Fuzzy Logic Model for Performance Evaluation of Industrial Enterprises in Algeria with Applied Study on Brood (HODNA)

Benmessaoud Nassreddine, Mohammed bouknadil, Ismail Morad, Hind Mehdaoui

Abstract— **In this paper fuzzy reasoning methodology is proposed as a technique for the balanced scorecard method to evaluate the performance of the industrial enterprises, and this is the integration of qualitative and quantitative variables expressed in terms expressive language, and to see how effective that emulate the information and data obtained from the study applied to one of the institutions that operate in the field of food production that using matlab program to emerge in recent results indicate the performance ratio reached from enterprise under study during the period 2005 to 2014.**

Index Terms— **Performance Evaluation, Fuzzy Logic, Fuzzy Inference**

I. INTRODUCTION

Development of performance evaluation is an organization vital pillars of the modern management and the key elements of the regulatory process which seeks to achieve the goals of the Organization efficiently and effectively, The performance appraisal was known generally as the measurement of the activities of the Foundation on the basis of the results achieved at the end of the accounting period which is usually a year to know the reasons that led to these conclusions and propose solutions for overcoming them in order to perform well in the future, and to correct errors and deviations between what is And what is an investigator and which are often the result of poor planning and management and lack of attention to modern management approaches that change from time to time most especially with the technological development which became changed daily, Performance is a critical task for top management where do and ensure that it may increase the success and development of the economic foundation and its continuation, and here it is clear that the process of performance measurement and evaluation objectives, for example, may lie in the oversight and follow-up planned enterprise to reveal strengths and weaknesses maintains that strengthen and improve, in order to assess and measure the performance of many methods and techniques may find them method of controlling budgets (1912), economic value added, the owners Interests, style paintings (1930), and finally the balanced scorecard method (1992) which uses abounded in many studies because it provides comprehensive information on the development of the enterprise through several financial and non-financial perspectives from the perspective of internal processes, learning and growth perspective, the research included that there is a study of K, Robert S N, David (1992) study, for L. Bible, S . Kerr, M. Zanini (2006), a study of A. Paul (2007), a study of M. Toru (2002), a study of M J. Epstein, J. Manzoni (1997), a study of K. Menor Hendricks Larry, CH. Wiedman (2004) ،But in spite of this however, those methods remain limited noama characterized by palaces, we find depends on financial indicators only as income and accounting results which reflect the financial position only which does not help to explain and analyze the facts and does not reflect the truth, making decisions arbitrarily random makes a diagnosis of crises take to senior management of the Organization, and thus assess the performance in this case would be considered a classic classic suffers from weak points first is the neglect of non-quantitative benchmarks and indicators non-financial Focus on financial and quantitative metrics that make financial and quantitative prompt only, Missing attribute of universality that should characterize performance, either the second weakness is the neglect of the strategic dimension that could happen to a bug in the basic structure of the system, in addition to the lack of information and data on many indicators in the performance appraisal process, the aforementioned methods are inadequate for evaluation may produce inaccurate results, so turn to systems designers incorporate artificial intelligence techniques in the different processes of the Department, and among them we find ambiguous conclusion technology techniques (Fuzzy Reasoning) Based on the theory of fuzzy logic (FuzzyLogic) Presented by world L.Zadah 1988 and is a form of reasoning used to reach a clear conclusion to the document vague and ambiguous problem and inaccurate, C J. Bezdek (1993), and this is a particular approach to the complex data that vague (Fuzzy) and uncertainty (Uncertainty) that allows to eliminate those shortcomings and deficiencies determined by conventional methods above, here it is clear that the main objective of this research lies in the design of fuzzy expert system to determine the performance efficiency of the industrial enterprises of Algerian road allowance depending on the Scorecard indicators.

And studies that preceded us in applying this approach in assessing performance we found a study of A. Costea (2012)

Manuscript received March 26, 2016

Nassreddine Benmessaoud, Department of economie, University of Ain Temouchent, Algeria
Mohammed bouknadil, Department of economic, University of Ain Temouchent, Algeria
Ismail Morad Department of economie, University of Ain Temouchent, Algeria
Hind Mehdaoui Department of economie, University of Ain Temouchent, Algeria

has to assess the level of financial performance using fuzzy logic depending on the benchmarking method for a group of financial institutions, To assess performance in mechanical industries to find out the place reached in production quality, study of R. N. Beheraand P.V.S.S.Gangadhar (2012) used ambiguous reasoning to assess the level of performance of the staff of the Government study, for S. A Kayode and all (2012) hedftali e-government performance appraisal from globalization, technological standards to monitor the quality of services provided to citizens, examine for Shruti S Mudholkar Jamsandekar, R.R (2013) Targeted use of ambiguous reasoning methodology for evaluating the performance and quality of education for the purpose of improving the level of students and learn the strengths of preservation and weaknesses to be reconsidered and corrected study (2013) Amina S. al Omarand and Verónica Gurrea and al (2014) fuzzy logic used for qualitative performance evaluation of supply chain economic institutions, and there is a study of R. Singh Yadav and al (2014) and are also using fuzzy inference to the evaluation of the educational level of students at different learning stages of the school year, classes, study for S.Mudholkar Jamsandekar, R.R (2014) aimed to assess the functioning of the institutions of agricultural productivity by using fuzzy logic road allowance.

And the tracks dealt with previous studies is generally considered one of the modern methods of fuzzy logic to assist in the planning and conduct of many crises that complain of economic enterprises and social institutions, they are also easy especially require technology when applied to rely on software to facilitate calculations and access the result quickly, the main feature of this method on the other methods is dealing with quantitative and qualitative variables with some wakhd if the thumb caused by lack of information and data or permanently unavailable at times, in addition It has resorted to this method in micro and even macroeconomic.

In this ask the following question: how to contribute to vagal inference methodology in evaluating the performance of industrial enterprises under shortage and uncertainty of available information and data available on many quantitative and qualitative variables? And the answer that we offer this paper dealing with both the General introduction included outlines and general aspects of this important topic was in the first part, second part contains ambiguous reasoning model approach with the most basic steps and stages, and then comes the third part as an applied study on one of the economic institutions specialized in industrial food production, which has an important place in the national economy to determine the level of performance of the survey on the status and prestige and knowledge of the effectiveness of the proposed approach in helping, to conclude The most important conclusion the findings and interpretations.

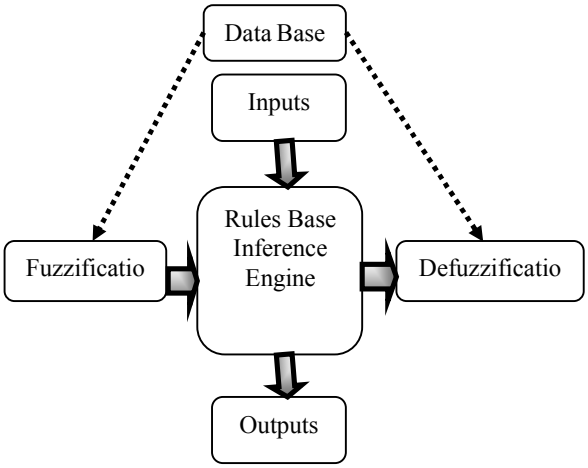
II. FUZZY REASONING METHODOLOGY (FUZZY REASONING)

Inference or conclusion vagus is a model used in modelling the fuzzed difficult decisions and nonlinear systems, especially when knowledge is partial and the thumb problem variables and, in the case of decisions that are more involved in Government and is the dominant factors and variables of the problem, and can be defined as Reyes (2000) that the mathematical model is built based on concepts derived from group theory vague (Fuzzy Set Theory) is working to address any problem in the form of a system, this system is input (Inputs) are factors and basic variables Affecting problem and exits (Outputs) is the best and final result to be accessed by the address of such inputs as well as the existence of rules (Rules) and certain conditions (If-Then) between input and output. There are two as Ruan (1997) and Zadeh (1995) fuzzy inference systems that can be applied to help with MATLAB software namely model (Mamdani Type) (1975) and is more common in use for special input of human knowledge and human model (Takagi-Sugemo Type) (1985) and the difference between them is the way they represent their output is in the form of totals are vague and there are fixed values, respectively.

Fuzzy reasoning and inference mechanism or what we call form is a fuzzy expert system illustrates the relationship between inputs and outputs of any system through a set of rules and conditions, the primary goal of resorting to vague system is to control complex processes using sequential analysis strategy based on knowledge derived from experience and human experience, and may adopt such a mechanism in many cases to be sequenced stages between them could be clarified by both Babuska (2006) and Works (2005) and Chortaras et al (2006) and Saifizul et al (2008) As follows:

- **Fuzzification**: the first step in building a form is vague as you convert the input to input opaque through membership functions that take different forms (triangular, trapezoid,...) , Which through this step is convert input expressed in terms of language (linguistic expression) to a digital form variables organic functions;
- **Ambiguous operations (Appling Fuzzy Operators)**: when the input to the process of fuzzing will know the degree of factors that will determine it, and will evaluate all the rules if the selection has more than one part, the logical operations applied to a vague will get one result;
- **Method of embedding (Applying Implication Method)**: in this phase is giving weight to each rule between inputs and outputs, this weight is limited between 0 and 1, it is called inter If;
- **Collect all output (Aggregating All Outputs)**: this phase consists in collecting and taking all outputs obtained from all the rules to create the final product,
- -Defuzzification: this phase is the last phase in the construction of the model is vagal and convert the output to the output of a vague numerical values real.

We can summarize the above stages in more detail in the following figure:



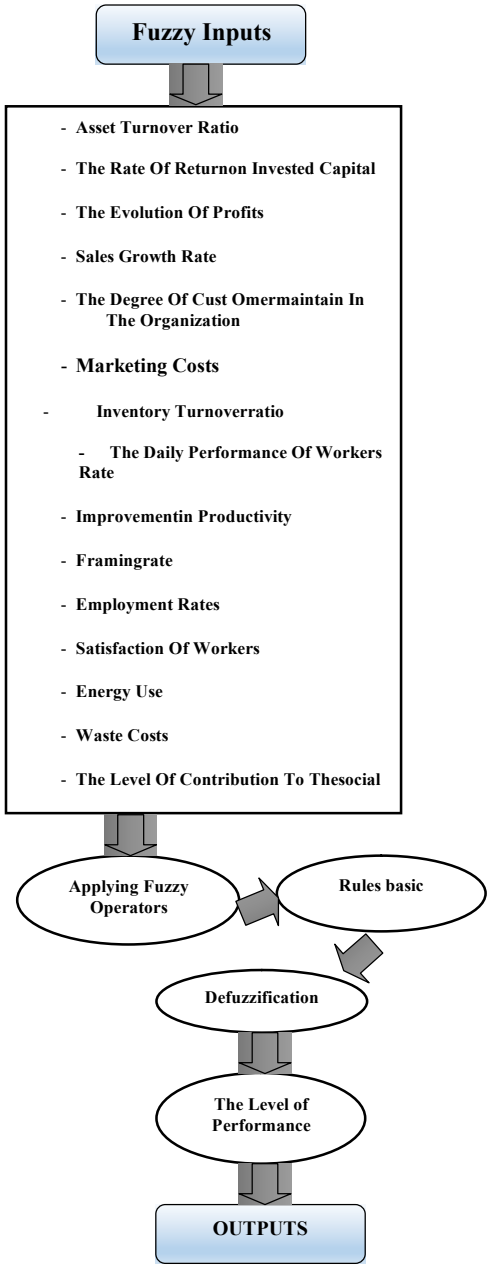
Resource:Joao M.C. Sousa,Uzay Kaymak, Fuzzy Decision Making In Modeling And Control,World Scientific Series in Robotics and Intelligent Systems - Volume 27, 2002, P08.

So to control some problems alkrarih especially characterized by uncertainty and ambiguity and human is controlled and difficult to solve using traditional methods, relying on vague inference approach presented above, this reliance on logic fuzzy which plays a big role in reducing personal diligence to decision-makers, especially in such matters that are predominantly human knowledge what he heard to integrate and declarations and resolutions modeling by crossing language and converted to variables with precise numerical values allowing resolution So the absolute integrity of the semi final and far from bias, from here we can describe best fuzzy logic and soft which allows reasonable and acceptable solutions to the many problems of realistic, affordable and effective compared with other technologies, possibly in the form of a simulation of human thinking depends on varying degrees of truth.

III. BUILD A MODEL FUZZY INFERENCE TO EVALUATE THE PERFORMANCE OF INDUSTRIAL ENTERPRISES

In this part shows how fuzzy inference (limbo) (Fuzzy Reasoning) use methodology Mamdani (1977) in assessing the level of performance to the industrial enterprises on the basis of the indicators relied upon is balanced performance, relying on the set of inputs are divided into groups of opaque (FuzzySets), processed and give the latter outputs of these status level of performance can be reached under the available data and information with the mystery and ambiguity, and to clarify that offer The following figure:

. The entries shown in the figure above may change depending on the company and the area in which it is active.



IV. CASE STUDY

To illustrate the effectiveness of the methodology proposed in this paper on evaluation of performance on the ground, put it on an industrial companies operating in the field of milk production in Algeria, following fig. (2) according to the following stages:

Step (01): at this stage, scoping and vague totals corresponding to all inputs and outputs according to the following table:

Table No. (01): ambiguous term and totals corresponding to the input and output

Variable	Range and Fuzzy Sets				
	0--100	-50-40	30-70	60-90	80-100
ATR (%)	V.L	L	M	H	V.H
RRIC (%)	V.L	L	M	H	V.H
EP (million DA)	(-)* 150 - 0	(-)80-50	40 - 120	100 - 170	150 - 200
	V.L	L	M	H	V.H
SGR (%)	0 – 30	20 – 40	35– 70	60 – 90	80– 100
	V.L	L	M	H	V.H
DCMO (%)	0--100	-50-40	30-70	60-90	80-100
	V.L	L	M	H	V.H
MC million DA	0,7 – 2,5	2 – 3,5	3 – 4,5	4 – 5,5	5 – 7,5
	V..L	L	M	H	V.H
ITR (%)	0 – 30	20 – 40	35– 70	60 – 90	80– 100
	V..L	L	M	H	V.H
DPW (%)	V..L	L	M	H	V.H
IP (million DA)	40 - 140	130 - 230	220 - 320	310 - 410	400 - 600
	V..L	L	M	H	V.H
FR (%)	0 – 30	20 – 40	35– 70	60 – 90	80– 100
	V..L	L	M	H	V.H
ER (%)	V..L	L	M	H	V.H
SW (1000 DA)	10 - 30	20 - 50	40 - 70	60 - 90	80 - 100
	V..L	L	M	H	V.H
EU(%)	0 – 30	20 – 40	35– 70	60 – 90	80– 100
	V..L	L	M	H	V.H
WC (million DA)	5 - 10	9 - 15	14 - 20	19 - 25	24 - 30
	V..L	L	M	H	V.H
LCS(%)	0 – 30	20 – 40	35– 70	60 – 90	80– 100
	V..L	L	M	H	V.H
The Level of Performance (LP) (%)	V..L	L	M	H	V.H

* Indicates that the profit is less than zero any negative (150 < 0) and same thing for the value (190 < 0).

For (V.L, L, M, H, VH) is a summary of the terminology (Very Low, Low, Meduim, High, Very High) respectively.

Step (2): using software (MATLAB) are building functions belonging to each of the inputs and outputs as follows:

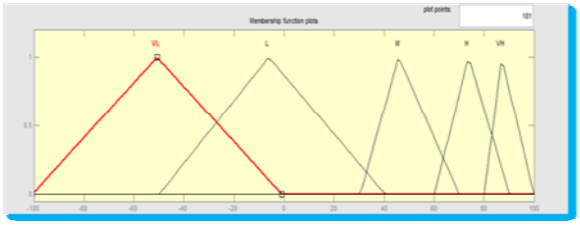


Figure (03): Membership Functions for ATR, RRIC, DCMO

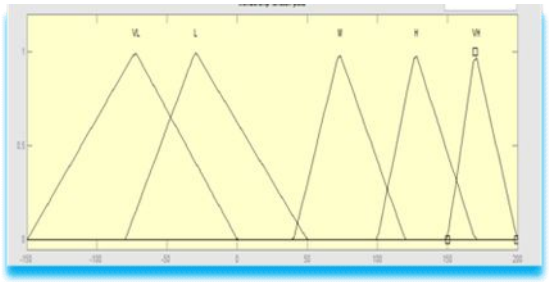


Figure (04): Membership Functions for EP

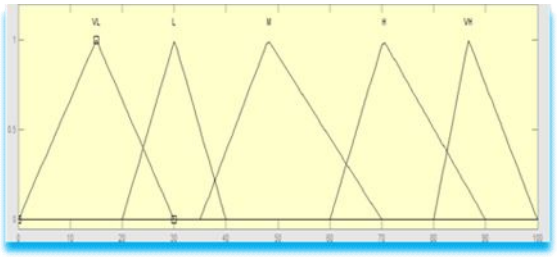


Figure (05): Membership Functions for SGR, ITR, DPW, FR, ER, EU, LCS, LP

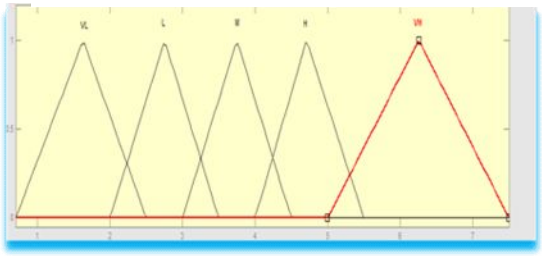


Figure (06): Membership Functions for MC

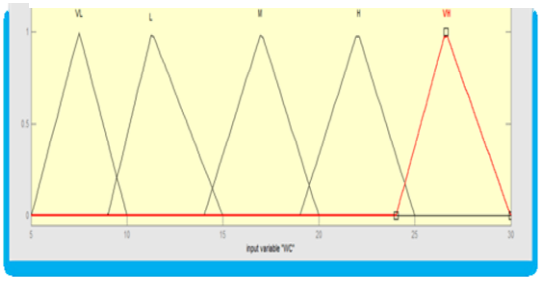
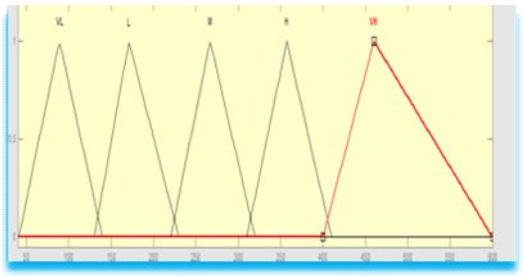


Figure (07): Membership Functions for WC



Figure(08): Membership Functions for IP

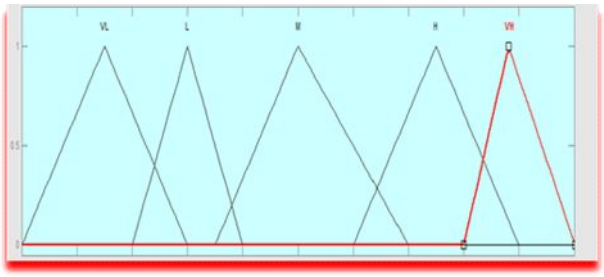


Figure (09): Membership Functions for Level Performance

Step (3): this step is in the formation of laws expressed in conditional rules (Rules base), these rules incorporate inputs to give the final result of the Director, be drafted, for example in the following figure:

IF ATR **IS** VL **AND** RRIC **IS** VL **AND** EP **IS** VL **AND** SGR **IS** VL **AND** DCMO **IS** VL **AND** MC **IS** VH **AND** ITR **IS** VL **AND** DPW **IS** VL **AND** IP **IS** VL **AND** FR **IS** VL **AND** ER **IS** VL **AND** SW **IS** VL **AND**EU **IS** VL **AND**WC **IS** VH **AND** LCS **IS** VL **THEM** L . PERFORMANCE **IS** VL.

The table below shows some of the fuzzy inference mechanism laws used in the system as follows:

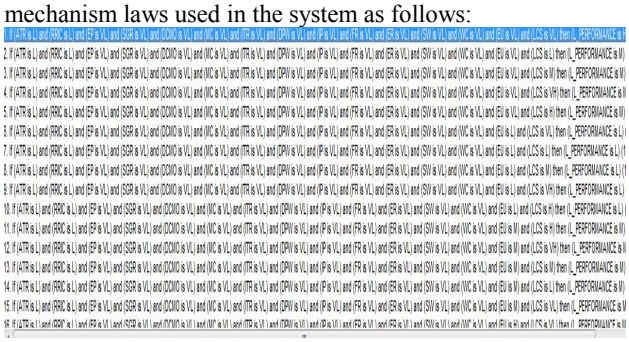


Figure (10): A section of the outputs of MTLAB program shows the some of the rules contained in the fuzzy inference model

Step (4): laws of output obtained from building rules

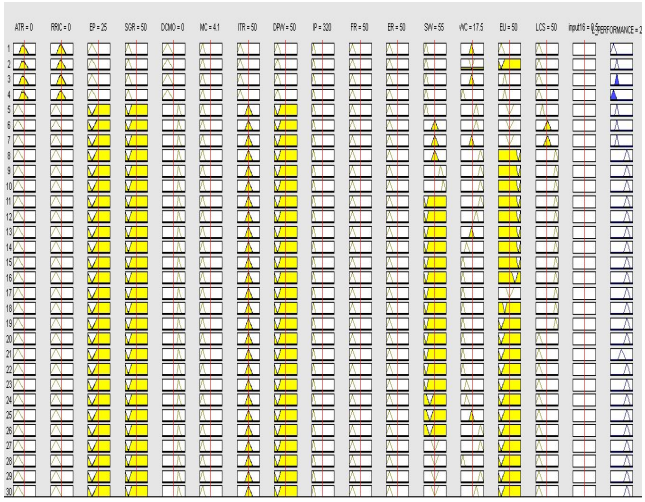


Figure (11): A section of the output based on MATLAB software

Step (5): select the performance level reached according to the data, the available data about the company under study during the period 2005-2014, on the basis of output obtained in step (4), and the results are shown in the following table:

Years / Fuzzy Inputs	2005	2006	2007	2008	2009
ATR (%)	90	92.67	100	100	90
RRIC (%)	-24	0.23	2.34	7.73	6.40
EP (M.DA)	-150	-115.8	100	56.83	50
SGR (%)	20	30	40	45	30
DCMO (%)	28	75	-5.35	66.98	1.13
MC (M.DA)	0.28	0.783	2.51	6.745	2.69
ITR (%)	5.85	12.23	3.34	7.23	2.4
DPW (%)	22.4	40.79	71.13	85.25	23.45
IP (M.DA)	439	116.34	216.90	344.04	300.45
FR (%)	22.4	15.49	25.64	22.58	22
ER (%)	18.36	100	37.32	27.17	26.67
SW(1000)	10.36	27.23	42.10	49.5	40.5
EU (%)	7.59	84.11	100	50.29	50.45
WC (M.DA)	5.293	9.16	22.09	16.6	28.49
LCS (%)	22.41	15.41	25.65	22.58	32.82
Outputs (L.P) (%)	**21.18**	**30.7**	**40.8**	**45.67**	**23.45**

Years / Fuzzy Inputs	2010	2011	2012	2013	2014
ATR (%)	100	100	100	100	100
RRIC (%)	8.40	8.90	9.10	9.40	9.40
EP (M.DA)	100	110	140	150	150
SGR (%)	60	60	70	80	80
DCMO (%)	30	40.23	40.43	40.50	45.60
MC (M.DA)	7.33	8.50	9.4	9.5	9.67
ITR (%)	7.7	8.4	8.6	8.9	9
DPW (%)	40	59.5	69.6	83.45	89.12
IP (M.DA)	457.45	460	465	470	480
FR (%)	32.82	34	35	35	35
ER (%)	59.67	60.67	65.6	70.45	74.54
SW(1000)	90.61	95	95	95	95
EU (%)	100	100	100	100	100
WC (M.DA)	30.40	35.45	36.6	37.5	40
LCS (%)	34.5	36.6	37.7	38.6	39.5
Outputs (L.P)(%)	**30.5**	**30.8**	**46.7**	**50.7**	**60.78**

To reference the code table values (10) reflect the level of each variable of the form variables inference vagal inputs and the predominantly by the ambiguity, to be entered into the form and run it using software (MATLAB) to give the final result of the performance of the Director in each year of the period studied,

CONCLUSION

After running the model fuzzy reasoning with all his results were obtained the code in the table above (10) these results indicate that the performance of this company (HODNA) change from year to year and statement (12) clarifies that, where performance in increasing level slower rates of 21.18 to 45.67 during years 2005-2008 and the result of the improvement of various variables (inputs) of all financial and non-financial dimensions, and in 2009 it knew the level of performance A decrease of $ 23.45, and this might be due to the low level all indicators due to the investments of the company during that period, growth failure, and subsequently returned to its previous level performance to know growing in a log about 60, 78 in 2014 with a good level and this rise was the result of a good control on some non-financial variables such as costs of waste.

The reliance on traditional tools for performance measurement and evaluation in industrial enterprises was insufficient to advance all aspects of the company and its environment, and determine impact and vulnerability by demonstrating the shortage and lack of inclusiveness in the provision of sound information about the status of the institution for which the adoption of effective decisions and successful, it represents a model of fuzzy inference is one of the most important and most effective methods in measuring and assessing the overall performance of the enterprises being includes all dimensions at once, including financial and non-financial, quantitative and non-quantitative (qualitative), and this Fuzzy inference method is an important tool in solving this kind of problems faced by organizations in particular industrialized allowing decision know the place and the position of his company and of TMP know landmarks future planning in the short term or the long term.

REFERENCES

[1] G. O. Young, "Synthetic structure of industrial plastics (Book style with paper title and editor)," in *Plastics*, 2nd ed. vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 15–64.

[2] W.-K. Chen, *Linear Networks and Systems* (Book style).Belmont, CA: Wadsworth, 1993, pp. 123–135.

[3] H. Poor, *An Introduction to Signal Detection and Estimation*. New York: Springer-Verlag, 1985, ch. 4.

[4] B. Smith, "An approach to graphs of linear forms (Unpublished work style)," unpublished.

[5] E. H. Miller, "A note on reflector arrays (Periodical style—Accepted for publication)," *IEEE Trans. Antennas Propagate.*, to be published.

[6] J. Wang, "Fundamentals of erbium-doped fiber amplifiers arrays (Periodical style—Submitted for publication)," *IEEE J. Quantum Electron.*, submitted for publication.

[7] C. J. Kaufman, Rocky Mountain Research Lab., Boulder, CO, private communication, May 1995.

[8] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interfaces(Translation Journals style)," *IEEE Transl. J. Magn.Jpn.*, vol. 2, Aug. 1987, pp. 740–741 [*Dig. 9th Annu. Conf. Magnetics* Japan, 1982, p. 301].

[9] M. Young, *The Technical Writers Handbook*. Mill Valley, CA: University Science, 1989.

[10] (Basic Book/Monograph Online Sources) J. K. Author. (year, month, day). *Title* (edition) [Type of medium]. Volume(issue). Available: http://www.(URL)

[11] J. Jones. (1991, May 10). Networks (2nd ed.) [Online]. Available: http://www.atm.com

[12] (Journal Online Sources style) K. Author. (year, month). Title. *Journal* [Type of medium]. Volume(issue), paging if given. Available: http://www.(URL)

[13] R. J. Vidmar. (1992, August). On the use of atmospheric plasmas as electromagnetic reflectors. *IEEE Trans. Plasma Sci.* [Online]. *21(3).* pp. 876—880. Available: http://www.halcyon.com/pub/journals/21ps03-vidmar