Proceeding International Conference on Economy, Education, Technology, and Environment
Vol. 3, No. 1, July 2025
https://prosiding.utp.ac.id/index.php/ICEETE

Applying the Fuzzy Tsukamoto Method to Determine Eligibility for Village Fund BLT (Direct Cash Assistance)

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ABSTRACT

The Village Fund Direct Cash Assistance (BLT DD) is a government program aimed at supporting rural communities by improving their economic conditions and quality of life. According to Indonesian regulations, there are five categories of eligible beneficiaries, including those who have lost their livelihood, have a chronically ill or disabled family member, are not receiving assistance from the Family Hope Program, live in households with a single elderly member, or are female-headed households from extremely poor families. However, the regulation lacks clear criteria regarding the income threshold for extreme poverty, creating uncertainty during the beneficiary selection process. This study proposes the use of the Fuzzy Tsukamoto method as a decision support tool to assist verification officers in determining the eligibility of potential BLT DD recipients. The Fuzzy Tsukamoto method, based on fuzzy logic principles, allows for degrees of truth and membership, enabling more nuanced decision-making in conditions of uncertainty. By applying this method, the selection process can become more objective, transparent, and aligned with the actual socioeconomic conditions of rural residents. The research is expected to contribute to the accurate targeting of government aid and to help reduce poverty in rural areas. Additionally, this study enhances understanding of fuzzy logic applications in social assistance programs and highlights its potential for broader use in complex decision-making environments.

KEYWORDS: BLT DD, Direct Cash Assitance, Fuzzy, Tsukamoto, Village Fund

INTRODUCTION

The Village Fund Direct Cash Assistance (BLT DD) is provided to support rural communities in improving their economy and quality of life. According to the Regulation of the Minister of Villages, Development of Disadvantaged Regions, and Transmigration of the Republic of Indonesia Number 13 of 2023 concerning Operational Guidelines for the Focus of Village Fund Usage in 2024, paragraph (3) outlines five categories of BLT DD beneficiary families: loss of livelihood, having a family member with a chronic illness or disability, not receiving social assistance from the Family Hope Program, households with an elderly single member, and female-headed households from extremely poor families. (Danang Rifai, 2023)

However, the regulation does not specifically mention the income threshold for individuals categorized as extremely poor. Article 3 Paragraph 4 states that in determining beneficiary families as referred to in Paragraph (3), the Village Government may use government data as a reference to identify families eligible for Village Fund Direct Cash Assistance. Meanwhile, Paragraph 5 states that the list of beneficiary families, as referred to in Paragraphs (2), (3), and (4), shall be discussed and agreed upon in a Village Meeting and formalized through a decision by the Village Head. (Astri

Charolina, 2024) This creates uncertainty regarding the income level that qualifies a person as extremely poor, which may hinder data collection officers and potentially lead to inaccurate data recording, resulting in the misallocation of aid.

In this study, the author aims to examine the distribution of Village Fund Direct Cash Assistance (BLT DD) using the Fuzzy Tsukamoto method. The objective of this research is to assist verification officers in determining the eligibility of beneficiaries for BLT DD through the application of the Fuzzy Tsukamoto method. Moreover, it is expected that this government program can be more accurately targeted and contribute to reducing poverty levels in rural communities. This study also provides significant benefits for the author, particularly in gaining a deeper understanding of fuzzy logic, especially the Fuzzy Tsukamoto method. (Ipung Dwi Antoni, 2024) Fuzzy logic was introduced in the 1960s by Professor Lotfi Zadeh from the University of California, Berkeley, who discovered that the binary true-or-false principles of Boolean logic do not account for the complexity of real-world conditions. Fuzzy logic introduces degrees of membership and degrees of truth, allowing a statement to be partially true and partially false at the same time. This has been supported by Bart Kosko, who demonstrated that Boolean logic is a special case of fuzzy logic. Fuzzy logic offers a way to find solutions to problems that involve uncertainty or vagueness.

Rainfall forecasting is necessary to help predict the start of seasons due to the frequent weather anomalies occurring nowadays. In this study, we forecasted decadal rainfall in Sumenep using the Tsukamoto fuzzy inference method. The rainfall forecasting results using the Tsukamoto fuzzy inference method showed good accuracy with a MAPE value of 10.64%. Forecasting with fuzzy Tsukamoto was able to predict the start of the dry season in the third ten-day period of April 2020, and the start of the rainy season in the second ten-day period of November 2020. (Isnaini Muhandhis, 2021). This research investigates the application of modern technology in rice field management, specifically focusing on developing a fuzzy inference system algorithm for electronic engineering. The core problem addressed is how to effectively monitor and control rice field conditions. To achieve this, a Raspberry Pi-based prototype was developed, leveraging Python for Internet of Things (IoT) integration. The primary goal was to design a new model for a comprehensive rice field monitoring and control system, displaying real-time conditions via the IoT, which aims to provide solutions for common rice field issues like drought and maintaining optimal plant health. (Deden Farhan, 2023) Test results demonstrated the system's effectiveness: automated irrigation control operates optimally based on a set schedule and features automatic irrigation control based on water pH levels analyzed by the fuzzy Tsukamoto method, yielding a defuzzification value (Z) of 3.5 for both low and high irrigation control and a Z value of 1.83 for normal irrigation control. Furthermore, the scheduling of liquid fertilizer spraying was optimized, with a duration of 60 minutes found appropriate for the required fertilizer dose. Finally, the monitoring data is successfully accessible anywhere via a website due to the use of hosting servers and domains. (Lukman Medriavin Silalahi, 2022). A child's growth and future potential are significantly shaped by education, a primary formation strongly supported by the state to ensure every citizen can achieve a decent schooling. Schools employ diverse assessment systems, yet all are guided by national education regulations. Grade promotion is key to measuring students' learning achievements against graduate competency standards and assessing overall educational quality. Among the critical decisions made in education, the choice to advance students to the next grade stands out as particularly important. (Alamsyah, Ramdhani, & Nurbeni, 2022). Here are a few ways to rephrase the paragraph, each with a slightly different emphasis. This research harnesses the Internet of Things (IoT) to extend the benefits of internet connectivity, enabling the operation of any internet-connected electrical device. Specifically, this study applies IoT to create a mobile-based application for controlling a fan and monitoring room temperature and humidity. This allows users to remotely manage their room's environment via smartphone, ensuring it's always comfortable. Maintaining a stable room temperature is crucial for boosting productivity and preventing potential health issues. Furthermore, this IoT integration simplifies turning off the fan, even if you forget to do so manually. The fan itself is integrated with an ESP32 microcontroller, which includes a Wi-Fi module for

accessing and responding to data changes in the Firebase Realtime Database. (Sunardi, Yudhana, & Furiza, 2023) To meet daily commuting needs, electric vehicles (EVs) often require recharging at public spots like malls, restaurants, and parking lots. However, current public charging methods (EVSE) often lead to long waiting times for users, which reduces EV travel efficiency and user comfort. While much research has focused on optimizing energy consumption and charging costs, the critical issue of waiting time optimization from the EV user's perspective has received less attention. This paper addresses that gap by framing waiting time optimization as a fuzzy integer linear programming problem. We then introduce a new, heuristic algorithm called Fuzzy Inference System-based Algorithm (FISA). This algorithm is designed to solve the problem and, most importantly, minimize the waiting time for EVs at public charging stations. (Shahid Hussain, 2022)

METHODOLOGY

A Fractional Fuzzy Inference System (FFIS) is a specialized type of fuzzy inference system (FIS) that uses fractional membership functions in the "consequent" (output) part of its rules. These fractional membership functions are unique because they are defined by fractional indices, which can be either fixed (constant) or changing (dynamic). The key innovation of an FFIS is its ability to consider both the truthfulness (truth degree) and the amount (volume) of information contained within membership functions when drawing a conclusion. This means that the more certain a piece of information is (i.e., the higher its truth degree), the more heavily it influences the final decision. Interestingly, standard fuzzy inference systems like Mamdani's or Larsen's can be seen as specific instances of an FFIS. As the fractional indices in an FFIS get closer to the value of one, the FFIS behaves just like a typical FIS. Furthermore, research demonstrates that, regardless of the specific problem, a standard FIS will never produce more satisfactory results than an FFIS that is configured with a suitable set of fractional indices. In other words, an FFIS generally offers improved performance compared to traditional fuzzy systems. (MEHRAN MAZANDARANI, 2020) This paper introduces a Fuzzy Inference System (FIS) specifically developed to thoroughly evaluate challenges, risks, and threats in the complex and often uncertain world of security and defense. Because defining these elements precisely can be difficult, the system uses fuzzy logic to handle that inherent ambiguity. (Darko Bozanic, 2023), Prostate cancer is a major cause of male mortality worldwide. This study explores using a Fuzzy Inference System (FIS) for its early detection. The FIS assesses the risk factor for prostate cancer by taking into account the patient's age, prostate volume (PV), % free PSA (FPSA), and prostate-specific antigen (PSA) levels as input parameters. The Mamdani method is specifically employed to evaluate and analyze the computed Prostate Cancer Risk (PCR). (Raul Boadh, 2022) This study focuses on developing highly accurate, very short-term energy consumption forecasts for an educational building. The primary goal is to create a predictive model that aids in energy planning, effectively balancing the power supplied by renewable systems with the building's electrical load demands. To achieve this, an Adaptive Neuro-Fuzzy Inference System (ANFIS), a machine learning approach, was utilized for the energy forecasting. The forecasting model was developed using a substantial dataset of 20,520 instances, comprised of data from smart energy meters installed in the building and corresponding weather information, with 80% of the data used for training, 10% for testing, and 10% for validation. (Chaouki Ghenai, 2022)

Legal aid is crucial for upholding justice and human rights, and both central and local governments have a responsibility to provide it. However, the current provision of legal aid for underprivileged communities is unfortunately still inadequate. This is often due to administrative hurdles and issues with the legal recognition of legal aid practices carried out by activists, institutions, mass organizations, political parties, and non-governmental organizations, which hinder its effectiveness. This research highlights the significant advantages of providing legal assistance to these communities and proposes a new legal viewpoint and reforms to ensure a more equitable distribution of justice. (Ikbal, 2023), This paper presents findings from a two-year monitoring and evaluation (M&E) study on a scholarship program's impact on underprivileged students. The research utilized data collected through interviews with parents and teachers, alongside school records, over two academic years. The report identifies key enablers and barriers to academic success experienced by the scholarship recipients. (Miriam Mutevere, 2024)

Based on the issues described above, the author employs the Tsukamoto fuzzy logic method to determine the eligibility of beneficiaries for Village Fund Direct Cash Assistance (BLT DD) based on

the five criteria outlined in the Regulation of the Minister of Villages, Development of Disadvantaged Regions, and Transmigration of the Republic of Indonesia Number 13 of 2023 concerning Operational Guidelines for the Focus of Village Fund Usage in 2024. The fuzzy method consists of four main stages in solving the problem:

1. **Fuzzification**
   In this stage, crisp input values are converted into fuzzy sets. This involves defining membership functions that represent the degree to which each input value belongs to each fuzzy set.
2. **Inference**
   At this stage, fuzzy rules are applied to the fuzzified input values to generate fuzzy outputs. This involves evaluating the antecedents of each rule and combining the results using fuzzy operators.
3. **Rule Base**
   The rule base is a collection of fuzzy rules representing expert knowledge or the relationships between input and output variables. These rules are typically expressed in "IF-THEN" statements, where the antecedent (IF part) describes the input conditions and the consequent (THEN part) describes the output consequences.
4. **Defuzzification**
   In this stage, the fuzzy output is converted back into a crisp value. This involves selecting a single value from the fuzzy output set that best represents the overall outcome of the inference process.

RESULTS AND DISCUSSION

This study uses two variables to determine the distribution of assistance: condition and income. The author collected several samples of community income data to assess their eligibility for receiving Village Fund Direct Cash Assistance (BLT DD).

A. Condition Variables

Condition variables serve as indicators in determining the eligibility of community members to receive BLT DD. There are five categories of assessment variables based on the Regulation of the Minister of Villages, Development of Disadvantaged Regions, and Transmigration of the Republic of Indonesia Number 13 of 2023 concerning Operational Guidelines for the Focus of Village Fund Usage in 2024. The author assigns weights to these variables to simplify the assessment process, which is represented in the following table.

Table 1. Asessment Variable Categories

NO	CONDITION	WEIGHT
1	Loss of Livelihood	10
2	Family member with chronic illness/disability	10
3	Not Receiving family Hope Program (PKH) assistance	20
4	Household with an elderly single household member	30
5	Female head of household from an extremely poor family	30

B. Income Variable

The income variable serves as an additional indicator in determining the eligibility of beneficiaries for Village Fund Direct Cash Assistance (BLT DD), particularly when there is difficulty due to equal weighting in the assessment of the condition variables. This is represented in the table below:

Table 2. Income Variable Categories

NO	INCOME (RUPIAH)	CATEGORY	WEIGHT
1	≤ 300.000 **2**	Extremely Poor	40
	≤ 500.000 **3**	Poor	30
	≤ 1.000.000	Low Income	20
4	≤ 2.050.000 / based on Klaten UMR	Income Below Minimum Wage (UMR)	10

Steps for Determining Aid Distribution Using the Fuzzy Tsukamoto Method are as follows:

1. Fuzzification

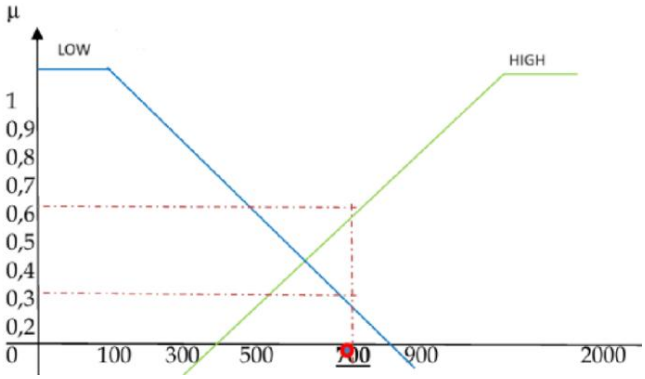

Table 3. Fuzzification of the Income Variable

Monthly Income: 700,000

μ low[700] = (900 - 700) / (900 - 300)
= 200 / 600
= **0.33**

μ high [700] = (700 - 300) / (900 - 300)
= 400 / 600
= **0.66**

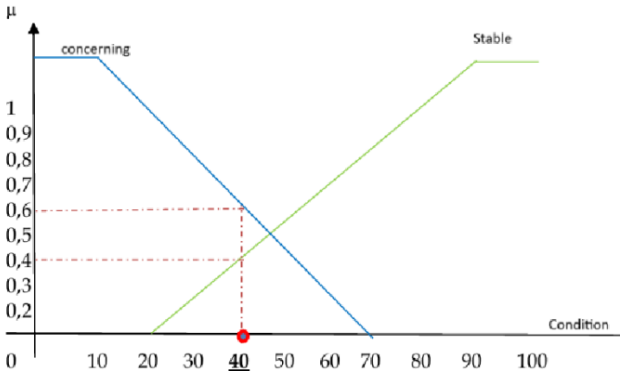

Table 4. Fuzzification of Condition Variable

Weight of Condition 40
μ Concerning [40] = (40-20)/(70-20)
= 20/50 = 0,4
μ stable [40] = (70-40)/(70-20)
= 30/50 = 0,6

2. Fuzzy Input
Income 700(ribu)
- Low (0,33)
- High (0,66)

Weight of Condition 40
- Concerning (0,4)
- Stable (0,6)

3. Inference

Condition / Income	**Low**	**High**
Concerning	Eligible	Eligible
Stable	Not Eligible	Not Eligible

Tabel 5 Inferensi

[R1] IF Income = Low AND Condition = Stable THEN Status = Not Eligible
[R2] IF Income = Low AND Condition = Concerning THEN Status = Eligible
[R3] IF Income = High AND Condition = Stable THEN Status = Not Eligible
[R4] IF Income = High AND Condition = Concerning THEN Status = Eligible

Income 700 (thousand)
- Decrease (0.33)
- Increase (0.66)

Condition 300
- Few (0.4)
- Many (0.6)

List of IF THEN Rules:
a. IF Income = Low AND Condition = Stable THEN Status = "Not Eligible" 0.33
b. IF Income = Low AND Condition = Concerning THEN Status = "Eligible" 0.33
c. IF Income = High AND Condition = Stable THEN Status = "Not Eligible" 0.6
d. IF Income = High AND Condition = Concerning THEN Status = "Eligible" 0.4

Assistance Recipient Status:
Not Eligible = 0.33
Eligible = 0.6

4. Defuzzyfication

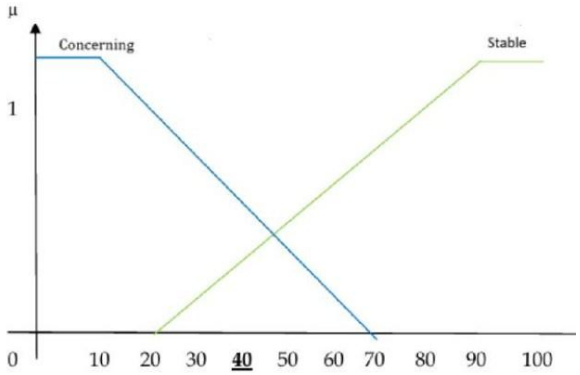

Table 6. Defuzzification of Condition Variable

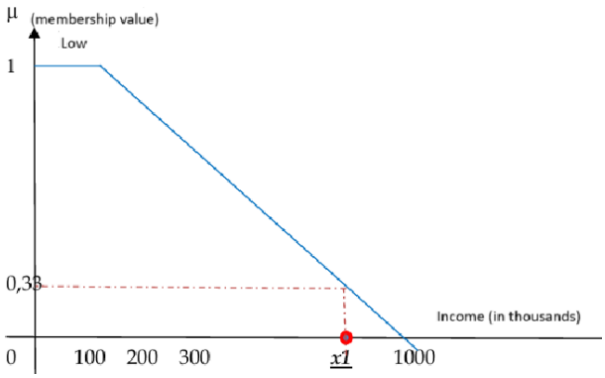

Table 7. Defuzzification of Low Income Variable

μ = (1000 - x1) /(1000 - 100)
0,33 = (1000 - x1) / 900
0,33 x 900 = 1000 – x1
x1 = 1000 - 297
x1 = 703

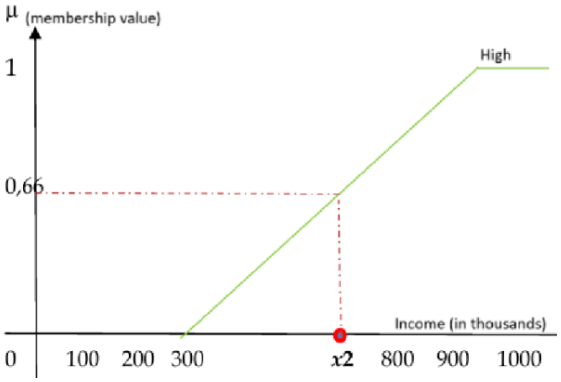

Table 8. Defuzzification of High Income Variable

μ = (x2- 300) (900 - 300)
0,66 = (x2- 300) 600
0,66 x 600 = x2- 300
396 + 300 = x2
696 = x2

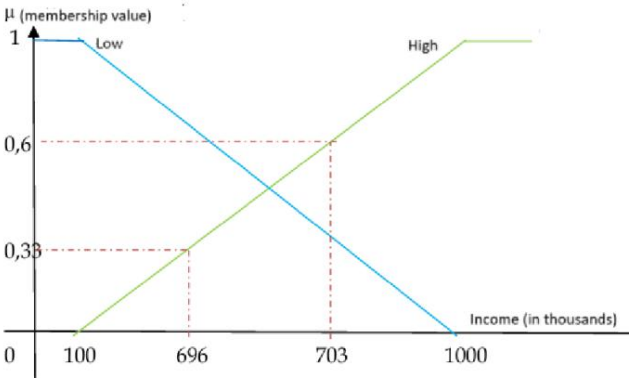

Table 9. Defuzzification Results of High Income Variable

Status = (0,33 x 696) + (0,6 x 703) / 0,33+0,6
= 229.6 + 421.8 / 0.93
= 700.4

CONCLUSION

This study successfully applied the Fuzzy Tsukamoto method to determine the eligibility of potential Village Fund Direct Cash Assistance (BLT DD) recipients, addressing the ambiguity in income thresholds for extreme poverty within current regulations. The research demonstrates that the Fuzzy Tsukamoto method, by leveraging fuzzy logic principles, enables a more nuanced and objective decision-making process for aid distribution, particularly in conditions of uncertainty. Through the fuzzification of income variables (with a membership value for low income (μ low) = 0.33 and high income (μ high) = 0.66 for an income of Rp 700,000) and condition variables (with a membership value for concerning (μ concerning) = 0.4 and stable (μ stable) = 0.6 for a condition weight of 40), inference rules, and subsequent defuzzification, the method provides a systematic approach to assess eligibility. From the inference results, the "Not Eligible" status has a value of 0.33 and the "Eligible" status has a value of 0.6. With defuzzification, the final status of the assistance recipient is obtained as 700.4, reflecting the level of eligibility based on the determined criteria.

The findings indicate that implementing the Fuzzy Tsukamoto method can significantly contribute to the accurate targeting of government aid, thereby helping to reduce poverty levels in rural communities. This approach enhances the transparency and objectivity of the beneficiary selection process, aligning it more closely with the actual socioeconomic conditions of rural residents. Furthermore, this study enriches the understanding of fuzzy logic applications within social assistance programs and underscores its potential for broader utility in complex decision-making scenarios where vagueness or uncertainty is present.

For future research, it is suggested to explore the integration of additional socioeconomic indicators into the fuzzy model to further refine eligibility criteria. Comparative studies with other decision support systems could also provide valuable insights into the efficiency and effectiveness of the Fuzzy Tsukamoto method in various contexts of social aid distribution.

Acknowledgments

The authors would like to express their sincere gratitude to all colleagues and lecturers at Universitas Sahid Surakarta who provided invaluable guidance, support, and constructive feedback during the preparation and writing of this manuscript. Their insights and assistance were instrumental in the successful completion of this research.

References

Alamsyah, D. P., Ramdhani, Y., & Nurbeni, R. D. (2022). Implementation of the Fuzzy Inference System Tsukamoto Method in the Decision Support System. *IEEE*.

Astri Charolina, F. F. (2024). Fuzzy Mamdani Model for Assessing the Level of Service Satisfaction for Requirements of Social Welfare Services at the "Prof. Dr. Soeharso" . *IJCIS*.

Chaouki Ghenai, O. A.-M.-I. (2022). Chaouki Ghenai, Omar Ahmed Abduljabbar Al-Mufti, Omar Adil Mashkoor Al-Isawi, Lutfi Hatem Lutfi Amirah, Adel Merabet,. *Journal of Building Engineering*.

Danang Rifai, F. F. (2023). Penerapan Logika Fuzzy Sugeno dalam Keputusan Jumlah Produksi
Berbasis Website. *Hello World Jurnal Ilmu Komputer*, 102-109.

Darko Bozanic, D. T. (2023). Ranking challenges, risks and threats using Fuzzy Inference System. *Decision Making: Applications in Management and Engineering*, 933-947.

Deden Farhan, F. S. (2023). IMPLEMENTATION OF FUZZY TSUKAMOTO LOGIC TO DETERMINE THE NUMBER OF SEEDS KOI FISH IN THE SUKAMANAH CIANJUR FARMER`S GROUP. *JUTIF*.

Ikbal, G. A. (2023). Legal Assistance for Underprivileged Communities to Access Justice within the Human Rights Perspective. *Lampung Journal Of International Law (LaJIL)*, 93 - 102.

Ipung Dwi Antoni, Y. F. (2024). Implementation of Fuzzy Logic to Determine the Amount of Bread Production Using Tsukamoto Method. *Smatika Jurnal*.

Isnaini Muhandhis, A. S. (2021). Implementasi Metode Inferensi Fuzzy Tsukamoto Untuk Memprediksi Curah Hujan Dasarian Di Sumenep. *Jurnal Ilmiah Edutic* .

Lukman Medriavin Silalahi, D. J. (2022). Internet of things implementation and analysis of fuzzy Tsukamoto in prototype irrigation of rice. *International Journal of Electrical and Computer Engineering (IJECE)* .

MEHRAN MAZANDARANI, X. L. (2020). Fractional Fuzzy Inference System: The New Generation of Fuzzy Inference Systems. *ICORIS* (hal. 126066 - 126082). IEEE.

Miriam Mutevere, T. R. (2024). Empowering underprivileged students beyond financial aid: Insights from a scholarship program's monitoring and evaluation,. *Evaluation and Program Planning*.

Raul Boadh, D. D. (2022). Study and prediction of prostate cancer using fuzzy inference system. *Materialstoday: Proceedings*, (hal. 157-164).

Shahid Hussain, Y.-S. K. (2022). Optimization of Waiting Time for Electric Vehicles Using a Fuzzy Inference System. *IEEE Transactions on Intelligent Transportation System*, 15396-15407.

Sunardi, Yudhana, A., & Furiza. (2023). Tsukamoto Fuzzy Inference System on Internet of Things-Based for Room Temperature and Humidity Control. *IEEE*.