ISSN 1746-7659, England, UK
Journal of Information and Computing Science
Vol. 13, No. 2, 2018, *pp*.131-140

Fuzzy Driven Decision Support System for Enhanced Performance Appraisal

Ojokoh Bolanle Adefowoke[1], Oluwasefunmi Tale Arogundade[2], Mojisola Grace Asogbon [3,4], Babatope Sunday Adeniyi [5], Oluwarotimi Williams Samuel[4,*]
[1]*Department of Computer Science, Federal University of Technology, P.M.B. 704, Akure, Nigeria*
[2]*Department of Computer Science, Federal University of Agriculture, P.M.B. 2240, Abeokuta, Nigeria*
[3]*Shenzhen College of Advanced Technology, University of Chinese Academy of Sciences, Shenzhen 518055, China*
[4]*Shenzhen Institues of Adavanced Technology, Chinese Academy of Science, Shenzhen 518055, China*
[5]*Department of Computer Science, Babcock University, Ilisan-Remo, Nigeria*
(Received March 14 2018, accepted March 29 2018)

Abstract: Employees' performance appraisal is often considered as a core management task in most standard organizations because it could potentially inspire an employee towards the pursuit of organizational goals and objectives. Meanwhile, issues such as delay in appraisal processes, inevitable human error, and emotional status of the appraiser, are common with the traditional appraisal methods. Hence, this research proposes a fuzzy decision support system based on Henri Fayol's 14 principles of management for the appraisal of employees' performance. A questionnaire consisting of 44 structured questions was designed based on these principles and administered to the employees of Babcock University, Ilisan-Remo, Ogun State, Nigeria. Fuzzy inference system that incorporates Mamdani computational technique was built based on the feedback extracted from the questionnaires, and used for appraising the employee performance. Experimental results show that the proposed system could predict the appraisal status of an employee with 75% accuracy in comparison to the conventional appraisal method.

Keywords: Employee performance appraisal, Human resource manager, Fuzzy logic, Decision support system, Henri Fayol's principles of management

1. Introduction

In standard organizations, performance as it relates to employee is basically perceived as the extent to which the member of staff contributes towards achieving organizational goals and objectives. Performance appraisal (PA) involves identifying and evaluating the performance of employees with the aim of effectively rewarding their efforts in order to motivate them towards incessant pursuit of organizational objectives (Lansbury, 1988). Aside from compensation, PA have other important functions such as career planning, service quality assurance, employee motivation, and helping employees to position or reposition themselves in their organization. The concept of PA is equally viewed as the assessment of an individual's performance in a systematic way which often represents a significant tool used for all round development of the employee and the organization. Terminologies such as performance assessment, performance evaluation, and performance management are also commonly used to describe PA. Appraisals are generally viewed to have positive influence on employees' performance, but they also may have negative impact on motivation, role perceptions, and turnover when poorly designed and administered (Churchill, 1985). The performance of an employee in an organization is usually measured against factors such as job knowledge, quality and quantity of output, initiative, leadership abilities, supervision, dependability, co-operation, judgment, and versatility among others. In addition, at times behavioral and health status of employees are considered as they have been proved to affect job results. Therefore, the most controversial yet indispensable human resource tool that has drawn the attention of researchers and practitioners is undoubtedly PA (Murphy and Cleveland 1991; Andy et al., 2000). Effectively appraising the performance of employees' constitute a core part of any corporate establishment since it determines the status of employees and as well provides the organization's management with information on proper remuneration plan for its employees. In line with this, a number of methods have been proposed in previous studies for appraising the performance of employees in an organization. Most of these methods have one form of limitation or the other when used to evaluate the performance of an employee and this eventually results to inconsistent, unreliable, and invalid appraisal (Folger et al., 1992; DeNisi and Williams, 1988).These inadequacies have undesirably affected the performance of employees in such organization and as well discouraged a number of them from properly carrying out their job functions. Another important point is that such ineffective appraisal methods might reduce the chances of attaining organizational objectives (Martin and Bartol, 1998). Based on these

limitations, the development of an efficient decision support system for appraising the performances of employees in an organization is of great significance. The above stated limitations associated with the conventional appraisal systems serve as the key motivating factors behind this research.

It is worthy to note that appraisal of employees' performances is a key part of managerial task that organizations need to perform at certain interval of time. As a result, effective management principles could provide a substantial base upon which adequate PA system could be built. Henri Fayol, a French industrialist proposed 14 core management principles which have been widely practiced across all forms of business enterprise (small, medium, and large scale business enterprises) globally (Rodrigues, 2001). Also, these principles are found to exhibit certain characteristics that could be used to effectively evaluate the performance of the organization and its employees.

Advances in technology have led to the incorporation of intelligent Soft computing techniques into decision support systems with the aim of enhancing their performance. Among several soft computing techniques, fuzzy logic has been extensively used for modeling decision support systems built to address real life problems (Samuel et al., 2013; Ojokoh et al., 2012). Therefore, this study proposes a fuzzy logic decision support system based on Henri Fayol's principles of management for the appraisal of employees' performance in an organization. The proposed PA system is aimed at providing human resource managers in corporate organizations with a tool that promotes effective decision making and motivates employees towards earnestly pursuing organizational goals.

2. Related works

Employee PA became a widely used human resource management (HRM) tool in businesses around 1980's to measure the frameworks set by organizations regarding their employees (Taylor, 2005). Since then, PA has served as an integral component of HRM in

From the 14 principles, a total of 45 questions that relate to the operational procedure of the organization were coined and the response of an employee to each of the question was quantified with a Likert scale that range from 1 (Strongly Agree) to 5 (Strongly Disagree) as shown

most organizations as well as a strategic approach being used to connect the aims of the organization to the performance of their employees. Basically, an employee's performance is measured against factors such as job knowledge, quality and quantity of output, initiative, leadership abilities, supervision, dependability, co-operation, judgment, versatility and health among others (Singh and Gupta, 2013). PA is used to track individual contribution and performance against organizational goals and to identify individual strengths and opportunities for future improvements. In addition, it provides a means to assess whether organizational goals are achieved and offers a basis for the company's future planning and development.

Over the years, PA has remained one of the most widely research area in human resource management according to report in literature (Amie, 2013). Recent findings from research works reveal that several computing tools such as fuzzy logic in addition to different appraisal methods (top-down evaluation, peer review, probationary review, self-assessment, 360 degree and 720-degree evaluation), have been employed by human resource managers to measure and evaluate employee's performance in an organization aside the conventional methods (Shaout and Yousif, 2014). For instance, Maheswari and Kumari (2013), demonstrated the application of Fuzzy multi criteria group decision making (FMCGDM) for ranking appraisal methods in human resource management. Using Schwartz Beat Path method, they were able to rank employees in an organization based on performance. They quantified performance variables using trapezoidal fuzzy numbers in order to capture the uncertainties with human judgment. They used a private software company in India known as Inforyas Software limited as a case study to validate the effectiveness of their model. Neogi et al. (2017), presented a technique based on cascaded fuzzy inference techniques (FIS) to study performance evaluation of non-teaching staff of a university based on specific performance appraisal criteria. The proposed method was based on Mamdani type fuzzy inference system that has five FISs sub-modules namely: fuzzy communication block, fuzzy motivation block, fuzzy interpersonal block, fuzzy decision making block and fuzzy knowledge level block. They compared their method with existing methods and found out that their method could be used to improve the efficiency of PA for University staff with large availability of datasets. Shaout and Yousif (2014), designed and implemented a performance appraisal system using fuzzy logic technique. Their system consists of a stepwise inference engine which was demonstrated by the min operator, algebraic product, sup-min and sup-product in a relational manner. The performance of their system was evaluated based on certain assessment factors relating to employees in a number of oil companies in Sudan. Singh and Kharola (2013), proposed a methodology based on Stage-

wise fuzzy reasoning approach for the evaluation of performance rating (PR) of employees. The proposed model was tested through simulation and results obtained considerably show a shift in PR towards being realistic and practical. Also, the PR model was compared with the traditional non-fuzzy logic approach and the latter proved to be more realistic and flexible in terms of assigning different weights to different performance attributes. Meenakshi (2012), developed a performance appraisal system based on 360 feedback method and fuzzy logic concept. The model follows a systematic step in determining staff's performance and therefore, creates a system of appraisal which is able to consistently produce reliable and valid results for the appraisal process. In addition, Samuel et al. (2014), proposed an online fuzzy decision support system for appraising the performance of academic staff in institution of higher learning. In their work, the performance of academic staff was appraised based on attributes such as academic qualification, number of scientific publications, years of teaching experience, contribution to societal development among others. Experimental results show that the proposed system has a probability of 0.78 incorrectly predicting the appraisal status of an academic staff.

From existing literature, there appears to be several works on employee performance appraisal but most of them are not built on the core principles of management which have been widely applied across various forms of business enterprises globally. These core principles of management were proposed by a French industrialist known as Henri Fayol in an attempt to develop a standard and effective means of managing the affairs of corporate organization. Furthermore, he proposed a total of 14 principles of management that have been reported to exhibit certain characteristics that could be used to effectively evaluate the performance of an organization and its employees. Due to advancement in technology, several computational techniques have been proposed for the appraisal of employee's performance. Among the existing computational methods, Fuzzy logic has attracted wide range of applications across several fields primarily because it could be used to model nonlinear functions of arbitrary complexity to a desired degree of accuracy and represent knowledge that are imprecise and uncertain in nature.

Therefore, in this study a fuzzy decision support system for human resource performance appraisal based on Henri Fayol's principles of management is proposed. The performance appraisal model proposed in this study was designed using fuzzy logic technique and the choice of the technique used was based on the incomplete and imprecise nature of the required input data. In addition, it has been discovered that the evaluation of performance appraisal requires approximate knowledge and fuzzy logic technique has been proved to be an appropriate tool that addresses these problems as it mimics human decision making with the ability to generate precise solutions from certain or approximate information (Ojokoh et al. 2012; Samuel et al., 2013; Gurrea et al., 2014; Omisore et al., 2017). The proposed system is aimed at providing an efficient decision support platform that could aid the appraisal of employees' performance in standard organizations.

The remaining part of this paper is organized as follows: Section 3 presents the proposed system architecture as well as its operational principle. Section 4 presents experimental results and discussion, while, section 5 presents the conclusion of the study and possible future research direction.

3. Materials and Methods

3.1. Data Collection

The dataset used for the experiment in the current study was collected from a number of questionnaires administered to the employees of Babcock University, Ilisan-Remo Ogun State, Nigeria. The questionnaires were designed based on the 14 Henri Fayol principles of management which are presented in Table 1.

Table 1: Input variables definition and their value rating

S/N	CODE	Input Variable Description
1	DW	Division of Work
2	AR	Authority and Responsibility
3	PN	Discipline
4	UC	Unity of Command
5	SIIGI	Subordination of Individual Interest to General Interest
6	RE	Remuneration to Employees
7	CDE	Centralization and Decentralization
8	SC	Scalar Chain
9	ORD	Order
10	ETY	Equity
11	INTV	Initiative
12	SP	Stability of Personnel
13	EDC	Esprit de corps
14	UD	Unity of Direction

From the 14 principles, a total of 45 questions that relate to the operational procedure of the organization were coined and the response of an employee to each of the question was quantified with a Likert scale that range from 1 (Strongly Agree) to 5 (Strongly Disagree) as shown

Table 2: Variables description categories

Numeric Rating	Linguistics Categories
1	Strongly Agree
2	Agree
3	Neither Agree nor Disagree
4	Disagree
5	Strongly Disagree

The questionnaires were distributed by the human resource officers of the organization to the employees to obtain a set of relevant information that could aid decision making with respect to staff appraisal. To obtain objective response from the employees, the staffs were not in any way informed that the questionnaires would be considered in appraising their performance. Later on, the required dataset were extracted from the feedback of the questionnaires and subsequently used to evaluate the built Fuzzy based appraisal model. A copy of the administered questionnaire is presented in Appendix A.

3.2. Proposed Fuzzy Model

The framework that drives the proposed performance appraisal model is presented in Figure 1.

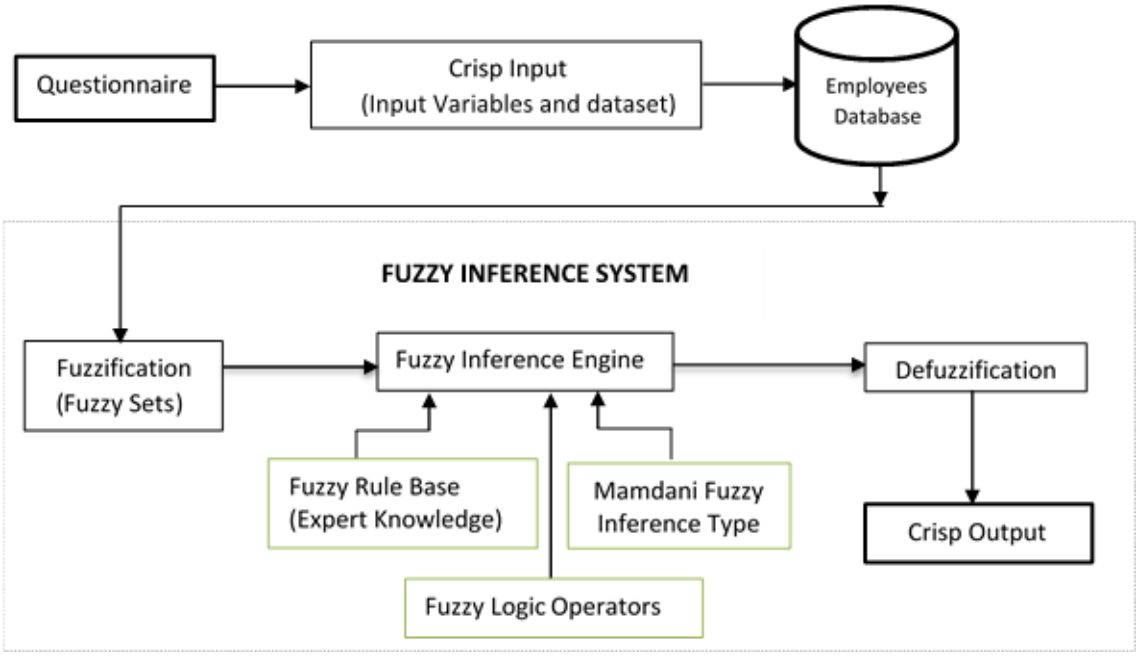

Fig. 1: Proposed model for human resource performance appraisal

The architecture consists of two sequential stages namely the data processing and fuzzy inference stages. The data processing stage is basically responsible for the pre-processing of the data extracted from the questionnaires as well as storing the pre-processed data in the database. The fuzzy inference stage is based on the Mamdani type of inference (Mamdani and Assilian, 1975; Zadeh, 1973). The inference process primarily maps the input variables to the corresponding output using fuzzy rules and it comprises of three major parts; the fuzzification of the input variables, fuzzy inferencing, and defuzzification of the output. The fuzzification module retrieves the crisp input variables from the database and converts them into linguistic variables with associated linguistic terms using a membership function. As shown in equation (1), suppose A denotes the fuzzy set consisting of the performance appraisal input variables, the elements of the fuzzy set A are mapped to the universe of membership values, X in an interval of [0,1].

$$A = \{(x, \mu_A(x))\}, x \in X \ [0,1] \tag{1}$$

where $\mu_A(x)$ is the membership function, X is the universe of membership values and x is the element of X. This process determines the degree to which the input variables belong to each of the appropriate fuzzy set based on the membership function (MF) defined in equation (2). The MF was used to establish a mapping relation between the crisp input variables to the fuzzy linguistic terms. This study adopted generalized bell shape MF due to its computational efficiency in determining the degree of membership the input variables.

$$f(x; a, b, c) = \frac{1}{1 + \left|\frac{x-c}{a}\right|^{2b}} \tag{2}$$

where *c* determines the center of the corresponding MF; *a* is the half width; and *b* (together with *a*) controls the slopes at the crossover points.

Once the fuzzification process is completed, a rule base that contains a set of fuzzy rules that maps the input variables to a corresponding output is built. The fuzzy rule base built in this study consists of rules that are characterized by a set of IF-THEN constructs in which the antecedents (IF parts) and the consequents (THEN parts) are linguistic variables which were carefully formulated based on the knowledge and experience of human resource experts of Babcock University, Ilisan-Remo, Ogun State, Nigeria. A rule in the rule base is triggered if any of its precedence parameter such as *low*, *moderate*, and *high* evaluates to true (1), otherwise it remains un-triggered. After a rule has been successfully triggered, a decision is reached. A representative rule in the rule base designed in this study is shown as follows:

$$\boldsymbol{IF}(DW\ is\ Agree)\ and\ (AR\ is\ Disagree/Agree)\ and\ (PN\ is\ Strongly\ Agree)\ and\ (UC\ is\ Agree)\ and\ (SIIGI\ is\ Strongly\ Disagree) and\ (RE\ is\ Disagree/Agree)\ and\ (CDE\ is\ Agree)\ and\ (SC\ is\ Disagree)\ and\ (ORD\ is\ Agree) and\ (ETY\ is\ Disagree)\ and\ (SP\ is\ Agree)\ and\ (INTV\ is\ Disagree/Agree)$$

$$and\ (EDC\ is\ Agree) and\ (UD\ is\ Agree)$$

THEN $(Performance\ Prediction\ is\ Moderate)$

Using Mamdani fuzzy inference type with the Min-operator, the inference engine receives its input from the rule base and the fuzzifier, and then applies a pre-defined process to the set of input to produce the desired output. Table 3 presents the possible categories of fuzzy output value range and the corresponding linguistic variables that could be obtained from the fuzzy inference model developed in this study.

Table 3: Fuzzy value output performance rating and its linguistic variables

S/N	Fuzzy Value	Linguistic Variables
1	<3.50	Low
2	3.50 - 3.99	Moderate
3	>3.99	High

The defuzzification process translates the output of the inference engine using the centroid of area (CoA) concept given in equation (3) into the crisp form that can be easily interpreted by the human resource managers.

$$\text{CoA} = \frac{\sum_{i=1}^{n} \mu Y(x_i) x_i}{\sum_{i=1}^{n} \mu Y(x_i)} \tag{3}$$

where $\mu Y(x_i)$ is the membership value of x_i as given in Figure 2 and x_i is the center of the membership function.

4. Experimental Results

The proposed performance appraisal system was simulated with the aid of MATLAB (Matrix Laboratory) R2014a and the acquired dataset were first cleaned using Microsoft Excel 2013version. The Mamdani fuzzy type inference engine was constructed using the generalized bell membership function with five degree of membership namely strongly agree, agree, neither agree nor disagree, disagree and strongly disagree respectively, and the bell shaped membership function of a representative input variable is shown in Figure 2.

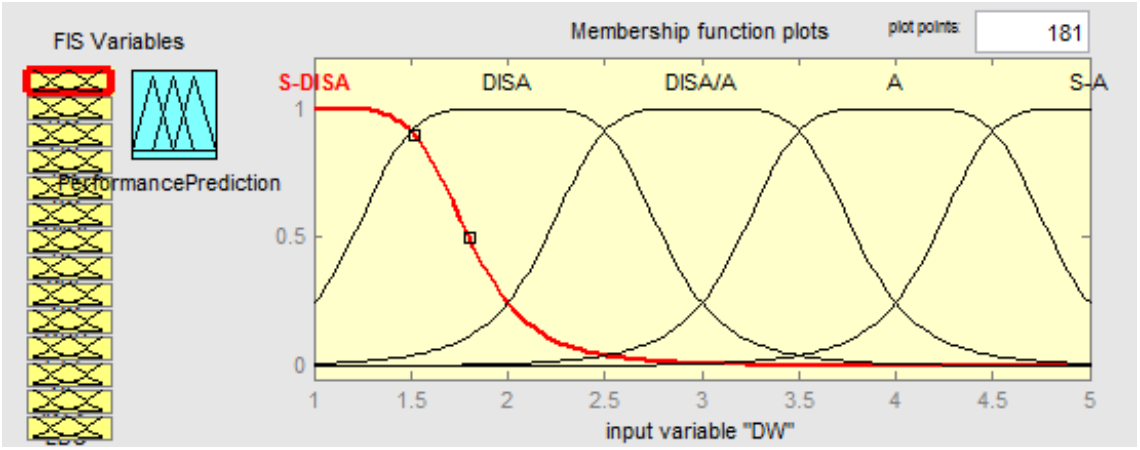

Fig. 2: Five degree bell shaped membership function for input variable 'DW'

Similarly, the output membership function was also constructed using the generalized bell shaped membership function with a total of three degrees namely low, moderate, and high as shown in Figure 3. Each degree denotes the possible output state of the performance appraisal system for a given appraisal task. In other words, the outcome of an employee appraisal performance status can either be low, moderate or high.

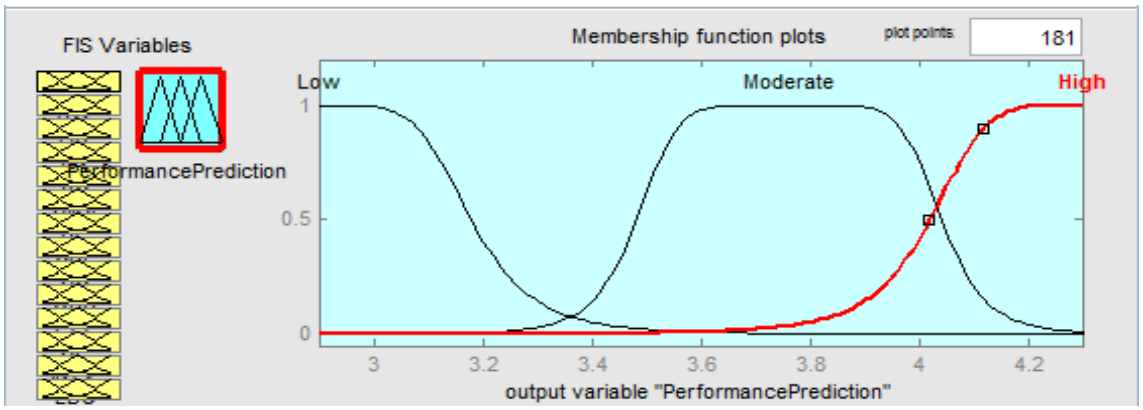

Fig. 3: Three degree bell shape output membership function of the proposed system

The fuzzy rule base built in the study consist of 20 rules which were determined by considering the total number of input variables alongside the information obtained from the human resource department of the organization. The antecedent parts of the rules were combined using the product operator and each of the rule's weight was determined using the product implication method. The formulated rules are shown in Figure 4.

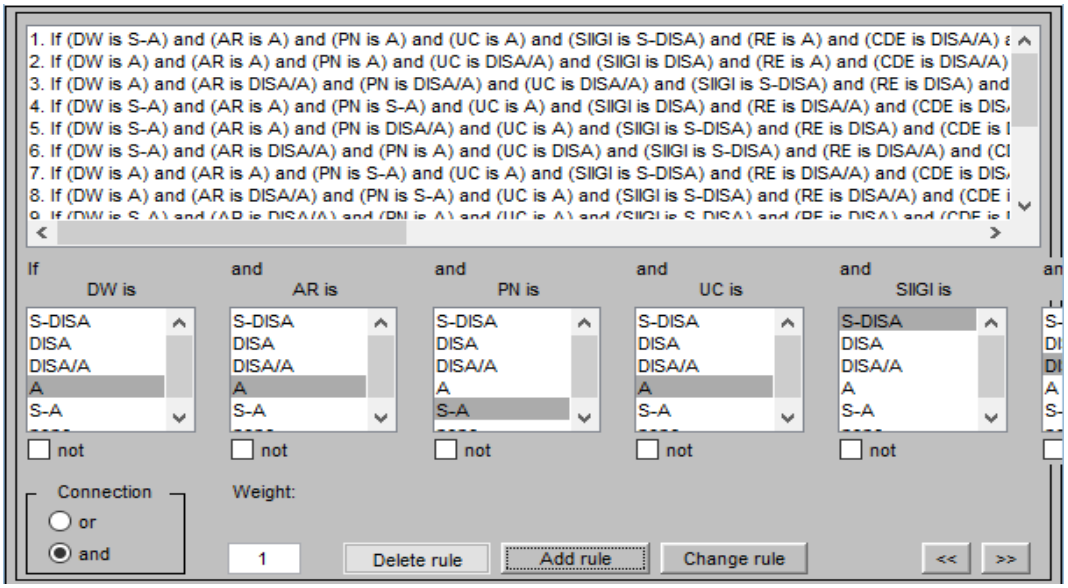

Fig. 4: Fuzzy rule *base* interface of the proposed system

The Rule viewer component of the inference engine offers an interpretation of the overall inference process regarding the appraisal status of a particular employee. Figure 5shows the Rule viewer component which provides a means on entering the appraisal attribute values for the employees in order to predict the appraisal status. For example, when the input variables [5.00, 4.00, 4.70, 4.00, 1.00, 4.00, 3.70, 4.70, 4.30, 3.70, 5.00, 3.30, 3.30, 3.30] for a representative employee that corresponds to the 14 attributes considered in this study are supplied, an appraisal status of the representative employee is predicted to be 3.79, and based on the output scale defined in Table 3, this result shows that the employee performance is *moderate*.

Figure 5: Employee performance prediction interface of the proposed system

Figure 6 shows the Surface viewer component of the inference system, and it displays the dependency of any two input variables with respect to the predicted appraisal outcome. Thus, an output surface map for the entire system with respect to any two selected input variables is generated. In other words, it could be said that a three-dimensional curve which represents the mapping the two input variables to the predicted appraisal status is obtained.

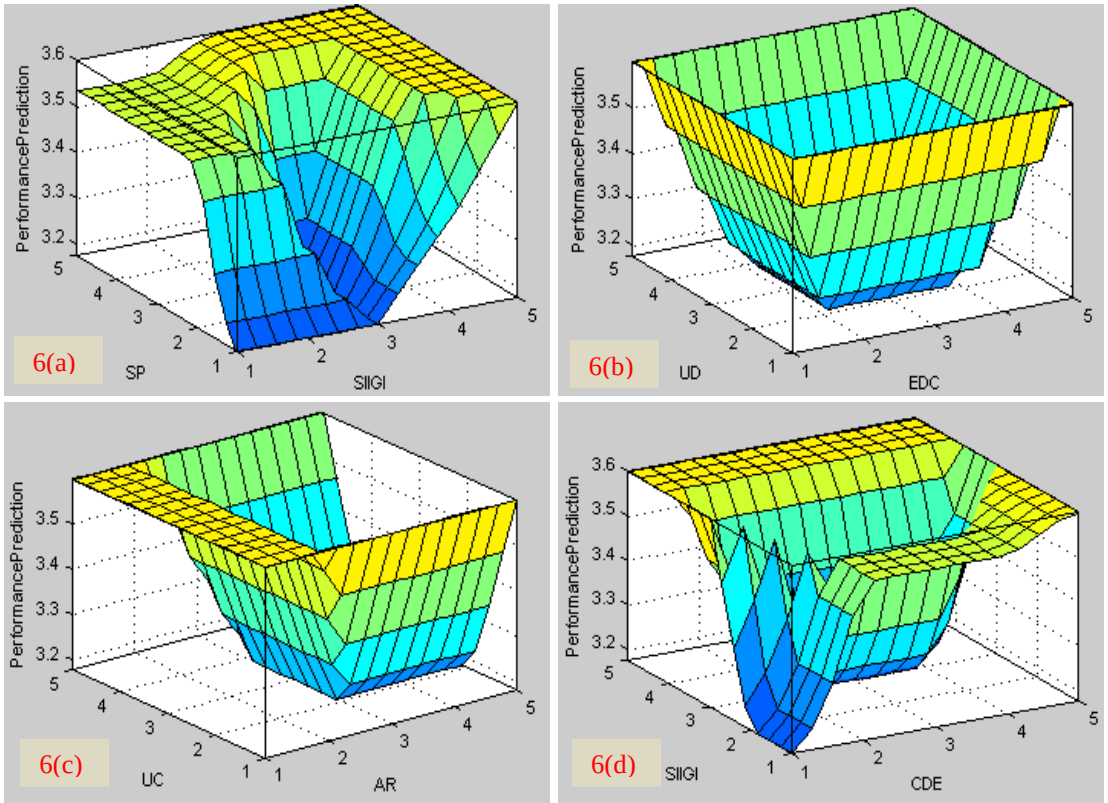

Fig. 6 (a)-(d): 3-D surface plots of some performance input variables

Figure 6(a)-(d) represent the 3D surface plots that give interpretation of the input-output relations of variables of the proposed system. The blue color surface indicate low prediction while yellow color surfaces shows high prediction outputs and the intermediate surfaces (green like surfaces) which lies between the blue

and yellow regions shows moderate performance prediction values.

4.1. System Evaluation

The performance of the proposed fuzzy based appraisal system was evaluated by comparing its prediction accuracy for a set of eight randomly selected employees with the evaluation results obtained from the conventional employee appraisal method as shown in Table 4. The performance predictions of the proposed system (Prop.Meth) and its possibility grades of the eight selected candidates are shown in Table 4 alongside the appraisal outcomes of the conventional appraisal method (Conv.Meth).

The status for each employee as indicated in Table 4 determines if there is an exact match in the appraisal results of *Conv.Meth* and *Prop.Meth* or not. A value of 1 was used when the proposed method accurately predict the appraisal status of the Employee while the status becomes 0 when the prediction is inaccurate. That is, Let *Sk* denote the status appraisal status of the *Kth* employee such that:

Table 4: Employee performance appraisal prediction

Employee_Id	**Emp01**	**Emp02**	**Emp13**	**Emp11**	**Emp07**	**Emp04**	**Emp20**	**Emp17**
Conv.Meth	Moderate	Low	Moderate	High	Low	Moderate	Low	High
Prop.Meth	Moderate	Low	Low	High	Low	Moderate	Moderate	High
ErrInPred.	0.07	0.03	0.15	0.03	0.02	0.20	0.06	0.08
Status	1	1	0	1	1	1	0	1

***Conv.Meth: Conventional method result, Prop.Meth:Proposed method result, Err.InPred. : Error in prediction**

$$S_k = \begin{cases} \mathbf{1}(IF\ the\ kth\ employee\ using\ Prop.Meth\ is\ Accurate) \\ \mathbf{0}(IF\ the\ kth\ employee\ using\ Prop.Meth\ is\ Inaccurate) \end{cases}$$

Hence, the mean accuracy of the proposed system is given as:

$$\text{Precision } = \frac{1}{n}\sum_{k=1}^{n} S_k \quad For\ All\ (S_k = 1) \tag{4}$$

$$\text{Precision } = \frac{(\text{Count of Accurate Prediction})}{(\text{Total Number of Prediction})} = \frac{6}{8} = 0.75 \tag{5}$$

Therefore, the proposed system has 0.75 chance of accurately predicting the appraisal status of an employee in the organization.

5. Conclusion

Appraising the performance of employees is a core part of any standard organization since it plays a significant role in motivating the staff towards being more productive. To provide objective appraisal results, a fuzzy decision support system driven by the fourteen principles of management proposed by Henri Fayol was built to predict the appraisal status of employees in Babcock University, Ilisan-Remo, Ogun State, Nigeria. The accuracy of the proposed system was examined and compared with that of conventional employee appraisal method, and we found that the appraisal platform in this study could provide appraisal results with up to 75% efficiency. Finally, this study has practically demonstrated the effectiveness of Fuzzy inference concept using Henri Fayol's principles of management for employee performance appraisal. The membership function is an important parameter of the fuzzy inference engine and its construction process was time consuming in the current study. Also, the rule base was determined manually, hence only a limited number of rules could be formulated, and this factor would affect the robustness of the system in situation where the system is supplied with a set of inputs whose corresponding rule is not in the rule base. In the future, we hope to integrate learning capability into the proposed system by considering machine learning techniques such as deep learning, convolutional neural networks, and artificial neural networks among others.

6. Conflict of interest

All authors declare that they have read and agreed to the content of the manuscript. In addition, there is no conflict of interest among the authors of this manuscript.

7. References

[1] Amie, F. (2013). An investigation into performance appraisal effectiveness from the perception of Employees in an Irish consumer services company. Master thesis, Dublin, National College of Ireland.
[2] Andy, N., John, M., Ken, P. Huw, R., et al. (2000). Performance measurement system design: developing and testing a process-based approach. International Journal of Operations & Production Management, 20(10) 1119-1145.
[3] Churchill, G.A. Jr., Ford, N.M., Hartley, S.W., Walker, O.C.Jr. (1985). The determinants of salesperson performance: A meta-analysis. Journal of Marketing Research, 22, 103-118.
[4] DeNisi, A.S., & Williams, K.J. (1988). Cognitive Approaches to performance appraisal in G.R. Ferris and K.M. Rowland (eds.). Research in Personnel and Human Resource Management, Vol. 6, CT; JAI Press, pp. 109-55.
[5] Folger, R., Konovsky, M.A., & Cropanzano, R. (1992). A due process metaphor for performance appraisal, research organizational behavior. 14, 129-177.
[6] Gurrea V., Alfaro-Saizb, J.J., Rodríguez, R., & Verdecho, M.J. (2014). Application of fuzzy logic in performance management: a literature review. International Journal of Production Management and Engineering, 2(2), 93-100.
[7] Lansbury, R. (1988). Performance Management: A Process Approach. Human Resource Management, Australia, 46-55.
[8] Longenecker, C.O., Jr. Sims, H.P., & Gioia, D.A. (1987). Behind the mask: The politics of employee appraisal. Academy of Management Executive, 1, 183-193.
[9] Maheswari, A.U., & Kumari, P. (2013). A performance appraisal model using fuzzy multi criteria group decision making. International Journal of Scientific & Engineering Research, 4(5), 442-449.
[10] Mamdani, E.H., & Assilian, S. (1975). An experiment in linguistic synthesis with a fuzzy logic controller. International Journal of Man-Machine Studies, 7(1), 1–13.
[11] Martin, D.C., & Bartol, K.M. (1998). Performance appraisal: Maintaining system effectiveness. Public Personnel Management, 27(2), 223-230.
[12] Meenakshi, G. (2012). Multi source feedback based performance appraisal system using Fuzzy logic decision support system. International Journal on Soft Computing, 3(1), 91-106.
[13] Murphy, K., & Cleveland, J.N. (1991). Performance appraisal: An organizational perspective. Boston-Allyn and Bacon.
[14] Neogi, A., Mondal, A.C., & Mandal, S.K. (2011). A cascaded fuzzy inference system for university non-teaching staff performance appraisal. Journal of Information Processing Systems, 7(4), 595-612
[15] Ojokoh B.A., Omisore, M.O., Samuel, O.W., & Ogunniyi, T. (2012). A Fuzzy Logic Based Personalized Recommender System. International Journal of Computer Science and Information Technology and Security, 2(5), 1008-1015.
[16] Omisore, M. O., Samuel, O. W., & Atajeromavwo, E. J. (2017). A Genetic-Neuro-Fuzzy inferential model for diagnosis of tuberculosis. Applied Computing and Informatics, 13(1), 27-37.
[17] Rodrigues, C.A. (2001). Fayol's 14 principles of management then and now: a framework for managing today's organizations effectively. Management decision, 39(10), 880-889.
[18] Samuel, O.W., Omisore, M.O., & Ojokoh, B.A. (2013). A web based decision support system driven by fuzzy logic for the diagnosis of typhoid fever. Expert Systems With Applications, Elsevier, 40, 4164–4171.
[19] Samuel, O.W., Omisore, M.O., & Atajeromavwo, E.J. (2014). Online fuzzy decision support system for human resource performance appraisal. Measurement, Elsevier, 55(2014), 452-461.
[20] Shaout, A., & Yousif, M.K. (2014). Employee performance appraisal system using fuzzy logic. International Journal of Computer Science & Information Technology (IJCSIT), 6(4).
[21] Shaout, A., & Yousif, M.K. (2014). Performance evaluation: Methods and techniques survey. International Journal of Computer and Information Technology, 3(5), 966-979.
[22] Singh, P., & Gupta, S. (2013).Performance appraisal: Building trust among employees or not-the dilemma continues. International Journal of Scientific and Research Publications, 3(8), 1-6.
[23] Singh, S.B., & Kharolam, A. (2013). Development of fuzzy logic model for performance rating (PR) of employee's. Advanced Modelling and Optimization, 15(3), 839-853.
[24] Taylor, S. (2005). People resourcing. 3rd Edition, London: Chartered Institute of Personnel & Development; 3rd edition (August 1, 2005), ISBN-10: 1843980770.
[25] Zadeh, L.A. (1973). Outline of a new approach to the analysis of complex systems and decision processes. IEEE Transactions on Systems, Man, and Cybernetics, 3(1), 28–44.