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Modelling of Key Performance Indicators for Staff Advancement in Higher Institutions of Learning ---A fuzzy logic approach

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ABSTRACT

Key Performance Indicators (KPIs) are variables for performance assessment. It is paramount to measure or evaluate the qualities of an individual's performance periodically for a sustainable progression. One of the viable means of motivating staff in the academic environment is to ensure that staff are rewarded with promotion and other forms of advancement as at when due. In practice, this is not automatic as staff advancement is usually based on a number of criteria or indicators that should be aggregated to achieve a fair and transparent judgment. Staff advancement may be in form of promotion, opportunity for special training, administrative role etc. The objective of this study, therefore, was to model some Key Performance Indices (KPIs) with a view to determining the staff that indeed merits advancement in Kampala International University, using the concept of fuzzy logic. The techniques basically involve fuzzification, application of fuzzy operators, rule generation, aggregation of the rule output and defuzzification. The implementation of the identified KPIs is carried out in Matlab software environment; in the process, a number of rules were generated. The proposed study shows the standard procedures of representing staff's achievements in a way that pave smooth path for their advancement through a number of transparent steps that is free of subjectivity. This study further shows that all the staff whose performances were appraised got the form of advancement that corresponds to their achievement; thus, the technique used gives a much better way of addressing classification problems. The technique used also solves the problem of sharp boundaries that exist in the classical approach being used in the study domain.

Keywords: *fuzzy logic, performance appraisal, staff advancement, classification, KPIs.*

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1. INTRODUCTION

The overall success of an institution in achieving its strategic goals relies so much on the performance level and general efforts put in by the collective employees (Kiruja & Mukuru, 2018), therefore, staff motivation has some key roles to play at ensuring that an institution achieve its set goals. Unfortunately, several higher institutions of learning are not doing enough to reciprocate the commitments of their employees and this is capable of affecting the growth and development of such institution either directly or indirectly. Although, some employers are aware of this simple fact but deliberately choose to exploit their staff, this act is capable of frustrating the staff and may also result in lowering the institutions' standard.

Determining the eligibility of staff for any form of advancement requires the use of appropriate variables such as the Key Performance Indicators (KPIs). KPIs are very crucial for planning purposes and decision making. The use of KPIs through supporting information, creates transparency and it support decision makers at the management level (Meier et al., 2013). There are several ways by which staff may be encouraged or motivated, one of them is by ensuring that they are promoted as at when due. Motivation is the process that leads to behaviour, and this process cannot be directly measured or observed (Mawoli & Babandako, 2011).

Previous study reported in (Panagiotakopoulos, 2013), revealed various competing theories and models which attempt to explain motivation at work. Maslow's hierarchy of needs model shows five levels from physiological needs through safety needs, love needs, and esteem needs, to the need for self-actualisation at the highest level. In the expectancy-based model, the performance depends on the perceived expectation regarding effort expended and achieving the desired outcome. Others are equity theory, which focuses on how people feels and how fairly they have been treated in comparison with the treatment received by others; and goal-setting theory in which the intentions of people play a very vital role in determining their behavioural pattern (Martin, 2001).

In several institutions of learning, the procedure used to select those to be promoted is sometimes subjective and not transparent enough. It is subjective in the sense that, the opinions of the promotion panel sometime matters a lot. The management team saddled with the responsibility of choosing the most qualified applicants are sometimes compromised and the affected applicants that are not in their good book always fall victim of their biasness. In view of this, the proposed study focuses on using a transparent and knowledge representation approach, fuzzy logic, to model a number of KPIs which is usually inevitable for staff advancement in a typical higher institution of learning. Fuzzy logic is widely reported in the literature and it has been reported for use in employee appraisal as proposed in (Shaout & Yousif, 2014).

Fuzzy logic is part of the theory of fuzzy sets; sets that calibrate vagueness and reflects how people think (Negnevitsky, 2011). The technique is a powerful problem solving approach that is capable of capturing the way humans represent data and reason with the real-world knowledge in the face of uncertainty. As reported in (Rajasekaran & Pai, 2003), uncertainty arises due to generality, vagueness, ambiguity, or incomplete knowledge. The present study identified and modelled the required indicators, and subsequently implements them using matlab software. The rules generated in the course of this study bring the clarity required to transform the proposed model to a system for fairness in decision making.

When the judgement or decision taken on employee is generally considered as fair, especially as regards to motivation, job satisfaction sets in. Job satisfaction is very essential in revitalizing staff motivation and the gesture keeps their enthusiasm alive (de Lourdes Machado-Taylor et al., 2016) If an employee is well-motivated, they can put in all the efforts required to build a good reputation for the organization that employ them and anything short of this may lead to low commitment.

The scope of this study focuses on the academic staff; the modelling of data would therefore, be limited to this category of staff only. A number of attributes identified as indices and considered for modelling of academic staff advancement in this study includes: research publications, higher degree certificates, service to the community/administrative role, student supervision role and teaching load.

This paper is structured as follows: In the next section, some of the published works related to this study is discussed; the concept of fuzzy set theory was briefly discussed in section 3; while in section 4, the detail modelling and evaluation techniques are illustrated. Section 5 discusses some of the results generated, the existing evaluation and the proposed evaluation approach

is compared, while we summarised and concluded this study in Section 6; also in Section 6, the direction for further studies is indicated.

2. LITERATURE REVIEW

Studies reported in the literature have shown that every employee deserve to be motivated and adequately compensated for their efforts, as motivation usually boost staff commitment towards the institution's strategic goals. Regular promotion of staff in the institution of higher learning serves as a way of boosting their personal morale as each staff is expected to receive commensurate occupational earnings, acceptable compensation cost, incidence and provision of employees benefit plan etc. A survey on exploring key performance indicators reported in (Badawy et al., 2016), identified different types of KPIs approaches. The study however, focused more on business organization.

In this study, we look at KPIs as requirements that need to be adequately provided by individual staff in a typical higher institution of learning for evaluation purposes and in order to solve classification problems that relate to advancement. KPIs as reported in (Amishi & Sukhbir, 2015), are very important variables for planning and ensure proper control through supporting information, creation of transparency and supporting decision makers (Badawy et al., 2016). Generally, most employees desires a good working environment within the organization (Omar, Jusoff, & Hussin, 2010), and failure of the organization to ensure the staff advances as at when due can hinder the institutions growth. Further findings from the study reported by Omar et al. (2010), indicates that the incentives that the employee stand to benefit such as: favourable working environment and Peer Corporation have the biggest influence on employee loyalty and commitment to work.

The cumulative benefits of motivating staffs in an organization are enormous, the reports in (Nikita, Elena, & Ulyana, 2015), relates the act of motivating staff in the institutions of higher learning to research and accomplishment. The study also identified course scheduling such as: conducting lectures, seminars, laboratory works as activities that facilitate the increase of motivation among teaching staff for research work.

A nationwide study carried out in Portuguese higher education (de Lourdes Machado-Taylor et al., 2016), identified academic staff as a key resource in higher institutions of learning. Further analysis of the findings in the study revealed that, the academic staff expressed less satisfaction especially in research climate and conditions of employment; the study concludes that it is imperative to halt trend like these for the progress of the institution.

There is possibility of high retention rate where staff are adequately rewarded for their efforts; it is certain that the performance of academic staff may have substantial impacts on student learning and this is in line with the study reported in (Oyagi & Kembu, 2014). The study investigates the relationship between motivation and retention of academic staff in a number of selected public higher institutions of learning in Dar es-salaam, Tanzania. The study further shed light on proper knowledge management in the organization.

Also the research carried out and reported in (Panagiotakopoulos, 2013), recommends an immediate need for firm owners to train their staff in order to regain employee motivation, which has been lost due to the provision of poor financial rewards. It is important to appraise staff performance using the right techniques. Fuzzy logic has been identified as one of the reliable knowledge representation techniques that can be used for performance evaluation. Fuzzy logic is a powerful problem solving methodology that capture the way humans represent and reason with the real-world knowledge in the face of uncertainty (Macwan & Sajja, 2013).

In order to ensure that the right staffs are compensated for their efforts, there is need to ensure a transparent evaluation of staff performance. This is why a model is proposed in this study based on a number of KPIs for staff advancement, using a knowledge representation technique, fuzzy logic. This study aimed at filling the gaps that is being experienced through the use of classical approach in the study domain.

3. FUZZY LOGIC AS A KNOWLEDGE REPRESENTATION TECHNIQUE

In 1965, Lotfi Zadeh introduced fuzzy logic as a means of modelling uncertainty in natural language (Yousif, 2016). The concept of fuzzy logic describes the qualitative nature aspects of the object, while a conventional logic system focuses on their quantitative aspects. Fuzzy Logic (FL) is a powerful problem solving methodology that captures the way humans represent and reason with the real-world knowledge in the face of uncertainty (Macwani and Sajja,

2013). Uncertainty arises due to generality, vagueness, ambiguity, or incomplete knowledge. The technique of FL provides a simple way to draw definite conclusions from imprecise information.

Fuzzy logic is part of the theory of fuzzy sets; sets that calibrate vagueness and reflects how people think (Negnevitsky, 2011). The concept has been in existence for a long time and it is an extension of an ordinary set usually referred to as crisp set. It is also affirmed in (Xu & Zhou, 2011), that Fuzzy provides a simple way to arrive at a conclusion from terms that are vague and imprecise. Fuzzy logic therefore, resembles the human make decisions and possesses the ability to deal with reasoning that is approximate rather than fixed and exact (Pavani, Gangadhar, & Gulhare, 2012). The approaches used in fuzzy set mimics how a person would make decisions much faster; it resembles human decision making with its ability to work from approximate data and find precise solutions.

Unlike classical logic which requires a deep understanding of a system, exact equations and precise numeric values, the use of fuzzy logic incorporates an alternative way of thinking, which allows modelling complex systems using higher level of abstraction that originates from a knowledge-base and experience. The classical logic does not allow for degrees of imprecision, as usually indicated by words of phrases such as poor, average and good; but instead, it relies on binary values such as true or false. With the technique of FL, it is possible to introduce a multi-valued logic linguistic statements consisting of unsatisfactory, satisfactory, average, good, and excellent. Fuzzy systems implement fuzzy logic, which uses sets and predicates of this kind.

3.1 *Analysis and operation of a fuzzy set structure*

The concept of fuzzy set is an extension of the concept of a crisp set (Ganesh, 2006). Just like a script set on a universal set *U* is defined by its characteristic function from U to {0, 1}, a fuzzy set on a domain *U* is defined by its membership function from *U* to [0,1]. The membership of any data point, therefore, can be indicated in a set by {0, 1} (Dua & Du, 2011).

In fuzzy set theory, the membership can be described by a value in the range [0.0, 1.0], with 0.0 representing absolute falseness and 1.0 representing absolute truth. It follows that given a set of data points X = {x} and a fuzzy set Z, the membership of each data point x $\in$ Z can be denoted by a membership function *m* as *f* (x), where Z is a fuzzy set and *f:* Z $\rightarrow$ [0, 1]. For each data set, x $\in$ Z, *f* (x) is the weight of membership of x. For instance, an element mapping to the value 0 means that the member is not included in the fuzzy set, while an element mapping to 1 describes a fully included member. Values strictly between 0 and 1 characterize the fuzzy set members. The set {x $\in$ Z | *m* (x) > 0} is referred to as support of the fuzzy set (Z, *m*).

Three common operations usually defined on fuzzy sets are: complement, intersection and union. The complement of a set is its exact opposite. For instance, the complement of a set of staff with satisfactory number of publications is the set of staff with NOT satisfactory number of publications. In other word, when we remove the set of satisfactory number of publications by staff from the universe of discourse, we obtain the complement with respect to the variable removed.

Also, in fuzzy sets, the union is the reverse of the intersection, in other word; the union is the largest membership of the element in either set. Let U be a domain and A, B, be fuzzy sets on U. Then three operations can be defined on fuzzy sets, namely, union, intersection and complement. These operations extend and generalize the corresponding operations on Crisp Set theory (Ganesh, 2006) :

The *union* of *A* and *B*, denoted by $A \cup B$, is defined as that fuzzy sets on *U* for which

$$(A \cup B)(x) = \max(A(x), B(x)) \ \forall \ x \ in \ U \ . \qquad (1)$$

In a fuzzy set, an element may belong to more than one set with different membership (Negnevitsky, 2011). A fuzzy intersection is the lower membership in both sets. For instance:

The intersection of *A* and *B*, denoted by $A \cap B$, is defined as that fuzzy set on *U* for which

$$A \cap B(x) = \min(A(x), B(x) \ \forall \ x \ in \ U \qquad (2)$$

The complement of *A*, denoted by A^1 or $\bar{A}$, is defined as that fuzzy set on *U* for which

$$A^1(x) = 1\text{-}A(x) \ \forall \ x \ in \ U \qquad (3)$$

4. MATERIAL AND METHODS

4.1 *Data collection and scope of the study*

In the institution of higher learning, there are both academic and non-academic staffs; however, this study focuses on academic staff in Kampala International University (KIU). As we earlier identified some forms of staff advancements, this study specifically focused on *staff promotion*. Some academic staffs in KIU were interviewed and relevant information was collected. Information obtained from the academic staff revealed their academic qualifications, publications, teaching load, the number of students they have successfully supervised and the managerial roles they have been performing etc. In order to have complete information requested, the staff interviewed also supported their information with their curriculum vitae. In addition, this study relies on some oral interview conducted with some senior officers in Human Resource and Quality Assurance units of the university, with a view to getting the detail information on all the documented KPIs for the university.

4.2 *The proposed modelling of kpi for staff advancement*

In this study, we used the concept of fuzzy logic to model some input variables identified as Key Performance Indicators, (KPIs), namely: academic publications, higher degree certificates, student supervision, community development/administrative roles and teaching load. The domain expert assigns values to each variable with regards to their importance within the academic settings. The indices were transformed to numeric values based on the assigned values provided in Table 1. Fuzzy logic based method was chosen for this task because it has proved to be suitable in the handling of vagueness in a systematic way and the theory of fuzzy set combines set-wise thinking and continuous variables in a rigorous fashion (Smithson & Verkuilen, 2006). The achievements of each staff based on the five attributes being considered in this study were coded and fuzzified as shown in Table 1.

The steps required for the design of fuzzy logic models are basically four (Negnevitsky, 2011), these steps are listed as: fuzzification, rule evaluation, aggregation of the rule output and defuzzification. We adopt Mamdani-style inference system in Matlab Software for the implementation.

4.2.1 *Fuzzification*:

This involves taking the input variables and determining the degree to which it belongs to each of the appropriate fuzzy sets via membership functions. The crisp input is always a numerical value limited to the universe of discourse of the input variables and in this case, it is the interval between 1 and 16. The study appraises the attributes identified as KPI which gives the achievements in respect of each staff. The input variables are fuzzified against the linguistic statements to give its membership value as represented in Table 1. Each of the staff performance based on the selected KPI was mapped to appropriate value within the membership function. In other words, the input variables: *r,t,s,p* and *c* are limited to the universe of discourse R, T, S, P and C respectively. This is how the input variables are transformed to their corresponding numeric values within the given range of the membership functions in Table 1.

For instance, if a staff supervised a PhD student, being the highest in that category, it has a code of '9' as shown in Table 2; and it has a corresponding membership value (or fuzzy value) of 0.4 as shown in Table 1. The fuzzy value ranges between 0 and 1, and it is usually determined through the domain expert.

Also, each of the attribute was further fragmented for coding purposes and tabulated as shown in Table 2. The table also shows the description of each attribute and how they are transformed to numeric values.

The Fuzzification of each performance indicator based on their linguistic variables is further analysed and illustrated as follows. The fuzzy value of those linguistic variables that is not within the membership function is assigned 0.0.

Certificates
Highest (Ph.D) = {14/1.0, 15/0.0, 16/0.0}
Higher (Master) = {15/0.8, 14/0.0, 16/0.0}
High (Bachelor) = {16/0.7, 14/0.0, 15/0.0}

Teaching Load
V. Adequate = {4/0.5, 5/0.0, 6/0.0}
Adequate = {5/0.4, 4/0.0, 6/0.0}
Inadequate = {6/0.2, 4/0.0, 5/0.0}

Academic Publications
V. Satisfactory = { 10/0.6, 11/0.0, 12/0.0, 13/0.0}
Satisfactory = {11/0.5, 10/0.0, 12/0.0, 13/0.0}
Acceptable = {12/0.4, 10/0.0, 11/0.0, 13/0.0}
Not acceptable = {13/0.1, 10/0.0, 11/0.0, 12/0.0}

Although not all institutions have the named designations or roles, however, they are available in the study domain, while committee comprised of a number of staff take charge in some other institutions.

Similarly, the number of students successfully supervised by each academic staff is one of the indicators used for modelling in this study. Supervision in this context implies thesis completed and submitted for a postgraduate degree. The modelling of each linguistic variable and associated membership values are illustrated as follows:

Students Supervision
Higher Scholar (Ph.D) = { 7/0.4, 8/0.0, 9/0.0}
High Scholar (Master) = {8/0.3, 7/0.0, 9/0.0}
Scholar (PGD) = {9/0.1, 7/0.0, 8/0.0}

Also, one of the attributes being considered in this study is the responsibility or roles assigned to an academic staff. These roles may be principal, managerial or operational in nature. Although, there may be a direct benefit for performing any of these roles, it makes sense to ensure these roles attract scores for promotion purposes.

Responsibilities / Roles
Principal Role = {1/0.3, 2/0.0, 3/0.0}
Managerial Role = {2/0.2, 1/0.0, 3/0.0}
Operational Role = {3/0.1, 1/0.0, 2/0.0}

4.2.2. *Application of fuzzy operators and* r*ule generation*: This defines the shaping of the consequent (a fuzzy set) based on the antecedent (a single number). Generally, in a situation where the fuzzy rule has multiple antecedents, the use of AND operator or OR operator becomes inevitable so as to obtain the single number that represent the antecedent evaluation.
Through the implementation in Matlab software, some rules were generated and the excerpt of these rules is represented in Figure 5.1. These rules were applied to the fuzzified inputs. When the antecedents of the fuzzy rules are aggregated, it determines the corresponding decision that should be taken as consequent.

4.2.3 *Aggregation of the rule output:* This is the process of unification of the outputs of all the rules. It involves taking all the fuzzy sets that represent the output of each rule and combining them into a single fuzzy set in preparation for the fifth and final step. The membership functions of the rule consequents that are previously scaled are combined into a single fuzzy set. In other words, the output in respect of each staff are determined and combined as a single fuzzy set through the use of fuzzy operator.

The data represented in Table 3, takes into consideration ten (10) staffs being the excerpt of the data collected from staff (S1, S2,……,S10) and the five key performance indicators ($PI_{1,\ldots}PI_5$), for their performance ratings. The table shows the linguistic variables assigned to each academic staff based on their performance as contained in their curriculum vitae (the data source). In order for these attributes to be implementable in the matlab software environment, there was the need to transform them into their equivalent numerical values as shown in Table 4, which is based on membership value earlier represented in Table 1.

4.2.4 *Defuzzification:*
This is the last process in the fuzzy inference implementation. In fuzzy system model, the final output should be a crisp number. The aggregate output fuzzy set is what is required as the input for defuzzification. There are several defuzzification methods reported in the literature, centroid technique according to (Negnevistky, 2011), is one of the most popular formulae used for computing defuzzification. The Mamdani- style inference requires that a centroid of two-dimensional shape be integrated across a continuously varying function. Mathematically, the centre of gravity (COG) can be expressed as:

$$\text{COG} = \frac{\int_a^b \mu A(x)\,x\,dx}{\int_a^b \mu A(x)\,dx} \qquad (4)$$

'A' denotes fuzzy set A while a, b represents the interval on A

However, in this study, the set of values in Table 5, being the aggregated outputs were defuzzified. This is achieved by applying maximum function to the aggregated output values, and this gives 0.5. This is a crisp single value required for taking final decision. The said table represent the final output of this operation.

5. RESULTS AND DISCUSSION

The objective of this study was to model a number of key performance indicators with a view to achieving staff advancement in the institutions of higher learning. The modelling approach earlier represented in Section 4, computes the mean membership values of the performance indicators shown in Table 4, and consequently generates the values shown in Table 5 in accordance with the fuzzy logic techniques. This gives the proposed performance model represented in Figure 5.1.

Although, only 4 of the 10 staffs actually taken as sample data merits promotion as shown in Table 5, however, in a situation where other forms of advancements are available but not enough for all staff to benefit, information in Table 5 can be used for fair sharing. This makes fuzzy logic technique to be more preferable in handling classification problems to some other approaches, especially the use of classical approach which in most cases relies solely on discrete target values such as 0 and 1 for decision making.

From Figure 5.1, three sets of performances can be inferred. Those staff whose performance is very satisfactory can be considered for promotion, while those whose performance appears to be satisfactory may be considered for other forms of staff advancement as earlier listed, which include special training/workshop as these are usually subject to available funding.

Furthermore, the implementation of the proposed modelling approach generates a number of rules. An excerpt of the rules generated is illustrated in Figure 5.2. The essence of rule generation is to bring about a clear means of combining the attributes for decision making purposes. By using any suitable high level language, the rules generated can be implemented to achieve a system that output a decision based on a number of antecedents.

Figure 5.3 determines the relationship that exists between the performance indicators and the decision output. The surface view plotted for academic publication and certificate against the output is represented in Figure 5.3. The surface view shows that the higher the strengths of an attribute, the higher the output.

Comparison of the existing technique with the fuzzy logic technique shows that, the technique of fuzzy logic is more flexible. In order to determine the eligibility of staff for promotion within the study domain, the classical approach being used classifies data based on sharp boundaries, i.e. there is need to meet a particular threshold value. This implies that there are only two possibilities; it is either a staff qualifies to move forward or remain on the same level till another year. A more flexible fuzzy logic technique showcases the staff achievement in more details, by mapping scores in respect of each staff to appropriate linguistic statement.

Also, since the technique of fuzzy logic follows a number of sequential steps, the resulting model developed is not affected by human opinion; it is therefore free of subjectivity. This comparison is summarized in Table 6. The comparison of the existing and proposed approaches is based on a number of metrics.

6. CONCLUSION

The existing evaluation approaches used in appraising the performance of academic staff in the study domain tilt towards classical and based classification on sharp boundaries. This paper attempts to fill this gap by presenting a modelling approach that uses the techniques of fuzzy logic. The proposed study models the data collected from a number of academic staff at Kampala International University. Some attributes identified as indices and considered for measuring the performance of academic staff for advancement purposes in their career include: research publications, higher degree certificates, services to the community/administrative role, student supervision role and teaching load. In order to have a better understanding of the proposed model, some rules were generated. An excerpt of these rules is represented in Figure 5.2. The rules can be implemented using any suitable high level language.

Although, this study mainly focuses on promotion as a form of staff advancement, however, the proposed model shows how staff can still benefit from other forms of advancement; this is why the fuzzy logic technique used in this study is usually preferable to a classical approach that sometimes relies on binary values. The proposed approach shows how those that meets the threshold for promotion automatically gets it, while those that appears very close to the threshold may be compensated for other forms of advancement such as special training, administrative role etc. However, those found to have performed unsatisfactorily are to be left out.

The excerpt of the relationships that exist between indicators and performance output was determined by

plotting the surface view as illustrated in Figure 5.3. It can be deduced from the diagram that the higher the value measured in respect of each indicator, the higher the performance output and vice versa.

This work can be extended by ensuring the transformation of the proposed model to a system that automatically measures staff performance based on the identified indices. The computation of such staff achievement in real time would fast-track the decision making by the institution's management.

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Table 1: Fuzzy inference system (FIS) Input variables

Input variables	*Linguistic variables*	*Membership value*	*Membership function*
Responsibilities/Roles (r)	*Principal Role*	*0.3*	*1*
	Managerial Role	*0.2*	*2* $1 \geq R \leq 3$
	Operational Role	*0.1*	*3*
Teaching Load (t)	*V. Adequate*	*0.5*	*4*
	Adequate	*0.4*	*5* $4 \geq T \leq 6$
	Inadequate	*0.2*	*6*
Students Supervisions (s)	*Higher Scholar (Ph.D)*	*0.4*	
	High Scholar (Master)	*0.3*	*7* *8* $7 \geq S \leq 9$ *9*
	Scholar ((PGD)	*0.1*	
Academic Publications (p)	*V. Satisfactory*	*0.6*	
	Satisfactory	*0.5*	*10* *11* $10 \geq P \leq 13$ *12*
	Acceptable	*0.4*	
	Not acceptable	*0.1*	*13*
Certificates (c)	*Highest (PhD)*	*1*	*14* *15* $14 \geq C \leq 16$ *16*

Table 2: The descriptions of the input variables and their possible numeric values

S/No.	*Attributes*	*Description*	*Codes*	*Obtainable values*
1	*RS*	*Responsibilities such as:* *Principal Roles (P.R) e.g DVC, Dean.* *Managerial Roles (M.R.) e.g. Directors, HODs.* **Operational Roles (O.R.) e.g. TLCs, D.Os.*	*Principal role 3* *Managerial role 2* *Operational role 1*	*1 – 3*
2	*TL*	*Teaching Load*	*V. Adequate 6* *Adequate 5* *Inadequate 4*	*4 - 6*
3	*SS*	*Students Supervisions*	*Higher Scholar (Ph.D) 9* *High Scholar (Master) 8* *Scholar (PGD) 7*	*7 – 9*
4	*AP*	*Academic Publications*	*≥ 20 publications 13* *≥ 15 publications 12* *≥ 8 publications 11* *≥ 3 publications 10*	*10 – 13*
5	*C*	*Certificates*	*Ph.D 16* *Masters 15* *Degree 14*	*14 – 16*

*TLC: Staff under the supervision of the dean / hod, assigned to oversee teaching, learning and control in the department.

* D.Os.: The desk officers are staffs under the supervision of the dean / hod, assigned to address issues on students' results.

Table 3: Performance rating across the selected staff (Linguistic variables)

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
PI_1 (Cert)	Highest	High	Higher	Highest	High	Higher	Highest	Higher	High	High
PI_2 (Teaching)	Adequate	Adequate	Adequate	V. adequate	Adequate	Inadequate	Adequate	V.Adequate	Adequate	V. adequate
PI_3(Acad. pub)	V.S	N.A	A.	V.S	A	S	V.S	V.S.	N.A.	A
PI_4 (Supervisn)	Higher Scholar	Scholar	Scholar	Higher. Scholar	Scholar	Scholar	Higher Scholar	Scholar	None	Scholar
PI_5 (Roles)	P	O.R.	O.R.	M.R.	None	M.R.	P	M. R.	O.R.	O.R.

Note: S – satisfactory; V.S.—very satisfactory; A—acceptable; N.A. – not acceptable
P.--principal role; O.R—operational role; M.R.—managerial role

Table 4: Performance rating across the selected staff (Linguistic values)

	S1	*S2*	*S3*	*S4*	*S5*	*S6*	*S7*	*S8*	*S9*	*S10*
*PI_1 (Certificate)	*1*	*0.7*	*0.8*	*1*	*0.7*	*0.8*	*1*	*0.8*	*0.7*	*0.7*
PI_2 (Teaching)	*0.4*	*0.4*	*0.4*	*0.5*	*0.4*	*0.2*	*0.4*	*0.5*	*0.4*	*0.6*
PI_3 (Acad.Pub)	*0.6*	*0.1*	*0.4*	*0.6*	*0.4*	*0.5*	*0.6*	*0.6*	*0.1*	*0.4*
PI_4 (Supervision)	*0.4*	*0.3*	*0.3*	*0.4.*	*0.3*	*0.3*	*0.4*	*0.3*	*0.0*	*0.3*
PI_5 (Roles)	*0.3*	*0.1*	*0.1*	*0.2*	*0.0*	*0.2*	*0.3*	*0.2*	*0.1*	*0.1*

*where PI denotes performance indicator.

Table 5: The aggregated values of the performance rating

	Criteria					
	Certificates	*Quality teaching*	*Publication*	*Student supervision*	*Admin. roles*	**Average fuzzy values*
S1	*1*	*0.4*	*0.6*	*0.4*	*0.3*	*0.5*
S2	*0.7*	*0.4*	*0.1*	*0.3*	*0.1*	*0.3*
S3	*0.8*	*0.4*	*0.4*	*0.3*	*0.1*	*0.4*
S4	*1*	*0.5*	*0.6*	*0.4*	*0.2*	*0.5*
S5	*0.7*	*0.4*	*0.4*	*0.3*	*0.0*	*0.4*
S6	*0.8*	*0.2*	*0.5*	*0.3*	*0.2*	*0.4*
S7	*1*	*0.4*	*0.6*	*0.4*	*0.3*	*0.5*
S8	*0.8*	*0.5*	*0.6*	*0.3*	*0.2*	*0.5*
S9	*0.7*	*0.4*	*0.1*	*0.0*	*0.1*	*0.3*
S10	*0.7*	*0.6*	*0.4*	*0.3*	*0.1*	*0.4*

*the mean value is computed to 1 place of decimal.

Figure 5.1: The proposed performance model for staff advancement

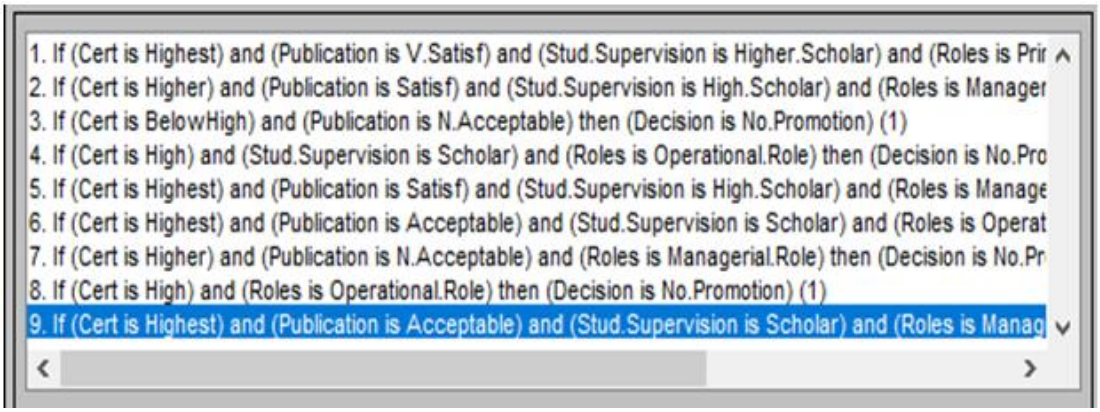

Figure 5.2: Excerpts of the rules generated

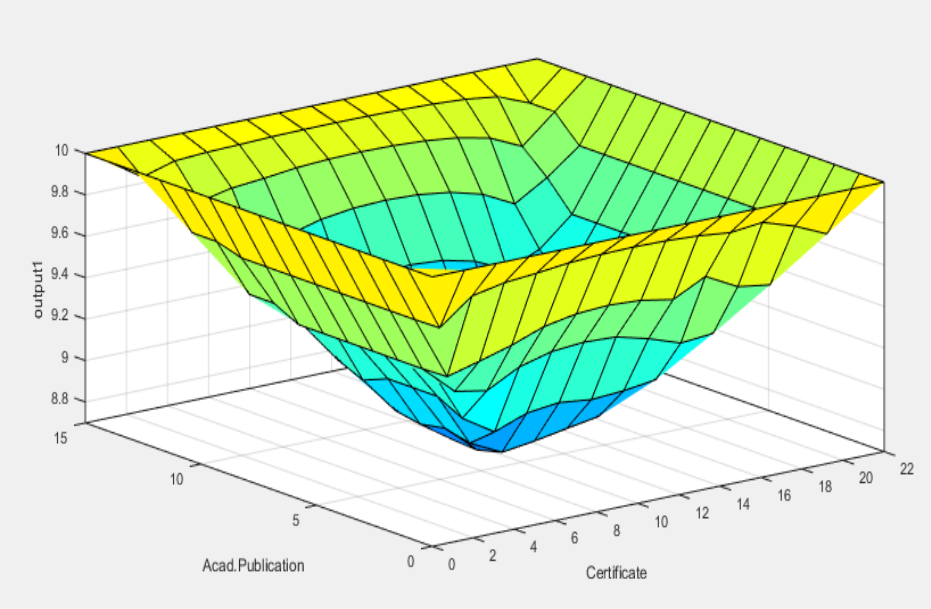

Figure 5.3: Surface view of academic publication versus certificate

Table 6: Comparison of the existing evaluation approach and the proposed evaluation approach.

Metrics	***Classical***	***Fuzzy logic***
Evaluation methods	*It is relatively rigid.*	*It is Flexible, due to the use of fuzzy values.*
Degree of Imprecision	*Not allowed*	*It allows degree of imprecision.*
Classification of data	*Based on discrete values such as 2-value system, 0 and 1.*	*Fuzzy values are mapped to appropriate linguistic statement.*