International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

Fuzzy-DSM for Determining Public Transporter based on Geographical Condition

Ditdit Nugeraha Utama, Dwi Adji Prasetyo, Finka Aninditha Anggari, Firas Abdullah Bar, Muhammad Fascal Bhaskara

Abstract**:** ***Numerous types of public transporter in one region (in Indonesia) should be examined. The paper presents a decision support model (DSM) for examine the properness of public transporter implemented in one region (district) in Indonesia. Main method operated technically in this study is fuzzy logic with rule base as an engine core. Three types of public transporter examined are ojek, metromini, and angkot; respectively, in Indonesia they are public motorcycle, public mini bus, and public family vehicle. Four geographical parameters considered in the model are road traffic condition, traffic road length, rainfall, and congestion point. The model was finally able to recommend the most proper public transporter implemented in seven districts.***

Keywords**:** ***decision support model, fuzzy logic, public transporter.***

I. INTRODUCTION

In an urban or rural area, a public transportation is needed very much. It is able to support the community in fulfilling their various activities practically. Activities also vary from those leaving for the office, school or others. Of course the selection of an appropriate public transportation (transporter) is required. The users of the public transportation users want to quickly and comfortably reach their destination.

Therefore, in this study we created a decision support model (DSM) in selecting the public transporter which is based and adapted to the geographical conditions of an urban or rural area (one region). As, often in many areas operate the public transporter only based on economical reason (for the provider), where the users efficiency and effectiveness are note considered. With this DSM, it is hoped that a region is able to determine or add a public transportation fleet that is suitable for that region. The election was of course in order to be able to make efficient and effective use of the transportation so that no community as a service user or those carrying out the service felt disadvantaged.

Revised Manuscript Received on March 30, 2020.
* Correspondence Author

Ditdit Nugeraha Utama, Computer Science Department, BINUS Graduate Program – Master of Computer Science, Bina Nusantara University, Jakarta, Indonesia 11480. Email: ditdit.utama@binus.edu

Dwi Adji Prasetyo, Information System Department, UIN Syarif Hidayatullah, Jakarta, Indonesia.

Finka Anindhita Anggari, Information System Department, UIN Syarif Hidayatullah, Jakarta, Indonesia.

Firas Abdullah Bar, Information System Department, UIN Syarif Hidayatullah, Jakarta, Indonesia.

Muhammad Fascal Bhaskara, Information System Department, UIN Syarif Hidayatullah, Jakarta, Indonesia

II. RESEARCH METHODOLOGY

Fuzzy Logic (FL) is a mathematical calculation to determine the uncertainty values that can be used in various fields. Fuzzy logic can also be interpreted as a way to use scientific language into logic so that it is easy to understand [1]. We use three parameters in this study. First is the traffic road which is divided into sub-parameters into road conditions and road length. Road conditions determine how good or damaged the existing road, then the length of the road is to find out how far the distance will be traveled. Then the second one is rainfall where to determine how low or high rainfall. The third parameter is the point of congestion where there are several congestion-prone points in an area.

Table-I: Linguistic Variable

Parameter	Linguistic Variable		
Road condition	Damaged	Medium	Good
Road length	Near	Medium	Far
Rainfall	Low	Medium	High
Congestion Point	Low	Medium	High

Table-II: Data of Road Condition (Km)

No.	District	Road Condition (Km)		
		Damaged	Moderate	Good
1.	Setu	1	4,890	28,587
2.	Serpong	1,320	7,880	42,921
3.	Pamulang	1,205	19,220	65,228
4.	Ciputat	1,180	9,981	45,084
5.	Ciputat Timur	1	7,709	50,801
6.	Pondok Aren	2,440	16,160	77,603
7.	Serpong Utara	1	4,605	27,125

Parameters are also divided into several linguistic variables (see Table-I). The parameter road conditions are categorized as damaged, medium, and good (for data please see Table-II). The length of the road becomes near, medium, and far (data is in the Table-III). Then for rainfall is categorized as levels low, medium, and high (Table-IV). For congestion-prone points are categorized as high, medium, and low (the data is presented in Table-V). Language-based variable division is used in the fuzzification process in the membership function.

A. Data Collecting

The first thing to do is to look for data from each parameter and sub-parameter. The data source we obtained is secondary data which is a source of research data obtained indirectly through intermediary media (obtained and recorded by other parties) or collected by people conducting research from existing sources. This data is usually obtained from libraries or from previous research reports [2].

The data that has been obtained, will be useful to make a decision later. We conducted research in the South Tangerang area, therefore we only looked for data from parameters and sub-parameters only in that area. The data we got from the official website of the Central Statistics Agency (BPS) for the South Tangerang region [3].

Road condition data is explained in the form of kilometers (km) where the data is data about road conditions in the South Tangerang are. Road length data is explained in the form of kilometers (km) where the data is the length of the road per district in the South Tangerang area. Rainfall data is explained in the form of millimeters (mm) where the data is rainfall data per month in the South Tangerang area. The congestion point data is explained how many congestion-prone points on the road in each district in the South Tangerang area.

Table-III: Data of Road Length (Km)

No.	District	Road Length (Km)
1.	Setu	33,478
2.	Serpong	52,121
3.	Pamulang	85,653
4.	Ciputat	56,245
5.	Ciputat Timur	58,511
6.	Pondok Aren	96,203
7.	Serpong Utara	31,731

Table-IV: Rainfall Level

No.	Month	Rainfall Level (mm)
1.	January	361
2.	February	259
3.	March	205
4.	April	161
5.	May	130
6.	June	24
7.	July	0
8.	August	10
9.	September	2
10.	October	10
11.	November	101
12.	December	73

Table-V: Congestion Point

No.	District	Congestion Point
1.	Setu	5
2.	Serpong	7
3.	Pamulang	9
4.	Ciputat	7
5.	Ciputat Timur	9
6.	Pondok Aren	14
7.	Serpong Utara	11

B. Membership Function

This Membership Function is a representation of language variables mapped to degrees of the truth (DoT) [1]. Where in making this membership function diagram, we use an application software called Fispro. For example, the membership function of parameter road condition is presented in Fig.1.; with it linguistic variables damaged (0.00, 0.25, 0.50), medium (0.25, 0.50, 0.75), and good (0.50, 0.75, 1.00).

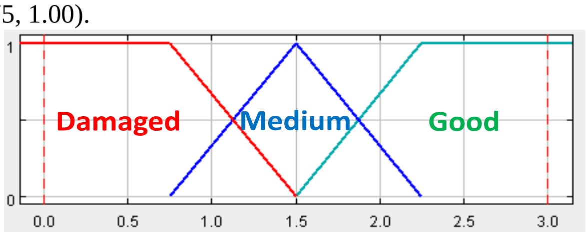

Fig. 1. Membership Function for Parameter Road Condition (in x10^5)

III. RESULT AND DISCUSSION

A. Calculating the Intersection Value

One method that can be used to get membership values is through the approach of calculating the intersection value [4]. According to the value of existing parameters, they will be calculated to find the value of up-linear-representation and down-linear-representation. The up-linear line representation is presented in Fig.2., with equation (1) operated. Then, the down-linear line representation is configured in Fig.3., with equation (2) is executed technically. For specific triangular curve, the configuration is depicted in Fig.4., and the calculation is performed via equation (3).

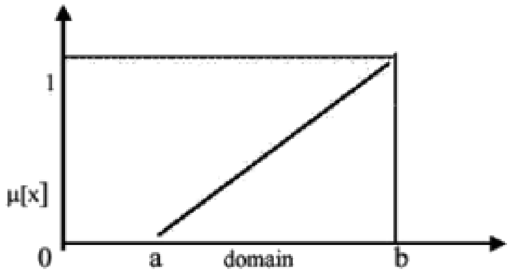

Fig. 2. Representation of Up-Linear Line

$$\mu[x] = \begin{cases} 0; & x \le a \\ (x-a)/(b-a)\,; & a \le x \le b \\ 1; & x \ge b \end{cases} \quad (1)$$

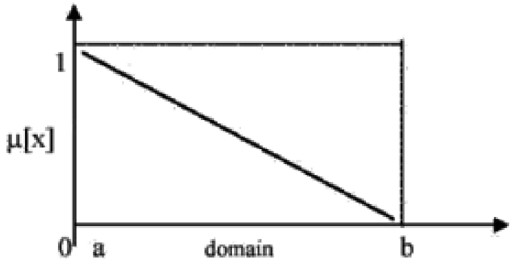

Fig. 3. Representation of Down-Linear Line

$$\mu[x] = \begin{cases} 1; & x \le a \\ (b-x)/(b-a)\,; & a \le x \le b \\ 0; & x \ge b \end{cases} \quad (2)$$

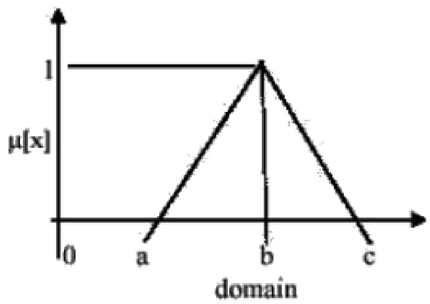

Fig. 4.Representation of Triangular Curve

$$\mu[x] = \begin{cases} 0; & x \le a \text{ or } x \ge c \\ (b-a)/(x-a)\,; & a \le x \le b \\ (b-x)/(c-b)\,; & b \le x \le c \end{cases} \quad (3)$$

For example, to calculate the value of road conditions (per district), the first thing to do is multiply the value of the membership scale with the provisions that the value of the condition of the road is either 3, moderate is 2, and damaged is 1, to the value of the linguistic variable data (the value of the road condition is good, moderate, and damaged).

Then calculate the total amount of the value and divide it by the original value data of good road conditions (see equation (4)); where DRC_{Total} is total value of district road condition, m represents road number, j is donating a road condition type (three for good, two for medium, and one for damaged), C_{ij} is a length of ith road jth condition type, and RL_i donates a length of the ith road.

$$DRC_{Total} = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}(j \times C_{ij})}{\sum_{i=1}^{m}(RL_i)} \qquad (4)$$

All result of the calculation of each parameter's up-line and down-line representation are represented in Table-VI until Table-IX. Then, the results of each district are obviously showed in Table-X.; they are represented in fuzzy value definitely.

Table-VI: The Intersect Value of Road Condition

No.	District	Congestion Point	
		Down	Up
1.	Setu	0.28	0.72
2.	Serpong	0.28	0.72
3.	Pamulang	0.35	0.65
4.	Ciputat	0.30	0.70
5.	Ciputat Timur	0.18	0.82
6.	Pondok Aren	0.30	0.70
7.	Serpong Utara	0.18	0.82

Table-VII: The Intersect Value of Road Length

No.	District	Congestion Point	
		Down	Up
1.	Setu	0.06	0.94
2.	Serpong	0.91	0.09
3.	Pamulang	0.58	0.42
4.	Ciputat	0.75	0.25
5.	Ciputat Timur	0.65	0.35
6.	Pondok Aren	0.15	0.85
7.	Serpong Utara	0.74	0.26

Table-VIII: The Intersect Value of Rainfall

No.	District	Congestion Point	
		Down	Up
1.	January	0.39	0.61
2.	February	0.41	0.59
3.	March	0.95	0.05
4.	April	0.39	0.61
5.	May	0.70	0.30
6.	June	0.46	0.54
7.	July	1.00	
8.	August	0.90	0.10
9.	September	0.98	0.02
10.	October	0.90	0.10
11.	November	0.99	0.01
12.	December	0.27	0.73

Table-IX: The Intersect Value of Congestion Point

No.	District	Congestion Point	
		Down	Up
1.	Setu	1.00	
2.	Serpong	0.60	0.40
3.	Pamulang	0.20	0.80
4.	Ciputat	0.60	0.40
5.	Ciputat Timur	0.20	0.80
6.	Pondok Aren	0.20	0.80
7.	Serpong Utara	0.80	0.20

Table-X: The Fuzzy Value of Each District's Parameter

No	District	Parameter			
		Road Condition	Road Length	Rainfall	Congestion Point
1.	Setu	0.28 good	0.06 near	3.84 low	1.00 low
		0.72 good	0.93 near		
2.	Serpong	0.28 good	0.91 medium	3.84 low	0.60 low
		0.72 good	0.08 far		0.40 medium
3.	Pamulang	0.34 good	0.57 far	3.84 low	0.20 low
		0.65 good	0.42 far		0.80 medium
4.	Ciputat	0.29 good	0.75 medium	3.84 low	0.60 low
		0.70 good	0.24 far		0.40 medium
5.	Ciputat Timur	0.18 good	0.65 medium	3.84 low	0.20 low
		0.81 good	0.34 far		0.80 medium
6.	Pondok Aren	0.29 good	0.15 far	3.84 low	0.20 medium
		0.70 good	0.84 far		0.80 high
7.	Serpong Utara	0.17 good	0.73 near	3.84 low	0.80 medium
		0.82 good	0.26 medium		0.20 high

B. Rule Base

Fuzzy rule base is another element needed to solve a classic problem by using the concept of fuzzy logic intact [1]. After obtaining the meeting point value of each parameter, the value of the Down-linear and Up-linear representations are entered into the predetermined rule base.

The results of the values that have been entered into the rule base are showed in Table-XI; where "Ojek" is a motorcycle operated for public transporter, "Angkot" is a family size vehicle benefited for public transporter, and "Metromini" is a mini bus operated for public transport.

Eighty one rule-bases operated technically in the model. The example of such rule-bases are represented in Table-XII; where F, G, H, L, M, and N are respectively far, good, high, low, medium, and near.

Table-XII: The Example of Fuzzy-Rule-Base Operated in the Constructed Model

Rainfall	Road Condition	Road Length	Congestion Point	Result
L	G	N	L	Angkot
L	G	N	M	Angkot
L	G	N	H	Ojek
L	G	M	L	Metromini
L	G	M	M	Angkot
…	…	…	…	…
H	D	F	L	Angkot
H	D	F	M	Angkot
H	D	F	H	Angkot

Table-XI: The Fuzzy-Rule-Base Execution Results for Each District's Parameter

No	District	Parameter				Public Transporter
		Road Condition	Road Length	Rainfall	Congestion Point	
1.	Setu	0.72 good	0.93 near	3.84 low	1.00 low	Ojek
2.	Serpong	0.72 good	0.91 medium	3.84 low	0.60 low	Angkot
3.	Pamulang	0.65 good	0.57 far	3.84 low	0.80 medium	Angkot
4.	Ciputat	0.70 good	0.75 medium	3.84 low	0.60 low	Angkot
5.	Ciputat Timur	0.81 good	0.65 medium	3.84 low	0.80 medium	Metromini
6	Pondok Aren	0.70 good	0.84 far	3.84 low	0.80 high	Ojek
7.	Serpong Utara	0.82 good	0.73 near	3.84 low	0.80 medium	Angkot

C. Model Dashboard

The picture configured in Fig. 5. is a dashboard display of the results of the selection of public transporter based on the geographical location of the city South Tangerang. On the dashboard display, on the left, there is the name of the web that was made, there is also a menu consisting of the dashboard menu, parameters, rule base, chart, and options.

Then the dashboard display as in the picture, displays the results of the data in the Ciputat region, which shows the results of each parameter that the public transportation that corresponds to the Ciputat region is Angkot (City Transport).

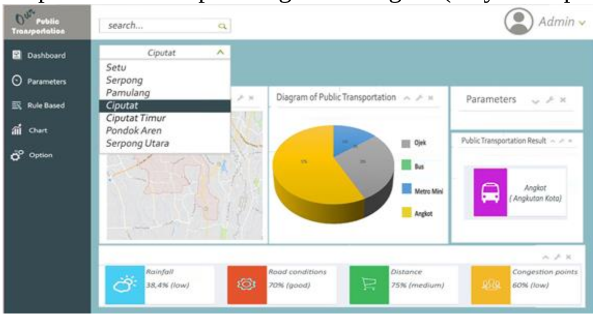

Fig. 5.The Constructed Model Dashboard

IV. CONCLUSION AND FURTHER WORKS

The results obtained from this study after entering all data and values into the rule base, it can be concluded that in Setu district, the most suitable public transportation is ojek, Serpong district is angkot, Pamulang district is angkot, Ciputat district is angkot, East Ciputat district is mini metro, Pondok Aren district is ojek, and North Serpong district is angkot. So, the most dominant public transportation in South Tangerang City is Angkot (City Transportation).

ACKNOWLEDGMENT

We would like to thank BINUS University who has supported our works, particularly BINUS graduate program, Master of Computer Science and Online Learning.

REFERENCES

1. D. N. Utama, Sistem Penunjang Keputusan Filosofi,Teori dan Implementasi. Yogyakarta: Garudhawaca, 2017.
2. P. Elriza, "Tingkat akurasi penetapan njop bumi terhadap nilai pasar dengan metode," Jurnal EMBA, 2013, pp. 1375-1385.
3. Pemerintah Kota Tangerang Selatan, Rancangan Rencana Kerja Pemerintah Daerah. Tangerang Selatan, 2015.
4. S. Kusumadewi, and I. Guswaludin, "Fuzzy Multi-Criteria Decision Making" Media Informatika, 2005.
5. D. T. Absari, "Perencanaan pembuatan sistem penunjang keputusan dengan menggunakan metode clustering pada studi kelayakan pembukaan jaringan trayek angkutan kota (sistem penunjang keputusan jaringan trayek angkutan kota)," Komputer dan Sistem Intelijen (KOMMIT2004), 2004, pp. 45-53.
6. M. A. Muslim, "Aplikasi Penentuan Rute Terbaik Berbasis Sistem Informasi Geografis," Jurnal Ilmiah Teknologi Informasi DINAMIK, 2005, pp. 76-83.
7. I. U. Susanti, Tinjauan geografis terhadap upaya pengembangan kawasan obyek wisata goa lawa di kecamatan karangreja kabupaten purbalingga. Semarang, 2005.

AUTHORS PROFILE

Ditdit Nugeraha Utama is a faculty member of Computer Science Department, BINUS Graduate Program – Master of Computer Science, Bina Nusantara University, Jakarta, Indonesia. He graduated from Mathematics and Informatics department of Doctoral Program in Göttingen University, Germany; where his doctoral-research conducted in environmental-informatics field specifically. His research interest is regarding decision support model for solving several cases of decision making problem.

Dwi Adji Prasetyo is a bachelor from Information System Department, UIN Syarif Hidayatullah, Jakarta, Indonesia. His research topic is regarding user acceptance in a parking mobile technology.

Finka Aninditha Anggari is a bachelor from Information System Department, UIN Syarif Hidayatullah, Jakarta, Indonesia. Her research is about digital provider preparedness analysis using the technology readiness index (TRI).

Firas Abdullah Bar is a bachelor from Information System Department, UIN Syarif Hidayatullah, Jakarta, Indonesia. His research concerns on design of the academic system. Now he also works at an event company as a project manager assistant.

Muhammad Fascal Bhaskara is a bachelor from Information System Department, UIN Syarif Hidayatullah, Jakarta, Indonesia. His research is talking about financial technology analysis, specifically in user acceptance.