Fuzzy Inference Sytem for Teaching Staff Performance Appraisal

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Abstract—**Performance Appraisal is the systematic assessment of performance of employees to understand the abilities for further development. According to sixth pay commission the approach adopted for evaluation of teaching staff performance focuses on areas like Teaching, Learning, Extension, Research, Publication etc. which are actually fuzzy concepts that can be captured in fuzzy terms. In the proposed research we are developing a fuzzy inference system (FIS) for teaching staff performance appraisal using Matlab. The research formulates the mappings from factors affecting performance to the incentives**

Keywords- assessment, fuzzification, membership functions, inference techniques

I. INTRODUCTION

High quality teaching is essential to improving student outcomes and reducing gaps in student achievement. The Teacher Performance Appraisal System provides teachers with meaningful appraisals that encourage professional learning and growth. The process is designed to foster teacher development and identify opportunities for additional support where required [1]. By helping teachers achieve their full potential, the performance appraisal process represents one element of achieving high levels of student performance.

Conventional evaluation systems are representatives of structured systems that employ quantifiable and non quantifiable measures of evaluation. It is often difficult to quantify performance dimensions. For example, "teaching" may be an important part of the appraisal. However, how exactly does one measure "teaching". Academic administrators often face such issues when trying to evaluate a staff's performance. Fuzzy approach can be effectively utilized to handle imprecision and uncertainty [2]. This approach to performance appraisal allows the organization to exercise professional judgment in evaluating its employees.

In this research we are developing a fuzzy inference system (FIS) for teaching staff performance appraisal using Matlab [3]. The model can be viewed as an alternative to the use of addition in aggregating the scores from all categories, and to produce a final score [4]. The factors used for evaluating the performance are considered as input parameters for fuzzification. The study utilizes FIS to deal with the problem associated with rule explosion [5]. The proposed FIS is implemented using Mamdani-type inference. To defuzzify the resulting fuzzy set the center of gravity defuzzification method is selected.

II. FUZZY LOGIC – AN OVERVIEW

Dr. Lotfi Zadeh, a professor of mathematics from U.C. Berkeley, proposed the fuzzy theory 1965 [8]. Fuzzy logic is based on the theory of fuzzy sets, where an object's membership of a set is gradual rather than just member or not a member. Fuzzy logic uses the whole interval of real numbers between False and True to develop logic as a basis for rules of inference. It is a mean to transform linguistic experience into mathematical information. It is implemented in three phases as shown in the figure 1.

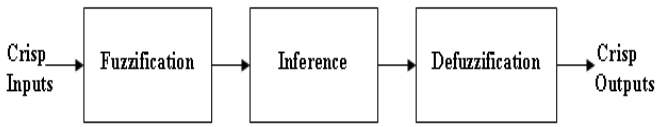

Figure 1: Fuzzy Logic Phases

A. Fuzzification is a means of mapping measured input values fuzzy membership functions. A membership function is a curve that defines how each point in the input space is mapped to a membership value between 0 and 1. There are different shapes of membership functions; triangular, trapezoidal, piecewise, Gaussian, bell-shaped, etc.

B. Inference can be done by if-then rules which relates multiple input and output variables. Because the rules are based on word descriptions instead of mathematical definitions, any relationship that can be described with linguistic terms can typically be defined by a fuzzy logic. This means that even nonlinear systems can be described and easily controlled with a fuzzy logic.

C. Defuzzification is a conversion of internal fuzzy output variables into crisp values that can actually be used. It is done after the evaluation of inputs and applies them to the rule base. The centroid calculation method is commonly used for defuzzification.

III. ACADEMIC PERFORMANCE INDICATORS – AN OVERVIEW

As per U.G.C. Notification approved by Govt. of Maharashtra State, the Academic Performace Indicators are [4]:

Category I: Teaching, learning and evaluation related activities:

- Lectures, Seminars, tutorials, practical, contact hours undertaken taken as percentage of lectures allocated
- Lectures or other teaching duties in excess of UGC norms
- Preparation & Imparting of knowledge / instruction as per curriculum; syllabus enrichment by providing the additional resources to students
- Use of participatory & innovative teaching learning methodologies; updating of subject content, course improvement, etc.
- Examination duties as per allotment.

Category II: Co-curricular, Extension, Professional Development Related Activities:

- Institutional Co-curricular activities, Positions held/ Leadership role played in organization, Students and Staff Related Socio-Cultural and Sports Programme, Community work
- Contribution to Corporate life, Institutional Governance responsibilities, Participation in committees, Responsibility for Students Welfare, Counseling and Discipline Organization of Conference/Training
- Membership in Profession related committees at state and national level, Participation in subject associations, conferences, Participation in short term training courses, Membership in education Committees, Publication of articles in newspapers, magazines

Category III: Research, Publications and Academic Contributions:

- Published Papers in Referred Journals, Non refereed but recognized, indexed and reputed Journals, Full Papers published in Conference Proceedings
- Other Research Publications, Research Monographs, Text Books, Reference Books, Chapters contributed to edited knowledge, Editing of the proceedings of the Seminar
- Research Projects, Ongoing and Completed Research Projects, Consultancy Projects.
- Research Guidance

IV. STRUCTURAL DESIGN OF PROPOSED SYSTEM

The main objective of this research is to propose a new methodology to carry out performance appraisal of teaching staffs. In order to analyze and organize the appraisal information a FIS with specific characteristics is proposed. The proposed architecture is based on Fuzzy Inference System contains following modules:

1. Fuzzy module for Teaching, learning and evaluation related activities

2. Fuzzy module for Co-curricular, Extension, Professional Development Activities

3. Fuzzy module for Research, Publications and Academic Contributions

Figure 2 illustrates the components of the proposed FIS with its modules, input and output parameters. It represents a construction of a multi-input, non-linear model.

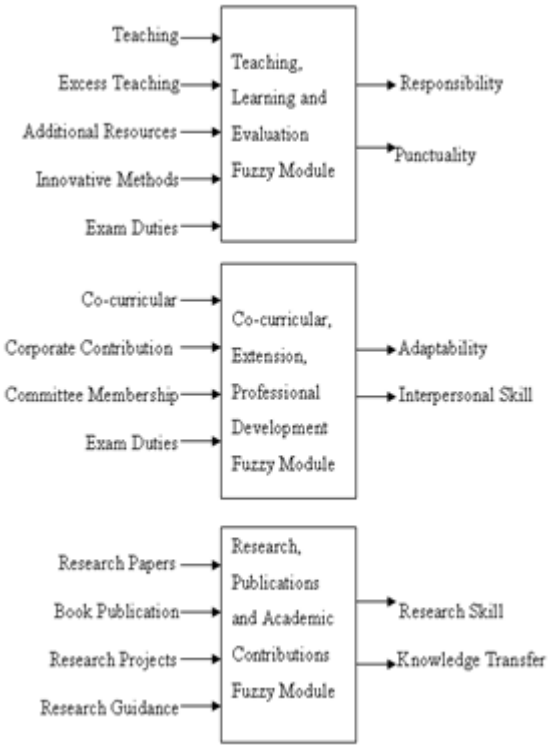

Figure 2: Architecture of proposed FIS

V. APPLICATION DEVELOPMENT OF FIS

Since the research is in progress we are presenting explanation of FIS for Teaching, learning and evaluation fuzzy module. Fuzzification comprises the process of transforming crisp value into grade of membership for linguistic terms of fuzzy sets. The membership function is used to associate a grade to each linguistic term. The first step in using fuzzy logic within this model is to identify the parameters that will be fuzzified and to determine their respective range of values. The final result of this interaction is the value for each performance parameter. We have used MATLAB for the development of FIS.

A. Input and Output Parameters

The input and output parameters are created in FIS editor as shown in the figure 3. We have considered five input parameters and two outputs of the category 1 and applied to the FIS.

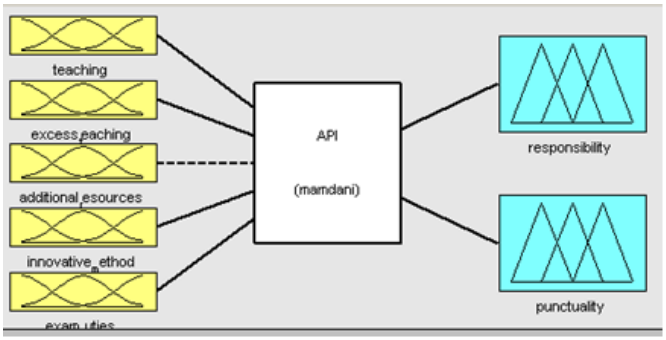

Figure 3: Input and output parameters

Measuring teacher's performance involves assigning a number to reflect a teacher's performance in the identified dimensions. Technically, numbers are not mandatory. Labels such as "excellent", "good", "average", "fair" and "poor" are used. Rating scale of input and output parameters is classified into different categories as given in the table 1 and 2.

Input Name	**Linguistic**
Teaching	Poor
	Fair
	Average
	Good
	Excellent
Excess Teaching	Poor
	Average
	Good
Additional Resources	Low
	Medium
	High
Innovative Method	Abstract
	Better
	Relevant
Exam Duties	Poor
	Fair
	Average
	Good
	Excellent

Table 1: Rating scales of input parameters

Output Name	**Linguistic**
Responsibility	Poor
	Fair
	Average
	Good
	Excellent
Punctuality	Poor
	Fair
	Average
	Good
	Excellent

Table 2: Rating scales Output Parameters

B. Membership Functions

Fuzzification comprises the process of transforming crisp value into grade of membership [12]. The membership function is used to associate a grade to each linguistic term. The membership function editor is used to define the properties of the membership function for the systems variables. Figure 4 shows fuzzification of input parameters of first fuzzy module with membership function as explained in table1, the membership function are overlapping with each other for achieving better results.

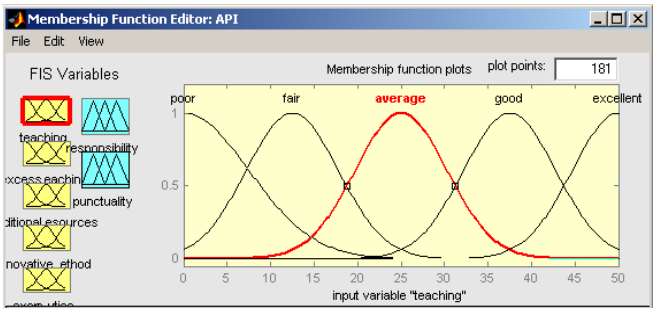

Figure 4: Membership function for input teaching activities

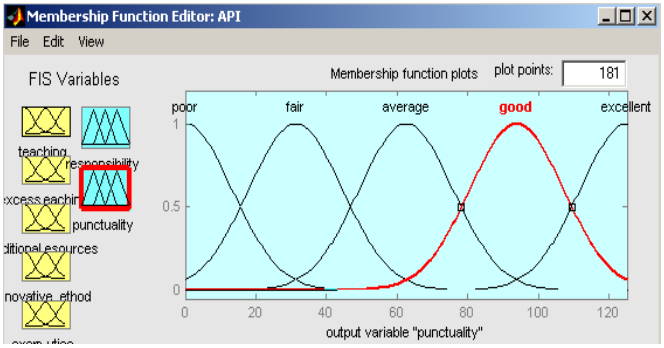

Figure 5: Membership functions for output "punctuality"

Figure 5 shows fuzzification of output parameter performance with membership function as explained in table 2, the membership function are touching with each other for achieving better results.

C. Rule Base

A fuzzy rule base is a collection of knowledge in the If-Then format from experts. It describes the relationship between fuzzy input parameters and output. It is used to display how an output is dependent on any one or two of the inputs. The rule editor enables the user to define and edit the rules that describe the behavior of the system. As per the input and output parameters fuzzified, rule base is generated by applying reasoning to evaluate the performance of a teacher. There are 34 numbers of rules generated. Following are the sample rules collected from rule base which are responsible for the assessment:

1. If (teaching is excellent) and (excess_teaching is good) and (additional_resources is high) and (innovative_method is relevant) then (responsibility is excellent)(punctuality is excellent)
2. If (teaching is fair) and (additional_resources is high) and (innovative_method is relevant) then (responsibility is average)
3. If (teaching is average) and (additional_resources is low) and (innovative_method is abstract) then (responsibility is fair)
4. If (teaching is excellent) and (excess_teaching is good) and (additional_resources is high) and (innovative_method is relevant) and (exam_duties is excellent) then (responsibility is excellent)(punctuality is excellent)

If (teaching is poor) and (excess_teaching is poor) and (additional_resources is low) and (innovative_method is abstract) and (exam_duties is excellent) then (responsibility is poor)(punctuality is fair)

D. Experimental Results

In this case, the proposed method is applied to evaluate the performance appraisal of teaching staff. Sample data were examined and randomly selected for the present study. This is an example of the activation of rules relative to an aspect of staff performance appraisal for the initial FIS. Figure 6 and 7 shows snapshots of results of work done in MATLAB. The rule viewer is a read only tool that displays the whole fuzzy inference diagram. The surface viewer is also a read only tool. Table 3 explains input and output parameters values for the selected cases.

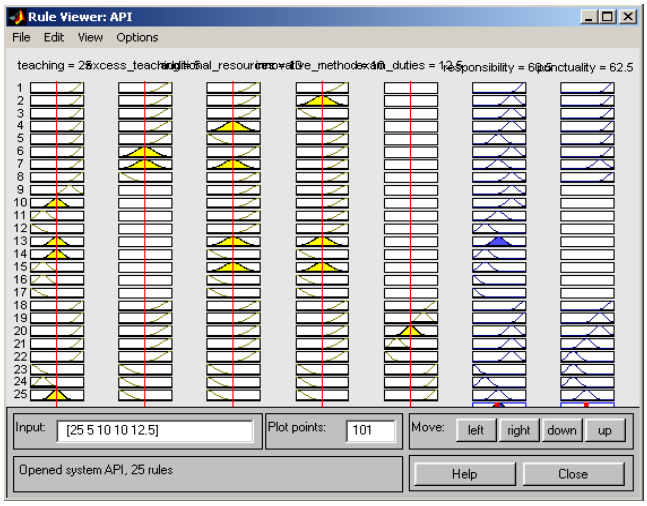

Figure 6: Rule viewer view of input, output parameters

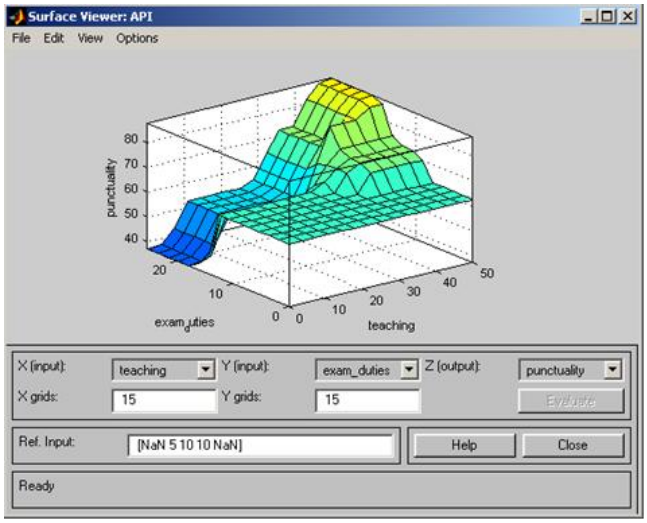

Figure 7: Surface viewer view of input, output parameters

Staff	**Input variables**					**Outputs**	
Sl. No.	Teaching (0-50)	Excess teaching (0-10)	Additional resources (0-20)	Innovative method (0-20)	Exam_ Duties (0-25)	Responsibility (0-125)	Punctuality (0-125)
1	25	5	10	10	12.5	60.5	32.9
2	20.6	3.29	7.2	6.07	8.76	50.5	31.6
3	16.4	2.64	5.51	4.21	6.43	44	29.6
4	5.79	1.44	3.27	2.71	3.15	18.7	18.5
5	36.2	1.06	19.9	19.5	0	92.7	89.1
6	47.5	1.16	11.3	12.6	7.13	69.9	91.8
7	43.8	1.53	6.45	9.07	15.8	60.2	75.7
8	45.1	4.03	14.1	14.9	21.6	74.8	94.5
9	48.8	1.9	18.8	17.7	23	91	105
10	38.2	9.31	5.7	3.46	22.8	49.9	34.4

Table 3: Inputs and outputs for the selected cases

VI. SIGNIFICANCE AND CONCLUSIONS

Teacher's performance plays a key role in success or failure of any educational institute. Proper system to motivate the teachers to improve their work performance is the primary aim of this research. This paper presents how fuzzy inference system can be used to build performance evaluation models based on realistic data. This FIS acts as a solution to qualitative assessment. A large number of factors affecting the staff's performance were identified and incorporated in the system. The membership functions and fuzzy rule bases were developed based on logical reasoning. The results obtained reflect that the proposed system can be used to improve the efficiency teaching staff performance which was not possible in previous systems based on entering scores related to Academic Performance Indicators (API) By using FIS encourages teaching staff which results in improvement of quality, adequacy, satisfaction, efficiency and innovation in their teaching. This research can be extended by considering remaining categories for the evaluation of teacher's performance can be used for judgmental and developmental purposes in order to make good administrative decisions in higher education field.

REFERENCES

[1]. Sirigiri Pavani, P.V.Gangadhar, K.K.Gulhare, "Evaluation of teachers performance using fuzzy logic techniques", International Journal of Computer Trends and Technology- Vol. 3 No. 2- 2012

[2]. Amartya Neogi, Abhoy Chand Mondal and Soumitra Kumar Mandal - A Cascaded Fuzzy Inference System for UniversityNon-Teaching Staff Performance Appraisal, Journal of Information Processing Systems, Vol.7, No.4, December 2011

[3]. Fuzzy Logic Toolbox for use with Matlab – Users Guide

[4]. "Performance Based Appraisal System", retrieved from www.ugc.ac.in

[5]. Marcus Foley, John McGrory - The Application of Fuzzy Logic in Determining Linguistic Rules and Associative Membership Functions for the Control of a ManufacturingProcess - Dissertations School of Electrical Engineering Systems, Dublin Institute of Technology

[6]. Vinod Kumar, R.R.Joshi, "Hybrid Controller based Intelligent Speed Control of Induction Motor", Journal of Theoretical and Applied Information Technology 2005

[7]. P.V.S.S. Gangadhar, Dr.R.N.Behera, "Evaluation of government officer performance using fuzzy logic techniques", Indian Journal of Computer Science and Engineering (IJCSE)

[8]. Lotfi A Zadeh, Fuzzy Logic, Neural Networks, and Soft Computing

[9]. Ms. Pooja Dhiman, Mr. Gurpreet Singh, Mr. Manish Mahajan, "Fuzzy Logics & it's Applications in Real World"

[10]. Kai Meng Tay, Chee Peng Lim, Tze Ling Jee, "Enhancing Fuzzy Inference System Based Criterion Referenced Assessment with an Application" Proceedings 24th European Conference on Modelling and Simulation

[11]. Michael Gr. Voskoglou, "Fuzzy Logic and Uncertainty in Problem-Solving", Journal of Mathematical Sciences & Mathematics Education Vol. 7 No. 1

[12]. Shikha Rao, Lini Mathew, Rahul Gupta, "Performance Comparison of Fuzzy Logic Controller with Different Types of Membership Function using Matlab Tools", IRNet Transactions on Electrical and Electronics Engineering