

# BANK SYARIAH INDONESIA SHARE PRICE PREDICTION USING FUZZY TIME SERIES MODEL LEE METHOD

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**Abstract:** In a forecasting using historical data available in the field there is often a violation of the assumptions required by each method. So that in forecasting there are often obstacles in the fulfillment of these assumptions. Because the forecasting method with the Fuzzy Time Series (FTS) method is a solution to do forecasting without requiring data assumptions. The purpose of this study is to find out how the results of the prediction of the highest stock price of Bank Syariah Indonesia by using the FTS method lee model. This research uses the highest price value of Bank Syariah Indonesia shares, and the data analysis technique used in this study is descriptive statistical analysis Based on the results of research conducted obtained the results of the highest price prediction of Bank Syariah Indonesia daily shares for the next period is as of July 21, 2021 is \$2,492.67 per share, and the fuzzy time series error rate using MAPE is 2.28263%.

**Keywords:** Fuzzy Time Methods, Lee Model, BSI.

**Abstrak:** Dalam suatu peramalan dengan menggunakan data historis yang tersedia di lapangan sering kali terjadi pelanggaran asumsi yang disyaratkan oleh setiap metode. Sehingga dalam peramalan sering terjadi kendala dalam pemenuhan asumsi tersebut. Oleh karena metode peramalan dengan metode *Fuzzy Time Series* (FTS) memberikan solusi untuk melakukan peramalan tanpa mensyaratkan asumsi-asumsi data. Tujuan dari penelitian ini adalah untuk mengetahui bagaimana hasil prediksi harga saham tertinggi Bank Syariah Indonesia dengan menggunakan metode FTS model Lee. Penelitian ini menggunakan nilai harga tertinggi saham Bank Syariah Indonesia, dan teknik analisis data yang digunakan dalam penelitian ini adalah analisis statistika deskriptif Berdasarkan hasil penelitian yang dilakukan diperoleh hasil prediksi harga tertinggi saham harian Bank Syariah Indonesia untuk satu periode berikutnya adalah pada tanggal 21 Juli 2021 adalah 2,492,67 per lembar saham, dan tingkat kesalahan *fuzzy time series* dengan menggunakan MAPE adalah sebesar 2,28263%.

**Kata kunci:** Fuzzy Time Methods, Model Lee, BSI.

## Introduction

Today stocks are familiar to millennials many young people who plunge into the world of high-risk stocks. In order to get optimal profits, investors certainly need a deep knowledge or understanding of stocks. Shares are capital market instruments that provide the most attractive level of interest so that many investors are interested.

One of the problems for investors is to reduce the level of losses obtained. One way to reduce losses is through an understanding of future stock predictions. Prediction is a technique for making a value in the future by paying attention to old data and current data. The purpose of this prediction

model is to find a pattern in historical data series and use them for future predictions. The data must meet the requirements to be collected periodically based on the order of time in hours, days, weeks, months, quarters and years.<sup>1</sup>

For investors or stock players, the way to analyze stocks means a lot for investors to know the current condition and situation of the stock.<sup>2</sup> Time series is one of the methods that can

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<sup>1</sup> Kristiawan Nugroho. "Prediction Analysis Model Using the Fuzzy Time Series method" no.1, vol. .XII, (March 2016).

<sup>2</sup> Fauziah Normalita, Wahyuningsih Sri, Yuki Novia Nasution, "Peramalan menggunakan Fuzzy Time series Chen (studi kasus: Curah Hujan Kota Samarinda)," *Jurnal Statistika*, vol. 4, no. 2 (2016), p. 52-61.

be used to predict a stock price. A time series is a series of observations according to the time sequence of the quantitative characteristics of one or a collection of events taken over a given period of time.<sup>3</sup> Prediction is a technique to create a value in the future by paying attention to past data and current data.<sup>4</sup>

The time series is then processed using a fuzzy system, known as *Fuzzy Time Series* method. The Fuzzy Time Series is a method introduced by Song and Chissom which is a concept to predict problems where the actual data is formed in linguistic values.<sup>5</sup>

In time series analysis has several options that can be used in forecasting a data, such as Auto Regressive (AR), Moving Average (MA), ARIMA, Exponential Smoothing and so on. These methods have some disadvantages, namely they require a lot of historical data and require certain assumptions to be met. After seeing the development of the method by analyzing the weaknesses in the forecasting method above the way to overcome it is to use the Fuzzy Time Series (FTS).<sup>6</sup> Fuzzy sets are used to replace historical data to be predicted so that FTS forecasting does not require large amounts of historical data. FTS is a method introduced by Song and Chissom which is a concept used to predict problems where actual data is formed in linguistic values.<sup>7</sup>

One model of the FTS method that was a development of the Song and Chissom models, and Chen in predicting a future value was the FTS Lee model. FTS Lee is used for short-term forecasting with both stationary and non-stationary data patterns.<sup>8</sup> To determine the movement of shares

on the Indonesia Stock Exchange (IDX) then you can use the composite stock price index indicator (JCI). Calculation of JCI is done every day, namely after the close of the market price every day, so that JCI data is classified as time series data.<sup>9</sup> If the economic condition of a country is unstable it will affect the JCI will decrease which results in the decision of investors to sell, hold, or buy a stock. Therefore, forecasting is needed by investors in order to have stronger considerations with this prediction.

As we know that the JCI is an indicator of stock movements on the Indonesia Stock Exchange (IDX). The JCI is calculated every day after the closing of market prices, so the JCI data is classified as time series data. This index is used to regulate whether stock prices increase or decrease. When the economic condition of a country declines, the JCI will also experience a decline which will result in investors leaving the market. This will affect the investor's decision to sell, hold, or buy a stock. Therefore, forecasting is needed by investors to have stronger considerations with this prediction.<sup>10</sup>

The advantage of this fuzzy time series is that the calculation process does not require complicated systems such as genetic algorithms and neural networks, so of course it is easier to develop, besides that, this method can also solve the problem of forecasting historical data in the form of linguistic values. Lee's FTS is one of the models of the FTS method which is a development of the Song and Chissom, and Chen models in predicting a value in the future. Lee's FTS is used for short-term forecasting with stationary and non-stationary data patterns. In predicting the data, there are several methods that can be used, one of which is technical and fundamental analysis method that the technical analysis is concerned with studying historical performance of price movements by measuring it against future price movements. Meanwhile, technical analysis is more concerned with patterns of increase or decrease in prices of a company than conditions of macro economy. This also causes investors who choose

<sup>3</sup> Sumartini, Memi Nor Hayati, Wahyuningsih Sri, "Peramalan Menggunakan Metode Fuzzy Time Series Cheng," *Jurnal Eksponensial*, Vol.8, No. 1 (2017), p 51-56.

<sup>4</sup> Dwi Anugrah Wibisono, Dian Anggraeni, Alfian Futuhul Hadi, "Perbaikan Model Seasonal ARIMA dengan Metode Endemle Kalman Filter Pada Hasil Prediksi Curah Hujan," *Jurnal ilmiah Matematika dan Statistika*, vol. 19, no. 1 (2019), p 9-16.

<sup>5</sup> Sumartini, et al, Peramalan., 2017.

<sup>6</sup> Wang Y, Lei Y, Fan X, & Wang Y, "Intuitionistic Fuzzy Time Series Forecasting Model Based on Intuitionistic Fuzzy Reasoning," *International Journal of Mathematical Problems in Engineering*, vol. 2016 no.1 (2015), p 1-12.

<sup>7</sup> Sumartini, et al, Peramalan., 2017.

<sup>8</sup> Lestari Handayani, Darni Anggriani, "Perbandingan model Chen dan Model Lee pada Metode Fuzzy Time series untuk

prediksi harga emas," *Jurnal Pseudocode*, Vol.2 no. 1 (2015), p 28-36.

<sup>9</sup> Sumartini, et al, Peramalan., 2017.

<sup>10</sup> Sumartini, et al, Peramalan., 2017.

to use technical analysis to focus on short-term investment developments. So, any changes that occur over time will affect investor's analysis. An investor who uses the technical analysis must understand the movement of graph that occurs because the technical analysis is based on the pattern of price changes, and it can be visualized with graphs or charts. In addition, fundamental analysis has more emphasis on general analysis of company's performance.

This is one of the main differences between fundamental and technical analysis in which fundamental analysis considers things that can affect stock prices, including financial performance, level of business competition, industry potential, market and economic analysis, both macro and micro. This makes fundamental analysis usually chosen by investors who focus on long-term performance. And time series data analysis is used to perform data analysis that considers the effect of time. This study uses technical analysis with forecasting method which are divided into 2 types, namely the casual method (regression) and the time series method. The time series methods that have been developed include: *ARIMA*, fuzzy time series and time series regression. The fuzzy time series method is divided into several models, one of which is the Lee model.

For potential investors or shareholders, a way to analyze stocks is very necessary to be able to see the situation and condition of the stocks in order to minimize the risks that occur, at least investors can predict stock prices based on data on past stock price movements. That way, if there is an increase in the price of a stock, the interest in the stock itself will be high, and vice versa if the stock decreases, the interest in the stock will be low.

One of the stocks that have recently been attractive to investors is BRIS or Bank BRI Syariah which is then in Merger from the three banks namely Bank Syariah Mandiri, BNI Syariah, and BRI Syariah, conducted on February 1, 2021.

As seen in table 1, the value of BRIS stocks at the beginning of August 2020 was 540.00 per share and in September it increased by 970.00 per share then in October it decreased by 760.00 per share, following in November it experienced

a significant increase very rapidly at 1,245.00 per share. And after the merger was carried out in February, BRIS shares rose rapidly at a price of 2,940 per share. BRIS shares have experienced abnormal movements since September until now due to news that there will be a merger between 3 Islamic banks, namely Bank Rakyat Indonesia Syariah (BRIS), Bank Mandiri Syariah (BSM), Bank Negara Indonesia Syariah (BNI Syariah).

Table 1. BSI Stock Price Table Before and After Merger

Month	Share Price Per Share
<b>Stock Price Before Merger</b>	
August	540.00
September	970.00
October	760.00
November	1,245.00
December	1,395.00
January	2,440.00
<b>Stock Price After Merger</b>	
February	2,940.00
March	2,290.00

As we see that there is a very drastic change after merger, therefore analyzing stocks is needed to be able to see the situation and condition of the stock in order to minimize the risk that occurs, at least investors can predict stock prices based on data on stock price movements in the past. That way, if there is an increase in the price of a stock can be an interest in the stock itself becomes high, and vice versa if the stock decreases then the interest of the stock is low.<sup>11</sup>

In this study the author will use the fuzzy time series method. By using Lee's model using high price data, because it will make it easier for investors to determine when the investor will sell his shares. Based on the background and problems above, the daily share price of Bank Syariah Indonesia can experience increases and decreases that cannot be ascertained when the time of occurrence is needed stock predictions.

<sup>11</sup> Yulia, "Analisis pengaruh resiko rasio Liquiditas terhadap return saham (studi pada perusahaan LQ45 yang terdaftar di BEI)" *Jurnal khatulistiwa informatika*, vol.IV, no.2 (2016), pp. 192-203

## Method

This research is conducted to find out the prediction of the stock price of Bank Syariah Indonesia using the Lee Model FTS Method. Because the Lee method is a development of the Chen method. where according to Lee that the fuzzy logic relationship group (FLRG) can affect the predicted value, then that value must be calculated, while in the Chen model FLRG which is considered the same can only be represented by one of them. The population in this study is high price data of PT. Bank Syariah Indonesia. And the sample in this study is the daily high price report of PT Bank Syariah Indonesia from April 01, 2021 to July 19, 2021. Because the amount of data already meets the requirements for the fuzzy time series. The data analysis techniques in this study are descriptive statistical analysis and fuzzy time series methods using Lee's model. Data analysis is done to describe or provide an overview of the results of forecasting carried out with the FTS Lee Model approach.

Processing and data analysis is done using the R application with the following steps:

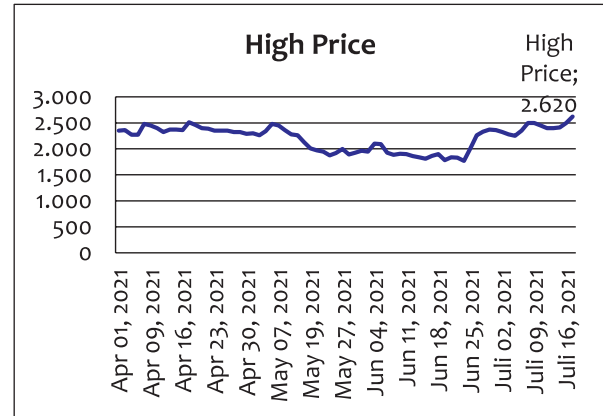
1. Determine the set of universe  $U$
2. Determine the number of fuzzy sets
3. Calculate the middle value of the fuzzy set
4. Define the degree of fuzzy set membership against  $A_i$
5. Fuzzification of data
6. Forming FLR order 1
7. Forming FLRG order 1
8. Determine defuzzification of order 1 forecasting value
9. Calculate the accuracy of FTS Lee's forecasting accuracy order 1

## Results and Discussions

Descriptive Analysis is done by looking at the size of the spread, and the concentration of data and visuals of the rhythm of the series plot. The data used in this researcher is high price data from April 01, 2021 to July 19, 2021. The first step done in forecasting using fuzzy time series is to create a time series plot. Time series plots can show patterns of movement of data, as well as

see the highest and lowest points of the data pattern. Time series plot data on the value of BSI's share price from April 01, 2021 to July 19, 2021 can be seen in the following image:

Figure 1. Time series Plot Data BSI Stock Price Value



Based on Figure 1. it is seen that the time-to-t data is represented by the horizontal axis while the data for the closing value of the BSI stock price is- represented by a vertical line. Figure 1 shows that the high price value of BSI shares has a trend data pattern. The highest BSI stock high price in Gorontalo occurred on July 19, 2021 and the lowest occurred on June 24, 2021.

## Determining the Universe of Conversations

The first step in starting modeling with fuzzy time series approaches is to determine the universe of conversation. In determining the universe of conversation. In determining the universe of talks required maximum and minimum value. Based on data on the high price of BSI Shares is from April 01, 2021 to July 1, 2021. The highest (maximum) high price of the stock on July 19, 2021 was \$2,620 and the lowest (minimum) high price of the stock on June 24, 2021 was \$1,770. The value of  $Z_1$  and  $Z_2$  are any positive number. Researchers found  $Z_1=0.20$  and  $Z_2=0.70$ . Thus the universe of Talks ( $U$ ) is  $[1.7698.8, 2,620,7]$

## Determining the Number of Fuzzy Sets

1. Determine the length of the interval universe of speech ( $U$ ) To determine the length of the interval  $U$  is used equation as follows:

$$R = \text{Maximum Value} + Z_2) - (\text{Minimum Value} - Z_1) = 850.9$$



2. Calculate the average absolute difference of each data

The average absolute difference of each data is sought by calculating the number of absolute differences between historical data at  $t+1$  and  $t-1$  historical data. The number of absolute differences of the data is divided by the number of data reduced by 1. The difference in absolute historical data can be seen in table 2.

**Table 2:** Absolute Difference High Price Value of BSI Shares

No	Date	High Price	Absolute Difference
1	01 Apr 2021	2,350	10
2	05 Apr 2021	2,360	90
3	06 Apr 2021	2,270	0
4	07 Apr 2021	2,270	210
⋮	⋮	⋮	⋮
69	14 Jul 2021	2,400	10
70	15 Jul 2021	2,410	90
71	16 Jul 2021	2,500	120
72	19 Jul 2021	2,620	
Jumlah			4.190

The number of absolute differences of the data is used to calculate the average value of the absolute difference of each data. Calculation of the average value of absolute difference of each data using the following equation:

$$\text{Mean} = \frac{\sum_{t=1}^{N-1} |(D_{t+1}) - D_t|}{N-1}$$

So that the mean value is obtained at 59.01. Then the mean value is used to determine the base interval of the fuzzy set.

3. Calculate fuzzy set interval bases

To determine the base interval fuzzy set will use the absolute difference mean. For the calculation in accordance with the following steps:

$$K = \frac{\text{mean}}{2}$$

$$K = \frac{59,01}{2}$$

$$K = 29,505$$

In accordance with the results of the calculation of fuzzy interval base obtained 29.50. Then the value of the interval base is used to determine the number of fuzzy sets.

4. Calculate the number of fuzzy sets

To determine the number of fuzzy sets will be used interval base using the following equation:

$$n = \frac{R}{K}$$

$$n = \frac{850,9}{29,50}$$

$$n = 28.84$$

$$n = 29$$

Based on these calculations, the number of fuzzy sets is obtained is 29 fuzzy sets. The Fuzzy set has the same interval length of 29.50. So that the value of the set  $U = [1,769.8, 2,620.7]$  will be divided into 29 sets whose class intervals are the same, namely  $u_i$  where  $i = 1, 2, 3, \dots, 29$ .

Based on the results of the division, the fuzzy set divided into 29 partitions is as follows:

$$u_1 = [1.769,8 \ 1.799,3], \quad u_2 = [1.799,3 \ 1.828,8]$$

$$u_3 = [1.828,8 \ 1.858,3], \quad u_4 = [1.855,2 \ 1.887,8]$$

$$u_5 = [1.887,8 \ 1.917,3], \quad u_6 = [1.917,3 \ 1.946,8]$$

$$u_7 = [1.946,8 \ 1.976,3], \quad u_8 = [1.976,3 \ 2.005,8]$$

$$u_9 = [2.005,8 \ 2.035,3], \quad u_{10} = [2.035,3 \ 2.064,8]$$

$$u_{11} = [2.064,8 \ 2.094,3], \quad u_{12} = [2.094,3 \ 2.123,8]$$

$$u_{13} = [2.123,8 \ 2.153,3], \quad u_{14} = [2.153,3 \ 2.182,8]$$

$$u_{15} = [2.182,8 \ 2.212,3], \quad u_{16} = [2.212,3 \ 2.241,8]$$

$$u_{17} = [2.241,8 \ 2.271,3], \quad u_{18} = [2.271,3 \ 2.300,8]$$

$$u_{19} = [2.300,8 \ 2.330,3], \quad u_{20} = [2.330,3 \ 2.359,8]$$

$$u_{21} = [2.359,8 \ 2.389,3], \quad u_{22} = [2.389,3 \ 2.418,8]$$

$$u_{23} = [2.418,8 \ 2.448,3], \quad u_{24} = [2.448,3 \ 2.477,8]$$

$$u_{25} = [2.477,8 \ 2.507,3], \quad u_{26} = [2.507,3 \ 2.536,8]$$

$$u_{27} = [2.536,8 \ 2.566,3], \quad u_{28} = [2.566,3 \ 2.595,8]$$

$$u_{29} = [2.595,8 \ 2.625,3]$$

### Calculate the Middle Value of Fuzzy Sets

Determines the middle value of a fuzzy set by using the equation:

$$m_i = \frac{(u_i \text{ Lower Limit} + u_i \text{ Upper Limit})}{2}$$

$$m_i = \frac{(1.769,8 + 1.799,3)}{2}$$

$$m_i = \frac{(3.569,1)}{2}$$

$$m_i = 1,784.55$$

In accordance with the calculation of the middle value, the middle value obtained for each fuzzy is as follows:

Table 3. Median Fuzzy Set

$u_i$	$m_i$	$u_i$	$m_i$	$u_i$	$m_i$
1	1.784,55	11	2.079,6	21	2.374,65
2	1.814,055	12	2.109,105	22	2.404,155
3	1.843,56	13	2.138,61	23	2.433,66
4	1.873,065	14	2.168,115	24	2.463,165
5	1.902,57	15	2.197,62	25	2.492,67
6	1.932,075	16	2.227,125	26	2.522,175
7	1.961,58	17	2.256,63	27	2.551,68
8	1.991,085	18	2.286,135	28	2.581,185
9	2.020,59	19	2.315,64	29	2.610,69
10	2.050,095	20	2.345,145		

### Fuzzification Process to Define the Degree of Membership of A Fuzzy Set Against $A_i$

The definition of the degree of fuzzy set membership to  $A_i$  is adjusted to the number of fuzzy sets formed in the division of previous fuzzy sets. After that assume the fuzzification value of the linguistic variable for the *High Price* value data of BSI shares to  $A_1, A_2, A_3, \dots, A_{27}$ . Each fuzzy set where  $i = 1, 2, 3, \dots, 27$  is defined against  $A_i$  according to the equation above.

$$\begin{aligned}\mu_{A_1}(u_1) &= \left[ \frac{1}{u_1} + \frac{0,5}{u_2} + \frac{0}{u_3} + \frac{0}{u_4} + \frac{0}{u_5} + \frac{0}{u_6} + \frac{0}{u_7} + \frac{0}{u_8} + \frac{0}{u_9} + \frac{0}{u_{10}} + \frac{0}{u_{11}} + \frac{0}{u_{12}} + \frac{0}{u_{29}} \right] \\ \mu_{A_2}(u_2) &= \left[ \frac{0,5}{u_1} + \frac{1}{u_2} + \frac{0,5}{u_3} + \frac{0}{u_4} + \frac{0}{u_5} + \frac{0}{u_6} + \frac{0}{u_7} + \frac{0}{u_8} + \frac{0}{u_9} + \frac{0}{u_{10}} + \frac{0}{u_{11}} + \frac{0}{u_{12}} + \frac{0}{u_{29}} \right] \\ \mu_{A_3}(u_3) &= \left[ \frac{0}{u_1} + \frac{0,5}{u_2} + \frac{1}{u_3} + \frac{0,5}{u_4} + \frac{0}{u_5} + \frac{0}{u_6} + \frac{0}{u_7} + \frac{0}{u_8} + \frac{0}{u_9} + \frac{0}{u_{10}} + \frac{0}{u_{11}} + \frac{0}{u_{12}} + \frac{0}{u_{29}} \right]\end{aligned}$$

Further

$$\begin{aligned}\mu_{A_{29}}(u_{29}) &= \left[ \frac{0}{u_1} + \frac{0}{u_2} + \frac{0}{u_3} + \frac{0}{u_4} + \frac{0}{u_5} + \frac{0}{u_6} + \frac{0}{u_7} + \frac{0}{u_8} + \frac{0}{u_9} + \frac{0}{u_{10}} + \frac{0}{u_{11}} + \frac{0}{u_{12}} + \frac{0,5}{u_{28}} + \frac{1}{u_{29}} \right]\end{aligned}$$

$u_i$  is a fuzzy set of  $i$  and numbers given the symbol “/” express the degree of membership towards  $u_i$ ,  $A_i = 1, 2, 3, \dots, 29$  whose value is 0, 0,5, or 1.

### Fuzzification of BSI Share Price Closing Value

After processing the degree of membership [there is fuzzy definition on In accordance with

the fuzzification process, the high price data of BSI shares starting from April 01, 2021 to July 19, 2021 is carried out fuzzification process. For example, for April 01, the value of the high price of the stock is 2,350. The value is entered into the 19th fuzzy set ( $u_{19}$ ) at interval  $[2,300.8 \ 2,330.3]$ . So that the results of fuzzyfication of the high price value of BSI shares for April 01, 2021 are  $A_{20}$ . For Fuzzification from April 05, 2021 to July 19, 2021 is as follows in accordance with the results of data processing.

Table 4. Fuzzification of BSI Stock High Price Data

No	Tanggal	High Price	Fuzzyfikasi
1	01 Apr 2021	2,350	$A_{20}$
2	05 Apr 2021	2,360	$A_{21}$
3	06 Apr 2021	2,270	$A_{17}$
4	07 Apr 2021	2,270	$A_{17}$
⋮	⋮	⋮	
72	19 Jul 2021	2,620	$A_{29}$

### Confirm Fuzzification Logical Relationship (FLR) Order 1

To be able to determine fuzzy relationships, you must first determine fuzzification. Based on the results of fuzzification data on the high price value of BSI shares in table 4.5 the next step is to determine fuzzy logical relationship (FLR) order  $\lambda$  in this case is order 1. The results of FLR order  $\lambda$  (1) are as follows:

Table 5. FLR order 1 Data High Price BSI Shares

No	Tanggal	Fuzzy fikasi	FLR Orde 1
1	01 Apr 2021	$A_{19}$	-
2	05 Apr 2021	$A_{16}$	$A_{20} \cdot A_{21}$
3	06 Apr 2021	$A_{17}$	$A_{21} \cdot A_{17}$
4	07 Apr 2021	$A_{16}$	$A_{17} \cdot A_{17}$
⋮	⋮		
69	14 Jul 2021	$A_{20}$	$A_{22} \cdot A_{22}$
70	15 Jul 2021	$A_{21}$	$A_{22} \cdot A_{22}$
71	16 Jul 2021	$A_{22}$	$A_{22} \cdot A_{25}$
72	19 Jul 2021	$A_{27}$	$A_{25} \cdot A_{29}$

Based on table 4 determination fuzzy logical relationship (FLR) order 1 using historical data  $D_{(t-1) \rightarrow D_t}$  for example for April 01, 2021 is the current state,  $(D_{(t-1)})$  with the fuzzification value is  $A_{19}$ . April 05, 2021 is the next state ( $D_t$ ) with a fuzzification value of  $A_{16}$ . For FLR results formed

on April 1, 2021 with April 05, 2021 are  $A_{19} \rightarrow A_{16}$  to determine FLR the following months can follow the same steps as the determination of FLR on April 01, 2021 with April 05, 2021.

### Determining Fuzzy Logical Relationship Group (FLRG) Order 1

FLRG order 1 is done by grouping fuzzification that has the same current state  $(D_{(t-1)})$  value. Then grouped into one group in the next state. The results of Fuzzy Logical Relationship Group (FLRG) order 1 are as follows:

Table 6. FLRG Order 1 for BSI Stock High Price Data

Group	FLRG
1	$A_1 \rightarrow A_3, A_9$
2	$A_{11} \rightarrow A_6$
3	$A_{12} \rightarrow A_{11}$
4	$A_{13} \rightarrow A_9$
...	
18	$A_6 \rightarrow A_4, A_7, A_8, A_{12}$
19	$A_7 \rightarrow A_6$
20	$A_8 \rightarrow A_5$
21	$A_9 \rightarrow A_7, A_{17}$

### Defuzzification of Forecasting Value and Mape Value 1st Order of High Price Data of BSI Shares

The next stage is to change the fuzzification output of numerical values to determine forecasting. Defuzzification in this study using fuzzy time series Defuzzification Lee order 1. Based on the results of the formation of FLRG in table 4.5, 21 groups were obtained. The results of defuzzification of forecasting values from the 21 groups formed can be seen in table 7.

Table 7. Results of Defuzzification of FLRG Order 1 Forecasting

Group	FLRG	Forecasting
1	$A_1 \rightarrow A_3, A_9$	$A_1 = \frac{1}{2} \times 1.843,56 + \frac{1}{2} \times 2.020,59 = 1.932,075$
2	$A_{11} \rightarrow A_6$	$A_{11} = 1.932,075$
3	$A_{12} \rightarrow A_{11}$	$A_{12} = 2.079,6$
4	$A_{13} \rightarrow A_9$	$A_{13} = 2.020,59$
...	...	...
21	$A_9 \rightarrow A_7, A_{17}$	$A_9 = \frac{1}{2} \times 1.961,58 + \frac{1}{2} \times 2.256,63 = 2.109,105$

Based on table 7 the forecasting value of FLRG order 1 group to 1 is 1,932,075. the value is obtained because the FLR formed in FLRG order 1 group 1 is only 1 that is  $A_1 \rightarrow A_3, A_9$ . Therefore, defuzzification of forecasting values from FLRG order 1 group 1 using equations  $\hat{y}_t^{(1)} = m_i$ . Forecasting values are based on the middle value of those with the highest membership degrees in  $A_3$  and  $A_9$ . The highest degree of membership is in and the middle value It is 1,843.56. Thus, the forecasting value of FLRG order 1 group 1 is 1,932,075. Defuzzification in the next group has similar steps as in defuzzification in group 1.

The value in the final forecasting for the high price data of BSI shares from April 01 to July 1, 2021 was obtained by the results of defuzzification of FLR group 1 in table 7. The full forecasting results can be seen in table 8.

Table 8. Defuzzification Results of High Price Forecasting Value of BSI Order 1

NO	Date	High Price	$\hat{y}_t^{(1)}$
1	01 Apr 2021	2,350	-
2	05 Apr 2021	2,360	2.394,32
3	06 Apr 2021	2,270	2.357,79
4	07 Apr 2021	2,270	2.315,64
...	...	...	...
72	19 Juli, 2021	2,620	2.463,16

For the forecasting value the next day that can be calculated by looking for the FLRG formed, first determine the fuzzification dated July 19, 2021  $D_{(t-1)}$ . based on table 5 fuzzification value dated July 19, 2021 is  $A_{29}$ . Based on table 7, the FLR results are included in the defuzzification group FLRG to  $A_{29} \rightarrow A_{25}$ , with the forecasting result being 2,492.67. so the forecasting result on July 21, 2021 is 2,492.67.

That is, on April 21, 2021 the high price value will reach 2,492.67, by looking at the forecast results on April 21, 2021 compared to April 19, 2021 with a high price value of 2,463.16, after the prediction of an increase of 29.51 per share, it means that when investors want to sell the stock will get a profit of 29.51 per share. On April 1, 2021 the value of forecasting results is empty because, forecasting today's data is used to forecast results the next day.

Next calculate MAPE forecasting fuzzy time series results with Lee's approach to order 1. Mape values in this study are calculated using equations:

$$MAPE = \left( \frac{1}{N} \sum_{t=1}^N \frac{|D_t - \hat{y}_t^{(m)}|}{D_t} \right) \times 100\%$$

Calculations from mape value the forecasting results of Fuzzy Time Series Lee order 1 can be seen in table 4.10.

Table 4.10. Mape Value Calculation of order 1 forecasting results

NO	Tanggal	Actual data	$\hat{y}_t^{(1)}$	$\frac{ D_t - \hat{y}_t^{(1)} }{D_t}$
1	01 Apr 2021	2,350	-	
2	05 Apr 2021	2,360	2.394,32	0,01454
3	06 Apr 2021	2,270	2.357,79	0,03867
...	...	...	...	
72	19 Juli, 2021	2.463,16	2.463,16	0,05986
Sum				1,62067

$$MAPE = \left( \frac{1}{71} \sum_{t=1}^{72} \frac{|D_t - \hat{y}_t^{(m)}|}{D_t} \right) \times 100\%$$

$$MAPE = \left( \frac{1}{71} \times 1,162067 \right) \times 100\%$$

$$MAPE = 2.28263\%$$

Based on the calculation of MAPE, mape value is obtained at 2.28263%. In doing the forecasting method then we have to choose a result or method that is close to accurate, this can be seen by using error measurement or error calculation.<sup>12</sup> states that the measure of accuracy of forecasting results which is a measure of forecasting error is a measure of the level of difference between forecasting results and demand that occurs. In this study the data used is the highest price data (high price) of BSI shares from April 01, 2021 to July 19, 2021, because by predicting or knowing the highest price can make it easier for investors to determine when investors will sell and buy shares. After the highest price data (high price) of BSI shares is obtained, data analysis will be done using the fuzzy time series method of Lee's model, the analysis step is, determining

the set of U obtained from the minimum and maximum values in the daily data of BSI stock high prices, determining the number of fuzzy sets by calculating the number of intervals by finding the maximum data difference and at least divided by the number of intervals, Then, calculate the middle value of the Fuzzy set, perform data fuzzification form FLR (Fuzzy Logical relationship), and form FLRG (Fuzzy Logical relationship Group).

Then defuzzification of the results of the prediction of order 1, researchers only limit to order 1, because researchers only predict shares for 1 period, if you want to predict the next 2 periods, the calculation is done up to order 2, the results of the prediction of defuzzification of order 1 that has been obtained is 2,492.67 per share. This means that one period ahead or one day ahead of July 21, 2021 based on the results of forecasting the highest price value (high price) of BSI shares is 2,492.67 per share. After the defuzzification process will be extraction of data prediction results and calculation of error rates that occur based on mape values for Lee model, and obtained the error rate fuzzy time series lee model is 2.28263%.

Based on the accuracy rate of predictions of values less than 10% categorized as very good, 10% to 20% are categorized as good, and values greater than 20% are categorized as not good, According to Lewis theory (1992) if the MAPE value is below 10% it means that the accuracy rate of the prediction is very good, the smaller the MAPE value, the smaller the error of the guessing result, conversely if the larger the MAPE value, the greater the error of the results of the restoration. In forecasting certainly will not be separated from errors or errors because there is no definite accurate forecasting despite using a variety of forecasting methods. As per the results of MAPE obtained, which is 2.28263%, it is included in the category is very good because it has a value of less than 10%. This means that the forecasting results conducted using Fuzzy Time Series Lee model with a forecasting value of 2,492.67 per share are categorized very good by looking at the accuracy of the prediction which is 2.28263%, the MAPE value shows that the forecasting results of high price using FTS Lee are very good because it is less than 10%. The small MAPE value of 2.28263%, due to the conformity

<sup>12</sup> Lewis, C. D., *International and Business Forecasting Methods*, Butterworths, London, 1982.



of the FTS Lee method used with the high price data pattern obtained. In addition, mape's small value is affected because FTS Lee pays attention to looping or still calculates the same fuzzy logical relationship group. MAPE is a measure of relative sticking used to determine the percentage of forecasting deviations, with predictions that can make it easier for prospective investors to make transactions, especially for novice investors.

In time series analysis, there are several options that can be used to predict data, such as ARIMA, SARIMA, Smoothing, and so on. These methods have some weaknesses, namely the method requires a lot of historical data and certain assumptions to be met. After seeing the development of the method by analyzing the weaknesses in the forecasting method above, the way to overcome it is to use the fuzzy time series method.

Fuzzy time series is a forecasting that uses fuzzy sets as the basis for forecasting modeling. Forecasting using the fuzzy time series method uses past data to predict future data. The advantage of this method is that it does not require large amounts of historical data and assumptions in forecasting. Fuzzy time series is a forecasting method using artificial intelligence to process the actual data formed into linguistic values known as fuzzy sets and it uses data in the form of fuzzy sets derived from real numbers over the universe set on actual data. Fuzzy sets are used to replace historical data to be forecasted so that fuzzy time series forecasting does not require large amounts of historical data.

Lee's fuzzy time series is one of the models as the development of the shong and chissom, and chen models. The shong and chissom models were implemented to predict the number of registrations, then used to predict the weather. Due to the lack of accuracy using the model, then it was refined by chen, and in 2009 Lee's model was found which is considered better in predicting the fuzzy time method series than the Chen model in terms of accuracy. One of the implementations of Lee's FTS is by predicting the high price of Islamic Bank stocks for a period. Based on the results of the study, it was obtained that the highest daily stock price prediction of BSI was

2,492.67 per share with a prediction accuracy rate of 2.28263%. According to Lewis theory (1992) if the MAPE value is below 10%, it means that the accuracy of the prediction is very good. The smaller the MAPE value is, the smaller the error in the estimation results will be, on the other hand, the larger the MAPE value is, the greater the error in the estimation results become. In measuring the level of prediction accuracy based on previous research using MSE, the difference between MSE and MAPE is that the MSE is the calculation used for the average error rank and MAPE is the calculation used to calculate the average absolute percentage error. This research is supported by Mahadi Muhammad's research entitled Application of Lee's Fuzzy Time Series for Value Forecasting Previous researchers used MAPE to measure the accuracy of predictions<sup>13</sup>.

Based on previous research, the equation in the results of this study is that the Lee model has an error rate with low prediction results in the fuzzy time series method. While the difference with this study is that fuzzy time series can be used to predict other than the highest stock price, including predicting the number of tourist arrivals, gold prices, and production results. To find out the error rate, the MAPE value can be used. Meanwhile, there are various methods of fuzzy time series that can be used ranging from Invariant, genetic algorithm, and Chen.

Keeping in mind that stocks can increase and decrease at any time which cannot be ascertained when they occur, predictions are very important for investors because they aim to reduce or minimize risk that can occur at any time. Prediction or forecasting is also very important in decision-making, an accepted argument that the better the forecast, the better the work performance in making decisions.

## Conclusion

Based on the data and discussions conducted by researchers, several conclusions were obtained as follows: The results of forecasting high price

<sup>13</sup> Mahadi Muhammad, "Penerapan Fuzzy Time Series Lee Peramalan Nilai Tukar Petani Subsektor Peternakan Di Kalimantan Timur", Samarinda:UMS, ( 2020).

data of BSI shares on July 21, 2021 using the fuzzy time series method using the Lee model order 1 is 2,492.67. MaPe value from the results of forecasting high price data of BSI shares using fuzzy time series method with Lee model order 1 is 2.28263%. The MAPE value shows that the results of forecasting high price data of BSI shares using the fuzzy time series method with the Lee model order 1 are very good.

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