Employee Performance Appraisal System Using Fuzzy Logic

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Abstract:
Performance Appraisal is the systematic evaluation of the performance of an employee under certain aspects of consideration and to understand the potential of a person for further growth and development of an employee in an organization with specific ratings. This paper presents a design and implementation of a performance appraisal system using the fuzzy logic. It extracts the performance of an employee at each level, thereby generating the ratings automatically with respect to the amount of work completed by them. An automated employee rating system is used for this purpose to track the employee work performance. The performance will be measured based on certain factors such as technical knowledge, quality and quantity of output, etc. Based on these attributes, it automatically separates them into three categories such as high-level performers, mid-level and low-level performers.

Keywords: Employee evaluation, fuzzy logic controller, performance appraisal and performance criteria, rating

1. Introduction

Performance Appraisal may be defined as a structured, formal interaction between a subordinate and a supervisor that usually takes the form of a periodic interview (annual or semi-annual) in which the work performance of subordinate is discussed and examined to identify strengths& weaknesses, opportunities for improvement and skills development. The main aim o0oof a performance appraisal system is to identify the performance gap. This gap occurs when performance does not meet the standards set by the organization as acceptable. Secondly, a feedback system is supposed to inform the employee about the quality of his/her performance. Fuzzy logic has rapidly become one of the most successful of today's technologies for developing sophisticated control systems. The reason for which is simple. Fuzzy logic addresses such applications perfectly as it resembles human decision making with an ability to generate precise solutions from certain or approximate information. It fills a gap in engineering design methods left vacant by purely mathematical approaches and purely logic-based approaches in system design. While other approaches have equations to model real world behaviors, fuzzy design can handle the ambiguities of real-world human language and logic. It provides a method for describing systems in human terms and automates the conversion of those system specifications into effective models. This paper presents literature review, the methodology, the detailed system components, process workflow, recommended parts for future development and conclusion.

2. Related Work

Fuzzy logic describes the qualitative nature aspects of the object while conventional logic systems focus on their quantitative aspects. Two fuzzy approaches are used to construct performance appraisal. The first is the conventional fuzzy approach. This evaluates overall rating from many linguistic fuzzy input variables without any intermediate fuzzy reasoning using if-then rules. In this approach, it generates too many rules and it is difficult for the expert to take into account all aspects and formulates rules with accurate weight. The organization may need to weight some factors such as employee safety observation over quantity, any critical element and employee attitude. In this situation, the whole process will become extremely complicated.The function of designing inference rules need to use customize high level language. The second approach defines the relationship between the performance critical elements and accordingly specifies new large groups [1].These groups are used in fuzzy reasoning to determine intermediate parameter 'Work'. Similarly, 'Reliability' and 'Relationship' are used in fuzzy reasoning to determine intermediate parameter person's 'attitude' and then both group 'work' and 'attitude' are combined in second stage to build work–attitude analysis which is then finally combined with

regulatory requirement like 'safety' to generate the overall performance rating. This process is known as stagewise fuzz reasoning where it will be possible & flexible to give different degree of weight to different performance group. The proposed application of multifactorial evaluation was designed to be as a demonstrative example that inspires the application of one of the fuzzy set theory in the multi-criteria performance appraisal system. C.C. Yee and Y.Y. Chen proposed a performance appraisal system using multi-factorial evaluation model in dealing with appraisal grades, which are often expressed vaguely in linguistic terms [2]. Accordingly, a performance appraisal system has been developed using performance appraisal criteria from information and communication base company (Malaysia). The system uses multifactorial assessment model in helping top-level management to evaluate their subordinates. In fuzzy interference technique [3],handling different kinds of vague data was proposed. It is reasoning based on fuzzy models that replicate the way the people meditate and make judgments. As the result of evaluation, discrepancy in outcome is observed between classes using traditional non-fuzzy method and the new proposed fuzzy method. The non-fuzzy traditional methods follow the exact mathematical rules. The assessment for performance appraisal using fuzzy logic provides excellent flexibility. The fuzzy logic was utilized as calculating technique to appraise the student's academic performance. Performance appraisal system is essential for evaluating the employee's contribution to the organization. Most of the performance appraisal criteria are based on quantitative, qualitative elements. The proposed fuzzy assessment methodology [4] specifies substantial assessment parameters and presents system architecture that establishes a reliable assessment standard for smoothing a decision process. It is a comprehensive method for managing vagueness inherent in performance appraisal. It is common to use discrete scales with sharp real values in the evaluation process. The theory of fuzzy sets allows for the use of such linguistic fuzzy scales. The various scale values are expressed linguistically and modeled by fuzzy numbers. The purpose of using the linguistic fuzzy modelling is an exact mathematic data processing that excludes unwanted subjective influence. On the other hand, the expression of the expertly defined vague evaluations using natural language [5]. The project was carried out in collaboration with one of the Information and Communication Technology Company in Malaysia with reference to its performance appraisal process. Gin-Shuh Liang and Ming-Shin Kuo presented a performance evaluation method for tackling fuzzy multi-criteria decision-making (MCDM) problems based on combining VIKOR and interval-valued fuzzy sets [6]. To illustrate the effectiveness, a case study of this method for evaluating the performances of three major intercity bus companies from an intercity public transport system is conducted. G Meenakshi proposed a Multi source feedback or 360-degree feedback based performance appraisal system using Fuzzy logic and implemented it in academics especially engineering colleges [7]. The 360 degree appraisal system includes self, superior's, subordinate's, student's and peer's appraisal. Adam Golec and Esra Kahya presented a comprehensive hierarchical structure for selecting and evaluating a right employee [8]. The process of matching an employee with a certain job is performed through a competency-based fuzzy model. The main aim of performance assessment is to reward an employee who achieves the organizational goals and to determine which goals are not fulfilled, and to maintain plans to make sure they are achieved in future.

3. Methodology
Fuzzy logic that has been used in this paper is a superset of Boolean logic that has been extended to handle the concept of partial truth-truth values between "completely true" and "completely false". A Fuzzy Inference System (FIS) is a way of mapping an input space to an output space using fuzzy logic. It tries to formalize the reasoning process of human language by means of fuzzy logic (that is, by building fuzzy IF-THEN rules). FIS make a decision and act accordingly. In general, a fuzzy inference system consists of four modules: Fuzzification, Rule base, Inference engine, Defuzzification. Also, MySQL database was used to maintain the data.

4. System Components

4.1. Structure of a Fuzzy Logic Controller
- Fuzzification: It transforms the system inputs (crisp numbers) into fuzzy sets by applying a fuzzification function.
- Fuzzy Rule base: stores IF-THEN rules provided by experts.
- Fuzzy Inference engine: It simulates the human reasoning process (by making fuzzy inference on the inputs and IF-THEN rules).
- Defuzzification: transforms the fuzzy set (obtained by the inference engine) into a crisp value.
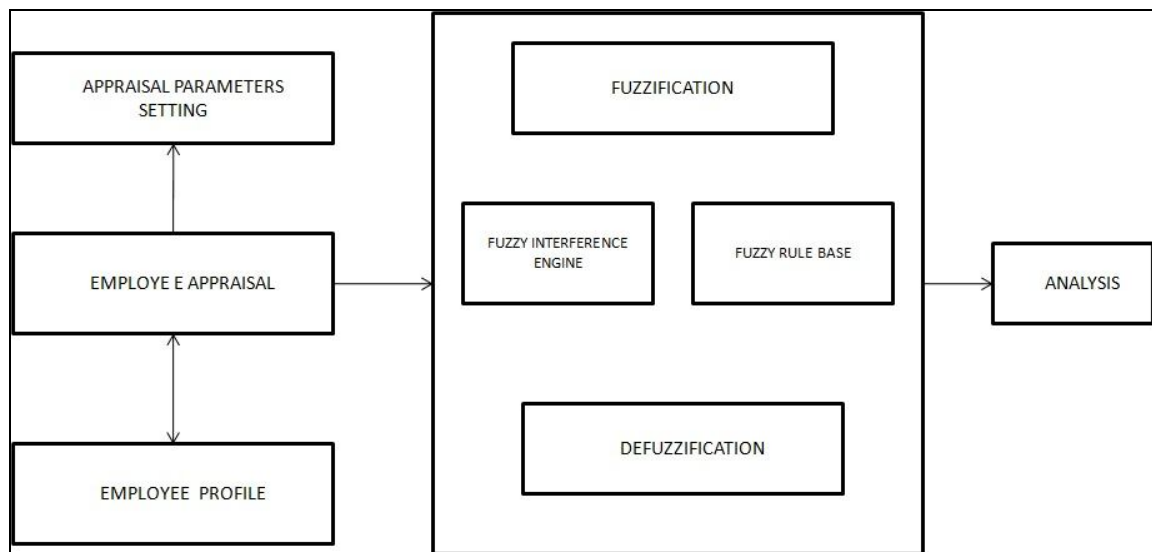
Figure 1: Structure of Fuzzy Logic Controller

4.2. System Components List
This section demonstrates the application subprograms and functions related to it. The implementation for this system application consists of five modules. Each module contains several applications as follows:
   a.   Inference Engine/System (Compute the output of the Mamdani model)
   b.   Performance Criteria Setting
   c.   Setting Functional Rules & Rules Report
   d.   Employee Performance Assessment Sheet & Evaluation Report
   e.   Employee Master Data: Performance Criteria Setting

4.2.1. Inference Engine/System
It consists of several sub-parts.. Each sub-parts computes one step in order to get the final result of the Mamdani model. The inference engine module performs the following functions as given below:
   1.   Compute Relation (Min Operator or Algebraic product): This process computes the relations using MIN Operator or algebraic product.
   2.   Compute Input (Input o R or Input x R): This process computes the outputs using the compositional rule of inference (Inputs o Relation) with Sup-min operator or (Inputs x Relation) with Sup-product operator.
   3.   Aggregation (Max operator or Additive operator): This process calculates the final output by aggregating the outputs using Max operator or the Additive operator (sum).
   4.   Defuzzification: This process computes the final output defuzzification using centroid for both methods.

4.2.2. Performance Criteria Setting
   1.   Define Appraiser- In this application; admin will be able to define Criteria type's master data such as projects &soft skill. Appraisal & objectives setting is one of the appraisal methods uses to evaluate employee where you need to define two types of criteria: the employee objectives/projects for the specific period of time and the general requirements of employee soft linguistic value. It also generates the required membership skill.
   2.   Define Criteria Type - enables the admin to define the criteria type.
   3.   Define Evaluation Criteria -In this application admin will define the criteria like attendance, training attended, conference conducted, maintaining the file etc.
   4.   Define Scale (Linguistic Values)- In this application admin will be able to define the scale of the proficiency level which will be used to evaluate the each criteria and the final employee evaluation.
   5.   Define Membership function - This part of the application allows you to set the degree of membership for each degree graph for all linguistic values.
   6.   Define Setting Functional Rules & rules Report
         Fuzzy inference system (FIS) allows you to set the calculation methods. (aggregation, defuzzification.)

4.2.3. Setting Functional Rules & Rules Report
The fuzzy inference engine (algorithm) combines fuzzy IF–THEN rules into a mapping from
fuzzy sets in the input space X to fuzzy sets in the output space Y based on fuzzy logic principles.In this window, Admin will be able to maintain all fuzzy related rules. In our design, we use stage-wise fuzzy reasoning (group related critical factors). For example; the element like 'Contributing to teamwork' & 'Achieving Work Targets' are combined to reflect 'Work Achievement'.

4.2.4. Employee Performance Assessment Sheet & Evaluation Report
It allows appraisers to evaluate their subordinates as per agreed criteria and setting planned objectives.

4.2.5. Employee Master Data: Performance Criteria Setting
In this part of the application, HOD will be able to maintain the employee information (Employee Detail, Position, etc.)

5. Process Workflow
The process workflow of the performance Appraisal System in figure2 shows who and where the processes will be performed. Therefore, it's easy to map the whole process, responsibilities, the roles and the interdependencies of a given individual or department.
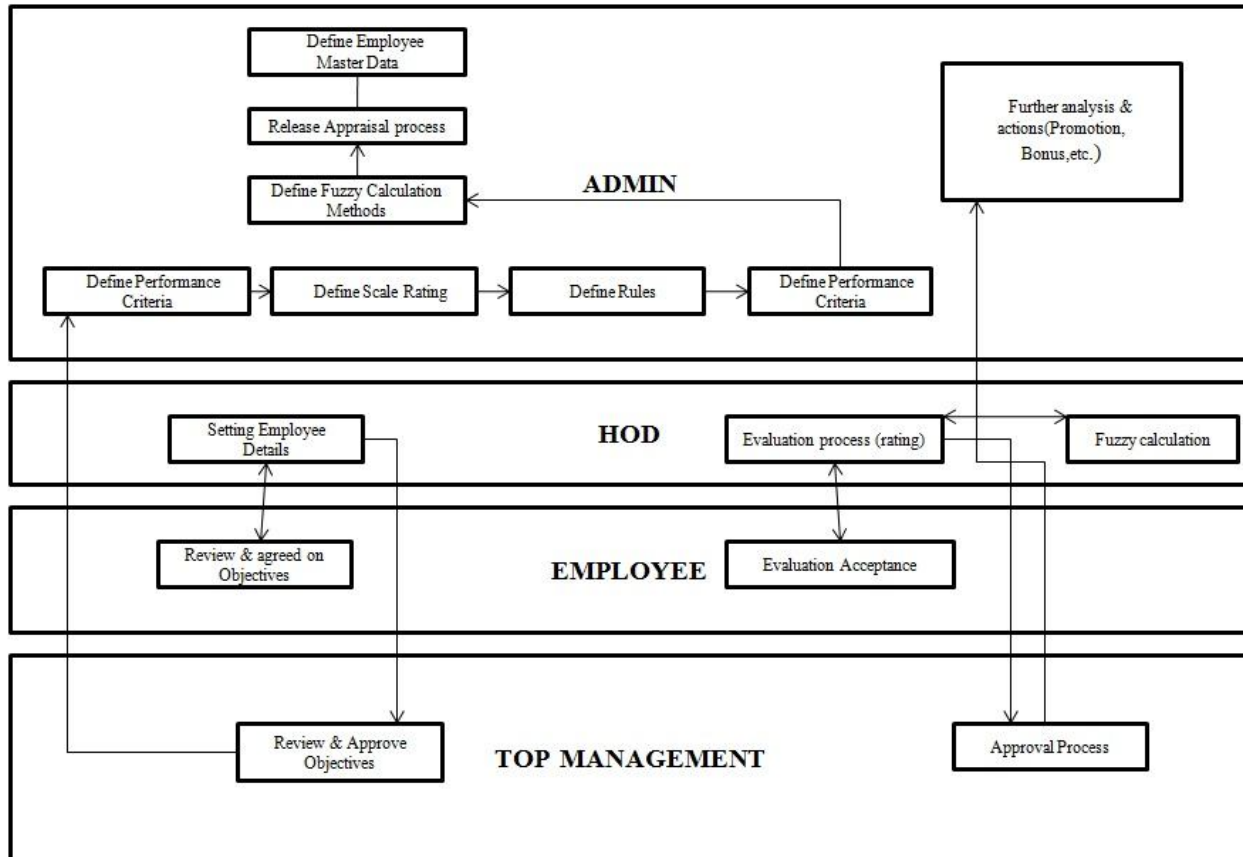

Figure 2: Workflow of Performance Appraisal System
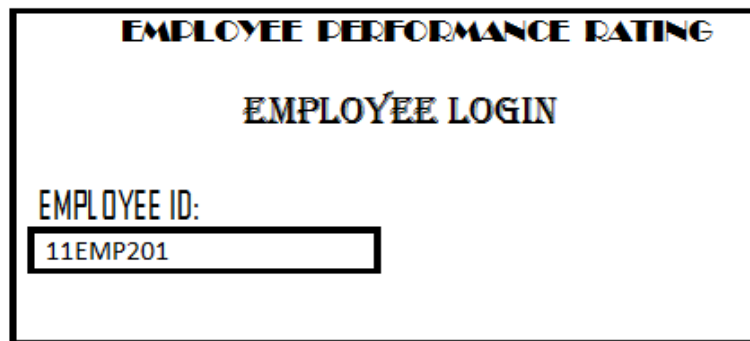
6. Experimental Results

Figure 3: Employee login

EMPLOYEE PERFORMANCE RATING   LOGOUT

EMPLOYEE ID: 11EMP201

WELCOME **Ms.S.Geetha!**

Enter the Qualification:

M.Tech

Please enter the details given below

No of leave taken	5
No of Conference Conducted	0
No of Guest Lecture Conducted	2
Industrial Visit	0
Notes given	2
No of Symposium Conducted	0
No of Training Attended	1
Enter the activities handled	CSI
–Seminar Conducted	2

Figure 4

EMPLOYEE PERFORMANCE RATING   LOGOUT

EMPLOYEE ID: 11EMP104

WELCOME **Ms.K.John!**

Enter the Qualification:

PHD

Please enter the details given below

No of leave taken	6
No of Conference Conducted	0
No of Guest Lecture Conducted	2
Industrial Visit	0
Notes given	2
No of Symposium Conducted	0
No of Training Attended	0
Enter the activities handled	Placement incharge
–Assessment Conducted	7

Figure 5: Employee Activities Details

EMPLOYEE PERFORMANCE RATING   LOGOUT
(Employee Ratings on the monthly basis activities)

EMPLOYEE NAME: Ms.S.Geetha

PARAMETERS	POSITIVE	NEGATIVE
ATTENDANCE	🟩	
CONFERENCE		🟥
GUEST LECTURE	🟩	
INDUSTRIAL VISIT		🟥
MAINTAINING FILE	🟩	
SYMPOSIUM		🟥
TRAINING	🟩	
ADDITIONAL ACTIVITIES	🟩	

RATING :

🟩

GOOD…

Figure 6

EMPLOYEE PERFORMANCE RATING   LOGOUT
(Employee Ratings on the monthly basis activities)

EMPLOYEE NAME: Mr.K.John

PARAMETERS	POSITIVE	NEGATIVE
ATTENDANCE		🟥
CONFERENCE		🟥
GUEST LECTURE	🟩	
INDUSTRIAL VISIT		🟥
MAINTAINING FILE	🟩	
SYMPOSIUM		🟥
TRAINING		🟥
ADDITIONAL ACTIVITIES	🟩	

RATING :

🟥

POOR….

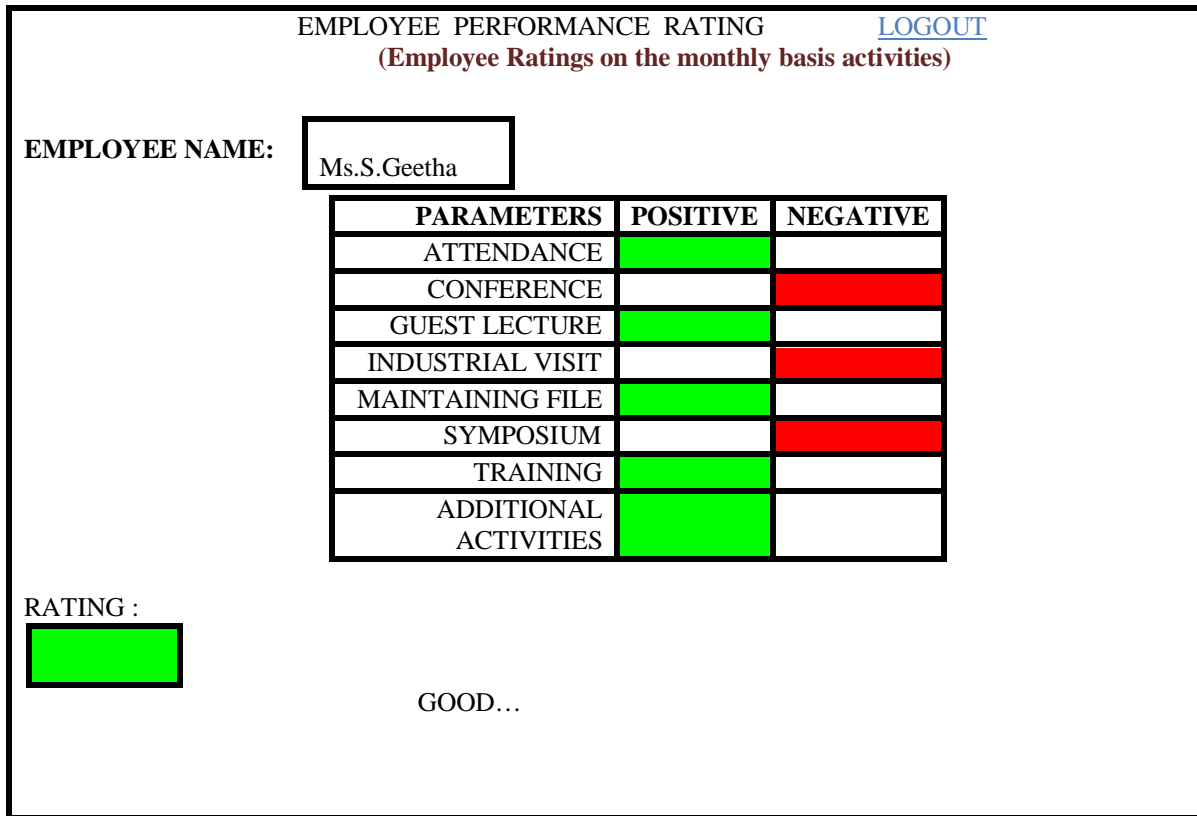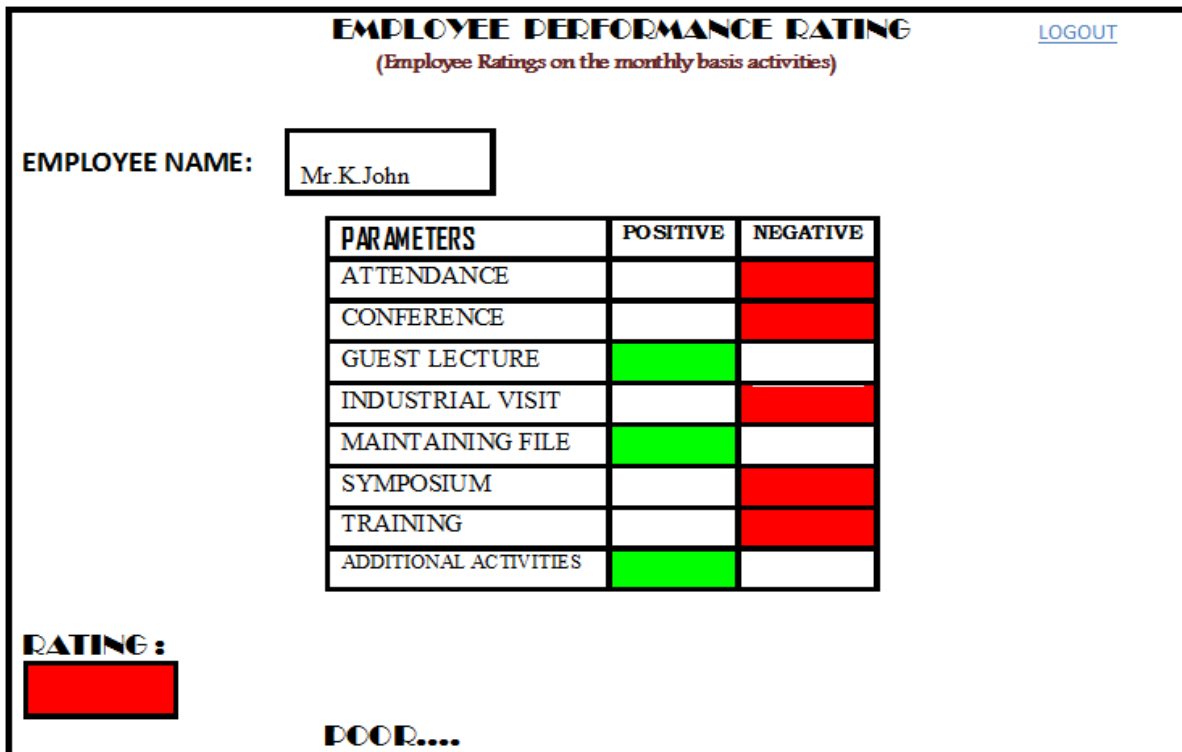*Figure 7: Employee Performance rating*

The ratings for the employee will be given based on the inputs given by the employee. Figure3 shows that the employee must login using his/her employee id to enter the inputs for each parameter. Figure 4 &5 shows the account of an employee where the employee must enter the valid inputs. From these inputs, the system will automatically rate the employee and the system will generate appraisal. For example the employee will enter the qualification, and as per the qualification the employee must enter other valid inputs such as

number of leaves taken, guest lectures attended, Industrial visits, etc. If the inputs are up to the mark then the system will rate accordingly indicating that the performance is good. Similarly, if the inputs entered are not up to the mark, then the system will rate accordingly indicating that the performace is poor and has to be improved. From figure. 6 and 7 the performance of an employee is rated as per the given parameters. According to the diagram shown above, if the employee fulfills the criteria given for each parameter, then the employee will be rated with green color indicating that he/she is on the safer side. Similarly, if the employee does not fulfill the criteria for each and every parameter, then the employee will be rated with red color indicating that he/she is in danger zone and thus the employee must improve his/her performance. For example, if attendance is taken into consideration, the employee will be given a certain number of days for taking leave. If the employee takes leave equal to or less than the specified number of days then he is on the safer side and the rating will be given accordingly which is indicated in green color. But if the employee exceeds the number of days, then he will be in the danger zone, thereby the rating will also be reduced. Similarly the other parameters will also be measured in the same manner. The ratings, which is specified above is nothing but the points which is given to employees in accordance with performance, taking into considerations each and every parameter. Finally the appraisal will be generated based on the ratings given above.

7. Conclusion

This paper demonstrates the application of fuzzy logic in the employee evaluation process.. The system has been implemented using MySQL database which was used to maintain the data. Employee evaluation represents the decision which often involves subjective information about them based on many parameters like responsibility, attitude, leadership qualities, communication skills, commitment, creativity, etc. While evaluating an employee for such parameters the scores given by the reviewer are approximated as they are based on judgment making ability of the reviewer. The use of fuzzy logic, allows them to express themselves linguistically and to make assessments that are subjective in nature and helps represent a higher level of abstraction originating from our knowledge and experience, thereby providing a simple way to draw definite conclusions from ambiguous, vague, imprecise information

8. Future Work

The proposed approach can be used for other domains like student evaluation, production evaluation or software quality assurance, etc. with small modifications. Also extend the system to use a combination of more than one input. This system can also be extended to be used in hospitals to evaluate the hospital management and thereby generating the appraisal for the employees in the hospital by taking certain parameters into consideration.

9. References

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