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Prediction of Telkomsel Product Inventory and Sales Using the *Fuzzy Time Series (FTS) Method* at PT. Graha Informatika Nusantara (GRATIKA) Kisaran

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Abstract

PT. Graha Informatika Nusantara (GRATIKA) is a company engaged in the infocom sector covering the business of Development and Development of Telecommunication Devices and Systems including its support system. Business activities at PT. GRATIKA Coverage includes sales transactions, purchases, and product stock inventory. However, in inventory sales and purchase transactions at PT Graha Informatika Nusantara (GRATIKA) Kisaran, it is difficult to determine how much product inventory to optimize product stock in inventory management and product sales, because there is no prediction system to prevent errors in determining the amount of inventory and product sales. in the future, because the prediction system that is carried out still uses a manual system so it is classified as old and inaccurate. For this reason, a system is needed to predict the inventory and sales of Telkomsel products using the Fuzzy Time Series (FTS) method to facilitate the prediction process so that there are not many errors in the prediction process. This method was chosen because it tends to get a small error value and the process does not require a complex and dynamic learning system of language variables whose linguistic values are fuzzy sets, with the aim of getting maximum profit with the right business strategy plans and techniques. Method This system was developed with the PHP programming language. The results of this study are the application of the FTS method to the system with the Fuzzy calculation process, which results in the prediction of inventory and product sales.

Keywords *: Prediction, Inventory and Sales, Fuzzy Time Series, System*

1. INTRODUCTION

The level of competition is getting tougher and the number of consumer requests is getting higher and more diverse, making companies required to produce products that are in accordance with consumer desires. One of the most important things in realizing company goals is to make the company run have developments that are going well, namely by predicting the amount of inventory and sales or production of goods produced. Prediction is a very important element in predicting the future and for decision making. Demand prediction is an attempt to determine the amount of inventory and product sales in the future under certain conditions.

One of the company's plans or techniques that can be carried out in determining the strategy of Predicting Inventory and Sales of Telkomsel Products is the Fuzzy Time Series (FTS) Method. The Fuzzy Time Series (FTS) method is a data prediction method that uses fuzzy principles, where time series values are represented by fuzzy sets. The Fuzzy Time Series (FTS) method is a method with a prediction system that can capture patterns from historical data to project future data, the advantages of this method are that it tends to get small error values and

the process does not require a complex and dynamic learning system from an linguistic variables whose linguistic values are fuzzy sets. [1]

Business activities at PT. GRATIKA Coverage includes sales transactions, purchases and product stock inventory. In inventory sales and purchase transactions in the prediction system, it is still calculated manually so it is difficult to determine how many products will be in stock and to optimize product stock in inventory management and product sales, because there is no prediction system to prevent errors in determining the amount of inventory. and product sales in the future. Based on the above problems, the researcher will conduct a study entitled Prediction of Telkomsel Product Inventory and Sales Using the Fuzzy Time Series (FTS) Method at PT. Graha Informatika Nusantara (GRATIKA) Range.

The purpose of this research is to find out how predictable future inventory and product sales are and to get maximum profit with the right business strategy plans and techniques using the *Fuzzy Time Series (FTS) method* .

2. RESEARCH METHODOLOGY

2.1. Product Inventory Analysis

The benefits of product inventory analysis are as an asset which includes goods belonging to the company with the aim of being sold in the normal business period, or inventory of goods that are still in process or production, or inventories of raw goods waiting to be used in the production process [2].

2.2. Product Sales Analysis

The benefit of *Sales Analysis* is to help make data *driven* decisions or make decisions based on data, To understand and satisfy the needs and wants of target *customers* . The field of consumer behavior studies how individuals, groups and organizations select, purchase, use and dispose of goods, services, ideas or experiences to satisfy *customer needs* [3].

2.3. Prediction Analysis

Prediction analysis is a process for systematically estimating something that is most likely to happen in the future based on past and present information that is owned, so that the error (the difference between something that happened and the forecast result) can be minimized [4].

2.4. *Fuzzy Time Series* (FTS)

The *Fuzzy Time Series (FTS)* method is a data prediction method that uses the *fuzzy principle, where the time series values are represented by Fuzzy* sets . The *Fuzzy Time Series (FTS)* method is a method with a prediction system that can capture patterns from historical data to project future data [1].
The steps for implementing the *fuzzy time series markov chains* are as follows:

2.4.1. Getting the Highest and Lowest Scores

The highest and lowest values are used to determine the universal or universal set (U) which is written as follows:

Jurnal Riset Sistem Informasi Dan Teknik Informatika (JURASIK)
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$$U = [U_{min} - D_1, U_{max} + D_2] \quad (1)$$

With :

U_{max} and U_{min} : The largest and smallest values of a dataset.

D_1 and D_2 : Positive Numbers. Award for value D_1 and D_2 is random or arbitrary, because the purpose of adding the values of *D1 and D2* , namely in the form of positive numbers for U_{max} and U_{min} , is to make it easier to divide the intervals, where the size of the D 1 and D_2 values *input will* produce different *forecast values* . (Liu, Hao-Tien). D_1 is the real number specified by the *user* to widen the lower bound of the interval and D_2 is the real number specified by the *user* to widen the upper bound of the interval.

2.4.2. Calculating Interval Range

The number of intervals is a real number that is determined by the *user* and the interval jumps can be calculated using the formula:

$$Lompataninterval = \frac{U_{max}+D_2-U_{min}-D_1}{interval} \quad (2)$$

With :

U_{max} : The highest data value

U_{min} : The lowest data value

Interval : The real number selected by the *user,* then Create a Range *of intervals* with a distance of *interval jump*

2.4.3. Creating *Linguistic Fuzzy* on Each Interval

Making *fuzzy linguistics* at each interval is defined as fuzzy sets *At* which are formed using split intervals. The set of *fuzzy variables At represents the linguistic* variables of each interval.

2.4.4. Creating FLRG (*Fuzzy Linguistic Relationship Group*)

Fuzzification of data by using and categorizing each raw data into intervals, so that each *linguistic relation* is obtained based on changes in data from time to time. By using these changes combine each change into one group each *linguistic Ai.*

2.4.5. Create a Probability Matrix

Calculating the probability in a matrix R, using the following formula:

$$R = \begin{bmatrix} P_{11} \dots P_{1j} \\ \dots \dots \dots \\ P_{i1} \dots P_{ij} \end{bmatrix} \quad (3)$$

The following formula is used:

$$P_{ij} = \frac{S_{ij}}{S_i} \quad (4)$$

Where :

P_{ij} : Probability of changing *state* A_i to A_j

S_i : Number of transactions from *state* A_i

Jurnal Riset Sistem Informasi Dan Teknik Informatika (JURASIK)
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https://tunasbangsa.ac.id/ejurnal/index.php/jurasik

2.4.6. Defuzzification

The defuzzification process with the Tsaur method has two rules as follows: [5]

a. Rule 1

Fuzzy Relationship Reaction from *Ai* is *One to One* ($A_i \rightarrow A_j$), then:

$$F_t = M_k \quad (5)$$

Where :

F_t : Prediction results

M_k : Mid value of the interval U_k

b. Rule 2

If the *Fuzzy Relationship* from A_i is *One to Many* ($A_i \rightarrow A_j, A_k$), then:

$$A_t = M_1 * P_{i1} + M_2 * P_{i2} + \cdots + M_{i-1} * P_{ii} + Y_{i-1} * P_{ii} + M_{i+1} * P_{ii+1} + \cdots + M_n * P_{in} \quad (6)$$

2.4.7. *Adjusting*

To calculate the *error* of the prediction or prediction, the prediction value will be calculated as an *Adjust* or trend value. The rules for *Adjust* calculations are as follows:

a. Rule 1 : If *State* A_i is related to A_i, start from *State* A_i on time *t -1* as $Y_{(t-1)} = A_i$, and make an upward transition to *state* A_j at time *t* where *(i < j)*, then

$$A_{r2} = \frac{t}{2} \quad (7)$$

Where :

l : Interval basis value

b. Rule 2 : If *State* A_i is related to A_i, start from *State* A_i on time *t -1* as $Y_{(t-1)} = A_i$, and make a downward transition to the *state* A_j at time *t* where *(i > j)*, then

$$A_{r2} = \frac{t}{2} \quad (8)$$

c. Rule 3 : If *State* A_i is related to A_i, start from *State* A_i on time *t -1* as $Y_{(t-1)} = A_i$, and make a jump transition to the *state* A_j at time *t* where *(1 ≤ s ≤ n - i)*, then:

$$A_{r2} = \frac{t}{2}s \quad (9)$$

d. Rule 4 : If *State* A_i is related to A_i, start from *State* A_i on time *t -1* as $Y_{(t-1)} = A_i$ and make a jump transition behind *state* A_{j+v} at time *t* where *(1 ≤ v ≤ i)*, then:

$$A_{r2} = \frac{t}{2}s \quad (10)$$

[6]

2.5. *Average Forecasting Error Rate* (AFER)

Average Forecasting Error Route (AFER) is used to determine the amount of deviation that occurs in the predicted data from the actual data (Jilani, et al., 2008). *Average* Prediction *Error Rure (AFER)* is calculated using the following formula:

$$AFER = \frac{\sum_{i=1}^{n} |Ai - Fi/Ai|}{n} x100\% \quad (11)$$

Jurnal Riset Sistem Informasi Dan Teknik Informatika (JURASIK)
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Where :

A_i : Actual value in data *i*
F_i : Predicted value for data *i*
n : The amount of data
100% : Value to get the percentage result

The higher the value of the *Average Forecasting Error Rate (AFER)* , the greater the *error* of the prediction . The lower the *average value,* the Prediction *Error Rate* , the smaller the *error* from the prediction . The following is a table of assessment criteria for the *Average* Prediction *Error Rate (AFER)* [6] :

Table 1. Evaluation criteria *for Average* Prediction *Error Rate (AFER)*

AFTER	**Information**
< 10%	Very good
10% - 20%	Good
20% - 50%	Enough
> 50%	Bad

3. RESULTS AND DISCUSSION

The discussion in this section is how to apply the *Fuzzy Time Series (FTS) method* in predicting product inventory and sales and how the results of an application capable of predicting product stock and sales use the *Fuzzy Time Series (FTS) method* . As well as other discussions is a detailed explanation of the manual calculation of the *Fuzzy Time Series (FTS) method.* The following are the stages of predicting inventory and product sales using the *Fuzzy Time Series (FTS) method* :

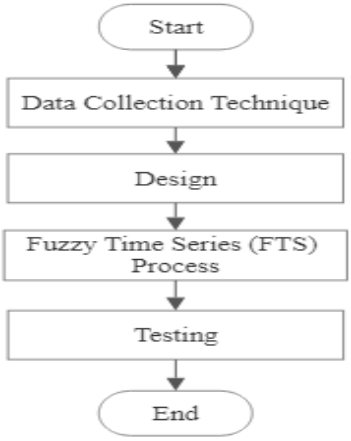

Figure 1. The Prediction Stages of the *Fuzzy Time Series (FTS) Method*

3.1. Data collection

In determining inventory predictions and product sales, data collection and needs analysis are carried out, to determine criteria based on observation studies and literature studies and obtain data sources from PT. Graha Informatika Nusantara (GRATIKA) Range. Inventory and sales data consists of 10 products, namely Vouchers 1.5 GB, 2 GB, 3 GB, Prime Internet 3 GB (Zone 2), 3 GB (Zone 3),

6.5 GB (Zone 3), Prime Regular Simpati, US, Loop and *LinkAja* . The following is an example of data from a product, namely the regular initial supply of sympathy.

Table 2. Simpati Regular Initial Supply

Time	Supply		
Jan-20	1,000 Pcs	Jan-22	4,100 Pcs
Feb-20	2,000 Pcs	Feb-22	2,130 Pcs
Mar-20	5,000 Pcs	Mar-22	6,500 Pcs
Apr-20	3,000 Pcs	Apr-22	5,630 Pcs
May-20	2,000 Pcs	May-22	2,000 Pcs
Jun-20	5,000 Pcs	Jun-22	7,000 Pcs
Jul-20	7,000 Pcs	Jul-22	4,000 Pcs
Aug-20	3,500 Pcs	Aug-22	3,500 Pcs
Sep-20	6,000 Pcs	Sep-22	3,450 Pcs
Oct-20	10,500 Pcs	Oct-22	1,500 Pcs
Nov-20	15,000 Pcs	Nov-22	2,300 Pcs
Dec-20	3,300 Pcs	Jul-21	2,300 Pcs
Jan-21	2,500 Pcs	Aug-21	5,400 Pcs
Feb-21	7,500 Pcs	Sep-21	3,200 Pcs
Mar-21	2,300 Pcs	Oct-21	1,200 Pcs
Apr-21	1,230 Pcs	Nov-21	5,200 Pcs
May-21	3,450 Pcs	Dec-21	2,400 Pcs
Jun-21	1,500 Pcs	Dec-22	5,400 Pcs

Source: PT. Graha Informatika Nusantara (GRATIKA) Range, 2022

3.2. Design

Before implementing it into an application program, it is necessary to first design a prediction system for inventory and sales of Telkomsel products using the *Fuzzy Time Series (FTS) method* , so that the system can run as it should and can be used for predictions in the following month. The system design consists of the Initial menu design which consists of the Calculation, About, and Login menu designs, as well as the system design also consists of the Main menu design which consists of the Type menu design, Password Calculation Period and Logout.

3.3. *Fuzzy Time Series* (FTS) Process

The process of calculating predictions using the *Fuzzy Time Series (FTS) method* is to use regular initial inventory data for sympathy contained in the data set. The following is the process of calculating predictions using the *Fuzzy Time Series (FTS) method.*

3.3.1. Get the Highest and Lowest Score

The highest and lowest values are used to determine the universal or universal set (U) which is written as follows:

$U = [U_{min} - D_1, U_{max} + D_2]$
$U = [1{,}000 - 0, 15{,}000 + 0]$
$U = [1{,}000, 15{,}000]$

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https://tunasbangsa.ac.id/ejurnal/index.php/jurasik

3.3.2. Calculating Interval Range

The number of intervals is a real number that is determined by the *user* and the interval jumps can be calculated using the formula:

a) Basis Interval = $\frac{0.5 * \text{Total Lag}}{(36\text{-}1)}$

Basis Interval = $\frac{0.5 * 96{,}780}{(36\text{-}1)} = 1{,}383$

b) Intervals = $\frac{D_{Max} - D_{Min}}{\text{Interval Basis}}$

Intervals = $\frac{15{,}000 * 1{,}000}{1{,}383} = 10.1229212$

To find the value of the lower limit and upper limit on the interval, namely in the following way by taking 3 sample data

a) Lower Limit = D_{min} + Sequential No. * Basis Interval
= 1,000 + 0 * 1,383
= 1,000

b) Upper Limit = D_{min} + (Sequential Number + 1) * Basis Interval
= 1,000 + (0 + 1) * 1,383
= 2,383

c) Lower Limit = 2.383
Upper Limit = D_{min} + (Sequential Number + 1) * Basis Interval
= 2.383 + (1 + 1) * 1.383
= 3,766

d) Lower Limit = 3,766
Upper Limit = D_{min} + (Sequential Number + 1) * Basis Interval
= 3.766 + (2 + 1) * 1.383
= 5,149

Meanwhile, to find the Middle Value is known by the following formula:

a) Mid Value = $\frac{\text{Lower bound + Upper bound}}{2}$

Middle Value = $\frac{1{,}000 + 2{,}383}{2} = 1{,}691.5$

b) Mid Value = $\frac{\text{Lower bound + Upper bound}}{2}$

Middle Value = $\frac{2{,}383 + 3{,}766}{2} = 3{,}074.5$

c) Mid Value = $\frac{\text{Lower bound + Upper bound}}{2}$

Middle Value = $\frac{3{,}766 + 5{,}149}{2} = 4{,}457.5$

The following will be explained in tabular form for the results of calculations in the next data.

3.3.3. Creating *Linguistic Fuzzy* At Each Interval

Fuzzy Lingusitic at each interval that has been searched by calculating the range of intervals is made in the table as follows:

Jurnal Riset Sistem Informasi Dan Teknik Informatika (JURASIK)
Volume 8, Nomor 1, Februari 2023, pp 272-284
Terakreditasi Nomor 204/E/KPT/2022 | ISSN: 2527-5771/EISSN: 2549-7839
https://tunasbangsa.ac.id/ejurnal/index.php/jurasik

Table 3. *Linguistic Fuzzi at Each Interval* for Inventory Prediction

No	Ui	Lower limit	Upper limit	Ai	Middle value
0	U1	1.000	2.383	A1	1.691.5
1	U2	2.383	3.766	A2	3.074.5
2	U3	3.766	5.149	A3	4.457,5
3	U4	5.149	6.532	A4	5.840.5
4	U5	6.532	7.915	A5	7.223.5
5	U6	7.915	9.298	A6	8.606.5
6	U7	9.298	10.681	A7	9.989.5
7	U8	10 .681	12.064	A8	11.372.5
8	U9	12.064	13.447	A9	12.755.5
9	U10	13.447	14.830	A10	14.138.5

3.3.4. Fuzzification

Fuzzification is a process of converting *non-fuzzy sets (crisp)* into *fuzzy sets, non-fuzzy* inputs *(crisp) are* mapped to the form of *fuzzy sets* according to the symbols (A1-A10) that are made or variations of the universe of input speech. The following is the fuzzification table [7]:

Table 4. Fuzzification for Inventory Prediction

Time	Inventory Data	Fuzzification			
Jan-20	1,000 Pcs	A1	Feb-21	7,500 Pcs	A5
Feb-20	2,000 Pcs	A1	Mar-22	6,500 Pcs	A4
Mar-20	5,000 Pcs	A3	Apr-22	5,630 Pcs	A4
Apr-20	3,000 Pcs	A2	May-22	2,000 Pcs	A1
May-20	2,000 Pcs	A1	Jun-22	7,000 Pcs	A5
Jun-20	5,000 Pcs	A3	Jul-22	4,000 Pcs	A3
Jul-20	7,000 Pcs	A5	Aug-22	3,500 Pcs	A2
Aug-20	3,500 Pcs	A2	Sep-22	3,450 Pcs	A2
Sep-20	6,000 Pcs	A4	Oct-22	1,500 Pcs	A1
Oct-20	10,500 Pcs	A7	Nov-22	2,300 Pcs	A1
Nov-20	15,000 Pcs	A10	Dec-22	5,400 Pcs	A4
Dec-20	3,300 Pcs	A2			
Jan-21	2,500 Pcs	A2			
Feb-21	7,500 Pcs	A5			
Mar-21	2,300 Pcs	A1			
Apr-21	1,230 Pcs	A1			
May-21	3,450 Pcs	A2			
Jun-21	1,500 Pcs	A1			
Jul-21	2,300 Pcs	A1			
Aug-21	5,400 Pcs	A4			
Sep-21	3,200 Pcs	A2			
Oct-21	1,200 Pcs	A1			
Nov-21	5,200 Pcs	A4			
Dec-21	2,400 Pcs	A2			
Jan-22	4,100 Pcs	A3			

3.3.5. Create FLR *(Fuzzy Logical Relationship)*

Fuzzification of data by using and categorizing each raw data into intervals, so that each *linguistic relation* is obtained based on changes in data from time to time. By using these changes combine each change into one group each *linguistic* . The following is a table of FLR

Table 5. *FLR (Fuzzy Logical Relationship)* for Inventory Prediction

Time	Inventory Data	FLR		Relationships
Jan-20	1,000 Pcs		A1	
Feb-20	2,000 Pcs	A1	A1	A1=>A1
Mar-20	5,000 Pcs	A1	A3	A1=>A3
Apr-20	3,000 Pcs	A3	A2	A3=>A2
May-20	2,000 Pcs	A2	A1	A2=>A1
Jun-20	5,000 Pcs	A1	A3	A1=>A3
Jul-20	7,000 Pcs	A3	A5	A3=>A5
Aug-20	3,500 Pcs	A5	A2	A5=>A2
Sep-20	6,000 Pcs	A2	A4	A2=>A4
Oct-20	10,500 Pcs	A4	A7	A4=>A7
Nov-20	15,000 Pcs	A7	A10	A7=>A10
Dec-20	3,300 Pcs	A10	A2	A10=>A2
Jan-21	2,500 Pcs	A2	A2	A2=>A2
Feb-21	7,500 Pcs	A2	A5	A2=>A5
Mar-21	2,300 Pcs	A5	A1	A5=>A1
Apr-21	1,230 Pcs	A1	A1	A1=>A1
May-21	3,450 Pcs	A1	A2	A1=>A2
Jun-21	1,500 Pcs	A2	A1	A2=>A1
Jul-21	2,300 Pcs	A1	A1	A1=>A1
Aug-21	5,400 Pcs	A1	A4	A1=>A4
Sep-21	3,200 Pcs	A4	A2	A4=>A2
Oct-21	1,200 Pcs	A2	A1	A2=>A1
Nov-21	5,200 Pcs	A1	A4	A1=>A4
Dec-21	2,400 Pcs	A4	A2	A4=>A2
Jan-22	4,100 Pcs	A2	A3	A2=>A3
Feb-22	2,130 Pcs	A3	A1	A3=>A1
Mar-22	6,500 Pcs	A1	A4	A1=>A4
Apr-22	5,630 Pcs	A4	A4	A4=>A4
May-22	2,000 Pcs	A4	A1	A4=>A1
Jun-22	7,000 Pcs	A1	A5	A1=>A5
Jul-22	4,000 Pcs	A5	A3	A5=>A3
Aug-22	3,500 Pcs	A3	A2	A3=>A2
Sep-22	3,450 Pcs	A2	A2	A2=>A2
Oct-22	1,500 Pcs	A2	A1	A2=>A1
Nov-22	2,300 Pcs	A1	A1	A1=>A1
Dec-22	5,400 Pcs	A1	A4	A1=>A4
Jan-23		A4		A4

Jurnal Riset Sistem Informasi Dan Teknik Informatika (JURASIK)
Volume 8, Nomor 1, Februari 2023, pp 272-284
Terakreditasi Nomor 204/E/KPT/2022 | ISSN: 2527-5771/EISSN: 2549-7839
https://tunasbangsa.ac.id/ejurnal/index.php/jurasik

3.3.6. Create FLRG *(Fuzzy Logical Relationship Group)*

The data from the FLR that has been obtained will then be carried out by FLRG or divided into several groups. The following are the results of the FLRG contained in the following table:

Table 6. FLRG (*Fuzzy Logical Relationship Group*) For Inventory Prediction

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
A1	4	1	2	4	1	0	0	0	0	0
A2	4	2	1	1	1	0	0	0	0	0
A3	1	2	0	0	1	0	0	0	0	0
A4	1	2	0	1	0	0	1	0	0	0
A5	1	1	1	0	0	0	0	0	0	0
A6	0	0	0	0	0	0	0	0	0	0
A7	0	0	0	0	0	0	0	0	0	1
A8	0	0	0	0	0	0	0	0	0	0
A9	0	0	0	0	0	0	0	0	0	0
A10	0	1	0	0	0	0	0	0	0	0

Furthermore, to find the FLRG value is to add up the Middle Value in the variable linguistic table seen from the groups contained in the previous FLRG table. The following is a table for determining FLRG values based on fuzzification that has been searched before and based on the sum of the mean values in the variable linguistic table seen from the groups contained in the previous FLRG table. [6]

Table 7. *FLRG (Fuzzy Logical Relationship Group) Values* for Inventory Prediction

	Average/ Deffuzify	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
A1	4.457,5	1.691.5	3.074.5	4.457,5	5.840.5	7.223.5	0	0	0	0	0
A2	4.457,5	1.691.5	3.074.5	4.457,5	5.840.5	7.223.5	0	0	0	0	0
A3	3.996.5	1.691.5	3.074.5	0	0	7.223.5	0	0	0	0	0
A4	5.149	1.691.5	3.074.5	0	5.840.5	0	0	9.989.5	0	0	0
A5	3.074.5	1.691.5	3.074.5	4.457,5	0	0	0	0	0	0	0
A6	0	0	0	0	0	0	0	0	0	0	0
A7	14.138.5	0	0	0	0	0	0	0	0	0	14.138.5
A8	0	0	0	0	0	0	0	0	0	0	0
A9	0	0	0	0	0	0	0	0	0	0	0
A10	3.074.5	0	3.074.5	0	0	0	0	0	0	0	0

3.3.7. Prediction Results

The prediction results are taken from the *Fuzzy Logical Relationship Group (FLRG)* which have been grouped and the value is known then the FLRG results in the last year become the results for predictions in the following year. The following are the prediction results contained in the table.

Table 8. Product Inventory Prediction Results

Time	Inventory Data	Fuzzification	Predictions				
Jan-20	1,000 Pcs	A1		Feb-21	7,500 Pcs	A5	4.457.5 Pcs
Feb-20	2,000 Pcs	A1	4.457.5 Pcs	Mar-21	2,300 Pcs	A1	3.074.5 Pcs

Mar-20	5,000 Pcs	A3	4.457.5 Pcs	Apr-21	1,230 Pcs	A1	4.457.5 Pcs
Apr-20	3,000 Pcs	A2	3.996.5 Pcs	May-21	3,450 Pcs	A2	4.457.5 Pcs
May-20	2,000 Pcs	A1	4.457.5 Pcs	Jun-21	1,500 Pcs	A1	4.457.5 Pcs
Jun-20	5,000 Pcs	A3	4.457.5 Pcs	Jul-21	2,300 Pcs	A1	4.457.5 Pcs
Jul-20	7,000 Pcs	A5	3.996.5 Pcs	Aug-21	5,400 Pcs	A4	4.457.5 Pcs
Aug-20	3,500 Pcs	A2	3.074.5 Pcs	Sep-21	3,200 Pcs	A2	5.149 Pcs
Sep-20	6,000 Pcs	A4	4.457.5 Pcs	Oct-21	1,200 Pcs	A1	4.457.5 Pcs
Oct-20	10,500 Pcs	A7	5.149 Pcs	Nov-21	5,200 Pcs	A4	4.457.5 Pcs
Nov-20	15,000 Pcs	A10	14.138.5 Pcs	Dec-21	2,400 Pcs	A2	5.149 Pcs
Dec-20	3,300 Pcs	A2	3.074.5 Pcs	Jan-22	4,100 Pcs	A3	4.457.5 Pcs
Jan-21	2,500 Pcs	A2	4.457.5 Pcs				

The results of the Prediction for the supply of Perdana Simpati Card Products in January 2023 were 5,149 Pcs and the amount of inventory to be stocked in the following month increased so that the number of sales also increased. The following is a display on the system.

3.4. Testing

Manual and system testing with data used for predictions is inventory data and regular Prime sales for the last three years , namely 20 20 , 202 1 , and 202 2 . This test is carried out by looking at the magnitude of the *error* or looking for the *AFER (Average Forecasting Error Rate)* value obtained after making predictions for inventory and product sales and program testing.

The following is the calculation of the *AFER value,* Calculation of the *Average Forecasting Error Rate (AFER) Value* in Telkomsel's Product Sales Prediction **.** *Average Forecasting Error Route (AFER)* is used to determine the magnitude of the deviation that occurs in the predicted data from the actual data (Jilani, et al., 2008). *Average* Prediction *Error Rure (AFER)* is calculated using the following formula:

$$AFER = \frac{\sum_{i=1}^{n} |Ai - Fi/Ai|}{n} x100\% \quad (12)$$

Or

$$AFER = \frac{\sum_{i=1}^{n} |Ai \; x \; n|}{Fi} x100\% \quad (13)$$

Where :

A_i : Actual value in the *i -th* data or first data
F_i : Difference in value from prediction results for data *i*
n : The amount of data
100% : Value to get the percentage result

Here's how to calculate the 3 data taken as an example:

a. $AFER = \frac{\sum_{i=1}^{n} |Ai \; x \; n|}{Fi} x100\%, AFER = \frac{(2.000 \; x \; 36)}{2.457,5} x100\% = 3\%$

b. $AFER = \frac{\sum_{i=1}^{n} |Ai \; x \; n|}{Fi} x100\%, AFER = \frac{(5.000 \; x \; 36)}{542,5} x100\% = 0\%$

c. $AFER = \frac{\sum_{i=1}^{n} |Ai \; x \; n|}{Fi} x100\%, AFER = \frac{(3.000 \; x \; 36)}{996,5} x100\% = 1\%$

The following is explained in tabular form for the results of calculating the AFER value.

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Table 9. Results of the Percentage of AFER Values for Product Inventory Prediction

Supply	Predictions	Difference	After	Afer/Year
1,000 Pcs			0	
2,000 Pcs	4.457.5 Pcs	2.457.5 Pcs	3%	
5,000 Pcs	4.457.5 Pcs	5.42.5 Pcs	0%	
3,000 Pcs	3.996.5 Pcs	996.5 Pcs	1%	
2,000 Pcs	4.457.5 Pcs	2.457.5 Pcs	3%	
5,000 Pcs	4.457.5 Pcs	542.5 Pcs	0%	
7,000 Pcs	3.996.5 Pcs	3.003,5 Pcs	1%	
3,500 Pcs	3.074.5 Pcs	425.5 Pcs	0%	
6,000 Pcs	4.457.5 Pcs	1.542.5 Pcs	1%	
10,500 Pcs	5.149 Pcs	5.351 Pcs	1%	
15,000 Pcs	14.138.5 Pcs	861.5 Pcs	0%	
3,300 Pcs	3.074.5 Pcs	225.5 Pcs	0%	1%
2,500 Pcs	4.457.5 Pcs	1.957.5 Pcs	2%	
7,500 Pcs	4.457.5 Pcs	3.042.5 Pcs	1%	
2,300 Pcs	3.074.5 Pcs	774.5 Pcs	1%	
1,230 Pcs	4.457.5 Pcs	3.227.5 Pcs	7%	
3,450 Pcs	4.457.5 Pcs	1.007,5 Pcs	1%	
1,500 Pcs	4.457.5 Pcs	2.957.5 Pcs	5%	
2,300 Pcs	4.457.5 Pcs	2.157.5 Pcs	3%	
5,400 Pcs	4.457.5 Pcs	942.5 Pcs	0%	
3,200 Pcs	5.149 Pcs	1.949 Pcs	2%	
1,200 Pcs	4.457.5 Pcs	3.257.5 Pcs	8%	
5,200 Pcs	4.457.5 Pcs	742.5 Pcs	0%	
2,400 Pcs	5.149 Pcs	2.749 Pcs	3%	3%
4,100 Pcs	4.457.5 Pcs	357.5 Pcs	0%	
2,130 Pcs	3.996.5 Pcs	1.866.5 Pcs	2%	
6,500 Pcs	4.457.5 Pcs	2.042.5 Pcs	1%	
5,630 Pcs	5.149 Pcs	481 Pcs	0%	
2,000 Pcs	5.149 Pcs	3.149 Pcs	4%	
7,000 Pcs	4.457.5 Pcs	2.542.5 Pcs	1%	
4,000 Pcs	3.074.5 Pcs	925.5 Pcs	1%	
3,500 Pcs	3.996.5 Pcs	496.5 Pcs	0%	
3,450 Pcs	4.457.5 Pcs	1.007,5 Pcs	1%	
1,500 Pcs	4.457.5 Pcs	2.957.5 Pcs	5%	
2,300 Pcs	4.457.5 Pcs	2.157.5 Pcs	3%	
5,400 Pcs	4.457.5 Pcs	942.5 Pcs	0%	2 %

Table 10. Evaluation Criteria *Average* Prediction *Error Rate (AFER)*

AFTER	**Information**
< 10%	Very good
10% - 20%	Good
20% - 50%	Enough
> 50%	Bad

From the results of calculating the *AFER value* for predicting product sales, it can be concluded that the average *AFER value* for predictions of Telkomsel product inventory in 2020 is 1%, in 2021 is 3% and in 2022 is 2%, which means the *error*

value in the predictions made included in the very good category, because the *error value* <10% [6].

4. CONCLUSION

From the research that has been done, it can be concluded that: Test results carried out by the inventory and sales prediction system using the *Fuzzy Time Series (FTS)* method at PT. Graha Informatika Nusantar (GRATIKA) Range, can provide an overview of changes in existing inventory and sales patterns to minimize losses . And the sales prediction produces an average *AFER (Average Forecasting Error Rate) value* with the results for predictions of inventory and sales of Telkomsel products in 2020, which is 1%, in 2021, which is 3% and in 2022, which is 2%, which means that the *error value* in the prediction is carried out is included in the very good category, because the *error value is* <10%.

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