# Implementation of Fuzzy TOPSIS on Expert Systems for Core Competency Detection

Sutiah[1], Supriyono[2], Indah Aminatuz Zuhriyah[3], Zainul Arifin[3]

[1,3] *Islamic Education Department, Faculty of Tarbiyah and Teaching Training, State Islamic University of Maulana Malik Ibrahim, Malang, Indonesia*
[2] *Informatics Engineering Department, Faculty of Science and Technology, State Islamic University of Maulana Malik Ibrahim, Malang, Indonesia*
[4] *Psychology Department, Faculty of Psychology, State Islamic University of Maulana Malik Ibrahim, Malang, Indonesia*

Keywords: fuzzy TOPSIS, core competencies, expert system, application, learning.

Abstract: The expert system on core competency detection is a fairly important system development. The study aims to implement the fuzzy TOPSIS (Technique For Others Reference by Similarity to Ideal Solution) in the core competency detection expert system, and the student learning achievement was majoring in Islamic religious education in Islamic Religious College. In the process of learning an Indonesian National Qualification framework based curriculum designed to detect the level of development of core competencies and student achievement in the Faculty of Tarbiyah and Teaching Training or Islamic Education study program at Islamic Religious College. The leading product development of the study is an expert system application with the fuzzy TOPSIS method in measuring the development indicators of core competencies include hard skills and soft skills and learning factors that impact the students learning achievement. The result of this expert system can help students and lecturers independently to detect how the level of development of student core complications, detecting internal learning factors and external influences, and measuring how they influence student learning achievements. The results obtained indicate the level of use of fuzzy TOPSIS reaches an accuracy is excellent.

## 1 INTRODUCTION

A college is a strategic unit of education in preparing outstanding human resources and excellence. Global competition demands that colleges should be able to deliver their students to increase competition globally. The college is required to respond to the development speed of science and technology and the rapid development of information technology, which can affect the student's thinking style more advanced. The development of Islamic religious colleges in Indonesia is speedy. It is not apart from the demands of the era of globalization and the work that requires qualified workforce consisting of graduate graduates, masters graduates even the level of competency of doctors who are experts in their field. It is due to fulfill the demands of employment competence following the working standards in the era of globalization that refers to international working standards. The needs of workers in the period of globalization not only require

graduates who are competent as a working requirement, but they are also required to possess interpersonal skills competence, information technology skills, problem-solving skills, and other skills. There are still many college graduates who are not ready to work according to the demands and development of continuously changing qualifications and competencies and in line with the pace of development of science and technology as expected by stakeholders. This illustrates that there are still many colleges, including the state Islamic religious college, which has the quality of graduates yet not following the demands of the community of users and has not been able to competitiveness in the global community.

The quality of higher education graduates, including the state Islamic religious college, can be measured from how the level of achievement of student learning and the level of the absorption of graduates in employment following their field of expertise. The competency level of graduates can

affect the quality of Islamic college graduates. The College of Islam must prepare graduates who can possess core competencies and produce quality graduates who excel. Excellent human resources can succeed in the ideals of the nation and state development. The performance of academic skills, special skills, and personality attitudes can be affect students learning achievements. Personality is essential to be known to everyone so that each individual can develop and improve their strengths. A person who has difficulty in developing himself is likely not knowing all the weaknesses and faults he controls. Many students do not achieve a learning accomplishment even fail not because it is not intelligent, but fail in managing themselves or do not know how to recognize himself.

The success of achieving high learning achievements in college lectures become the ideals and expectations of each student. Significant learning achievements impact the level of comfort in doing decent work and can compete openly in global competition. However, each student faces various obstacles, challenges, and difficulties so that each student is not necessarily able to face challenges and succeed in obtaining the achievement. The facilities and environment in the learning environment are very influential in student learning achievements. High motivation becomes an internal factor in encouraging students to achieve good performances. While the climate is conducive and also adequate, facilities as an external factor can impact the learning system that can affect students learning achievement in colleges.

The following research discusses the implementation of the fuzzy TOPSIS method applied to expert systems in detecting the core competencies of students. The analysis of student learning experts can help students and lecturers in decision making to support the improvement of student learning achievement. The following research can produce an expert system application with the Fuzzy TOPSIS method. The main issues are raised by detecting core competencies and learning factors that influence the level of student learning achievement.

The implementation of the fuzzy TOPSIS can solve complicated problems. The expert systems are a representation of the performance from the human brain that seeks to simulate the way human brains work to replace social work. For that, in the introduction of patterns to predict, classifying can be solved using expert systems. Therefore, this development has adopted the method of the Fuzzy TOPSIS method, which aims to detect the perception of students and lecturers in the event of core complications, internal and external factors in identifying student learning achievements.

Other methods of use include Fuzzy AHP and Fuzzy SAW. Fuzzy TOPSIS has an advantage over Fuzzy AHP, which requires a somewhat complicated calculation process. The technique also has linguistic variables. Other researchers also use fuzzy TOPSIS to other issues. Based on the above, it is a primary developed method of Fuzzy TOPSIS based Neural Network on an expert system of detection of core competencies and learning factors that affect the achievement of student learning achievement. Optimization of Fuzzy TOPSIS on core competency, learning elements, and student learning achievements designed and created by integrating core competencies development levels, learning factors, and student learning achievement from student perceptions and lecturers in the curriculum learning process based on the Indonesian National Qualification Framework. The development of this application system can help lecturers and students to avoid failures in learning and directing and help students can achieve the highest learning achievement.

## 2 LITERATURE REVIEW

The theory of the fuzzy set is a mathematical framework used to present uncertainty, obscurity, imprecision, lack of information, and partial truth. The fuzzy logic is an appropriate step in mapping an input space into an output space. The technique for Order Performance by fuzzy TOPSIS is a well-known method in dealing with any Multiple Criteria Decision Making (MCDM) problem (Ahmad and Mohamad 2017). Implementation of the Fuzzy TOPSIS method to solve a problem in MCDM with the concept that the most effective alternatives were the closest to the ideal solution positive and the farthest of the perfect negative solution. The fuzzy method of AHP and fuzzy TOPSIS can use to set preferences by having a level of correspondence to the ideal solution and is primarily developed to handle data value.

One such technique is to implement a method most often used in the process of making Multi-criteria (MCDM). After calculating the rankings against the solution, as well as finding that the technology used to offer customers against real-time and demand knowledge ' is the best solution with a single rating (Bhosale and Kant 2018). A membership function is a curve that shows the mapping of data input points into its membership value that has

intervals between 0 and 1. Standard function approaches used in Fuzzy logic utilization. It is one way to get the membership value on the Fuzzy logic.

The problem of multi-criteria decision making (MCDM) is the need for an efficient computing approach. In particular, in a distributed system, the brokerage agents containing the scheduler and dispatcher modules have limited time to decide the scheduling and delivery of tasks over resources as some tasks may have interdependence and Deadline. The Fuzzy TOPSIS method is a suitable tool because it carries a low overhead cost and because of the robustness of its results and its sacrifice reaches among a variety of applicable objectives. Also, our approach used is optimal and measurable, where applications on large-scale problems have low overhead costs. However, this module works well in static and batch processing environments, such as grid computing that has predefined behaviors. The only drawback is that it does not fit in dynamic settings such as dynamic cloud environments due to varying workloads. The implementation of several scenarios indicates that the results are appropriate for a dynamic environment by adding a predictive method. Related research discusses the development of Fuzzy TOPSIS using data mining techniques that will result in better decisions in MCDM issues.

An example is by utilizing data mining techniques to extract data history, recognizing workload behavior, and then triggering an increase in Fuzzy TOPSIS (Shirvani et al. 2017). The problem of multi-criteria decision making (MCDM) is the need for an efficient computing approach. In particular, in a distributed system, the brokerage agents containing the scheduler and dispatcher modules have limited time to decide the scheduling and delivery of tasks over resources as some tasks may have interdependence and Deadline. The Fuzzy TOPSIS method is a suitable tool because it carries a low overhead cost and because of the robustness of its results and its sacrifice reaches among a variety of applicable objectives. Also, our approach used is optimal and measurable, where applications on large-scale problems have low overhead costs. However, this module works well in static and batch processing environments, such as grid computing, that has predefined functions. The only drawback is that it does not fit in dynamic settings such as dynamic cloud environments due to varying workloads. The implementation of several scenarios indicates that the results are appropriate for a dynamic environment by adding a predictive method. Related research discusses the development of Fuzzy TOPSIS using data mining techniques that will result in better

decisions in MCDM issues. An example is by utilizing data mining techniques to extract data history, recognizing workload performance, and then triggering an increase in Fuzzy TOPSIS (Shirvani et al. 2017).

An example of a Fuzzy TOPSIS implementation is a variable weight linguistic and can be assessed very low, low, medium, high, very high, and so on. Fuzzy numbers can also represent linguistic values. The fuzzy hybrid analytics process and fuzzy technique for order performance with similarities to the Fuzzy TOPSIS method to prioritize and rank from the solutions offered. Fuzzy AHP used to determine preference weights, and Fuzzy TOPSIS used to rank the solution (Sirisawat and Kiatcharoenpol 2018). MADM regarding the proposed issue is not will be obtained an optimum solution. But the result of this alignment can be used to systematically evaluate and reduce the risk of the quality selection of poor service.

In related studies discussed the utilization of MCDM methods such as on the fuzzy use of VIKOR and fuzzy ELECTRE to examine alternate locations and compare results along with the findings gained (Senvar, Otay, and Bolturk 2016). The sharp value illustrates individual assessments in the conventional approach of TOPSIS. It is not always possible to set a crisp value for personal preference. In such cases, linguistic forecasts are more likely than definite benefits, although there may be some uncertainty related to linguistic judgment but can be solved using a blurred approach (Singh and Sarkar 2019).

The best alternative not only has the shortest distance from the ideal positive solution produced but also has the most extended range from the perfect negative solution. It is a concept of the Fuzzy TOPSIS method. Decision-making to solve practical decision problems with the modeling concepts of multiple attributes. That's because the idea is simple and understandable; the calculations are efficient. They can measure the relative performance of the decision in a relatively pure form of mathematics. The Fuzzy TOPSIS implementation procedure has specific steps. Among them makes the decision matrix normalized. Also, making a weighted decision matrix normalized, determining the ideal matrix of positive solutions and a perfect matrix of harmful solutions, determines the distance between each other value with an perfect positive matrix solution and matrix solution Ideal, specify a preference value for each alternative (Ahmed et al. 2016).

In determining the weight of each criterion set, the pressure will be stored in the system database. Next is determining the alternative rules decision of any given alternative. Decision rules the alternative

arrangement will be used to calculate the value of an option provided by each respondent. After calculating the alternative value decisions, then the next stage is determining the fuzzy membership used to determine the fuzzy matrix decision in the future. After that, turn into the normalized decision matrix. An attendant is multiplying the predefined criteria weights with the normalized decision matrix, thus generating a model weighted normalized decisions. Once obtained the decision matrix, the most weighted normalization can be determined as the ideal positive solution and the perfect solution negative. The final step is to calculate the criteria distance with the perfect solution in the fuzzy TOPSIS, the relative importance of alternative or alternate ratings concerning attributes can be several fuzzy. Therefore the calculations are done in fuzzy environmental, and fuzzy operators are used (Sadi-Nezhad and Damghani 2011).

The main differences between the fuzzy TOPSIS approach can be summarized in selecting the normalization method of the decision matrix, specifying the Fuzzy Positive Ideal (FPIS), and Fuzzy Solutions Ideal Negative solution (FNIS), calculation of distances between fuzzy numbers, and the defuzzification method applied. Most of all, these research works are presented procedures using the defuzzification method at the beginning or middle step of the fuzzy TOPSIS algorithm. This method converts the fuzzy numbers to the corresponding crisp values that will cause some rounding errors as well as possible and significant interference in the final rankings of various alternatives. TOPSIS requires the performance rating of each Ai alternative on each Cj criterion that is normalized.

$$R_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \qquad (1)$$

with i=1, 2, … , m; and j = 1, 2, … , n

## 3 METHODOLOGY

The methodology of the research is a series of activities undertaken by systematic and orderly researchers to achieve the objectives of the study shown in Figure 1. The research methodology consists of Identification Problem, literature review, data collection, requirement specification, design system, testing, result analysis, recommendations.
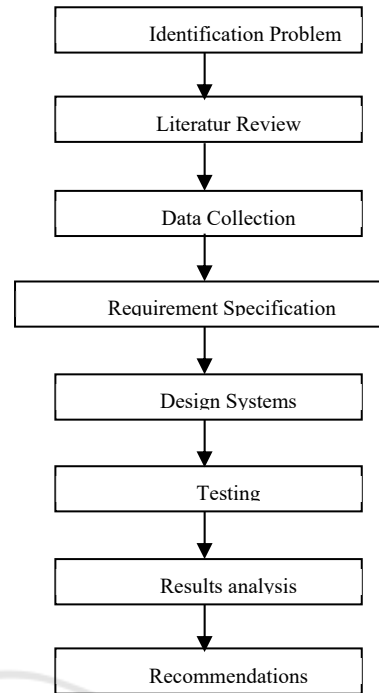


Figure 1: Research methodology.

Figure 1 describes several processes to complete subsequent studies. The first step in this study is to study and analyze the condition of the Islamic Education Study program at Islamic State University of Maulana Malik Ibrahim. The research object discusses the level of core competency and achievement in an Islamic study program at Islamic State University of Maulana Malik Ibrahim Malang. The results of the analysis can identify and formulate problems faced by the Department of Islamic Education at the State Islamic University of Maulana Malik Ibrahim Malang as a research object.

Furthermore, the study and literature studies in the study of the field conducted observations more deeply to the company that used to be a research object, especially the part to be focused on the research. As for the literary study, the stage will be conducted, learning about the literature that supports the implementation of this research. This step aims to deepen and understand the theory or method to be used in the solve the problem. The literature study was conducted by searching for the literature relating to the issues faced. The reference used can solve the problem as a solid foundation in the study. In this study, the researchers studied was the Related to the Decision Support System (DSS) and the Fuzzy TOPSIS method. The next step is data collection.

Data and information According to the fact the field is very influential in the research.

# 4 IMPLEMENTATION OF FUZZY TOPSIS

The study used questionnaires distributed to 70 respondents among Islamic religious education students at the Islamic State University of Maulana Malik Ibrahim Malang as an object of study.

Table 1: Criteria fuzzy TOPSIS

| Code | Criteria | Fuzzy weights 1 | Fuzzy weights 2 | Fuzzy weights 3 |
|------|----------|------|------|------|
| A1 | Soft Skill | 0,57 | 0,77 | 0,93 |
| A2 | Hard Skill | 0,53 | 0,67 | 0,87 |
| A3 | Religious | 0,43 | 0,60 | 0,80 |
| A4 | Knowledge | 0,50 | 0,60 | 0,80 |
| A5 | Quran Memorization | 0,37 | 0,47 | 0,67 |
| A6 | Hadits Memorization | 0,40 | 0,60 | 0,80 |

In TOPSIS fuzzy criteria consisting of Soft skills, Hard skills, Religious, Knowledge, Quran Memorization, hadith Memorization shows good results.
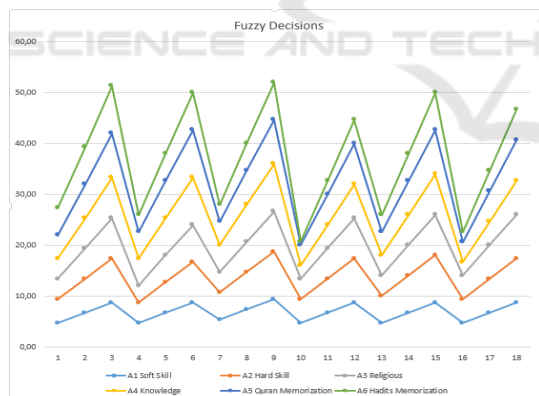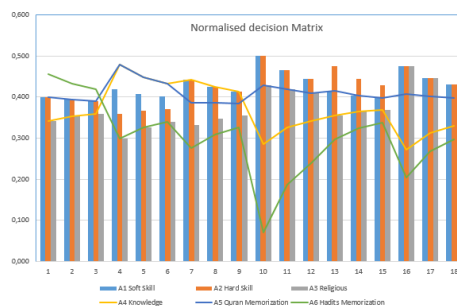


Figure 2: Fuzzy decisions



Figure 3: Normalized decision matrix

The result of normalization of fuzzy TOPSIS method calculations with its six fuzzy criteria TOPSIS shows good results. Figure 4 shows a weighted normalized decision matrix.
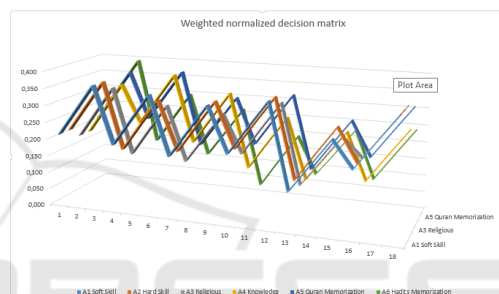


Figure 4: Weighted normalized decision matrix

# 5 CONCLUSIONS

The following research uses six criteria consist of Soft skills, Hard skills, Religious, Knowledge, Quran Memorization, Hadith Memorization. Testing the data by using these parameters indicates that each parameter has a dependency function. The implementation of the fuzzy TOPSIS method on an expert system to detect core competencies in the Department of Islamic Religious Education, Faculty of Tarbiyah and the Teacher at state Islamic University Maulana Malik Ibrahim Malang produced optimal results.

The following research uses the fuzzy TOPSIS on an expert system to detect core competencies at the Islamic State University of Maulana Malik Ibrahim Malang. The obtained results show an implementation of the fuzzy TOPSIS achieving good accuracy results.

# REFERENCES

Ahmad, Sharifah Aniza Sayed, and Daud Mohamad. 2017. "A Comparative Analysis between Fuzzy Topsis and Simplified Fuzzy Topsis." *AIP Conference Proceedings* 1870.

Ahmed, Shameem et al. 2016. "A Comparative Decision-Making Model for Sustainable End-of-Life Vehicle Management Alternative Selection Using AHP and Extent Analysis Method on Fuzzy AHP." *International Journal of Sustainable Development and World Ecology* 23(1): 83–97.

Bhosale, V. A., and R. Kant. 2018. "Examining the Solutions to Overcome the SCKFBS Using Fuzzy AHP and Fuzzy TOPSIS Method." *IEEE International Conference on Industrial Engineering and Engineering Management* 2017-Decem: 403–7.

Sadi-Nezhad, Soheil, and Kaveh Khalili Damghani. 2011. "A Modified Topsis Technique in Presence of Uncertainty and Its Application to Assessment of Transportation Systems." *International Journal of Management Science and Engineering Management* 6(1): 3–13.

Senvar, Ozlem, Irem Otay, and Eda Bolturk. 2016. "Hospital Site Selection via Hesitant Fuzzy TOPSIS." *IFAC-PapersOnLine* 49(12): 1140–45. http://dx.doi.org/10.1016/j.ifacol.2016.07.656.

Shirvani, Mirsaeid Hosseini, Negin Amirsoleimani, Saeideh Salimpour, and Ahmed Azab. 2017. "Multi-Criteria Task Scheduling in Distributed Systems Based on Fuzzy TOPSIS." *Canadian Conference on Electrical and Computer Engineering* (Figure 1): 1–4.

Singh, P. K., and P. Sarkar. 2019. "A Framework Based on Fuzzy AHP-TOPSIS for Prioritizing Solutions to Overcome the Barriers in the Implementation of Ecodesign Practices in SMEs." *International Journal of Sustainable Development and World Ecology* 26(6): 506–21. https://doi.org/10.1080/13504509.2019.1605547.

Sirisawat, Pornwasin, and Tossapol Kiatcharoenpol. 2018. "Fuzzy AHP-TOPSIS Approaches to Prioritizing Solutions for Reverse Logistics Barriers." *Computers and Industrial Engineering* 117(January): 303–18. https://doi.org/10.1016/j.cie.2018.01.015.