Medan City Unemployment Rate Prediction Using the Fuzzy Time Series Method of the Chen Model for 2022-2024

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Abstract

Indonesia is one of the developing countries based on the standard of living; one of the problems that is still being experienced is the problem of unemployment. One method that can be used to predict future conditions is the Fuzzy Time Series Method. The fuzzy Time Series method combines fuzzy logic with time series analysis, where fuzzy logic aims to imitate the human ability to think, which is an alternative to crisp logic. Unemployment is a problem in the life sector that can impact not only yourself and your family but also the country because high unemployment can cause severe impacts, such as a decrease in state income from the tax sector or an increase in crime in society. This study aims to predict the open unemployment rate in the city of Medan, which will continue to increase from 2018-2021, based on the number of the workforce as a consideration for making a policy. The method used is Fuzzy Time Series Chen. The result obtained of discussion and calculation, the unemployment rate prediction in 2022 is 11,998.14; in 2023, it is 11,791.21; and in 2024, it is 11,687.75 people.

Keywords: *Prediction; Unemployment; Fuzzy Times Series (FTS) Chen.*

Abstrak

Indonesia merupakan salah satu negara berkembang berdasarkan taraf hidup, salah satu permasalahan yang masih dialami adalah masalah pengangguran. Salah satu metode yang dapat digunakan untuk memprediksi kondisi masa depan adalah Metode Fuzzy Time Series. Metode Fuzzy Time Series digunakan untuk menggabungkan logika fuzzy dengan analisis deret waktu dimana logika fuzzy bertujuan untuk meniru kemampuan berpikir manusia yang merupakan alternatif dari logika crisp. Pengangguran merupakan masalah di bidang kehidupan yang dapat berdampak tidak hanya bagi diri sendiri dan keluarga tetapi juga bagi negara karena pengangguran yang tinggi dapat menimbulkan dampak yang serius seperti penurunan pendapatan negara dari sektor pajak atau peningkatan kriminalitas di masyarakat. Penelitian ini bertujuan untuk memprediksi tingkat pengangguran terbuka di Kota Medan yang terus meningkat dari tahun 2018-2021 berdasarkan jumlah angkatan kerja sebagai pertimbangan pengambilan kebijakan. Metode yang digunakan adalah Fuzzy Time Series Chen. Hasil pembahasan dan perhitungan yang diperoleh, prediksi tingkat pengangguran tahun 2022 sebesar 11.998,14, tahun 2023 sebesar 11.791,21, dan tahun 2024 sebesar 11.687,75 orang.

Kata Kunci: Prediksi; Pengangguran; Fuzzy Times Series (FTS) Chen.

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INTRODUCTION

Unemployment is an essential factor in the field of employment, where unemployment can be used as a measure of the extent to which the labor force can be absorbed unemployment is an essential factors in the field of employment, where unemployment can be used as a measure of the extent to which existing employment opportunities can absorb the labor force. High unemployment can be a significant source of increasing poverty, triggering high crime rates and hindering the development process in the long run and existing employment opportunities. High unemployment can substantially increase poverty, starting high crime rates and impeding the development process in the long run. (Artriyan, 2013).

High unemployment is a significant problem in developing countries. Apart from the low level of education or the quality of education, the facilities and capabilities need to be qualified, and the feeling of laziness to improve the standard of living, which ultimately causes a high level of unemployment in Indonesia, especially the city of Medan.

Prediction is the process of estimating future or future events by using past data on a variable or set of variables to predict the value of a variable in the future. Prediction is synonymous with time series data analysis. Time series data are observed values measured based on fixed time intervals within a specific time. One of the methods that can be implemented to make predictions is the fuzzy time series method.

Fuzzy Time Series can be used to combine fuzzy logic with time series analysis. Fuzzy logic or fuzzy logic aims to imitate the human ability to think in the form of algorithms, which are then executed by machines. Fuzzy logic was first introduced by Zadeh (1965) from the University of California, which is an alternative to crisp logic. This research will carry out Fuzzy logic relationship (FLR) or classification of data on the number of unemployed and form a Fuzzy Logical Relationship group (FLRG), which aims to classify the FLR that has been obtained into groups to facilitate defuzzification in predicting the number of

unemployed. Defuzzification calculates the median value and indicates the number of unemployed using the Fuzzy Times Series method.

Several previous studies have used the fuzzy time series method, including: Wati (2020) concerning applying the Fuzzy Time Series Method in Predicting Tourist Visits at the Mulawarman Museum. Setaini (2020) regarding the Application of Chen's Fuzzy Time Series and Cheng's Fuzzy Time Series in Predicting the Rupiah Exchange Rate against the Singapore Dollar. Putra (2019) regarding Population Prediction Using Chen's Fuzzy Time Series Model (Case Study: Tangjungpinang City, it can be concluded that the results of predictions made have a relatively high level of accuracy and tend to get a lower error rate, therefore the fuzzy times series method is appropriate to use to predict the number of unemployed in the city of Medan in 2022-2024.

RESEARCH METHODS

Predictions

Prediction is a process of systematically estimating something that is most likely to happen in the future based on past and present information that is owned so that errors can be minimized. Predictions do not have to give a definite answer to what will happen but try to find answers as close as possible to what will happen (Herdianto, 2013).

Unemployment

According to the Big Indonesian Dictionary V unemployment is a thing or a state of being unemployed. Meanwhile, according to Sadono Sukirno (1994), unemployment is a workforce that wants to get a job but has not gotten a job.

Fuzzy Logic

Fuzzy logic is a mathematical technique that is used to imitate human intelligence in thinking in the form of an algorithm which is then executed by a machine.

Fuzzy Time Series

Fuzzy Time Series (FTS) is a data prediction method with the fuzzy principle, where the fuzzy set shows the value of the time series. Fuzzy

predictions for time series identify and utilize patterns from previous data for future predictions (Admirani, 2018).

Fuzzy Time Series

Fuzzy time series is a new method of prediction introduced by Song and Chissom (1993), which is a time series prediction used to explain vague data and linguistic values. Place tables and figures in the following sections.

RESULTS AND DISCUSSION

As for the research results from the data on the number of generations K, the work of the City of Medan in 2017-2021 taken from the Central Bureau of Statistics for the city of Medan can be seen in Table 1.

Determining the Universal Set (U) of Historical Data

Formation of the universal set (U) can be through data on the number of residents aged 15 years and over according to the type of activity during the past week and gender in the city of Medan, from 2017 to 2021. The steps for forming an estimate of the number of unemployed in the town of Medan are using the Fuzzy Time Series Chen method.

The steps for forming an estimate of the number of unemployed in the city of Medan with Chen's Fuzzy Time Series method are as follows:

Step 1. Determining the Universal Set (U) from historical data can be written as follows:

$$\text{Range} = \text{Dmax} - \text{Dmin}$$
$$= 12.496 - 6.114$$
$$= 9.305$$

Step 2. Determination of the number and width of the interval

In determining the interval's length along with the interval's width using Sturges' rule: Number of Intervals = 1 + (3.3 x log (60) 6,867 = 7

Table 1. Data on the Population Aged 15 Years and Over

Years	Time	Data
2017	January	7740
	February	8435
	March	9110
	April	7661
	May	8120
	June	9662
	July	8001
	August	8935
	September	8211
	October	8410
	November	9111
	December	8238
2018	January	7112
	February	8940
	March	7432
	April	7880
	May	8111
	June	7614
	July	7019
	August	6821
	September	6497
	October	7556
	November	7941
	December	8830
2021	January	8922
	February	9445
	March	8355
	April	8210
	May	8782
	June	9123
	July	10710
	August	9914
	September	11371
	October	11325
	November	12496
	December	12412

Source: Central Bureau of Statistics (BPS) Medan City

After the number of intervals is obtained, the width of the interval will be sought to divide the data into the same number of intervals

ℓ = Dmax-Dmin/number of intervals

= 12,496-6,114/7

= 911.71

Table 2. Linguistic Interval

Linguistic Interval	Frame	
6.114	7.025,71	U_1
7.025,71	7.937,42	U_2
7.937,42	8849,143	U_3
8849,143	9760,858	U_4
9760,858	10672,57	U_5
10672,57	11584,29	U_6
11584,29	12496	U_7

Source: Results of Calculating the width of the Interval from the Number of Classes

In Table 2, it is known that there are seven classes From, which can be denoted by U_1, U_2, U_3 to U_7, where, U_1 has a value range of 7,025.71, U_2 7,937.42 and so on up to class 7, namely 12,496 residents aged 15 years and over.

Step 3. Determine the Fuzzy set for the entire universe U, through 3 fuzzy sets that can be formed are as follows:

$A_1 = \{ 1 / U_1 + 0.5 / U_2 + 0 / U_3 + 0/U_4 + 0 / U_5 + 0 / U_6 + 0 / U_7 \}$

$A_2 = \{ 0.5 / U_1 + 1 / U_2 + 0.5 / U_3 + 0 / U_4 + 0 / U_5 + 0 / U_6 + 0/U_7 \}$

$A_3 = \{ 0 / U_1 + 0.5/ U_2 + 1 / U_3 + 0.5 / U_4 + 0 / U_5 + 0 / U_6 + 0 / U_7\}$

Step 4. The next step determines linguistic numbers

Fuzzification

Fuzzification aims to determine the appropriate data set to form a Linguistic Value. Can be seen in Table 3.

Then the historical data for the population aged 15 years and over in 2017-2021, which has been obtained above, will be divided into several groups. In January 2017, the historical data is U_1 7740, this data is included in U_2, so it is denoted as A_2. In 2017 February is 8435, the data is contained in U_3, so it is meant in A_3.

Table 3. Fuzzification

Years	Time	Data
2017	January	7740
	February	8435
	March	9110
	April	7661
	May	8120
	June	9662
	July	8001
	August	8935
	September	8211
	October	8410
	November	9111
	December	8238
2018	January	7112
	February	8940
	March	7432
	April	7880
	May	8111
	June	7614
	July	7019
	August	6821
	September	6497
	October	7556
	November	7941
	December	8830
2021	January	8922
	February	9445
	March	8355
	April	8210
	May	8782
	June	9123
	July	10710
	August	9914
	September	11371
	October	11325
	November	12496
	December	12412

Source: Fuzzification Data for 2017-2021 Based on Population

In March 2017, it was 9110, this data is included in U_3, so it is denoted A_3. In 2017 April is 7661, this data is contained in U_2, so it is denoted A_2. In 2017 May was 8120, and the data is included in U_3, so it is characterized A_3 And so on until December 2021, is 12412; this data is contained in U_7, so it is denoted by A_7. Complete details can be seen at.

Table 4. Fuzzified Data

Time	Data	Symbol	Time	Data	Symbol
Jan-17	7740	A_2	Jul-19	8210	A_3
Feb-17	8435	A_3	Augus-19	7500	A_2
Mar-17	9110	A_3	Sept-19	6114	A_1
Apr-17	7661	A_2	Octo-19	6120	A_1
May-17	8120	A_3	Nov-19	7141	A_2
Jun-17	9662	A_4	Dec-19	7260	A_2
Jul-17	8001	A_3	Jan-20	10310	A_5
Augus-17	8935	A_3	Feb-20	11775	A_6
Sept-17	8211	A_3	Mar-20	10110	A_4
Octo-17	8410	A_3	Apr-20	9921	A_4
Nov-17	9111	A_3	May-20	10882	A_5
Dec-17	8238	A_3	Jun-20	9998	A_4
Jan-18	7112	A_1	Jul-20	10121	A_5
Feb-18	8940	A_3	Augu-20	9325	A_4
Mar-18	7432	A_2	Sept-20	10010	A_4
Apr-18	7880	A_2	Octo-20	10415	A_5
May-18	8111	A_2	Nov-20	9120	A_4
Jun-18	7614	A_2	Dec-20	9836	A_4
Jul-18	7019	A_1	Jan-21	8922	A_3
Augus-18	6821	A_1	Feb-21	9445	A_4
Sept-18	6497	A_1	Mar-21	8355	A_3
Octo-18	7556	A_2	Apr-21	8210	A_3
Nov-18	7941	A_2	May-21	8782	A_3
Dece-18	8830	A_3	Jun-21	9123	A_4
Jan-19	7812	A_2	Jul-21	10710	A_5
Feb-19	7935	A_2	Augu-21	9914	A_4
Mar-19	8192	A_3	Sept-21	11371	A_6
Apr-19	9450	A_4	Octo-21	11325	A_6
Mei-19	9321	A_4	Nov-21	12496	A_7
Jun-19	9110	A_3	Dec-21	12412	A_7

Source: Formation of Fuzzified Data from Historical Data

Here is the data that has been divided into several groups. After all the data is fuzzyfied, the next step is to determine the Fuzzy Logical Relationship (FLR).

Step 5a. Determine Fuzzy Logical Relationship (FLR)

Table 5. Fuzzy Logical Relationship (FLR)

Time	Data	Linguistic	Time	Data	Linguistic
Jan-17	7740	$A_2 \rightarrow A_2$	Jul-19	8210	$A_3 \rightarrow A_3$
Feb-17	8435	$A_2 \rightarrow A_3$	Augus-19	7500	$A_3 \rightarrow A_2$
Mar-17	9110	$A_3 \rightarrow A_3$	Sept-19	6114	$A_2 \rightarrow A_1$
Apr-17	7661	$A_3 \rightarrow A_2$	Octo-19	6120	$A_1 \rightarrow A_1$
May-17	8120	$A_2 \rightarrow A_3$	Nov-19	7141	$A_1 \rightarrow A_2$
Jun-17	9662	$A_3 \rightarrow A_4$	Dec-19	7260	$A_2 \rightarrow A_2$
Jul-17	8001	$A_4 \rightarrow A_2$	Jan-20	10310	$A_2 \rightarrow A_5$
Augus-17	8935	$A_2 \rightarrow A_3$	Feb-20	11775	$A_5 \rightarrow A_6$
Sept-17	8211	$A_3 \rightarrow A_3$	Mar-20	10110	$A_6 \rightarrow A_4$
Octo-17	8410	$A_3 \rightarrow A_3$	Apr-20	9921	$A_4 \rightarrow A_4$
Nov-17	9111	$A_3 \rightarrow A_3$	May-20	10882	$A_4 \rightarrow A_5$
Dec-17	8238	$A_3 \rightarrow A_3$	Jun-20	9998	$A_5 \rightarrow A_4$
Jan-18	7112	$A_3 \rightarrow A_1$	Jul-20	10121	$A_4 \rightarrow A_5$
Feb-18	8940	$A_3 \rightarrow A_3$	Augus-20	9325	$A_5 \rightarrow A_4$
Mar-18	7432	$A_3 \rightarrow A_2$	Sept-20	10010	$A_4 \rightarrow A_4$
Apr-18	7880	$A_2 \rightarrow A_2$	Octo-20	10415	$A_4 \rightarrow A_5$
May-18	8111	$A_2 \rightarrow A_2$	Nov-20	9120	$A_5 \rightarrow A_4$
Jun-18	7614	$A_2 \rightarrow A_2$	Dec-20	9836	$A_4 \rightarrow A_4$
Jul-18	7019	$A_2 \rightarrow A_1$	Jan-21	8922	$A_4 \rightarrow A_3$
Augus-18	6821	$A_1 \rightarrow A_1$	Feb-21	9445	$A_3 \rightarrow A_4$
Sept-18	6497	$A_1 \rightarrow A_1$	Mar-21	8355	$A_4 \rightarrow A_3$
Octo-18	7556	$A_1 \rightarrow A_2$	Apr-21	8210	$A_3 \rightarrow A_3$
Nov-18	7941	$A_2 \rightarrow A_2$	May-21	8782	$A_3 \rightarrow A_3$
Dec-18	8830	$A_2 \rightarrow A_3$	Jun-21	9123	$A_3 \rightarrow A_4$
Jan-19	7812	$A_3 \rightarrow A_2$	Jul-21	10710	$A_4 \rightarrow A_5$
Feb-19	7935	$A_2 \rightarrow A_2$	Augus-21	9914	$A_5 \rightarrow A_4$
Mar-19	8192	$A_2 \rightarrow A_3$	Sept-21	11371	$A_4 \rightarrow A_6$
Apr-19	9450	$A_3 \rightarrow A_4$	Octo-21	11325	$A_6 \rightarrow A_6$
May-19	9321	$A_4 \rightarrow A_4$	Nov-21	12496	$A_6 \rightarrow A_7$
Jun-19	9110	$A_4 \rightarrow A_3$	Dec-21	12412	$A_7 \rightarrow A_7$

Source: Formation of Fuzzified Data from Historical Data

FLR is the relationship between each subsequent data sequence in the form of fuzzy sets. It can be formed based on Table 4. The FLR for all unemployment data is presented in Table 5. The process of determining the fuzzy location can be done by looking at the previous time to the next time, which can be seen in the Table 5.

Furthermore, after dividing into groups based on data obtained based on historical data, it can be seen in Table 6. that a Fuzzy Relationship Group (FLRG).

Step 5b. After obtaining the FLR, the next step is to determine the FLRG, which is formed based on the existing FLR and is the result of grouping each FLRG state shift.

Table 6. Fuzzy Logical Relationship Group (FLRG)

Group	Linguistic
1	$A_1 \rightarrow A_1, A_2, A_3$
2	$A_2 \rightarrow A_1, A_2, A_3, A_5$
3	$A_3 \rightarrow A_1, A_2, A_3, A_4$
4	$A_4 \rightarrow A_3, A_4, A_5, A_6$
5	$A_5 \rightarrow A_4, A_6$
6	$A_6 \rightarrow A_4, A_6, A_7$
7	$A_7 \rightarrow A_7$

Source: FLR Data Adjustment Results from Fuzzy Fictional Data

Step 6. Calculate the initial forecasting results.

Next, the process of calculating the forecasting results is carried out using Chen's Fuzzy Time Series. Based on the FLRG that has been determined previously in Group 7, there is Relations Group $A_7 \rightarrow A_7$, namely: 11584.29. Then the two middle values are calculated on average or written as:

F(t) = Dmax + Linguistic Value (A_7)

F(t) = 12.412+11584.29

     = 23,996.29/2

     = 11,998.14

Calculating the Results of the Initial Forecasting

After the Fuzzy Logical Relations Group (FLRG) is obtained, the forecasting results are calculated using Chen's Fuzzy Time Series. Based on the FLRG that has been determined previously in Group 7, there is Relations Group $A_7 \rightarrow A_7$, namely: 11584.29. Then the two middle values are calculated on average or written as:

Table 7. Prediction Result

Time	Data	Linguistic	Middle Point	Predict
2021	12.412	$A_7 \rightarrow A_7$	11584,29	12.412,00
2022	12.614	$A_7 \rightarrow A_7$	11584,29	11.998,14
2023	12.614	$A_7 \rightarrow A_7$	11584,29	11.791,21
2024	-	-	-	11.687,75

Source: FLRG results from FLR Data

The results of the calculations that have been carried out are by historical data; the prediction results for 2022 are 11,998.14 people. The prediction results for 2023 are 11,791.21 people, and in 2024, the prediction results are found to be 11,687.75 people. Complete data on the Open Unemployment Rate for the city of Medan for 2017-2024 can be seen in Table 8 below.

Table 8. Prediction Results of the Medan City Open Unemployment Rate for 2018-2024

Years	Open Unemployment Rate
2018	8,25%
2019	8,53%
2020	10,74%
2021	10,81%
2022	10,71%
2023	10,52%
2024	10,43%

Source: Predictions of Unemployment Rates for 2022-2024

Based on the results of the predictions that have been made, you can see in Table 8. the development of the Medan City Open Unemployment Rate (TPT), which has increased from 2018 to 2024; the government must adopt appropriate policies so that the surge in the unemployment rate can be handled optimally.

The following is a graph of the development of the 2018-2024 Medan City Unemployment Rate.

Sumber : Badan Pusat Statistik, 2021
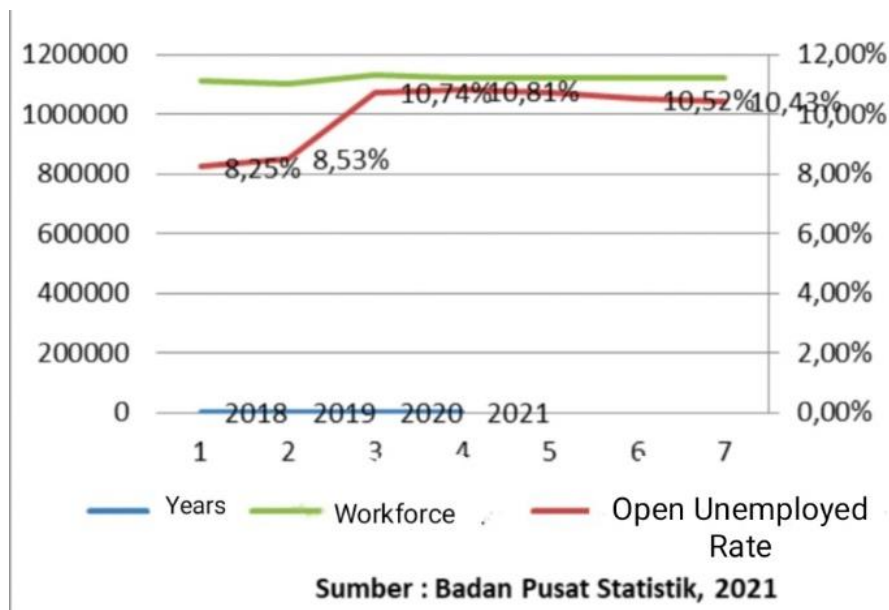
Figure 1. Graph of the Development of the Medan City Open Unemployment Rate in 2018-2024

CONCLUSION

Based on the results of data analysis and discussion that has been carried out in the previous chapter, it can be concluded that the Fuzzy Time Series Chen Model method can be used to solve the problem of predicting the unemployment rate in the city of Medan. The results of the discussion and calculation of the prediction of the Open Unemployment Rate (TPT) for the city of Medan in 2022 are 11,998.14, then in 2023, it will be 11,791.21, and in 2024 it will be 11,687.75 people.

From the prediction results, it can be seen that the development of the Medan City Open Unemployment Rate (TPT) has decreased; this can occur due to the increase in the quality of job seekers and the Covid-19 pandemic, which has begun to be overcome by the Medan city government, North Sumatra.

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