# Mamdani Fuzzy inference system Application Setting For Traffic Lights

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## ABSTRACT

*System traffic light settings that exist in Indonesia today there are many who use the timer (timer) resulting in the accumulation of vehicles on any or all channels. Therefore, designed a fuzzy logic-based system that can manage the traffic lights in accordance with the density that occurs. So it is no longer in the accumulation of vehicles, especially at intersections adjacent. This system is a traffic light settings at adjacent intersections using fuzzy logic The workings of this system based on the rule (rule) that have been made. If the state of the roads at the time when the green light more or equal to the number of vehicles waiting for the red light, then the system will continue the green light on the road. Then if a state road when the green light less than the number of vehicles waiting roads or when the red light, then the roads will be green, and so on. It is expected to be applied to the actual conditions that the accumulation of vehicles on adjacent intersections can be resolved. Crisp logic is a logic system that has only two true or false membership values' concept is much application primarily for control systems, one of which at trffic light 'system trafrc light settings with the concept of fuzzy logic is able to work according to road conditions being regulated' inference system is then evaluated by using the knowledge base rules fuzzy which eventually produced a solution fuzzy region.*

**Keyword:-** decision support system, Fuzzy mamdani,

## 1. INTRODUCTION

The use of traffic lights (traffic light) at the crossroads is one of the solutions are used to control traffic flow more baik.Strategi better in controlling the traffic flow impacts of pollution reduction, fuel savings, and improve the movement of vehicles to shorten the travel time [1].Traffic lights are lights that control traffic flow attached crossroads, t lintasempat then others, but that becomes the scope of this study is the traffic light at persimpanganjalan. The number of vehicles passing a large city causing congestion is likely to occur. therefore the traffic lights has an important role in regulating the flow of traffic, especially crossroads[8]. But sometimes a lot of congestion occurs at the junction of the roads. when traffic lights are there, should be able to regulate the flow of traffic so as to avoid congestion or vehicle density. This happens because the rations green light equally to all channels, regardless of the number of vehicles available on each[8]. A better strategy in controlling the traffic flow impacts of pollution reduction, fuel savings, and improve the movement of vehicles to shorten the travel time [9] [1].Parameters used for the duration menentukkan the traffic light system is the density of vehicles sector in the affected side of the intersection of the flow of vehicles on the side. This parameter value can not be known with certainty because it changes with time can be green mathematical model based on historical data of traffic flow or with artificial intelligence[10] [1].

## 2. FUZZY LOGIC AND TRAFFIC LIGHT SETTING

Some aspects in real life usually are beyond a certain model matematis or are inexact. cause, many are unclear on something Area uncertainty. Some forms of uncertainty, including ambiguity (ambiguity), randomness (randomness). uncertainty due to not complete information (in-completeness) not exactly late (imprecis ion), and haziness semantik. Semantic vagueness blur caused u shape the meaning of a word that can not be precisely defined concepts that underlie the birth of logic and set theory Fuzzyset . So that the crisp set theory there would only be two grades of membership (x) namely: p (x): 1 to become a member, and p (x): 0 for non anggota.Himpunan fuzzy based on the idea of extending the reach of the characteristic function such that the function will include real numbers in the interval [0,1]. Membership value indicates a variable not only be true or false, but there is value in between [7]. The universe of discourse is an overall problem space from the smallest to the largest rtilai are allowed to operate. Fuzzy set is the whole domain of values allowed in a universe of discourse in a fuzzy set. This control system will be used to set the four intersections where there are two lanes each way. So for an intersection of four to eight sensor.Sistem needed to use two inputs and one output. Used two inputs intended that the system made no just pay attention to the path set out alone, but also look at the condition of the other lines are also waiting for system services. For example, to determine the duration

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of the green light Path I, the whole space pennasalahan from the smallest to the largest value that is allowed to operate. domain fuzzy set is the overall value allowable in a universe of discourse in a fuzzy set.

## 3. FUZZY LOGIC (FUZZY LOGIC)

Fuzzy logic is a way to map an input space into an output space. Between inputs and outputs of the black box there should map the inputs to the corresponding outputs. Fuzzy logic was first introduced by Prof. Lofti Zadeh, in 1965, the Iranian nationals who became a professor at the University of California at Berkeley, USA. On that occasion also made with a paper describing the basic idea of fuzzy sets that include incluion, union, intersection, complement, relation, and conversity. Pioneer the application of fuzzy sets in the field of control is Prof. Ebrahim Mamdani and colleagues from Queen Mary College London (still in the lab scale). The development of the theory of fuzzy logic has attracted experts control system for use in controlling a system in the form of automated algorithms that can be expressed, as in the use of traffic control, automatic transmission systems, household appliances, and other industries.

**Fuzzy Inference System with Mamdani Method**
Mamdani method is often known as the Max-Min method. This method was introduced by Ebrahim Mamdani in 1975 To get an output, required 4 stages [3]:
a. The formation of fuzzy sets
b. Application function implications
c. composition Rules
d. The assertion (defuzzy)
a. Average method (Average)

$$z^* = \frac{\sum \mu_i z_i}{\sum \mu_i}$$

b. Midpoint method (Center of Area)

$$z^* = \frac{\int \mu(z) z \, dz}{\int \mu(z) z \, dz}$$



**Figure 2.1** The structure of the fuzzy system inferens
(1)
There are a few things to know in understanding a fuzzy system are [3]:

**a. Fuzzy variable**
Fuzzy variables are variables to be discussed in a fuzzy system.

**b. Fuzzy set**
Fuzzy set is a group that represents a particular condition or circumstance in a fuzzy variables.

**c. Universe Discussion**
The universe of discourse is the overall value is allowed to be operated in a fuzzy variables. The universe of discourse is the set of real numbers is always up (increases) monotonically from left to right. Value of the universe of discourse can be either positive or negative numbers. value of the universe of discourse is not limited to its upper limit.

**d. Domain**
Fuzzy set is the whole domain of values allowed in the universe of discourse and should be operated in a fuzzy set. Just as the universe of discourse domain is the set of real numbers is borne up (increases) monotonically from left to right. Domain values can be either positive or negative numbers.

## 4. RESEARCH METHODOLOGY

The steps are performed weeks to obtain data and information related to this study are:
**a. Observation, in this case the authors made some observations on the Ground**
**b . Studies Library, the authors obtained data from sources such as:**
- Related books and support research.
- Literature, reference or referral form of journals, theses or reports of previous studies that support this research.

c.  **Making Plant Simulation**

d.  **Testing and Analysis**

Search Analyze and conclude the results and take a conclusion from the test results.

## 5. RESULT AND DISCUSSION

**Lighting Systems and Traffic Now**

There are two types of traffic light controller system in Indonesia, namely [2]:

a. Traffic light controller system which is a system of conventional traffic light controller using the conventional system, where the colour of the light is measured every constant, which means that instead of the maximum solution, For example, the sector in a deserted crossroads given the same time as another crossroads was crowded kendaraan.Kasus worse is when the intersection is empty at all, and given the time passed (marked with a green light) which is equal to another crossroads padat.Tentu just enough to make the violation of this rule may result in kecalakaan, let alone if it is empty intersection only empty for a while, but it will be crowded in sebentar.System time like this is considered less effective because in addition to spending time, contributed to air pollution and noise.

b. System controller with a vehicle proximity sensor system is one that is currently ini.System using only sensors that determine the presence of a car in a persimpangan.Ini provide replacement technique traffic lights better than the way konvensional. But because only the existence determine car, this system is less effective if there is a density vehicle ratio. For Examples course, there is a vehicle at an intersection but only 2 or 3 pieces, but in another very solid. Then intersection should be given more time on the more slightly.This intersection because the main purpose is reduced as much as possible the average cost of all vehicles available, both in terms of waiting times and a solid amount of pollution cars created.Iintersection  more then the average cost of the most widely donate given by the intersection .waiting time amount of 1 minute by donate given by the intersection.Waiting time amount of 1 minute by 50 cars is certainly much greater than the total waiting time of 15 seconds by 3 cars only.

c. Traffic light controller system smart. Sistem is an artificial intelligence system that adds to the traffic light controller lintas.  Many techniques have been proposed digunakan.Di Indonesia itself (though not yet implemented).DCSP is one of the techniques in the field of Artificial intelligence which is a variant of Constraint Satisfaction existing Problem.Teknik others also uses fuzzy logic controller for an existing building.
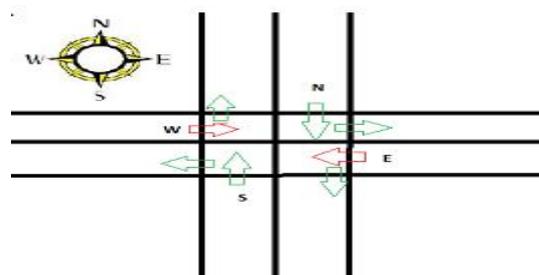
**Traffic Lights system is proposed.**

The system proposed by the authors is the traffic control system using fuzzy logic. Here's the reason the author chose this system, namely [2]:

1. Fuzzy logic has a much simpler calculation must use techniques from complex and consists of many variables such as the DCSP.
2. Fuzzy logic can map the input is not crisp, meaning that is easy to understand and easy man to get direct input from humans.
3. Fuzzy logic apply heuristics. That is a very reliable expert required to fill the form input values existing linguistic variables, member functions and rules which existed. Experts in the example as a traffic cop who is accustomed to dealing with congestion a certain way. Because fuzzy logic uses linguistic input, it will be easier to translate input from experts. For example, suppose a police officer said "if the traffic is a lot at the intersection of the north south and east west a little bit then to the intersection of north-south, the green light should be longer". It may be noted that the input is "banya", "a little", "somewhat old" here can be translated and understood by a computer using fuzzy logic. This is where the main advantages of fuzzy logic in addition to simplicity.

**Description of Problems**

**The layout of the traffic.**

There are various forms of intersection. Total intersection (junction consists of 3 or 4 junction), bandwidth can be skipped by every junction and other configurations. Therefore, in this question, use the intersection as follows[2]:



**Gambar 5.1** Traffic layout

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From the picture above can be seen in the traffic layout of this issue is:

1. There are four cross-roads. Each junction can always turn to the left from the junction and can only forward if it is his turn.
2. When the traffic from north to south is on, then the traffic from west to east must stop and reverse. Traffic north and south of sync so well east and west, meaning the color of the light at the same intersection synchronous.
3. Mamdani fuzzy logic in this case only determines whether to speed up or slow down a green light from a single direction For example, if that is lit is north-south direction, the input sensors are used only in the north and the sensor.
4. There is a minimum time a green light goes on and the time of maximum green lights. This is used to prevent the starvation or in other words there is a junction that does not visit the receive queue. These constants obtained from experts in this traffic policy. If a threshold has been met, for example, is over the maximum time the green light goes on, then the light is no longer green.



**Gambar 5.2** location Research

The results or outputs of this research is a Mamdani Fuzzy Logic Application for Red Light.

**Analysis and Planning**

**Analysis Input Supplies**

Activities performed in the collection of data from the total amount of vehicles and queues the maximum vehicle. Elements the most fundamental elements in this study because of the large number of vehicles and vehicle through which the minimum wait time or indefinitely green light equated time, so there are starvation. Primary data from many vehicles and the maximum number of seconds to wait antrian.Variabel study used the input variables and output variables.

X1= Many of its number of vehicles waiting

Based on the above data variables are the number of vehicles waiting fuzzy set consists of 3 (Low, Medium and High)

X2= Maximum distance queue

Based on the above data, the maximum distance variable queue consists of a collection of fuzzy 3 (Low, Medium and High).

**Logic Analysis Process**

Application of Mamdani Fuzzy Inference System For Traffic settings and adapted to the conditions existing in the field research of Street Corner Shop held its place in Serang, Banten
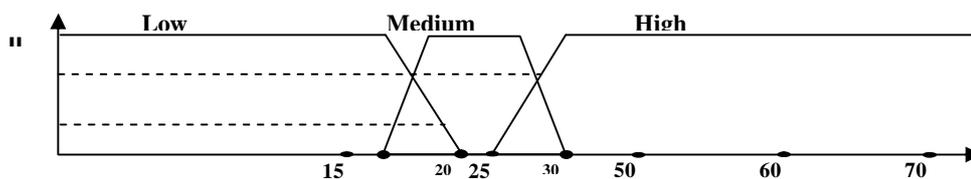
**Tabel 5.1** Vehicle Data Samples

| sample data | The number of vehicles waiting | Maximum Queue vehicle (m) | Output |
|---|---|---|---|
| intersection 1 | 30 | 100 | 75 |
| intersection2 | 26 | 80 | 53 |
| intersection 3 | 29 | 90 | 53 |
| intersection 4 | 19 | 65 | 37.5 |

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**Tabel 5.2** Variables and Universe Discussion

| Function | Name Description Variable | the universe of discourse | Remarks |
|---|---|---|---|
| Input | NR_ Number Vehicle Waiting | [15-30] | The average value for the category of the number of vehicles waiting |
| | NR_ Distance Maximum queue | [60-100] | The average value of the maximum number of queues |
| output | Long green light | [37,5-75] | Value assessment that meets the green light |

**Tabel 5.3** Fuzzy set

| Function | Name Description Variable | Fuzzy Set | the universe of discourse | Domain |
|---|---|---|---|---|
| Input | NR_ Number Vehicle Waiting | Low Medium High | [ 15 – 30 ] | [15 – 20 ] [15 – 30 ] [ 25 - 30 ] |
| | NR_ Distance Maximum queue | Low Medium High | [ 60 - 100 ] | [60 – 70 ] [60 – 100 ] [ 80 - 100 ] |
| output | Long green light | Fast Medium Slow | [ 37.5 - 75 ] | [ 37.5 - 50] [ 37.5 - 75] [60 – 75] |



**Gambar 5.3** Graph degrees Membership for NR_ Number Vehicle Waiting
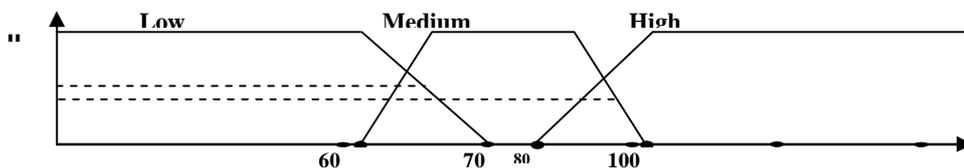


**Gambar 5.4** Graph degree of membership graphs for NR-Distance maximum queue

The next process is to conduct inference on the Variable Rate Vehicle waiting and distance maximum queue in the same way at the top, in this case we use a trapezoidal function to define its linguistic value as follows:
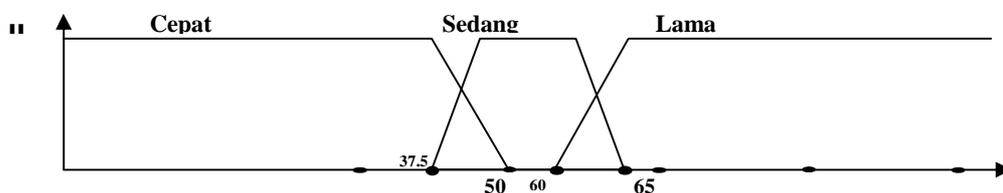


**Gambar 5.5** Graph Inferensi Variabel Long time Green

Next step is to define the fuzzy rules to be used Of a number of existing variables obtained by 9 fuzzy rules are established Results Fuzzyfication the value NR_Jumlah Vehicle waiting and the vehicle queues NR_ maximum distance Then fed into the Fuzzy rules are formed, so as to obtain rule as a rule as follows:

1) If NR_ Number Vehicle Low and NR_ maximum vehicle queue LowTHEN (1)
2) If the vehicle NR_Jumlah maximum queue NR_ Low and Medium Vehicles THEN (2)
3) If NR_Number Vehicle Low and NR_distance maximum vehicle queue High THEN (3)
4) If NR_Amount Vehicle Medium and maximum queue NR_Distance maximum queue Low THEN (4)
5) If NR_ Number Vehicle Medium and maximum queue of vehicles MediumTHEN (5)
6) If NR_ Vehicle Medium and maximum queue of vehicles NR_Distance High THEN (6)

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7) If NR_Distance  Vehicle maximum NR_Distance High and Low THEN queue of vehicles      (7)

8) If NR_Jumlah Vehicle maximum NR_Distance High and Medium THEN .vehicle queue      (8)

9) If NR_Jumlah Vehicle maximum queue NR_Distance High and High THEN vehicles      (9)

The Result of   Fuzzyfication on NR_ Number vehicle waiting and NR_Distance maximum queue  are  4 Rule  they are:

1).If NR_ Number vehicle waiting Low and NR_Distance maximum queue Low THEN      (1)

2) If NR_Number vehicle waiting Low and NR_Distance maximum  Medium THEN      (2)

3) If NR_Number vehicle waiting Medium and NR_ Distance maximum Low THEN      (4)

4) If NR_Number vehicle Medium and NR_Distance maximum  queueMedium THEN      (5)

By using Mamdani inference method, the inference process is obtained by using the conjunction rule (^) of the above 4 new rules, to take a minimum degree of membership of existing linguistic value_ Here are the new rules while obtained:

1). If NR_ Number Vehicle Low  (0,33) and NR_ maximum vehicle queue Low (0.5) THEN Long Time green Fast(0.33)      (1)

2) If NR_ Number Vehicle Low (0.33) and NR_Low and medium vehicle Medium (0.5) THEN Long Time green Fast (0.33)      (2)

3) If NR_ Number Vehicle Medium (0,67) and NR_Distance maximum Queue (0.5)THEN Long Time green  Fast (0.5)      (4)

4) If NR_Amount  vehicle Medium (0.67) and NR_ maximum queue of vehicle Medium (1) THEN Long time Green Sedang (0.67)      (5)

Based on the above calculation, obtained 4 linguistic values with different degrees of membership values, namely:

1)     Old Time Fast Green (0.33)

2)     Long Time Fast Green (0.33)

3)     Long Time Fast Green (0.5)

4)     Green Medium Long Time (0.67)

Next step is, using the rules of disjunction (V) to determine the maximum degree of membership value of Linguistics values linked:

• Long Time Green fast (0.33) v Old Time Green fast (0.33) v Old Time Green quickly (0.5) generated Green Duration Time fast (0.5)_

• Long Time Green Medium (0.67) are generated Green Duration Time (0.67).

By using the process of clipping on Mamdani, 2 fuzzy sets can be illustrated graphically in accordance with the degree of membership in accordance with the variable degree of membership NR_ Total Vehicles waiting (see figure 5.3), a variable degree of membership Distance Maximum (see figure 5.4).
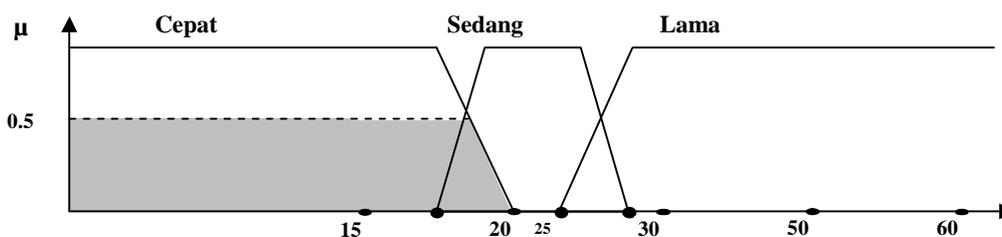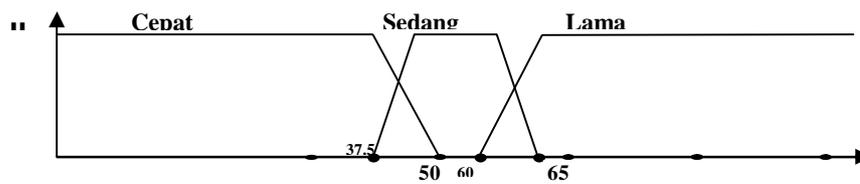


**Gambar 5.6** Graph degrees Membership for NR_ Number Vehicle Waiting
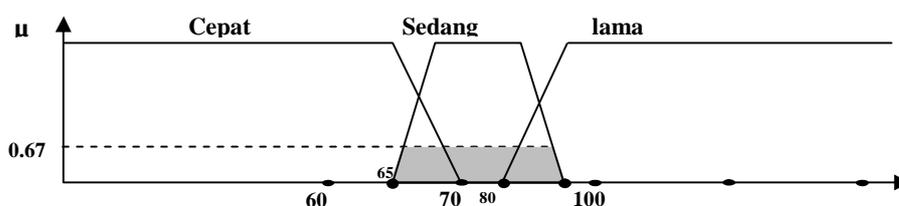


**Gambar 5.7  Graph** degree of membership graphs for NR-Distance maximum queue

The next process is to conduct inference on the long variable green light in the same way at the top, in this case we use a trapezoidal function to define its linguistic value as follows:

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**Gambar 5.8** Graph Inferensi Variabel Long time Green

After that, do the composition of fuzzy sets in the top 3 so as to produce a single fuzzy set_ Then specify the points on the gray area at random to perform further calculations, eg those points are:

Sehingga diperoleh :

$$\frac{\big((65 + 66.25 + 67.5 + 70)*0.5\big)+\big(65 + 67.5 + 70 + 75 + 80 + 90 + 100\big)*0.67}{(0.5 + 0.5 + 0.5 + 0.5)+(0.67 + 0.67 + 0.67 + 0.67 + 0.67 + 0.67 + 0.67)}$$

$$\frac{134.375 + 366.825}{2 + 4.69} = \frac{501.2}{6.69} = 74.9$$

By looking at the value end of the calculation, where the value of 74.9is in the value of output interval longer green time Slow.

## 6. CONCLUSION

From the results of analysis and discussion of this research, several conclusions can be drawn as follows:

a. Traffic lights play an important role in regulating the smooth traffic. Traffic light control system that willeither

b. be able to automatically adjust to the density of traffic flow on the path arranged. Application of fuzzy logic in the control system, requires three steps, namely: Fusifikasi, Rule Evaluation, and Defuzifikasi.

c. Planning arrangements with Mamdani fuzzy inference system method can provide results more equitable services perceived as a new system solution pengaturanyang traffic light. The system is able to work in accordance with the state of the roads on the path that is being arranged at the time, which is different from the conventional traffic light to enter the input number of vehicle lanes

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