SOME OBJECTIVE METHODS FOR DETERMINING RELATIVE IMPORTANCE OF FINANCIAL RATIOS

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ABSTRACT

The segregation of financial ratios into input and output ratios are useful to determine the business insolvency/failure and financial efficiency of the business organizations. A total of 18 software companies are considered with nine financial ratios. The aim of this study is to examine the efficiency of various financial ratios and identify their average weights through objective methods namely MLP of Artificial Neural Network, Entropy and Critic Methods.

Key word: MLP, Entropy, Critic Methods.

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1. INTRODUCTION

Financial ratio analysis is much popular among regulators due to its effectiveness in different countries including India, this method could not import the weights to the financial ratios to evaluate the performance of business organizations. Multi-criteria decision making methods consider the relative weights of financial ratios to evaluate the performance of business organizations.

The weights of criteria are usually assigned by the DMs, based on their own experiences, knowledge and perception of the problem. However, the DMs involved in the decision process usually have different attitudes and can rarely reach an agreement on the relative importance of criteria. Another difficulty is the inconsistency problem in subjective weighting. These problems can be overcome by using an objective weighting process, which is carried out independently from the subjective preferences of the DMs. The logic behind such a weighting process is that each alternative is objectively described by its performance scores, and these scores in the performance matrix represent the sources of information provided to the DM.

In Entropy Method (EM), the criteria weights are obtained directly from the performance matrix, i.e., independently of the DM. This qualifies the entropy method (EM) as an unbiased evaluation procedure. In addition to the entropy method, any other method of measuring the divergence in performance ratings can be used to determine the objective weights. Diakoulaki et al. (1995) has proposed the CRITIC (CRiteria Importance Through Inter-criteria Correlation) method.

One interesting area for the use of neural networks is in event prediction. This study develops a neural network model for determination of relative weights of predictor variables using financial data from the organizations. Relative importance of input variables in neural networks is computed as the sum of the product of raw input-hidden, hidden-output connection weights, proposed by Olden et al. 2004.

1.1. Stockholders' equity ratio (FR1)

The ratio is expressed as a percentage and is calculated by dividing a company's total shareholder equity by its total assets.

1.2. Turnover rate of accounts receivable (Debtor Turnover Ratio) (FR2)

Receivables turnover ratio can be calculated by dividing the net value of credit sales during a given period by the average accounts receivable during the same period = net value of credit sales/average accounts receivable Debtor turnover ratio is the relationship between net sales and average debtors.

1.3. Turnover rate of inventory (FR3)

The inventory turnover ratio is defined as ratio of cost goods sold to average inventory maintained.

1.4. Return of stockholder equity (FR4)

The return on equity ratio or ROE is a profitability ratio that measures the ability of a firm to generate profits from its shareholders investments in the company.

1.5. Quick ratio (FR5)

The quick ratio is an indicator of a company's short-term liquidity position and measures a company's ability to meet its short-term obligations with its most liquid assets.

1.6. Operating income ratio (FR6)

Operating income can be calculated by subtracting operating expenses, depreciation, and amortization from gross income or revenues, = Net profit (Results of Operations)/Revenue from operations.

1.7. Ratio of cash flow (FR7)

The operating cash flow ratio is a measure of the number of times a company can pay off current debts with cash generated within the same period Cash flow ratio = Operating cash flow /current liabilities

1.8. Return of assets (FR8)

Return on assets is displayed as a percentage and it's calculated as: $ROA = \text{Net Income} / \text{Total Assets}$.

1.9. Market share (FR9)

Market share is calculated by taking the company's sales over the period and dividing it by the total sales of the industry over the same period. $\text{Market share} = \text{Company's sales} / \text{Total industry's sales}$

2. PROBLEM STATEMENT

There are some dimensionality reduction techniques and correlation methods used to group a range of financial ratios that characterizes business failure/success in IT companies. However these techniques have not addressed the financial efficiency. The financial efficiency of the MLP must be compared with Entropy measurement method and CRITIC method for cross validation.

3. DATA SOURCE

In this case, Data has been collected from 18 IT companies. Last 5 years financial data is considered for the analysis and subsequently these financial ratios are separated as 9 variables based on different parameters.

4. LITERATURE REVIEW

Hsiang-Hsi Liu et al. (2013) considered data envelopment analysis (DEA), three-stage DEA (3SDEA) and artificial neural network (ANN) are employed to measure the technical efficiency of 29 semi-conductor firms in Taiwan. Estimated results show that there are significant differences in efficiency scores among DEA, 3SDEA and ANN analysis. The advanced setting of the three stages mechanism of DEA does show some changes in the efficiency scores between DEA and ANN approaches.

Krzysztof Piasecki and Aleksandra Wójcicka-Wójtowicz (2017) investigated the use of different structure NN and DA in the process of the classification of banks' potential clients. The results of those different methods are juxtaposed and their performance compared.

Nor Mazlina Abu Bakar and Izah Mohd Tahir (2009) made a study to predict bank performance using multiple linear regression and neural network. The study then evaluates the performance of the two techniques with a goal to find a powerful tool in predicting the bank performance. Data of thirteen banks for the period 2001-2006 was used in the study. The study concluded that artificial neural network is the more powerful tool in predicting bank performance.

Ayan Mukhopadhyay et al. (2012) combined Data Envelopment Analysis and Multi-Layer Perceptron (MLP) to suggest a new method for prediction of bankruptcy that not only focusses on historical financial data of firms. The proposed method thus identifies firms that have a high chance of facing bankruptcy along with those that have filed for bankruptcy.

Olanrewaju A Oludolapo et al. (2012) presented techniques based on the development of multilayer perceptron (MLP) and radial basis function (RBF) of artificial neural network (ANN) models, for calculating the energy consumption of South Africa's industrial sector between 1993 and 2000. The approach examines the energy consumption in relation to the gross domestic product. The results indicate a strong agreement between model predictions and observed values,

Mehdi Alinezhad Sarokolaei et al. (2012) made a research to forecast the performance of 10 Iranian banks using multi-linear regression method and artificial neural network and to compare these two methods. To do so, the financial data related to 10 Iranian banks during the years between 2006 and 2010 were collected from the most reliable resources.

Viju Raghupathi and Wullianallur Raghupathi (2015) deployed neural networks to examine the strategic association between hospitalization experience and treatment results. The healthcare data for the years 2009-2012 are downloaded from the Statewide Planning and Research Cooperative System (SPARCS) of the New York State Department of Health (NYSDOH).

Mahmoud H. Al-Osaimy (1998) used neural networks for predicting Islamic banks performance. A data sample of twenty six Islamic banks has been collected for the period 1991-1993. Seven financial ratios were constructed from the data sample. Kohonen neural network was used first to group the Islamic banks into high and low performance groups using the seven financial ratios for the performance year (1993). The results of this network have assigned twelve banks to the high performance group and fourteen banks to the low performance group.

Satish Sharma and Mikhail Shebalkov (2013) presented an application of neural network and simulation modeling to analyze and predict the performance of 883 Russian Banks over the period 2000-2010. Neural network was trained over the entire dataset, and then simulation modeling was performed generating values. Next, a combination of neural network and simulation modeling techniques was validated with the help of back-testing.

Faruk Erinci and Serhat Duranay (2016) have been estimated future-oriented performance using 2457 input and 364 output normalized data of 28 deposit bank continuously operating during 2002-2014 in Turkish Banking Sector. The study is helpful in the banking sector to the decision-making experts to help with these parameters and for the visualization of prediction results for the future.

5. METHODOLOGY TO BE ADOPTED:

Entropy Measurement Method

It is assumed that there is a set of m feasible alternatives, A_i ($i = 1, 2, \dots, m$) and n evaluation criteria C_j ($j = 1, 2, \dots, n$) in the problem.

Step-1: The decision matrix X which shows the performance of different alternatives with respect to various criteria is formed.

$$X = [x_{ij}]_{m \times n} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (i = 1, 2, \dots, m; j = 1, 2, \dots, n) \quad (1)$$

x_{ij} presents the performance value of i^{th} alternative on j^{th} criterion.

Step-2: The decision matrix is normalized. Beneficial (maximization) and non-beneficial (minimization) criteria are normalized by Eq.(2) and Eq.(3) respectively. To have the performance measures comparable and dimensionless, all the entries of the decision matrix are linear normalized using the following two equations:

$$r_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \quad i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n \quad (2)$$

$$r_{ij} = \frac{\max(x_{ij}) - x_{ij}}{\max(x_{ij}) - \min(x_{ij})} \quad i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n \quad (3)$$

Step-3: Entropy values (e_j) are determined for each criterion.

$$e_j = \frac{\sum_{i=1}^m f_{ij} \ln f_{ij}}{\ln m} \quad i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n \quad (4)$$

where $f_{ij} = \frac{r_{ij}}{\sum_{i=1}^m r_{ij}}$ and $0 < e_j < 1$.

If f_{ij} are all the same, then the entropy values of each criterion is the maximum ($e_j = 1$). If f_{ij} is 0, then $f_{ij} \ln f_{ij}$ is 0 (Wu et al., 2011).

Step-4: Entropy weights (W_j) are calculated.

$$W_j = \frac{1 - e_j}{n - \sum_{i=1}^m e_j} \quad \text{where} \quad \sum_{j=1}^n W_j = 1 \quad (5)$$

$(1 - e_j)$ represents the inherent contrast intensity of each criterion. In other words it is the degree of divergence of the intrinsic information of each criterion. If $(1 - e_j)$ is normalized, then the final weights of each criterion can be obtained. The entropy weight is a parameter that describes the importance of the criterion. The smaller the value of the entropy, the larger the entropy-based weight, then the specific criterion provides more information and this criterion becomes more important than the other criteria in the decision making process (Wu et al., 2011).

6. CRITIC METHOD

It is based on analytical testing of the decision matrix in order to determine the information contained in the criteria by which variants are evaluated. For each criteria x_{ij} membership function r_{ij} which translates all the values of criteria f_j into interval $[0, 1]$, is defined

$$r_{ij} = \frac{x_{ij} - x_j^{\min}}{x_j^{\max} - x_j^{\min}}$$

This transformation is based on the concept of an ideal point. In this way, the initial matrix is converted into a matrix with generic elements r_{ij} .

Each vector r_j is characterised by the standard deviation (s_j), which quantifies the contrast intensity of the corresponding criterion. So, the standard deviation of r_j is a measure of the value of that criterion to be considered in the decision-making process. Next, a symmetric matrix is constructed, with dimensions $m \times m$ and a generic element l_{jk} , which is the linear correlation coefficient between the vectors r_j and r_k . It can be seen that the more discordant the scores of the alternatives in criteria j and k are, the lower is the value l_{jk} . In this sense, Eq. (6) represents a measure of the conflict created by criterion j with respect to the decision situation defined by the rest of the criteria:

$$\sum_{k=1}^m (1 - l_{jk}) \quad (6)$$

The amount of information C_j conveyed by the j^{th} criterion can be determined by composing the measures which quantify the above 2 notions through the multiplicative aggregation formula (Eq. (7)).

$$C_j = \sigma_j \sum_{k=1}^m (1 - l_{kj}) \quad (7)$$

The higher the value C_j is, the larger is the amount of information transmitted by the corresponding criterion and the higher is its relative importance for the decision-making process. Objective weights are derived by normalizing these values to unity (Eq. (18)).

$$w_j = C_j \left[\sum_{k=1}^m C_k \right]^{-1} \quad (8)$$

Objective criteria weights are obtained by normalizing the values C_j :

$$w_j = \frac{c_j}{\sum_{i=1}^m c_i}$$

7. RESULTS AND ANALYSIS

Nine financial ratios of 18 software companies during five financial years as discussed. Relative weights of the financial ratios are determined through objective methods namely MLP of artificial neural network, entropy method and critic method. Finally average weights of the financial ratios are determined.

In this study, FR1, FR2 and FR3 are considered as input financial ratios and FR4, FR5, FR6, FR7, FR8 and FR9 are considered as output ratios.

CCR model of data envelopment analysis is used for determining the category of financial efficiency based on input and output financial ratios using LINGO 8.0 software.

Table 1 Financial efficiency of software companies during 1st financial year

Software Companies (SWC)	Input			Out puts						Financial Efficiency	Financial Efficiency Group
	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9		
SWC1	0.1298	6.1418	981.2177	-0.6244	0.3774	0.0697	0.0404	-0.0811	0.0052	0.0622	NE
SWC2	0.0047	6.3151	136.2825	46.4965	2.1518	0.2500	0.6807	0.2166	0.1274	1	E
SWC3	0.0050	6.4964	3016.0000	37.2587	3.8368	0.2671	0.7710	0.1861	0.1988	0.6308	NE
SWC4	0.0172	4.7198	1350.6822	6.7102	1.5198	0.1402	0.2634	0.1153	0.0107	0.474	NE
SWC5	0.0147	6.9437	1299.9365	4.6751	2.5468	0.0976	0.4650	0.0687	0.0037	0.3568	NE
SWC6	0.0199	5.7679	1301.4115	10.8106	3.8261	0.2012	0.7064	0.2147	0.0120	0.736	NE
SWC7	0.0300	3.6304	1299.8089	1.4404	2.4361	0.1694	0.1465	0.0432	0.0103	1	E
SWC8	0.0331	4.5276	417.7281	3.7979	2.7036	0.1537	0.2895	0.1256	0.0091	0.7176	NE
SWC9	0.0043	5.3117	1307.6618	32.3109	9.2470	0.3740	0.7097	0.1398	0.0148	1	E
SWC10	0.0257	6.0927	1300.9625	6.2320	3.4367	0.2482	0.8481	0.1601	0.0066	0.781	NE
SWC11	0.0221	3.3705	1297.3562	1.7584	0.3089	0.3276	0.2878	0.0389	0.0099	1	E
SWC12	0.0427	5.0058	146.0758	2.4187	3.9531	0.1166	0.6923	0.1034	0.0018	1	E
SWC13	0.0160	8.9554	1466.2900	7.3926	2.2570	0.0636	0.4550	0.1180	0.0062	0.2488	NE
SWC14	0.0029	5.0615	3116.4230	97.8397	3.2098	0.3075	0.8360	0.2854	0.3244	1	E
SWC15	0.0792	5.3193	4098.0000	2.4120	1.8727	0.1773	0.7977	0.1911	0.0031	0.5258	NE
SWC16	0.0146	6.2134	1405.6346	12.9713	1.9744	0.2225	0.2496	0.1900	0.0746	0.4126	NE
SWC17	0.0099	5.3555	121.6289	16.1199	2.2232	0.2219	0.5476	0.1599	0.1722	1	E
SWC18	0.0295	6.7336	16.9201	5.4265	1.9696	0.1534	0.5656	0.1598	0.0093	1	E

Note: E- Efficient; NE- Not Efficient;

From Table-1 it is observed that software companies namely: SWC2, SWC7, SWC9, SWC11, SWC12, SWC14, SWC17 and SWC 18 are grouped as efficient decision making units (Software companies). Remaining companies are arrived as Not-efficient organizations, during 1st Financial Year.

Table 2 Financial efficiency of software companies during 2nd financial year

Software Companies (SWC)	Input			Out puts						Financial Efficiency	Financial Efficiency
	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9		
SWC1	0.1660	6.9077	836.6929	-1.6170	0.4026	0.1284	-0.0290	-0.2684	0.004693	0.1845	NE
SWC2	0.0080	6.0060	201.6980	26.0209	2.4413	0.2309	0.5317	0.2073	0.128143	0.7296	NE
SWC3	0.0086	5.9033	1301.0146	21.6294	3.4819	0.2791	0.5263	0.1857	0.186165	0.0622	NE
SWC4	0.0165	4.3579	202.6233	6.3012	1.5730	0.1085	0.5998	0.1038	0.010439	1	E
SWC5	0.0136	8.0919	1299.7027	1.5732	2.3440	0.0468	0.2834	0.0213	0.003535	0.2299	NE
SWC6	0.0315	5.4938	1300.7675	6.4074	3.2675	0.1991	0.9353	0.2020	0.012436	0.6369	NE
SWC7	0.0282	8.2604	1299.9875	3.2103	2.5911	0.1496	0.4397	0.0905	0.020233	0.2515	NE
SWC8	0.0303	4.0544	297.3188	1.8688	2.2119	0.1391	0.3963	0.0566	0.008284	1	E
SWC9	0.0067	6.0902	1299.1862	28.1806	1.8961	0.3974	0.3751	0.1901	0.013634	0.5616	NE
SWC10	0.0444	5.7189	1301.0629	3.6329	3.5237	0.2064	0.7971	0.1614	0.006603	0.5479	NE
SWC11	0.0191	3.4431	1297.4939	1.5197	0.4284	0.3517	0.2067	0.0290	0.012847	1	E
SWC12	0.0382	5.2617	385.7953	5.6026	4.6112	-0.1447	1.7252	0.2139	0.001494	1	E
SWC13	0.0130	6.4877	354.6815	12.7091	2.0666	0.0997	0.2163	0.1654	0.005873	0.4523	NE
SWC14	0.0027	4.8954	4486.3619	101.3539	2.6936	0.2587	0.8544	0.2695	0.330468	1	E
SWC15	0.0662	5.4860	4635.4483	3.3044	1.9887	0.2087	0.7669	0.2188	0.002966	0.3408	NE
SWC16	0.0242	4.7352	1074.5364	5.4698	2.0811	0.1854	0.3548	0.1324	0.078983	0.7068	NE
SWC17	0.0083	5.3047	102.6374	17.5428	2.1787	0.2194	0.5451	0.1459	0.163931	1	E
SWC18	0.0253	6.5412	18.0122	5.9686	2.0244	0.1475	0.7641	0.1510	0.009273	1	E

Note: E- Efficient; NE- Not Efficient;

From Table-2 it is observed that software companies namely: SWC4, SWC8, SWC11, SWC12, SWC14, SWC14, SWC17 and SWC 18 are grouped as efficient decision making units (Software companies). Remaining companies are arrived as in Not-efficient organizations, during 2nd Financial Year.

Table 3 Financial efficiency of software companies during 3rd financial year

Software Companies (SWC)	Input			Out puts						Financial Efficiency	Financial Efficiency
	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9		
SWC1	0.4034	6.2637	1689.2743	-0.8610	0.5238	-0.6959	0.3602	-0.3473	0.003574	0.0551	NE
SWC2	0.0072	4.3669	116.0055	19.8611	2.4697	0.2137	0.3496	0.1421	0.098853	1	E
SWC3	0.0152	5.9346	1302.2510	11.7911	4.5542	0.2735	0.7370	0.1790	0.198242	0.994	NE
SWC4	0.0171	4.6595	91.6409	7.4767	1.9310	0.1348	0.7307	0.1279	0.010237	1	E
SWC5	0.0269	4.5697	1300.8451	1.1948	3.3349	0.0287	0.2913	0.0321	0.001673	0.8169	NE
SWC6	0.0506	5.5994	1299.7556	3.2926	2.3899	0.1757	0.4914	0.1666	0.014836	0.4921	NE
SWC7	0.0295	9.5450	2545.3073	3.0045	4.3873	0.1419	0.9124	0.0885	0.019306	0.3932	NE
SWC8	0.0263	4.4945	503.1328	4.4118	1.8866	0.1755	0.4832	0.1160	0.008534	0.7442	NE
SWC9	0.0074	5.7670	1302.2844	24.7672	4.5831	0.3916	0.6701	0.1828	0.013116	1	E
SWC10	0.0373	5.8828	1301.0457	3.4663	3.5089	0.1693	0.5257	0.1293	0.007341	0.621	NE
SWC11	0.0172	2.3494	1297.4821	1.1296	0.4181	0.3021	0.2125	0.0194	0.012063	1	E
SWC12	0.0278	5.8140	323.5205	11.6416	4.3087	0.0224	1.8110	0.3235	0.001534	1	E
SWC13	0.0106	5.8396	201.6851	15.0751	1.6740	0.0989	0.4587	0.1599	0.006161	0.6341	NE
SWC14	0.0022	4.8818	4862.4259	123.1980	4.2836	0.2824	1.0727	0.2723	0.344937	1	E
SWC15	0.0514	5.8231	5706.8276	4.9714	2.2688	0.2304	0.5511	0.2557	0.003414	0.3571	NE
SWC16	0.0193	4.8275	685.9136	6.8723	2.2918	0.1612	0.4568	0.1327	0.084116	0.6922	NE
SWC17	0.0066	5.3613	79.0081	18.0285	2.0085	0.2107	0.4899	0.1191	0.162693	1	E
SWC18	0.0233	5.9399	20.2269	6.4878	2.3456	0.1486	0.5056	0.1509	0.009372	1	E

Note: E- Efficient; NE- Not Efficient;

From Table-3 it is observed that software companies namely: SWC2, SWC4, SWC9, SWC11, SWC12, SWC14, SWC17 and SWC 18 are grouped as efficient decision making units (Software companies). Remaining companies are arrived as in not efficient organizations, during 3rd Financial Year.

Table 4 Financial efficiency of software companies during 4th financial year

Software Companies (SWC)	Input			Out puts						Financial Efficiency	Financial Efficiency
	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9		
SWC1	0.7223	5.2397	973.2874	0.0800	0.4050	0.1564	0.1149	0.0578	0.002826	0.1624	NE
SWC2	0.0062	5.9378	137.5962	30.1965	2.3498	0.2183	0.7172	0.1868	0.133911	1	E
SWC3	0.0136	5.7910	1302.3524	12.5463	4.6421	0.2717	0.7663	0.1708	0.192792	0.9407	NE
SWC4	0.0148	4.5157	73.0530	6.3366	1.9498	0.1050	0.2847	0.0938	0.009346	0.7949	NE
SWC5	0.0160	6.1482	1299.4242	2.7725	2.1025	0.0812	0.2177	0.0443	0.001577	0.2904	NE
SWC6	0.0491	5.6034	1300.2779	2.4917	2.8430	0.1345	0.8781	0.1224	0.014741	0.5793	NE
SWC7	0.0285	9.5181	2494.1024	3.7619	4.4497	0.1586	0.6872	0.1073	0.017106	0.388	NE
SWC8	0.0247	5.2965	7740.3333	4.0733	2.0441	0.1713	0.6070	0.1004	0.007888	0.3356	NE
SWC9	0.0070	5.7150	1299.1445	27.9112	1.8600	0.3908	0.4030	0.1961	0.012461	0.8823	NE
SWC10	0.0338	6.3758	1301.5167	3.7684	3.9173	0.1583	0.6165	0.1274	0.008103	0.5113	NE
SWC11	0.0156	1.9229	1297.6098	1.0150	0.5288	0.3044	-0.0278	0.0158	0.008952	1	E
SWC12	0.0256	5.3704	337.9028	4.9497	5.8861	0.1069	0.2594	0.1266	0.001315	1	E
SWC13	0.0087	5.4230	435.4106	15.0723	1.7774	0.0808	0.3342	0.1305	0.006674	0.5501	NE
SWC14	0.0019	5.0532	4630.0000	133.4467	5.1366	0.2739	1.4336	0.2539	0.332091	1	E
SWC15	0.0432	5.3794	1301.3368	5.6127	3.7613	0.2211	0.8859	0.2426	0.003483	0.8037	NE
SWC16	0.0168	5.2467	492.2367	6.4104	2.0357	0.1436	0.4926	0.1079	0.082035	0.6019	NE
SWC17	0.0059	5.7028	94.8469	17.4719	2.0497	0.2042	0.5785	0.1036	0.156095	1	E
SWC18	0.0209	5.6944	22.4173	5.2345	2.5092	0.1250	0.5587	0.1092	0.008602	1	E

Note: E- Efficient; NE- Not Efficient:

From Table-4 it is observed that software companies namely: SWC2, SWC11, SWC12, SWC14, SWC17 and SWC 18 are grouped as efficient decision making units (Software companies). Remaining companies are arrived as not efficient organizations, during 4th Financial Year

Table 5 Financial efficiency of software companies during 5th financial year

Software Companies (SWC)	Input			Out puts						Financial Efficiency	Financial Efficiency
	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9		
SWC1	0.9961	4.7757	874.7225	0.0436	0.5345	0.1572	0.1356	0.0434	0.002695	0.1607	NE
SWC2	0.0058	5.6376	175.5491	31.3705	2.4869	0.2224	0.7369	0.1808	0.13749	1	E
SWC3	0.0135	5.5390	1302.0376	14.7325	4.3691	0.2696	0.8507	0.1992	0.19174	1	E
SWC4	0.0138	4.6083	97.9456	6.6715	2.0681	0.1013	0.6633	0.0923	0.009961	1	E
SWC5	0.0141	7.4214	1299.6222	5.9038	2.2742	0.1220	0.2904	0.0833	0.002222	0.3276	NE
SWC6	0.0433	5.7151	1300.1192	3.4783	2.7053	0.1356	0.7575	0.1505	0.014853	0.5989	NE
SWC7	0.0276	9.0946	1300.8642	4.3333	3.3514	0.1622	0.6429	0.1194	0.017797	0.4101	NE
SWC8	0.0228	5.6774	8298.0000	4.5561	1.9668	0.1678	0.4235	0.1038	0.008133	0.2613	NE
SWC9	0.0071	5.2477	1301.6730	28.9909	4.0529	0.4000	0.9130	0.2070	0.01231	1	E
SWC10	0.0300	6.3194	1301.5781	4.0386	3.9706	0.1545	0.7778	0.1210	0.008248	0.6438	NE
SWC11	0.0145	2.0309	1297.6936	-0.6395	0.6016	0.2889	0.0303	-0.0092	0.007778	1	E
SWC12	0.0232	6.4312	1303.9958	4.8171	6.0674	0.1381	0.6861	0.1120	0.001368	0.8937	NE
SWC13	0.0084	5.3559	1299.2248	18.5482	1.9296	0.0941	0.5448	0.1561	0.006672	0.7028	NE
SWC14	0.0018	5.1768	3854.8085	135.2147	4.4735	0.2641	1.2029	0.2430	0.334704	1	E
SWC15	0.0655	5.0276	1301.6462	3.8542	4.0296	0.2513	0.9269	0.2524	0.003769	0.9091	NE
SWC16	0.0145	5.2001	410.4457	8.6027	1.9674	0.1530	0.3862	0.1248	0.083667	0.6062	NE
SWC17	0.0116	5.5646	121.0707	8.8448	1.9927	0.1906	0.5226	0.1027	0.148143	0.9341	NE
SWC18	0.0193	5.2878	25.0863	5.3685	2.6411	0.1174	0.3182	0.1039	0.00845	1	E

Note: E- Efficient; NE- Not Efficient:

From Table-5 it is observed that software companies namely: SWC2, SWC3, SWC4, SWC9, SWC11, SWC14 and SWC 18 are grouped as efficient decision making units (Software companies). Remaining companies are arrived as not efficient organizations, during 5th Financial Year.

The efficiency groups obtained through DEA are considered as dependent variables in MLP.

8. MLP METHOD

The aim of this study was to examine relative importance of financial ratios through MLP neural networks by analyzing data obtained from the annual reports from 1st FY to 5th FY of the 18 software companies. MLP of Neural networks is implemented to the case study using SPSS 17 and the following outputs of the analysis are discussed in the following sections.

8.1. MLP Network information

- Number of inputs = 9 Financial Ratios.
- Number of output units =1(financial Efficiency Group)
- Number of hidden units = 13
- Training dataset = 90% of the sample
- Testing dataset = 5% of the sample.
- Holdout dataset= 5% of the sample.
- Type of training = Batch training
- Optimizing Algorithm = scaled conjugated method
- Training options, Initial $\lambda = 0.0000005$

8.2. Case Processing Summary

Table-6 gives information about the datasets used to build the ANN model. From the table it is observed that the training, testing and holdout dataset contains 90%, 5% and 5% of the sample respectively.

Table 6 Case processing summary

		N	Percent
Sample	Training	90	90
	Testing	5	5
	Holdout	5	5
Valid		100	100
Excluded		0	
Total		100	

Network Information: The Table-7 shows network information. The table shows the number of neurons in every layer. Input layer contains 9 factors (FR1, FR2,...,FR9). The Automatic architecture selection chose 13 nodes for the hidden layer, while the output layer had 2 nodes and the depended variable financial efficiency group. For the hidden layer the activation function was the hyperbolic tangent, while for the output layer also the softmax function is used.

Table 7 Network information

Input Layer	Factors	1	FR1
		2	FR2
		3	FR3
		4	FR4
		5	FR5
		6	FR6
		7	FR7

		8	FR8
		9	FR9
	Number of Units ^a		723
Hidden Layer(s)	Number of Hidden Layers		1
	Number of Units in Hidden Layer 1 ^a		13
	Activation Function		Hyperbolic tangent
Output Layer	Dependent Variables	1	GROUP
	Number of Units		2
	Activation Function		Softmax
	Error Function		Cross-entropy
^a . Excluding the bias unit			

Model Summary: The model summary is shown in Table-8.

Table 8 Model Summary

Training	Cross entropy error	6.524E-5
	Percent incorrect predictions	0.0%
	Stopping rule used	Training error ratio criterion (0.001) achieved
	Training time	0:00:00.28
Testing	Cross entropy error	1.255E-6
	Percent incorrect predictions	0.0%
Holdout	Percent incorrect predictions	0.0%
Dependent variable: GROUP		

Table-8 provides information related to the results of training, testing and holdout samples. Cross entropy error is given for training, testing and holdout samples. The small value (6.524 E-5) of this error of training set indicates the power of the model to predict financial efficiency. The cross entropy error (1.255 E-6) is also very less for the testing data set, meaning that the network model has not been over-fitted to the training data. The result justifies the role of testing sample which is to prevent overtraining. From the results, it is observed that, there are no incorrect predictions based on training and testing samples.

Classification Summary: Table-9 displays classification for categorical dependent variable (financial efficiency).

Table 9 Classification

Sample	Observed	Predicted		
		E	NE	Percent correct
Training	E	36	0	100.0
	NE	0	54	100.0
	Overall percent	40.0	60.0%	100.0
Testing	E	3	0	100.0
	NE	0	2	100.0
	Overall percent	60.0	40.0%	100.0
Holdout	E	2	0	100.0
	NE	0	3	100.0
	Overall percent	40.0	60.0%	100.0
Dependent Variable: GROUP				

As can be seen, the MLP network correctly classified all 18 software companies out of 90 observations, in the training sample in training and sample and two out of two in testing sample

were correctly classified. Overall 100.0% of the training cases and testing case were correctly classified.

Importance Analysis: Table-10 gives the impact of each independent variable in the ANN model in terms of relative and normalized importance.

Table-10 Independent variable importance

	Importance	Normalized importance
FR1	0.118	83.5%
FR2	0.108	76.0%
FR3	0.132	93.4%
FR4	0.109	76.9%
FR5	0.104	73.4%
FR6	0.095	66.8%
FR7	0.100	70.6%
FR8	0.092	64.8%
FR9	0.142	100.0%

From the Table-10, it is apparent that the financial ratio FR9 has the greatest effect on financial efficiency since the relative importance of the variable is 0.142. FR8 has the lowest effect on the financial efficiency since the relative importance of the variable is 0.0928. The importance of the variables, i.e., how sensitive is the model is in the change of each input variable is depicted.

The accuracy of prediction of overall financial performance measured by MLP is measured by the area under the ROC curve. An area of 1 represents a perfect test; an area of 0.5 represents a worthless test. A rough guide for classifying the accuracy of prediction is Excellent (0.9 to 1.0), Good (0.8 to 0.9), Fair (0.7 to 0.8), Poor (0.6 to 0.7) and Fail (0.5 to 0.6). Excellent prediction of overall financial performance is obtained through the proposed MLP is obtained in this study, since the area under ROC for all groups is equal to 1.00.

9. ENTROPY MEASUREMENT METHOD

Decision matrix: The decision matrix shows the payoff eighteen software companies during 5 financial years with respect to nine financial ratios. The decision matrix is shown in Tables A.1-A.5 of Appendix.

Normalized Decision matrix: The normalized decision matrix is shown in Tables A.6-A.10 of Appendix.

Entropy values: Entropy values are shown in Table-11.

Table 11 Entropy values

FRs	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9
e_j	0.4374	0.6638	0.5482	0.4907	0.6517	0.6427	0.6147	0.6649	0.4801

Inherent contrast intensity ($1-e_j$): Inherent contrast intensity is the degree of divergence of the intrinsic information of each criterion is determined *Entropy Weight (w_j):* Entropy weight is determined The entropy weights are shown in Table-12. Entropy weight is a parameter that describes the importance of the criterion. Smaller the value of the entropy, the larger the entropy based weight.

Table 12 Entropy weight

FRs	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9
------------	------------	------------	------------	------------	------------	------------	------------	------------	------------

w _j	0.2345	0.0304	0.1225	0.1749	0.0544	0.0554	0.0556	0.0272	0.2451
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FR9 (Market Share) is the most important criterion with the highest entropy weight of 0.2451. The contribution of FR8 (Return of Assets) is minimum (0.0272) for financial efficiency.

10. CRITIC METHOD

Standard Deviation: Standard deviations of FRs are determined as discussed in section 6. Standard deviation, of FRs represent the degree of deviation of variant values for a given criteria of a mean value. Standard Deviation of Financial Ratios are shown in Table-13

Table 13 Standard Deviation of Financial Ratios

FRs	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9
Standard deviation	0.1300	0.1662	0.1832	0.1971	0.1577	0.1147	0.1713	0.1414	0.2601

From Table-13, it is observed that highest standard deviation is obtained with FR4 (Return of Stock Holder Equity). FR6 (Operating income ratio) is obtained low standard deviation. A high standard deviation implies that, on average, data points are all pretty far from the average. A low standard deviation means most points are very close to the average.

Correlation Coefficient Matrix: Linear correlation coefficients between the financial ratios are determined as discussed in section 6. The correlation coefficient matrix is shown in Table-14.

Table 14 Correlation coefficient of financial ratios

FRs	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9
FR1	1.0000	-0.0166	-0.0255	-0.1713	-0.3145	-0.3023	-0.2540	-0.3880	-0.3880
FR2	-0.0166	1.0000	0.0516	-0.0701	0.2870	-0.2432	0.1785	0.0315	-0.0706
FR3	-0.0255	0.0516	1.0000	0.3784	0.1391	0.1518	0.2278	0.1986	0.2613
FR4	-0.1713	-0.0701	0.3784	1.0000	0.3131	0.3204	0.4564	0.4725	0.8321
FR5	-0.3145	0.2870	0.1391	0.3131	1.0000	0.1948	0.6336	0.5066	0.2326
FR6	-0.3023	-0.2432	0.1518	0.3204	0.1948	1.0000	0.0537	0.5222	0.3197
FR7	-0.2540	0.1785	0.2278	0.4564	0.6336	0.0537	1.0000	0.6619	0.3646
FR8	-0.3880	0.0315	0.1986	0.4725	0.5066	0.5222	0.6619	1.0000	0.4088
FR9	-0.1760	-0.0706	0.2613	0.8321	0.2326	0.3197	0.3646	0.4088	1.0000

Correlation coefficients are used in statistics to measure how strong a relationship is between two variables. 1 indicates a strong positive relationship. -1 indicates a strong negative relationship. A result of zero indicates no relationship at all. From table 4.10 it is observed that FR1 is showing negative correlation with all other financial ratios. There is strong correlation of 0.3880 is observed between, FR1- FR8 and FR1-FR9.

FR2 is showing negative correlation with FR1, FR4, and FR6 and FR9. There is strong correlation of 0.2870 is observed between, FR1 and FR5. FR3 is showing highest positive correlation (0.3784) with FR4. FR5 is showing highest positive correlation (0.6336) with FR7. FR6 is showing highest positive correlation (0.6619) with FR8. FR9 is showing highest positive correlation (0.8321) with FR4

Measure of Conflict: Measure of conflict is determined as discussed in section 6 and shown in Table-15.

Table 15 Measure of conflict

FRs	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9
Measure of conflict	9.6483	7.8218	6.6168	5.4685	6.0077	6.9828	5.6776	5.5861	6.0395

From Table-4.3.3, it is observed that there is a high measure of conflict of 9.6483 with FR1 and low measure of conflict of 5.4685 is obtained with FR4.

Amount of information in the FRs: The amount of information contained in the FR is determined as discussed in section 6. The values of Amount of information in the FRs are shown in Table-16.

Table 16 Information content of FRs

FRs	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9
C_j	1.2539	1.3046	1.2123	1.0777	0.9472	0.8007	0.9726	0.7897	1.5706

From Table-16, it is observed that, FR9 is obtained the highest value of C_j (1.5706). Hence FR9 transmits the largest information and it has the highest relative importance for the decision-making process.

Relative weights of FRs: Relative weights of FRs is obtained as discussed in section 6 and the relative weights of FRs is show in Table-17.

Table 17 Relative weights of FRs

FRs	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9
w_j	0.1263	0.1314	0.1221	0.1085	0.0954	0.0806	0.0979	0.0795	0.1582

From Table-17, it is observed that highest weight of 0.1582 is obtained with FR9 and the lowest weight (0.0795) is obtained with FR8. The relative importance order of FRs is is presented below.

Relative importance of FRs: FR9 > FR2 > FR1 > FR3 > FR4 > FR7 > FR5 > FR6 > FR8.

11. COMPARISON OF RELATIVE WEIGHTS

In this paper, three objective rating methods namely: MLP, EM and CRITIC methods are proposed for determination of relative weights of financial ratios in determining the financial efficiency of software manufacturing organizations. Comparison of relative weights obtained by the proposed methods are compared and presented in Table-18.

Table 18 Comparison of relative weights

FRs	Methods		
	MLP	EM	CRITIC
FR1	0.118(III)	0.2345(II)	0.1263(III)
FR2	0.108(V)	0.0304(VIII)	0.1314(II)
FR3	0.132(II)	0.1125(IV)	0.1221 (IV)
FR4	0.109(IV)	0.1749(III)	0.1085(V)
FR5	0.104(VI)	0.0544(VII)	0.0954(VII)
FR6	0.095(VIII)	0.0554(VI)	0.0806(VIII)
FR7	0.1(VII)	0.0556(V)	0.0979(VI)
FR8	0.092(IX)	0.0272(IX)	0.0795(IX)
FR9	0.142(I)	0.2451(I)	0.1582(I)

From the results shown in Table-18, it is observed that the proposed methods are consistent in prioritizing the FRs of FR9, FR8 in contributing the highest and lowest importance on the financial efficiency. Similar ranking is obtained based on relative importance of FRs on Financial efficiency for other financial ratios.

12. CORRELATION OF THE METHODS

Correlations between the three proposed in determining the relative weights methods are computed. Correlation coefficients are shown in Table-19.

From the correlations between objective weight methods, it is observed that there is high significant positive correlation (≥ 0.890) is existed between MLP and CRITIC methods. The p-values for the individual hypothesis tests of the correlations are being shown in brackets. Since all the p-values are less than or equal to 0.05, there is sufficient evidence at $\alpha = 0.05$ that there exists significant correlation between the three methods.

Table 19 Correlation coefficients

Method	MLP	EM	CRITIC
MLP	1.000	0.761 (0.017)	0.890 (0.001)
EM	0.761 (0.017)	1.000	0.696(0.037)
CRITIC	0.890 (0.001)	0.696(0.037)	1.000

13. AVERAGE RELATIVE WEIGHTS

Average relative weights of financial ratios are obtained by taking the average of the weights obtained from the proposed methods. Average Relative weights of financial ratios based on the data on financial ratio from FY2013-14 to 2017-18 are determined and average relative weights of financial ratios are shown in Table-20.

Table 20 Average relative weights of financial ratios

FRs	FR1	FR2	FR3	FR4	FR5	FR6	FR7	FR8	FR9
Average relative weight	0.1596	0.0899	0.1255	0.1308	0.0846	0.0770	0.0845	0.0663	0.1818

Order of Average relative weights of FRs is presented below.

Relative weights of FRs: FR9(0.1818) > FR1(0.1596) > FR4(0.1308) > FR3(0.1255) > FR2(0.0899) > FR5(0.0846) > FR7(0.0845) > FR6(0.0770).

Relative weights of financial ratios obtained by the proposed methods and average relative weights are presented in Figure 1.

Figure 1 Average relative weights

14. CONCLUDING REMARKS

The aim of this paper is to determine the relative weights of the financial ratios through MLP of artificial neural networks in predicting financial efficiency, based on financial ratios data collected from annual reports of eighteen software companies during 1st FY to 5th FY. Also, the results of the neural network analysis are compared with entropy measurement method and CRITIC method. Multilayer perceptron neural networks were trained, to predict financial efficiency also.

The classification accuracy rate of multilayer perception was very high, with 100%. The results also showed that MLP of ANN is the most powerful predictors of financial efficiency. Although future work will need to validate these findings in larger and more diverse samples, there is strong evidence that the proposed model can be used effectively to predict financial efficiency of business organizations in general and software companies in particular and to help the management to design interventions that increase the financial efficiency.

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APPENDIX

Table-A.1 Data belonging to financial ratios for the 1st year

Software company	Stockholder's equity ratio (FR1)	Turnover rate of accounts receivables (FR2)	Turnover rate of inventory (FR3)	Return of stockholder equity (FR4)	Quick Ratio (FR5)	Operating income ratio (FR6)	Operating cash flow ratio (FR7)	Return of Assets (FR8)	Market Share (FR9)
SWC1	0.1298	6.1418	981.2177	-0.6244	0.3774	0.0697	0.0404	-0.0811	0.0052
SWC2	0.0047	6.3151	136.2825	46.4965	2.1518	0.2500	0.6807	0.2166	0.1274
SWC3	0.0050	6.4964	3016.0000	37.2587	3.8368	0.2671	0.7710	0.1861	0.1988
SWC4	0.0172	4.7198	1350.6822	6.7102	1.5198	0.1402	0.2634	0.1153	0.0107
SWC5	0.0147	6.9437	1299.9365	4.6751	2.5468	0.0976	0.4650	0.0687	0.0037
SWC6	0.0199	5.7679	1301.4115	10.8106	3.8261	0.2012	0.7064	0.2147	0.0120
SWC7	0.0300	3.6304	1299.8089	1.4404	2.4361	0.1694	0.1465	0.0432	0.0103
SWC8	0.0331	4.5276	417.7281	3.7979	2.7036	0.1537	0.2895	0.1256	0.0091
SWC9	0.0043	5.3117	1307.6618	32.3109	9.2470	0.3740	0.7097	0.1398	0.0148
SWC10	0.0257	6.0927	1300.9625	6.2320	3.4367	0.2482	0.8481	0.1601	0.0066
SWC11	0.0221	3.3705	1297.3562	1.7584	0.3089	0.3276	0.2878	0.0389	0.0099
SWC12	0.0427	5.0058	146.0758	2.4187	3.9531	0.1166	0.6923	0.1034	0.0018
SWC13	0.0160	8.9554	1466.2900	7.3926	2.2570	0.0636	0.4550	0.1180	0.0062
SWC14	0.0029	5.0615	3116.4230	97.8397	3.2098	0.3075	0.8360	0.2854	0.3244
SWC15	0.0792	5.3193	4098.0000	2.4120	1.8727	0.1773	0.7977	0.1911	0.0031
SWC16	0.0146	6.2134	1405.6346	12.9713	1.9744	0.2225	0.2496	0.1900	0.0746
SWC17	0.0099	5.3555	121.6289	16.1199	2.2232	0.2219	0.5476	0.1599	0.1722
SWC18	0.0295	6.7336	16.9201	5.4265	1.9696	0.1534	0.5656	0.1598	0.0093

Table-A.2 Data belonging to financial ratios for the 2nd year

Software company	Stockholders equity ratio (FR1)	Turnover rate of accounts receivables (FR2)	Turnover rate of inventory (FR3)	Return of stockholder equity (FR4)	Quick Ratio (FR5)	Operating income ratio (FR6)	Operating cash flow ratio (FR7)	Return of Assets (FR8)	Market Share (FR9)
SWC1	0.1660	6.9077	836.6929	-1.6170	0.4026	0.1284	-0.0290	-0.2684	0.004693

SWC2	0.0080	6.0060	201.6980	26.0209	2.4413	0.2309	0.5317	0.2073	0.128143
SWC3	0.0086	5.9033	1301.0146	21.6294	3.4819	0.2791	0.5263	0.1857	0.186165
SWC4	0.0165	4.3579	202.6233	6.3012	1.5730	0.1085	0.5998	0.1038	0.010439
SWC5	0.0136	8.0919	1299.7027	1.5732	2.3440	0.0468	0.2834	0.0213	0.003535
SWC6	0.0315	5.4938	1300.7675	6.4074	3.2675	0.1991	0.9353	0.2020	0.012436
SWC7	0.0282	8.2604	1299.9875	3.2103	2.5911	0.1496	0.4397	0.0905	0.020233
SWC8	0.0303	4.0544	297.3188	1.8688	2.2119	0.1391	0.3963	0.0566	0.008284
SWC9	0.0067	6.0902	1299.1862	28.1806	1.8961	0.3974	0.3751	0.1901	0.013634
SWC10	0.0444	5.7189	1301.0629	3.6329	3.5237	0.2064	0.7971	0.1614	0.006603
SWC11	0.0191	3.4431	1297.4939	1.5197	0.4284	0.3517	0.2067	0.0290	0.012847
SWC12	0.0382	5.2617	385.7953	5.6026	4.6112	-0.1447	1.7252	0.2139	0.001494
SWC13	0.0130	6.4877	354.6815	12.7091	2.0666	0.0997	0.2163	0.1654	0.005873
SWC14	0.0027	4.8954	4486.3619	101.3539	2.6936	0.2587	0.8544	0.2695	0.330468
SWC15	0.0662	5.4860	4635.4483	3.3044	1.9887	0.2087	0.7669	0.2188	0.002966
SWC16	0.0242	4.7352	1074.5364	5.4698	2.0811	0.1854	0.3548	0.1324	0.078983
SWC17	0.0083	5.3047	102.6374	17.5428	2.1787	0.2194	0.5451	0.1459	0.163931
SWC18	0.0253	6.5412	18.0122	5.9686	2.0244	0.1475	0.7641	0.1510	0.009273

Table-A.3: Data belonging to financial ratios for the 3rd year

Software company	Stockholders equity ratio (FR1)	Turnover rate of accounts receivables (FR2)	Turnover rate of inventory (FR3)	Return of stockholder equity (FR4)	Quick Ratio (FR5)	Operating income ratio (FR6)	Operating cash flow ratio (FR7)	Return of Assets (FR8)	Market Share (FR9)
SWC1	0.4034	6.2637	1689.2743	-0.8610	0.5238	-0.6959	0.3602	-0.3473	0.003574
SWC2	0.0072	4.3669	116.0055	19.8611	2.4697	0.2137	0.3496	0.1421	0.098853
SWC3	0.0152	5.9346	1302.2510	11.7911	4.5542	0.2735	0.7370	0.1790	0.198242
SWC4	0.0171	4.6595	91.6409	7.4767	1.9310	0.1348	0.7307	0.1279	0.010237
SWC5	0.0269	4.5697	1300.8451	1.1948	3.3349	0.0287	0.2913	0.0321	0.001673
SWC6	0.0506	5.5994	1299.7556	3.2926	2.3899	0.1757	0.4914	0.1666	0.014836
SWC7	0.0295	9.5450	2545.3073	3.0045	4.3873	0.1419	0.9124	0.0885	0.019306
SWC8	0.0263	4.4945	503.1328	4.4118	1.8866	0.1755	0.4832	0.1160	0.008534
SWC9	0.0074	5.7670	1302.2844	24.7672	4.5831	0.3916	0.6701	0.1828	0.013116
SWC10	0.0373	5.8828	1301.0457	3.4663	3.5089	0.1693	0.5257	0.1293	0.007341
SWC11	0.0172	2.3494	1297.4821	1.1296	0.4181	0.3021	0.2125	0.0194	0.012063
SWC12	0.0278	5.8140	323.5205	11.6416	4.3087	0.0224	1.8110	0.3235	0.001534
SWC13	0.0106	5.8396	201.6851	15.0751	1.6740	0.0989	0.4587	0.1599	0.006161
SWC14	0.0022	4.8818	4862.4259	123.1980	4.2836	0.2824	1.0727	0.2723	0.344937
SWC15	0.0514	5.8231	5706.8276	4.9714	2.2688	0.2304	0.5511	0.2557	0.003414
SWC16	0.0193	4.8275	685.9136	6.8723	2.2918	0.1612	0.4568	0.1327	0.084116
SWC17	0.0066	5.3613	79.0081	18.0285	2.0085	0.2107	0.4899	0.1191	0.162693
SWC18	0.0233	5.9399	20.2269	6.4878	2.3456	0.1486	0.5056	0.1509	0.009372

Table-A.4: Data belonging to financial ratios for the 4th year

Software company	Stockholders equity ratio (FR1)	Turnover rate of accounts receivables (FR2)	Turnover rate of inventory (FR3)	Return of stockholder equity (FR4)	Quick Ratio (FR5)	Operating income ratio (FR6)	Operating cash flow ratio (FR7)	Return of Assets (FR8)	Market Share (FR9)
SWC1	0.7223	5.2397	973.2874	0.0800	0.4050	0.1564	0.1149	0.0578	0.002826
SWC2	0.0062	5.9378	137.5962	30.1965	2.3498	0.2183	0.7172	0.1868	0.133911
SWC3	0.0136	5.7910	1302.3524	12.5463	4.6421	0.2717	0.7663	0.1708	0.192792
SWC4	0.0148	4.5157	73.0530	6.3366	1.9498	0.1050	0.2847	0.0938	0.009346
SWC5	0.0160	6.1482	1299.4242	2.7725	2.1025	0.0812	0.2177	0.0443	0.001577
SWC6	0.0491	5.6034	1300.2779	2.4917	2.8430	0.1345	0.8781	0.1224	0.014741
SWC7	0.0285	9.5181	2494.1024	3.7619	4.4497	0.1586	0.6872	0.1073	0.017106
SWC8	0.0247	5.2965	7740.3333	4.0733	2.0441	0.1713	0.6070	0.1004	0.007888
SWC9	0.0070	5.7150	1299.1445	27.9112	1.8600	0.3908	0.4030	0.1961	0.012461
SWC10	0.0338	6.3758	1301.5167	3.7684	3.9173	0.1583	0.6165	0.1274	0.008103
SWC11	0.0156	1.9229	1297.6098	1.0150	0.5288	0.3044	-0.0278	0.0158	0.008952

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SWC12	0.0256	5.3704	337.9028	4.9497	5.8861	0.1069	0.2594	0.1266	0.001315
SWC13	0.0087	5.4230	435.4106	15.0723	1.7774	0.0808	0.3342	0.1305	0.006674
SWC14	0.0019	5.0532	4630.0000	133.4467	5.1366	0.2739	1.4336	0.2539	0.332091
SWC15	0.0432	5.3794	1301.3368	5.6127	3.7613	0.2211	0.8859	0.2426	0.003483
SWC16	0.0168	5.2467	492.2367	6.4104	2.0357	0.1436	0.4926	0.1079	0.082035
SWC17	0.0059	5.7028	94.8469	17.4719	2.0497	0.2042	0.5785	0.1036	0.156095
SWC18	0.0209	5.6944	22.4173	5.2345	2.5092	0.1250	0.5587	0.1092	0.008602

Table-A.5 Data belonging to financial ratios for the 5th year

Software company	Stockholders equity ratio (FR1)	Turnover rate of accounts receivables (FR2)	Turnover rate of inventory (FR3)	Return of stockholder equity (FR4)	Quick Ratio (FR5)	Operating income ratio (FR6)	Operating cash flow ratio (FR7)	Return of Assets (FR8)	Market Share (FR9)
SWC1	0.9961	4.7757	874.7225	0.0436	0.5345	0.1572	0.1356	0.0434	0.002695
SWC2	0.0058	5.6376	175.5491	31.3705	2.4869	0.2224	0.7369	0.1808	0.13749
SWC3	0.0135	5.5390	1302.0376	14.7325	4.3691	0.2696	0.8507	0.1992	0.19174
SWC4	0.0138	4.6083	97.9456	6.6715	2.0681	0.1013	0.6633	0.0923	0.009961
SWC5	0.0141	7.4214	1299.6222	5.9038	2.2742	0.1220	0.2904	0.0833	0.002222
SWC6	0.0433	5.7151	1300.1192	3.4783	2.7053	0.1356	0.7575	0.1505	0.014853
SWC7	0.0276	9.0946	1300.8642	4.3333	3.3514	0.1622	0.6429	0.1194	0.017797
SWC8	0.0228	5.6774	8298.0000	4.5561	1.9668	0.1678	0.4235	0.1038	0.008133
SWC9	0.0071	5.2477	1301.6730	28.9909	4.0529	0.4000	0.9130	0.2070	0.01231
SWC10	0.0300	6.3194	1301.5781	4.0386	3.9706	0.1545	0.7778	0.1210	0.008248
SWC11	0.0145	2.0309	1297.6936	-0.6395	0.6016	0.2889	0.0303	-0.0092	0.007778
SWC12	0.0232	6.4312	1303.9958	4.8171	6.0674	0.1381	0.6861	0.1120	0.001368
SWC13	0.0084	5.3559	1299.2248	18.5482	1.9296	0.0941	0.5448	0.1561	0.006672
SWC14	0.0018	5.1768	3854.8085	135.2147	4.4735	0.2641	1.2029	0.2430	0.334704
SWC15	0.0655	5.0276	1301.6462	3.8542	4.0296	0.2513	0.9269	0.2524	0.003769
SWC16	0.0145	5.2001	410.4457	8.6027	1.9674	0.1530	0.3862	0.1248	0.083667
SWC17	0.0116	5.5646	121.0707	8.8448	1.9927	0.1906	0.5226	0.1027	0.148143
SWC18	0.0193	5.2878	25.0863	5.3685	2.6411	0.1174	0.3182	0.1039	0.00845

Table-A.6:

Software company	Stockholders equity ratio (FR1)	Turnover rate of accounts receivables (FR2)	Turnover rate of inventory (FR3)	Return of stockholder equity (FR4)	Quick Ratio (FR5)	Operating income ratio (FR6)	Operating cash flow ratio (FR7)	Return of Assets (FR8)	Market Share (FR9)
SWC1	1.0000	0.4962	0.2363	0.0465	0.0077	0.0199	0.0000	0.0000	0.0104
SWC2	0.0137	0.5272	0.0292	0.5028	0.2062	0.6004	0.7927	0.8123	0.3895
SWC3	0.0164	0.5597	0.7349	0.4134	0.3947	0.6556	0.9045	0.7288	0.6106
SWC4	0.1124	0.2416	0.3268	0.1175	0.1355	0.2468	0.2761	0.5357	0.0275
SWC5	0.0928	0.6398	0.3144	0.0978	0.2504	0.1095	0.5257	0.4087	0.0057
SWC6	0.1335	0.4293	0.3147	0.1572	0.3935	0.4434	0.8246	0.8071	0.0316
SWC7	0.2134	0.0465	0.3144	0.0665	0.2380	0.3409	0.1315	0.3391	0.0263
SWC8	0.2377	0.2072	0.0982	0.0893	0.2679	0.2902	0.3085	0.5640	0.0227
SWC9	0.0111	0.3476	0.3163	0.3654	1.0000	1.0000	0.8287	0.6026	0.0404
SWC10	0.1795	0.4874	0.3146	0.1129	0.3499	0.5947	1.0000	0.6581	0.0149
SWC11	0.1515	0.0000	0.3137	0.0696	0.0000	0.8504	0.3064	0.3274	0.0251
SWC12	0.3138	0.2928	0.0316	0.0760	0.4077	0.1708	0.8071	0.5033	0.0000
SWC13	0.1028	1.0000	0.3551	0.1241	0.2180	0.0000	0.5133	0.5432	0.0136
SWC14	0.0000	0.3028	0.7595	1.0000	0.3245	0.7856	0.9850	1.0000	1.0000
SWC15	0.6014	0.3489	1.0000	0.0759	0.1750	0.3664	0.9377	0.7427	0.0039
SWC16	0.0924	0.5090	0.3403	0.1782	0.1863	0.5120	0.2590	0.7396	0.2255
SWC17	0.0552	0.3554	0.0257	0.2086	0.2142	0.5100	0.6279	0.6576	0.5282
SWC18	0.2091	0.6022	0.0000	0.0000	0.1858	0.2893	0.6503	0.6573	0.0231

Table-A.7

Software company	Stockholders equity ratio (FR1)	Turnover rate of accounts receivables (FR2)	Turnover rate of inventory (FR3)	Return of stockholder equity (FR4)	Quick Ratio (FR5)	Operating income ratio (FR6)	Operating cash flow ratio (FR7)	Return of Assets (FR8)	Market Share (FR9)
SWC1	1.0000	0.7192	0.1773	0.0000	0.0000	0.5039	0.0000	0.0000	0.0097
SWC2	0.0325	0.5320	0.0398	0.2684	0.4844	0.6928	0.3196	0.8844	0.3850
SWC3	0.0363	0.5107	0.2779	0.2258	0.7317	0.7818	0.3166	0.8443	0.5614
SWC4	0.0846	0.1899	0.0400	0.0769	0.2781	0.4671	0.3584	0.6920	0.0272
SWC5	0.0667	0.9650	0.2776	0.0310	0.4613	0.3534	0.1781	0.5386	0.0062
SWC6	0.1767	0.4257	0.2778	0.0779	0.6807	0.6342	0.5497	0.8745	0.0333
SWC7	0.1562	1.0000	0.2776	0.0469	0.5200	0.5429	0.2672	0.6672	0.0570
SWC8	0.1690	0.1269	0.0605	0.0339	0.4299	0.5235	0.2424	0.6041	0.0206
SWC9	0.0250	0.5495	0.2775	0.2894	0.3549	1.0000	0.2304	0.8525	0.0369
SWC10	0.2557	0.4724	0.2779	0.0510	0.7416	0.6477	0.4709	0.7990	0.0155
SWC11	0.1004	0.0000	0.2771	0.0305	0.0061	0.9157	0.1344	0.5528	0.0345
SWC12	0.2174	0.3775	0.0797	0.0701	1.0000	0.0000	1.0000	0.8966	0.0000
SWC13	0.0634	0.6320	0.0729	0.1391	0.3954	0.4508	0.1399	0.8065	0.0133
SWC14	0.0000	0.3015	0.9677	1.0000	0.5444	0.7441	0.5036	1.0000	1.0000
SWC15	0.3890	0.4241	1.0000	0.0478	0.3769	0.6519	0.4537	0.9057	0.0045
SWC16	0.1319	0.2682	0.2288	0.0688	0.3988	0.6089	0.2188	0.7451	0.2355
SWC17	0.0346	0.3865	0.0183	0.1861	0.4220	0.6716	0.3273	0.7702	0.4938
SWC18	0.1386	0.6431	0.0000	0.0737	0.3854	0.5390	0.4521	0.7797	0.0236

Table-A.8

Software company	Stockholders equity ratio (FR1)	Turnover rate of accounts receivables (FR2)	Turnover rate of inventory (FR3)	Return of stockholder equity (FR4)	Quick Ratio (FR5)	Operating income ratio (FR6)	Operating cash flow ratio (FR7)	Return of Assets (FR8)	Market Share (FR9)
SWC1	1.0000	0.5440	0.2935	0.0000	0.0254	0.0000	0.0924	0.0000	0.0059
SWC2	0.0123	0.2804	0.0168	0.1670	0.4926	0.8364	0.0857	0.7296	0.2834
SWC3	0.0323	0.4982	0.2254	0.1020	0.9930	0.8914	0.3281	0.7846	0.5728
SWC4	0.0371	0.3210	0.0126	0.0672	0.3632	0.7639	0.3242	0.7084	0.0253
SWC5	0.0615	0.3086	0.2252	0.0166	0.7003	0.6663	0.0493	0.5656	0.0004
SWC6	0.1206	0.4517	0.2250	0.0335	0.4734	0.8014	0.1744	0.7661	0.0387
SWC7	0.0679	1.0000	0.4440	0.0312	0.9530	0.7704	0.4378	0.6497	0.0518
SWC8	0.0600	0.2981	0.0849	0.0425	0.3526	0.8012	0.1693	0.6906	0.0204

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SWC9	0.0129	0.4750	0.2255	0.2066	1.0000	1.0000	0.2862	0.7903	0.0337
SWC10	0.0875	0.4911	0.2252	0.0349	0.7421	0.7956	0.1959	0.7105	0.0169
SWC11	0.0374	0.0000	0.2246	0.0160	0.0000	0.9176	0.0000	0.5467	0.0307
SWC12	0.0638	0.4815	0.0533	0.1008	0.9341	0.6605	1.0000	1.0000	0.0000
SWC13	0.0209	0.4850	0.0319	0.1285	0.3015	0.7308	0.1540	0.7561	0.0135
SWC14	0.0000	0.3519	0.8515	1.0000	0.9281	0.8995	0.5381	0.9237	1.0000
SWC15	0.1227	0.4828	1.0000	0.0470	0.4443	0.8517	0.2118	0.8990	0.0055
SWC16	0.0426	0.3444	0.1171	0.0623	0.4499	0.7881	0.1528	0.7156	0.2405
SWC17	0.0110	0.4186	0.0103	0.1523	0.3819	0.8336	0.1735	0.6954	0.4693
SWC18	0.0525	0.4990	0.0000	0.0592	0.4628	0.7766	0.1833	0.7428	0.0228

Table-A.9

Software company	Stockholders equity ratio (FR1)	Turnover rate of accounts receivables (FR2)	Turnover rate of inventory (FR3)	Return of stockholder equity (FR4)	Quick Ratio (FR5)	Operating income ratio (FR6)	Operating cash flow ratio (FR7)	Return of Assets (FR8)	Market Share (FR9)
SWC1	1.0000	0.4367	0.1232	0.0000	0.0000	0.2440	0.0976	0.1763	0.0046
SWC2	0.0059	0.5286	0.0149	0.2258	0.3548	0.4435	0.5098	0.7182	0.4009
SWC3	0.0163	0.5093	0.1658	0.0935	0.7730	0.6156	0.5434	0.6511	0.5789
SWC4	0.0179	0.3414	0.0066	0.0469	0.2818	0.0781	0.2138	0.3276	0.0243
SWC5	0.0195	0.5563	0.1655	0.0202	0.3097	0.0012	0.1680	0.1196	0.0008
SWC6	0.0655	0.4846	0.1656	0.0181	0.4448	0.1733	0.6199	0.4475	0.0406
SWC7	0.0369	1.0000	0.3203	0.0276	0.7379	0.2508	0.4892	0.3841	0.0477
SWC8	0.0316	0.4442	1.0000	0.0299	0.2990	0.2919	0.4344	0.3554	0.0199
SWC9	0.0071	0.4993	0.1654	0.2087	0.2654	1.0000	0.2948	0.7575	0.0337
SWC10	0.0443	0.5863	0.1657	0.0277	0.6408	0.2501	0.4409	0.4686	0.0205
SWC11	0.0190	0.0000	0.1652	0.0070	0.0226	0.7214	0.0000	0.0000	0.0231
SWC12	0.0329	0.4539	0.0409	0.0365	1.0000	0.0843	0.1965	0.4655	0.0000
SWC13	0.0094	0.4608	0.0535	0.1124	0.2504	0.0000	0.2477	0.4817	0.0162
SWC14	0.0000	0.4121	0.5970	1.0000	0.8633	0.6228	1.0000	1.0000	1.0000
SWC15	0.0573	0.4551	0.1657	0.0415	0.6123	0.4526	0.6252	0.9525	0.0066
SWC16	0.0207	0.4376	0.0609	0.0475	0.2975	0.2025	0.3561	0.3868	0.2440
SWC17	0.0056	0.4977	0.0094	0.1304	0.3001	0.3979	0.4148	0.3689	0.4679
SWC18	0.0263	0.4966	0.0000	0.0386	0.3839	0.1425	0.4013	0.3923	0.0220

Table-A.10

Software company	Stockholders equity ratio (FR1)	Turnover rate of accounts receivables (FR2)	Turnover rate of inventory (FR3)	Return of stockholder equity (FR4)	Quick Ratio (FR5)	Operating income ratio (FR6)	Operating cash flow ratio (FR7)	Return of Assets (FR8)	Market Share (FR9)
SWC1	1.0000	0.3886	0.1027	0.0050	0.0000	0.2062	0.0898	0.2012	0.0040
SWC2	0.0040	0.5106	0.0182	0.2356	0.3529	0.4193	0.6025	0.7261	0.4084
SWC3	0.0118	0.4966	0.1544	0.1132	0.6930	0.5735	0.6996	0.7967	0.5711
SWC4	0.0121	0.3649	0.0088	0.0538	0.2772	0.0236	0.5398	0.3879	0.0258
SWC5	0.0124	0.7631	0.1541	0.0482	0.3144	0.0910	0.2218	0.3536	0.0026
SWC6	0.0417	0.5216	0.1541	0.0303	0.3923	0.1354	0.6201	0.6105	0.0405
SWC7	0.0259	1.0000	0.1542	0.0366	0.5091	0.2226	0.5224	0.4918	0.0493
SWC8	0.0211	0.5162	1.0000	0.0382	0.2589	0.2409	0.3353	0.4320	0.0203
SWC9	0.0054	0.4554	0.1543	0.2181	0.6359	1.0000	0.7527	0.8266	0.0328

SWC10	0.0283	0.6071	0.1543	0.0344	0.6210	0.1974	0.6375	0.497 6	0.0206
SWC11	0.0127	0.0000	0.1538	0.0000	0.0121	0.6365	0.0000	0.000 0	0.0192
SWC12	0.0216	0.6230	0.1546	0.0402	1.0000	0.1436	0.5593	0.463 2	0.0000
SWC13	0.0067	0.4707	0.1540	0.1412	0.2521	0.0000	0.4388	0.631 8	0.0159
SWC14	0.0000	0.4454	0.4629	1.0000	0.7119	0.5557	1.0000	0.963 8	1.0000
SWC15	0.0641	0.4242	0.1543	0.0331	0.6317	0.5138	0.7646	1.000 0	0.0072
SWC16	0.0128	0.4487	0.0466	0.0680	0.2590	0.1926	0.3035	0.512 4	0.2469
SWC17	0.0099	0.5003	0.0116	0.0698	0.2635	0.3155	0.4198	0.427 7	0.4403
SWC18	0.0177	0.4611	0.0000	0.0442	0.3807	0.0762	0.2456	0.432 3	0.0212