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APPLYING FUZZY LOGIC TO EVALUATE THE BSC'S PERFORMANCE FOR A RANDOM PRIVATE IRAQI BANKS GROUP

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Abstract:

The bank managers must measure the performance of their activities, measuring the performance by Balanced Scorecard of banks is very important for the investors and decision makers . Evaluating the performance of the banks that measured by BSC has uncertainly values because of the uncompleted and linguistic information . Fuzzy logic can give the solution for these problems . Functions of fuzzy logic can transfer the values of uncompleted and linguistic information to classical values . for that the combination between BSC and Functions of fuzzy logic is very useful to get the true vision about the performance of the bank , and to let the mangers to make the best strategies for their banks . In this paper , a new method is applied to solve the up mentioned problem using the fuzzy functions embedded in the MatLab® program .

Keywords: Fuzzy Logic , Balanced Scorecard , Performance , Linguistic Values , Classical Values .

1. Introduction

Measuring the performance of banks shows the possibility of the banks to continue their activities , and their effectiveness , many approaches to measure performance were appeared which not only focus on measuring the performance of banks in financially. Balanced scorecard is one of the best approaches to measure performance because it focuses on financial and non financial perspectives , but measuring the performance of non financial perspectives will lead to appear linguistic variables that can not be accurately identified . Hence , the fuzzy logic appeared as a useful tool to find the true values of linguistic variables accurately .

2. Performance

Performance can be defined as the proficiency of an agency or authority in acquiring resources economically and using those resources efficiently (input-output) and effectively (output-outcome) in achieving performance targets (Thabit 2013) .

Evidences about performance that are collected and used systematically. Performance information may be quantitative (numerical) or qualitative (descriptive). The usefulness of performance information is enhanced by applying standards and other types of comparison (for example, with past performance, other lines of business, or level of need before the intervention) which allow judgments to be made about the extent to which interventions are achieving desired outcomes. Performance information collected for monitoring purposes often generates questions that are investigated in more depth in an evaluation (Toni & Tonchia 2001).

A target level of performance expressed as a tangible, measurable objective, against which actual achievement can be compared, including a goal expressed as a quantitative standard, value, or rate. Performance goals can be either outcome or output goals .

3. Balanced Scorecard

The balanced scorecard is a strategic planning and management system that is used extensively in business and industry, government, and non profit organizations worldwide to align business activities to the vision and strategy of the organization. Improve internal and external communications and monitor organization performance against strategic goals. It was originated by Drs. Robert Kaplan (Harvard Business School) and David Norton as a performance measurement framework that added strategic non-financial performance measures to traditional financial metrics to give managers and executives a more 'balanced' view of organizational performance. While the phrase balanced scorecard was coined in the early 1990s, the roots of this type of approach are deep, and include the pioneering work of General Electric on performance measurement reporting in the 1950's and the work of French process engineers (who created the *Tableau de Bord* – literally, a "dashboard" of performance measures) in the early part of the 20th century (www.balancedscorecard.org).

4. Perspectives of BSC

The balanced scorecard suggests that we view the organization from four perspectives, and to

develop metrics, collect data and analyze it relative to each of these perspectives (www.balancedscorecard.org):

- *The Financial Perspective*

Kaplan and Norton do not disregard the traditional need for financial data. Timely and accurate funding data will always be a priority, and managers will do whatever necessary to provide it. In fact, often there is more than enough handling and processing of financial data, with the implementation of a corporate database, it is hoped that more of the processing can be centralized and automated, but the point is that the current emphasis on financials leads to the "unbalanced" situation with regard to other perspectives. There is perhaps a need to include additional financial-related data, such as risk assessment and cost-benefit data, in this category.

- *The Customer Perspective*

Recent management philosophy has shown an increasing realization of the importance of customer focus and customer satisfaction in any business. These are leading indicators: if customers are not satisfied, they will eventually find other suppliers that will meet their needs. Poor performance from this perspective is thus a leading indicator of future decline, even though the current financial picture may look good.

- *The Business Process Perspective*

This perspective refers to internal business processes. Metrics based on this perspective allow the managers to know how well their business is running, and whether its products and services conform to customer requirements (the mission). These metrics have to be carefully designed by those who know these processes most intimately; with our unique missions these are not something that can be developed by outside consultants.

- *The Learning & Growth Perspective*

This perspective includes employee training and corporate cultural attitudes related to both individual and corporate self-improvement. In a knowledge-worker organization, people (the

only repository of knowledge) are the main resource. In the current climate of rapid technological change, it is becoming necessary for knowledge workers to be in a continuous learning mode. Metrics can be put into place to guide managers in focusing training funds where they can help the most. In any case, learning and growth constitute the essential foundation for success of any knowledge-worker organization.

In other words, BSC is a complete system to represent the performance of the organization From the point of view of all parties, as shown in Fig. 1.

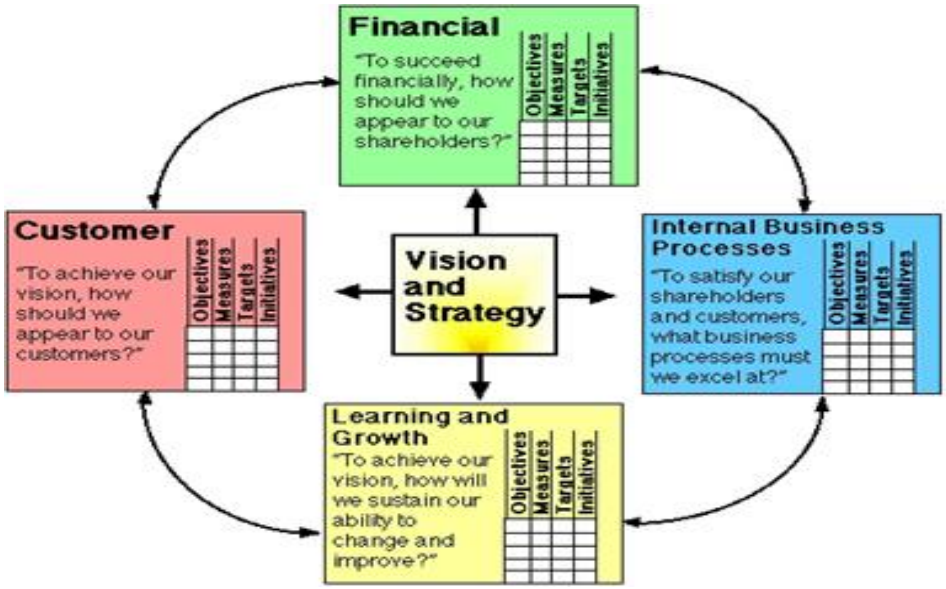

Fig. 1 The perspectives of BSC as they were presented by Kaplan and Norton in 1996 .

5. The combination between BSC and Fuzzy Logic

Fuzzy logic is a form of many-valued logic; it deals with reasoning that is approximate rather than fixed and exact. Compared to traditional binary sets (where variables may take true or false values). Fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false (Novák *et al.* 1999). Furthermore , when linguistic variables are used, these degrees may be managed by specific functions. Irrationality can be described in terms of what is known as the fuzzjective (Thabit 2013) .

The term "fuzzy logic" was introduced in the 1965 proposal of fuzzy set theory by Lotfi A.

Zadeh. Fuzzy logic has been applied to many fields, from control theory to artificial intelligence (Toni & Tonchia 2001).

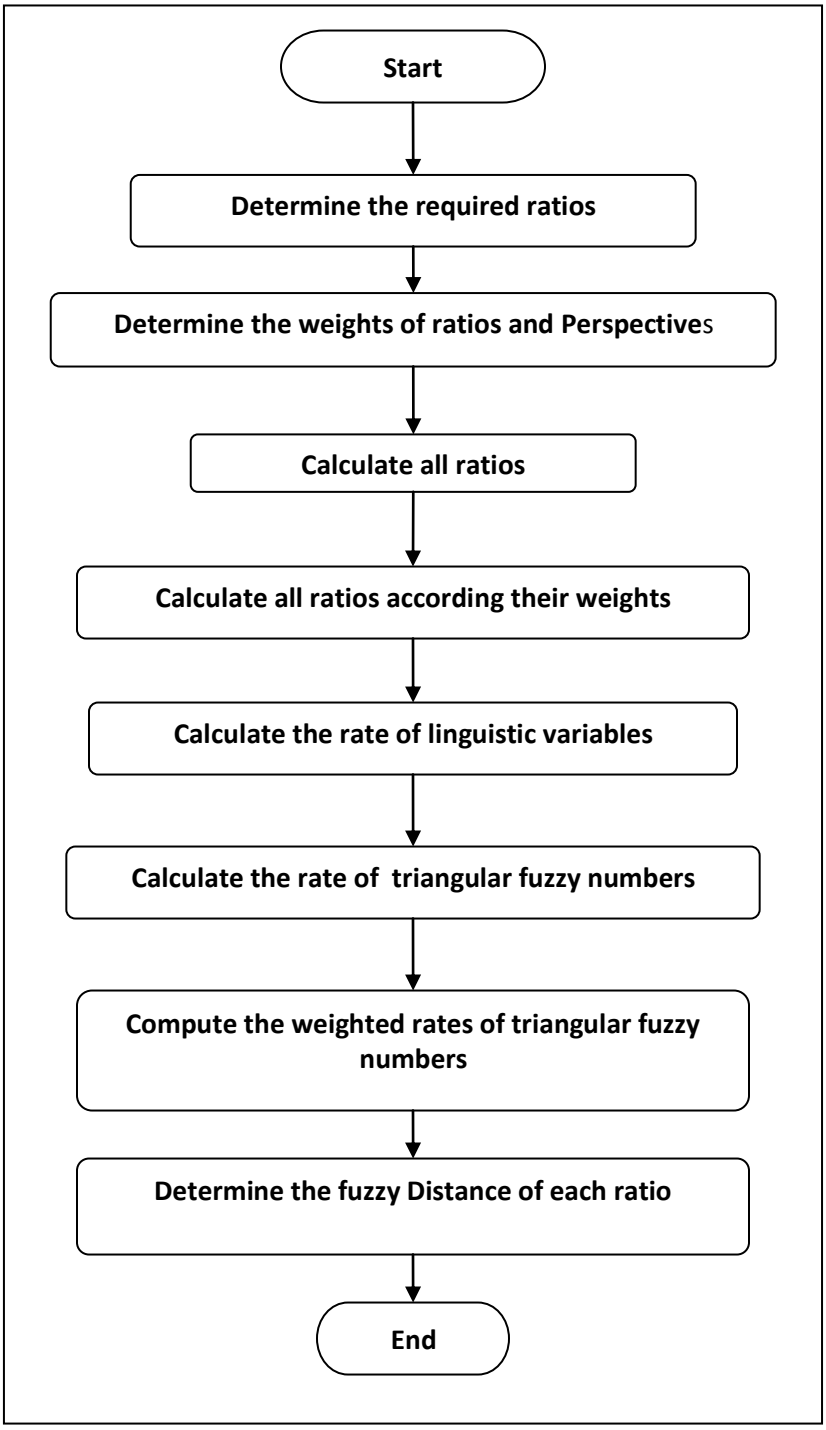

Fig. 2 The flowchart of the combination between BSC and Fuzzy Logic .

In fact, Zadeh made the following statement in his seminar paper of 1965 : The notion of a fuzzy set provides a convenient point of departure for the construction of a conceptual framework which parallels in many respects the framework used in the case of ordinary sets, but is more general than the latter and, potentially, may prove to have a much wider scope of applicability, particularly in the fields of pattern classification and information processing . Essentially, such a framework provides a natural way of dealing with problems in which the source of imprecision is the absence of sharply defined criteria of class membership rather than the presence of random variables (Ross , 2010). The combination between BSC and FL is shown in Fig 2.

The flowchart of the above combination illustrated by the following steps (Al-Hubaity & Thabit 2012) :

Step 1 : determine the required ratios , as shown in table 1 .

Perspective	ratio	Code
Financial Perspective	cash	F1
	legal reserve	F2
	legal liquidity	F3
	capital employed	F4
	Assess the profitability of capital	F5
	• Return on investment	F5-1
	• Return on equity	F5-2
	• Return on deposits	F5-3
Customer Perspective	Customer satisfaction	C1
	Customer retention	C2
	new customers attraction	C3
Business Process Perspective	exploitation of assets	B1
	Revenues growth of banking ops.	B2
	Revenues growth of investing ops.	B3
	Value-added	B4
	Quality	B5
Learning & Growth Perspective	Staff retention	L1
	Staff productivity	L2
	staff satisfaction	L3
	Staff training	L4
	Staff Benefits	L5

Table 1. The required financial ratios

Step 2 : determine the weights of ratios and **Perspective**s by dividing all the ratios on 100% , that will result every ratio equals 5% except (F5) that equals 15% .

Step 3 : Calculate all ratios, based on the data of the surveyed banks , as shown in table 2 .

BANKS			Mosul Bank	Iraqi Islamic Bank	North Bank	Iraqi Middle East Bank	United Bank	Elaf Islamic Bank	Union Bank of Iraq
Perspective	Code								
Financial Perspective	F1		1.080	1.155	0.686	0.732	0.458	1.496	1.147
	F2		0.103	0.052	0.100	0.111	0.092	0.052	0.041
	F3		0.107	0.119	0.068	0.020	0.045	0.135	0.118
	F4		0.115	0.151	0.423	0.374	0.933	0.515	0.316
	F5	F5-1	0.155	0.076	0.047	0.032	0.078	0.130	0.015
		F5-2	0.535	0.230	0.244	0.216	0.256	0.457	0.036
		F5-3	4.081	2.799	0.855	0.395	1.096	1.828	0.037
Customer Perspective	C1		-0.173	0.917	-0.121	0.038	-0.210	0.633	-0.410
	C2		0.862	-0.641	0.971	0.091	-0.923	0.302	0.303
	C3		0.423	0.969	-0.171	0.013	-0.242	-1.414	-0.230
Business Process Perspective	B1		0.049	0.041	0.037	0.026	0.061	0.070	0.031
	B2		0.137	0.903	0.288	0.314	0.177	0.361	-0.880
	B3		-0.057	-3.192	0.847	0.325	0.499	0.588	-0.330
	B4		0.208	0.964	0.307	0.609	0.287	0.506	-0.840
	B5		-0.190	0.742	0.597	0.048	0.681	0.224	0.135
Learning & Growth Perspective	L1		0.247	0.432	0.237	0.249	0.555	0.285	0.263
	L2		-0.157	-15.744	0.075	0.087	-0.830	0.107	-1.460
	L3		-0.466	0.329	0.178	0.215	-0.048	0.372	-0.010
	L4		0.187	1.000	0.543	-0.681	0.705	0.911	0.576
	L5		0.260	0.000	-0.649	0.271	0.395	0.503	0.524

Table 2 .The calculated ratios of surveyed banks

Step 4 : calculate all ratios according to their weights that were resulted in step 3 , as shown in table 3.

Banks			Mosul Bank	Iraqi Islamic Bank	North Bank	Middle East Bank	United Bank	Elaf Islamic Bank	Union Bank of Iraq
Perspectives	**R**	**W**							
Financial Perspective 0.35	F1	0.05	0.054	0.058	0.034	0.037	0.023	0.075	0.057
	F2	0.05	0.005	0.003	0.005	0.006	0.005	0.003	0.002
	F3	0.05	0.005	0.006	0.003	0.001	0.002	0.007	0.006
	F4	0.05	0.006	0.008	0.021	0.019	0.047	0.026	0.016
	F5	0.05	0.716	0.466	0.172	0.097	0.215	0.362	0.013
Customer Perspective 0.15	C1	0.05	-0.009	0.046	-0.006	0.002	-0.010	0.032	-0.021
	C2	0.05	0.043	-0.032	0.049	0.005	-0.046	0.015	0.015
	C3	0.05	0.021	0.048	-0.009	0.001	-0.012	-0.071	-0.011
Business Process Perspective 0.25	B1	0.05	0.002	0.002	0.002	0.001	0.003	0.004	0.002
	B2	0.05	0.007	0.045	0.014	0.016	0.009	0.018	-0.044
	B3	0.05	-0.003	-0.160	0.042	0.016	0.025	0.029	-0.017
	B4	0.05	0.010	0.048	0.015	0.030	0.014	0.025	-0.042
	B5	0.05	-0.010	0.037	0.030	0.002	0.034	0.011	0.007
Learning & Growth	L1	0.05	0.012	0.022	0.012	0.012	0.028	0.014	0.013
	L2	0.05	-0.008	-0.787	0.004	0.004	-0.042	0.005	-0.073

Perspective 0.25	L3	0.05	-0.008	0.016	0.009	0.011	-0.002	0.019	0.000
	L4	0.05	-0.008	0.050	0.027	-0.034	0.035	0.046	0.029
	L5	0.05	-0.008	0.000	-0.032	0.014	0.020	0.025	0.026

Table 3. The calculated ratios according their weights

Step 5 : Calculate the rate of linguistic variables by assuming a rated value to each linguistic variable by dividing the weight of each ratio on the number of linguistic variables (weak = 0.01, acceptable = 0.02, good = 0.03, very good = 0.04 and excellent = 0.05) , except F5 that the rated values of its ratio will equal (week = 0.03 , acceptable = 0.06 , good = 0.09 , very good = 0.12 , excellent = 0.15) .

Step 6 : calculate the rate of triangular fuzzy numbers by using the equations 1-4 (El-Hossainy 2011) , as shown in table 4.

$$r_{ij} = \left(\frac{X_{ij}}{\sum_{i=1}^{m} X_{ij}} \right) \ldots..1$$

$$r_{ij} = \left(\frac{X_{ij}^{-1}}{\sum_{i=1}^{m} X_{ij}^{-1}} \right) \ldots..2$$

$$r_{ij} = \left(\frac{a_{ij}}{\sum_{i=1}^{m} c_{ij}} , \frac{b_{ij}}{\sum_{i=1}^{m} b_{ij}} , \frac{c_{ij}}{\sum_{i=1}^{m} a_{ij}} \right) \ldots..3$$

$$r_{ij} = \left(\frac{c_{ij}^{-1}}{\sum_{i=1}^{m} c_{ij}^{-1}} , \frac{b_{ij}^{-1}}{\sum_{i=1}^{m} b_{ij}^{-1}} , \frac{a_{ij}^{-1}}{\sum_{i=1}^{m} a_{ij}^{-1}} \right) \ldots..4$$

Rates		Min	Avr	Max	R. I.
Perspectives	R.				
Financial Perspective	F1	0.0310	0.0393	0.0476	0.4025
	F2	0.0000	0.0083	0.0167	
	F3	0.0000	0.0083	0.0167	
	F4	0.0095	0.0178	0.0262	
	F5	0.0262	0.0333	0.0414	
Customer Perspective	C1	0.0072	0.0155	0.0238	0.2678
	C2	0.0095	0.0178	0.0262	
	C3	0.0060	0.0143	0.0226	
Business Process Perspective	B1	0.0000	0.0083	0.0167	0.2127
	B2	0.0071	0.0155	0.0238	
	B3	0.0083	0.0166	0.0250	
	B4	0.0095	0.0178	0.0262	
	B5	0.0107	0.0190	0.0274	
Learning & Growth Perspective	L1	0.0048	0.0131	0.0214	0.1170
	L2	0.0024	0.0107	0.0191	
	L3	0.0036	0.0119	0.0202	
	L4	0.0143	0.0250	0.0334	
	L5	0.0059	0.0143	0.0226	

Table 4. The rates of Triangular Fuzzy Numbers

Step 7 : Compute the weighted rates of triangular fuzzy numbers by using the equation 5 (El-Hossainy 2011) , after computing the weighted rates , the three values of triangular fuzzy number for every ratio (a, b, c) will appear , as shown in table 5 .

$$r_i = \sum_{j=1}^{n} wj \times \mathrm{r_{ij}} \ldots\ldots 5$$

Triangular Numbers		a	b	c
Perspective	R.			
Financial Perspective	F1	0.027308	0.051542	0.122798
	F2	0.0000	0.010888	0.053632
	F3	0.0000	0.010888	0.053632
	F4	0.008387	0.023409	0.084296
	F5	0.023107	0.043732	0.133288
Customer Perspective	C1	0.004191	0.013488	0.050991
	C2	0.005591	0.015566	0.056068
	C3	0.00349	0.012449	0.048422

Business Process Perspective	**B1**	0.0000	0.005754	0.028342
	B2	0.003324	0.010717	0.040482
	B3	0.003881	0.011542	0.042523
	B4	0.004437	0.012367	0.044563
	B5	0.004991	0.06526	0.046572
Learning & Growth Perspective	**L1**	0.001218	0.004988	0.020042
	L2	0.000609	0.004075	0.017825
	L3	0.000911	0.004533	0.018929
	L4	0.003662	0.00953	0.031201
	L5	0.001523	0.005441	0.021173

Table 5. The values of triangular fuzzy numbers

Step 8 : Determine the fuzzy Distance of each ratio by using the equations 6-7 (El-Hossainy 2011), and rank them according to their determined values , as shown in table 6 .

$$D^2(\tilde{X}, M) = (b-M)^2 + {}^1\!/_3\,(b-M)[(c+a)-2b] + {}^1\!/_{18}\,[(c-b)^2 + (b-a)^2] - {}^1\!/_{18}\,[(c-b)(b-a)]\; f(\alpha) \approx \alpha \;\ldots.6$$

$$D^2(\tilde{X}, M) = (b-M)^2 + {}^1\!/_2\,(b-M)[(c+a)-2b] + {}^1\!/_9\,[(c-b)^2 + (b-a)^2] - {}^1\!/_9\,[(c-b)(b-a)]\; f(\alpha) \approx 1 \;\ldots.7$$

From table 5 let Max (M) = 0.133288 and Min (M) = 0.0000 , the ordering values for all ratios can be obtained by equations 8 and 9 (El-Hossainy 2011), as shown as table 6 .

$$Max.(M) \geq \sup\left[D^{\alpha}_{\max i S}\,(P_i^{\sim})\right] \ldots.8$$

$$Min.(M) \leq \inf\,\left[D^{\alpha}_{\max i S}\,(P_i^{\sim})\right] \ldots.9$$

	f(α) ≈ 1		**f(α) ≈ α**	
	$D^{1}_{Max\,i}$	$D^{1}_{Min\,i}$	$D^{\alpha}_{Max\,i}$	$D^{\alpha}_{Min\,i}$
F1	0.005198	0.004306	0.005620	0.003683
F2	0.013197	0.000456	0.013764	0.000316
F3	0.013197	0.000456	0.013764	0.000316
F4	0.009889	0.001420	0.010561	0.001074
F5	0.005667	0.004153	0.006329	0.003284
C1	0.012790	0.000499	0.013289	0.000372
C2	0.012210	0.000628	0.012735	0.000475
C3	0.013087	0.000440	0.013572	0.000326

B1	0.015237	0.000127	0.015572	0.000088
B2	0.013733	0.000315	0.014150	0.000235
B3	0.013489	0.000355	0.013919	0.000266
B4	0.013249	0.000397	0.013691	0.000300
B5	0.007881	0.002250	0.006702	0.002825
L1	0.015757	0.000073	0.015989	0.000054
L2	0.016049	0.000055	0.016262	0.000039
L3	0.015903	0.000064	0.016125	0.000046
L4	0.014380	0.000208	0.014685	0.000162
L5	0.015612	0.000084	0.015853	0.000062

Table 6. The fuzzy distance of each ratio

From Above calculations , the ratios can be ranked according to their effectiveness . When $f(\alpha) \approx \alpha$ the ratios effectiveness ranking is F1, F5, B5, F4, C2, C1, C3, B4, F2, F3, B3, B2, L4, B1, L5, L1, L3, L2 . When $f(\alpha) \approx 1$ the ratios effectiveness ranking is also the same sequence. This means that the most effective ratio on the performance of the private Iraqi banks has the less fuzzy distance , as shown in Fig. 2

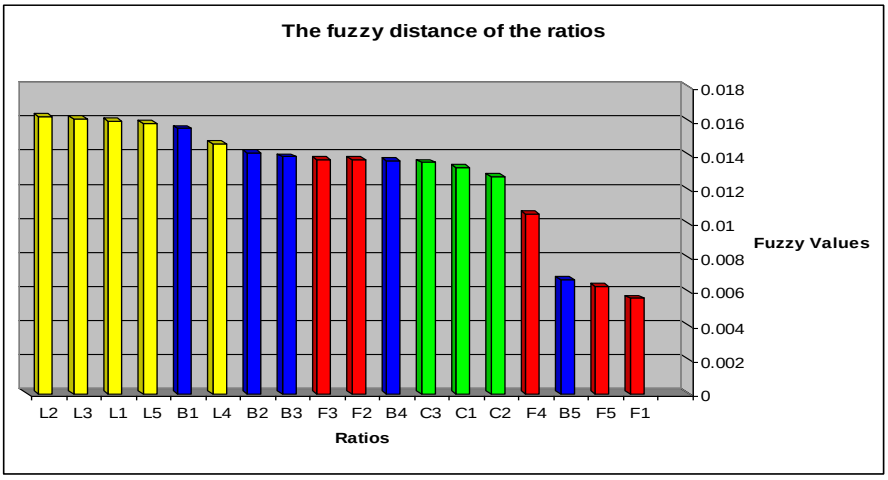

Fig. 2 shows the fuzzy distance of the financial ratios

6. conclusions

In this paper the results of proposed framework indicate the following :

- There is a gap between the true performance and the optimal performance because of then linguistic variables , for that the fuzzy logic is the best technique to measure this gap .
- The presented framework proved its capability to locate the most effectiveness ratio within a group of suggested proposed ratios even within unequal important attributed variables.

- The model can also provide ranking group of ratios applying in the banks .
- Finally, the proposed algorithm has the capability to deal with similar types of the same situations such as : ranking the best decisions to deal with, the best financial ratio in the bank , choosing the best applications in environmental sustainability , etc. In general, the proposed method provides accurate selection and can be used easily in many sectors.

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