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Developing a Credit Scoring of the SMEs Manufacturing based on Multi Criteria Decision Making (MCDM) Algorithm

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ABSTRACT

Credit risk is a very important risk to banks since failure of borrowers to make the required payment will lead to high non-performing loans. Hence, it is necessary for banks to develop a mechanism to gauge the credit risk of its borrowers. One of the methods is credit scoring. On the other hand, Small and Medium Enterprises (SMEs) are the backbone of the Malaysian economy and comprise of 98.5% of the total business established in Malaysia. Despite their importance to the economy of the country, access to finance is relatively limited. According to banks, lending money to SMEs is risky compared to large companies due to a few factors such as less of publicly available information, young and lack of collateral. Hence, this study tried to develop a credit scoring model to measure a score of the SMEs in malaysia by combining both financial and non-financial criteria. This study proposes a credit scoring method based on multi criteria decision making (MCDM) algorithm to measure the score of the potential borrowers at a certain time by using historic information.

Keywords: Credit risk, credit scoring, multi criteria decision making (MCDM), Small and Medium Enterprises (SMEs).

1 INTRODUCTION

The Small and Medium-sized Enterprises (SMEs) played an important role in stimulating innovation, economic growth, job creation and supporting the large-scale enterprises [1]. According to SME Corporation Malaysia, 98.5% of the businesses registered in Malaysia in 2016 are SMEs and contributed to 36.6% of the country's gross domestic product (GDP). On the other hand, SMEs contributes to more than half of national employment in Malaysia. However, the ability of SMEs to develop, grow, expand and strengthen themselves is totally depend on their capability to access finance. Report conducted by [2] shows that local SMEs have limited access to funding and only 52% of them are financed by bank funds.

The key reasons for rejection of SMEs financing applications include inadequate cash flow in meeting the repayment obligations, insufficient collateral and lack of solid accounting system, poor credit history, inability to provide the solid income tax statements and the integrity concerns [3], [4], [5].

The key rational of this paper is to examine the financial position of the SMEs company (manufacturing sector) applying loans from banks.

Study by [6] stated that the largest source of credit risk in banks come from default loans. Due to that, it is necessary for banks to look at the customer's financial information before granting loans and getting alerts on any credit issues related to the client that may give impact to the banks. Banks classify their customers as 'good' or 'bad' customers. The 'good' customers are classified as a group of customers that repaid the amount of loan on time, while 'bad' customers refer to the customers with the habit of late or missed payment. One of the most successful applications in classifying the customers risk categories is credit scoring. The customers are classified into 'good' or 'bad' depending on the aggregate score.

According to [7], credit scoring model is used to predict the probability of customer's default since it is able to assess the risk of the customers by capturing both financial and non-financial criteria. The financial are extracted from the customer's financial statement. Meanwhile, for non-financial, the customer's score is measured based on the relationship with banks, type of the business, collateral and so on. The score obtained from the credit scoring system helps banks in deciding either to grant loans or not.

Besides the credit scoring method, another famous model in forecasting the credit risk of the company are the Black Scholes Merton model and KMV model. The origin of both approaches went back to Fischer Black and Myron Scholes who developed Black Scholes model in 1973 to measure the option value.

2 DETERMINISTIC CRITERIA

The criteria used to develop the credit scoring in this study are divided into two main groups called financial and non-financial. The financial criteria are usually in the form of ratios and the value can be extracted based on the company's financial statement. The financial statement of the company includes the balance sheet, income statement and cash flow statement. Meanwhile, the non-financial criteria are evaluated based on the expert judgement. The criteria used in this study is summarized in Figure 1.

2.1 Financial Criteria

[8] define financial ratio as a relative magnitude of two selected numerical values, where the values are taken from the financial reports. The ratio is defined mathematically as simple division problem, which is to compare one number to other number. The ratio's value provide useful information regarding the company's financial condition and can be used to assess the company's strengths and weaknesses. According to [9], financial criteria are commonly used by banks to build their credit scoring model. In addition, ratio analysis is important for the banks and credit provider as they always rely on the financial ratio in assessing the performance of the company borrowing loans from them. Four categories of financial ratios are used in this study such as profitability, liquidity, activity and leverage. The formula to calculate the financial ratio is provided in Figure 2.

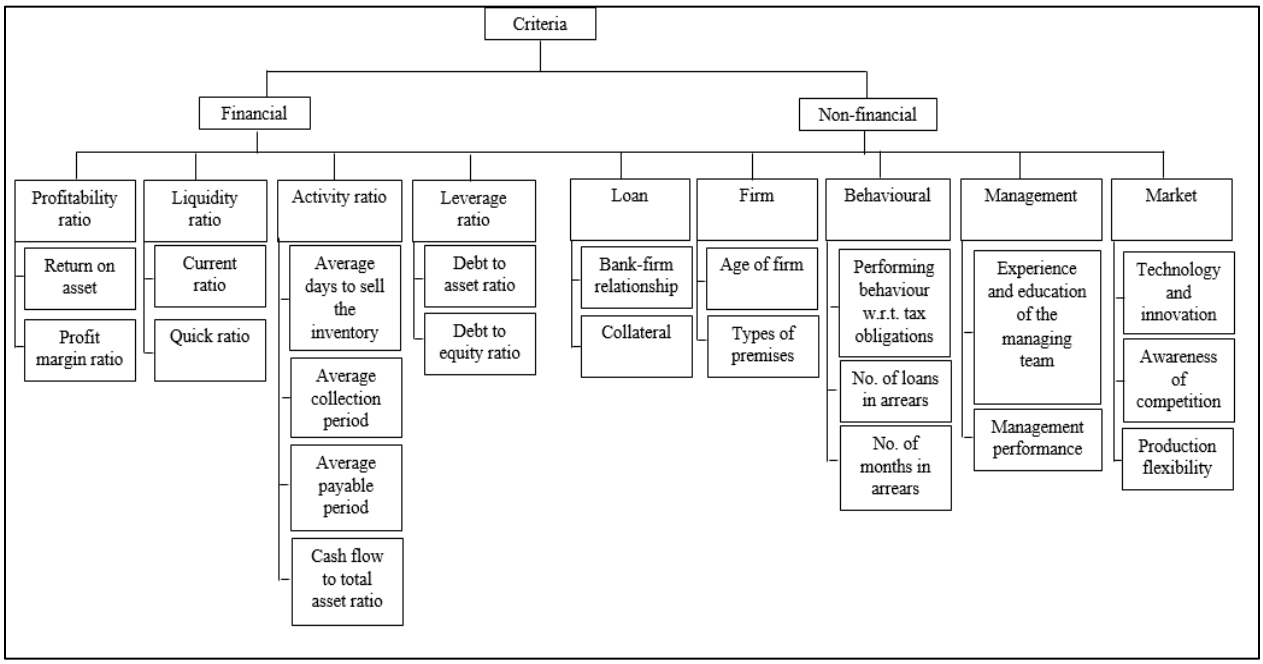

Figure 1 : The criteria and sub-criteria used in credit scoring development

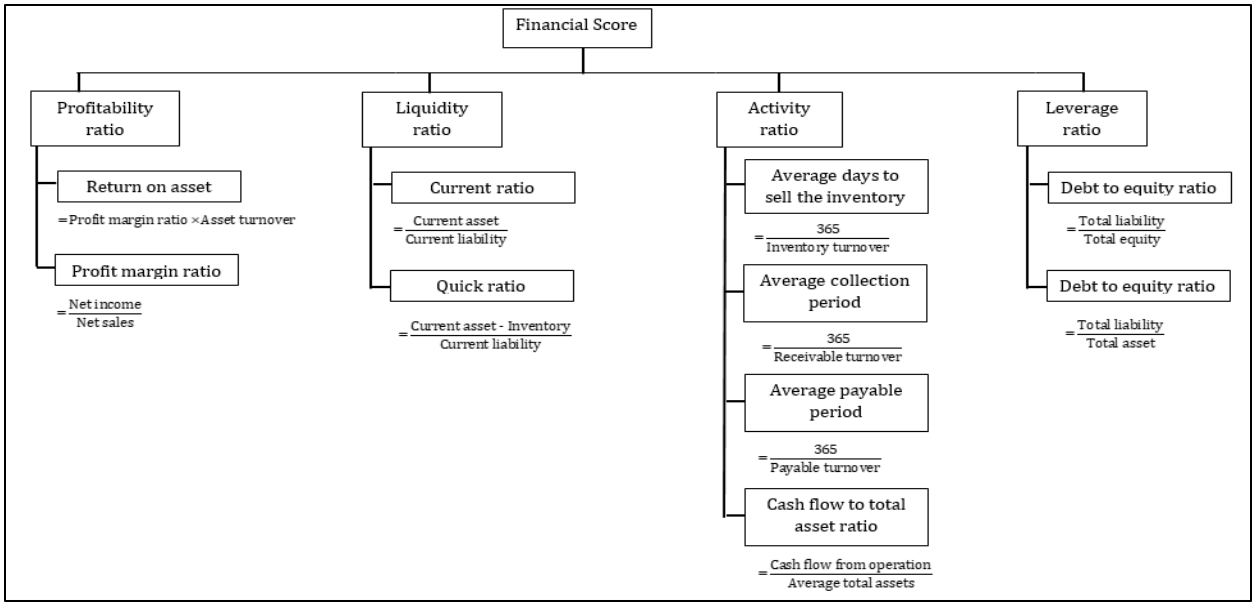

Figure 2 : The formula to calculate the financial ratio

2.1.1 Profitability Ratio

The profitability ratio is a group of financial metrics used to measure the ability of the company to use its cash and assets to generate profit and return on investment. For this ratio, the higher the value is favorable and shows that a company is doing well in generating profit and income. For this study, two ratios are used; return on assets and profit margin ratio.

Retun on assets is one important indicator to measure the company value. The finding by [10] show that the return on asset has a significance effect on the company value. This ratio is used to measure the relationship between the profits generated by the company and the assets that are used to generate those profits. Return on assets is a better measure of performance and profitability. Company with higher return on assets is most favorable since it shows that the company can manage their assets efficiently in generating profits.

The profit margin ratio is used to measure the efficiency of the company in converting it sales into net income. The greater value of profit margin ratio indicates the greater the ability of the company to cover expenses and also to earn a net profit. The market analysis always favors the company with profit margin above 25% since it indicates financial stability.

2.1.2 Liquidity Ratio

Liquidity ratio is an important financial metrics used to measure the company's potential to meet its near-term obligations as they come due. A company with adequate liquidity is favorable in dealing and negotiating with suppliers and financiers. [11] claim that both current and quick ratios are the most commonly ratios used to measure the company's short term liquidity.

Current ratio is used to measure the company's ability in paying its current obligations as they come due. Greater value of current ratio indicates the more capable the company in paying its short-term obligations on time. According to [12], the ideal minimum for current ratio is 2:1. The value of current ratio that is less than 1.0 shows that the company's current liabilities are more than the company's current assets and suggests that the company will have difficulty to pay off its obligations.

Quick ratio is more severe and strict test relative to current ratio and this ratio complements the current ratio. This test is considered more meaningful than the current ratio since this excludes current assets that may not be readily convert into cash such as inventories. Higher quick ratio is favorable since it indicates that the companies are capable in paying its obligations without selling any long-term assets.

2.1.3 Activity Ratio

The activity ratio refers to how the company's operations are being managed. This ratio indicates how company is able to efficiently use their assets and liabilities and capital share accounts to generate revenues in term of cash and sales. For this study, the ratios used are average days to sell the inventory, average collection period, average payable period, and cash flow to total asset ratio.

The average days to sell in inventory is used to measure how many days company takes to sell all of its inventory. Higher inventory turnover or less days to sell the inventories shows that the company has well managed its operation and less risky since the company can convert stock to cash quickly.

Average collection period is a ratio used to measure the period clients take to settle their debts. Prompt collection is favorable and the longer period the clients take to pay debts may affect the company's cash flow. It is also a sign that the clients are encountering difficulty to pay their debts.

The average payable period measure the time in days a company takes to pay dent to its supplier. A short period is favorable since it indicates the ability of the companies in settling their debts towards

their suppliers quickly. Longer period sometimes indicates that the company is having inefficient payment process. Besides, longer period will make the company paying extra debt to suppliers due to interest imposed for late payment.

The cash flow to total asset ratio is used to measure the amount of cash flow generated in relation to the company's assets. Higher ratio is preferable since it shows the efficiency of the company in using its assets. However, ratio that are too high sometimes show inability of the company in allocating enough resources in growing its business.

2.1.4 Leverage Ratio

The financial leverage is used to measure the company's solvency and the long-term debt obligations. The long-term debt is defined as the amount of loans owed lasting more than a year. The most common leverage ratio includes debt to equity ratio and debt to total asset ratio.

Debt to equity ratio is a ratio used to measure the relationship between debt and equity. It indicates the portion of debt and shareholder's equity used to finance the firm's assets and firm's operation.

The debt to total asset ratio is used by analyst, creditor and investor to measure debt level and overall risk of the business. It shows the percentage of total debt or liabilities to finance the company's assets.

2.2 Non-Financial Criteria

The non-financial or qualitative criteria are important in predicting the risk of the companies since the misspecification of financial criteria are largely corrected by non-financial criteria. The inclusion of non-financial criteria are necessary since the financial ratio of small companies do not contain enough and reliable annual income information. Study by [13] showed that the model with both financial and non-financial criteria is more efficient as compared to purely financial model and purely non-financial model. [14] in his study proved that the non-financial criteria are more important than the financial criteria. For this study, there are five non-criteria used such as loan criteria, firm criteria behavioral criteria, management criteria and market criteria.

2.2.1 Loan Criteria

The loan criteria are the criteria used to assess the relationship of the company with banks. During the process of reviewing the customer's loan, banks will consider how much the quality of the lending experience and relationship you have with bank. Good relationships with banks is one of the factors to determine the successful of the loan application. According to Fora Financial, one of the loan agencies in United States, a company could still receive the credit although the credit scoring of the company falls below bank requirement by submitting collateral. Banks define collateral as a property the company put up to secure or guarantee the repayment of loan. The collateral value is matched with the amount of loan. For this study, two sub-criteria are considered such as bank-firm relationship and collateral.

Bank-firm relationship measure the relationship between bank and the company. [15] state that these criteria measure the quality of the lending relationship with bank. Meanwhile, [9] measure the bank-firm relationship interms of the relationship between bank and the firm, also on the historical

records on the amount of loans and deposits. Besides, the study shows that this indicator is very important in accessing the company's credit score.

The collateral or guarantee refers to an asset that a bank or credoit provider accepts as a security for a loan. The collateral acts as a protection for the bank. The bank can seize the collateral if the client's default on their loan payments. Collateral helps bank in limitting the losses in the case of client's default by liquidating the collateral.

2.2.2 Firm Criteria

Firm criteria are the criteria used to assess the criteria related to firm. According to [16], the company is more profitable as it grows older, and its performance improves wuth the inrement of company's age. The criteria that we considered are age of firm and type of premises.

Age of firm refers to the length of time the company has started the business. [9] measures the age of firm in terms of firm's month of activity.

Meanwhile, type of premises refers to a building which is used to produce a good or services. [17] defines premises as the place where business is done. The choice of buying or renting is depend on the company's budget.

2.2.3 Behavioral Criteria

Behavioral criteria are the criteria used to explain the company's behavior. The sub-criteria that are involve under behavioral criteria are performing behavioral with respect to tax obligations, number of loans in arrears and number of months in arrears.

The sub-criteria performing behavioral with respect to tax obligations measures the company in terms of their compliance with all the laws, rules and regulations as a taxpayer. In Malaysia, self – assessment system (SAS) is implemented by Malaysian's government in collecting the tax from the taxpayer. Using this approach, the taxpayers are responsible to report their income and to determine their own tax liability.

Number of loans in arrears measure the number of loans which the instalment or a payment has been missed or not paid in full and is past its due date. Meanwhile, arrears as a financial term use to describe an obligation that has not received payment by its due date.

The number of months in arrears measures the number of months a loan payment has been missed or not paid in full and is past its due date. The clients who have missed payment for three consecutive months are considered as 'bad clients'.

2.2.4 Management Criteria

Management criteria are the factors used to assess the company's management team. The sub-criteria involve under management criteria include experience and education of the managing tem and management performance.

The sub-criteria experience and education of the managing team is a criterion used as indicator to measure the management team members in terms if their experience and education in managing the

company. The education reflects the person's knowledge and skill. In addition, they suggest that the education of management team is positively associated with innovation. The general experience of managing team leads to higher productivity and positively affect a firm's growth and economic value.

The management performance measure the management team members in terms of their performance in achieving the company's goal and target. The performance of management skills refers to the capability of an owners to channel the employees to achieve the company's goals.

2.2.5 Market Criteria

The criteria involve in market criteria include technology and innovation, awareness of competition and production flexibility.

The technology and innovation criterion measure the awareness of the company in adapting and implementing new technology in improving their productivity. The term innovation refers to introducing something new to the business by improving the business process to increase the efficiency and productivity, improving the existing product to differentiate the product from the competitors.

The awareness of competition measures the awareness of the company on the existence of the competitors and what action or research do they take to improve their products or services so that their product is acceptable in the market.

The production flexibility measure how company make used of the information, knowledge and is able to make changes on their product so that it satisfies the customer demands. According to [18], current manufacturing industries nowadays move towards more flexibility to respond quickly according to customer's requirements, new technologies and government regulations, and the ability to increase product variety while maintaining high system performance.

3 MEASURING TOTAL SCORE

This section provides the overall steps to measure the total score. The total score q is calculated by combining both the total financial score f and the total non-financial score b. Hence

$$q = f + b. \tag{1}$$

The value of f is calculated by using the formula:

$$f = W_{L1(f)} \times \sum_{i=1}^{10} S_{ci} \tag{2}$$

such that

$$\sum_{i=1}^{10} S_{ci} = S_{c1} + S_{c2} + S_{c3} + S_{c4} + S_{c5} + S_{c6} + S_{c7} + S_{c8} + S_{c9} + S_{c10}. \tag{3}$$

The variable W equals to weightage related to the criteria and S_{ci} is a score related to sub-criteria ci. Hence $W_{L1(f)}$ refers to level 1 financial criteria weightage. There are four criteria involved such as profitability ratio $z1$, liquidity ratio $z2$, activity ratio $z3$ and leverage ratio $z4$. Meanwhile, the sub-criteria involved in this study include return on asset $c1$, profit margin ratio $c2$, current ratio $c3$, quick ratio $c4$, average days to sell the inventory $c5$, average collection period $c6$, average payable period $c7$, cash flow-to-asset ratio $c8$, debt to asset ratio $c9$ and debt to equity ratio $c10$. The formula to calculate these 10 sub-criteria are given as:

$$S_{c1} = W_{L2(z1)} \times W_{L3(c1)} \times r \quad (4)$$

$$S_{c2} = W_{L2(z1)} \times W_{L3(c2)} \times r \quad (5)$$

$$S_{c3} = W_{L2(z2)} \times W_{L3(c3)} \times r \quad (6)$$

$$S_{c4} = W_{L2(z2)} \times W_{L3(c4)} \times r \quad (7)$$

$$S_{c5} = W_{L2(z3)} \times W_{L3(c5)} \times r \quad (8)$$

$$S_{c6} = W_{L2(z3)} \times W_{L3(c6)} \times r \quad (9)$$

$$S_{c7} = W_{L2(z3)} \times W_{L3(c7)} \times r \quad (10)$$

$$S_{c8} = W_{L2(z3)} \times W_{L3(c8)} \times r \quad (11)$$

$$S_{c9} = W_{L2(z4)} \times W_{L3(c9)} \times r \quad (12)$$

$$S_{c10} = W_{L2(z4)} \times W_{L3(c10)} \times r \quad (13)$$

The variable r is defined as performance rating, while $L2$ and $L3$ are level 2 and level 3 respectively. The value of performance rating r is obtaining by comparing the performance ratio ρ_{ra} with performance range ρ_{rg}. Each criterion has its own value of performance range and performance rating. As an example, Table 1 below provides the performance range and performance rating for return on asset $c1$.

Table 1 : Performance range and performance rating for return on asset

Performance range	Performance rating
$c1 < 0.015$	0.0
$0.015 \le c1 < 0.02$	0.1
$0.02 \le c1 < 0.03$	0.2
$0.03 \le c1 < 0.04$	0.3
$0.04 \le c1 < 0.05$	0.4
$0.05 \le c1 < 0.06$	0.5
$0.06 \le c1 < 0.07$	0.6
$0.07 \le c1 < 0.08$	0.7
$0.08 \le c1 < 0.10$	0.8
$0.10 \le c1 < 0.15$	0.9
$c1 \ge 0.15$	1.0

Meanwhile, the formula to calculate the total non-financial score, b is given as:

$$b = W_{L1(b)} \times \sum_{i=11}^{22} S_{ci} \tag{14}$$

such that

$$\sum_{i=11}^{22} S_{ci} = S_{c11} + S_{c12} + S_{c13} + S_{c14} + S_{c15} + S_{c16} + S_{c17} + S_{c18} + S_{c19} + S_{c20} + S_{c21} + S_{c22}. \tag{15}$$

The variable W equals to weightage related to the criteria and S_{ci} is a score related to sub-criteria ci. Hence $W_{L1(b)}$ refers to level 1 non-financial criteria weightage. There are five criteria involved such as loan criteria $z5$, firm criteria $z6$, behavioral criteria $z7$, management criteria $z8$ and market criteria $z9$. Meanwhile, the sub-criteria involved in this study include bank-firm relationship $c11$, collateral $c12$, age of firm $c13$, type of premise $c14$, performing behavioral with respect to tax obligations $c15$, number of loans in arrears $c16$, number of months in arrears $c17$, experience and education of the managing team $c18$, management performance $c19$, technology and innovation $c20$, awareness of competition $c21$ and production flexibility $c22$. The formula to calculate these 12 sub-criteria are given as:

$$S_{c11} = W_{L2(z5)} \times W_{L3(c11)} \times r \quad (16)$$

$$S_{c12} = W_{L2(z5)} \times W_{L3(c12)} \times r \quad (17)$$

$$S_{c13} = W_{L2(z6)} \times W_{L3(c13)} \times r \quad (18)$$

$$S_{c14} = W_{L2(z6)} \times W_{L3(c14)} \times r \quad (19)$$

$$S_{c15} = W_{L2(z7)} \times W_{L3(c15)} \times r \quad (20)$$

$$S_{c16} = W_{L2(z7)} \times W_{L3(c16)} \times r \quad (21)$$

$$S_{c17} = W_{L2(z7)} \times W_{L3(c17)} \times r \quad (22)$$

$$S_{c18} = W_{L2(z8)} \times W_{L3(c18)} \times r \quad (23)$$

$$S_{c19} = W_{L2(z8)} \times W_{L3(c19)} \times r \quad (24)$$

$$S_{c20} = W_{L2(z8)} \times W_{L3(c20)} \times r \quad (25)$$

$$S_{c21} = W_{L2(z8)} \times W_{L3(c21)} \times r \quad (26)$$

$$S_{c22} = W_{L2(z9)} \times W_{L3(c22)} \times r \quad (27)$$

For non-financial sub-criteria score, the value of r is obtained based on the evaluation from the bank officers. The value of r range from 0.0 to 1.0.

The total score for Company 01 is calculated and the total score is provided in Table 3. Based on the financial statement, we measure the financial score for each criterion by using the formula provided in Figure 2. The financial statement for Company 01 is attached in Appendix 1. As an example, the performance ratio and performance rating $c1$ until $c10$ for 20X1 is presented in Table 2 below.

Table 2 : The performance ratio and performance rating for Company 01

Performance ratio	Performance rating, r
$c1 = \text{Profit margin ratio} \times \text{Asset turnover}$ $= (-0.64) \times 0.2803362$ $= -0.18$	0.0
$c2 = \frac{\text{Net income}}{\text{Net sales}} = \frac{-634155}{986467} = -0.64$	0.0
$c3 = \frac{\text{Current asset}}{\text{Current liability}} = \frac{885531}{785364} = 1.13$	0.3
$c4 = \frac{\text{Current asset - Inventory}}{\text{Current liability}} = \frac{885531 - 67084}{785364} = 1.04$	0.1
$c5 = \frac{365}{\text{Inventory turnover}} = \frac{365}{13.49694413} = 27$	1.0
$c6 = \frac{365}{\text{Receivable turnover}} = \frac{365}{1.4424436} = 253$	0.1
$c7 = \frac{365}{\text{Payable turnover}} = \frac{365}{1.4880519} = 245$	0.1
$c8 = \frac{\text{Cash flow from operation}}{\text{Average total assets}} = \frac{-431032}{3518871} = -0.12$	0.0
$c9 = \frac{\text{Total liability}}{\text{Total equity}} = \frac{785364}{3518871} = 0.22$	1.0
$c10 = \frac{\text{Total liability}}{\text{Total asset}} = \frac{785364}{2733507} = 0.29$	1.0

Once the value of r is obtained, the score for each financial sub-criterion is calculated. Equations (4) to (13) are used to measure the score for all sub-criterion under financial. The table below shows the calculation of financial score for Company 01 for the year 20X1.

Table 3 : The calculation of financial score for Company 01

Criteria (ratio)	**Weight of criteria**	**Sub-criteria**	**Weight of sub-criteria**	ρ_{ra}	r	**Score**
Profitability	0.2522	Return of assets	0.4423	-0.18	0.0	0.0000
		Profit margin ratio	0.5577	-0.64	0.0	0.0000
Liquidity	0.2684	Current ratio	0.5332	1.13	0.3	0.0429
		Quick ratio	0.4668	1.04	0.1	0.0125
Activity	0.2299	Average days to sell the inventory	0.2770	27	1.0	0.0637
		Average collection period	0.2455	253	0.1	0.0056
		Average payable period	0.2794	245	0.1	0.0064
		Cash flow to total asset ratio	0.1981	-0.12	0.0	0.0000
Leverage	0.2495	Debt to asset ratio	0.484	0.22	1.0	0.1208
		Debt to equity ratio	0.516	0.29	1.0	0.1287
				Total sub-criteria score (financial)		0.3807
					f	0.2087

The total sub-criteria (financial) score is obtained by using (3) and to measure *f*, formula (2) is used. The weightage value for financial criteria $W_{L1(f)}$ is 0.2087. The weightage value for each criteria and sub-criteria are based on the input from 27 bank experts from 3 local banks. The weight of each criterion is presented in Appendix 2. The procedure in calculating the total sub-criteria (financial) score follows the study by [23].

For non-financial score, the performance scale ρ_{sca} is evaluated by the credit officer at the first time the customers applied for credit facility. The sample of credit rating is provided in Appendix 3. Meanwhile, the score for each non-financial sub-criterion is measured using (16) until (27). Table 4 shows the calculation of non-financial score for Company 01 for the year 20X1.

Table 4 : The calculation of non-financial score for Company 01

Criteria	Weight of criteria	Sub-criteria	Weight of sub-criteria	ρ_{sca}	Score
Loan	0.1907	Bank-firm relationship	0.5081	0.8	0.0775
		Collateral	0.4919	0.8	0.0750
Firm	0.1937	Age of firm	0.5146	0.5	0.0498
		Type of premises	0.4854	0.6	0.0564
Behavioral	0.2060	Performing behavior w.r.t. tax obligations	0.2758	0.9	0.0511
		No. of loans in arrears	0.3605	0.8	0.0594
		No. of months in arrears	0.3637	0.9	0.0674
Management	0.2066	Experience and education of the managing team	0.4973	0.5	0.0514
		Management performance	0.5027	0.6	0.0623
Market	0.2031	Technology and innovation	0.3282	0.6	0.0533
		Awareness of competition	0.3462	0.8	0.0563
		Production flexibility	0.3256	0.8	0.0529
				Total sub-criteria score (non-financial)	0.7128
				f	0.3220

The total sub-criteria (non-financial) score is obtained by using (15) and to measure b, formula (14) is used. The procedure in calculating the total sub-criteria (non-financial) score follows the study by [19]. Hence,

$$\begin{aligned} b &= W_{L1(b)} \times \sum_{i=11}^{22} S_{ci} \\ &= 0.4517 \times 0.7128 \\ &= 0.3220 \end{aligned}$$

where the weightage value for non-financial factor, $W_{L1(b)}$ is presented in Appendix 4 and

$$\begin{aligned} \sum_{i=11}^{22} S_{ci} &= 0.0775 + 0.0750 + 0.0498 + 0.0564 + 0.0511 + 0.0594 + 0.0674 + 0.0514 + 0.0623 \\ &\quad + 0.0533 + 0.0563 + 0.0529 \\ &= 0.7128 \end{aligned}$$

Hence, the total score for Company 01 for 20X1 is given as:

$$q = f + b$$
$$= 0.2087 + 0.3220$$
$$= 0.5307.$$

4 CONCLUSION

This study demonstrated the most important and useful variables to develop the credit scoring model. There are four financial criteria involved such as profitability, liquidity, activity and leverage ratios. For non-financial, the criteria involved are loan criteria, firm criteria, behavioural criteria, management criteria and market criteria. There are also the sub-criteria involved under each of the financial and non-financial criteria. List of all criteria and sub-criteria used in this study are presented in Figure 1. These criteria are filtered based on the discussion with the bank officers who involved directly in providing loan to SMEs companies.

The algorithm for credit scoring model is presented in Figure 3 until Figure 5. In Figure 3, the total score q is measured by combining the financial criteria f and non-financial criteria b.

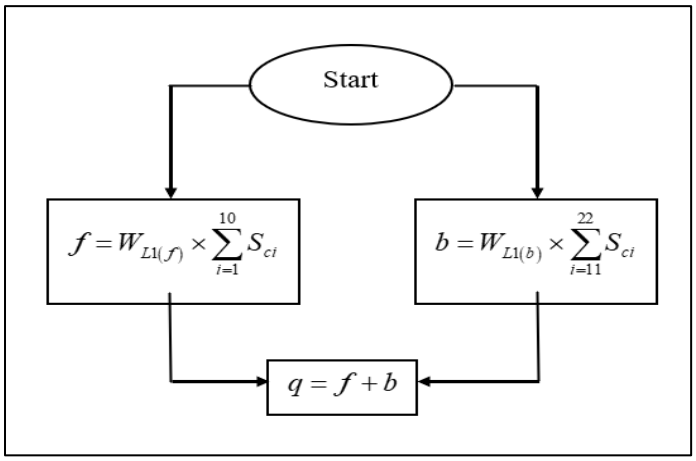

Figure 3 : Algorithm for credit scoring model (total score)

where:

q	=	Total score
f	=	Total financial score
b	=	Total non-financial score
S_{ci}	=	Score related to criteria i
$W_{l1(f)}$	=	Weightage of financial criteria
$W_{l1(b)}$	=	Weightage of non-financial criteria

Figure 4 presents the algorithm to measure the financial criteria. In the first column all the formula to measure the weightage of the criteria under financial are listed. In column three, all the formula to measure the financial ratio are presented meanwhile, the performance rating r in column four. The performance rating is generated by comparing the value of performance ratio with performance range. The score for each sub-criterion is shown in the last column. For example, to measure the score for sub-criterion return on asset S_{c1}, the formula in (4) is used:

$$S_{c1} = W_{L2(z1)} \times W_{L3(c1)} \times r$$

where $W_{L2(z1)}$ is the weightage for profitability ratio and $W_{L3(c1)}$ is the weightage for sub-criterion return on asset. Thus, the total score is calculated by using formula

$$f = W_{L1(f)} \times \sum_{i=1}^{10} S_{ci}$$

and $\sum_{i=1}^{10} S_{ci}$ is the summation of all the financial sub-criteria score.

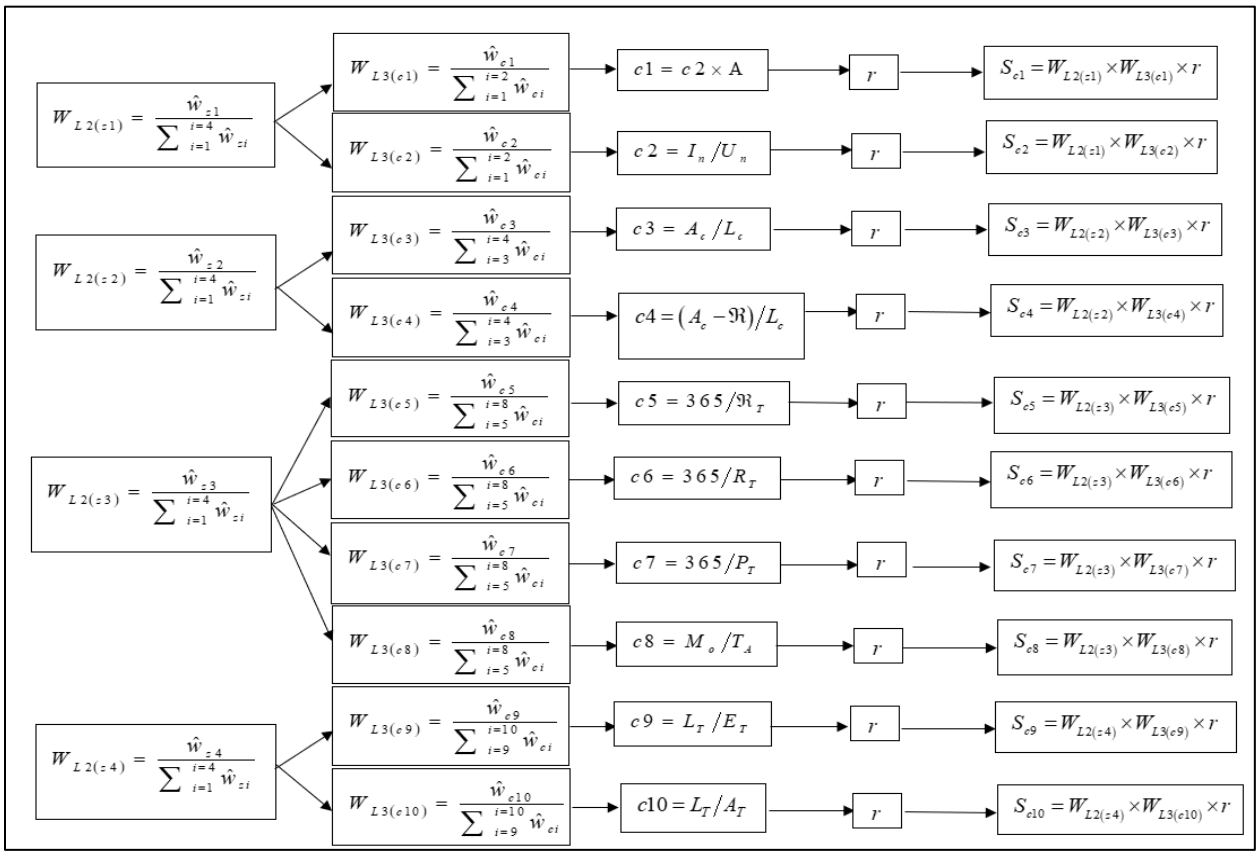

Figure 4 : Algorithm for credit scoring model (financial score)

Figure 5 presents the algorithm to measure the non-financial criteria. In the first column all the formula to measure the weightage of the criteria under non-financial are listed. Meanwhile, the formula to measure the weightage of the sub-criteria under non-financial are listed in the second column. The performance rating r is presented in column three. For non-financial sub-criteria, the performance rating is evaluated by bank officer once the company send the loan application. In the last column, the score for each sub-criterion is measured. For example, to measure the score for sub-criterion bank-firm relationship S_{c11}, the formula as in (16) is used:

$$S_{c11} = W_{L2(z5)} \times W_{L3(c11)} \times r$$

such that $W_{L2(z5)}$ is the weightage for loan criteria and $W_{L3(c11)}$ is the weightage for sub-criterion bank-firm relationship. Thus, the total score is calculated by using formula

$$b = W_{L1(b)} \times \sum_{i=11}^{22} S_{ci}$$

and $\sum_{i=11}^{22} S_{ci}$ is the summation of all the non-financial sub-criteria score.

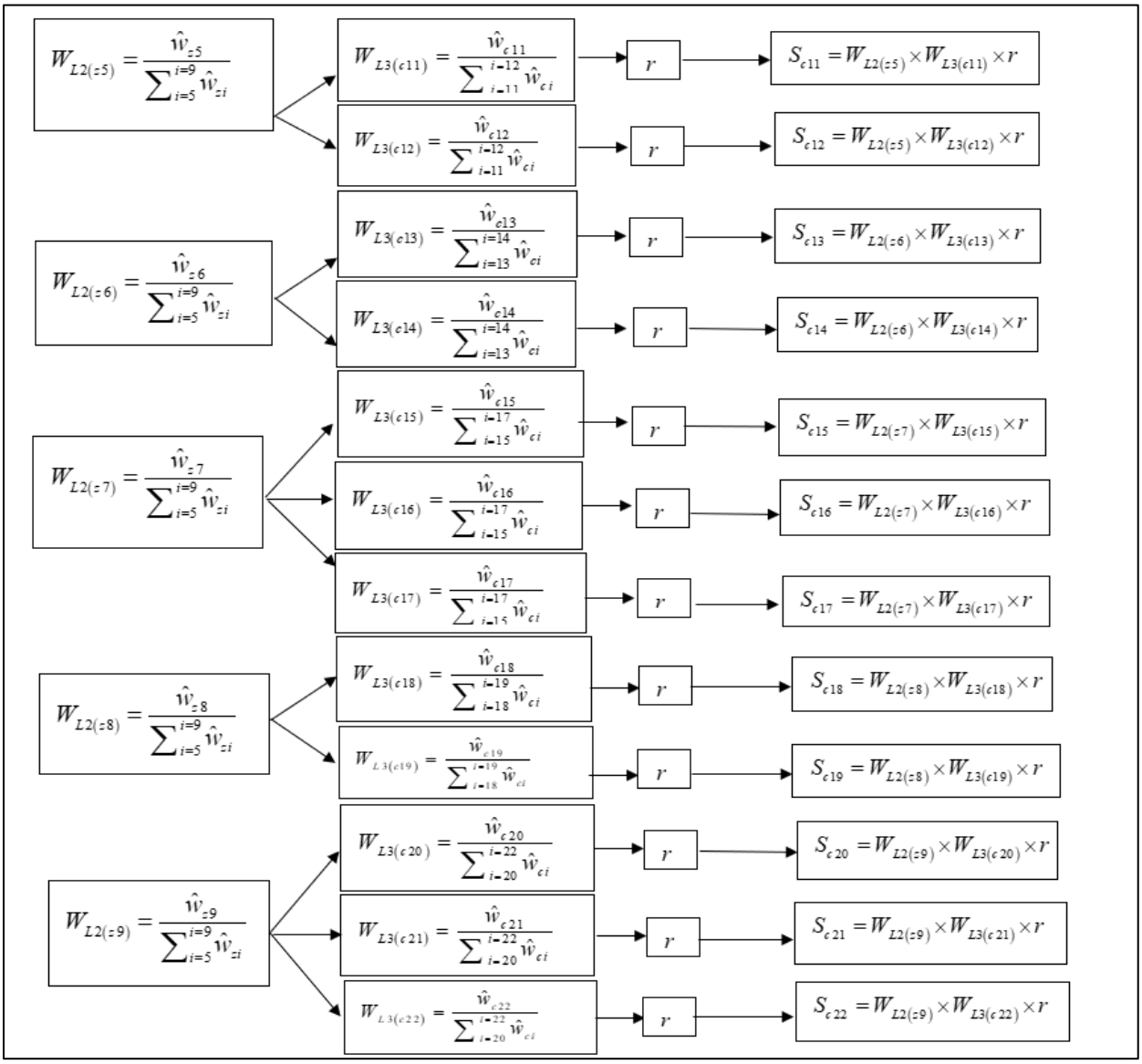

Figure 5 : Algorithm for credit scoring model (non-financial score)

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APPENDIX 1

"Company 01"

Statement of profit or loss and other comprehensive income For the year ended 20X3

Statement Date	**20X1**	**20X2**	**20X3**
Period Length	**12 months**	**12 months**	**12 months**
Revenue	986,467.00	5,146,287.00	32,269,811.00
Less: Cost of sales	905,429.00	1,345,224.00	17,226,593.00
Gross profit	81,038.00	3,801,063.00	15,043,218.00
Less: Operating expenses	3,166,748.00	5,568,829.00	8,825,236.00
Net operating income/(loss)	-3,085,710.00	-1,767,766.00	6,217,982.00
Other expenses	0.00	0.00	0.00
Other income	2,451,555.00	22,920.00	0.00
Earning before interest, tax and depreciation	-634,155.00	-1,744,846.00	6,217,982.00
Interest income	0.00	0.00	0.00
Finance costs	0.00	112,100.00	370,800.00
Earning before tax	-634,155.00	-1,856,946.00	5,847,182.00
Income tax expenses	0.00	0.00	0.00
Net income	-634,155.00	-1,856,946.00	5,847,182.00
Less: Dividends	0.00	0.00	0.00
Adjustments	**0.00**	**0.00**	**0.00**
Retained earnings	**-634,155.00**	**-1,856,946.00**	**5,847,182.00**

Company 01			
Balance sheet as of 31 December 20X3			
Statement Date	**20X1**	**20X2**	**20X3**
Period Length	**12 months**	**12 months**	**12 months**
ASSETS			
Current assets			
Cash and cash equivalents	134,561.00	697,040.00	9,402,054.00
Trade and other receivables	683,886.00	2,437,222.00	10,875,548.00
Inventories	67,084.00	116,988.00	3,892,681.00
Other current assets			0.00
Total current assets	**885,531.00**	**3,251,250.00**	**24,170,283.00**
Non-current assets			
Property, plant and equipment	2,288,340.00	17,771.00	550,672.00
Investment	345,000.00	345,000.00	275,000.00
Intangible assets	0.00	0.00	0.00
Deferred tax asset	0.00	0.00	0.00
Other non-current assets	0.00	0.00	0.00
Total non-current assets	**2,633,340.00**	**362,771.00**	**825,672.00**
Total assets	**3,518,871.00**	**3,614,021.00**	**24,995,955.00**
LIABILITIES			
Current liabilities			
Bank overdraft	0.00	0.00	0.00
Trade payables	608,466.00	2,585,972.00	16,179,600.00
Interest payable	0.00	0.00	0.00
Current tax liability	0.00	0.00	0.00
Other current liabilities	176,898.00	151,482.00	238,442.00
Total current liabilities	**785,364.00**	**2,737,454.00**	**16,418,042.00**
Non-current liabilities			
Borrowings	0.00	0.00	0.00
Deferred tax liabilities	0.00	0.00	0.00
Other non-current liabilities	0.00	0.00	0.00
Total non-current liabilities	**0.00**	**0.00**	**0.00**
			16,418,042.00
Equity			
Share capital	5,900,000.00	5,900,000.00	5,900,000.00
Retained earnings	-3,166,493.00	-5,023,433.00	2,677,913.00
Other equity	0.00	0.00	0.00
Equity	**2,733,507.00**	**876,567.00**	**8,577,913.00**
Total Liabilities and equity	**3,518,871.00**	**3,614,021.00**	**24,995,955.00**

Detailed cash flow

Statement Date	20X1	20X2	20X3
Period Length	12 months	12 months	12 months
Cash Flows from/(used in) Operating Activities			
Cash Receipt from customers	-67,084.00	-49,904.00	-3,241,438
Cash paid to suppliers and employees	2,809,413.00	3,415,871.00	24,365,740.00
Inventories	-3,173,361.00	-5,039,788.00	-13,874,761
Net cash from/(used in) operating activities	**-431,032.00**	**-1,673,821.00**	**7,249,541.00**
Cash flow from/(used in) investing expenses			
Purchase of property, plant and equipment	-36,765.00	-10,510.00	-832,064
Proceeds from disposal of property, plant and equipment	380,250.00	-1,903,447.00	2,200,578.00
Disposal of investment in subsidiaries	143,000.00	0.00	0.00
Loss in disposal of fixed assets	-148,150.00	4,175,660.00	0.00
Net cash from investing activities	**338,335.00**	**2,261,703.00**	**1,368,514.00**
Cash flow used in financing activities			
Repayment of borrowings	-4,626,758.00	-25,404.00	86,960.00
Issuance of shares	4,900,000.00	0.00	0.00
Interest paid	0.00	0.00	0.00
Dividends paid	0.00	0.00	0.00
Net cash used in financing activities	**273,242.00**	**-25,404.00**	**86,960.00**
Net increase in cash and cash equivalents during the year	180,545.00	562,478.00	8,705,015.00
Effect of exchange rate changes on cash and cash equivalents	0.00	0.00	0.00
cash and cash equivalents at beginning of year	-45,984.00	134,561.00	697,039.00
cash and cash equivalents at end of year	**134,561.00**	**697,039.00**	**9,402,054.00**

APPENDIX 2

Financial criteria	Weightage
Profitability ratio	0.2522
Liquidity ratio	0.2684
Activity ratio	0.2299
Leverage ratio	0.2495
Return on asset	0.4423
Profit margin ratio	0.5577
Current ratio	0.5332
Quick ratio	0.4668
Average days to sell the inventory	0.2770
Average collection period	0.2455
Average payable period	0.2794
Cash flow to asset ratio	0.1981
Debt to asset ratio	0.4840
Debt to equity ratio	0.5160

APPENDIX 3

Category	(1.0-0.71)	(0.7-0.51)	(0.5-0.31)	(0.3-0.0)	Score
Bank-firm relationship	The firm has a good relationship with bank and able to pay the loans on time. Besides, the firm always ready to provide any requested information and documents related to the firm.	The firm has no relationship with bank. However, the firm is generally regarded as a trustful client of other banks in the banking industry and able to pay loans on time.	The firm had difficulties to pay loans on time but they managed to pay its total debt at the end.	The firm is not regarded as a trustworthy client. Besides, this company is not able to pay loans on time and is considered as a risky client.	0.8
Collateral	The value of the collateral is enough to cover the credit and interest of the firm. Besides, it is easy to sell in the market.	The value of the collateral is enough to cover the credit and interest of the firm. However, it is difficult to sell in the market and bank may have difficulty in selling it when anything happen to the company.	The value of the collateral is not enough to cover the credit of the firm although it is easy to sell in the market.	The value of the collateral is not enough to cover the credit also it is difficult to sell in the market.	0.8
Age of firm	More than 16 years	11 - 15 years	6 – 10 years	3 – 5 years	0.5
Number of loans in arrears	All loans are up to date with the repayment instalments.	1-2 loans.	3-4 loans.	More than 4 loans.	0.8
Number of months in arrears	No arrears.	I month (one repayment instalment have not been paid).	2 months (two repayment instalments have not been paid).	3 and more months (three and more monthly repayment instalments have not been paid).	0.9
Production flexibility	The production line receive a great deal of information, knowledge and able to make changes on the products or services so that the products and services satisfy the customer demands.	The production line has a knowledge and able to make changes on the products or services, but didn't receive enough information related to what customers' needs.	Although the production line receives enough information related to the customers' demands, but they are not capable to make changes due to lack of knowledge.	The production line is unable to make changes on their product and services due to lack of knowledge and information on customers'' demands.	0.8

Category	(1.0-0.71)	(0.7-0.31)	(0.3-0.0)	Score
Performing behavioural w.r.t. tax obligations	The firm conducts its business as a good corporate citizen and complies with all laws, rules and regulations as a taxpayer. Besides, the firm keeping up-to-date records.	The firm is paying the tax but didn't comply with deadlines given by tax revenue authorities and has been charged tax fines and penalties.	The firm didn't register with the tax revenue authorities.	0.9
Experience and education of the managing team	The management team members are qualified to manage the firm. The have necessary education and experience to successfully manage the firm.	Although the management members have necessary education and experience in managing the firm but they are not fully dedicated to this firm.	The management members are lack of experience in managing the firm but they are not fully dedicated to this firm.	0.5
Management performance	The management team has successfully applied their current skills and has achieved the stated goals and objectives.	The management team does a good job but not fully achieved the stated goals and objectives.	The management team failed to achieve the stated goal and objectives.	0.6
Technology and innovation	The firm is adapting to the new technology and realize on the benefits of a given innovation. Besides, the firm implementing the technology in improving the productivity and customer services.	The firm realized about the new technology but not fully utilize it.	The firm didn't noticed at all about the new technology and still depends on the traditional ways in managing the firm.	0.8
Awareness of competition	The firm aware on the existence of the competitors and always doing research on how to improve the products or services from time to time so that it is acceptable in the market.	Although the firm aware on the existence of the competitors, but sometimes the improvement to the products or services are done without thinking on what customers really need.	The firm aware on the existence of the competitors but refuses to make any improvement on the products or services.	0.8

Category	(1.0-0.51)	(0.5-0.0)	Score
Types of premises	Owned	Rented	0.6

APPENDIX 4

Non-financial criteria	Weightage
Loan criteria	0.1907
Firm criteria	0.1937
Behavioral criteria	0.2060
Management criteria	0.2066
Market criteria	0.2031
Bank-firm criteria	0.5081
Collateral	0.4919
Age of firm	0.5146
Type of premises	0.4854
Performing behavior w.r.t. tax obligation	0.2758
No of loans in arrears	0.3605
No of months in arrears	0.3637
Experience and education of the management team	0.4973
Management performance	0.5027
Technology and innovation	0,3282
Awareness of competition	0.3462
Production flexibilty	0.3256