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Data Mining Analysis In Minimizing Company Losses Using Fuzzy Time Series Method

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ABSTRACT

Losses are the most avoided by all business entities in this case the research obtained a research study at PT. Sumatera Sarana Sekar Sakti. The company suffered a big loss in the expenditure / spending section that was not managed properly. Therefore, this research conducts an analysis by producing predictions of PT. Sumatera Sarana Sekar Sakti's expenditure data from November 2023 to January 2024 so that a value is obtained that will minimize company losses due to providing appropriate and efficient funds. The method used in this prediction is Fuzzy Time Series. It's a new category of methods that have been widely used in various studies because they produce good predictive values. In this study, the Fuzzy Time Series method can produce 0,31% error rate using the MAPE (Mean Absolute Percentage Error) formula from data analysis of 1.875 company expense transactions. MAPE (Mean Absolute Percentage Error) is a measurement that is often used in various studies with data prediction categories.

Keywords: Expenses, Loss, Prediction, Company, Fuzzy Time Series

INTRODUCTION

In recent years, the application of data analysis techniques has become increasingly relevant in various fields, including forecasting systems. One area where data analytics can provide valuable insights is in predicting corporate spending. Insight into the prediction of corporate expenditure plays an important role in understanding trends in capital provision and planning future resources for the company. PT. Sumatera Sarana Sekar Sakti, located in Medan City, North Sumatra Province, is a company with diverse and various socio-economic factors that can affect expenditure spending that always changes every month. By analyzing the company's expenditure budget data, it is possible to identify patterns and trends that can explain the factors underlying changes in the company's expenditure levels over time. These insights can help policy makers, senior officials and company stakeholders to develop targeted investments and policies to address the main causes of losses due to budget provision and expenditure discrepancies.

An example of expenditure that looks very different between budget provision and company expenditure is in December 2023 Rp. 278.618.755,- (detailed expenditure is in the attachment) even though the company's budget provision is Rp. 200.000.000,- The company provides a budget expenditure of two hundred million because in the previous month for six consecutive months the expenditure was below two hundred million. This resulted in the company having to cover the shortfall by making loans to third parties and this is a form of loss. Provision of excess budget is also a form of loss although logically spending expenditures not exceeding the budget is good but the provision of an effective and efficient budget is a much better choice so that the development of investment and resources for the company is further enhanced. Therefore, there is a need for a system that can predict (forecasting) company expenditures in order to minimize losses and increase preventive investment and resources.

Prediction (forecasting) is one of the branches of data mining that aims to produce data that can be used in future assumptions[1]. Prediction is divided into two types: qualitative (based on opinion and descriptive analysis) and quantitative (based on mathematical calculations). In this research, the data is based on mathematical calculations so it uses quantitative type forecasting. One of the quantitative forecasting methods is Fuzzy Time Series.

Fuzzy Time Series is a new method used by various studies in predicting special time series category data. This research is data with time series characteristics because it has the characteristics of continuous period data. Prediction research using the Fuzzy Time Series method has been widely used and produces predictions with small errors. Ica Admirani's research using the Fuzzy Time Series method to predict profits in companies with a very high prediction accuracy of 88,36% with an error of 11,64%[2]. Research by Normalita Fauziah, et al, predicting rainfall in Samarinda City using the Fuzzy Time Series method resulted in an accuracy of 84,91% with an error of 15,09%[3]. As well as research by Vivianti, et al, conducted research predicting tourist visitors to Fort Rotterdam Fort resulting in a prediction accuracy of 88% and an error rate of 12%[4]. Of the three studies is evidence that the Fuzzy Time Series method is feasible to use in research with the category of data mining forecasting (prediction).

Based on these problems, a good presentation of information is needed. So the researcher raised a research entitled “Data Mining Analysis in Minimizing Company Losses Using the

Fuzzy Time Series Method". Research contributes to companies in minimizing losses due to the provision of ineffective and inefficient spending.

The limitations of the problems that will be in this report, as follows:

1. Input Data: expenditure data as much as 1.875 company expenditure data
2. Process using the method: Fuzzy Time Series.
3. Output: Predicted expenditure for February 2024
4. Calculation of prediction accuracy using the Mean Absolute Percentage Error (MAPE) formula.

The objectives of this research are as follows:

1. To apply the Fuzzy Time Series method in company spending to minimize losses in budget provision.
2. To find out the relationship between budget provision and company expenditures that result in company losses.
3. To test the calculation of Fuzzy Time Series in prediction accuracy using the MAPE formula.

The benefits of this research are as follows:

1. Applying the Fuzzy Time Series method in company spending to minimize losses in budget provision.
2. Knowing the relationship between budget provision and company expenditures that result in company losses.
3. Testing the Fuzzy Time Series calculation in prediction accuracy using the MAPE formula.

METHODS

Time series analysis consists of methods for analyzing time series data to extract statistics and characteristics of data that have a natural temporal sequence. The method is to predict future values based on previously observed values. In time series analysis, the main goal is to understand and change aspects in the hope of more precisely expecting the course of events in the future.

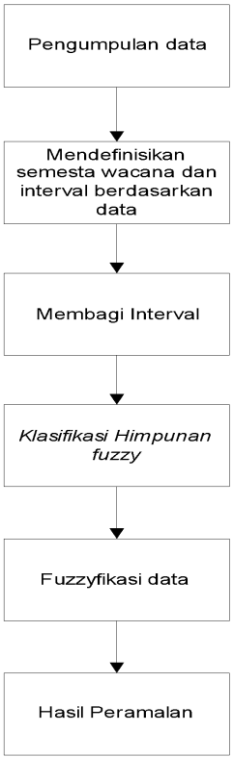

Figure 1. Flowchart Fuzzy Time Series

The data collection techniques carried out by the author are:

Observation, the author makes observations of products, consumers and shopping data (expenses) every month at PT. Sumatera Sarana Sekar Sakti precisely for the prediction system in order to minimize company losses by preparing the right data.

Interview, this technique is directly face to face with the party concerned to get an explanation of the problems that were previously unclear, namely about the mechanism of the system used in the company and also to ensure that the data obtained is collected is completely accurate. And ask questions to the company's expenditure recording staff.

Library Research, the author conducts a literature study to obtain data related to the writing of the thesis from various reading sources such as guidebooks for making PHP applications using HTML, data management, and forecasting books or journals that discuss the concept of prediction to minimize losses at PT. Sumatera Sarana Sekar Sakti.

Sampling, examining and selecting data - data that is available and in accordance with the selected field as an attachment file, namely in the November and December 2023 budget documents as much as 1.184 data at PT. Sumatera Sarana Sekar Sakti.

Defining the Universe of Discourse and Intervals is based on the range of data available in the historical time series data, with the following rules: U = [Dmax-D1,Dmin-D2] where D1 and D2 are two corresponding positive numbers.

Dividing Intervals into equal length intervals u1, u2.....uN. The number of intervals will converge to the number of linguistic variables (Fuzzy sets) A1,A2,.....An to consider. If we look at the relationship of the predicting facts with the fuzzy time series that has the smallest average error. The researcher has found the midpoint of the interval. Dividing the interval has the formula (mi) on the interval of the Fuzzy Set.

Classifying the fuzzy set in Figure 1 into linguistic variables A1 = very bad, A2 = bad, A3 = good, A4 = very good and so on. Each linguistic value corresponds to a fuzzy variable placed next to the correlated fuzzy set to determine the significance of this variable. If the value of variable U in the method is accepted as the midpoint of the corresponding fuzzy set interval defined as, Ai= [0,1] is a fuzzy set.

Fuzzify the historical data in Figure 1 and create a fuzzy logic relation with the following rules:
If Ai is the fuzzy price on day n and Aj is the fuzzy price on day n + 1, then the fuzzy logic relation is denoted by Ai→Aj, here Ai is called the current state and Aj is called the next state.

Defuzzify the forecasting results in Figure 1 by first finding the average of the data. Find the sum of the data values and divide the sum by the number of data values. Then find the absolute value of the difference between each data value and the average. Find the sum of the absolute values of the difference. Fuzzy Time Series has 3 (three) rules in the prediction stage, namely[4]:

Rule 1, If the fuzzification result in year t is Aj and there is a fuzzy set that does not have a fuzzy logic relationship, for example if Ai→∅, where the maximum value of the membership function of Ai is in the interval ui and the middle value of ui is mi, then the Ft+1 forecasting

result is mi.

Rule 2, If the fuzzification result of year t is Ai and there is only one FLR in FLRG, for example if Ai→Aj where Ai and Aj are fuzzy sets and the maximum value of the membership function of Aj is in the interval uj and the center value of uj is mj, then the Ft+1 forecasting result is mj.

Rule 3, If the fuzzification result in year t is Aj and Aj has multiple FLRs in FLRG, for example Ai→Aj1, Aj2, ..., Ajk where Ai, Aj1, Aj2, ..., Ajk are fuzzy sets and the maximum value of the membership function of Aj1, Aj2, ..., Ajp is on the interval uj1, uj2, ..., ujk and mj1, mj2, ..., mjk.

RESULTS

Data analysis of 1.875 budget transactions / expenditures of PT. Sumatera Sarana Sekar Sakti which made the company lose money due to the instability of expenses so that the company in preparing funds sometimes lacks and some are excessive which is included in the category of losses in the industrial world.

Table 1. Budget Data November 2023 to January 2024

No	DISPENSING DATE	ITEM NAME	UNIT	DISPENSING QTY	DISPENSING COGS
1	31-Jan-24	HOSE 1/4" X R1 X 60CM NU + 90	PCS	1	55.000
2	31-Jan-24	KAIN MAJUN	KG	1	8.200
3	31-Jan-24	LEM SILICON RED	PCS	1	8.000
4	31-Jan-24	KAIN MAJUN	KG	0,5	4.100
5	31-Jan-24	OBAT AIR RADIATOR @5 LITER	DRG	1	35.000
6	31-Jan-24	KAWAT LAS RB 26 ; 2.6MM KOBE	KG	0,5	15.050
7	31-Jan-24	MINYAK MESIN KLX-150 @1LITER	BOTOL	1	50.000
8	31-Jan-24	SELENDANG 750/16	PCS	1	31.500
9	31-Jan-24	BAN DALAM 700 / 750 -16	PCS	1	159.000
10	31-Jan-24	TIE ROD TAFT	SET	1	185.000

No	DISPENSING DATE	ITEM NAME	UNIT	DISPENSING QTY	DISPENSING COGS
		ROCKY			
11	31-Jan-24	HOSE 1" X R4 X 151 CM / SELANG HIDROLIK KOBELCO	PCS	1	430.000
12	31-Jan-24	OLI PRESLIA 68 @208LITER	LITER	1,5	52.800
13	31-Jan-24	SARUNG PISAU EGREK	PCS	14	812.000
14	31-Jan-24	SARUNG PISAU EGREK	PCS	25	1.450.000
15	31-Jan-24	SARUNG PISAU EGREK	PCS	17	986.000
16	31-Jan-24	SARUNG PISAU EGREK	PCS	7	406.000
17	31-Jan-24	CRAWLER TIRE 600KD	PCS	4	26.160.000
18	31-Jan-24	LAMPU LED BULB 50W	PCS	1	84.500
19	31-Jan-24	LAMPU LED BULB 50W	PCS	2	169.000
20	31-Jan-24	HERBISIDA BIONASA	LITER	2	160.000
21	31-Jan-24	PESTISIDA RAPID	GRAM	80	16.000
22	31-Jan-24	PESTISIDA RAPID	GRAM	317	63.400
23	31-Jan-24	HERBISIDA BIONASA	LITER	2	160.000
24	31-Jan-24	HERBISIDA BIONASA	LITER	8	640.000
25	31-Jan-24	SHUT OFF VALVE ASSY / KATUP PENGATUR LENGKAP KEP SOLO (NO.KATALOG 45)	PCS	1	13.750
26	30-Jan-24	AIR BATERAI 20LITER	LITER	18	85.500

No	DISPENSING DATE	ITEM NAME	UNIT	DISPENSING QTY	DISPENSING COGS
27	30-Jan-24	RELAY DINAMO STARTER EXCAVATOR	PCS	1	250.000
28	30-Jan-24	KEPALA BATERai +/-	PCS	2	18.000
29	30-Jan-24	MINYAK MESIN KLX-150 @1LITER	BOTOL	2	100.000
30	30-Jan-24	TIE ROD RH/LH MITS CANTER FE-83P / FE-84P	SET	1	140.000
31	30-Jan-24	TIE ROD STEERING / STANG PANJANG MITS CANTER FE-83P / FE-84P	PCS	1	500.000
32	30-Jan-24	BAUT + MUR HEXAGON 3" X 5/16"	PCS	2	1.800
33	30-Jan-24	OLI TRANSTEC 5 / MINYAK GERDANG 85W - 140 @208LITER	LITER	7	295.750
34	30-Jan-24	KING PEN MITS CANTER PS-136	SET	1	180.000
35	30-Jan-24	BAUT RODA BELAKANG ISUZU ELF RH (5-87411-891-1 / JPN)	PCS	1	40.000
36	30-Jan-24	KAWAT LAS LB 52 ; 3.2MM KOBE	KG	0,5	19.000
37	30-Jan-24	KAWAT LAS RB 26 ; 2.6MM KOBE	KG	0,5	15.050
38	30-Jan-24	LAHAR KING PEN H/DUTRO	PCS	1	25.000
39	30-Jan-24	TIE ROD RH/LH MITS CANTER FE-83P / FE-84P	SET	1	140.000

No	DISPENSING DATE	ITEM NAME	UNIT	DISPENSING QTY	DISPENSING COGS
40	30-Jan-24	LEM SILICON RED	PCS	1	8.000
41	30-Jan-24	SPRAY TUBE / PIPA SEMPROT 500MM KEP SOLO (NO.KATALOG 47) MODEL BARU	PCS	1	13.500
42	30-Jan-24	ELBOW KEP SOLO (NO.KATALOG 35)	PCS	1	2.500
43	30-Jan-24	CYLINDER / SILINDER KEP SOLO (NO.KATALOG 40)	PCS	1	18.000
44	30-Jan-24	SCREW CAP KEP SOLO (NO.KATALOG 22)	PCS	1	1.500
45	30-Jan-24	SPRAY TUBE / PIPA SEMPROT 500MM KEP SOLO (NO.KATALOG 47) MODEL BARU	PCS	1	13.500
46	30-Jan-24	SARUNG TANGAN KARET	PASANG	8	80.000
47	30-Jan-24	FLAT SPRAY JET / NOZEL HITAM KEP SOLO (NO.KATALOG 29)	PCS	1	2.000
48	30-Jan-24	SARUNG TANGAN KARET	PASANG	2	20.000
49	30-Jan-24	SHUT OFF VALVE ASSY / KATUP PENGATUR LENGKAP KEP SOLO (NO.KATALOG 45)	PCS	1	13.750
50	30-Jan-24	SARUNG TANGAN KARET	PASANG	2	20.000
51	30-Jan-24	PESTISIDA RAPID	GRAM	310,8	62.160

No	DISPENSING DATE	ITEM NAME	UNIT	DISPENSING QTY	DISPENSING COGS
52	30-Jan-24	HERBISIDA BIONASA	LITER	2	160.000
53	30-Jan-24	PESTISIDA RAPID	GRAM	80	16.000
54	30-Jan-24	HERBISIDA BIONASA	LITER	2	160.000
. . .					
1875	01-Nov-23	OLI RUBIA / MINYAK MESIN / RUBIA FLEET HD 300 SAE 15W-40 @208LITER	LITER	2	1.050.000

(Source: PT. Sumatera Sarana Sekar Sakti)

Referring to the data in Table 1 in Results, the fuzzy time series calculation is:

The historical data used is the actual shopping transaction data of the company PT. Sumatera Sarana Sekar Sakti from November 2023 to January 2024 with a total sample data of 1.875 data.

From historical data, the lowest data value (Dmin) is 120 and the highest data value (Dmax) is 26160000 and determined D = 26160000 / 16 using base mapping 1635000 so as to obtain the initial universe set value U = [120;1635120].

Furthermore, dividing the universe of U into several equal intervals (ui) using a distribution-based interval type obtained a base mapping value of 1635000. The base mapping value is set as the length of the data interval so that the number of intervals is 16, then the middle value of each interval is determined as in Table 2.

Table 2. Interval Value of Transaction Data

Intervals (U_i)	Center Value (m_i)
u1=[120;1635120]	817620

u2=[1635121;3270121]	2452621
u3=[3270122;4905122]	4087622
u4=[4905123;6540123]	5722623
u5=[6540124;8175124]	7357624
u6=[8175125;9810125]	8992625
u7=[9810126;11445126]	10627626
u8=[11445127;13080127]	12262627
u9=[13080128;14715128]	13897628
u10=[14715129;16350129]	15532629
u11=[16350130;17985130]	17167630
u12=[17985131;19620131]	18802631
u13=[19620132;21255132]	20437632
u14=[21255133;22890133]	22072633
u15=[22890134;24525134]	23707634
u16=[24525135;26160135]	25342635

Furthermore, the fuzzification process of historical company expense transaction data with results such as Table 3.

Table 3. Data Defuzzification

Time	Actual	Interval	Fuzzification
31-Jan-24	25764260	[24525135;26160135]	**A16**
30-Jan-24	4493610	[3270122;4905122]	**A3**
29-Jan-24	4307261	[3270122;4905122]	**A3**
27-Jan-24	750500	[120;1635120]	**A1**
26-Jan-24	2126024	[1635121;3270121]	**A2**
25-Jan-24	1244970	[120;1635120]	**A1**
24-Jan-24	1799485	[1635121;3270121]	**A2**
23-Jan-24	6708271	[6540124;8175124]	**A5**
22-Jan-24	7822795	[6540124;8175124]	**A5**
20-Jan-24	5170050	[4905123;6540123]	**A4**
19-Jan-24	1770115	[1635121;3270121]	**A2**
18-Jan-24	25147800	[24525135;26160135]	**A16**
17-Jan-24	3028924	[1635121;3270121]	**A2**
16-Jan-24	665180	[120;1635120]	**A1**
15-Jan-24	1880693	[1635121;3270121]	**A2**
13-Jan-24	675040	[120;1635120]	**A1**

12-Jan-24	3403338	[3270122;4905122]	**A3**
11-Jan-24	22002800	[21255133;22890133]	**A14**
10-Jan-24	673959,5	[120;1635120]	**A1**
9-Jan-24	13234565	[13080128;14715128]	**A9**
8-Jan-24	21334560	[21255133;22890133]	**A14**
6-Jan-24	17322560	[16350130;17985130]	**A11**
5-Jan-24	14003456	[13080128;14715128]	**A9**
4-Jan-24	5432347	[4905123;6540123]	**A4**
3-Jan-24	1212851	[120;1635120]	**A1**
2-Jan-24	312645	[120;1635120]	**A1**
30-Dec-23	14789564	[14715129;16350129]	**A10**
28-Dec-23	20245734	[19620132;21255132]	**A13**
27-Dec-23	1765342	[1635121;3270121]	**A2**
26-Dec-23	10543789	[9810126;11445126]	**A7**
23-Dec-23	18546234	[17985131;19620131]	**A12**
22-Dec-23	21456389	[21255133;22890133]	**A14**
21-Dec-23	23443556	[22890134;24525134]	**A15**
20-Dec-23	14890430	[14715129;16350129]	**A10**
19-Dec-23	18022110	[17985131;19620131]	**A12**
18-Dec-23	1756432	[1635121;3270121]	**A2**
16-Dec-23	23065043	[22890134;24525134]	**A15**
15-Dec-23	24076098	[22890134;24525134]	**A15**
14-Dec-23	18007342	[17985131;19620131]	**A12**
13-Dec-23	13567445	[13080128;14715128]	**A9**
12-Dec-23	10665112	[9810126;11445126]	**A7**
11-Dec-23	23123321	[22890134;24525134]	**A15**
9-Dec-23	10654652	[9810126;11445126]	**A7**
8-Dec-23	17045334	[16350130;17985130]	**A11**
7-Dec-23	16789665	[16350130;17985130]	**A11**
6-Dec-23	12112321	[11445127;13080127]	**A8**
5-Dec-23	14980050	[14715129;16350129]	**A10**
4-Dec-23	5123000	[4905123;6540123]	**A4**
1-Dec-23	24780050	[24525135;26160135]	**A16**
30-Nov-23	15001230	[14715129;16350129]	**A10**
29-Nov-23	18230300	[17985131;19620131]	**A12**
28-Nov-23	10710230	[9810126;11445126]	**A7**

27-Nov-23	16554334	[16350130;17985130]	**A11**
25-Nov-23	21708980	[21255133;22890133]	**A14**
24-Nov-23	15667350	[14715129;16350129]	**A10**
23-Nov-23	18005200	[17985131;19620131]	**A12**
22-Nov-23	15750650	[14715129;16350129]	**A10**
21-Nov-23	13450540	[13080128;14715128]	**A9**
20-Nov-23	16670650	[16350130;17985130]	**A11**
19-Nov-23	7123450	[6540124;8175124]	**A5**
18-Nov-23	1463052	[120;1635120]	**A1**
17-Nov-23	1010327	[120;1635120]	**A1**
16-Nov-23	971000	[120;1635120]	**A1**
15-Nov-23	1345896	[120;1635120]	**A1**
14-Nov-23	5386356	[4905123;6540123]	**A4**
11-Nov-23	330400	[120;1635120]	**A1**
10-Nov-23	4298595	[3270122;4905122]	**A3**
9-Nov-23	2815487	[1635121;3270121]	**A2**
8-Nov-23	1006000	[120;1635120]	**A1**
7-Nov-23	3791844	[3270122;4905122]	**A3**
6-Nov-23	2375700	[1635121;3270121]	**A2**
4-Nov-23	1471371	[120;1635120]	**A1**
2-Nov-23	110900	[120;1635120]	**A1**
1-Nov-23	595780	[120;1635120]	**A1**

From the fuzzification results, fuzzy logical relationship (FLR) and fuzzy logical relationship group (FLRG) from order one to order four are determined.

Next, the training stage prediction process is carried out in accordance with the algorithm and prediction rules of the fuzzy time series model.

Table 4. Fuzzy Logical Relationship (FLR)

Orde 1	**Orde2**	**Orde3**	**Orde4**
A16 => A3	A16,A3 => A3	A16,A3,A3 => A1	A16,A3,A3,A1=>A1

A3 => A3	A3,A3 => A1	A3,A3,A3 => A1	A3,A3,A3,A1=>A1
A3 => A1	A3,A1 => A2	A3,A1,A2 => A1	A3,A1,A2,A1=>A2
A1 => A2	A1,A2 => A1	A1,A2,A1 => A2	A1,A2,A1,A2=>A5
A2=> A1	A2,A1 => A2	A2,A1,A2 => A5	A8,A5,A12,A10=>A15
A1 => A2	A1,A2 => A5	A5,A12,A10=>A15	A5,A12,A10,A15=>A12
A2 => A5	A2,A5 => A5	A12,A10,A15=>A12	A12,A10,A15,A12=>A11
A5 => A5	A5,A5 => A4	A10,A15,A12=>A11	A10,A15,A12,A11=>A4
A5 => A4	A5,A4 => A2	A15,A12,A11=>A4	A15,A12,A11,A4=>A16
A4=> A2	A2,A16 => A2	A12,A11,A4=>A16	A12,A11,A4,A16=>A11
A2=> A16	A16,A2 => A1	A11,A4,A16=>A11	A11,A4,A16,A11=>A11
A16 => A2	A2,A1 =>A2	A4,A16,A11=>A11	A4,A16,A11,A11=>A10
A2 => A1	A1,A2 => A1	A11,A10,A11=>A10	A11,A10,A11,A10=>A8
A1 => A2	A2,A1 => A3	A10,A11,A10=>A8	A10,A11,A10,A8=>A13
A2 => A1	A10,A7 => A8	A10,A7,A8=>A13	A10,A7,A8,A13=>A9
A1=> A3	A7,A8 => A13	A7,A8,A13=>A9	A7,A8,A13,A9=>A14
A3 => A14	A8,A13 => A9	A8,A13,A9=>A14	A8,A13,A9,A14=>A9
A14 => A1	A13,A9 => A14	A9,A14,A12=>A9	A9,A14,A12,A9=>A9
A1 =>A9	A9,A14 => A12	A14,A11,A9=>A9	A14,A11,A9,A9=>A15
A9 => A14	A14,A11 => A9	A11,A12,A19=>A15	A11,A12,A19,A15=>A11
A14 => A11	A11,A12 => A9	A9,A4,A15=>A11	A9,A4,A15,A11=>A10
A11 => A9	A9,A4 => A15	A4,A15,A11=>A10	A4,A15,A11,A10=>A1
A9=> A4	A4, A15 => A11	A15,A11,A10=>A1	A15,A11,A10,A1=>A2
A1 => A2	A5,A1 => A10	A11,A10,A1=>A2	A11,A10,A1,A2=>A7
A2 => A7	A11,A10 => A1	A10,A1,A2=>A7	A10,A1,A2,A7=>A12
A7 => A11	A10,A1 => A2	A1,A2,A7=>A12	A1,A2,A7,A12=>A14
A15 => A10	A1,A2 =>A7	A2,A7,A12=>A14	A2,A7,A12,A14=>A15
A10 => A12	A2,A7 => A12	A7,A11,A14=>A15	A7,A11,A14,A15=>A7
A12 => A2	A7,A11 => A14	A13,A14,A15=>A7	A13,A14,A15,A7=>A12
A2 => A15	A1,A1 => A5	A15,A16,A7=>A12	A15,A16,A7,A12=>A2
A15 => A15	A15,A16 => A7	A15,A10,A12=>A2	A15,A10,A12,A2=>A15
A15 => A12	A15,A1 => A12	A10,A12,A2=>A15	A10,A12,A2,A15=>A15
A12 => A9	A10,A12 => A2	A12,A2,A15=>A15	A12,A2,A15,A15=>A12
A9 => A7	A12, A2 => A15	A2,A15,A15=>A12	A2,A15,A15,A12=>A7
A7 => A16	A2,A15 => A15	A15,A12,A9=>A7	A15,A12,A9,A7=>A16
A7 => A11	A1,A15 => A12	A12,A9,A7=>A16	A12,A9,A7,A16=>A11
A11 => A11	A15,A12 => A9	A9,A7,A16=>A11	A9,A7,A16,A11=>A11

A11 => A8	A12,A9 => A7	A7,A15,A11=>A11	A7,A15,A11,A11=>A8
A8 => A10	A9,A7 => A16	A7,A11,A11=>A8	A7,A11,A11,A8=>A10
A10 => A4	A7,A15 => A11	A11,A11,A8=>A10	A11,A11,A8,A10=>A4
A4 => A16	A7,A11 => A11	A11,A8,A10=>A4	A11,A8,A10,A4=>A16
A16 => A10	A11,A11 => A8	A8,A10,A4=>A16	A8,A10,A4,A16=>A10
A10 => A12	A11,A8 => A10	A10,A4,A16=>A10	A10,A4,A16,A10=>A12
A12 =>A7	A8,A10 => A4	A4,A16,A10=>A12	A4,A16,A10,A12=>A11
A7 => A11	A10,A4 => A16	A16,A10,A12=>A11	A16,A10,A12,A11=>A14
A11 => A14	A4,A16 => A10	A12,A7,A11=>A14	A12,A7,A11,A14=>A10
A14 => A10	A16,A1 => A12	A7,A11,A14=>A10	A7,A11,A14,A10=>A12
A10 => A12	A12,A7 => A11	A11,A14,A10=>A12	A11,A14,A10,A12=>A10
A12 => A10	A7,A11 => A14	A14,A10,A12=>A10	A7,A11,A14,A10=>A12
A10 => A9	A1,A14 => A10	A10,A12,A10=>A9	A11,A14,A10,A12=>A10
A9 => A11	A14,A1 => A12	A12,A10,A9=>A11	A14,A10,A12,A10=>A9
A11 => A5	A1,A12 => A10	A10,A9,A11=>A5	A10,A12,A10,A9=>A11
	A12,A10 => A9		A12,A10,A9,A11=>A5
	A10,A9 => A11		
	A9,A11 =>A5		

Table 5. Fuzzy Logical Relationship Group (FLRG)

Orde 1

A1=>A2,A3,A9

A2=>A1,A5,A16,A9

A3=>A1,A14

A4=>A15,A16

A5=>A12

A6=>Ø

A7=>A8,A11,A12,A15,A16

A8=>A5,A10,A13

A9=>A4,A7,A8,A9,A11,A14

A10=>A9,A12,A4,A1,A7,A15

A11=>A5,A11,A8,A14,A10,A4

A12=>A10,A7,A9,A11,A2

A13=>A9

A14=>A10,A11,A12

A15=>A12,A15,A10,A11

A16=>A10,A11

November 1, 2023 number of transactions 595780 category A1

A1=>A2,A3,A9

A2 => mi = 2452621; A3 => mi = 4087622; A9 => mi = 13897628

mi1 = (2452621 + 4087622 + 13897628) / 3 = 6812623.67

December 1, 2023 transaction amount 24780050 category A16

A16=>A10,A11

A10 => mi = 15532629; A11 => mi = 17167630

mi2 = (15532629 + 17167630) / 2 = 16350129.5

January 1, 2024 there is no spending transaction

So prediction = (mi1 + mi2) / 2 => (6812623.67 + 16350129,5) / 2

= 11.581.376,6

Next, the prediction of the testing stage is carried out, which is the final result of the prediction. Testing is done by comparing the prediction results with actual data. Actual data is data that actually occurs in the company's expenses in February 2024. The function of comparing is to determine the accuracy of the prediction by knowing how much the error is. In this study, the measurement of the error rate uses Mean Absolute Percentage Error (MAPE).

Table 6. Final Results Testing Stage

Time	Actual	Prediction
1 February 2024	83658708	11581376,6
2 February 2024	6481504	6812623,67
3 February 2024	1244400	817620
4 February 2024	-	55862892
5 February 2024	1784185	1699801
6 February 2024	2886310	2886309
7 February 2024	2440318	2441110
8 February 2024	-	650000
9 February 2024	77250	70250
10 February 2024	-	151230

11 February 2024	-	120000
12 February 2024	3012415	3011415
13 February 2024	5285760	5290000
14 February 2024	-	105000
15 February 2024	40723829	20123980
16 February 2024	7140880	7234410
17 February 2024	1988670	2045540
18 February 2024	-	25987650
19 February 2024	1728350	1804500
20 February 2024	2264810	2297510
21 February 2024	2573923	2589010
22 February 2024	4701015	4923510
23 February 2024	1656465	1876450
24 February 2024	11615155	13420100
25 February 2024	-	14510230
26 February 2024	6532550	6523350
27 February 2024	3277400	3301000
28 February 2024	9128580	9854450
29 February 2024	3815756	3884510

With the calculation of the error rate is

$$\text{MAPE} = \frac{211875827 - 204018233}{211875827}$$

$$= 0.037/12 \text{ x } 100\%$$

$$= 0.31\%$$

With a small error rate, the Fuzzy Time Series method produces good prediction data.

CONCLUSION

The conclusion that can be obtained in this study entitled Data Mining Analysis in Minimizing Company Losses Using the Fuzzy Time Series Method is the use of the Fuzzy Time Series method for predicting the expenditure of the company PT. Sumatera Sarana Sekar Sakti is very appropriate. Because the method is a new category so that the accuracy in high predictions gets 0,31% error which calculates the error measurement using MAPE (Mean Absolute Percentage Error). 1.875 company expenditure transactions can be processed properly so that the prediction results with high accuracy. This research is expected to help companies in preparing the right and efficient funds so that it will minimize losses.

The suggestions that the author can take from the discussion in the previous chapter are prediction methods in combination or compared with other prediction methods in one time series category, for example ARIMA (Autoregressive Integrated Moving Average). This research analysis can also be developed in an application that is attractive and easy to use by the user.

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