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Using Analytic Hierarchy Process (AHP) and Fuzzy Analytic Hierarchy Process (F-AHP) Methods in Criteria and Alternative Perspectives for Ranking

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Abstract

The application of Analytic Hierarchy Process (AHP) and Fuzzy - Analytic Hierarchy Process (F-AHP) is used as the main method in conducting the ranking process in the case of choosing a major in the Department of Information System UIN Suska Riau. The perspectives of both methods are applied in two levels of hierarchy, namely on criteria and alternatives. In this experiment, AHP was used to rank the criteria, while F-AHP was used for the alternatives. The results of the experiment show that both have a CR value smaller than 0.1. The rankings obtained in order on the criteria side are RP, PD, MMK, Kindergarten and MAP. On the alternative side, the CRM course is followed by SCM, SIC, DS, ITQ, and ITG. This assessment is based on the calculation of the pairwise comparison matrix of some of the best objects from 10 experiments conducted. The conclusion that can be given is that both methods can be implemented in the case study being worked on and all have a good consistency ratio.

Keyword: Analytic Hierarchy Process, Criteria and Alternative, Fuzzy Analytic Hierarchy Process, Optional Courses

1. INTRODUCTION

Choosing elective courses should not be done haphazardly. Although elective courses are courses that students can freely choose[1]. An obstacle that often occurs in filling out Study Plan Card (SPC) is students' confusion in determining elective courses, so that in choosing, it is not uncommon for students to take elective courses based on intuition, friends, lecturers[2].

Choosing elective courses in the Information Systems study program is often a challenging task for students. Students are faced with a wide choice of courses with various topics and focuses. They need to consider personal academic interests, career goals, class schedules, professors and prerequisite course requirements[3]. This kind of decision-making process can become complicated and confusing without proper guidance.

To overcome the problems above, we need a system that is able to provide accurate and fast decisions in choosing elective courses according to student interests [4][5]. AHP, a math-based tool invented by Saaty, helps you make decisions by comparing different options against important factors [6]. This research uses the Analytic Hierarchy Process (AHP) and Fuzzy AHP methods which are powerful enough to determine decisions tailored to the interests of students in the Information Systems study program at the Sultan Syarif Kasim State Islamic University, Riau.

In research, Wang Yuyang et al (2015) stated that the Fuzzy AHP method was able to test efficiently to overcome uncertain problems with research results of 41.0%[7] , Zulfi Azhar (2020) stated that using the AHP algorithm is more efficient and effective in determining SPK. [8] Ayu Cahyani Febryanti et al (2016) stated that the AHP method produces a weighted value for course grade criteria of 65%, and a potential trend criterion of 35% [9]. Afrizal Martin et al (2022) using the The Fuzzy Analytic Hierarchy Process (FAHP) provides a method for enhancing existing data and generating a more appropriate set of criteria to measure lecturer performance at STMIK Pringsewu[10], Kurnia Putri et al. (2019) stated that the AHP method is a form of decision making model that is suitable for use in multi-criteria and multi-alternative problems. The AHP method is also a comprehensive decision making method which takes into account quantitative and qualitative things at once [11]. Muhammad Fikra Adzaki et al (2023) stated that the AHP method could be one way to help implement village community empowerment more effectively [12]. Zulfi Azhar dan , Jeperson Hutahaean (2020) The AHP method can provide an assessment on a number of criteria with several alternative choices in selecting a cafe location in Kisara [13].

Previous research has not explained the comparison between the application of the F-AHP method and the AHP method. Therefore, the novelty of this study lies in analyzing the accuracy comparison of data processing results between the F-AHP and AHP methods. Based on the background, this study aims to understand students' interest in choosing elective courses in the Information Systems study program and to evaluate the performance of the Fuzzy AHP and AHP algorithms in determining elective courses. Empowering students to make course selections that are well-suited to their interests and career goals, 1) Optimizing course choices for a more efficient learning experience, 2) potentially saving time and resources, 3) Reducing wasted effort in course selection by helping students pick the right classes from the start.

2. MATERIAL AND METHOD

The following is Figure 1 of the research methodology in the flow diagram:

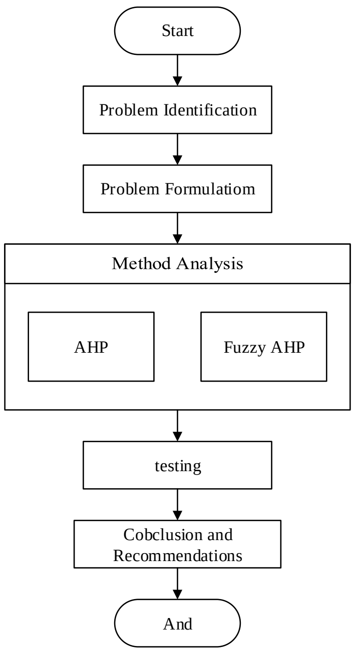

Figure 1. Research Methodology

2.1. Analytic Hierarchy Process (AHP)

While not exclusive to computer science, the Analytic Hierarchy Process (AHP) was developed in the 1970s by Thomas L. Saaty. It's a powerful tool used for making complex decisions [14]. This method breaks down complex problems involving multiple criteria into a hierarchical structure [15]. A hierarchy can be interpreted as a description of a complex or complicated problem in a multi-level structure [16].

AHP streamlines decision-making by providing a structured approach to evaluate complex options with multiple factors, leading to confident and accurate choices. The assessment is through pairwise comparison and relies on expert judgment to obtain a priority scale [17][18]. The stages in solving problems using the AHP method are decomposition (creating a hierarchy), comparative judgment (assessing criteria and alternatives), synthesis of priority (determining priorities) and logical consistency (logical consistency).

Table 1. Analityc Hierarchy

Level of Importance	Definition
1	Both elements have equally important
3	One element is a slightly more important

Level of Importance	Definition
5	One element is clearly more important
7	One element is very important
9	One of the most important elements
2,4,6,8	When in doubt between two adjacent values

1. Calculate the Consistency Index (CI) with the equation 1.

$$\mathrm{CI} = \frac{\max^{\lambda - n}}{n} \tag{1}$$

Explanation:

CI : Consistency Index
Max y : Maximum eigen
N : Number of Criteria

2. Calculate the Consistency Ratio (CR) using the equation 2.

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{IR}} \tag{2}$$

Explanation :

CR : Consistency Ratio
CI : Consistency Index
IR : Random Consistency Index

2.2. Fuzzy-Analytic Hierarchy Process (F-AHP)

Fuzzy AHP is an improvement on the existing AHP method. It tackles problems with many factors (multi-criteria). It organizes these factors in a hierarchy for better analysis[19]. Fuzzy AHP is an advanced methodology resulting from a combination of AHP theory with fuzzy set theory. This combination is used to solve fuzzy hierarchy problems [20][21]. The fuzzy AHP method provides benefits, one of which is helping overcome uncertainty in human judgment using linguistic variables [22].

However, the decision results obtained using Fuzzy AHP are better because they are able to minimize the vague decision descriptions produced by the AHP method [21]. TFN It incorporates three membership functions: the lowest value (I), the middle value (M), and the upper value (U)[23]. The steps for solving Fuzzy AHP are as follows:

1. Construct a hierarchical framework for the problem, then use the TFN scale to compare the relative importance of each criterion in pairwise matrices.. Determine the priority fuzzy synthesis value (Si) using the equuation 3.

$$\mathrm{Si} = \sum_{j=1}^{m} \mathrm{M}_i^j \mathrm{x} \frac{1}{\sum_{i=1}^{n} \sum_{j=1}^{m} \mathrm{M}_i^j} \tag{3}$$

2. The normalized fuzzy vector weight values (W) are calculated as equation 4.

$$\mathrm{W} = \left(\mathrm{d}(\mathrm{A}_1), \mathrm{d}(\mathrm{A}_2), \dots, \dots \mathrm{d}(\mathrm{A}_n)\right)^{\mathrm{T}} \tag{4}$$

Where w is non fuzzy.
The normalization formulation using eqution 5.

$$\mathrm{d}(\mathrm{A}_n) = \frac{\mathrm{d}'}{\sum_{i=1}^{n} \mathrm{d}'(\mathrm{A}_n)} \tag{5}$$

Table 2. Presentation of Analityc Hierarchy

Priority Intensity AHP	Linguistic Fuzzy Set	Triangular Fuzzy Number (TFN)	Reciprocal (Inverse)
1	Comparison of similar elements	(1,1,1)	(1,1,1)
2	Mid	(1/2, 1, 3/2)	(2/3, 1, 2)
3	One element is quite important than the others	(1, 3/2, 2)	(1/2, 2/3, 1)
4	The middle of one element is more important than the others	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
5	One element is stronger in importance than the others	(2, 5/2, 3)	(1/3, 2/5, 1/2)
6	Mid	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)

Priority Intensity AHP	Linguistic Fuzzy Set	Triangular Fuzzy Number (TFN)	Reciprocal (Inverse)
7	One element is stronger in importance than the other	(3, 7/2, 4)	(1/4, 2/7, 1/3)
8	Mid	(7/2, 4, 9/2)	(2/9, 1/4, 2/7)
9	One element is absolutely more important than the others	(4, 9/2, 9/2)	(2/9, 2/9, 1/4)

3. RESULTS AND DISCUSSION

Researchers at UIN Suska Riau's Information Systems Department gathered data from students using a special survey. This survey presented students with a table where they rated their educational goals against various important factors. The department then analyzed the completed surveys to understand student preferences. Several criteria are taken based on research results that influence determining elective courses in the Information Systems department at UIN Suska Riau, namely: Personal Academic Interests (MAP), Career Goals (TK), Lecturer Preferences (PD) and Research Plans (RP), Subject Interests College (MMK). To analyze the priority level of these criteria, it is done by forming. The AHP Stucture as be seen figure 2.

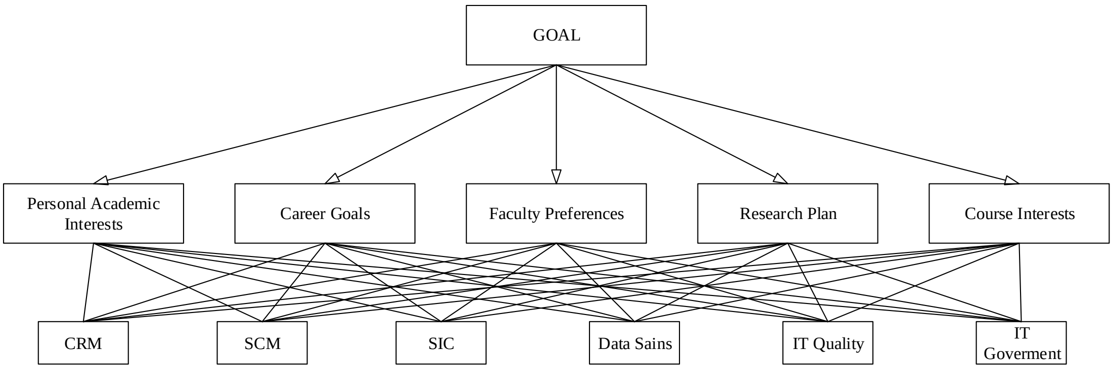

Figure 2. The AHP Stucture

3.1. AHP Criteria Comparison Matrix

In table 1 is a basic description of the comparison of several criteria factors that influence the selection of elective courses in the information systems study program. In table 1 is the assessment obtained from field data from the data form. Then a synthesis table is formed which is the basis for obtaining a priority scale for factors from the criteria.

Table 3. AHP Criteria Comparison Matrix

Criteria	MAP	TK	PD	RP	MMK
MAP	1	1	3	2	5
TK	1/1	1	2	1	3
PD	1/3	1/2	1	3	2
RP	1/2	1/1	1/3	1	2
MMK	1/5	1/3	1/2	1/2	1

Accurate comparisons between criteria rely heavily on thoughtful responses within the assessment. Errors in filling in data can occur if the data is collected incorrectly. The results will result in not achieving the expected priority values. Upon completion of filling in the comparison data in the criteria comparison matrix synthesis, the data will be normalized with table 4 Normalization.

Table 4. Normalization

Criteria	MAP	TK	PD	RP	MMK	Total
MAP	4.99	7.17	11.16	16.50	23.00	62.82
TK	3.76	5.00	8.83	11.50	17.00	46.09
PD	3.06	5.00	4.98	8.16	13.15	34.35
RP	2.51	3.33	5.16	4.99	10.16	26.15
MMK	1.15	1.62	2.43	3.23	5.00	13.43

The normalization table shows that the number of each criterion is 1 (one) and the number of all criteria is 5 (five). The total value of each criterion is shown in column 7 (seven). Once you've created the comparison tables (Table 1 and 2) for each criterion, you'll need to normalize them. This involves calculating the average weight for each criterion. To do that, you add up the values in each column of the tables and divide by the number of criteria. These average weights will then be used to rank the importance of each criterion. Normalization helps compare criteria on a common scale. You calculate the average weight by summing each column and dividing by the number of criteria. These average weights are used to rank the criteria by importance, show the table 5.

Table 5. Percentage and Priority Ranking

Criteria	Priority	Priority Presentation	Priority Ranking
MAP	0.344	34.36%	1
TK	0.252	25.21%	2
PD	0.188	18.79%	3
RP	0.143	14.30%	4
MMK	0.073	7.35%	5
Total	1.000	100%	

The calculation of the weighting results to determine the ranking of alternatives using Fuzzy AHP by convecting the criteria weighting values of each alternative and then calculating the weighting between the criteria and the alternative, so that from this calculation a ranking will be carried out where the CRM alternative code has a value. The highest alternative as an elective course and followed by the SCM, SIC, DS, ITQ and ITG codes can be seen in the following table 6.

3.2. Value Conventions

Table 6. Value Convention

	MAP	TK	PD	RP	MMK	Value
CRM	0.597	0.403	0.000	0.000	0.000	1.000
SCM	0.447	0.403	0.000	0.000	0.000	0.850
SIC	0.597	0.302	0.000	0.000	0.000	0.850
DS	0.447	0.302	0.000	0.000	0.000	0.750
ITQ	0.447	0.302	0.000	0.000	0.000	0.750
ITG	0.447	0.302	0.000	0.000	0.000	0.750

If the hierarchical consistency figure is more than 10%, the data assessment must be repeated. Hierarchical consistency ratio (CR) <0.1 calculations are correct. Let λ represent the maximum of the sum of multiplications in the synthetic matrix column, which corresponds to the criteria in Table 4 and the priority column in Table 6. Therefore, the goal is to find the maximum eigenvalue, CI and CR values can be calculated as follows:

$$\text{CI} = \frac{5.33-5}{5-1} = 0.082$$

$$\text{CR} = \frac{0.0825}{1.12} = 0.073$$

Determining the RI value is based on the number of criteria (n) that have been created. There are 5 criteria, hence the number of criteria is n = 5, resulting in an RI value of 1.12 based on the Random Index (RI) table. So the next step is to determine the CR value. So the CR value = 0.073 and meets the requirements, where CR < 0.1 so it can be illustrated that the process of determining the priority of criteria that influence the selection of elective courses can be declared consistently correct, with the CR value being 0.073 and the value is smaller than 0.1.

The findings of this research indicate that by comparing the matrices of various criteria, the results are consistent with previous studies, demonstrating a Consistency Ratio (CR) value of less than 0.1. And if the CR value is greater than 10% then the results of the comparison will be inconsistent. The results of this research are consistent with English research. Kurnia Putri et al. (2019) stated that the AHP method is a form of decision making model that is suitable for use in multi-criteria and multi-alternative problems. The AHP method is also a comprehensive decision making method which takes into account quantitative and qualitative things at once [11].

4. CONCLUSION

After carrying out calculations using 2 algorithms, namely AHP and Fuzzy AHP, several things were obtained, namely the AHP method was able to choose priorities based on criteria that influenced the selection of elective courses in the Information Systems department at UIN Suska Riau. The highest ranking value is a priority scale which influences the criteria for selecting elective courses. In calculations using AHP, values are obtained based on priority criteria with ranking from highest to lowest, namely (1) Research Plan (RP), (2) Lecturer Preference (PD), (3) Subject Interest (MMK), (4) Kindergarten (Career Goals) and (5) Personal Academic Interests (MAP). Meanwhile, the Fuzzy AHP method is able to calculate the best alternative, namely the elective course with the highest weight, namely the CRM course, followed by SCM, SIC, DS, ITQ, and ITG. This research can provide information and preferences in choosing elective courses in the Information Systems department so that selecting elective courses is no longer a problem that continues to occur when students choose elective courses. Based on the research results, further analysis is needed for future studies with broader data and diverse methods.

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