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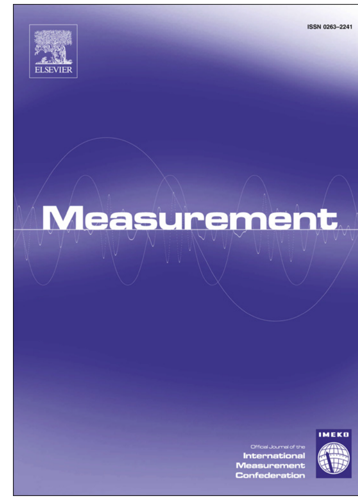

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ONLINE FUZZY BASED DECISION SUPPORT SYSTEM FOR HUMAN RESOURCE PERFORMANCE APPRAISAL

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Abstract: The evaluation of employees' performance is geared towards assessing individual's contribution to the attainment of organizational goals. Performance Appraisal (PA) is a key tool in an organization due to its potency to either make or mar such organization. Irregular standards for human resource PA, tribal sentiment, emotional status of assessors, and delay in appraisal processes among others are the key problems of the conventional methods of appraising employees' performances in an organization. This research therefore proposes an Online Fuzzy Based Decision Support System for Human Resource PA. The proposed system incorporates an efficient computational technique which handles the delays and bias associated with the orthodox performance appraisal system in organizations. The Fuzzy Inference System developed in this research uses Mamdani technique, Center of Gravity Deffuzification approach and takes as input the key attributes considered when appraising the performance of an employee. An experimental study of the proposed system was conducted using the dataset of academic staff. Standard statistical technique was used to measure the accuracy level of the System and the result shows that the proposed system has 0.78 probability (78%) of predicting accurately the appraisal status of an academic staff.

Keywords: **Performance Appraisal; Fuzzy Inference System; Human Resource Manager; Academic Staff;**

1. Introduction

Performance Appraisal (PA) is a process of identifying, evaluating, and compensating the works (efforts) of employees in an organization [1]. This exercise is performed with the aim of effectively rewarding employees' efforts in order to motivate them towards continuous pursuit of organizational objectives [2]. Appraisals are generally considered to have positive influence on employees' performances, but they also may have a negative impact on motivation, role perceptions, and turnover when poorly designed and administered [3].

Universities and other institutions of higher learning are perceived as the hubs of creativity from which several innovations had sprung forth. These innovations are mostly products of qualitative research and teaching. The quality of teaching depends on the qualifications and research potentials of the academic staff, and most importantly, the effective appraisal of performances of academic staff by the management of such institutions. Appraisal and management of performance have recently attracted much attention in European Universities and Colleges [4].

The conventional performance appraisal methods in most institutions of higher learning are defective in that evaluations of academic staff performances are subjectively biased and evaluators often apply different standards with different employees which eventually result in inconsistent, unreliable, and invalid evaluations [5, 6, 7]. These inefficiencies have adversely affected the performance of academics in institutions of higher learning and it has equally discouraged a large number of them from discharging their duties accordingly. In addition to the above challenge, it also dampens the chances of achieving institutional goals and objectives [8]. Hence, institutions of higher learning are expected to adopt new and improved PA approach for the appraisal of its academic staff performances. The above highlighted challenges faced by the conventional appraisal systems are the core motivating factors for this research.

Fuzzy Logic has been identified as a substantial soft computing tool that is used to efficiently model decision support systems [9]. Hence, this research proposes a fuzzy logic driven decision support system for the appraisal of academic staff performance in institutions of higher learning. The proposed system is aimed at providing human resource managers in institutions of higher learning with a tool that would aid effective decision making and motivate academic staff towards self development and pursuit of institutional objectives.

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2. Background of Study

2.1 Performance Appraisal

Performance Appraisal (PA) is aimed at determining the results of an employee's work with a goal of offering a justified compensation to employees' efforts. Beside the determination of compensation, PA has several other important functions such as career planning, service quality assurance, job security etc. The appraisal of performance especially the compensation paid to educators (academic staff) have been a major subject in public discussion due to its potential influence on future and quality of educational systems in most part of the world [10]. A well established PA system could help educators reposition themselves in the organizational setting of their Universities, renders enough information for determining justified compensations, and as well help top management to attain justified decisions regarding incentive to its employees' [11, 12].

Employees' compensation is a process of rewarding employees with monetary and non-monetary benefits according to the value of their contributions (performances). The value of work done by an employee during a given period of time is determined via performance appraisal, while taking into account other factors. Resourceful PA system is essentially a key component of any corporate organization since it helps to justify employees' compensations, promotions, demotions, and selection validations. PA outcomes might be used during layoffs in order to retain more valuable employees, to determine the quality of training programs for employees, to measure equality of treatment, to manage employees' compensation, and to promote or dismiss them [13]. Thus, appraisal results have a very important role in Human Resource Management activities of an organisation.

Although performance-based compensation has been traditionally very common, and sometimes complemented by experience-based compensation, more contemporary compensation systems are based upon employee's skills and competences [14]. Interestingly, a comparative study of the Human Resource Manager (HRM) functions showed that private-sector companies tend to use skills-based or competency-based appraisal technique, while public organizations prefer more traditional compensation systems [15]. This allows us to conclude that compensation policies develop faster in the private sector.

2.2 PA in Institutions of Higher Learning

PA systems vary from one organization to the other due to the fact that different organizations have their respective modes of operations. For instance, Universities in the developed countries declined the introduction of judgmental appraisal technique initially proposed by the government of their countries and adopted development review PA technique which appear to be more in line with their inherent needs [16]. In a University community, PA is based on teaching, research and development, and the exercise is usually done once in a year or every two years. That is, appraisal takes account of the teaching results, level of research and teaching methodology, as well as the results of development and administration. Appraisal of academic staff also depends on regular self-analysis, which is mainly based on teaching loads and scientific publications. Although the principles of appraisal vary in universities and their faculties [17].

PA in Universities also involve the use of teaching loads in the form of lectures and supervision of papers (exams), scientific research and teaching material publications and results of student surveys, which all contribute to the appraisal of the quality of teaching [17]. Relatively, less value is attributed to administrative workloads, negotiated and fulfilled contracts. PA of the academic staff has several important pluses, including a rise in the motivation of the staff through feedback and acknowledgement [16]. These, will no doubt guarantee employee development, effectiveness of their work and improve work quality. The main minuses, however, are the complexity and time consumption of the PA systems.

The conventional procedure for appraising the performance of academic staff in institutions of higher learning is charged with a number of problems such as emotional status of the assessor, tribal sentiment, social and political factors. For instance, an assessor who judges a staff to be excellent on a particular decision variable today may likely record good on that particular variable for the same staff tomorrow due to his emotional feelings. This will no doubt introduce certain level of unfairness (bias) into the PA process in such an organization and it is capable of discouraging affected staff from putting in their best at work. Hence there is need to device a more objective means of appraising human resource performance in institutions of higher learning [18].

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2.3 Expert Systems

Computing tools help to organize, store and retrieve appropriate knowledge needed by HRMs to deal with difficult managerial problems and provide appropriate decision support platforms for them. Expert Systems (ESs) are intelligent interactive computer based decision tool that uses facts and rules to solve difficult real life problems based on the knowledge acquired from one or more human expert in a particular field [9]. ESs have gained prominence over the years due to their ability to utilize human expert knowledge in the form of facts and rules to solve complex problems in a given domain.

ESs applies domain-specific knowledge gleaned from human experts in handling a variety of situations reasonably competently. They have shown their practicality in dealing with a variety of frequently occurring situations in diverse fields [19]. ESs are characterized by capturing and preserving irreplaceable human experiences; rendering of services in a more consistent way than human expert; minimizing the number of human expertise needed in an hostile environment; and offering of faster, affordable, and accurate solutions than human experts [20]. ESs have equally played important role in modern intelligent systems and have had applications in strategic goal setting, planning, design, scheduling, fault monitoring, diagnosis and so on. The basic architecture of an ES is shown in figure 1.

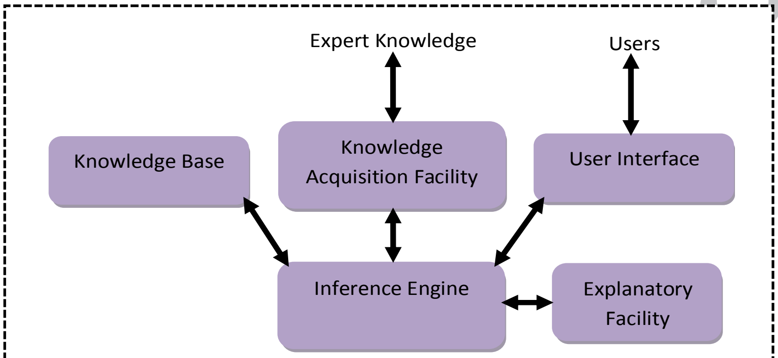

Figure 1: Basic Architecture of an Expert System

The *Knowledge Base* (KB) stores all relevant information, data, rules, cases, and relationships used by the ES; *Inference Engine* seeks information and relationships from the KB and provides solutions, prediction, and suggestions in the way a human expert would; *Explanation Facility* allows a user to understand how the ES arrived at certain results; *Knowledge Acquisition Facility* provides a convenient and efficient means for capturing and storing all components of the KB; while the *User Interface* enables easy access for users of the system.

2.4 Fuzzy Logic

The world of information is surrounded by uncertainty and imprecision. Human reasoning can handle inexact, uncertain, and vague concepts in an appropriate manner [21]. Usually, human reasoning and perception cannot be expressed precisely. These types of experiences can rarely be expressed or measured using statistical or probability theory. Fuzzy Logic provides a formal methodology for representing and implementing uncertainties associated with human heuristic knowledge and perceptions. Apart from handling uncertainty (vagueness), Fuzzy Logic also provides efficient solution to problems that involves several decision variables [22].

Fuzzy Logic is a popular computing technique based on the concept of fuzzy set theory, fuzzy if-then rules, and fuzzy reasoning. It has been successfully applied in fields such as automatic control, data classification, decision analysis, expert systems, and computer vision. Due to its multi-disciplinary nature, Fuzzy Logic Systems are known by a number of names, such as fuzzy rule-based system, fuzzy expert system, fuzzy model [23], fuzzy associative memory [24], fuzzy logic controller [25] and simply fuzzy system. Fuzzy Logic is one of the Soft Computing computational methods that are tolerant to sub-optimality, impreciseness, vagueness and thus giving quick, simple and sufficient solutions [26].

Fuzzy Logic has attracted growing interest in modern information technology, production technique, decision making, pattern recognition, medical diagnosis and data analysis among others [27]. By using Fuzzy Logic framework, the attributes of human reasoning and decision making in the domain of PA can be formulated by a set of simple and intuitive IF (Antecedent) and THEN (Consequent) rules. In this research, Fuzzy Logic technique is used to model an ES for Human Resource Performance Appraisal.

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3.0 Research Methodology

Figure 2 presents the architecture of the proposed Fuzzy Logic based Human Resource Performance Appraisal System. The architecture is made up a *User Interface* which provides a means of communicating and receiving feedback from the system; an *Input* component that enables the entry of the decision variables; *Output* component which displays the overall appraisal result of a given staff; a *Knowledge Base* that houses the knowledge of Domain Experts (HRMs); a *Fuzzy Inference System* (FIS) which utilizes a set of pre-defined procedures based on the fact and rules in Performance Appraisal and input decision variables in order to provide an efficient PA result for a particular staff. Details of the procedures employed by the FIS component of figure 2 is described as follows.

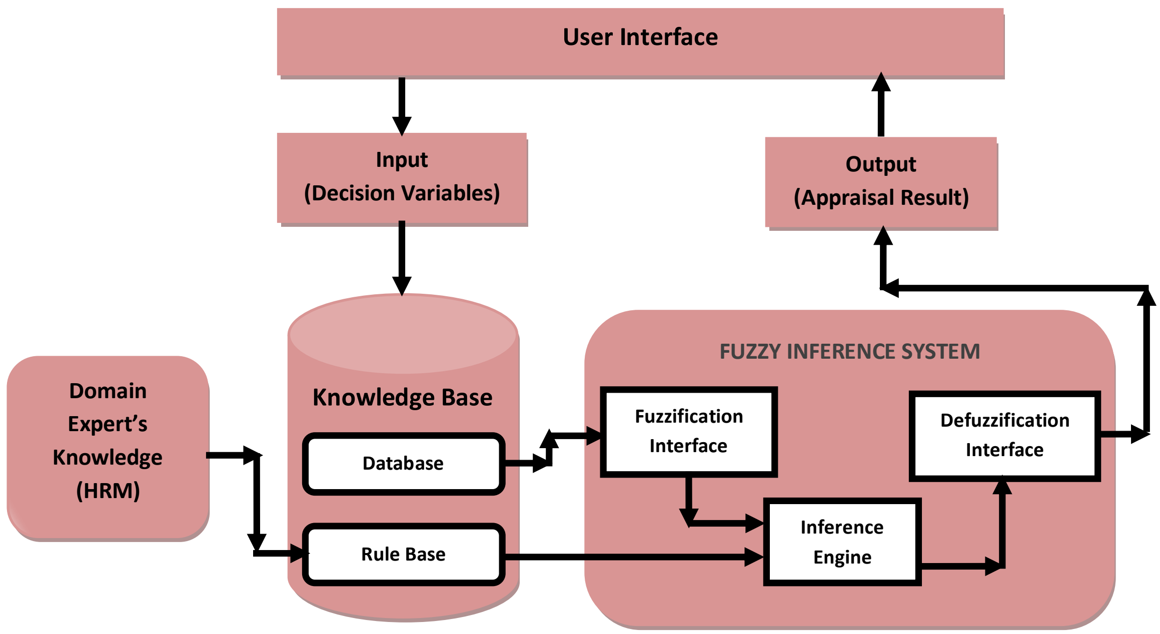

Figure 2: Architecture of an Online Fuzzy Based Performance Appraisal System

3.1 Fuzzy Inference System Procedure

In Fuzzy Systems implementations, Mamdani inference procedure is widely adopted for capturing and representing experts' knowledge. This is because it allows us to describe the knowledge expertise in more intuitive and human-like manner. However, Mamdani-type fuzzy inference entails a substantial computational burden [20]. This research work adopts the Mamdani inference method due to the nature of the problem at hand. The Mamdani inference method consists of the following four steps:

3.1.1 Fuzzification of the Input Decision Variables

The proposed system is designed to take as input the decision variables that would be used to determine the status of an academic staff with respect to his/her performance (contributions) in the organization. After a series of consultation with HRMs in institutions of higher learning and relevant literature in the domain of Human Resource Performance Appraisal, we were able to elicit the main attributes considered when appraising the performance of academic staff in institutions of higher learning and these attributes are shown in figure 3 in a hierarchical manner. The attributes are grouped under the following: academic qualification, number of publications, teaching experience, supervision of research works, contributions to the University community and society at large, membership of professional bodies, and professional qualifications.

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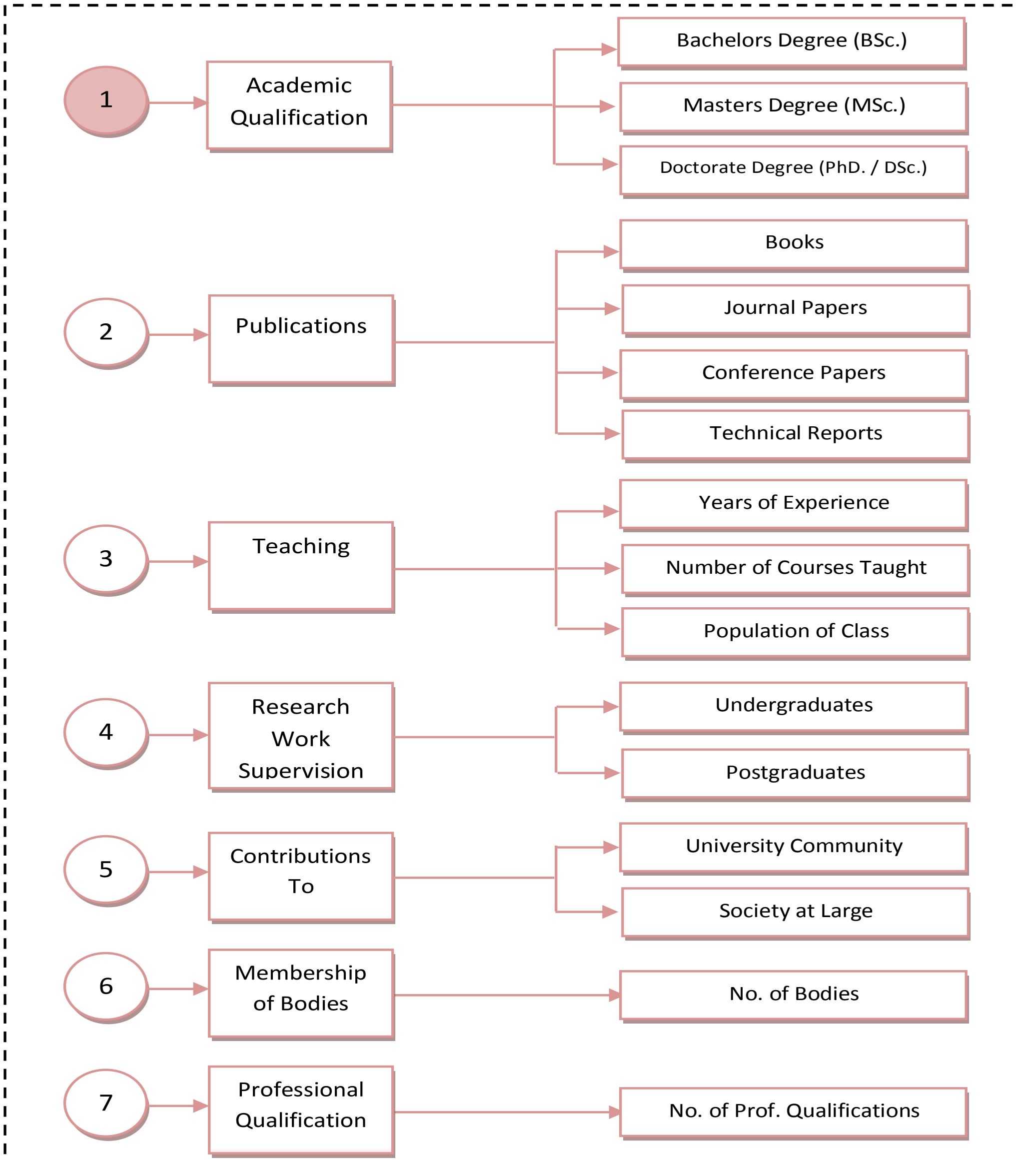

Figure 3: Attributes Considered for Appraising Academic Staff Performance

From figure 3, there are seven key factors considered when appraising the performance of an academic staff and some of these factors are even sub-divided.

Given ***A*,** such that ***A*** is the set of attributes considered when appraising the performance of an academic staff. Then ***A*** is defined by equation (1).

$$\boldsymbol{A} = \{X_1, X_2, X_3, \ldots, X_n\} \quad \textbf{(1)}$$

Where X_i, represents the i^{th} performance appraisal attribute and $i = 1, 2, 3, \ldots, n$.

The corresponding fuzzy set ***B*** that describes each attribute of the set ***A*** is given by equation (2)

$$\boldsymbol{B} = \{V_1, V_2, V_3, \ldots, V_n\} \quad \textbf{(2)}$$

Where V_1 denotes the corresponding numeric value of X_1 and so on. A set consisting of linguistic variables used to describe a given element of set ***A*** based on its corresponding numeric value in set ***B*** is given by equation (3).

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$$L_i = \{L_1, L_2, L_3, \ldots, L_n\} \quad (3)$$

Where L_i represent the i^{th} linguistic variable and $i = 1 \ldots n$. For instance, assuming X_1 is *Academic Qualification (BSc.)* whose numeric value (V_1) is 1, then the corresponding linguistic variable (L_1) is ***Low*** and X_2 is *Number of Journal Papers (14)* whose numeric value (V_2) is 3, then the corresponding linguistic variable (L_3) is ***High***. Therefore the following fuzzy rules can be drawn from this assumption.

IF X_1 *is* L_1 **AND** X_2 *is* L_3 **THEN** *APP. is* L_2

It is interpreted as: “If Academic Qualification is *Low* and Number of Journal Papers is *High* Then Appraisal (*APP*) is *Moderate*.

The degree to which the input values belong to each linguistic variable in the above defined fuzzy set is determined by using a Triangular Membership Function (TMF) that is conceptualized in figure 4.

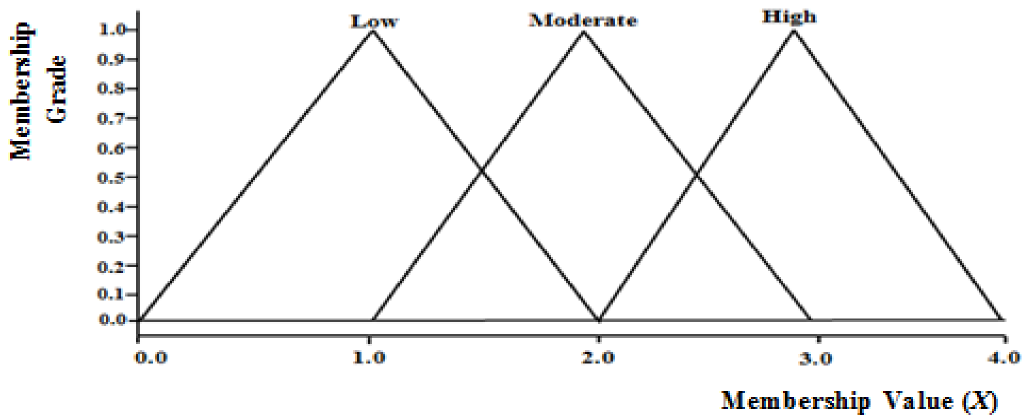

Figure 4: Triangular Membership function for input variables

The TMF in figure 4 simply shows the degree of belongingness of an input Xi to a linguistic variable drawn from the given fuzzy set. Such a membership value can be computed by using equation (4).

$$\mu X(Xi) = (Xi - q)/(p - q) \quad (4)$$

Where p and q are the attributes of the TMF that bounds its shape such that $q \leq Xi \leq p$.

3.1.2 Rule Evaluation

In this stage, the fuzzified inputs are mapped to the antecedents of the fuzzy rules contained in the rule base component of figure 2. Since the structure of the fuzzy rule considered for this research work have multiple antecedents, the fuzzy operator (**AND** or **OR**) can be used to obtain a singular value which represents the result of the antecedent evaluation. This value (Truth value) is then applied to the consequent membership function defined for the system’s output. To evaluate the disjunction of the rule antecedents, the **OR** fuzzy operation which is also known as fuzzy **union** operation as shown in equation (5) is applied.

$$\mu X_1 \cup X_2(X_i) = max\ [\mu X_1(Xi), \mu X_2(Xi)] \quad (5)$$

Similarly, in order to evaluate the conjunction of the rule antecedents, the **AND** fuzzy operation also known as fuzzy **intersection operation** as shown in equation (6) is applied.

$$\mu X_1 \cap X_2(X_i) = min\ [\mu X_1(Xi), \mu X_2(Xi)] \quad (6)$$

Eventually, the membership function of the rule consequent is adjusted by multiplying its membership degrees by the truth value of the rule antecedent. This research work adopted the fuzzy **AND** operations for its rule evaluation due to the nature of problem to be solved.

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3.1.3 Aggregation of Rule Outputs

Aggregation involves unification of the outputs of all fired rules. The membership functions of all rule consequents previously computed are combined into a single fuzzy set. The input of the aggregation process is the list of computed consequent membership functions, and the output is a single value that is contained in the output fuzzy set. The Aggregation process (***AGGRE***) is done by the Inference Engine component of figure 2 which is driven by equation (7).

$$AGGRE = \sum_{j=1}^{n} Rul_j^2 \tag{7}$$

Where Rul_j represents a fired rule and j = **1, 2, 3, . . ., n**; while **n** represents the number of fired rules when appraising the performance of a particular academic staff.

3.1.4 Deffufication

The last stage in the fuzzy inference process is the defuzzification. Fuzziness helps us to evaluate the rules better, but the final output of a fuzzy system has to be converted to a crisp value since crisp values are easily interpreted and aid efficient decision making. The input for the defuzzification process is the aggregate fuzzy output gotten from equation (7). There are several defuzzification methods, but the most popular amongst them is the Centre of Gravity (***COG***) technique and it is adopted by this research. The ***COG*** is expressed mathematically as:

$$COG = \frac{\int_a^b \mu X(Xi)\, Xi dXi}{\int_a^b \mu X(Xi)\, dXi} \tag{8}$$

Where $\mu X(Xi)$ represents the membership value of Xi as given by the TMF in figure 4 and Xi is the center of the membership function, while a and b represent the interval over which the integral is meant to take place.

3.2 Indicator of PA and Their Classification

The core criteria required for the appraisal of an academic staff in consideration for the position of a *Senior Lecturer* in the University system were elicited after several interactions with HRMs in some Nigerian Universities and relevant literature in the domain of human resource performance appraisal. It was realized that a Doctorate degree is required for the position of a senior lecturer in some universities, while in some other Universities, it not compulsory, but it only makes it faster for the staff to be promoted to position of a senior lecturer. The criteria, their fuzzy classifications, and corresponding linguistic variables are presented in tables 1, 2, and 3.

Table 1: Academic Qualification Classification

Criteria 1	PA Attribute	Numeric Value	Linguistic Variable
Academic Qualification	BSc.	1	Low
	MSc.	2	Moderate
	PhD./DSc.	3	High

Table 2: Research Publication Classification

Criteria 2	PA Attribute	Fuzzy Range	Linguistic Variable
Publications	Books	Xi <2	Poor
		2≤Xi< 4	Average
		Xi ≥4	Excellent
	Journal Papers	Xi <5	Fair
		5≤Xi< 10	Average
		Xi ≥10	Good
	Conference Papers	Xi <4	Poor
		4≤Xi< 7	Average
		Xi ≥7	Good

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Table 3: Years of Experience Classification

Criteria 3	PA Attribute	Numeric Value	Linguistic Variable
Years of Experience	Xi <5	1	Low
	5≤Xi< 10	2	Moderate
	Xi ≥10	3	High

4.0 Experiment and Results

The system proposed by this research work was implemented using Hypertext Markup Language (HTML), Hypertext Preprocessor (PHP), Asynchronous JavaScript & XML (AJAX), My Structured Query Language (MySQL), and Matrix Laboratory (MATLAB) programming languages.

A module was designed using the above stated tools to capture and store the Bio data of each academic staff that is to be considered for appraisal. The values regarding performance appraisal attributes of all academic staff that are been considered for the position of a senior lecturer were captured via the web page presented in figure 5. The captured values were preprocessed to a desired format and stored in the database. A copy of the preprocessed values is as well exported to an excel file format in preparation to be loaded into the MATLAB workspace where it can be easily accessed by the *Fuzzy Inference System*. The dataset of 50 academic staff that are due to be considered for promotion to the position of a senior lecturer were collected and preprocessed to a required format. The dataset contains basic performance appraisal parameters such as: *number of published books*, *number of journal papers*, *number of conference papers*, *years of experience* and so on.

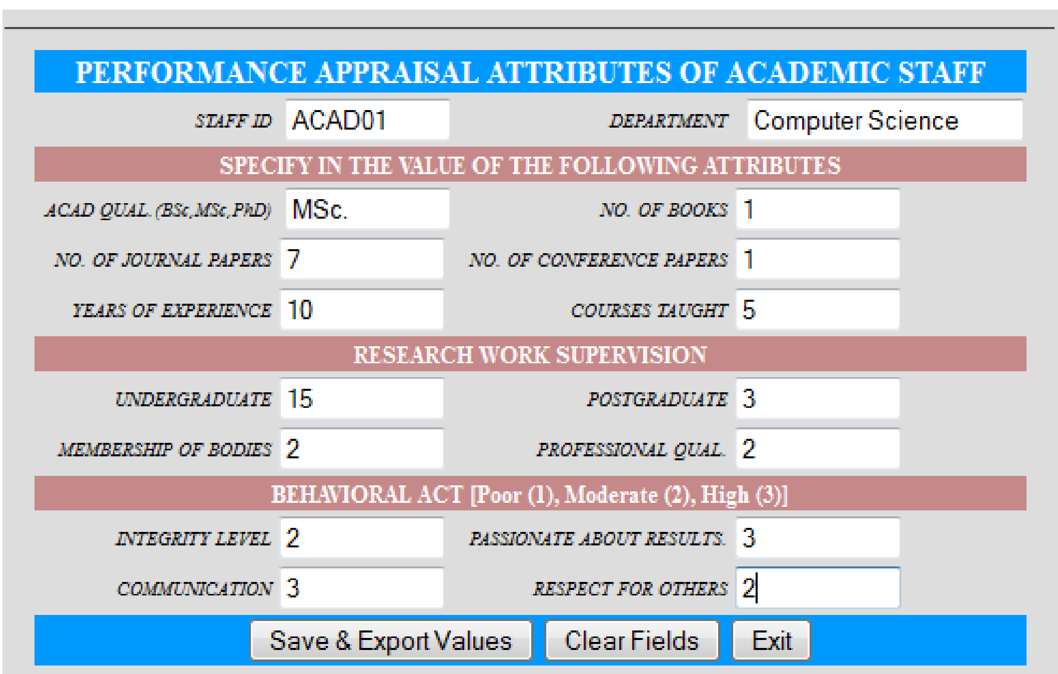

Figure 5: Web Interface for PA Attributes of Academic Staff

The *Fuzzy Inference System* developed in this research work is presented in figure 6. It consist of the following basic input variables among others: *Academic Qualification* (ACAD-QUAL), *Number of Books* (BOOKS) published, *Number of Journal Papers* (JOUR_PAPERS) published, *Number of Conference Papers* (CONF_PAPERS) published, and *Years of Experience* (YEARS-EXPER) and so on. It also shows an output (PA_RESULT) which represents the performance appraisal result of a given academic staff. This system contains other sub-modules such as *Membership function*

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module, Rule viewer module, and Surface viewer module. All this sub modules have their respective functions which collectively gives rise to entire *Fuzzy Inference System*.

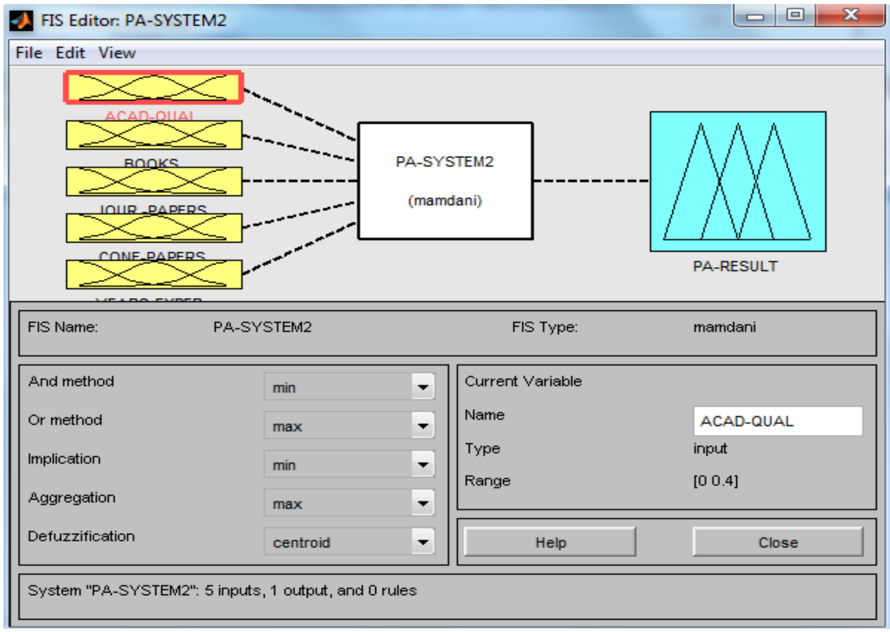

Figure 6: Fuzzy Inference System for PA

The degree of belongingness defined for each input variable considered is determined by the membership function module of the *Fuzzy Inference System* as shown in figure 7. For instance, the qualification of an academic staff and its respective degree of membership is shown as: BSc. [0.0 0.1 0.2], MSc. [0.1 0.2 0.3], and PhD. [0.2 0.3 0.4] with respect to the position being considered for. The Range of values specified for each input variable is given as [0.0 0.4] while the membership function type for each input variable was set to "*trim"* (triangular membership function) as shown in figure 7.

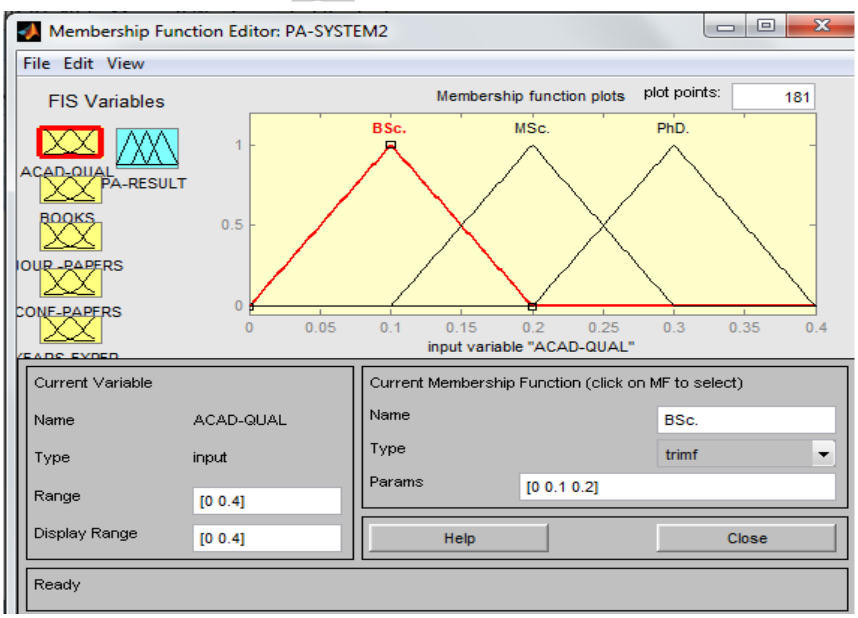

Figure 7: Membership Functions of PA variables

The Rule Viewer module of the *Fuzzy Inference System* presents an interpretation of the entire fuzzy inference process regarding the appraisal status of a given academic staff. Figure 8 depicts the Rule Viewer module which equally provides *Input text* field that allows HRMs to key in values representing performance appraisal attributes of a particular academic staff in order to predict the appraisal status (level) of such a staff. The input values for a particular academic

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staff as shown in figure 8 is [0.3536 0.2464 0.2291 0.02121 0.2879] while the corresponding output is given as [0.30]. This output value shows a High appraisal level with 75% possibility.

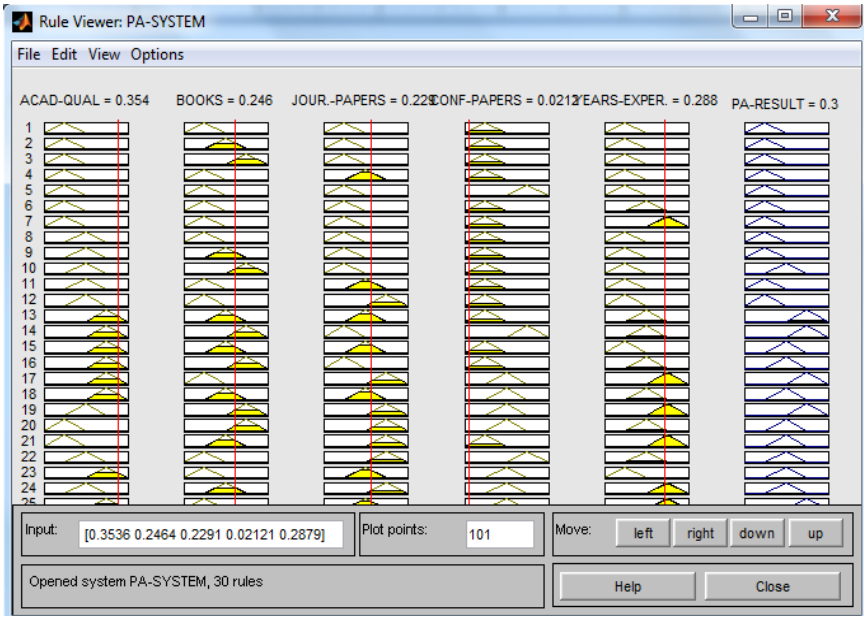

Figure 8: Rule Viewer Module of the Fuzzy Inference System

Figure 9 presents the Surface Viewer module of the *Fuzzy Inference System* and it displays the dependency of any two inputs variables with respect to the performance appraisal result (PA-RESULT). That is, this module generates and plots an output surface map for the entire system with respect to any two selected input variables. In other words, it displays a three-dimensional curve that represents the mapping from any two input variables (JOUR-PAPERS and YEARS-EXPER.) to the performance appraisal result (PA-RESULT).

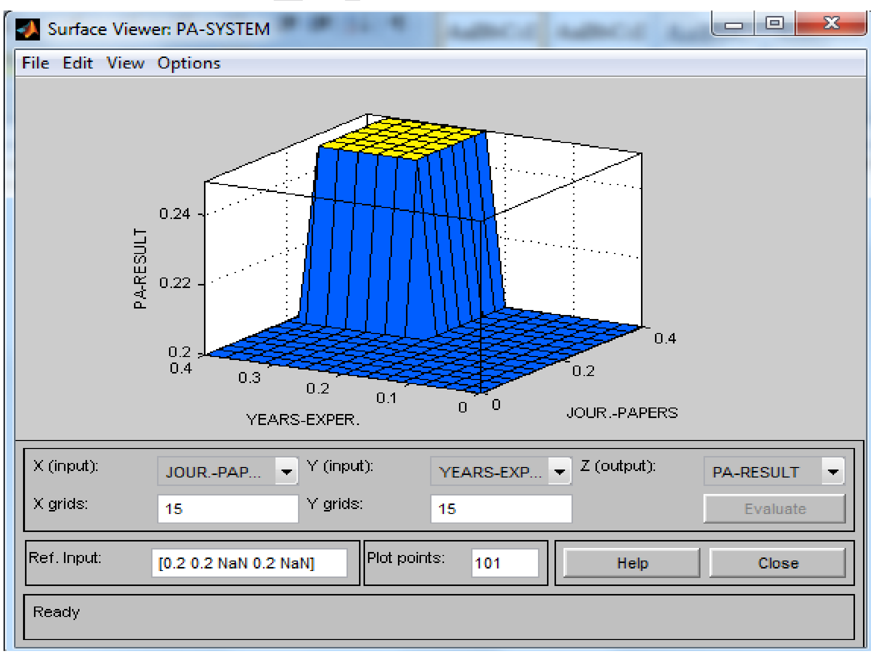

Figure 9: Surface Viewer Module of the Proposed System

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5.0 Proposed System Evaluation

In scientific research, indicators for measuring the effectiveness of developed systems or methods are important since it provides information on the extent of validity of such proposed initiative. To evaluate the effectiveness of the proposed system, a dataset of 9 academic staff consisting of core performance appraisal attributes was selected at random out of the 50 that are being considered for the position of a senior lecture as shown in Table 4. These dataset were fuzzified by the system based on the classification procedure outlined in Tables 1, 2, 3. The results of the fuzzified input values are shown in Table 5 while subsequent processes such as *Aggregation* and *Defuzzification* was carried out on the fuzzified inputs to produce the *Appraisal Outcome* in Table 6. The performance appraisal predictions of the proposed system (PPA_RESULT) and its possibility grades (POSSIBILITY) of the 9 selected candidates are shown in Table 6. Also, Table 6 contains the appraisal outcomes (CPA_RESULT) of the nine candidates via the conventional appraisal method.

Table 4: Values Representing Core PA Attributes of Academic Staff

STAFF_ID	ACAD-QUAL	BOOKS	JOUR-PAPERS	CONF-PAPERS	YEARS-EXPER
ACAD01	BSc.	0	3	4	8
ACAD02	MSc.	1	7	1	10
ACAD03	MSc.	0	5	2	4
ACAD04	PhD.	1	8	4	12
ACAD05	MSc.	2	6	3	8
ACAD06	PhD.	3	12	5	11
ACAD07	MSc.	1	6	3	8
ACAD08	PhD.	4	10	4	6
ACAD09	MSc.	0	3	1	4

Table 5: Fuzzified PA Input Values of Academic Staff

STAFF_ID	ACAD-QUAL	BOOKS	JOUR-PAPERS	CONF-PAPERS	YEARS-EXPER
ACAD01	0.10	0.10	0.10	0.20	0.20
ACAD02	0.20	0.10	0.20	0.10	0.30
ACAD03	0.20	0.10	0.20	0.10	0.10
ACAD04	0.30	0.10	0.20	0.20	0.30
ACAD05	0.20	0.20	0.20	0.20	0.20
ACAD06	0.30	0.20	0.30	0.20	0.30
ACAD07	0.20	0.10	0.20	0.10	0.20
ACAD08	0.30	0.30	0.30	0.20	0.20
ACAD09	0.20	0.10	0.10	0.10	0.10

Table 6: Performance Appraisal Prediction of Academic Staff

STAFF_ID	ACAD01	ACAD02	ACAD03	ACAD04	ACAD05	ACAD06	ACAD07	ACAD08	ACAD09
CPA_RESULT	Low	Moderate	Moderate	High	Moderate	Low	Moderate	High	Low
PPA_RESULT	Low	Moderate	Low	High	Moderate	High	Moderate	High	Low
POSSIBILITY	84%	76%	59%	75%	66%	87%	61%	74%	56%
STATUS	1	1	0	1	1	0	1	1	1

CPA_RESULT: Conventional PA Result; PPA_RESULT: Proposed PA Result

The value in the STATUS row of Table 6 shows whether the performance of each candidate is accurately predicted or not when compared with the results gotten from the conventional method. A value of One (1) represents accurate prediction while Zero (0) represents inaccurate prediction as shown in Table 6.

Let X_k represent the status of the prediction for the *Kth* performance appraisal outcome (PPA-RESULT) such that:

$$X_k = \begin{cases} \mathbf{1} \ \textit{(IF the kth PPA-RESULT is Accurate)} \\ \mathbf{0} \ \textit{(IF the kth PPA-RESULT is Inaccurate)} \end{cases}$$

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Therefore, the average precision of the proposed system is computed as follows:

$$\mathbf{Precision} = \frac{1}{n}\sum_{k=1}^{n} X_k \quad \textbf{\textit{For All}}\ (X_k = 1) \qquad (9)$$

$$\mathbf{Precision} = \frac{(\textbf{Count of Accurate Prediction})}{(\textbf{Total Number of Prediction})} = \frac{7}{9} = 0.78 \qquad (10)$$

While the Average Imprecision of the proposed system is computed as follows:

$$\mathbf{Imprecision} = \frac{(\textbf{Count of Inaccurate Predition})}{(\textbf{Total Number of Prediction})} = \frac{2}{9} = 0.22 \qquad (11)$$

Therefore, the proposed system has 0.78 probability of predicting accurately the appraisal of an academic staff, and 0.22 chances of predicting wrongly the appraisal of an academic staff.

6.0 Conclusion

According to research, employees are the principal tool for the attainment of organizational goals and objectives. As a result of this fact, employee performance appraisal system is basically considered as a vital tool because of its use for purposes such as staff promotion, recognition, and selection for training and development. An efficient performance appraisal system based on fuzzy logic approach is proposed by this research. The proposed system renders a scalable design that efficiently combines core performance appraisal attributes of an academic staff and instantly predicts accurately the appraisal level of such a staff. This research provides an enabling platform capable of aiding human resource managers to properly discharge their statutory duties via the handling of delays in appraisal processes, external influences on appraisal results, and incommensurate befits assigned to appraisal outcomes. In addition, the system will also help to reduce the huge cost associated with conducting performance appraisal exercises in a given organization. The accuracy of the proposed system was investigated via standard statistical technique and the results proved the system to be 78% efficient in providing accurate appraisal predictions. Lastly, this research has been able to exhibit both theoretical and practical applications of Fuzzy Logic concept in the domains of human resource performance appraisal.

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HIGHLIGHTS

- Online Fuzzy Based System for Employee Performance Appraisal (PA) is proposed
- Fuzzy Logic technique was used to model the system with PA attributes as inputs values
- An experimental study shows that the proposed system is 78.0 % efficient
- The system is capable of providing accurate, timely and cost effective PA predictions
- The system is capable of promoting social-economic stability in organizations.