Implementation of fuzzy tsukamoto method in decision support system of journal acceptance

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Abstract. Journal acceptance is a difficult problem to solve since in the practice it involves some reviewers who can produce different decisions from various perspectives. Therefore, a decision support system is needed to assist the reviewers to decide the acceptance of the paper. This study was purposed to develop the decision support system using the Fuzzy Tsukamoto method for journal acceptance. The Fuzzy Tsukamoto method described the relationship between input and output of the system by using a set of fuzzy if-then rules. From the comparison results, it is obtained that the accuracy from the result of comparison of the manual method, expert decision, and DSS of journal acceptance using Fuzzy Tsukamoto Method is 95% with 5% errors. Based on the results of the accuracy and error, it shows that the DSS of journal acceptance using the Fuzzy Tsukamoto Method is accurate and has high precision.

1. Introduction
A scientific journal is one type of scientific works in which the authors publish scientific articles which effectively give contribution to the theory or application of science. To ensure the scientific quality of the published article, the article initially should be reviewed by colleagues which then can be revised by the author of the article. The reviewer read the submitted article, then judged them on every aspect provided in the form and then collected into one in the article manager. Thus, it took longer time.

Therefore, a web-based decision support system that can speed up the review process is necessary. This specific information system intended to help management in making a decision related to semi-structured issues, and does not replace decision-making functions to make decisions [1].

To solve the problems in multi-criteria evaluation, one of Multi-Criteria Decision Making (MCDM) methods was very needed; MCDM consists of : (1) Multi-Attribute Utility Theory (MAUT); (2) Analytic Hierarchy Process (AHP); (3) Fuzzy logic; (4) Case-Based Reasoning (CBR); (5) Data Envelopment Analysis (DEA); (6) Simple Multi-Attribute Rating Technique; (7) Goal Programming; (8) ELECTRE; (9) PROMETHEE; (10) Simple Additive Weighting (SAW), and (11) Technique for Order of Preference by Similarity to Ideal Solution [1, 2].

In this research, the Fuzzy Logic method would be applied. In fuzzy logic, several methods were used to present the results of fuzzy logic namely Tsukamoto, Sugeno and Mamdani ones [3]. Those three methods were used on different issues. Therefore, on the issue of journal acceptance, Fuzzy
Tsukamoto Method was suitable to apply. Fuzzy method has several advantages such as (1) having the ability to solve complex problems; (2) representing knowledge that was easily interpreted by humans; (3) Being flexible for modelling architecture and inference mechanism which can be adapted to the given problem [4]. Another reason is related to the method’s excellent accuracy [5-8].

Several studies mentioned above had proved the accuracy of Fuzzy. Thus, those results led the researchers in this study to prove the accuracy of Fuzzy Tsukamoto Method, particularly in providing recommendations related to journal acceptance.

2. Methods
This research was used to know the accuracy of the implementation of Fuzzy Model Tsukamoto Method on decision support system. The Fuzzy Tsukamoto method consisted of three stages of count: fuzzification, inference engine, and defuzzification [9].

2.1. Fuzzification
Fuzzification defines as inputs, whose true value of truth (Crips input) is converted to fuzzy input, in the form of linguistic values based on membership function [9]. At this stage, the Crips input was the values of each input variable consisting of significance, originality, quality, clarity, and relevance.

### Table 1. Linguistics Variables

| Input    | Significance | Poor       | Value <= 40  |
|----------|--------------|------------|--------------|
|          |              | Fair       | 41 >= Value <=70 |
|          |              | Good       | Value >= 71  |
| Originality | Poor       | Value >= 40 |
|          |              | Good       | 50 >= Value <=70 |
| Quality  | Poor         | Value <= 40 |
|          |              | Fair       | 41 >= Value <=70 |
|          |              | Good       | Value >= 71  |
| Clarity  | Poor         | Value <= 40 |
|          |              | Fair       | 41 >= Value <=70 |
|          |              | Good       | Value >= 71  |
| Relevance| Poor         | Value <= 40 |
|          |              | Good       | 50 >= Value <=70 |

| Output   | Decision     | Rejected   | ∑ Value <= 205 |
|----------|--------------|------------|----------------|
|          | Accepted with major revision | 205 >= Value <=350 |
|          | Accepted with minor revision  | 351 >= Value <=499 |
|          | Accepted without revision  | Value = 500 |

The significance variables were categorized in the fuzzy set of poor, fair, and good by using the membership function of the trapezoidal function as seen in Figure 1.

![Figure 1. Membership Function Significance](image-url)
Originality variables categorized in fuzzy poor and good set course because the journal requirement can be said original if it does not contain plagiarism element more than 20%. This means that there are only two possibilities, when plagiarism is less than 20%, the originality is good, whereas if plagiarism is more than 20% is ensured the originality is low (poor). The accepted journals are only high-quality credible journals evidenced by low plagiarism levels [10]. The set of fuzzy poor and good by using the membership function of the trapezoidal function as seen in Figure 2.

![Figure 2. Membership Function Originality](image)

The quality variables were categorized in fuzzy set of poor, fair, and good by using membership function of the trapezoidal function as seen in Figure 3. On the other hands, the clarity variables were categorized in fuzzy set of poor, fair, and good by using membership function of the trapezoidal function as seen in Figure 4.

![Figure 3. Membership Function Quality](image)

![Figure 4. Membership Function Clarity](image)
Relevance variables categorized in the fuzzy poor and good set because in the relevance assessment only see the suitability of the theme and scope of the journal. The set of fuzzy poor and good by using the membership function trapezoidal function as seen in Figure 5.

![Figure 5. Membership Function Relevance](image)

The decision variables were categorized in fuzzy set of rejected, accepted with major revision, accepted with minor revision, and accepted without revision by using membership function of trapezoidal function as seen in Figure 6.

![Figure 6. Membership Function Decision](image)

2.2. Inference Engine
Inference engine in determining the decision of journal acceptance using input variable of significance, originality, quality, clarity, and relevance. Inference engine in this system consisted of 108 rules. Then, the rule formation based on this rule: IF antecedent THEN consequent [11].

2.3. Defuzzification
The defuzzification process of a fuzzy set was derived from the composition of fuzzy rules, while the resulting output was a number in the fuzzy set domain in the form of a decision of journal acceptance. In fuzzy, there are 5 methods of defuzzification: centroid method, height method, first (or last) of Maxima, Mean-Max Method, Weighted Average [12]. This system used a centre average defuzzied.

Equation formula for centre average defuzzied method is as follows:

\[ z = \frac{a_1 z_1 + a_2 z_2 + a_3 z_3 + a_4 z_4 + a_5 z_5}{a_1 + a_2 + a_3 + a_4 + a_5} \] (1)
3. Result and Discussions

This study was purposed to determine the accuracy of the Fuzzy Tsukamoto Method in providing recommendations related to the journal acceptance. This method was applied to a web-based decision support system.

Moreover, the pseudocode of Fuzzy Tsukamoto method applied to DSS of the paper acceptance was shown in Figure 7.

**Table 2. Comparison of the Calculation Results**

| Article | Expert score | Expert judgment | System score | System judgment | error |
|---------|--------------|-----------------|--------------|-----------------|-------|
| 1       | 358,78       | minor           | 358,79       | minor           | 0,01  |
| 2       | 365,98       | minor           | 365,99       | minor           | 0,01  |
| 17      | 354,27       | minor           | 354,29       | minor           | 0,02  |
| 18      | 352,94       | minor           | 351,94       | minor           | 0     |
| Total   |              |                 |              |                 | 0,05  |

From the results of the comparison, it was obtained an accuracy of 95%. The accuracy of the calculation indicated that the decision support system of the journal acceptance was accurate as the result of the expert's decision was not different from the results of both manual and program calculations. The errors were 5% obtained from the results of the comparison of the system and the expert, and 0% obtained from the results of the comparison of the system and manual calculation. The errors of low calculation indicated that the DSS of journal acceptance had high precision.

Fuzzy can be said to be the most effective MCDM method and can be implemented in different cases [2-13]. The results were proven by the results obtained based on the comparison of manual calculation and DSS of journal acceptance and reviewers’ decision. Thus, the use of Fuzzy Tsukamoto Method was accurate and precise.

4. Conclusion

The use of fuzzy logic using the Fuzzy Tsukamoto Method can be implemented to the DSS of journal acceptance. In addition, there are five input variables and one output variable in which the input variables
are significance, originality, quality, clarity, and relevance, while the output variable is the decision category. It is obtained that the accuracy from the result of comparison of the manual method, expert decision, and DSS of journal acceptance using Fuzzy Tsukamoto Method is 95\% with 5\% errors. Based on the results of the accuracy and error, it shows that the DSS of journal acceptance using the Fuzzy Tsukamoto Method is accurate and has high precision.

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