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# Designating the preference of tram shelter as a part of transit-oriented development's concept within Kota Tua Jakarta using fuzzy logic

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**Abstract.** This research is a part of multi-year research, which has been started since last year by conducting some studies, either literature or simulation, for photovoltaic technology used in public transportation. In supporting the primary research of the implementation of Transit-Oriented Development's concept within Kota Tua Jakarta, this research was also delivering the analysis of preferences through the community to designate the appropriate tram shelter within the historical area of Kota Tua Jakarta. By using fuzzy logic, this research has analysed the relevant point of tram shelter within the historical area of Kota Tua Jakarta. It has proposed together with another result of the study to be a good design. Thus, this research has completed some of the Transit-Oriented Development's basic principles, such as transiting, connecting, and shifting to support the need within the area of Kota Tua Jakarta.

## 1. Introduction

One of the basic concept of Transit-Oriented Development is connecting people from one place to another place easily and to do activities within one area to reduce the using of private vehicle [1,2] also mentioned that historical area is the most significant area within city which has unique character and usually become the identity of the city. One of the main problem within historical area is lack of utility such as infrastructure. Bahri and Purwantiasning [1] in the previous research also discussed and mentioned that there is a possibility to enhance the quality of historical area particularly Kota Tua Jakarta by providing a unique public transportation within the area to connect people from one place to another. The study of Bahri and Purwantiasning also proposed an alternative solution to serve local community particularly visitors within Kota Tua Jakarta by providing unique tram within the area. The previous study also proposed the possibility of the route for the tram by providing 10 tram's stops of shelter within the area of Kota Tua Jakarta. Those ten tram's shelter have been proposed as a main stop within Kota Tua Jakarta which representing all point of interest within Kota Tua Jakarta. This research as a next step of the previous research aimed to proposed the main halt or main tram's stop/shelter within Kota Tua Jakarta using a fuzzy logic as a decision maker. By using this fuzzy logic, hopefully the proposed of main halt or main tram's shelter will be decided significantly.



There are many previous researches which have been carried out by using a fuzzy logic method as a tool to be decision maker. For example Santos et al. [3] have been completed their research by using fuzzy logic to help as system in selecting an optimal and sustainable life cycle maintenance and rehabilitation strategies for road pavements. The similar research by Stetter [4] also mentioned that a fuzzy logic is very helpful to get decision making in virtual actuator in allowing the accommodation of several possible faults such as a slippery surface under one of the drive modules of Automatic Guided Vehicles. Another research referring to the fuzzy logic method also mentioned by Liu et al. [5], which described how to make an exit selection behaviour of pedestrians, because it has been mentioned that this decision making plays an important part in the process of evacuation. Those three examples of research which undertaken a fuzzy logic as a method to make decision making have shown that this fuzzy logic could be implemented to any field. In the research of Daradkeh and Tvoroshenko [6], it has been mentioned that a fuzzy logic method has been regarded as a technology which could be used for making reliable decision on variety needs.

This research aimed to propose a appropriate tram shelter within Kota Tua Jakarta as a part of the implementation of Transit-Oriented Development's concept. Similar with the previous researches, this research has undertaken a fuzzy logic method to make a reliable decision of the preference tram shelter. It has clearly mentioned in above statement, that to implement the concept of Transit-Oriented Development, a comfortable public transportation become the main issue. As supported by Bozzo et al. [7] that nowadays, in human mobility demands require rapid responses on behalf of public transportation, which must provide dependable, comfortable, economically and environmentally sustainable services, with high transport capacities. By delivering a concept of tram as a public transportation within Kota Tua Jakarta, this research has supported the idea of a comfortable public transportation which connect people from one place to another and from one activity to another.

## 2. Research methods

To obtain a practical location selection for main-halt of tram or tram-stop, this research has completed by using a simulation based on fuzzy logic as a decision making. This simulation system has been undertaken by using a MATLAB programme. There are some Point of Interest (POI) that have been designated in this research. Each data of POI has been described in the Table 1. Based on those data, it has been formulated a decision-making system with some variables and fuzzy sets which have been used in this research (see Table 2). From the data in the Table 1, moreover the designated system has been imported with data input to see which POI that has a high recommendation. Thus, the highest recommendation of POI has been decided as a main location of tram-shelter or tram-halt within Kota Tua Jakarta. And this main tram-shelter or tram-halt should be integrated with the existing transportation system within Kota Tua Jakarta.

**Table 1.** List of Point of Interest (POI) within Kota Tua Jakarta.

No.	Point of Interest Locations	Distance (m)	Number of Visitors/day (person)	Connectivity (unit)	Open Space (m <sup>2</sup> )
1	Wayang Museum	450	882	5	50
2	Fatahillah Museum	220	2031	5	3000
3	Bank Indonesia Museum	300	562	5	1000
4	Bank Mandiri Museum	250	500	5	1000
5	Maritim Museum	1700	90	2	100
6	Ceramic Museum	300	515	5	2000
7	Jembatan Kota Intan	1200	100	2	0
8	Pelabuhan Sunda Kelapa	4300	84	2	5000
9	Toko Merah	700	50	2	100

Determining of the main tram-shelter or tram-halt location simulated by using a decision making system based on Fuzzy Logic. This system simulation is done in MATLAB programming. The variables and fuzzy sets used are given in Table 2.

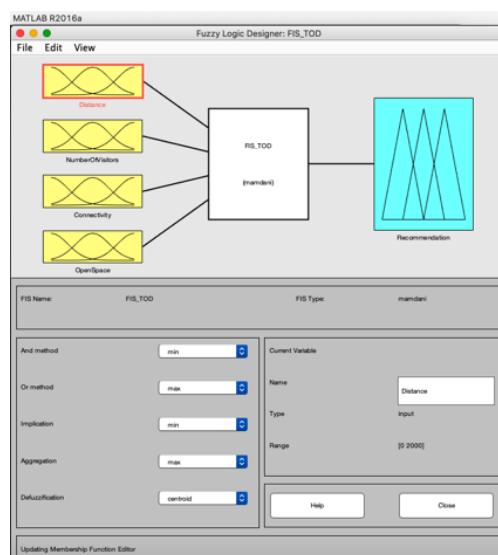
**Table 2.** Variables of fuzzy and fuzzy sets.

Items	Variables of Fuzzy				
	Input				Output
	Distance (m)	Number of Visitors (persons)	Connectivity (modes)	Open Space (m <sup>2</sup> )	Recommendation (%)
Fuzzy Sets	Close Distance (< 200)	Few (< 100)	Few (<2)	Small (<200)	Low (<20)
	Medium Distance (200-1000)	Moderate (100-1800)	Moderate (2-4)	Moderate (200-2800)	Moderate (20-80)
	Long Distance (>1000)	Many (>1800)	Many (>4)	Large (>2800)	High (>80)

**3. Results and discussion**

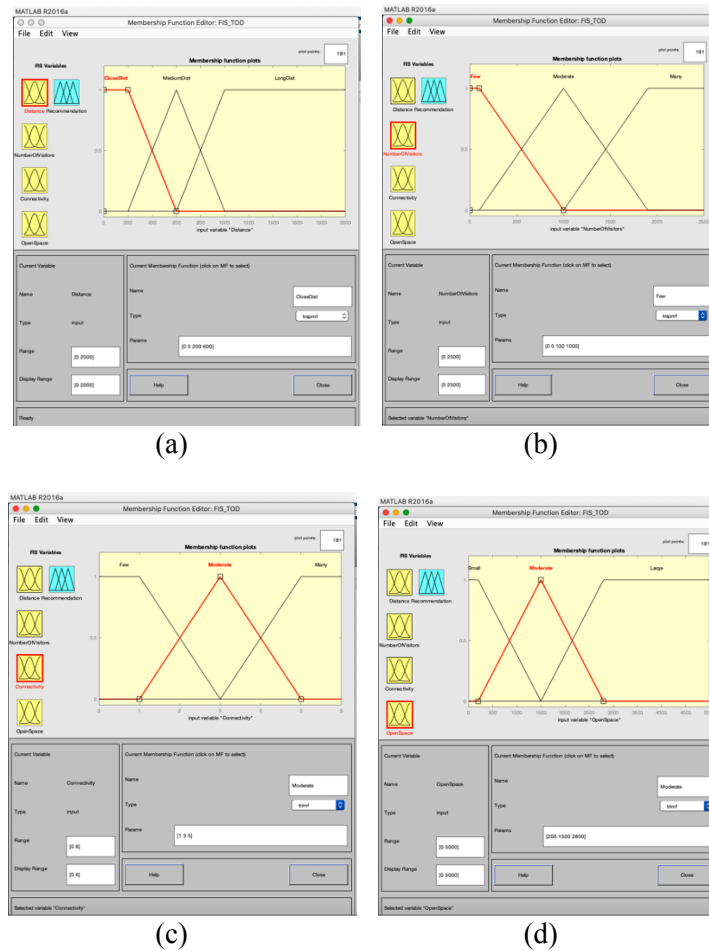
One of the Transit-Oriented Development’s concept is by connecting people from one place to another, one activity to another easily. Using the term of “easily” or “easy”, it should be related to the distance and connectivity as mentioned in previous study [8-11]. Table 1 describes the data of each Point of Interest (POI) that have been used as input variables of fuzzy logic, they are: the distance, the number of visitors, the connectivity and the availability of open space. The distance has been calculated from the main train station Stasiun Kota Jakarta or Stasiun Beos. The number of visitors of the POI has been adopted from the annual report of the statistic of Kemendikbud Indonesia. The connectivity has been calculated from the number of the available public transportation within the surrounded POI. The last used variable as a fuzzy logic input variable is the availability of open space within surrounded POI either inner or outer open space.

The fuzzy logic system has been designed to determine the location of the main tram-shelter or tram-halt is given in Figure 1. The Mamdani type of Fuzzy Inference System (FIS) fuzzy logic system was used with 4 input variables (Distance, Number of Visitors, Connectivity and Open Space) and 1 output variable (recommendation) as given in Table 1.

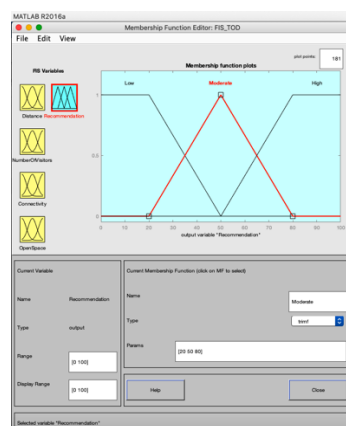


**Figure 1.** Fuzzy logic decision making design.

On the other hand, the Membership Function of each fuzzy variables and fuzzy sets for both either on input variables or output variables have been shown in the Figure 2 and Figure 3 respectively.



**Figure 2.** Fuzzy Sets of input variables and its membership function: (a) the distance, (b) the number of visitors, (c) the connectivity and (d) the open space.



**Figure 3** Fuzzy sets and its membership functions of recommendation.

Based on the number of input fuzzy variables, there are four fuzzy variables which have been used by fuzzy sets each number is three, therefore, there are eighty one fuzzy rules in total which have been used in this fuzzy system, as shown in Figure 4.

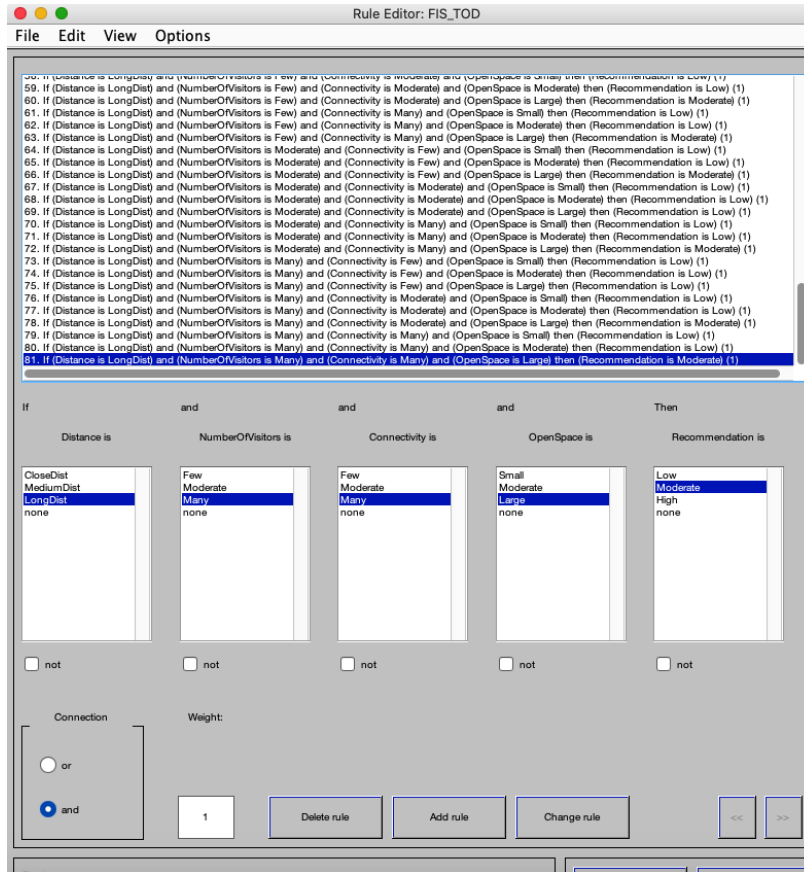


Figure 4. Fuzzy rules.

The result of the analysis using fuzzy variables and fuzzy sets has been concluded as described in the follow of Table 3:

Table 3. Fuzzy variables and fuzzy set result.

No.	Point of Interest Locations	Distance (m)	Number of Visitors/day (person)	Connectivity (unit)	Open Space (m <sup>2</sup> )	Recommendation Value (%)
1	Wayang Museum	450	882	5	50	18,1
2	Fatahillah Museum	220	2031	5	3000	78,5
3	Bank Indonesia Museum	300	562	5	1000	45,9
4	Bank Mandiri Museum	250	500	5	1000	46,1
5	Maritim Museum	1700	90	2	100	19,2
6	Ceramic Museum	300	515	5	2000	54,0
7	Jembatan Kota Intan	1200	100	2	0	19,2
8	Pelabuhan Sunda Kelapa	4300	84	2	5000	43,8
9	Toko Merah	700	50	2	100	19,2

Table 3 shown that the highest recommendation values is the Fatahillah Museum Point and the lowest recommendation values is Wayang Museum Point. Although Pelabuhan Sunda Kelapa Point has the

longest distance from Stasiun Beos, but this point has a relative large open space. From Teble 3, it has been recommended that Fatahillah Museum Point become the most significant and feasible point for the main tram-shelter or tram-halt within Kota Tua Jakarta.

#### 4. Conclusion

To conclude this research, the authors have stated that there is a big possibility to implement the service of unique tram within Kota Tua Jakarta as one main concept of Transit-Oriented Development's concept. To apply the service of the unique tram within Kota Tua Jakarta, we need to analyse the appropriate the tram-shelter or tram-stop particularly the main point. We have obtained the fuzzy logic system to analyzed the preference of main tram-shelter using fuzzy variables and fuzzy sets. The recommendation has been provided as a result from the analyze of fuzzy system.

As a result, we have recommended Fatahillah Museum Point as a main tram-shelter point and as a starter-point for the tram route within Kota Tua Jakarta. By delivering this recommendation, hopefully the implementation of the Transit-Oriented Development's concept could be applied appropriately.

#### Acknowledgement

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