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Internship Placement Recommendation for Final Year Students Using a Fuzzy Logic System of Artificial Intelligence

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ABSTRACT

This study presents a Fuzzy Logic System (FLS) to support the final-year Bachelor of Science (Hons.) Mathematics students at Universiti Teknologi MARA (UiTM), Shah Alam, in selecting suitable internship placements. The project aims to identify key decision-making criteria, develop a fuzzy logic control system, and evaluate its effectiveness and usability. Unlike traditional methods, the system handles uncertainty and subjective preferences through fuzzy logic. Based on the literature review and student interviews, four main criteria were selected: salary, location, job opportunity, and organizational reputation. Using the Mamdani inference method in MATLAB, the model was designed with triangular membership functions and a rule base. To test the system, data from three final-year students were analyzed, comparing their actual internship choices with system recommendations. Results showed that the system produced appropriate and reliable suggestions, while usability testing confirmed that the interface was simple and helpful for decision-making. Overall, the project successfully met all objectives, demonstrating the value of fuzzy logic in addressing the complexity of internship selection. Future improvements may include adding more criteria and developing a web or mobile platform to increase accessibility and impact.

Keywords: Decision support, Fuzzy logic system, Higher education, Internship placement.

1 INTRODUCTION

In higher education, industrial internships are part of the academic curriculum; each academic program has a particular number of industrial internships. Internships allow undergraduate students to relate work experience and knowledge to academic education while performing supervised and structured work in professional environments [1], [2], [3].

When choosing the best internship place, it is important to take students' requirements into consideration to enhance their morale and working productivity. A negative internship experience might cause individuals to change rapidly and start avoiding the industrialized atmosphere [4], [5],

[6]. For students of mathematics, internships are a crucial approach to exposing students to real-life problem-solving and analytical skills in areas such as data analysis, software development, finance, and research. However, choosing an internship that fits the student's academic profile, career goals, and individual interests is not always easy and is a process that involves several criteria [7].

In an attempt to solve this challenge, this project seeks to propose a decision support system for mathematics students. Based on the fuzzy logic criteria that include compensation [8], [9], job market [10], [11], organizational reputation [12], and location [13]. This system identifies the most suitable internship offers. This brings out a more effective and more selective method as compared to the other traditional methods. Recent studies have continued to demonstrate the effectiveness of fuzzy logic systems in various real-world applications, highlighting their adaptability in handling complex and uncertain data [14].

A study mentioned some important findings regarding selection factors for internships from the perceptive of tourism students. However, the paper only mentioned certain points of view, such as in the tourism domain, the decision-making of such options as internships by students from mathematics is not well explained [15]. From the methodological point of view, the overwhelming majority of the works discussed are based on rather conventional decision-making techniques, such as Stepwise Weight Assessment Ratio Analysis (SWARA), which can hardly reflect the subtleties and vagueness of students' preferences [16] In addition, the analysis of decision-making across different disciplines still lacks sufficient data to generalize, so the findings are only partial [17], [18], [19], [20], [21].

This project fills these gaps. First, by involving participants who are mathematics students, it expands the range of criteria considered in internship selection from subjects that are traditionally used in the research, which can be useful for other fields. Second, employing a Fuzzy Logic System means that here we have a more innovative and efficient approach to a problem at the same time at which it is possible to define the subjectivity and uncertainties of decision-makers. Finally, the framework provides the basis for future comparative research across academic disciplines, improving the general knowledge of various groups of students in choosing internships.

2 RESEARCH METHODS

This research methodology discusses the development process of a Fuzzy Logic System (FLS) that suggests internship locations to final year students. The methodology illustrates the procedures for selecting crucial decision-making elements and gathering data to create the fuzzy logic model, which gets verified through systematic testing.

This methodology implements both qualitative aspects and quantitative systems. Five final-year mathematics students receive interviews to capture their thoughts on how they chose their internships. The information acquired from data collection helps define fuzzy rules as well as membership functions to construct a functional decision-making framework. MATLAB serves as the platform to both develop and test the fuzzy logic system implementation.

2.1 Fuzzy logic model development

This subsection describes the step-by-step process of developing the fuzzy logic model used in the system, including the definition of input and output variables, the construction of membership functions, the rule base formulation, and the defuzzification method applied. Figure 1 shows the flowchart of internship placement recommendation for final year students by a fuzzy logic system.

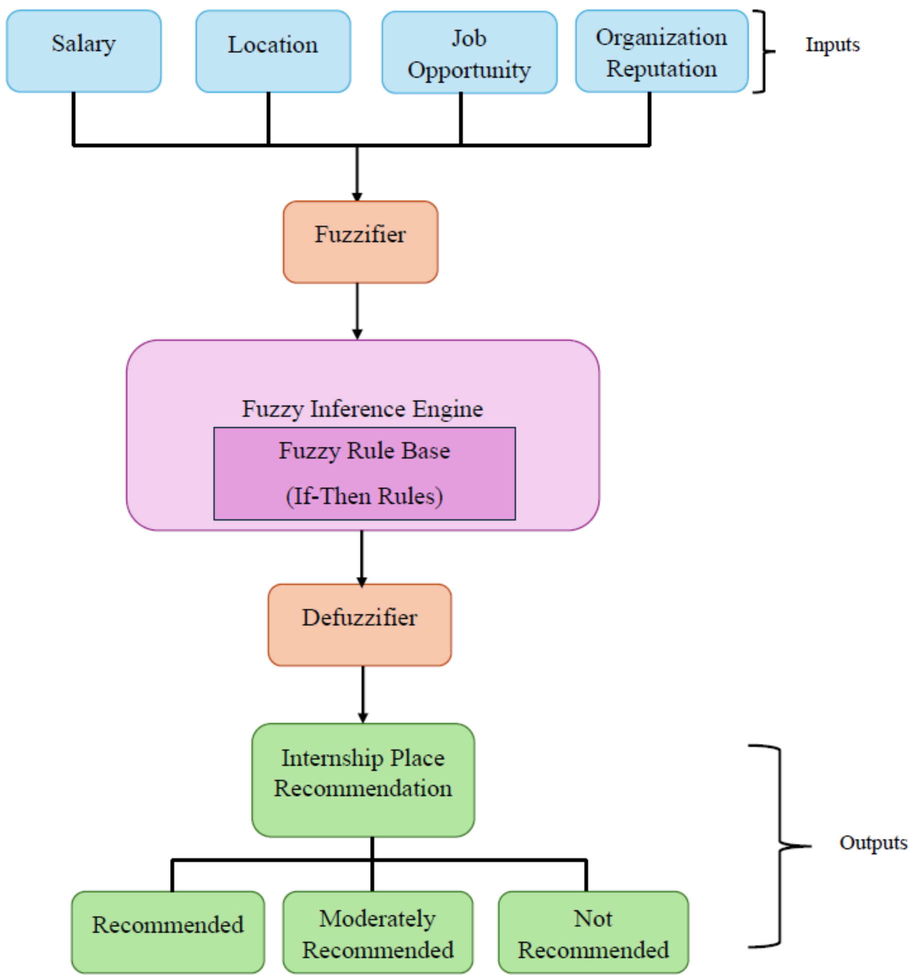


Figure 1 : Flowchart of Internship Placement Recommendation for Final Year Students by a Fuzzy Logic System

Fuzzification: Converting crisp input values for the criteria into fuzzy sets using membership functions. This process implies identification of the extent of the input to the measured linguistic variables.

For example:

a. Compensation (Low, Medium, High)

b. Location (Far, Moderate, Near)

This implies that each final-year student has three internship options from which to select using the fuzzy logic expert system's input variables. Three parameters (a, b, and c) will determine the triangle membership functions for each input variable as follows:

$$\mu_A(x) = \begin{cases} \dfrac{x-a}{b-a} \; ; a \le x \le b \, , \\ \dfrac{c-x}{c-b} \; ; b \le x \le c \, , \\ \;\; 0 \quad ; elsewhere \end{cases} \tag{1}$$

Rule Base Creation: Defining fuzzy rules based on expert input from the participating students. Specifically, the fuzzy rule bases comprise the following canonical fuzzy IF-THEN rules:

$$Ru^{(l)}: IF\ x_1\ is\ A_1^l\ and\ \ldots and\ x_n\ is\ A_n^l, THEN\ y\ is\ B^l \tag{2}$$

Where A_1^l and B^l are fuzzy sets in $U_i \subset R\ and\ V \subset R$ and $x = (x_1, x_2, \ldots, x_n)^T \in U$ and $y \in V$ are the input and output (linguistic) variables of the fuzzy system, respectively. Let M be the number of rules in fuzzy rule base; that is $l = 1,2, \ldots, M$.

Inference Engine: Applying the fuzzy rules using Mamdani inference to evaluate the criteria and compute the overall suitability of each internship option. The method proposed by Mamdani is given below [22]:

$$\mu_c(y) = Max_K[Min[\mu_A\big(input(i), \mu_B(input(j)\big)\big)] \\ where\ K = 1,2,3,4, \ldots, r \tag{3}$$

Defuzzification: Converting the fuzzy output back into a crisp score. This project uses Centroid method used to rank internships selection:

Centroid method:

$$y^* = \frac{\int \mu_{\tilde{B}}(y) \cdot ydy}{\int \mu_{\tilde{B}}(y)dy} \tag{4}$$

Where $\int$ denotes an algebraic integration.

2.2 Variables Overview and Linguistic Variables

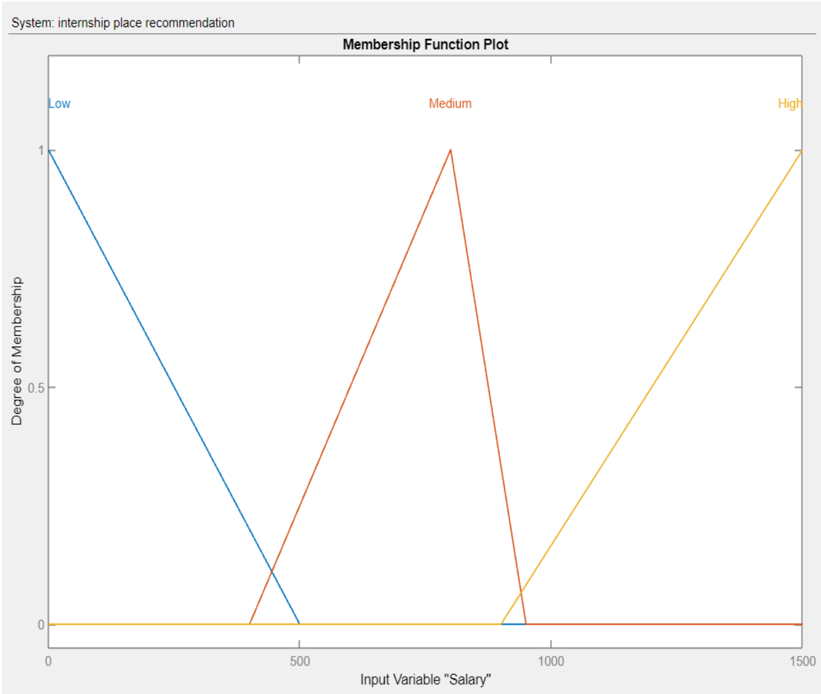
The fuzzy logic system recommends internship placements through the combination of input variables and output variables, which are shown in this table. The fuzzy logic system uses four input factors, which consist of Salary (RM), Location (km), Job Opportunity, and Organization Reputation. The set of linguistic values assigned to each variable consists of "Low", "Medium", or "High". These values describe qualitative aspects of the data measurement. The linguistic values receive numeric ranges in real-life applications through triangular membership functions to manage human judgment imprecision. The Internship Place output variable contains three categories with distinct "Not Recommend", "Moderately Recommend", and "Recommend" membership functions and definition explanations. Table 1 denotes the fuzzy logic linguistic variables, values, membership functions, and descriptions for the internship selection system. Meanwhile, Figure 2 shows the triangular membership functions for each variable.

Table 1 : Fuzzy Logic Linguistic Variables, Values, Membership Functions, and Descriptions for Internship Selection System.

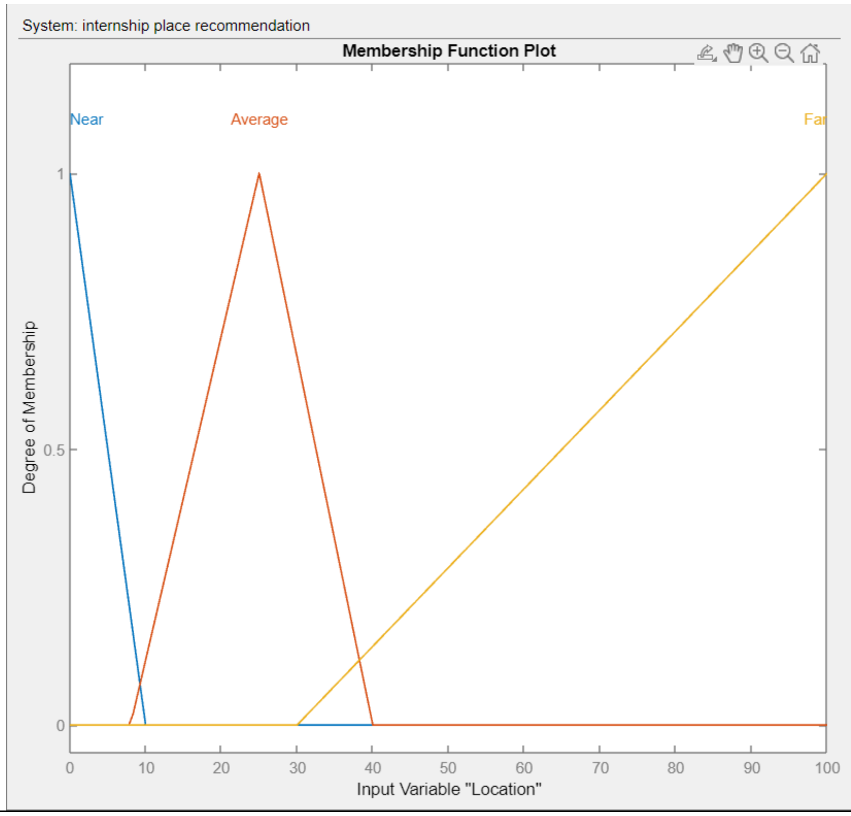
Linguistic Variable	Linguistic Value	Real-Life Range	Triangular Membership Function	Description
Salary (RM)	Low	0 – 500	(0.00, 0.00, 500)	Low stipend or unpaid internship
	Medium	400 – 950	(400, 800, 950)	Most internships only provide compensation that covers essential living costs.
	High	900-1500	(900, 1500, 1500)	High-paying internship (corporate)
Location (km)	Near	0 – 10	(0.00, 0.00, 10)	The site is reachable through walking and bicycling in addition to brief driving distances.
	Average	8 – 40	(8, 25, 40)	The transportation duration and expenses to this location hold reasonable levels.
	Far	30 – 100	(30, 100, 100)	The job requires substantial movement possibly involving permanent relocation or living in different locations.
Job Opportunity	Low	0-4	(0.00, 0.00, 4)	Very limited job potential
	Medium	3-7	(3, 5, 7)	Some job potential or skill development
	High	6-10	(6, 10, 10)	Strong job prospects after internship

Linguistic Variable	Linguistic Value	Real-Life Range	Triangular Membership Function	Description
Organization Reputation	Bad	0-4	(0.00, 0.00, 4)	New, unknown, or with bad reviews
	Good	3-7	(3, 5, 7)	The company exists under regional recognition or market industry standards
	Excellent	6-10	(6, 10, 10)	Companies that hold established positions and possess awards or accreditations
Level of Preference	Not Recommend	0-4	(0.00, 0.00, 0.40)	Should be avoided if possible
	Moderately Recommend	3-7	(0.30, 0.50, 0.70)	Acceptable choice with some trade-offs
	Recommend	6-10	(0.60, 1.0, 1.0)	This selection provides excellent results by satisfying most selection requirements.

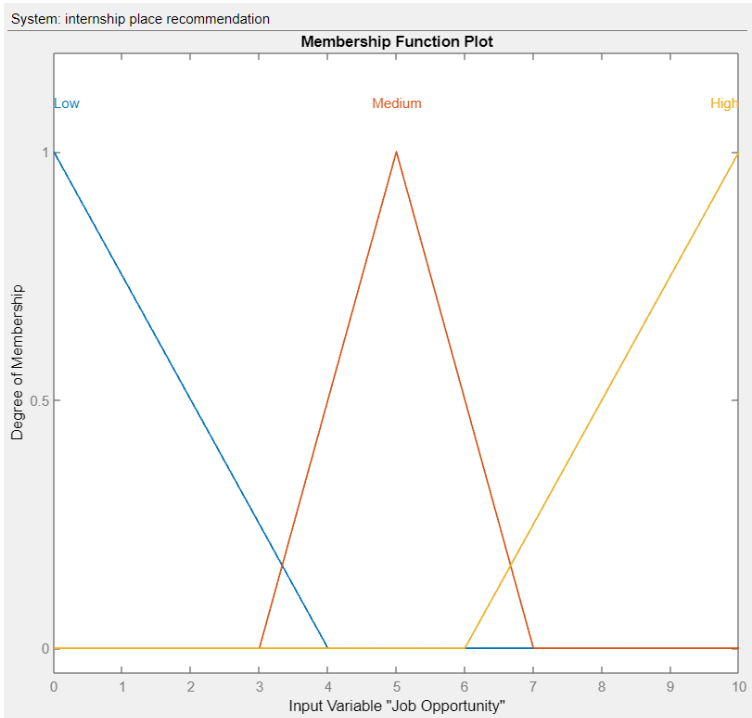
a) Salary



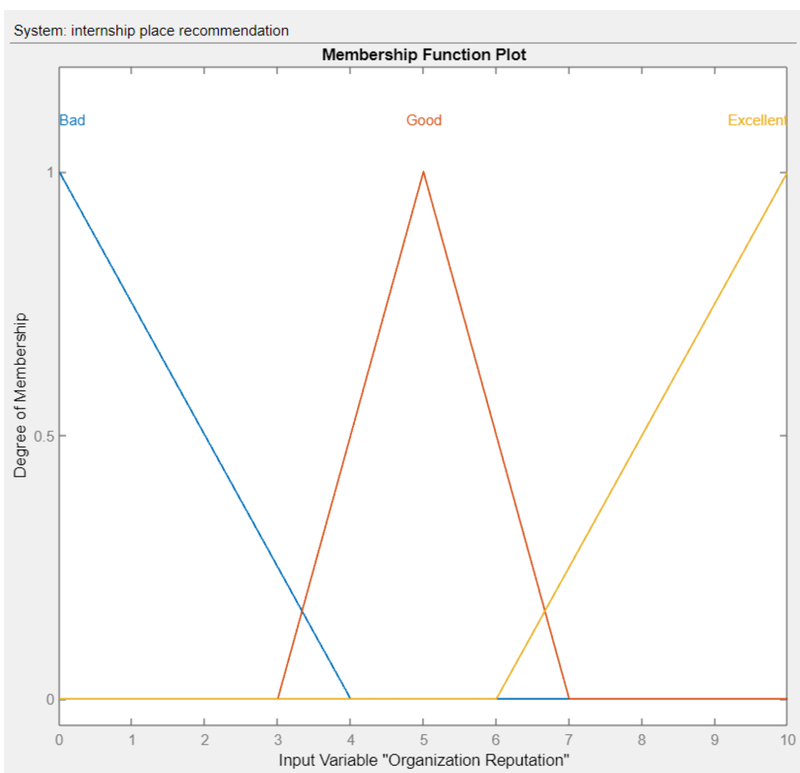
b) Location



c) Job Opportunity



d) Organization Reputation



e) Internship Place Recommendation

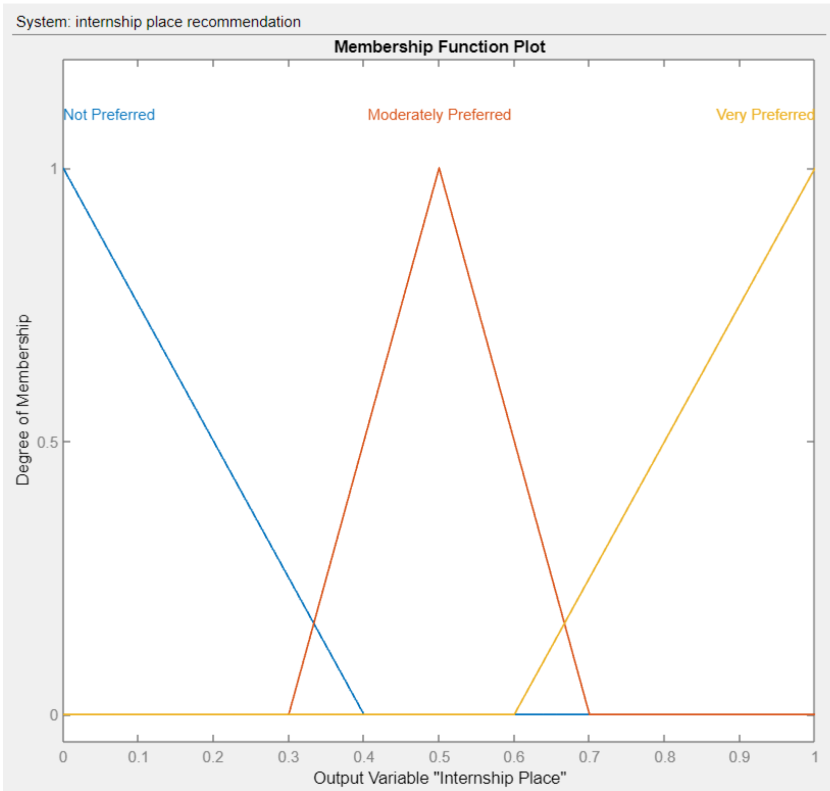


Figure 2 : Triangular Membership Functions for Each Variable

2.3 Fuzzy Rule Base for Internship Recommendation System in MATLAB

The system implements decision making through its fuzzy rule base which this figure illustrates some portions of it. The system uses IF-THEN rules that link multiple input variable factors, including Salary, Location, Job Opportunity, and Organization Reputation, to produce an output recommendation for Internship Placement Preference. These fuzzy rules were developed through the feedback of five final-year mathematics students of UiTM Shah Alam, who were used as the domain experts in this project. All students were interviewed in a session, in which they were asked to give their personal experiences, preferences, and rationale in choosing their own internship placements. Their answers were processed to extract general patterns and preferences, which were in turn mapped into the fuzzy logic rule base. For example, when salary is high along with a preferred location and high job opportunities, and an excellent organization reputation, the preference for internship placement becomes very strong. There are a total of 81 rules for this system. Figure 3 displays part of a fuzzy rule in MATLAB.

	Rule	Weight	Name
1	If Salary is Low and Location is Near and Job Opportunity is Low and Organization Reputation is Bad then Internship Place is Not Preferred	1	rule1
2	If Salary is Medium and Location is Near and Job Opportunity is Low and Organization Reputation is Bad then Internship Place is Not Preferred	1	rule2
3	If Salary is High and Location is Near and Job Opportunity is Low and Organization Reputation is Bad then Internship Place is Not Preferred	1	rule3
4	If Salary is Low and Location is Average and Job Opportunity is Low and Organization Reputation is Bad then Internship Place is Not Preferred	1	rule4
5	If Salary is Medium and Location is Average and Job Opportunity is Low and Organization Reputation is Bad then Internship Place is Not Preferred	1	rule5
6	If Salary is High and Location is Average and Job Opportunity is Low and Organization Reputation is Bad then Internship Place is Not Preferred	1	rule6
7	If Salary is Low and Location is Far and Job Opportunity is Low and Organization Reputation is Bad then Internship Place is Not Preferred	1	rule7
8	If Salary is Medium and Location is Far and Job Opportunity is Low and Organization Reputation is Bad then Internship Place is Not Preferred	1	rule8
9	If Salary is High and Location is Far and Job Opportunity is Low and Organization Reputation is Bad then Internship Place is Not Preferred	1	rule9
10	If Salary is Low and Location is Near and Job Opportunity is Medium and Organization Reputation is Bad then Internship Place is Not Preferred	1	rule10

Figure 3 : Part of Fuzzy Rule in MATLAB

2.4 Rule Inference for Each Criterion

The presented figure shows how the system processes inputs at median values to produce recommendations. The fuzzy system functions by processing medium-level inputs to decide well-balanced internship recommendations. This reference performance indicates the default behavior of the system for evaluative purposes. Figure 4 denotes the rule inference for the median value of inputs.

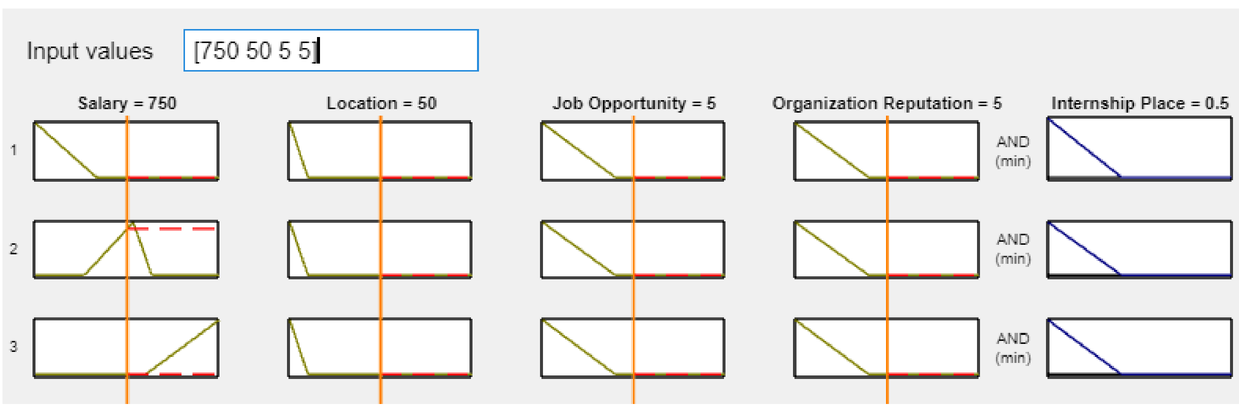


Figure 4 : Rule Inference for Median Value of Inputs

3 RESULTS AND DISCUSSION

This section displays the findings acquired from implementing and testing the Internship Placement Recommendation System through Fuzzy Logic. The system helped final-year mathematics students choose optimal internships through four ranking criteria, which included salary, location and job opportunities, and organization reputability. The system performance was examined through testing conducted with three final year students who have performed their internship. Every student entered actual values regarding different internship options into the recommendation system. Through the MATLAB implementation of the fuzzy rule base and membership functions, the system processed input values to generate output recommendations with preference scores and linguistic categories that include Not Recommend, Recommend, and Moderately Recommend.

3.1 Student 1 Internship Placement Recommendation Outcome

This section describes the evaluation process of the fuzzy logic system using real data from final-year students. For Student 1, they had two internship options: Company A and Company B. They provided specific input data for their internship options, and the system's recommendations were compared with the actual choices they made. Table 2 shows the fuzzy logic system evaluation for student 1.

Table 2 : Fuzzy Logic System Evaluation for Student 1

Company	Criteria	Input	Output	Currently Internship Place
Company A	Salary (RM)	1045.35	0.826 (Recommend)	Yes
	Location (km)	20		
	Job Opportunity	7		
	Organization Reputation	9		
Company B	Salary (RM)	1000	0.5 (Moderately Recommend)	No
	Location (km)	40		
	Job Opportunity	6		
	Organization Reputation	6		

The system testing consisted of evaluating three different internship choices conducted by Student 1. Through each set of inputs, the Fuzzy Logic System provided recommendation scores. The recommended score of 0.826 obtained by Company A determined it as the most suitable internship because the organization did exceptionally well across all assessment aspects, especially salary and reputation. This justifies their current placement. The rating evaluation of Company B resulted in a 0.5 score that indicates this organization falls between average and exceptional in its criteria assessments. The organizational reputation, combined with job opportunity scores, remains slightly below average, thus leading to the moderate recommendation rating. Student 1's preference for both high compensation and a strong reputation rating received support from the system, but a distance longer than 60 kilometers produced negative consequences. The selected internship perfectly suits what they consider important. Figure 5 displays the Rule Inference of Student 1. A study finds that salary and benefits strongly influenced students' placement choices is supported by a study that found that 35.6% of graduates cited salaries & benefits as the main reason for job choice [23].

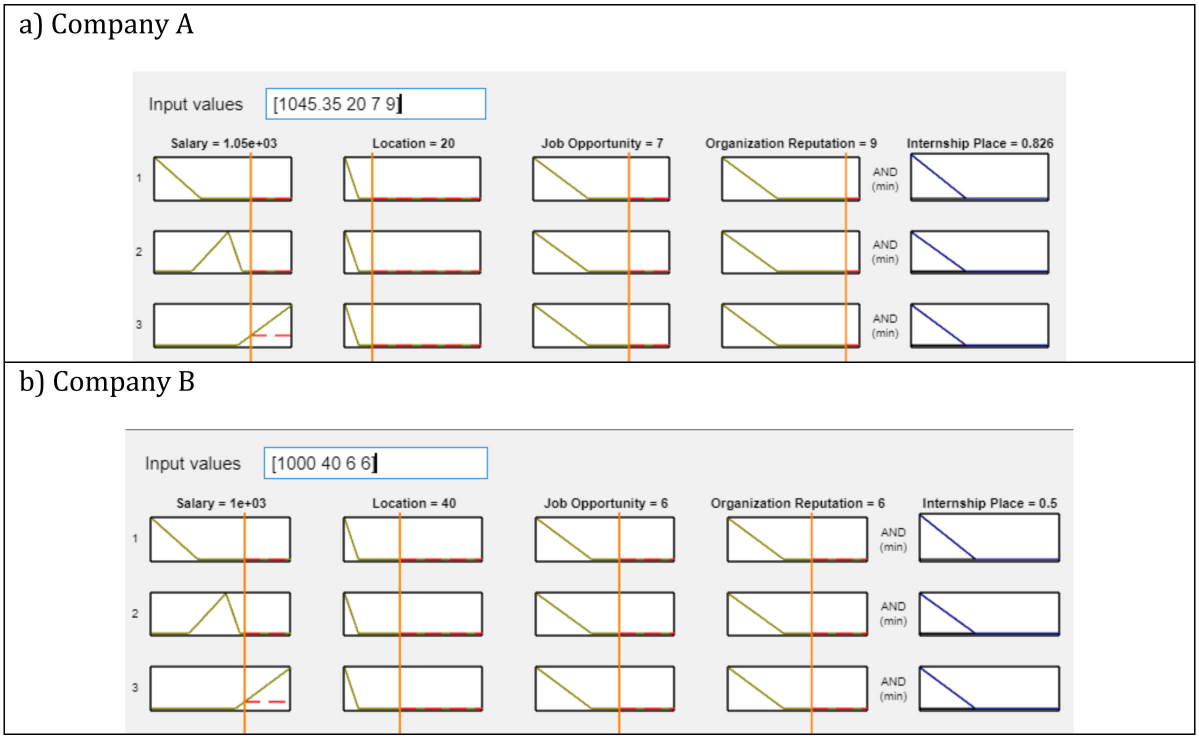


Figure 5 : Rule Inference of Student 1

3.2 Student 2 Internship Placement Recommendation Outcome

This section describes the evaluation process of the fuzzy logic system using real data from final-year students. For Student 2, they had two internship options: Company C and Company D. They provided specific input data for their internship options, and the system's recommendations were compared with the actual choices he made. Table 3 shows the fuzzy logic system evaluation for student 2.

Table 3 : Fuzzy Logic System Evaluation for Student 2

Company	Criteria	Input	Output	Currently Internship Place
Company C	Salary (RM)	1000	0.819 (Recommend)	Yes
	Location (km)	35		
	Job Opportunity	8		
	Organization Reputation	8		

Company D	Salary (RM)	0	0.5 (Moderately Recommend)	No
	Location (km)	48		
	Job Opportunity	7		
	Organization Reputation	9		

Student 2 evaluated two internship placement options. Company C received a Recommended rating (0.819) because its input scores remained high throughout all four criteria assessments. The high degree of compatibility established the rationality behind their preferred choice. The high reputation and excellent job opportunities at Company D were not sufficient to offset its zero salary and distant location, which produced a Moderately Recommend output score of 0.5 due to its combined ratings. The system accurately identified financial compensation issues and geographical obstacles as distinct weaknesses, which demonstrated its capacity to incorporate realistic student requirements. This case revealed that the bank's prestige could not sufficiently outweigh its significant negative aspects. Figure 6 displays the rule inference of student 2.

a) Company C

b) Company D

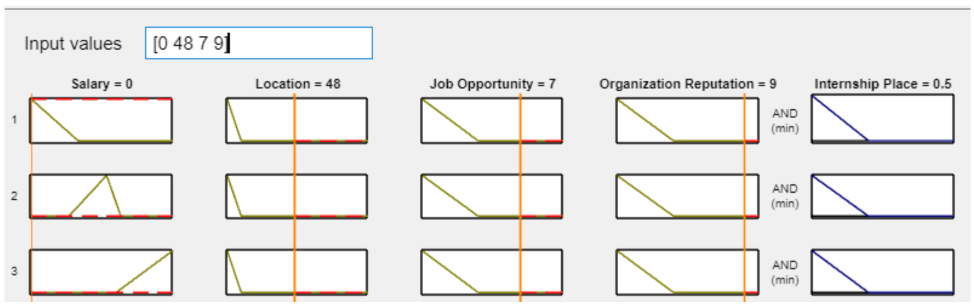


Figure 6 : Rule Inference of Student 2

3.3 Student 3 Internship Placement Recommendation Outcome

This section describes the evaluation process of the fuzzy logic system using real data from final-year students. For Student 3, they had two internship options: Company E and Company F. They provided specific input data for their internship options, and the system's recommendations were compared with the actual choices they made. Table 4 shows the fuzzy logic system evaluation for student 3.

Table 4 : Fuzzy Logic System Evaluation for Student 3

Company	Criteria	Input	Output	Currently Internship Place
Company E	Salary (RM)	1000	0.819 (Recommend)	Yes
	Location (km)	8		
	Job Opportunity	7		
	Organization Reputation	6		

Company F	Salary (RM)	1500	0.5 (Moderately Recommend)	No
	Location (km)	12		
	Job Opportunity	6		
	Organization Reputation	7		

Student 3 examined two possible sites where they could complete their internship. The recommendation from Company E earned a Recommend position at 0.819. The internship located just 8 kilometres from their house provides both a good salary and promising employment prospects, which match their desired criteria exactly. The company Company F paid its interns RM1500 but scored lower than Company E in organizational reputation and job opportunities despite being farther from their house. The evaluation of these factors reduced the system score to 0.5 and classified the option as Moderately Recommended. This situation demonstrates how the system effectively weighs financial payment in relation to multiple key elements. The combination of a higher salary along with slightly lower scores for reputation and opportunity forced Company F to receive a lower ranking position. The chosen internship proves to be the most suitable among all options. Figure 7 shows the rule inference of student 3. Similarly, a study found that higher remuneration and positive organizational attributes increased students' intention to accept an internship offer [24].

a) Company E

b) Company F

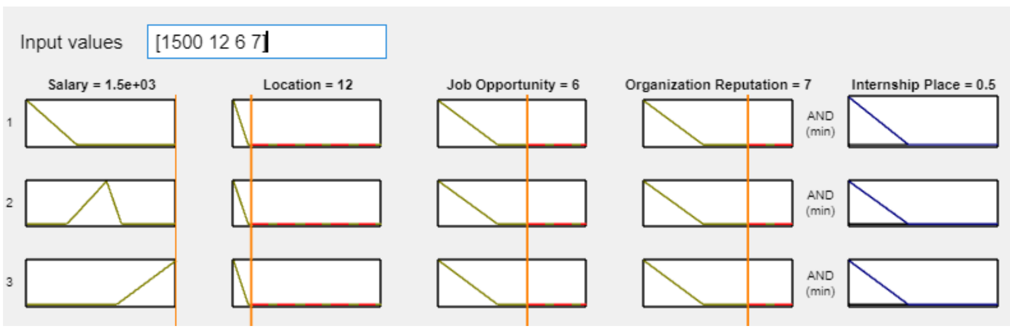


Figure 7 : Rule Inference of Student 3

4 CONCLUSION

The objective of this work involved building an algorithm using Fuzzy Logic to recommend appropriate internship positions for final-year math students. The system included subjective student preferences for four main factors, which included salary, along with location and job opportunities, alongside organizational reputation. Research through literature review and surveys of the target demographic served as the basis for selecting those factors.

The system generated effective personalized recommendations that integrated quantitative as well as qualitative requirements of internship selection. The participating students received specific internship suggestions from the system through linguistic labels that matched their preferences while closely matching their anticipated and selected options.

The system demonstrated versatility through its ability to understand minor differences in input values among related internship options, thus revealing its capability to identify subtle student preference differences. MATLAB implementation facilitated the visualization of fuzzy inference, making the entire recommendation process more transparent and easier to interpret.

This project was able to meet all its set objectives. Firstly, the system could learn and narrow down important selection criteria for internship placement decision-making, including salary, location, job opportunity, and organization reputation, which generated valuable and relevant results. Secondly, the recommendation system was designed and applied in MATLAB, which was a functional fuzzy logic recommendation system with membership functions and rule-based reasoning, considering the actual student preferences. Finally, the model was tested with real data that was obtained from three final-year students, and it could provide useful and customized internship placement suggestions with the inputs. The results confirm that fuzzy logic provides accurate and practical recommendations. Future enhancements should expand evaluation criteria and deploy the system on web or mobile platforms for broader accessibility.

The Internship Placement Recommendation System can be improved by adding more factors, such as work-life balance, skill relevance, mentorship quality, and company culture. Connecting it to university databases and internship platforms will make data entry easier and more accurate. Changing it from a MATLAB system to a web or mobile app will also make it more accessible for students. Testing it with a larger and more diverse group of students will help measure its performance. Adding a feedback feature will allow users to rate suggestions and help the system improve over time. These updates will make the system more useful, practical, and student-friendly.

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