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A FUZZY LOGIC BASED EVALUATION MODEL FOR THESIS TOPIC FEASIBILITY TO ENHANCE STUDENT RESEARCH RELEVANCE

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Abstract: The determination of thesis topics is a fundamental stage in academic research, yet the evaluation process remains predominantly manual and subjective. This reliance on individual lecturer perception often leads to inconsistent feasibility assessments and fails to systematically measure the topic's alignment with strategic needs. This research aims to develop a Decision Support System (DSS) model based on fuzzy logic to assess the feasibility of thesis topics objectively and systematically, focusing on enhancing the relevance of student research. The research method employed the Fuzzy Inference System (FIS) with the Sugeno method. This model was designed through literature review and FGD to establish four criteria (Topic Relevance, Difficulty Level, Idea Novelty, Reference Availability) and 81 rule bases. The model validation results against expert judgment using 15 test data showed a high accuracy rate of 91.31%, with a Mean Absolute Percentage Error (MAPE) value of 8.69%. In conclusion, this DSS model is proven to be valid and consistent, and it can be relied upon as an objective tool to improve the quality and relevance of thesis topics.

Keywords: academic evaluation; decision support system; fuzzy logic; fuzzy sugeno; thesis feasibility

Abstrak: Penentuan topik skripsi merupakan tahapan fundamental dalam penelitian akademik, namun proses evaluasinya hingga kini masih cenderung manual dan subjektif. Ketergantungan pada persepsi dosen secara individu sering kali menyebabkan penilaian kelayakan yang tidak konsisten serta kegagalan dalam mengukur keselarasan topik dengan kebutuhan strategis secara sistematis. Penelitian ini bertujuan mengembangkan model Sistem Pendukung Keputusan (SPK) berbasis logika fuzzy untuk menilai kelayakan topik skripsi secara objektif dan sistematis, dengan fokus pada peningkatan relevansi penelitian mahasiswa. Metode penelitian yang digunakan adalah Fuzzy Inference System (FIS) dengan metode Sugeno. Model ini dirancang melalui tinjauan pustaka dan Focus Group Discussion (FGD) untuk menetapkan empat kriteria (Relevansi Topik, Tingkat Kesulitan, Kebaruan Ide, Ketersediaan Referensi) serta 81 basis aturan. Hasil validasi model terhadap penilaian pakar menggunakan 15 data uji menunjukkan tingkat akurasi yang tinggi yaitu 91,31%, dengan nilai Mean Absolute Percentage Error (MAPE) sebesar 8,69%. Kesimpulannya, model SPK ini terbukti valid dan konsisten, serta dapat diandalkan sebagai alat objektif untuk meningkatkan kualitas dan relevansi topik skripsi.

Kata kunci: evaluasi akademik; sistem pendukung keputusan; logika fuzzy; fuzzy sugeno; kelayakan skripsi

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INTRODUCTION

The thesis is a scientific paper that tests a student's capacity for independent research while also serving as a benchmark for graduate quality. One of the main challenges in this process is the determination of the topic [1]. The success of the research highly depends on selecting an appropriate topic, characterized by scientific relevance, a suitable level of difficulty for the student's capabilities, and data availability. Currently, the thesis topic submission process tends to be conventional and subjective. Lecturers, with limited time, must evaluate stacks of proposals, resulting in inconsistent assessments that heavily rely on the perception of each evaluator [2]. Consequently, students often get trapped in a cycle of repeated revisions, which triggers demotivation and potentially prolongs the study period [3].

To overcome this subjectivity and inefficiency, a Decision Support System (DSS) offers a promising systematic solution. A DSS is a computer-based system designed to assist decision-makers in tackling semi-structured problems by utilizing data and models [4]. A DSS uses computational models to process various criteria consistently, thereby generating objective recommendations [5]. Specifically for handling uncertain linguistic variables, such as 'high level of difficulty' or 'sufficient relevance,' fuzzy logic becomes the ideal approach. This method is capable of quantifying ambiguous qualitative input, effectively mimicking the intuitive reasoning process of an expert (lecturer) in making decisions [6].

Analysis of the state of the art demonstrates that fuzzy logic has been extensively applied in academic decision-making. Previous studies have successfully utilized this method to assess thesis feasibility [1] and proposal viability [6], as well as for scholarship selection [7], supervisor allocation [8], and graduation prediction [3]. However, these existing models predominantly focus on operational feasibility (e.g., student capability or technical difficulty) and treat thesis topics as isolated entities.

A critical gap remains, there is currently no model that explicitly quantifies the alignment of thesis topics with external strategic needs, such as industry demands or the study program's research roadmap[9], [10]. The primary novelty of this research is the development of a Fuzzy Sugeno-based evaluation model that integrates 'Strategic Relevance' as a core decision variable. Unlike prior works that limit assessment to internal feasibility, this study advances the state of the art by proposing a model that systematically links student topics to strategic objectives, thereby ensuring the resulting research is not only feasible but also substantial and relevant.

Therefore, this research aims to develop a fuzzy logic-based thesis topic evaluation model. This model is designed as an objective tool for lecturers and study programs to recommend topics that are not only technically feasible but also relevant and substantial. This study fills the gap by making 'relevance' one of the main pillars in the developed evaluation model, aiming to enhance the overall quality of student research.

METODE

This research implements a Fuzzy Inference System (FIS) based on the Takagi-Sugeno-Kang (TSK) framework, specifically the Zero-Order Sugeno

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model, to construct a thesis topic feasibility estimator. Mathematically, the system performs a nonlinear mapping from an input vector $x = [x_1, x_2, x_3, x_4]^T$ (representing Topic Relevance, Difficulty, Novelty, and Reference Availability) to a scalar output y (Feasibility Score). The inference mechanism is governed by a set of fuzzy rules, where the i rule (R_i) is formally defined as: (R_i) : IF x_1 is A_{i1} ... AND x_4 is A_{i4} THEN $z_1 = k_1$.

Here, A_{ij} denotes the linguistic fuzzy sets associated with the antecedents, and k_1 represents the crisp consequent constant (singleton). This mathematical structure is selected for its computational efficiency and suitability for generating precise evaluation scores compared to the Mamdani model. This research was conducted through four main, continuous stages. The first stage was the preliminary study, which included an extensive literature review and a Focus Group Discussion (FGD) with senior lecturers. This stage successfully identified and validated four input criteria deemed most representative: Topic Relevance, Difficulty Level, Idea Novelty, and Reference Availability, as well as one output variable: Feasibility Score.

To illustrate the data structure, each dataset sample is quantified as a numerical vector based on expert assessment (scale 0-100). For instance, a sample data point for a specific thesis proposal is represented as x = [85, 70, 80, 90], corresponding to scores for Relevance, Difficulty, Novelty and Reference Availability, respectively. The second stage was the design of the fuzzy logic model. In this stage, the Fuzzy Sugeno method was chosen due to its superiority in computational efficiency and its ability to produce a crisp output. Membership functions were designed for each input variable (Low, Medium, High; Easy, Medium, Difficult; Few, Sufficient, Many), and 81 IF-THEN rule bases were formed based on expert discussion to cover various scenario combinations. The third stage was model implementation and testing.

RESULTS AND DISCUSSION

The implemented FIS model in a functional prototype was then tested for its validity. A total of 15 historical thesis titles that had been previously assessed were used as test data. Each title was given an input score (0-100) for the four criteria by three expert lecturers, and the average value was taken. The same scores were then inputted into the system.

Each input and output variable was broken down into several fuzzy sets (linguistic variables) with a value range (universe of discourse) from 0 to 100. The membership function used was a combination of triangular and trapezoidal shapes due to their ease of implementation.

Table 1. Design of Fuzzy Sets for Input and Output Variables

Variable	Fuzzy Set (Linguistic)	Value Range
Topic Relevance	Low, Medium, High	0-100
Difficulty Level	Easy, Medium, Difficult	0-100
Idea Novelty	Low, Medium, High	0-100
Reference Availability	Few, Sufficient, Many	0-100
Feasibility Score	Rejected, Considered, Accepted	40,70, 95

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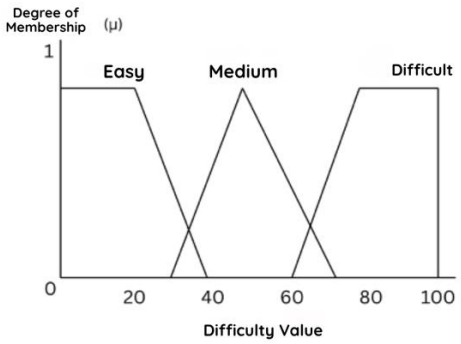

Image 1. The Membership Function for the 'Difficulty Level' Variable

Based on the four input variables, each having three fuzzy sets, the total possible combination of rules is $3^4 = 81$ rules. These rules were formulated based on in-depth discussion with experts.

The following are some representative examples of the 81 rules that were created: [R1] IF Relevance IS Low AND Difficulty IS Difficult AND Novelty IS Low AND References IS Few THEN Feasibility IS Rejected. [R25] IF Relevance IS Medium AND Difficulty IS Medium AND Novelty IS Medium AND References IS Sufficient THEN Feasibility IS Considered. [R81] IF Relevance IS High AND Difficulty IS Medium AND Novelty IS High AND References IS Many THEN Feasibility IS Accepted.

The scores obtained from the prototype were then compared with the average scores given by the three expert lecturers, as summarized in Table 2.

Table 2. Comparison of System Assessment Results vs. Expert Assessment

Title ID	Average Expert Score	System Score	Absolute Error (%)
J-01	85	88.2	3.76
J-02	55	51.5	6.36
J-03	92	94.1	2.28
J-04	78	68.9	11.67
J-05	45	42.0	6.67
...	...	...	...
J-15	88	90.5	2.84
Average	74.5	72.8	8.69

Error (MAPE) The use of multiple metrics allows for a more varied assessment of the error distribution compared to relying on a single metric.

The MAE measures the average magnitude of the errors in a set of predictions, without considering their direction, as defined in Equation (1):

$$\text{MAE}=\frac{1}{n}\sum_{i=1}^{n}\left|Y_i-\widehat{Y_i}\right| \quad (1)$$

Equation (1) is Calculates the Mean Absolute Error (MAE), representing the average absolute difference between the system's prediction and the expert's score.

Meanwhile, MSE measures the average of the squares of the errors, giving higher weight to larger discrepancies, as shown in Equation (2):

$$MSE = \frac{1}{n}\sum_{i=1}^{n}\left(Y_i - \widehat{Y_i}\right)^2 \quad (2)$$

Equation (2) is Defines the Mean Squared Error (MSE), which computes the average of squared errors to penalize larger discrepancies significantly.

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Finally, MAPE is used to calculate the average absolute percentage error, as shown in Equation (3):

$$MAPE=\frac{1}{n}\sum_{i=1}^{n}\left|\frac{Y_i-\widehat{Y_i}}{Y_i}\right|\times 100\backslash\% \qquad (3)$$

Equation (3) is Shows the Mean Absolute Percentage Error (MAPE), used to measure the relative average error in percentage terms to determine model accuracy.

Where n is the number of data points, $\widehat{Y_t}$ is the expert score (actual), and $\widehat{Y_1}$ s the system score (predicted). Based on the calculation of 15 test data points in Table 2, the model achieved an MAE of 6.42 and an MSE of 55.85. Furthermore, a MAPE value of 8.69% was obtained, indicating a high accuracy rate of 91.31%. This combination of low error values confirms that the proposed fuzzy model is capable of mimicking expert decisions with a high degree of conformity.

Reflecting on these findings, specific nuances emerge in the error distribution. Although the overall accuracy is high, there are cases, such as Title J-04, with a relatively significant deviation (which contributes to the MSE value). Upon analysis, this difference tends to occur in multi-disciplinary topics, where expert perception regarding 'Relevance' and 'Difficulty' can vary greatly. The system, with its 81 rigid rule bases, provides a consistent assessment, whereas experts may introduce additional subjective considerations. This finding highlights the main strength of the DSS: consistency. The system successfully eliminates bias and variability among assessors, aligning with the primary research objective.

Beyond technical consistency, this research offers significant practical implications for thesis supervisors. The implementation of this model serves as an efficient pre-screening mechanism, significantly reducing the cognitive load and administrative time required to evaluate raw proposals. By automating the feasibility assessment, supervisors can shift their focus from technical verification to providing substantive academic guidance. Furthermore, the system provides a defensible, objective basis for decision-making. The objectivity offered by this fuzzy logic model provides a quantitative basis for decision-making. By relying on calculated scores rather than purely subjective perception, this approach has the potential to minimize friction between students and supervisors, providing transparent justification particularly when a topic must be rejected due to lack of strategic relevance or low novelty.

CONCLUSION

This research successfully developed and validated a Decision Support System (DSS) model based on Fuzzy Sugeno Logic to evaluate the feasibility of student thesis topics objectively and systematicall. Scientifically, this study demonstrates that expert reasoning in academic evaluation can be effectively modeled using the Fuzzy Sugeno framework, providing a quantifiable basis for decision-making that previously relied solely on intuition. By transforming qualitative assessments into crisp outputs, the system minimizes inter-assessor bias and ensures fairness. For future development, the functional prototype that has been built can be integrated into the Academic Information System (Siakad) for the full automation of the

topic submission process, allowing for real-time monitoring of research trends

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