SciencePG
Science Publishing Group

Knowing Ahead Mathematical Determinant of Bank Customers Credit Worthiness: A Safe Strategy for Funding Loan in a Critical Economy

Margaret Ose Asika

Department of Curriculum and Instruction, Faculty of Education, Ambrose Alli University, Ekpoma, Nigeria

Email address:
asikatrinity@gmail.com, chrisben@gmail.com

To cite this article:
Margaret Ose Asika. Knowing Ahead Mathematical Determinant of Bank Customers Credit Worthiness: A Safe Strategy for Funding Loan in a Critical Economy. *Mathematics and Computer Science*. Special Issue: *One and Two Levels of Trade Credit Based on Discounted Cashflow and Inventory Inaccuracy*. Vol. 6, No. 1, 2021, pp. 16-23. doi: 10.11648/j.mcs.20210601.13

Abstract: The study was carried out to identify relevant attributes that signals the capacity of borrower to pay back the loan and determine the fit of mathematical scoring model to evaluate credit worthiness of a potential borrower. The data was taken from primary and secondary sources which was through the use of questionnaires (primary source) while the secondary source was collection of data from all the financial statements of selected business owners in Ekpoma, Edo State credits history of these business owners as well. The descriptive research and the explanatory research designs were employed in this study. Two research questions were raised while one hypothesis was formulated to guide the study. Thirty five (35) business owners were randomly selected from Ekpoma metropolis of Edo state for this study based on loan applications and business capacity. The data collected were analyzed using Altman Z-scores, frequencies and percentages while the Pearson Product Moment Correlation Co-efficient was used to determine the relationship between Mathematical Scoring model and credits worthiness. The result showed that credit scores developed from borrower financial and non-financial records and history such as turnover, assets, previous loan repayment rate and trading capital perfectly classified them into five risk classes of A (Worthy and very able to payback), B (worthy and less able to pay back) and D (not worthy at all). The result revealed that credit score can safe award banks and creditors against credit risk default and loss of money. It was therefore recommended among others, that banks and credit facilities handlers should adopt mathematical credit scoring techniques to avoid loss of their money.

Keywords: Credits Worthiness, Credit Scoring, Credits Risk, Bank Customers

1. Introduction

Banks are the main hub of financial services in any economy. The credit function of banks enhances the ability of investors to exploit desired profitable ventures. Credit creation is the main income generating activity of banks [1]. However, it exposes the banks to credit risk, a possibility of losing the outstanding loan partially or totally, due to customers 'credit default risk [2]. Credit risk is an internal determinant of bank performance. The lesser the exposure of a bank to credit risk, the lesser the tendency of the bank to encounter financial crisis and vice-versa. Bank services are not only essential to economic and financial development but, their role as financial intermediaries facilitates rapid economic growth, employment creation and financial stability which is vital for any nation. Therefore, financial institutions need to be properly managed, guarded and protected against credit risk.

The rate of loan delivery and performance in an economy significantly influences national productivity [3]. According to them, one basic function of the bank is to redirect funds from the surplus sector to the deficit sector in a profitable and sustainable manner. Interest on loans and advances are the main sources of income for a commercial bank, by given out loans, banks are exposed to different forms of risks e.g. Liquidity risk, credit risk, amongst others [1].

Despite these visible risks, banks have the onus to perform and rely on loan delivery and credit performance to energize its growth and expansion. Unfortunately, not all customers are able to return payments for loans giving to them. This

poses a major risk of sustainability for the banking sector. Risk is inherent part of bank's business [4]. Granting any loan to customer always involves some risk. Prominent bank risk is the credit risk which is the risk of default on a debt that may arise from a borrower failing to make required payments. The risk is that of the lender and includes lost principal and interest, disruption to cash flows and increased collection which may bring about banking crisis.

The decisions on credits granting is one of the most important issues in day to day banks' policy. Properly allocated credits may become one of the biggest sources of profits for any financial institution. The key problem consists of distinguishing between good credit applicants that will surely repay and bad credit applicants that are likely to default [5]. The aim of this paper therefore is to advocate the relevance of distinguishing between good and bad credit applicants ahead of loan facility disbursement.

1.1. Statement of the Problem

The business of the banking industry in Nigeria encompasses providing financial capital to the business community as well as individual customers. Banks engage in this transaction with the expectation of achieving targeted rates of returns on the extensions of credit over a period of time, and at the end of the given period reclaim their principal with interest. Researchers have focused on measuring bank performance with their ability to manage credit loans extension and reclaim the principal and accrued interest. The lack of general credit review system in many banks and the lack of precise methods for measuring credit risk are two important reasons why an expert support system is necessary. The concerns of many researchers and economists over the years have been on effective loan returns and interest made. This paper however, seeks to fill the gap in literature by developing strategies banks can used to know ahead if a credit will be to their detriment or contribute significantly to their performance. The focus of this paper therefore is to find out a mathematical method of predicting bank customer's credit worthiness before committing credit to them in order to create a high performance loan culture among commercial banks in Nigeria.

1.2. Objective of the Study

The objective of this study is to
1. Identify relevant attributes that signal the capacity of borrowers to pay back the loan.
2. Determine the fit of scoring model to evaluate worthiness of a potential borrower.

1.3. Research Questions

1. What are the relevant attributes that signal the capacity of borrowers to pay back the loan?
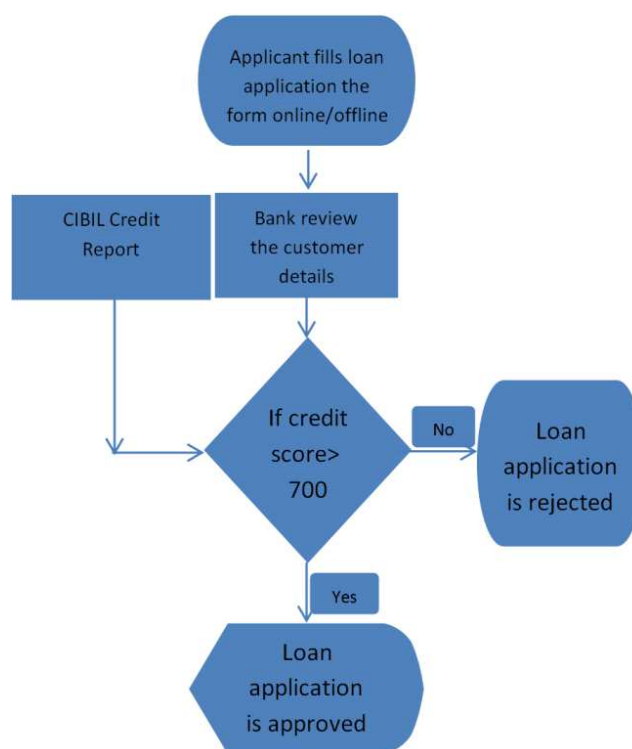2. Is credit scoring mathematics modela good measure to determine credit worthiness?

1.4. Research Hypothesis

There is no correlation between the attributes of a

borrower and its pay back potential.

2. Literature Review

In Nigeria, banking crisis has led to banking revolution which gave birth to the consolidated banks we have today. The 2008/2009 financial crash in Nigeria was a result of pressure which generated from the 2007/2008 global financial crisis; and the report of the Growth Commission which posits that the crisis was a destructive malfunction of the financial sectors of the advanced economies, which spread rapidly to the real economy and culminated to global distressed economies.

Source [4].

Figure 1. *Credit Approval Process.*

Risk management is one of the most critical standing factors behind banking crisis. Banking crisis as a situation where an economy faces large-scale financial distress within a short period [7, 8]. Banking crisis to a situation in which failures induce banks to suspend the internal convertibility of their liabilities or which compels the government to intervene to prevent this by extending assistance on a large scale [9]. Broadly speaking, banking crisis is the inability of a bank or group of banks to meet or sustain operational, supervisory and regulatory requirements.

Credit function is the heart of banking. Interest income is the main source of income for any bank. Therefore sustainable banking critically needs a sustainable loan management system which has a foresight and insight and able to predict customers performance potentials ahead of credit facility disbursement. Before approving the credit, proper evaluation process has to be followed. Before a potential debtor wants to obtain credit,

he must be evaluated on certain areas. There are five C's involved in credit evaluation. They are: credit report/score, character, collateral, capacity and cash flow. The five Cs of credit is a system used by banks to measure the creditworthiness of potential loan applicants [10]. The system weighs five characteristics of the borrower and conditions of the loan, using it to estimate the chance of default and, also the risk of a financial loss for the bank. The important in a bank relationship is the "know your client" (KYC) principle [4]. KYC is the main term used to garner and understand the customers' profile. It is crucial that banks deal with customers with proven reputation and credit-worthiness.
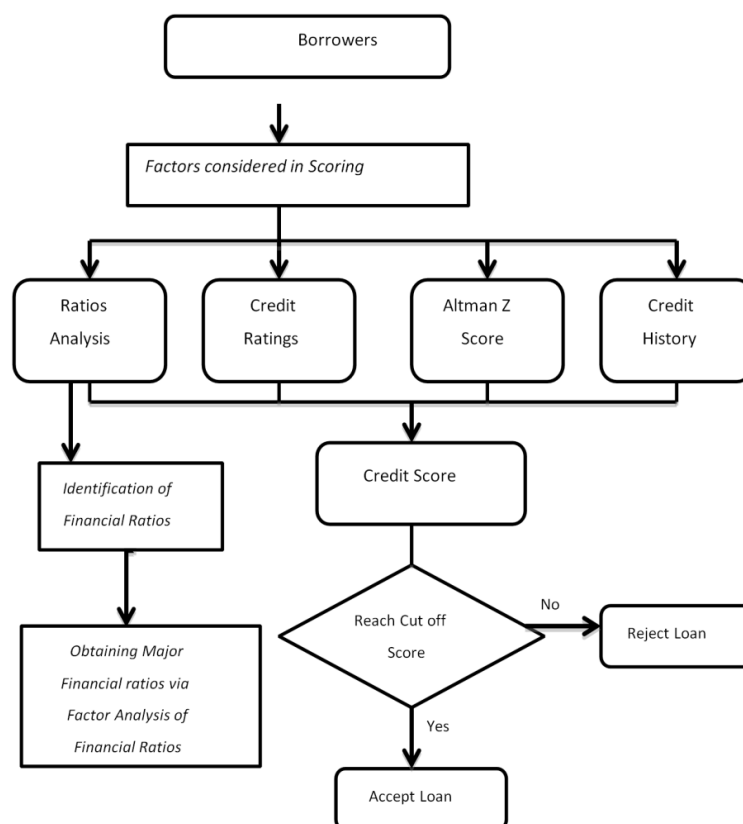
2.1. Loan Performance Rate in Nigeria

A loan default occurs when the borrower does not make required payments or in one way or the other way does not adhere to the terms of a loan [11]. The study, the Extent that Bank Credit Stimulate Economic Growth revealed that the lagged value of credit to the private sector is positively and significantly influencing economic growth in Nigeria while the lagged value of credit to the public sector shows a positively insignificant relationship with GDP [12]. Also in a research, "perceived loan risk and Ex Post Default" the outcome showed that the banks screening criteria was limited by the presence of information asymmetry [13]. Adverse selection and moral hazard were observed to persist in the loan market. In the same vein, examined Loan default rate and its impact on profitability in financial institutions. Results of the study show that there is high positive correlation between the constructs of loan default rate and profitability of the various micro-finance institutions [14]. The statistical finding showed significantly that proper management of loans given to client will yield more profit for the firm.

2.2. Credit Scoring Process

Over the years mathematics has attempted to proffer solution to many real world challenging situations in all fields of life especially in Computer Science, Accounting, Economy and Banking Sector. Credit scorecards are mathematical models which attempt to provide a quantitative estimate of the probability that a customer will display a defined behavior (e.g. loan default, bankruptcy or a lower level of delinquency) with respect to their current or proposed credit position with a lender or a bank. Scorecards are built and optimized to evaluate the credit files for good or bad performance. Credit scoring relies on customers' previous records and observations or data from clients who defaulted on their loans plus observations on a large number of clients who have not defaulted. Statistically, estimation techniques such as logistic regression or probit are used to create estimates of the probability of default for observations based on historical data. This model can be used to predict probability of default for new clients using the same observation characteristics (e.g. age, income, house owner). The default probabilities are then scaled to a "credit score." This score ranks clients by riskiness without explicitly identifying their probability of default.

Source [15].

Figure 2. A Typical Scoring Model.

There are a number of credit scoring techniques such as: hazard rate modeling, reduced form credit models, weight of evidence models, linear or logistic regression. The primary differences involve the assumptions required about the explanatory variables and the ability to model continuous versus binary outcomes. Some of these techniques are superior to others in directly estimating the probability of default. Despite much research from academics and industry, no single technique has been proven superior for predicting default in all circumstances.

2.3. Altman's Z Score

Altman's Z-Score is the most prominent and popular credit scoring model, it was developed in 1968, the Z-score equation was developed by Dr. Edward Altman, which is still used today to measure the financial position of an organization and a powerful indicative method that predict the bankruptcy of a corporation within couple of years and provide 75% to 80% accurate results. [16]

The Altman's Z Score formula is as allows:

$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 \ 1.0 + X_5$

X1 = Working capital/ Total assets ratio
X2 = Retained earnings/ Total assets ratio
X3 = Earnings before interest and taxes/ Total assets ratio
X4 = Market value of equity/ Book value of long-term debt ratio
X5 = Sales/Total assets ratio

Table 1. *Z Score Zone of Differentiation.*

Z > 2.99	"Safe" Zone	Low Default Risk
1.8 < Z < 2.99	"Grey" Zone	Medium Default Risk
Z < 1.80	"Distress" Zone	High Default Risk

In Table 1, there are three classes of Z score according to [16]. As the Z score increases the probability of default decreases "Any firm with a Z-Score less than 1.81 have been considered as having a high default risk, between 1.81-2.99 an indeterminate default risk, and greater than 2.99 a low default risk and lies in safe zone."

3. Methodology

This study aimed to determine the creditworthiness of bank customers by using proposed credit scoring model. The data was taken from primary as well as from secondary sources. Primary data was collected through the use of questionnaires. The secondary data was collected from all the financial statements of selected business owners in Ekpoma (Edo State) and credit history of these business owners as well. Two research design techniques were employed in this study. Namely: descriptive research and explanatory research designs. For the descriptive approach, unstructured interviews were conducted from the credit managers of some of the banks in Ekpoma to understand how they evaluate debtors' creditworthiness when granting credit facilities while for the explanatory research, components of credit scoring models were identified. The primary data was collected by personal interviews with the credit managers and by administering questionnaires while the secondary data were from the business owners profile and statements of accounts. 35 business owners were randomly selected from Ekpoma metropolis Edo State for this study based on loan applications and business capacity. Data collected were analysed using Altman Z-Score, frequencies and percentages while Pearson Product Moment Correlation was used to determine the relationship between scoring model and credit worthiness.

3.1. Scoring Method

Two factors were considered in scoring the respondents, Viz: financial and non-financial factors. Financial factors were obtained from the banks officer rating they include cash flow, previous loan return rate, Savings and turnover rate. While the non-financial factors include assists and collateral. The financial factors as well as non-financial components were given either 1, 2 or 3 credit score. Thus, the banks can choose scoring that is most suitable to them; this scoring was chosen because it seems easy. Credit score 1 means high default risk, 2 represent the medium risk and 3 credit score indicate a low level of default risk. So lower the credit score the higher the risk and the lesser the creditworthiness of a customer and high credit score represents a low default risk and more creditworthiness of the customer. The ranges of ratios were divided into three categories which are low, medium and high risk and accordingly assigned credit score of 3, 2 & 1 respectively.

3.2. Financial and Non-financial Factors

The total weightage of financial factors are 80%. Financial factors include all the relevant ratios necessary while evaluating the credit risk of an applicant, all the financial ratios have 70% weightage in this model, while the Altman''s Z-Score which is also the part of financial factors have 10% weightage. The nonfinancial factors have 20% weightage in the credit scoring model for corporations. There are two factors in the non-financial component which are credit rating and credit scoring. Credit rating as well as credit history has equal weightage equal to 10%.

Table 3	Scoring	Scoring	Scoring	Score
1. FINANCIAL FACTORS =80%	**1**	**2**	**3**	
Liquidity Ratios				
Current Ratio	< 1	1-1.5	> 1.5	
Quick Ratio	< 0.75	0.75-1.25	> 1.25	
Profitability Ratios				
Gross Profit Margin	< 1.5	1.5 - 5%	> 5%	
Operating Income Margin	< 1.5	1.5 - 5%	> 5%	
Net Profit Margin	< 1.5	1.5 - 5%	> 5%	
Return on Assets (ROA)	< 5%	5 – 15%	> 15%	
Return on Equity (ROE)	< 10 %	10 - 20%	> 20%	
Sales growth (in past 2 years)	< 5%	5-20%	> 20%	
Financial Leverage Ratios				
Debt to Equity	> 1.2	0.8 - 1.2	< 0.8	
Total Debts to Assets	> 1.2	0.8 - 1.2	<0.8	
Debt Leverage Ratio	> 5	1.5 - 5	< 1.5	
Coverage Ratios				
Interest Coverage Ratio	< 1	1 - 1.5	>1.5	
Debt Service Coverage Ratio	< 1.2	1.2 - 2	> 2	
Activity / Efficiency Ratios				
Receivable Turnover – days	> 120	60 - 120	< 60	
Days Sales in Inventory	> 180	90-180	< 90	
Payable Turnover – days	> 90	30 - 90	< 30	
Market Ratios				
Earnings Per Share (EPS)	< 10	10 - 50	>50	
Price Earnings (PE) Ratio	< 20	20 - 25	> 25	
Altman Z-Score = 10%	<1.8	1.80-2.99	> 2.99	
Total Score - Financial factors				80(max)
2. NON-FINANCIAL FACTORS=20%				
Credit Rating	CCC-C	B-BBB	A-AAA	
Credit History- days	>= 90	>=30 &<90	Never defaulted	
Total Score – Non-Financial factors				20(max)
TOTAL SCORE				**100(max)**

Source [15].

***Figure 3.** Credit Scoring Model for Corporations (CSMC).*

Haven considered these previous model developed by [15] and Altman Z-Score a 4 point rating scale was developed for this study using the loan applicants financial and non-financial of data. The model developed for this study is shown below:

***Table 2.** Credit Scoring method and Risk level.*

Credit Score Range (In %)	Risk Level	Risk Class and Credit worthiness
91 -100	Very Low Risk	A (Worthy & very able to payback)
76- 90	Low Risk	B (Worthy& less able to pay back)
55 – 75	High risk	C (worthy& not able to pay)
< 55	Very High Risk	D (not Worthy at all)

Based on the scoring techniques there are four risk classes which are A, B, C & D. Risk class A shows very low default risk due to highest credit score and considered qualified for loan. Risk class B shows low default risk because of high credit score and also judged qualified. Risk class C represents high level of default/ credit risk as having average level of credit score, though judged qualified the tendency of payback is highly probable. Risk class D indicates the highest level of risk and also having below average credit score and it is considered not qualified at all. When the credit score of any individual lies in the first category between range of 91% to 100%, (Risk class A) which has lowest possible default risk and judge by banks as good loan demanding highest quality.

The cut off score of this model is 55%. When the credit score is below 55%, the prospective borrower does not succeed for the grant of credit. Any customer having credit score below 55%, which is the cut off score, will be rejected and does not qualify for a loan. While, any borrower having credit score above 55% will be accepted and loan will be granted. Below cut off score it is riskiest to grant credit to a customer while above cut off score there is relatively low default risk depending upon their risk class.

4. Results

Table 3 shows that majority of the respondents 20 (57.10%) out of the 35 respondents were judged to be credit worthy and have the capacity to pay back the credit promptly, 8 (22.90%) were found worthy and less able to pay back the credit facilities, 5 (14.30%) were also found worthy but are likely to be unable to pay back the credit facility while 2 (5.70%) were found not to be credit worthy at all.

***Table 3.** Scoring Analysis.*

Credit Score Range (In %)	Risk Class	Weight	Frequency	Percentage %
91 -100	A	3	20	57.10
76- 90	B	2	8	22.90
55 – 75	C	1	5	14.30
< 55	D	-	2	5.70
Total			35	100

Source Field Survey.

***Table 4.** Correlations of credit score and creditworthiness.*

		Credit score	Credit worthiness
Credit score	Pearson Correlation	1	1.000^{**}
	Sig. (2-tailed)		.000
	N	35	35
Credit worthiness	Pearson Correlation	1.000^{**}	1
	Sig. (2-tailed)	.000	
	N	35	35

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4 shows the Pearson Product Moment Correlation between credit score and credit worthiness, from the table r =1.000 which shows a strong perfect positive correlation. This indicate that the higher the credit score the more credit worthy the loan applicant. There is also a significant ($p<0.005$) relationship between credit score and credit worthiness

5. Discussion

The credit risk management strategies are measures employed by banks to avoid or minimize the adverse effect of credit risk. A sound credit risk management framework is crucial for banks so as to enhance profitability, sustainability and constantly breathing business in the modern crucial economic state. The developed model used in this study grouped loan applicants into four risk classes and perfectly forecast their repayment abilities. This can been seen from the r value of 1.000 which shows a strong perfect positive relationship and the proven significant ($p<0.005$) statistical relationship between credit score and credit worthiness.

6. Conclusion

This study was carried out to identify relevant attributes that signal the capacity of borrowers to pay back the loan and determine the fit of scoring model to evaluate credit worthiness of a potential borrower. Two research questions were raised to guide the study and a hypothesis tested. The results showed that credit scores developed from borrowers financial and non-financial record and history such as turnover, assets, previous loan repayment rate and trading capital perfectly classified them into five risk classes of A (Worthy and very able to payback), B (Worthy & less able to pay back), C (worthy and not able to pay) and D (not Worthy at all). Evaluating the result shows that credit score can safe guard banks and creditors against credit risk default and loss of their money.

7. Recommendation

Based on the findings the study recommend as follows
1. Banks and Credit facilities handler should adopt credit

scoring techniques to avoid loss of their money.

2 customers below the average score on the credit scoring model should not be given loan facilities.

3. Customers on average score should be granted loan facilities with intensive follow up.

Appendix

DESCRIPTIVES VARIABLES=Score
/SAVE
/STATISTICS=MEAN STDDEV MIN MAX.

Table 5. Z-Score Analysis of Respondents.

SN	Credit Score	Z-score	Remark
1.	3.00	.77152	W&AP
2.	3.00	.77152	W&AP
3.	2.00	-.30861	W&LAP
4.	1.00	-1.38873	W&NAP
5.	3.00	.77152	W&AP
6.	2.00	-.30861	W&AP
7.	3.00	.77152	W&AP
8.	3.00	.77152	W&AP
9.	2.00	-.30861	W&LAP
10.	3.00	.77152	W&AP
11.	1.00	-1.38873	W&NAP
12.	3.00	.77152	W&AP
13.	3.00	.77152	W&AP
14.	1.00	-1.38873	W&NAP
15.	1.00	-1.38873	W&NAP
16.	1.00	-1.38873	W&NAP
17.	2.00	-.30861	W&LAP
18.	3.00	.77152	W&AP
19.	3.00	.77152	W&AP
20.	3.00	.77152	W&AP
21.	3.00	.77152	W&AP
22.	3.00	.77152	W&AP
23.	3.00	.77152	W&AP
24.	3.00	.77152	W&AP
25.	2.00	-.30861	W&LAP
26.	2.00	-.30861	W&LAP
27.	3.00	.77152	W&AP
28.	3.00	.77152	W&AP
29.	.00	-2.46885	NW
30.	3.00	.77152	W&AP
31.	3.00	.77152	W&AP
32.	2.00	-.30861	W&LAP
33.	2.00	-.30861	W&LAP
34.	2.00	-.30861	W&LAP
35.	.00	-2.46885	NW

Table 6. Notes.

Output Created		08-JAN-2020 14:05:31
Comments		
Input	Active Dataset	DataSet0
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	37
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	All non-missing data are used.
Syntax		DESCRIPTIVES VARIABLES=Score /SAVE /STATISTICS=MEAN STDDEV MIN MAX.
Resources	Processor Time	00:00:00.05
	Elapsed Time	00:00:00.09
Variables Created or Modified	ZScore	Zscore (Score)

***Table 7.** Descriptive Statistics.*

	N	Minimum	Maximum	Mean	Std. Deviation
Score	35	.00	3.00	2.2857	.92582
Valid N (listwise)	35				

[DataSet0]

***Table 8.** Correlations of credit score and creditworthiness.*

		Credit score	Credit worthiness
Credit score	Pearson Correlation	1	1.000[**]
	Sig. (2-tailed)		.000
	N	35	35
Credit worthiness	Pearson Correlation	1.000[**]	1
	Sig. (2-tailed)	.000	
	N	35	35

[**]. Correlation is significant at the 0.01 level (2-tailed).
Correlation between credit scores and Credit wordiness.

References

[1] Kargi, H. S. (2011). Credit Risk and the Performance of Nigerian Banks, Ahmadu Bello University, Zaria.

[2] Basel Committee on Banking Supervision (2001). Risk Management Practices and Regulatory Capital: Cross-Sectional Comparison (available at www.bis.org).

[3] Afriyie, H. O. and Akotey J. O. (2011) Credit Risk Management and Profitability of Selected Rural Banks In Ghana. Faculty of Economics and Business Administration Catholic University College of Ghana. Pp 1-18.

[4] Sudhakar M1 and Reddy C. V. K. (2016) Two Step Credit Risk Assessment Model for Retail Bank Loan Applications using Decision Tree Data Mining Technique. *International Journal of Advanced Research in Computer Engineering & Technology* (IJARCET), 5 (3), pp 1-14.

[5] Bakpo F. S. and Kabari, L. G. (2009) Credit Risk Evaluation System: An Artificial Neural Network Approach. Nigerian Journal of Technology, publishing research reports.

[6] https://en.m.wikipedia.org.

[7] Vodová, P. (2014) Credit Risk as a Cause of Banking Crises. Silesian University, School of Business Administration, Czech Republic pp 1-25.

[8] https://www.google.com/m?q=slaessens+and+laeven+%29+ba nking+crisis&clients=ms-opera-mobile&chanel=new&espv=1.

[9] IMF (1999). Annual Report of the Executives board for the financial year ended April, 30 1999.

[10] Bharati M. R., (2019) "Data Mining Techniques and Applications", Indian Journal of Computer Science and Engineering Vol. 1 No. 4. pp 3-8.

[11] Murray, J. (2011). Default on loan united states Business law and Taxes Guide.

[12] Bakare, I. A. O, Ajibola, A. I & Samuel, K. H. (2015). To what extent does Banks' credit stimulate Economic Growth? Evidence from Nigeria. 13 (1).

[13] Ofonyelu, C. C., & Alimi, R. S. (2013). Perceived bank risk and Expose Default outcome. Are the Banks' loans screening criteria Efficient? Asian Economic and Financial Review, 3 (8), 991–1002.

[14] Ntiamuah, B & Ofeng, A. (2014). Loan default rate and its impact on profitability in financial institution. Research journal of Finance and accounting, 5, 14, 67-72.

[15] Asia, et al (2013). International Journal of Applied Information Systems (IJAIS) - ISSN: 2249-0868. Foundation of Computer Science. FCS, New Year, USA. www.ijais.org.

[16] Altman, E. (1968). Financial Ratios, Discrimination Analysis and the Prediction of Corporate Bankruptcy. *Journal of Finance, Vol. 23, No. pp. 589-609.*