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Hierarchical Fuzzy Logic System for Manuscript Evaluation

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Abstract: The purpose of the project paper is to develop a hierarchical fuzzy logic system that can evaluate a potential manuscript for publication. The model was designed and developed based on the manuscript evaluation processes and procedures of different journal publishing companies. It also considered the duties and responsibilities of editors and reviewers during the development of linguistic variables and values. The model was tested using primary data collected from editor-in-chiefs' and reviewers' of various journal publishing companies. The findings show that there is possibility to substitute, at least partly, a human editors and reviewers in the process of manuscript evaluation during article publishing.

Key words: Fuzzy · Hierarchical fuzzy · Manuscript · Editor · Reviewers · Fuzzification · Diffuzzification

INTRODUCTION

The selection of the most novel and scientific manuscript in the journal publication process has a markedly premeditated aspect for a journal publishing company. In this regard, the authors guide and manuscript submission processes show some uniformity in the requirements used to evaluate and qualify a manuscript. Moreover, the steps and the review processes used to select manuscript evaluation that best suit the requirements of a particular journal is somehow similar among publishing companies and scholars.

The journal publication process can be improved in time and quality through the use of intelligent agents that can evaluate and select a manuscript on behalf of editors and reviewers. However, literatures show that there is no attempt, so far, in the development of an intelligent system that can evaluate a manuscript.

The use of soft computing in many real world intelligent decision support systems becomes very important as the decision making environment and grows more complex than ever before. Assessment of scientific articles is made based on the different scientific research standards and requirements of the publishing company. Such process is also a very complex in the decision making environment. So far, the scientific world of a journal publication is mostly operating with volunteer practitioners and academicians in the field to review potential manuscripts. Though there are barely very few journal publishing companies who provide remuneration for reviewers most of them use volunteer reviewers and editors. The exogenous reason for using volunteer practitioners and academicians in the field is for the ethical consideration and contribution of producing quality scientific research work to the world. This objective is totally in line with the objective of most of journal publishing companies.

However, the number of volunteer reviewers or the time reviewers have sometimes may be limited in some field of study. Moreover, paying remuneration for review is also, from the outset, setbacks its objective. In addition to this, in some cases a manuscript that would have been rejected may be accepted or vice versa due to inconsistent decision making of editors and/or reviewers. Therefore developing an intelligent system that can evaluate manuscripts and make decision on behalf of editor (s) and reviewers is one approach to overcome these problems.

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Among the many others, a useful approach to examine such decision environments is characterized by linguistic relationship which is fuzzy approximate reasoning or fuzzy logic system. Fuzzy rules and fuzzy reasoning are the backbone of fuzzy inference systems, which are the most important modeling tool based on fuzzy se theory. They have been successfully applied to a wide range of areas such as automatic controls, expert systems, pattern recognition, time series prediction and data classification [1].

The fuzzy logic system has been used in various multi-criteria decision making environment that have qualitative as well as quantitative in nature. The use of fuzzy intelligent system has shown significant improvement in the decision making environments such as suppliers' selection in the procurement process [2] to evaluate automated manufacturing and agricultural production system [3-4] for commercial loan analysis [5-8] evaluation of software product families and many others. Furthermore, literature shows a wide variety of individual and integrated methodologies that have been developed, so far in an attempt, to optimize different selection in various multi-criteria decision making environment. The concept and approach of evaluation such systems have similarity to the evaluation processes of a manuscript in the journal publication processes.

The motive that initiated this research is to develop a hierarchal fuzzy intelligent system that can evaluate manuscripts during the process of journal publication. This paper therefore, tries to introduce an application of a computer based hierarchal fuzzy logic system for manuscript evaluation and analysis. It will describe the fuzzy sets and linguistic variables that contribute to the article evaluation. It will also present a computer based Fuzzy Logic manuscript Evaluation System consisting of different components that Specify Fuzzy Sets, Edit Rules and Evaluator. The paper will be the first of its kind in the field of soft computing to introduce a hierarchal fuzzy logic for manuscript evaluation and at large contributes to the scientific world in support the very complex process of manuscript evaluation and selection. This research therefore, tries to attempt to develop a hierarchal fuzzy logic intelligent system that can evaluate manuscript in the journal publication processes.

Literature Review: Since the introduction of fuzzy set theory and its application in the decision making process by Bellman and Zadeh [9], the application of fuzzy set theory to decision making in a fuzzy environment has been the issue of much research. It has been used in many real world applications to support the multi-criteria decision making processes [10]. Among the many others, fuzzy system is used in the manufacturing environment such as evaluation of automated manufacturing systems to select the best automated manufacturing system [4], to evaluate agricultural production systems [3-11]. It is also used to assess the enterprise systems in business intelligence aspects. It evaluates the business intelligence systems of an enterprise before buying and deploying of vital importance to create decision support environment for mangers in the organizations [12]. Nero fuzzy system is also applicable in the marketing areas of organizations. Like E-commerce markets which is the usage of intelligent agents which negotiate and execute contracts on behalf of their owners [13]. In their research they used fuzzy-based system logic that provides a customizable trust evaluation model based on fuzzy logic that can also demonstrates the integration of post-interaction processes. Fuzzy decision support system for suppliers' evaluation and selection model also developed to select the most suitable supplier for a procurement process [2].

Yaolin *et.al*., [11], used an integrates a genetic algorithm with a multi-criteria evaluation based fuzzy inference system (FIS) to construct a self-adapting system that calibrates its evaluation criteria by self-learning from land samples. The model estimates agricultural land suitability. With regards to the financial sectors, like bank loan approval or denial, are also attempted in the fuzzy logic system. In this area, Developed a fuzzy rule based expert system to construct appropriate portfolios by taking investor's preferences and risk profile into account in a realistic, flexible and practical manner [14]. Fuzzy logic is also used in commercial loan analysis as well as to identify bad and good creditors [5-15-16].

The application of fuzzy concept on health evaluation system for fault detection and health evaluation of ground-testing bed, risk identification and assessment in network based enterprise collaborations using fuzzy logic based system is also more comment in the soft computing world [17-18].

Moreover, fuzzy systems are used in many other multi-criteria decision making environment such as performance evaluation of enterprise resource planning (ERP) systems [19], in the academic world to evaluate student learning systems [20-24]. It also used for the purpose of performance evaluation. Even it is used to evaluate the performance of fuzzy-based decision system itself [6], the performance of a production system

or an even for a single machine or components such as evaluating the performance of grinding fluids [25], evaluating the performance of weapon system using fuzzy arithmetic operations [26]. Very recently a fuzzy weighted SERVQUAL model was used to evaluate airline service quality [27].

Fuzzy Sets: Fuzzy logic is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth- truth values between "completely true" and "completely false". As its name suggests, it is the logic underlying modes of reasoning which are approximate rather than exact. The importance of fuzzy logic derives from the fact that most modes of human reasoning and especially common sense reasoning are approximate in nature [28-1].

Although classical sets are suitable for various applications and have proven to be an important tool for mathematics and computer science, they do not reflect the nature of human concepts and thoughts, which tend to be abstract and imprecise or inexact. In contrast to a classical set, a fuzzy set, as the name implies, is a set without a crisp boundary [1].

Fuzzy logic is a logic based on fuzzy sets, i.e. sets of elements or objects characterized by truth values in the (0, 1) interval rather than crisp 0 and 1, as in the conventional set theory. The function that assigns a number in (0, 1) to each element of the universe of discourse of a fuzzy set is called the Membership Function (MSF). A fuzzy set is a collection of elements having varying degree of membership, from non-membership grade of zero to a full membership grade of one [15. The principal idea introduced by fuzzy logic sets are the involvement of MSF and membership values (MSV).

According to Costas and Constantinos [28], the membership function is defined as, let X denote the universe of discourse of a fuzzy set A. A is completely characterized by its membership function $\mu_{A:}\mu_{A:}X \_ [0, 1]$ and is defined as a set of pairs: $A = \{(x, \mu_A(x))\}$.

Fuzzification and Defuzzification: Fuzzification is the process of making a crisp quantity fuzzy. This can be simply done by recognizing that many of the quantities considered to be crisp and deterministic are actually not deterministic at all. They carry considerable uncertainty. If the form of uncertainty happens to arise because of imprecision, ambiguity, or vagueness, then the variable is probably fuzzy and can be represented by a MSF.

The fuzzy inference system is a popular computing framework based on the concept of fuzzy set theory, fuzzy if-then rules and fuzzy reasoning. Its basic structure is consists of three conceptual components: a rule base, which contains a selection of fuzzy rules; database or dictionary, which defines the MSF used in the fuzzy rules; and a reasoning mechanisms, which performs the inference procedure [1].

Fuzzification is to transform crisp inputs into fuzzy subsets. Given crisp inputs x_i, i= 1,…,n, fuzzification is to construct the same number of fuzzy sets A_i, A_i = fuzz (x_i), where fuzz (.) is a fuzzification operator. Fuzzification is determined according to the defined MSFs.

Defuzzification is to map fuzzy subsets of real numbers into real numbers. In fuzzy inference system (FIS), defuzzification is applied after aggregation. Popular defuzzification methods include the centroid defuzzified and the mean-of-maxima defuzzifier [29]. The centroid defuzzifier is the best known method, which is to find the centroid of the area of surrounding by the MF and the horizontal axis or the universal discourse [30]. Aggregation and defuzzification can be combined into a single phase, such as the weighted-mean methods [9] or using Center of Gravit method [29].

MATERIALS AND METHOD

The research methodologies used in this research are including literature review, questionnaire, web portal browsing and organizing the evaluation processes. For the primary data collection, more than five editor-in-chief and six reviewers from various scientific journals publishing companies were contacted and completed the questionnaire.

Browsing Authors Guidelines: For the development of the language variables and values, a thorough investigation was conducted on the authors' guideline and review process of a manuscript. This includes various journal publication companies namely: Elsiver, Emrald, science direct, spring, Jstor and others.

Developing Linguistic Variables and Values: In its broad sense, evaluating a manuscript for journal publication is a very complex process. However, in order to map these processes into intelligent system, it requires modification without losing the essence of reality. In this paper, the evaluation process is hierarchically grouped in to two major phases namely the editorial and review processes.

Table 1: Fuzzy linguistic Variables, linguistic Values and the range value assumed

Rule Base	Linguistic Variables	Ranges	Linguistic Value
Inputs	Manuscript Relevance (MR)	[0, 10]	•Not Related (NR)
			•Somehow Related (SR)
			•Related (R)
			•Highly Related (HR)
	Manuscript Formats (FM)	[0, 10]	•Poor Formatting (PF)
			•Good Formatting (GF)
			•Excellent Formatting (EF)
Output	Editor Decisions (ED)	[0, 1]	•Reject Manuscript (RM)
			•Return to authors (ReA)
			•Accept as it is (AA)
Inputs	Recommendations Reviewer1(RR1)	[0, 10]	•Reject automatically (RA1)
			•Accept with Major Comment (AM1)
			•Accept with Minor Comment (Am1)
			•Accept (A1)
	Recommendations Reviewer2 (RR2)	[0, 10]	•Reject automatically (RA2)
			•Accept with Major Comment (AM2)
			•Accept with Minor Comment (Am2)
			•Accept (A2)
Output	Publication Decisions (PD)	[0, 10]	•Reject Publication (RP)
			•Reassessed following Major revision (RM)
			•Published following Minor alteration (PM)
			•Publication Unchanged (PU)

In the editorial processes, the editor (s) may evaluate the manuscript based on its relevancy and format required by the journal publishing company. If the manuscript passes this step, it will be forwarded to at least two reviewers depending on the policy of the journal publishing company. In the manuscript evaluation processes, the following linguistic variables and their corresponding values are identified and presented in Table1.

Model Development for Manuscript Evaluation: In the journal publication processes, potential manuscripts submitted from the author (s) are evaluated in an iterative way between the author (s), editor (s) and the reviewer (s). In any case the final decision will be passed to the author (s) after such a long processes. The time required to make decision may take a minimum of two to three months in a standard and reputable journals. The reason is that the editorial and review work is taken care of by volunteers in the field of study. There some open access journals that can publish relatively in a very short period of time as compared to closed access journals. In both cases still, to produce an ethical and scientific article that can contribute to the scientific world, one way or another require and editorial and review processes. The overall processes are nearly similar to each other from journal to journals. After making some survey and browsing the authors' guidelines of selected publishing companies, the hierarchical fuzzy logic model is developed with modification of the real manuscript evaluation process. The common processes in every journal publishing company are first the author(s) must submitter his/their work based on the pre-specified format, standard and procedures such as via e-mail, or online. These days, submitting a hard copy manuscript is becoming outdated and from the survey none of them requires this. For the purpose if the fuzzy evaluation system, the author may be required to submit every section and sub-section separately. The overall process may take 3 to 6 months in some journals such as Emerald, Science Direct, IEEE and even more in some cases. After submission by the authors the next processes are the works of the editorial and the reviewer. These processes are summarized in form that it will somehow fit to the fuzzy reasoning systems by excluding the submission process.

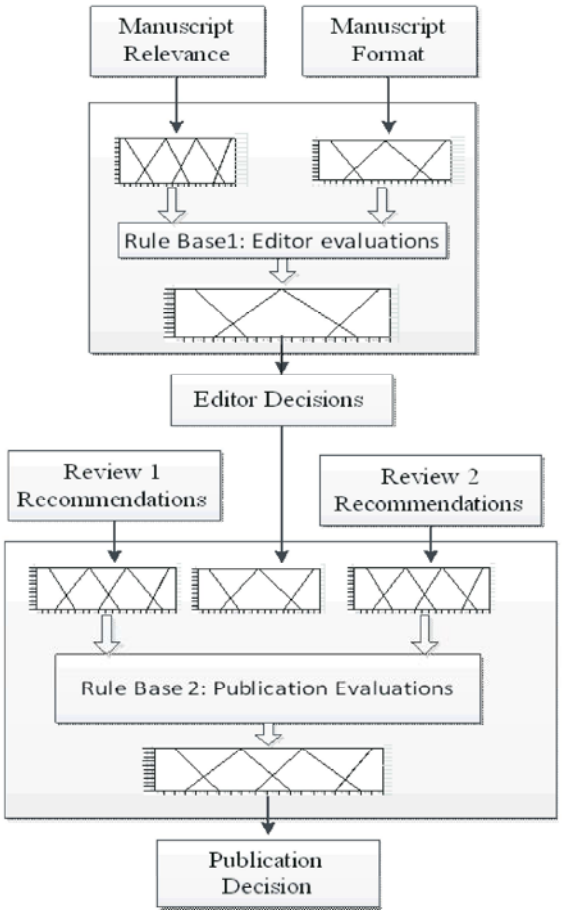


Fig. 1: Hierarchical Fuzzy Model for manuscript evaluation

The entire editorial process or workflow is handled either via Online Management System (OMS) or through softcopy submission to the editor. Depending on the submission process, the subject matter and availability the manuscript is forwarded to the most suitable editor. The editor will follow the procedures and make the following decisions:

The Editor Rejects the Manuscript If:

- S/He finds the manuscript is of unsatisfactory quality or format
- Subject matter does not suit the journal's content.

If the editor does not reject the manuscript, s/he forwards it to at least two peer reviewers for assessment.

In order to forward the manuscript to the reviewer, the editor should invite potential reviewers. Based on their response and interest, the editor will assign reviewers. In some journals there are cases where author (s) can refer reviews during manuscript submission. Whatever the process it follows, at least two reviewers will be assigned by the editor. The review process has to be a blind peer review and expected to pass the following decisions.

After assessing the manuscript the peer reviewers send their reports to the editor. The peer reviewers give a recommendation as to the further course of action. The editor decides on the further course of action. The decisions for the manuscript may be:

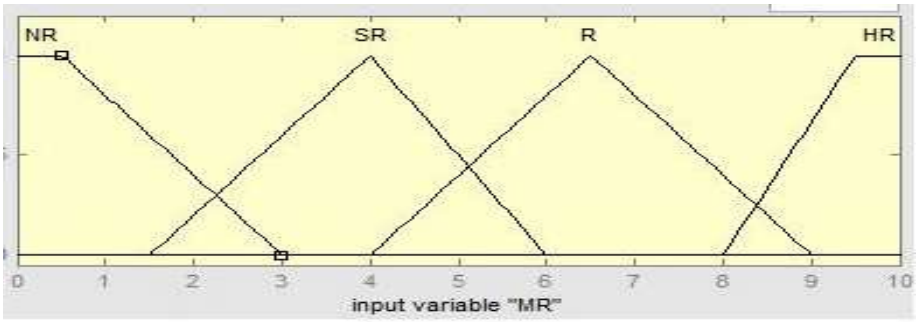
Published following minor alterations or minor revision. The authors are requested to produce and submit a final version of the manuscript with the required amendments.

Reassessed following major alterations or major revision. The authors are requested to produce and submit a version of the manuscript with the required amendments. The manuscript is sent to the peer reviewers for reassessment. The peer review process begins again in a new way.

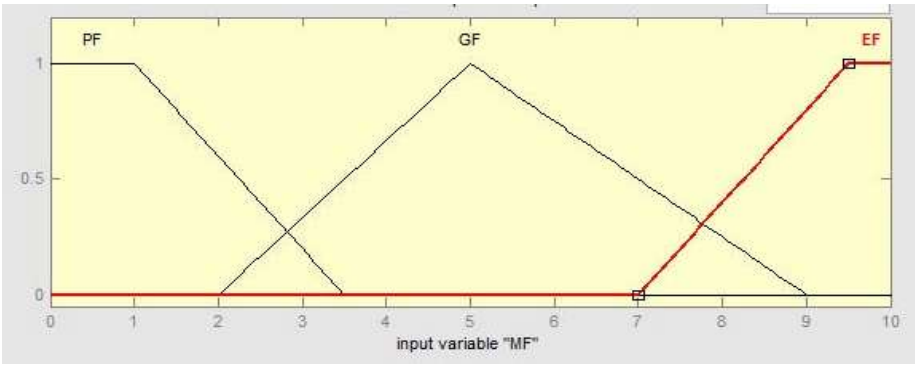
Once the editor initiates no further changes, the manuscript is approved for publication. The final decision generally lies with the editor. The hierarchical fuzzy logic for the manuscript evaluation is modeled and shown in figure1.

Fuzzy Linguistic Variables: The paper considered the following fuzzy linguistic variables. The associated value assumed by the researcher and their respective fuzzy sets are also reported in Table 2 and illustrated in Figure 2. The major linguistic variables are the editorial decision (ED), the reviewers' recommendation (RR) and the publication decision (PD). Since it is a hierarchical system the input output of the system are explained here. From the table 1, the fuzzy set editorial decision (ED) has two sub sets namely manuscript formatting (MF) and Manuscript relevance (MR). In the first phase, the inputs are MR and MF and the output is EE. For the output of PD, the two major inputs are the recommendations of the first and the second reviewer and labeled as RR1 and RR2.

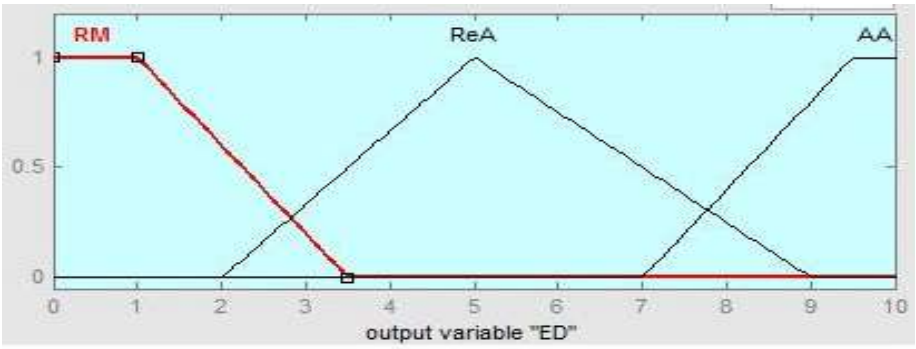
For example a fuzzy set PF in the universal set editorial evaluation (MF) is a set of order pairs, $\{(mf, \mu PF (MF))|mf \in MF\}$ where $\mu PF: MF \rightarrow [0,1]$, is the MSF of PF. An element mf may have partial MSF in MF that is $0= \mu PF (MF) = 1$. It may also exhibit a non-MSF ($\mu PF (ED) =0$) or full MSF ($\mu PF(ED) = 1$).



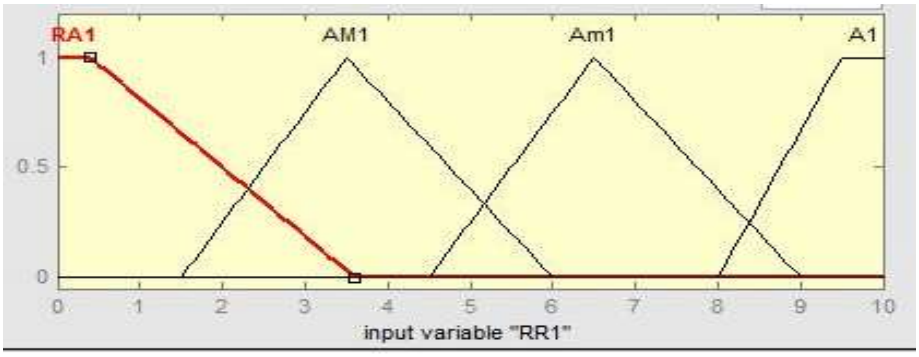
a)Manuscript Relevance(MR)



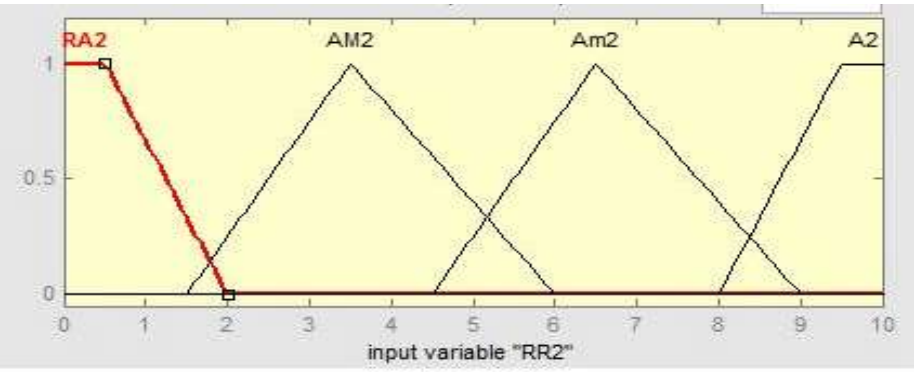
b) Manuscript Format (MF)



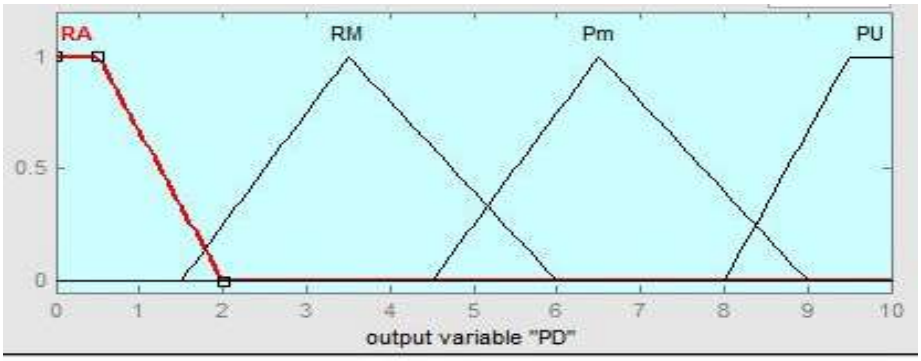
c)Editor Decision (ED)



d)Reviewers Recommendations (RR1)



e)Reviewers Recommendations (RR2)



f)Publication Decisions (PD)

Fig. 2: MSF for the input and output Linguistic variables.

As shown in Table 1 and Figure 2a, the sub sets of MR are: NR = {manuscript that is not related to the interests of the publishing journal} are μNR (MR) = LL (x, 0.5, 3) (MR), which a monotonous linear MSF to the left; SR = {manuscript that have some relevance to the interests of the publishing journal} are μSR (MR) = Tri (1.5, 4, 6) (MR) with triangular MF; R = {manuscript that have relevance to the interests of the publishing journal} are μR (MR) = Tri (4, 6.5, 9) (MR) with triangular MSF and HR = { manuscript that have high relevance to the interests of the publishing journal} are μHR (MR) = LR (8, 9.5, 10) (MR) with monotonous linear MF to the right. Therefore, the complete sets of MR in EE are: μNR, μSR, μR and μHR. Similarly the MSFs of other linguistic variables are also given in similar fashions and reported in Table 2.

Fuzzy Logic for Manuscript Evaluation: The researchers believe that the use of fuzzy logic is well suited to manuscript evaluation in the journal publication processes. The manuscript evaluation process relies on the concepts of evaluating and weighting the contents of the manuscript in related to the mental concepts of the editor and reviewer. The decision making environment in such a situation becomes very unclear to categorize a manuscript below or above a certain criterion. For instance, consider a journal evaluation criterion that deserves a rank of above average value, let, be 8 out of 10points. A manuscript that scores 7.5 out 10 points may indistinctly consider as above average. But it would be very difficult for the editor or the reviewer to produce a sound decision in such a scenario. But using fuzzy logic system, a manuscript that scores 7.5 out 10points may also possible be above average or would be otherwise.

In the fuzzy logic system, the decisions epochs are categorized into different linguistic states and are evaluated by production rules as the same time to produce multiple outcomes. In the manuscript evaluation processes for example, after a serious of evaluation the outcome may be automatic rejection, rejection with comment, accept with major review, accept with minor review or automatically accepted. The reason is that the fuzzy logic inherently avoids the rigidity of standard mathematical reasoning because of its capacity to handle ambiguous and inexact knowledge [5].

Table 2: Linguistic variables and their range

Linguistic Variable Manuscript Relevance, MR		
Linguistic Values	Notation	Numerical Range
Not Related	NR	[0, 3]
Somehow Related	SR	[1.5, 6]
Related	R	[4, 9]
Highly Related	HR	[8, 10]
Linguistic Variable Manuscript Format, MF		
Linguistic Values	Notation	Numerical Range
Poor Format	PF	[0, 3.5]
Good Format	GF	[2, 9]
Well format	WF	[7, 10]
Linguistic Variable Editor Decision, ED		
Linguistic Values	Notation	Numerical Range
Reject Manuscript	RM	[0, 3.5]
Return to authors	ReA	[2, 9]
Accept as it is	AA	[7, 10]
Linguistic Variable Review1 Recommendations, RR1		
Linguistic Values	Notation	Numerical Range
Reject automatically	RA1	[0, 2]
Accept with Major Comments	AM1	[1.5, 6]
Accept with Minor Comments	Am1	[4.5, 9]
Accept	A1	[8, 10]
Linguistic Variable Review1 Recommendations, RR2		
Linguistic Values	Notation	Numerical Range
Reject automatically	RA2	[0, 2]
Accept with Major Comments	AM2	[1.5, 6]
Accept with Minor Comments	Am2	[4.5, 9]
Accept	A2	[8, 10]
Linguistic Variable Publication Decision, PD		
Linguistic Values	Notation	Numerical Range
Reject Automatically	RA	[0, 3]
Reassessed following major Revisions	RM	[1.5, 6]
Published following Minor alterations	Pm	[4.5, 9]
Published Unchanged	PU	[8, 10]

After a thorough revision of the authors' guidelines of various journal publishing companies or organizations, the hierarchal manuscript evaluation process is mapped in the following diagram. The categories are formed by merging different criteria from different publishing companies but without losing its generality. It is classified into the following three major categories. Namely: Editorial process,

Review process and decision process. Though it is not possible to assess the entire processes and requirements of all the publishing companies, the activities under each category was also further elicited to make the hierarchal manuscript evaluation process more closer to the decision of human intelligent. As it shown in Figure 1, the majority of the task lies in the review process. In this project, under this category, two major sub-categories and eleven activities are considered.

However, in the evaluation criteria, identifying the linguistic variables and values was so challenging. The researchers believe that this research paper would be a spring board to develop an intelligent system for manuscript evaluation.

Fuzzy Sets for Manuscript Evaluation: Once the ranges of possible values (crisp inputs) for the input and output linguistic variables are determined, the next step is determining the degree to which these inputs belong to each of the appropriate fuzzy sets. These (in language of Fuzzy Set theory) are the membership functions (Input variable vs. the degree ofmembership function) used to map the real world measurement values to the fuzzy values, so that the operations can be applied on them. Fig. 2 shows the labels ofinput and output variables and their associated membership functions. Values of the input variables are considered in terms of numbers ranging from 0 to 10. From Figure2, trapezoidal and triangular MSF are selected.

A linguistic variables that have a triangular MSF, let MF in figure 2b, has trapezoidal, triangular and trapezoidal shape for the linguistic variable poor format, good format and excellent format respectively. Each input variables are fuzzified over all the MSF using the formula given below.

$$Y(\text{trap})(x; x0, x1, x2, x3) = \max\left\{\min\left(\frac{x-x_0}{x_1-x_0}, 1, \frac{x_3-x}{x_3-x_z}\right), 0\right\}; \text{ and}$$

$$Y(\text{tri})\ (x; x0, x1, x2) = \max\left\{\min\left(\frac{x-x_0}{x_1-x_0}, 1, \frac{x_z-x}{x_z-x_1}\right), 0\right\} \text{ for}$$

trapezoidal and triangular shape respectively. For instance, a manuscript that have a relevance value of 2.5 in the x-axis of the figur1a will have a probability of max {min (5, 1, 0.20), 0} which is 0.20 not related to the journal, but will have max {min (0.40, 1, 0.75), 0}, which is 0.40 probability to be somehow related to the journal.

Fuzzy Based Decision Rules: The decision which the fuzzy inference system makes is derived from the rules which are stored in the database. These are stored as a set of rules. Basically the rules are 'If-Then' statements that are intuitive and easy to understand, since they are nothing but common English statements. 'If" refers to an antecedent that is compared to the inputs and "Then" refers to a consequent, which is the result or output [31]. It can be simply represented as IF-<antecedent> Then <consequent> rules.

All the rules that have any truth in their antecedent will fire and contributes towards the fuzzy conclusion set. Rules used in this paper are derived from experience of the author and discussion with colleagues. These rules transform the input variables to an output that will tell the degree of PD in the output variables. Based on the manuscript publication processes and MSF for the input and output variables potential rules are defined in this paper. Since some rules are redundant, they are excluded in the report. The rules developed in this paper are given below:

Rule Base1:

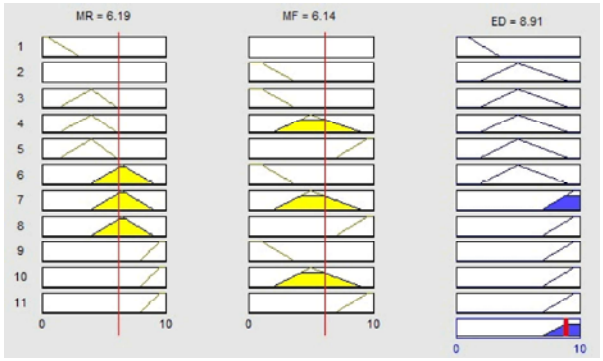
1. If (MR is NR) then (ED is RM) (1)
2. If (MF is PF) then (ED is ReA) (1)
3. If (MR is SR) and (MF is PF) then (ED is ReA) (1)
4. If (MR is SR) and (MF is GF) then (ED is ReA) (1)
5. If (MR is SR) and (MF is EF) then (ED is ReA) (1)
6. If (MR is R) and (MF is PF) then (ED is ReA) (1)
7. If (MR is R) and (MF is GF) then (ED is AA) (1)
8. If (MR is R) and (MF is EF) then (ED is AA) (1)
9. If (MR is HR) and (MF is PF) then (ED is AA) (1)
10. If (MR is HR) and (MF is GF) then (ED is AA) (1)
11. If (MR is HR) and (MF is EF) then (ED is AA) (1)

In the case the decision rule2, most of the fuzzy rules are not executed due to the fact that if the two reviewers can provide recommendations when the manuscript is accepted by the editors. Rule base2 shows that out of 48 possible rules, only 16 are executed.

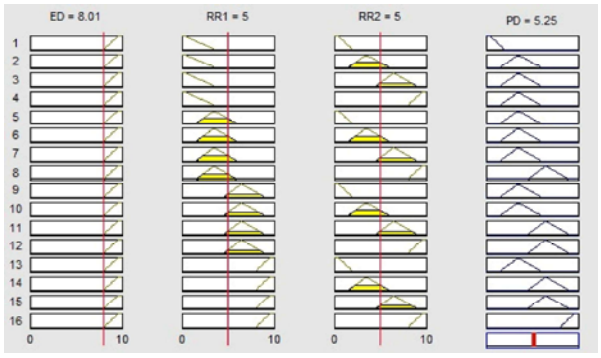
Rule Base2:

1. If (ED is AA) and (RR1 is RA1) and (RR2 is RA2) then (PD is RA) (1)
2. If (ED is AA) and (RR1 is RA1) and (RR2 is AM2) then (PD is RM) (1)
3. If (ED is AA) and (RR1 is RA1) and (RR2 is Am2) then (PD is RM) (1)
4. If (ED is AA) and (RR1 is RA1) and (RR2 is A2) then (PD is RM) (1)
5. If (ED is AA) and (RR1 is AM1) and (RR2 is RA2) then (PD is RM) (1)
6. If (ED is AA) and (RR1 is AM1) and (RR2 is AM2) then (PD is RM) (1)
7. If (ED is AA) and (RR1 is AM1) and (RR2 is Am2) then (PD is RM) (1)
8. If (ED is AA) and (RR1 is AM1) and (RR2 is A2) then (PD is Pm) (1)
9. If (ED is AA) and (RR1 is Am1) and (RR2 is RA2) then (PD is RM) (1)
10. If (ED is AA) and (RR1 is Am1) and (RR2 is AM2) then (PD is RM) (1)
11. If (ED is AA) and (RR1 is Am1) and (RR2 is Am2) then (PD is Pm) (1)
12. If (ED is AA) and (RR1 is Am1) and (RR2 is A2) then (PD is Pm) (1)
13. If (ED is AA) and (RR1 is A1) and (RR2 is RA2) then (PD is RM) (1)
14. If (ED is AA) and (RR1 is A1) and (RR2 is AM2) then (PD is Pm) (1)
15. If (ED is AA) and (RR1 is A1) and (RR2 is Am2) then (PD is Pm) (1)
16. If (ED is AA) and (RR1 is A1) and (RR2 is A2) then (PD is PU) (1)

Defuzzification of the Manuscript Evaluation Processes: Defuzzification refers to the way a crisp value is extracted from a fuzzy set as a representative value [1]. The Defuzzification typically involves weighting and combining a number of fuzzy sets resulting from the fuzzy inference process in a calculation, which gives a single crisp value for each output. Defuzzification is an important



a.MSF for Phase one



b.MSF for phase two

Fig. 3: Rule view of the two phase's separately

operation in the theory of fuzzy sets. It transforms fuzzy sets information into numeric data information. This operation along with the operation of fuzzification is critical to the design of fuzzy systems as both of these operations provide nexus between the fuzzy set domain and the real-valued scalar domain [31]. In this paper the defuzzification method considered is the center of gravity or area method in order to produce a result. It is the most commonly used and popular method though has drawbacks. According to Jyh-shing *et.al*, [1] and Negnevitsky [32-35], for a fuzzy set A of a universe of discourse Z, the center of area COG is given by: $COG = \frac{\int_a^b \mu A(z) z\, dz}{\int_a^b \mu A(z)\, dz}$ where μA(Z) is the aggregated output MSF. Based on this approach, the defuzzification process is illustrated using Mamdani-style fuzzy inference approach to aggregate rule consequents and is shown in Figure 3.

RESULT AND DISCUSSION

In order to test the model, a phase by phase approach was used. Each phase was tested separately. Each of the phases was tested and run using Mamdani Fuzzy inference Systems and min, or max methods and centroid

defuzzification methods. The implication method used the minimum value but the aggregation was made using max. The rule view of the two phases are shown in Figure3 a and b.

As shown in figure3a, when the value of μR(MR) = 6.19 and the value of μGF(MF) = 6.14, the editorial decision ED will be 8.91. This show that a manuscript with μR (MR) value of 6.19 is related to the interest of the publisher and μGF(MF) value 6.14 is good formatting. In such decision environment the manuscript will has very less probability (0.023) to be returned to the author, but has higher probability (0.61) to be accepted as it is.

Similarly, if a manuscript has higher probability to be accepted by the editor and send to the reviewers, the final publication decision is mostly lies on the decisions of the reviewers. As illustrated in Figure3b, a manuscript with higher probability to be accepted such as μAA(ED) greater than 8 will have a probability to be sent to reviewers. Since μAA(ED) is a condition to send the manuscript to reviewers, any larger value of μAA(ED) does not affect the publication decision. The publication decision is rather extremely affected by the recommendations of the two reviewers. For example μAA(ED) = 8.01 and μAA(ED) = 9.46 will result in a μPm(PD) = 6.69 when the μAm1(RR1) and μAm2(RR2) values kept constant at 7.65 and 6.57 respectively.

The μPm(PD) value at μAA(ED) = 9.46, μAm1(RR1) = 7.65 and μAm2(RR2) = 6.57 is 6.69. This indicates the manuscript will have a probability of 0.92 to be published following Minor alterations.

CONCLUSION

This paper is the first of its kind to attempt to model the processes of manuscript evaluation as an intelligent system in the field of computing science. The model is developed with assumptions drawn by the authors. It was also evaluated based on input data collected suing questionnaire from editor-in-chief and reviewers of various journals. From the findings of the research it can be conclude that there is a possibility to replace a human editor and reviewers with an intelligent system at least partly to facilitate the works of editor-in-chiefs' and reviewers' work. Nevertheless, the linguistic value, MSF and its range also require further in-depth discussion with editors and reviewers to fully model the publication processes. Moreover, when a human reviewer and/or editors are replaced by an intelligent system, knowledge transfer may be hindered in the academic world.

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