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Decision Support System on Independent Curriculum Learning Models with Artificial Intelligence at Islamic Universities

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Abstract

The design of curricula in Islamic universities frequently encounters difficulties in addressing the evolving needs of students, industry demands and the distinctive integration of Islamic values. Conventional methodologies are inadequate in their capacity to adapt to the evolving needs of the modern educational landscape. Furthermore, the integration of artificial intelligence (AI) in this domain remains underdeveloped, with many instances overlooking the crucial role of religious principles and institutional characteristics. This study addresses this gap by developing a Decision Support System (DSS) using Mamdani type 1 fuzzy logic, with the objective of assisting in determining an independent curriculum learning model tailored to Islamic higher education. The system incorporates a number of input variables, including student needs, industry requirements, institutional characteristics and data analysis. The output variables include an evaluation of the suitability of the learning model and a recommendation as to the most appropriate model. To illustrate, in situations where student needs are high, industry demands are moderate, institutional characteristics are high, and data analysis is moderate, the recommended model places an emphasis on balancing theoretical knowledge with practical application, while also aligning with Islamic values. The validation of this AI-based model, utilizing 2023 historical data from five Islamic universities in West Sumatra, yielded an average Mean Absolute Error (MAE) of 0.64, thereby demonstrating good predictive accuracy. The integration of AI in this system facilitates data-driven decision-making, thereby enhancing the relevance and adaptability of the curriculum. It has the potential to improve the quality of education, support balanced student learning outcomes, and ensure alignment with Islamic principles, making it a transformative tool for curriculum development in Islamic higher education.

Keywords: Artificial Intelligence; Decision Support System; Fuzzy Logic; Independent Curriculum; Learning Model.

Introduction

Higher education, especially in Islamic universities, has an important role in shaping a generation with competence and integrity. One factor that greatly affects the quality of higher education is the curriculum used in the learning process. In recent years, Indonesia has launched an independent curriculum initiative, which gives universities greater freedom to design their own curriculum. This independent curriculum aims to improve the relevance of the curriculum to the needs of industry and society.

However, behind the freedom provided by the independent curriculum, Islamic universities face a great challenge in designing a curriculum that is not only in line with government policies, but also takes into account the needs of society, industry, as well as the religious values on which the university was founded [1], [2], [3]. This leads to the need to develop learning models that are more adaptive and relevant, as well as aligned with the vision and mission of the Islamic college itself [4], [5]. In the face of this challenge, the author conducted this research to fill a gap in the literature, namely how to integrate artificial intelligence (AI) technology with Islamic principles in the process of designing an independent curriculum in Islamic universities. This research aims to explore how AI can be maximally utilized in the curriculum decision-making process that is not only data-driven, but also considers fundamental Islamic values.

One of the main challenges faced is how to determine the most effective learning model and in accordance with the vision and mission of Islamic universities [4], [6]. This process is very complex and requires in-depth analysis of various factors, such as student needs, industry needs, and the characteristics of the institution itself [7], [8], [9].

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Therefore, this research is motivated by the desire to contribute in designing an AI-based decision-making system that can help Islamic universities in overcoming this challenge, while maintaining compatibility between technological developments and the demands of religious values that must be held firmly [10]. Technology is becoming an increasingly attractive solution. Artificial intelligence (AI) can help colleges analyze data, design appropriate learning models, and make smarter decisions based on available information [11]. However, the implementation of AI in the decision-making process for independent curriculum learning models in Islamic higher education also faces a number of issues that need to be addressed [12]. There is a deep need to understand how AI technology can be used in the decision-making process related to the independent curriculum learning model in Islamic higher education [13], [14], [15]. This research needs to include both quantitative and qualitative aspects to provide a holistic view of how AI can impact learning in this environment [16] [4].

One of the main problems is the availability of adequate data. Universities need to have access to relevant data, such as student data, previous curriculum data, and industry demand data, to make accurate decisions [17], [18], [19]. In addition, a deep understanding of how to combine AI with Islamic values and understanding in this decision-making process is required. Currently, there are a number of articles that discuss AI in the context of higher education, including its use in curriculum design [4]. However, most of the existing research tends to be general and not specific to Islamic higher education. Therefore, there is no research that specifically combines AI technology with the specific context of Islamic higher education within the framework of an independent curriculum. This is a gap that this study needs to fill, to provide relevant practical guidance for Islamic higher education institutions that want to adopt AI in their curriculum decision-making process.

In addition, it is necessary to consider specific factors that may affect Islamic higher education in the process of deciding on an independent curriculum learning model. These factors include religious values, culture, and unique institutional identity [20], [21], [22]. Given the complexity of these challenges, research in this domain has immense importance. This research will help Islamic universities integrate AI technology with a deep understanding of Islam in the decision-making process regarding independent curriculum learning models. In addition, this research can also provide practical guidance for the college in making better and more effective decisions in designing its curriculum. Therefore, this research aims to identify and overcome the main problems that arise in making decisions about the independent curriculum learning model using AI technology in Islamic universities using the Mamdani 1 type fuzzy logic method, accompanied by the use of MATLAB applications in creating membership functions, generating rules, and designing independent curriculum-based learning models in Islamic universities, as well as testing the validity of the models created using the Mean Absolute Error (MAE) method.

This article also complements the lack of existing research by combining AI technology and Islamic principles in making decisions about independent curriculum learning models. This differs from previous writings that generally only focus on the use of AI in education without considering religious values or the specific characteristics of Islamic higher education, thus providing more specific and relevant guidance for Islamic higher education in making curriculum-related decisions. The main objective of this research is to provide practical guidance for Islamic universities in designing their curriculum by utilizing AI technology integrated with Islamic principles. By using fuzzy logic method, it is expected that Islamic colleges can more easily determine the right learning model, efficient, and relevant to the needs of students, industry, and the vision and mission of the college itself. This research is expected to improve the quality of Islamic higher education and make a significant contribution in developing a better and more adaptive curriculum to the times.

Method

This research uses an artificial intelligence-based methodology with a Mamdani Type 1 fuzzy logic approach to design a decision support system [23] in determining the appropriate Independent Curriculum learning model. The research stages begin with problem identification and determination of input variables, namely student needs, industry needs, college characteristics, and data analysis, as well as output variables in the form of learning model suitability and learning model recommendations. Next, the membership function for each variable is made based on questionnaire data from lecturers and students, by dividing the fuzzy set into low, medium, and high. The fuzzy inference process using the Mamdani method is carried out by building rules that combine all input and output variables. The defuzzification process is carried out to obtain the final value of suitability and recommendation of the learning model, which is then validated using the Mean Absolute Error (MAE) value to measure the accuracy of the system. The validation results show that the designed model performs quite well and can be used as a basis for decision making [24], [25]. The steps for solving cases using fuzzy logic to determine the independent curriculum learning model at Islamic universities are as follows [26]:

a. Step 1: Determine Fuzzy Input and Output

Identify relevant input and output variables in the context of determining the Independent Curriculum learning model. The input variables consist of four, namely: Student Needs, Industry Needs, College Characteristics, Data Analysis and variables o the output consists of two pieces, namely: Suitability of the Learning Model and Recommendations for the Learning Model.

b. Step 2: Determine Variable Ranges and Membership Functions

Determine the range of values for each fuzzy variable. Determine the membership function for each fuzzy variable. The membership function describes the extent to which a variable value can be a member of a particular fuzzy set (low, medium, high). The membership function used for both input and output variables is triangular in shape.

c. Step 3: Define Fuzzy Rules

Create fuzzy rules based on possible input combinations and generate fuzzy output. One of the fuzzy rules:

If Student Needs (KM) are high AND Industry Needs (KI) are medium AND Higher Education Characteristics (KPT) are high AND Data Analysis (AD) is high, then the Suitability of the Learning Model (KMP) is high AND the Recommendation Learning Model (RMP) is Model A.

d. Step 4: Perform Fuzzy Inference

Use the fuzzy rules that have been created to combine fuzzy input and produce fuzzy output. Use inference operators (for example, AND, OR, MIN, MAX) that suit the fuzzy rules used.

e. Step 5: Defining Implication Functions and Fuzzy Combinations

Determine the implication function used to relate fuzzy rules to fuzzy inputs. Use appropriate implication operators (e.g., MIN, PROD).

f. Step 6: Finishing the Fuzzy Output

Aggregate all fuzzy inference results using appropriate operators (e.g., MAX). This will produce fuzzy output for the output variables (KMP and RMP).

g. Step 7: Defining the Defuzzification Function

Define a defuzzification function that will convert the fuzzy output into concrete values. Use an appropriate defuzzification method (for example, Centroid or Max Membership method).

h. Step 8: Evaluate Results

Evaluate the defuzzification results to obtain concrete values that indicate the suitability of the learning model and recommendations for the most appropriate learning model.

i. Step 9: Decision Making

Use the defuzzification results to make concrete decisions about the learning model that will be adopted by Islamic universities.

j. Step 10: Validation and Testing

Validate the results by testing the fuzzy logic model using real data and measuring the extent to which this model corresponds to decisions taken in a real context. These steps help make more contextual and in-depth decisions in selecting an independent curriculum learning model that is suitable for Islamic higher education, considering various relevant input factors. The method commonly used to measure the level of validation in the context of the Mamdani type 1 method, one of which is calculating the Mean Absolute Error (MAE). The MAE formula is as follows [27]:

$$MAE = \sum \frac{(AE)}{n} \quad (1)$$

Where:

$\Sigma(AE)$: the sum of all Absolute Error (AE) values for all universities.

n: total number of universities evaluated.

The lower the MAE value, the better the fuzzy logic model designed, this can be seen in **Table 1**.

Table 1. Range of MAE Values and Conclusions

MAE range	Interpretation of Conclusions
< 0.1	Very good
0.1 - 0.3	Good
0.3 - 0.5	Pretty good
0.5 - 0.7	Intermediate
0.7 - 1.0	Not Good
> 1.0	Not satisfactory

*Source: [28]

Results and Discussion

The first stage in this research is to identify the problem to be solved, namely determining the learning model that is most suitable for the characteristics of students, so the researchers distributed questionnaires to lecturers and students at various Islamic universities in West Sumatra This was done with reference to the concept of an independent curriculum-based learning model, where each student has unique needs and learning styles. Based on the results of distributing questionnaires via google form that the researchers distributed, there were 20 lecturers and 35 students who responded, so there are several factors that determine the selection of learning models in the implementation of the independent curriculum, and are determined as input variables consisting of four, namely: Student Needs, Industry Needs, Higher Education Characteristics, Data Analysis and output variables consist of two, namely: Learning Model Suitability and Learning Model Recommendation.

The second stage determines the membership function for each input and output variable obtained in the first stage. Determination of the range of values for each fuzzy variable from **Tables 2** to **7** based on the results of questionnaires distributed to students and lecturers conducted in stage 1. Each table is then presented with its membership functions. In this table, each input and output variable has three fuzzy sets (low, medium, high) with membership functions that describe the extent to which a value can be a member of the set. This membership function will be used in the fuzzy logic process to determine the suitability of the learning model and recommendations for appropriate learning models based on input values. The following researchers present the membership function tables contained in **Tables 2** to **7** for input and output variables along with their membership function graphs in the case of determining the Independent Curriculum learning model using fuzzy logic along with fuzzy sets, value ranges.

a. Input Variables:

1. Student Needs (KM)

Table 2. Fuzzy Membership Function Student Needs (KM)

Fuzzy Sets	Range	Membership Functions
Low	0 - 3	[-4, 0, 2]; triangle graph
Medium	2 - 7	[2, 5, 7]; triangle graph
High	5 - 10	[5, 6, 10]; triangle graph

2. Industrial Needs (KI)

Table 3. Fuzzy Membership Function for Industrial Needs (KI)

Fuzzy Sets	Range	Membership Functions
Low	0 - 3	[-4, 0, 2]; triangle graph
Medium	2 - 7	[2, 4, 7]; triangle graph
High	5 - 10	[5, 8, 10]; triangle graph

3. Characteristics of Higher Education (KPT)

Table 4. Fuzzy Membership Function of Higher Education Characteristics (KPT)

Fuzzy Sets	Range	Membership Functions
Low	0 - 3	[0, 1, 2]; triangle graph
Medium	2 - 7	[2, 3, 7]; triangle graph
High	5 - 10	[5, 7, 10]; triangle graph

4. Data Analysis (AD)

Table 5. Fuzzy Data Analysis (AD) Membership Function

Fuzzy Sets	Range	Membership Functions
Low	0 - 3	[0, 1, 3]; triangle graph
Medium	2 - 7	[2, 5, 7]; triangle graph
High	5 - 10	[6, 8, 10]; triangle graph

b. Output Variables:

1. Suitability of Learning Model (KMP)

Table 6. Fuzzy Membership Function Suitability Learning Model (KMP)

Fuzzy Sets	Range	Membership Functions
Low	0 - 3	[-4, 0, 2]; triangle graph
Medium	2 - 7	[2, 5, 8]; triangle graph
High	5 - 10	[7, 9, 10]; triangle graph

In other words, the output variable "Conformity of Learning Model (KMP)" measures the level of suitability between the recommended learning model (for example, Model A, Model B, or Model C) with the situation being faced by Islamic higher education in the context of the Independent Curriculum. This suitability reflects the extent to which the learning model can meet student needs, industry demands, university characteristics, and the availability of data that has been input into the fuzzy logic system.

A higher KMP result indicates that the recommended learning model is most appropriate to existing conditions and needs, while a lower value indicates that the learning model may be less suitable. The suitability of this learning model can be used as a guide in making decisions about the learning model that will be adopted by Islamic universities in order to improve the quality of their education in accordance with the Independent Curriculum.

2. Recommended Learning Model (RMP)

Table 7. Fuzzy Membership Function Recommended Learning Model (RMP)

Fuzzy Sets	Range	Membership Functions
Model A	0 - 3	[-4, 0, 2]; triangle graph
Model B	2 - 7	[2, 3, 5, 7]; trapezoidal graph
Model C	5 - 10	[3, 7, 10]; triangle graph

The following is a more specific explanation of the learning model recommendation in the context of determining the Independent Curriculum learning model using fuzzy logic, the output variable Learning Model Recommendation (RMP):

1. Model A (Low): A learning model that is suitable for conditions where student needs (KM) tend to be low, industry needs (KI) tend to be low, university characteristics (KPT) tend to be low, and data analysis (AD) tends to be low. This learning model may place more emphasis on traditional and theoretical aspects of the curriculum [29]. Example of a learning model for type A:

a. Conventional Lectures: Teaching in the form of lectures with a focus on conveying theories and concepts systematically. Understanding basic concepts is the main goal.

b. Written Exam: Student evaluation is carried out through a written exam that tests theoretical understanding. This exam can be a multiple choice exam or an essay.

c. Reading Material: Students are given comprehensive reading material to study concepts and theories in more depth.

d. Classic Curriculum: A curriculum that tends to follow a traditional model with dominant core courses.

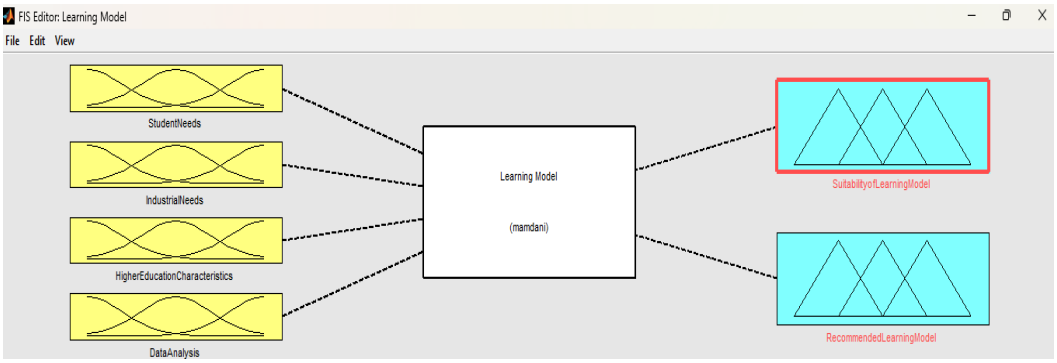

Figure 1. Fuzzy Logic Design Using MATLAB Mamdani Type 1

2. Model B (Medium): A learning model that is suitable for conditions where student needs (KM) and industry needs (KI) are balanced or moderate, university characteristics (KPT) are moderate, and data analysis (AD) is moderate. This model combines theoretical aspects with practical applications in the curriculum [30]. Example of type B learning model:

   a. Project Based Learning: Students are given projects that allow them to apply theory in a practical context. For example, research or product development projects.

   b. Group Discussion: Students are involved in group discussions to share their experiences and understanding of the concepts studied.

   c. Diversified Evaluation: Evaluation involves various forms, including exams, presentations, project reports, and portfolios.

   d. Balanced Curriculum: The curriculum includes core theoretical courses as well as courses that focus on practical application and skills.

3. Model C (High): A learning model that is suitable for conditions where student needs (KM) are high, industry needs (KI) are high, university characteristics (KPT) are high, and data analysis (AD) is high. This learning model may place more emphasis on practical experience, research, and the integration of Islamic values in the curriculum. Example of type C learning model:

   a. Compulsory Internship: Students are required to undergo an internship in the relevant industry as part of the curriculum [31].

   b. Skills Development: The main focus is the development of practical skills that are relevant to industry needs, such as problem solving skills, programming or other technical expertise [32] .

   c. Islamic Research and Studies: The curriculum includes courses that enable students to conduct research and learn how Islamic values can be integrated in educational and business contexts [33].

   d. Applied Evaluation: Evaluation includes practical projects, presentation of research results, as well as reflections on the application of Islamic values in their work [34].

   e. Student Empowerment: Students are encouraged to become agents of change in society by applying Islamic knowledge and values in daily practice [35].

Thus, the learning model recommendation (RMP) will greatly depend on the combination of input values provided into the fuzzy logic system. For example, if the input shows that KM is high, KI is medium, KPT is high, and AD is medium, then the recommended learning model might be Model C which emphasizes a balance between

theory and practical application and considers Islamic values. These recommendations are designed to provide Islamic higher education institutions with concrete guidance in selecting the learning model that best suits their needs and context, so as to maximize the quality of the education they offer and meet student, industry and Islamic religious values. Each of these learning models will suit different conditions and needs in Islamic universities, and recommendations for appropriate learning models will depend on factors such as student needs, industry demands, university characteristics, and data availability [36], [37].

The third stage is to determine the rules from the results of the membership function formed from the input and output variables obtained in stage 2. As for generating rules, the MATLAB application is used, so that 81 rules are obtained. The fourth stage, performing fuzzy inference from the results of the rules and fuzzy logic design which has been done in stage 3. Engine inference is carried out using the MATLAB application from the results of the Mamdani Type 1 fuzzy logic design, suppose the inputted data, with values: KM = 6, KI = 5, KPT = 7, AD = 6, the output KMB = 5 and RMB = 5 are obtained.

Stage 5, 6 and 7, based on the output values generated in step 4, the results of fuzzy logic inference with input Student Needs (KM) = 6, Industry Needs (KI) = 5, College Characteristics (KPT) = 7, and Data Analysis (AD) = 6, produce output Learning Model Suitability (KMB) = 5 and Recommended Learning Model (RMB) = 5, which indicates that the learning model applied is still at a low level or close to the medium category. This indicates that there is a mismatch between the learning model designed with student needs, industry needs, and the data analysis conducted. Although the characteristics of the college have shown a high level, the relevance to the world of work and the effectiveness of data analysis still need to be improved. Therefore, optimization measures are needed, especially in aligning student and industry needs, strengthening data analysis, and increasing the adaptability of learning models to better suit the objectives of the Independent Curriculum.

Stage 8, based on the defuzzification results which resulted in the Learning Model Conformance (KMB) = 5 and Recommended Learning Model (RMB) = 5, Islamic universities can make a concrete decision that the learning model to be adopted is in the low category. This indicates the need for significant improvement in aligning the learning model with the needs of students and industry, as well as strengthening data analysis capabilities to support academic and practical relevance. Considering these results, Islamic universities are advised to start by adopting collaboration and discussion-based learning approaches that are able to enhance active student engagement, while continuously evaluating and gradually refining technology- or project-based learning models to meet industry needs. This strategy allows for gradual improvement in creating learning models that are more adaptive and in line with the objectives of the Independent Curriculum.

Stage 9, As a result of the model design that has been created using the MATLAB application, it is necessary to carry out the model validation stage. Validate the model used in this model by measuring using the accuracy (accuracy) and MAE methods. The steps taken are as follows: calculate the absolute difference between the system's predicted results and the actual results (historical data), then calculate the average of this difference using formula 1. The historical data taken includes information about Islamic universities that will be evaluated, this data includes information about the actual learning model chosen, as well as other relevant information such as student needs, industry needs, university characteristics, and data analysis. Calculate the absolute difference between the predicted learning model produced by the fuzzy logic system and the actual learning model contained in historical data. This difference will be the Absolute Error (AE) value for each university. For each college, calculate the MAE by taking the average of the AE values that have been calculated. The MAE calculation results can be seen in table 8. MAE is the MAE value for each university, reflecting the average error level of the fuzzy logic system in predicting learning models. Table 8 provides a brief overview of the performance of the fuzzy logic system in the context of determining learning models in various Islamic universities.

Based on the MAE value rules in **Table 1**, a MAE value of 0.64 is quite good criteria for designing an independent curriculum learning model with artificial intelligence at Islamic Higher Education created by researchers. The results of fuzzy logic calculations are directly related to the selection of learning models in Islamic universities. The learning model chosen must be in accordance with the characteristics and needs of students as well as the vision and mission of the institution [14], [38]. By using fuzzy logic, it can predict appropriate learning models based on historical data, which is an important aspect in educational management.

Islamic education management seeks to improve the effectiveness of teaching and learning in Islamic universities. The results of fuzzy logic calculations that support the selection of appropriate learning models can contribute to increasing this effectiveness by ensuring that the learning models used are in accordance with the needs and goals of Islamic education [39]. The aims of Islamic education relate to achieving educational goals within the framework of

Islamic values and principles. Islamic education has a strong spiritual and moral dimension, in addition to the academic dimension. The goals of Islamic education can vary depending on the context and level of education, but some general goals include: development of faith and piety, character formation: Islamic education, increasing knowledge, social empowerment: Islamic education, balance between the world and the hereafter, respect for justice and concern social, intellectual and creative development: the goals of Islamic education, spiritual growth, respect for culture and diversity and understanding and compliance with sharia.

Table 8. MAE Calculation Results from 5 Islamic Universities in West Sumatra on the Design of Independent Curriculum Learning Models with Artificial Intelligence

No.	College	MAE	Conclusion
1	*Mahmud Yunus Batusangkar State Islamic University (UIN).*	0.8	Intermediate Performance
2	*State Islamic University (UIN) Sjech M. Djamil Djambek Bukittinggi*	0.5	Good Performance
3	*Imam Bonjol State Islamic University (UIN) Padang*	0.6	Intermediate Performance
4	*Ahlussunnah Bukittinggi Tarbiyah Science College (STIT).*	0.4	Good Performance
5	*Solok Nan Indah Islamic High School (STIA).*	0.9	Intermediate Performance
Average		0.64	**Intermediate Performance**

Source: Primary data processed, 2023

Islamic education management emphasizes the quality of learning and education provided at Islamic universities. Choosing the right learning model can influence the quality of learning. The results of fuzzy logic calculations that lead to the selection of appropriate models can help improve the quality of learning. One aspect of educational management is adapting the curriculum to educational goals and student needs. The results of fuzzy logic calculations can provide insight into the most suitable learning model to achieve this goal and assist in curriculum adjustments. The Independent Curriculum at Islamic universities is an educational initiative designed to give students greater freedom in choosing courses and developing their academic interests. The objectives of the independent curriculum at Islamic universities are as follows: providing academic freedom, developing independent learning abilities, flexibility in study choices, increasing creativity and innovation, respecting student diversity, increasing career skills, improving the quality of education and motivating and maintaining student involvement [40].

Islamic education management also involves making strategic decisions to develop educational institutions. The results of fuzzy logic calculations can be used as a basis for making strategic decisions related to curriculum development and improving the education system in Islamic universities. Islamic education management also includes the use of technology in education. Fuzzy logic is a technology that can be used to assist decision making in the field of education, including selecting appropriate learning models. Fuzzy logic has many benefits in making effective decisions in determining the appropriate learning model in the independent curriculum at Islamic universities. Following are some of the key benefits of fuzzy logic in this context: (1) Handling Uncertainty: Fuzzy logic enables effective decision making in situations where variables or conditions do not have definite values. In the educational context, many variables are vague, such as student interests, abilities, and learning preferences. Fuzzy logic makes it possible to overcome this uncertainty; (2) Flexibility and Adaptability: Fuzzy logic can be adapted well to changing situations, such as changes in student interests or needs over time. This is very much in line with the Independent Curriculum approach which provides students with flexibility in selecting courses; (3) Multi-Criteria Consideration: When making decisions related to learning models, there are many criteria that need to be considered, such as teaching methods, materials and learning environment. Fuzzy logic allows combining all these criteria and assigning appropriate weights to each criterion, so that decisions can be made holistically; (4) Optimizing Course Choices: In the context of an independent curriculum, students have many choices of courses that they can take. Fuzzy logic can help in optimizing course choices based on each student's interests, needs and learning goals; (5) Personalization of Learning: Fuzzy logic can be used to design learning plans tailored to each student's abilities and interests. This allows each student to gain the most beneficial learning experience for them; (6) Data Analysis and Understanding: Fuzzy logic can be used to analyze student learning outcome data and provide valuable insights into their academic development. This can help in adapting learning models according to student needs; (7) Resource Efficiency: By using fuzzy logic, universities can manage their resources more efficiently, including setting schedules, lecturer allocations, and other resources based on students' actual needs ; (8) Evidence Based Decision Making: Fuzzy logic enables decision making based on available evidence and data. This promotes more rational and informed decision making [41].

Independent Curriculum at Islamic universities, fuzzy logic can be used to help students and educational institutions make better decisions in selecting courses, adjusting study plans, and optimizing the learning process. This can enhance the educational experience, provide greater flexibility, and help achieve educational goals that are consistent with Islamic values. Overall, the results of fuzzy logic calculations in selecting learning models in Islamic universities are very relevant to Islamic education management. This can help improve the effectiveness, quality and relevance of education provided by Islamic educational institutions in accordance with the principles and values of Islamic education [42]. The calculated MAE results provide an overview of the extent to which the fuzzy logic system is able to predict appropriate learning models. An average MAE value of 0.64 indicates system performance that is at a medium level. These are useful results, but there is still room for improvement. Comparison of MAE results with previous research is an important step in evaluating system performance. If the MAE results are in line with similar studies, it can confirm the validity of the models used in fuzzy logic systems. If MAE results differ significantly from previous studies, this may indicate differences in the data, methods, or variables used.

Designing an independent curriculum learning model at Islamic universities, there are several causes of errors that need to be avoided to ensure the success and effectiveness of the curriculum. Some of the causes of errors that generally occur are: lack of understanding of the principles of an independent curriculum, lack of consultation with students, lack of lecturer support and training, unclear procedures and guidelines, lack of continuous evaluation and improvement, overly individualistic approach, lack of integration of Islamic values, not achieving educational goals, lack of evaluation of learning outcomes and lack of stakeholder involvement. Designing an effective independent curriculum learning model requires a deep understanding of the principles of the independent curriculum, involvement of students and lecturers, as well as attention to Islamic values and clear educational goals. These errors can be avoided with careful planning and development as well as the involvement of all stakeholders. Errors in designing the models created require in-depth analysis when determining input and output variables. This is related to the management used by universities or learning theories which influence the factors in selecting the appropriate learning model to use.

Conclusion

The results of this study indicate that the fuzzy logic system designed to determine the Independent Curriculum learning model in Islamic universities has succeeded in processing inputs in the form of student needs, industry needs, college characteristics, and data analysis into learning model recommendations and the level of suitability of the learning model. By using Mamdani Type 1 fuzzy logic inference, the defuzzification value of Learning Model Suitability (KMB) = 5 and Learning Model Recommendation (RMB) = 5 is obtained. This value indicates that the applied learning model is still at a low level and requires improvement to better suit the needs of students, industry, and university characteristics. Model validation using the Mean Absolute Error (MAE) value of 0.64 shows that the system error rate is quite low, so the prediction results can be considered accurate and can be used as a basis for decision making.

In further development, this research opens up opportunities to improve the adaptability of the system by expanding the scope of input variables. The addition of variables such as educational technology development trends, culture-based learning style preferences, and lecturers' level of readiness in using technology can provide more comprehensive results. In addition, the application of other artificial intelligence algorithms, such as artificial neural networks or genetic algorithms, can be used to optimize the designed system, so that the recommended learning model becomes more dynamic and responsive to changes in the educational and industrial environment.

Other researchers can also develop this research by testing on more Islamic universities in a wider area, so as to validate the system on a larger scale. In addition, the integration of this system with digital learning platforms can help universities in implementing the recommendations directly and monitoring the results in real-time. Thus, this research not only provides theoretical contributions, but also paves the way for wider practical applications in supporting the implementation of Independent Curriculum in Islamic tertiary institutions.

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