Bulletin of Applied Mathematics and Mathematics Education
Volume 4, Number 2, October 2024, pp. 75-84
https://dx.doi.org/10.12928/bamme.v4i2.11627
e-ISSN 2776-1029, p-ISSN 2776-1002

The Tahani fuzzy logic method for detecting violence against women in North Sumatra

Khairun Nisa, Rina Filia Sari*

Faculty of Science and Technology, Universitas Islam Negeri Sumatera Utara, Jl. Lapangan Golf, Desa Durian Jangak 20353, Medan, Indonesia

*Corresponding e-mail: rinafiliasari@uinsu.ac.id

ARTICLE INFO

Article History
Received 1 October 2024
Revised 5 October 2024
Accepted 10 October 2024

Keywords
Fuzzy logic
Tahani fuzzy logic method
Violence against women

How to cite this article:
Nisa, K., & Sari, R. F. (2024). The Tahani fuzzy logic method for detecting violence against women in North Sumatra. *Bulletin of Applied Mathematics and Mathematics Education, 4*(2), 75-84.

ABSTRACT

Violence against women is a pervasive issue in society. Violence often encompasses various forms, such as physical, psychological, economic, and sexual violence. This research employs the Tahani fuzzy logic method to predict cases of violence against women. The results of the analysis in query fuzzification indicate that there are 16 districts experiencing high number of cases of violence against women, namely: Asahan, Batu Bara, Dairi, Deli Serdang, Karo, Binjai, Gunung Sitoli, Pematang Siantar, Tanjung Balai, Labuhan Batu Utara, Labuhan Batu, Langkat, Padang Lawas Utara, and Simalungun. This research also provides recommendations based on detection results, utilizing the fire strength value as the highest-level ranking. Looking at the total 33 districts in North Sumatera, the highest level of violence against women is in Medan, which occurred from July to December 2022, where all four criteria for typical cases of violence against women are significantly high.

Introduction

Violence against women is an act that often occurs in the community. Usually, violence occurs because of various kinds of problems that are very difficult to solve. Violence against women can be said to be a violation of human rights against women, because violence against women has a great impact on women themselves (Alhakim, 2021).

According to data from the Central Bureau of Statistics (BPS), around 2 in 5 (41.7%) women aged 15-64 years who have been/are married have experienced at least 1 of 4 types of violence (physical, sexual, emotional, economic violence) during their lifetime, while around 1 in 6 (16.4%) women experienced it in the past year. Meanwhile, about 1 in 4 (28.3%) ever/never married women experienced at least 1 in 3 types of violence (physical, sexual, emotional) during their lifetime and about 1 in 10 (10.4%) women experienced it in the past year.

Physical and sexual violence tended to be more prevalent among highly educated women (high school and above). About 4 in 10 (39.4%) highly educated women experienced physical and sexual violence during their lifetime. Whereas for women with low education, the prevalence rate of physical and sexual violence during life is lower at 30.6% (3 out of 10). When viewed from employment status, the prevalence of physical and sexual violence in the period of about 35.1% of women who did not work experienced physical and sexual violence, while women who worked the prevalence of violence was about 32.1% experienced physical and sexual violence (Alhakim, 2021).

Research related to fuzzy methods in detecting bullying has been partly done. Such as research conducted by (Akhter *et al.,* 2019) in the detection and classification of cyber bullying using multimonial naïve bayes and fuzzy logic. The approach in violence detection was also carried out by research by (Wajid *et al*., 2022) entitled violence detection approach based on cloud data and neutrosophic cognitive maps. In this study, identification uses an algorithm method that runs or can be referred to as a determining factor. Testing in this study uses neutrosophic cognitive maps which model violent behavior by considering determinate and indeterminate factors.

In researching cases of predicting violence against women, one method that can be used is the Tahani fuzzy logic method. This method is able to provide precise and accurate data and is able to provide recommendations in making decisions. However, there are weaknesses in this Tahani fuzzy logic method including only being able to provide predictions of a case and not being able to make decisions only at the recommendation limit.

Method

Fuzzy logic

Fuzzy logic is used to estimate things, make decisions, and as a mechanical control (Maslim *et al.*, 2018). Fuzzy logic is an improvement of strict (crisp) logic or classical logic dealing with the concept of partial truth, where classical logic states that everything can be expressed in binary terms (0 or 1, black or white, yes or no) (Nur & Gernowo, 2015). Fuzzi logic is a technique or method used to overcome uncertainty in problems that have many answers. Fuzzi logic reasoning provides a way to understand system performance by assessing system inputs and outputs from observations. Fuzzi logic provides a way to draw definite conclusions from vague, ambiguous and imprecise information (Sirait, 2018).

Fuzzy Tahani

Fuzzy Tahani is a method used to obtain information from ambiguous data based on membership functions that represent the degree of closeness of an object to certain attributes in fuzzy set theory (Prasetio et al., 2023). Tahini's fuzzy model uses Structured Query Language (SQL) to perform fuzzy query processing, which is considered very suitable for accurate data search processes (Wijaya et al., 2021). The following are the stages of the Fuzzi logic method.

1. Describing the membership function for each criterion or fuzzy variable, which is a curve that shows the mapping of input data points into their membership values (degrees of membership) which have an interval between 0 and 1, one way that can be used is with a function approach. The membership function approach is triangular.
2. Fuzzification is the first phase of fuzzy calculation, which is the conversion of an explicit value to a fuzzy value. Where each fuzzi variable is calculated the value of its membership degree

10.12928/bamme.v4i2.11627

into Excel Software to facilitate calculations in a large amount of data. In the fuzzification process, because each system can have different levels of conformity (Abdullah et al., 2018).

3. Query Fuzzification is assumed to be a conventional (nonfuzzy) DBMS query that will try to create and implement a basic fuzzy logic query system or also called query formation using base relations. Operators used for basic relations in the formation of queries on fuzzy sets are as follows:
   a. Intersection, this operator is related to the intersection operation on the set. α-predicate as the result of the operation with the AND operator is obtained by taking the smallest membership value between elements in the sets concerned with the following equation:

$$\mu A \cap B = min(\mu A(X), \mu B(y)) \quad (1)$$

   b. Union, this operator relates to the union operation on the set. A- predicate as the result of the operation with the OR operator is obtained by taking the largest membership value between elements in the sets concerned with the following equation:

$$\mu A \cup B = max(\mu A(X), \mu B(y)) \quad (2)$$

   c. Complement, this operator deals with the complement operation on the set. A-predicate as the result of the operation with the NOT operator is obtained by subtracting the membership value of the element in the set concerned from 1 with the following equation:

$$\mu \bar{A} = 1 - \mu A(x) \quad (3)$$

   d. After obtaining the results of the relation operation from the formation of the query, the recommendation result data either AND or OR operator is the recommendation value > 0 (Taufiq *et al.*, 2016).

Results and discussion

First, we determined the input and output variables. The values of the input variables are adjusted to the values of the criteria for violence against women who are members of the fuzzy set in the low, medium, and high sections. The fuzzy input can be seen in Table 1.

Table 1. Fuzzy Tahani domain

Variable Name	Output Set	Value Input
Psychic Abuse	Low	[0-5]
	Medium	[5-10]
	High	[10-15]
Physical Abuse	Low	[0-5]
	Medium	[5-10]
	High	[10-15]
Sexual Abuse	Low	[0-5]
	Medium	[5-10]
	High	[10-15]
Neglect Household	Low	[0-5]
	Medium	[5-10]
	High	[10-15]

In this research, each input variable uses a linear function, triangular function, and trapezium function to obtain the degree of membership in the fuzzy set. After the input variables are entered into the membership function, the output variables are obtained, where each output variable is divided into three parts, namely low, medium, high. The membership function of each variable is as follows.

Membership function of psychic violence

In the psychological violence variable, three fuzzy sets are defined, namely low, medium, and high. Graphical representation for the membership of psychological violence results can be seen in Figure 1.

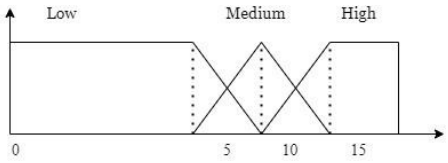

Figure 1. Psychic membership function curve

The function formula for each fuzzy membership for the psychological violence variable is as follows.

$$\mu_{low}[psychic] = \begin{cases} 0, & x \leq 5 \\ \frac{10-x}{5}, & 5 \leq x \leq 15 \\ 0, & x \geq 10 \end{cases} \quad (4)$$

$$\mu_{medium}[psychic] = \begin{cases} 0, & x \leq 5 \\ \frac{x-5}{5}, & 5 \leq x \leq 10 \\ \frac{5-x}{10}, & 10 \leq 5 \leq 10 \end{cases} \quad (5)$$

$$\mu_{high}[psychic] = \begin{cases} 0, & x \leq 5 \\ \frac{x-5}{5}, & 5 \leq x \leq 15 \\ 1, & x \geq 10 \end{cases} \quad (6)$$

Physical violence membership function

The physical violence variable is defined by three fuzzy sets, namely low, medium, and high. The graphical representation for the membership of the results of physical violence can be seen in Figure 2.

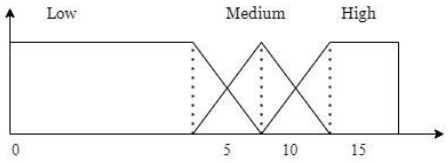

Figure 2. Physical membership function curve

The function formula used to express the degree of membership of the physical violence variable is as follows.

$$\mu_{low}[Physical] = \begin{cases} 0, & x \leq 5 \\ \frac{10-x}{5}, & 5 \leq x \leq 15 \\ 0, & x \geq 10 \end{cases} \quad (7)$$

10.12928/bamme.v4i2.11627

$$\mu_{medium}[Physical] = \begin{cases} 0, & x \leq 5 \\ \frac{x-5}{5}, & 5 \leq x \leq 10 \\ \frac{5-x}{10}, & 10 \leq 5 \leq 10 \end{cases} \quad (8)$$

$$\mu_{high}[Physical] = \begin{cases} 0, & x \leq 5 \\ \frac{x-5}{5}, & 5 \leq x \leq 15 \\ 1, & x \geq 10 \end{cases} \quad (9)$$

Sexual violence membership function

The sexual violence variable is defined by three fuzzy sets, namely low, medium, and high. The graphical representation for the membership of the results of sexual violence can be seen in Figure 3.

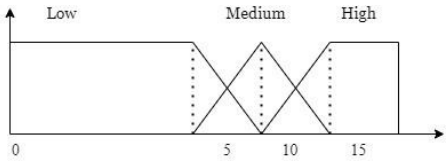

Figure 3. Sexual membership function curve

The function formula used to express the degree of membership of the sexual violence variable is as follows.

$$\mu_{low}[Sexual\ ] = \begin{cases} 0, & x \leq 5 \\ \frac{10-x}{5}, & 5 \leq x \leq 15 \\ 0, & x \geq 10 \end{cases} \quad (10)$$

$$\mu_{medium}[Sexual\ ] = \begin{cases} 0, & x \leq 5 \\ \frac{x-5}{5}, & 5 \leq x \leq 10 \\ \frac{5-x}{10}, & 10 \leq 5 \leq 10 \end{cases} \quad (11)$$

$$\mu_{high}[Sexual\ ] = \begin{cases} 0, & x \leq 5 \\ \frac{x-5}{5}, & 5 \leq x \leq 15 \\ 1, & x \geq 10 \end{cases} \quad (12)$$

Membership function of household neglect

The variable of household neglect is defined by three fuzzy sets, namely low, medium, and high. Graphical representation for the membership of psychological violence results can be seen in Figure 4.

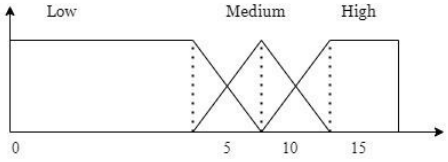

Figure 4. Household neglect membership function curve

The function formula used to express the degree of membership of the household neglect

variable is as follows.

$$\mu_{low}[neglect\ ] = \begin{cases} 0, & x \le 5 \\ \frac{10-x}{5}, & 5 \le x \le 15 \\ 0, & x \ge 10 \end{cases} \quad (13)$$

$$\mu_{medium}[neglect\ ] = \begin{cases} 0, & x \le 5 \\ \frac{x-5}{5}, & 5 \le x \le 10 \\ \frac{5-x}{10}, & 10 \le 5 \le 10 \end{cases} \quad (14)$$

$$\mu_{high}[neglect\ ] = \begin{cases} 0, & x \le 5 \\ \frac{x-5}{5}, & 5 \le x \le 15 \\ 1, & x \ge 10 \end{cases} \quad (15)$$

The system design that has been done is then implemented into the program. The program is made using Microsoft excel. The author uses the membership function formula for each criteria that has been determined. The results of the membership record of psychological violence can be seen in Table 2 .

Membership function implementation of psychological violence
Low category
= IF(E3 <= K$4,1, IF(AND(K$4 <= E3, E3 < K$5), (K5 − E3)/(K$5 − K4),0))

Medium category
= IF(E3 ≤ K$4,0, IF(AND(K$4 ≤ E3, E3 = K$5), (E3 − K$4)/(K$5 − K$4), IF(AND(K$5 <= E3, E3 <= K$6), (K$6 − E3)/(K$6 − K$5))))

High category
= IF(E3 ≤ K$4,0, IF(AND(K$4 ≤ E3, E3 ≤ K$5), (E3 − K$4)/(K$5 − K$4),1))

The results of the psychological violence membership can be seen in the Table 2.

Table 2. Calculation of membership degrees of psychological violence

No	Years	Month	City	Psychological	Low	Medium	High
1	2022	January - March	Nias	0	1	0	0
2	2022	January - March	Mandailing Natal	2	1	0	0
3	2022	January - March	Tapanuli Selatan	0	1	0	0
4	2022	January - March	Tapanuli Tengah	2	1	0	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
262	2023	October-December	Binjai	2	1	0	0
263	2023	October-December	Padang Sidempuan	2	1	0	0
264	2023	October-December	Gunung Sitoli	18	0	0	1

Implementation of physical abuse membership function
Low category
= IF(E3 <= K$4,1, IF(AND(K$4 <= E3, E3 < K$5), (K5 − E3)/(K$5 − K4),0)).

10.12928/bamme.v4i2.11627

Medium category

$= IF(E3 <= K\$4,0, IF(AND(K\$4 <= E3, E3 <= K\$5), (E3 - K\$4)/ (K\$5 - K\$4), IF(AND(K\$5 <= E3, E3 <= K\$6), (K\$6 - E3)/(K\$6 - K\$5)))) .$

High category

$= IF(E3 <= K\$4,0, IF(AND(K\$4 <= E3, E3 <= K\$5), (E3 - K\$4)/(K\$5 - K\$4),1)).$

The results of the physical violence membership can be seen in the Table 3.

Table 3. Membership degree calculation of physical violence

No	Years	Month	City	Physical	Low	Medium	High
1	2022	January - March	Nias	0	1	0	0
2	2022	January - March	Mandailing Natal	2	1	0	0
3	2022	January - March	Tapanuli Selatan	0	1	0	0
4	2022	January - March	Tapanuli Tengah	2	1	0	0
5	2022	January - March	Tapanuli Utara	0	1	0	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
262	2023	October-December	Binjai	4	1	0	0
263	2023	October-December	Padang Sidempuan	4	1	0	0
264	2023	October-December	Gunung Sitoli	18	0	0	1

Implementation of the sexual violence membership function

Low category

$= IF(F5 <= M\$7,1, IF(AND(M\$7 <= F5, F5 <= M\$8), (M\$8 - F5)/(M\$8 - M\$7),0)).$

Medium category

$= IF(F5 <= M\$7,0, IF(AND(M\$7 <= F5, F5 <= M\$8), (F5 - M\$7)/(M\$8 - M\$7), IF(AND(M\$8 <= F5, F5 <= M\$9), (M\$9 - F5)/(M\$9 - M\$8)))).$

High category

$= IF(F5 <= M\$7,0, IF(AND(M\$7 <= F5, F5 <= M\$8), (F5 - M\$7)/(M\$8 - M\$7),1)).$

The results of the sexual violence membership register can be seen in the Table 4.

Table 4. Sexual violence membership degree calculation

No	Years	Month	City	Sexual	Low	Medium	High
1	2022	January - March	Nias	4	1	0	0
2	2022	January - March	Mandailing Natal	3	1	0	0
3	2022	January - March	Tapanuli Selatan	7	0.6	0.4	0.4
4	2022	January - March	Tapanuli Tengah	2	1	0	0
5	2022	January - March	Tapanuli Utara	0	1	0	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
262	2023	October-December	Binjai	10	0	1	1
263	2023	October-December	Padang Sidempuan	5	1	0	0
264	2023	October-December	Gunung Sitoli	3	1	0	0

Implementation of household neglect membership function

Low category

$= IF(F5 <= M\$6,1, IF(AND(M\$6 <= F5, F5 <= M\$7), (M\$7 - F5)/(M\$7 - M\$6),0))$

Medium category

$= IF(F5 \leq M\$6,0, IF(AND(M\$6 \leq F5, F5 \leq M\$7), (F5 - M\$6)/(M\$7 - M\$6), IF(AND(M\$7 <= F5, F5 <= M\$8), (M\$8 - F5)/(M\$8 - M\$7)))$

High category

$= IF(F5 <= M\$6,0, IF(AND(M\$6 <= F5, F5 <= M\$7), (F5 - M\$6)/(M\$7 - M\$6),1))$

The results of the domestic neglect membership can be seen in the Table 5.

Table 5. Household neglect membership degree calculation

No	Years	Month	City	Neglect	Low	Medium	High
1	2022	January - March	Nias	0	1	0	0
2	2022	January - March	Mandailing Natal	0	1	0	0
3	2022	January - March	Tapanuli Selatan	3	1	0	0
4	2022	January - March	Tapanuli Tengah	1	1	0	0
5	2022	January - March	Tapanuli Utara	1	1	0	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
262	2023	October-December	Binjai	1	1	0	0
263	2023	October-December	Padang Sidempuan	2	1	0	0
264	2023	October-December	Gunung Sitoli	18	0	0	1

This research design ends with recommended results in detecting violence against women in North Sumatra using fuzzy query. The process of determining the recommendation results still uses excel where the implementation. The results of the fuzzy query recommendation can be seen in the Table 6.

Table 6. Fuzzy query recommendation

No	Years	Month	City	High Psychological	High Physical	High Sexual	High Abandonment	Recommended Outcome
1	2022	Jan-March	Nias	0	0	0	0	Low
2	2022	Jan-March	Mandailing Natal	0	0	0	0	Low
3	2022	Jan-March	Tapanuli Selatan	0	0	0.4	0	Medium
4	2022	Jan-March	Tapanuli Tengah	0	0	0	0	Low
5	2022	Jan-March	Tapanuli Utara	0	0	0	0	Low
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
262	2023	October-December	Kota Binjai	0	0	1	0	High
263	2023	October-December	Padang Sidempuan Kota	0	0	0	0	Low
264	2023	October-December	Gunung Sitoli	1	1	0	1	High

10.12928/bamme.v4i2.11627

Next, determine the fire strength which is selected from the smallest value between the membership degrees of each variable, then the results of the ranking recommendations are sorted from the highest value. So that the results of the decision recommendation in detecting it can be seen in the Table 7.

Table 7. Fire strength values and recommendation results

Years	Month	City	High Psychic (a1)	High Physical (a2)	High Sexual (b1)	High Abandonment (b2)	Fire Strength	Ranking
2022	July-September	Medan	1	1	1	1	1	1
2022	October-December	Medan	1	1	1	1	1	1
2023	January - March	Deli Serdang	1	0.4	1	1	0.4	2
2022	January - March	Medan	1	1	0.2	1	0.2	3
2023	October-December	Medan	0.6	0.2	1	0.6	0.2	4
2022	July-September	Deli Serdang	1	0.2	1	0.4	0.2	5
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
2023	April-June	Padang lawas Utara	1	1	0	1	0	8
2022	October-December	Dairi	0.8	1	0	1	0	9
2023	July-September	Asahan	1	1	0	0.8	0	10
2023	July-September	Pematang Siantar	0	0.2	1	0.6	0	11

In Table 7, it can be seen that violence against women in North Sumatra Province is the highest case located in Medan City from July to December 2022 and the typical cases of violence from the four criteria all dominate high scores.

Conclusion

The conclusion of this research is that Tahani fuzzy logic is one of the methods that can be used to predict violence against women, especially in North Sumatra. The research and analysis process used lies in determining the membership function of each of the specified criteria. Tahani fuzzy logic is standard data where it is only 0-1, so in the query fuzzification there are 16 districts that experience high values in the case of violence against women, namely Asahan, Batu Bara, Dairi, Deli Serdang, Karo, Binjai City, Gunung Sitoli City, Medan City, Pematang Siantar City, Tanjung Balai City, Tebing Tinggi City, North Labuhan Batu, Labuhan Batu, Langkat, North Padang Lawas, and Simalungun. This research also determines the results of recommendations in detecting using the fire strength value as the highest ranking level. Looking at the total of 33 districts in North Sumatra, the highest level of violence against women is in Medan City which occurred from July to December 2022, where the four criteria for typical cases of violence against women all dominate high.

References

Abdullah, D., Djanggih, H., Suendri, S., Cipta, H., & Nofriadi, N. (2018). Fuzzy model Tahani as decision support system for employee promotion. *International Journal of Engineering & Technology, 7*(2).

Akhter, A., Uzzal, K. A., & Polash, M. M. A. (2019). Cyber bullying detection and classification using multinomial Naïve Bayes and fuzzy logic. *International Journal of Mathematical Sciences and Computing, 5*(4), 1-12. https://doi.org/10.5815/ijmsc.2019.04.01

Alhakim, A. (2021). Kekerasan terhadap perempuan: Suatu kajian perlindungan berdasarkan hukum positif di Indonesia. *Jurnal Pendidikan Kewarganearaan Undiksha*, *9*(1), 115–122.

Maslim, M., Dwiandiyanta, B. Y., & Susilo, N. V. (2018). Implementasi metode logika fuzzy dalam pembangunan sistem optimalisasi lampu lalu lintas. *Jurnal Buana Informatika*, *9*(1)11–20.

Nur, E., & Gernowo, R. (2015). Implementasi fuzzy model Tahani untuk perancangan sistem pendukung keputusan penerimaan taruna baru. *Jurnal Sistem Informasi Bisnis, 5*(1), 63–71.

Prasetio, W. D., Zahrroh, A., Khudri, A., Rizki, B., Izzati, A. R., Brantadikara, D., Informatika, P. S., Teknik, F., & Bengkulu, U. (2023). Implementasi fuzzy Tahani dalam sistem rekomendasi. *Teknosia, 16*(2), 41–54.

Sirait, J. A. (2018). Penerapan logika fuzzy dalam menentukan biaya pembangunan rumah pada PT Cipta Group menggunakan metode Mamdani. *Dissertation*. UP Batam.

Taufiq, G. (2016). Implementasi logika fuzzy Tahani untuk model sistem pendukung keputusan evaluasi kinerja karyawan. *Jurnal Pilar Nusa Mandiri, 12*(1), 12-20.

Wajid, M. S., Terashima-Marin, H., Paul Rad, P. N., & Wajid, M. A. (2022). Violence detection approach based on cloud data and Neutrosophic cognitive maps. *Journal of Cloud Computing, 11*(1), 85. https://doi.org/10.1186/s13677-022-00369-4.

Wijaya, H., Virginia, M., & Hakim, L. (2021). Penerapan fuzzy Tahani untuk pemilihan perangkat smartphone berbasis website berdasarkan kriteria membeli. *Jurnal Teknik Informatika UNIKA Santo Thomas*, 412-421.

10.12928/bamme.v4i2.11627