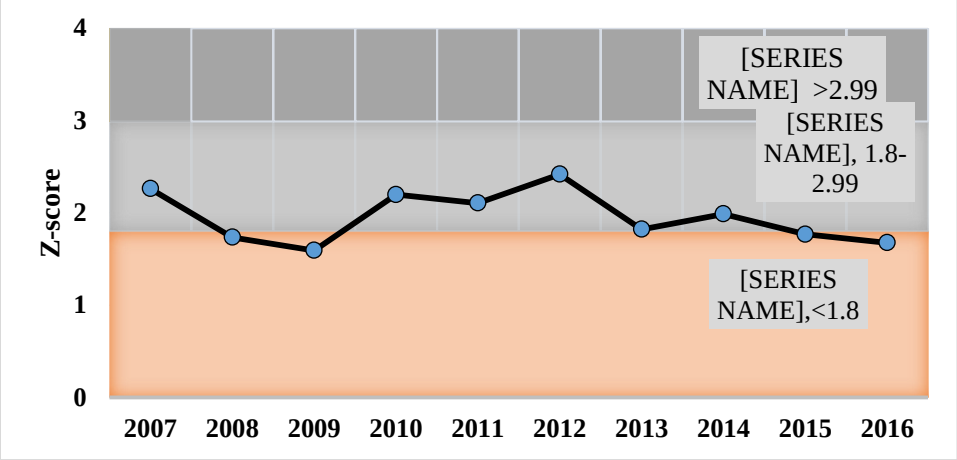

Figure B. 1: Z-score Values for Company C_1

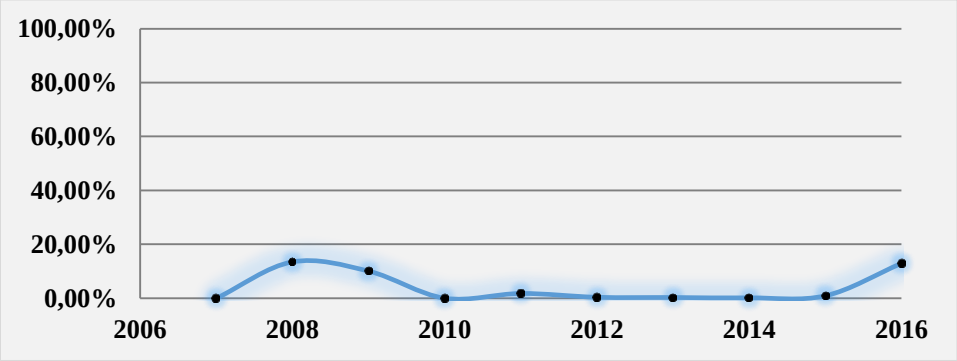

Figure B. 2: Probability of Default for Company C_1

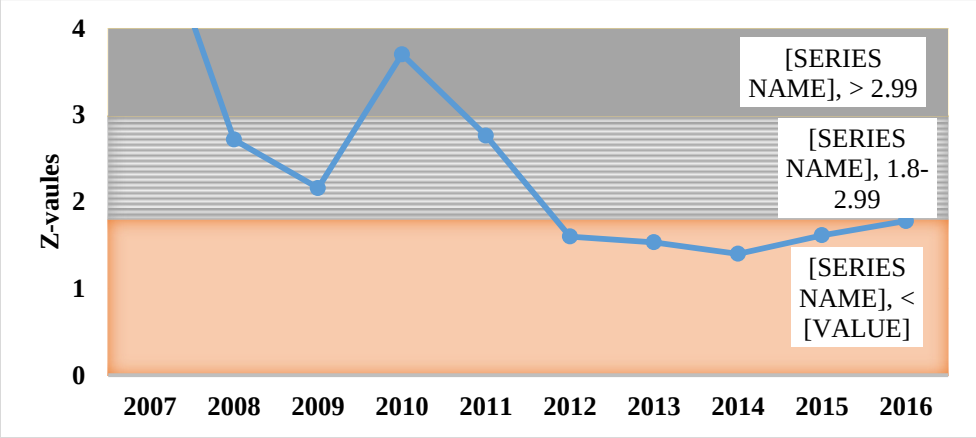

Figure B. 3: Z-score Values for Company C_2

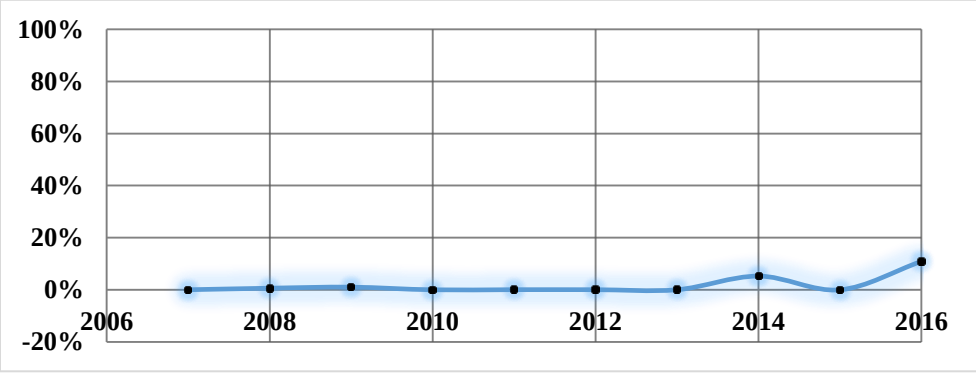

Figure B. 4: Probability of Default for Company C_2

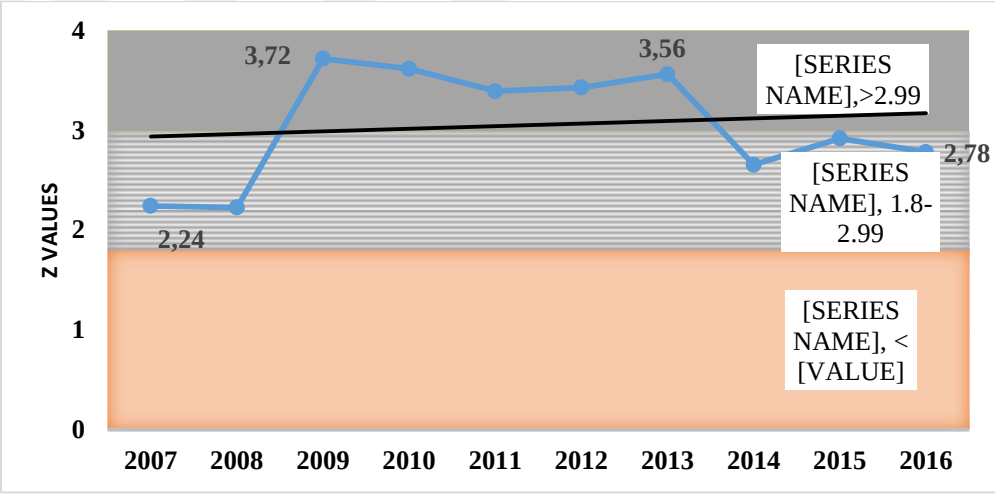

Figure B. 5: Z-score Values for Company C_3

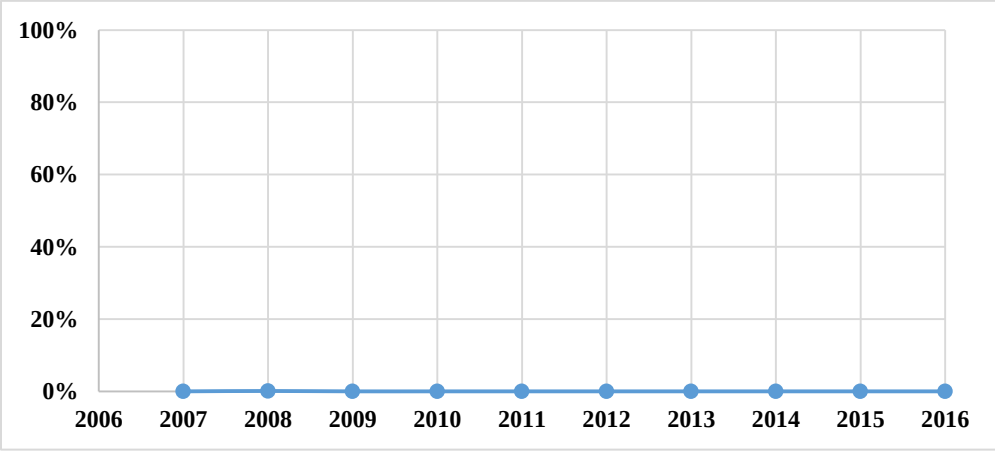

Figure B. 6: Probability of Default for Company C_3

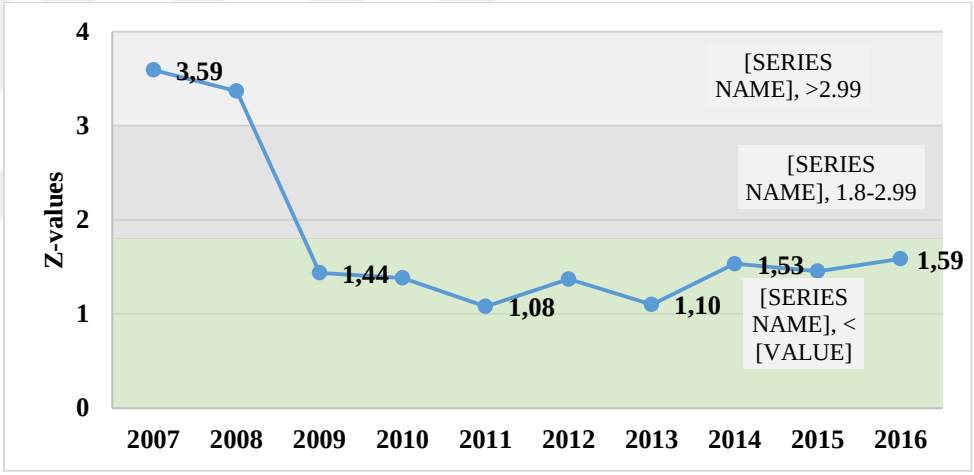

Figure B. 7: Z-score Values of Company C_4

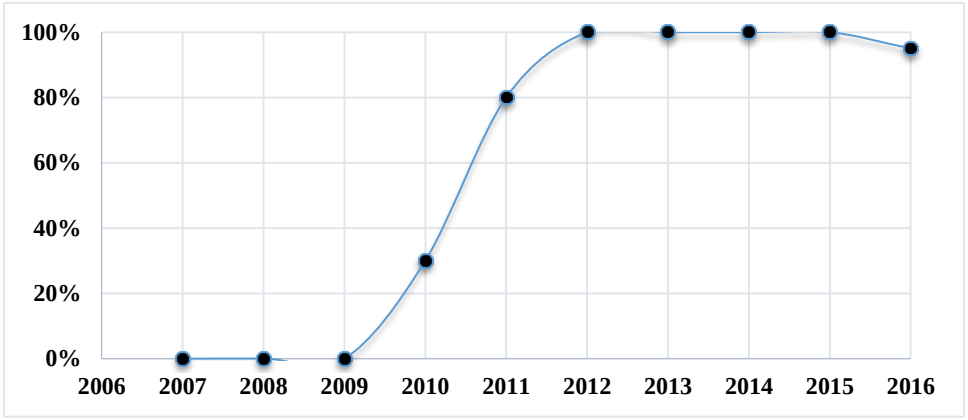

Figure B. 8: Probability of Default of Company C_4

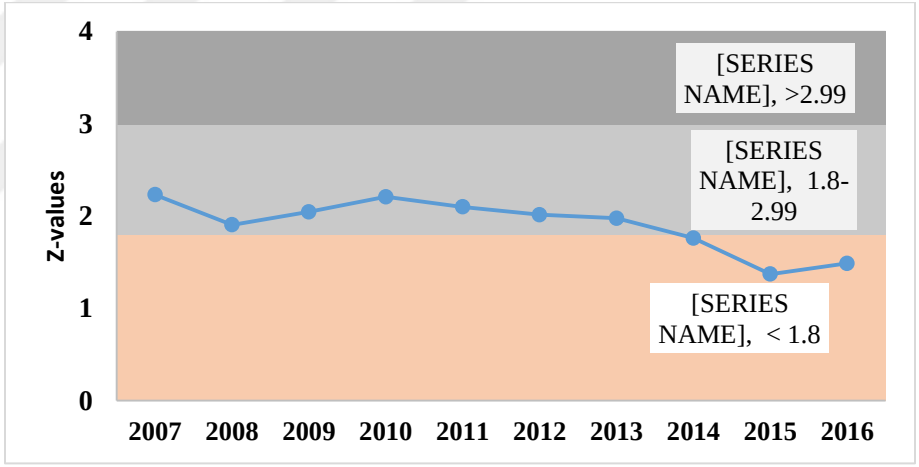

Figure B. 9: Z-score Values of Company C_5

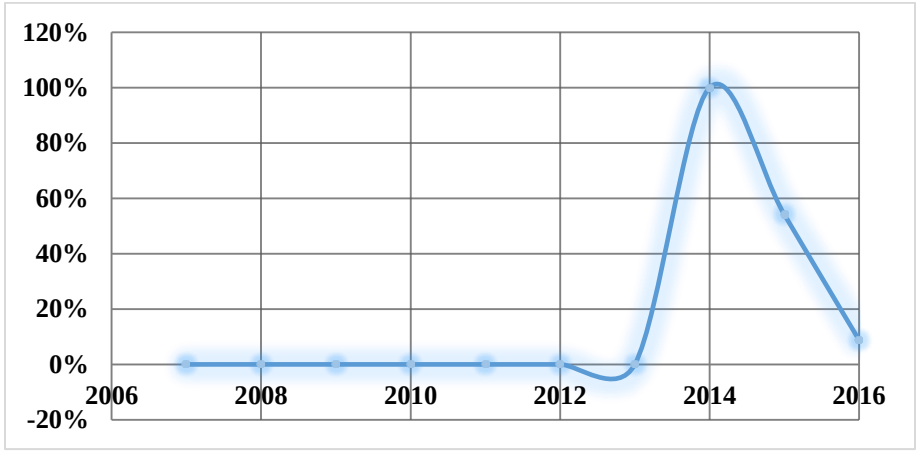

Figure B. 10: Probability of Default of Company C_5

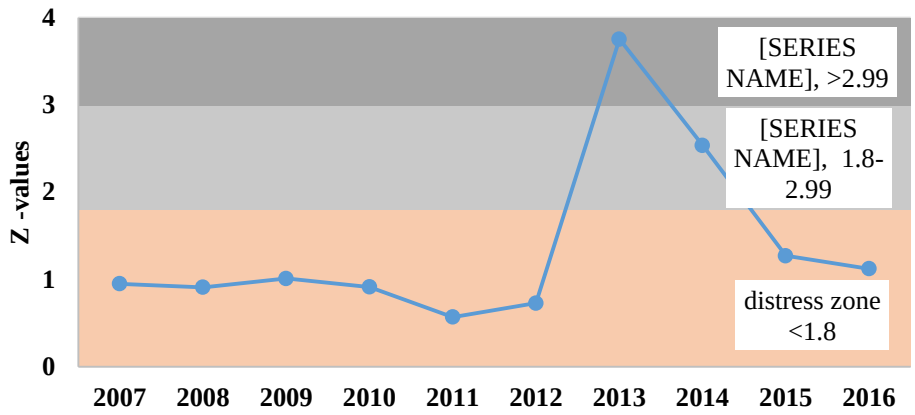

Figure B. 11: Z-score Values of Company C_6

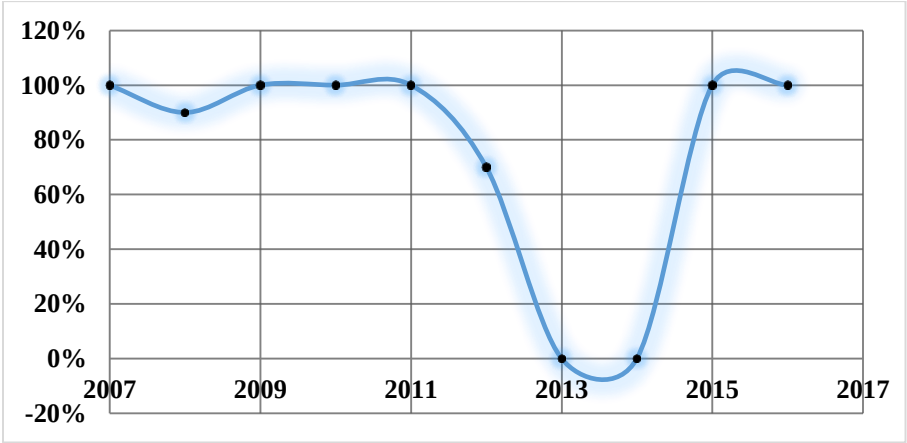

Figure B. 12: Probability of Default of Company C_6

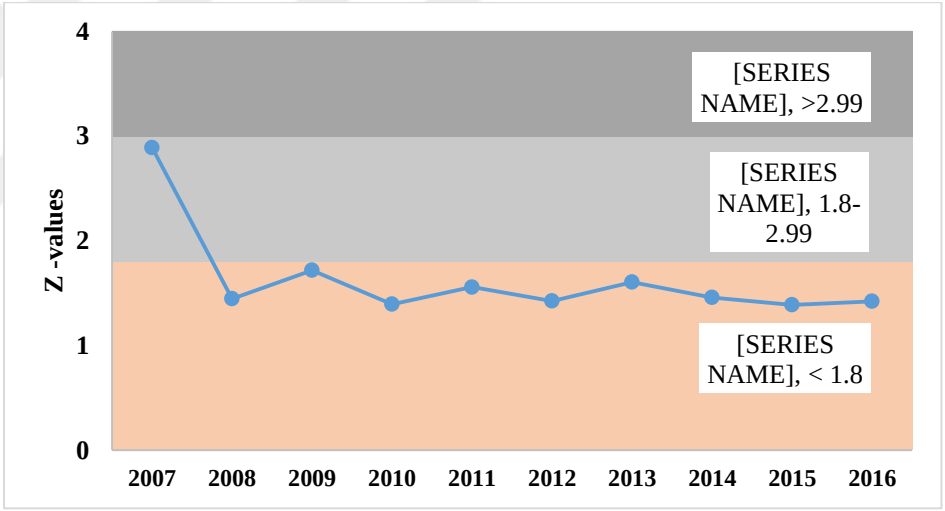

Figure B. 13: Z-score Values of Company C_7

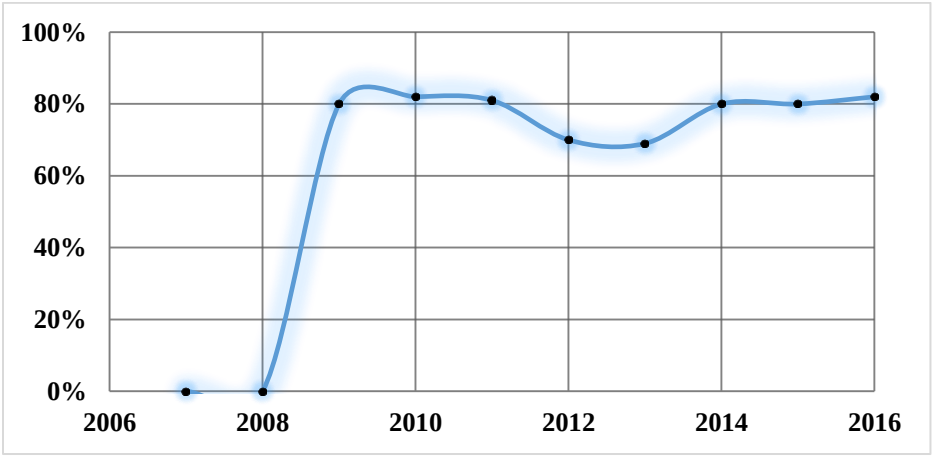

Figure B. 14: Probability of Default of Company C_7

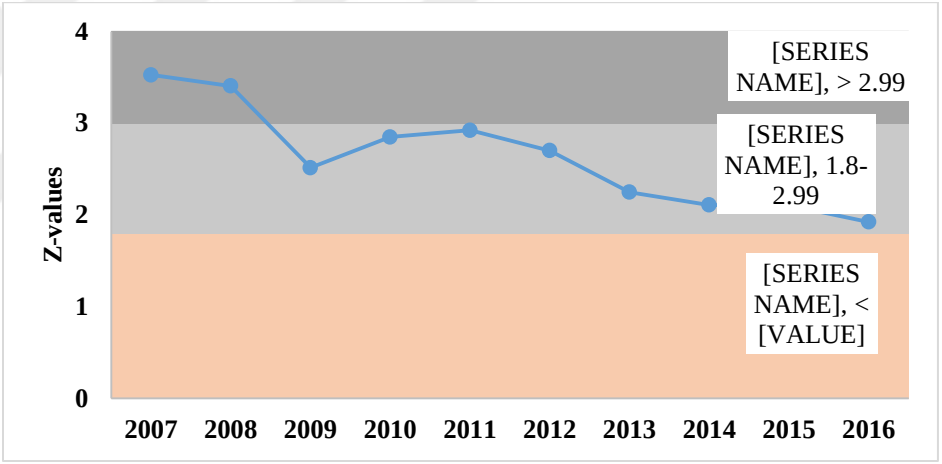

Figure B. 15: Z-score Values of Company C_8

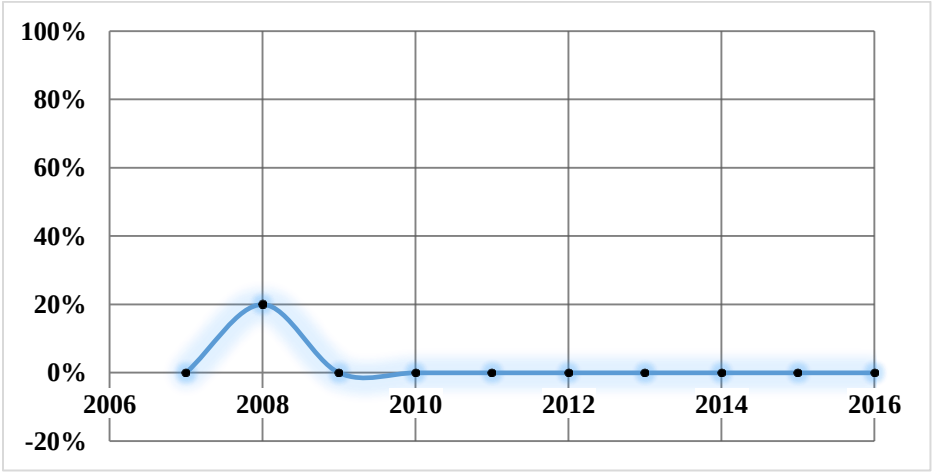

Figure B. 16: Probability of Default of Company C_8

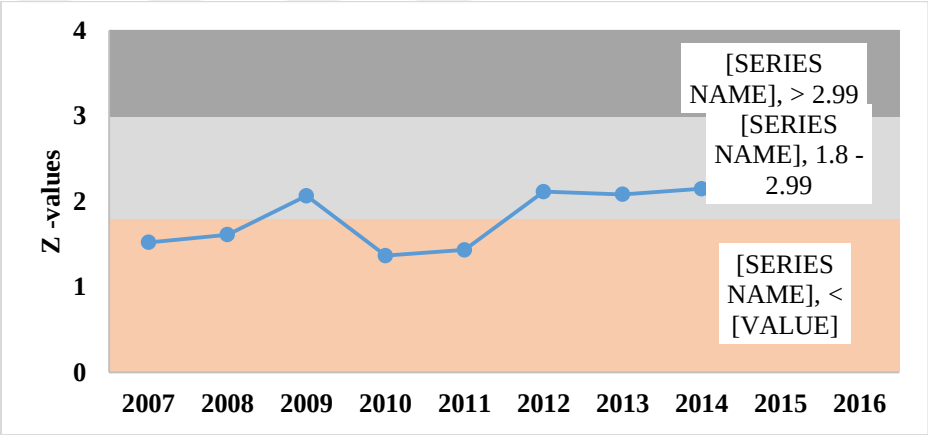

Figure B. 17: Z-score Values of Company C_9

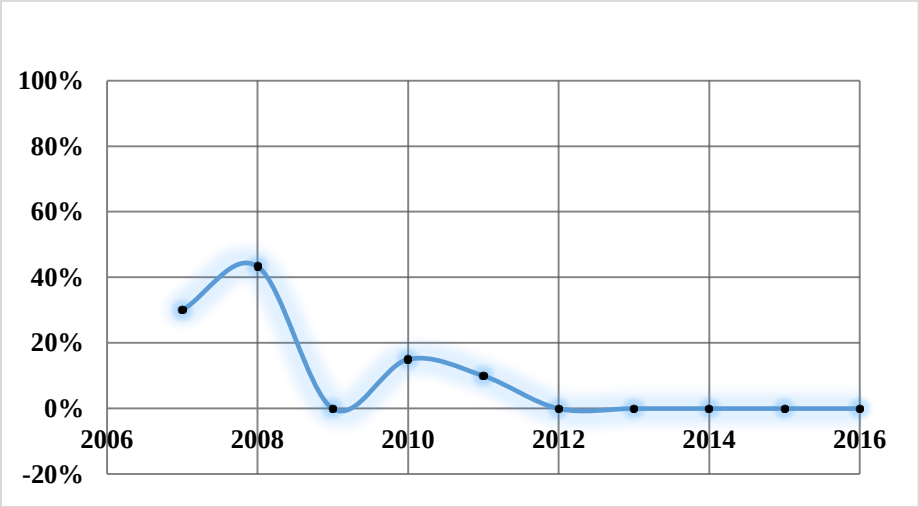

Figure B. 18: Probability of Default of Company C_9

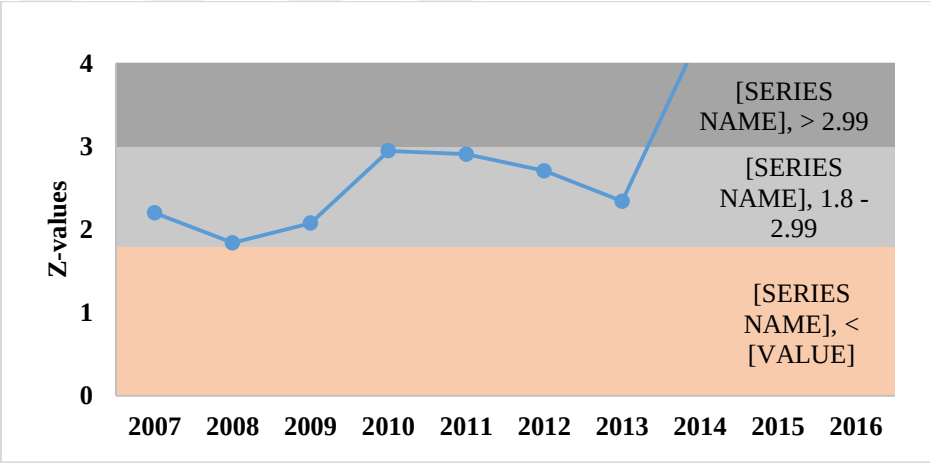

Figure B. 19: Z-score Values of Company C_{10}

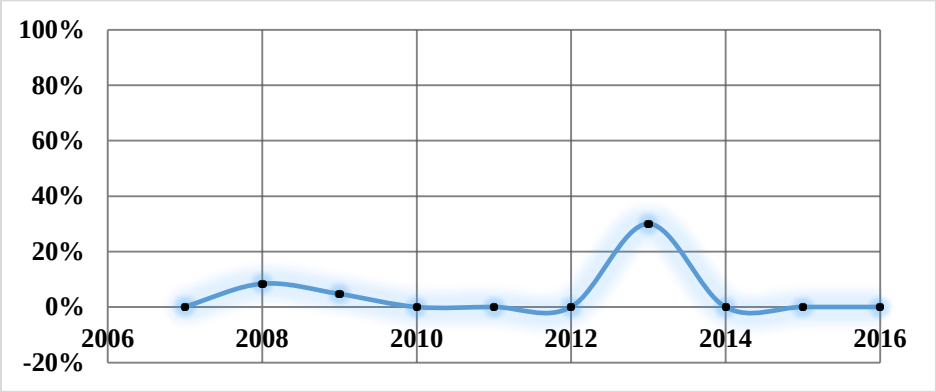

Figure B. 20: Probability of Default of Company C_{10}

RESUME

IFTIKHAR (Mechanical Engineer)

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Permanent Address: House # 138/C, Garden Town Sahiwal, Pakistan
Cell Number: +905054178792, +923436814792
iftikarali89@gmail.com

PERSONAL SUMMARY

A competent planning engineer with excellent communication, organization and coordination skills. Possessing a proven track record of preparing and executing project plans, ensuring that work is carried out in accordance with the companies procedures and clients satisfaction. Able to ensure timely, safe and cost effective design and implementation during the life cycle of project from conception till customer satisfaction.

PROFESSIONAL EXPERIENCE

S.ZIA Ul HAQ & SONS ENGINEERING PVT Limited, Karachi, Pakistan
(Jan-2015 to Sep-2015)
Designation: Management Trainee Engineer

Heavy Mechanical Complex, Taxila **(July 2013)**
Designation: As an Internee

QUALIFICATION

Degree	Institute / University	Percentage / CGPA	Passing Year
Masters in Business Administration (MBA) (Continue)	Istanbul Aydin University, Istanbul, Turkey	3.33 out of 4.00	2016-2018
Bachelor of Science (Mechanical Engineering)	COMSATS Institute of Information Technology, Sahiwal, Pakistan	3.68 out of 4.00	2010-2014
Intermediate (F.Sc – Pre Engineering)	The Educators College, Sahiwal, Pakistan	905 out of 1100	2008-2010
Matriculation (Science Group)	Government High School, Sahiwal, Pakistan	735 out of 850	2006-2008

KEY SKILLS AND PERSONALITY TRAITS

- Motivated, goal oriented and good team player.
- Ability to plan, organize and keep going when things get difficult.
- Ability to multitask in a demanding engineering environment.
- Good experience of interpreting specifications and preparing technical proposal.
- Sound knowledge of mechanical engineering concepts, engineering drawings.

TECHNICAL SKILLS

- Enterprises resources planning (ERP)
- MS-Office (Word, Excel, MS-Project, Visio)
- Auto-Cad
- Pro-E
- ANSYS
- Matlab
- ASME section ix (Welding & Brazing)
- HVAC & Maintenance Engineering as elective courses.
- Heating & Cooling load calculations.

LANGUAGES

- English (Expert in speaking, Listening & Writing)
- Urdu (Expert in speaking, Listening & Writing)
- Turkish (Intermediate)

REFERENCES

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