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ONION CRACKERS SALES FORECASTING USING ARTIFICIAL NEURAL NETWORK METHOD AND HOLT'S DOUBLE EXPONENTIAL SMOOTHING

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Abstract

Changes in product demand is a problem that is often faced by the industry as well as one of them is onion crackers. Tapioca flour is the main ingredient used to make onion crackers. Because the demand for crackers is always changing, this company often experiences excess or shortage of raw materials. If there is an excess of raw materials, the company must incur additional costs for the maintenance and storage of raw materials so that raw materials can be properly stored in accordance with existing standards, which of course costs a lot. Therefore, companies must plan to solve this problem by planning raw material requirements by forecasting raw material requirements using the artificial neural network method and double exponential smoothing holt. The results showed that the artificial network method had a mean square error of 0.120 and the mean square error using the double exponential smoothing method yielded a value of 206.19. Based on these two values, it can be concluded that the artificial neural network method is more accurate than the double exponential smoothing holt method. This can be seen by comparing the roat mean square error values of the two methods.

Keyword: Artificial neural networks, double exponential smoothing holt, forecasting.

INTRODUCTION

Onion crackers is one of the products made by this company. The company is still very much changing in the sales of its products. The company is still facing problems with raw materials due to this fluctuation in sales. Prior to this, companies often purchased large quantities of raw materials in an effort to increase purchasing efficiency. However, supply is not always the better for this. Raw materials are impacted by these fluctuating demand and sales. If the company produces products with a smaller capacity than the purchase of raw materials, the raw materials will be left over, which means that the raw materials must be treated or stored so they are not damaged. The materials used to make finished products are called raw materials[1]. Therefore, planning the purchase of this raw material is one of the most important things to do for a company.

Because it is closely related to the costs that must be borne by the business and the smooth production process, planning for the purchase of raw materials must be done properly [2]. Thus, PT. XYZ often experiences raw material shortages, which can lead to additional costs for raw material storage and

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maintenance. Raw materials that accumulate in the warehouse also require a large area, so that the warehouse space becomes narrow. Forecasting is one way to reduce this problem. Forecasting is an attempt to predict what will happen in the future. Sales forecasting is needed to evaluate a business over time and to predict how much product manufacturers will sell as raw materials in the future. [3].

Sales forecasting is needed to evaluate a business over time and to plan how much product manufacturers will sell as raw materials in the future. [4]. Companies can use sales forecasting to reduce the impact of uncertainty and anticipate changes in demand and supply [5]. Sales forecasting uses time series methods such as moving averages, linear regression, double exponential smoothing holt, and others. Double exponential smoothing Holt gets its forecasting value by estimating some of the average values of the period data.

Trend values with parameters that are not the same as the initial parameters are smoothed using a double exponential smoothing holt. Trend estimation is carried out after this smoothing using two parameters, namely alpha and beta[6]. In addition, data mining is a forecasting technique that can be used further. Data mining is the process of finding patterns of knowledge in large amounts of data. This process includes collecting methods to find unknown patterns in data [7]. Artificial neural network is one of the data mining techniques used. A collection of neurons organized into layers is known as an artificial neural network[8]. The human brain network system is the source of the concept of artificial neural networks, which basically focuses on two components of knowledge obtained from the learning process and the interaction of connections between neurons [9].

According to research conducted by Jayadianti with the title Artificial Neural Network Comparison Method for Rainfall Prediction, this method can provide results that can recognize patterns well and this method is easy to develop into various variants according to existing problems and parameters [10]. In addition, research conducted by Izati, Research on the Application of the Artificial Neural Network Method in Forecasting the Number of Visits of Pregnant Women (K4), found that the artificial neural network method has a relatively low error value and high accuracy, so the forecasting results can be used as information for program planning [11].

Sakinah's study entitled Prediction of Newspaper Demand with the Backpropagation Neural Network Method shows that this method has good forecasting results [12]. In this study, the backpropagation algorithm is used. Backpropagation is a learning algorithm that changes the weight according to the difference between the output and the target to reduce the error rate [13]. This algorithm is often used to solve difficult problems because this algorithm uses a learning method, it is often used to solve difficult problems. This method uses learning methods [14].

RESEARCH METHODS

The data used in this study is sales data for 4 years from 2018-2021. Flowchart Research process can be seen in figure 1.

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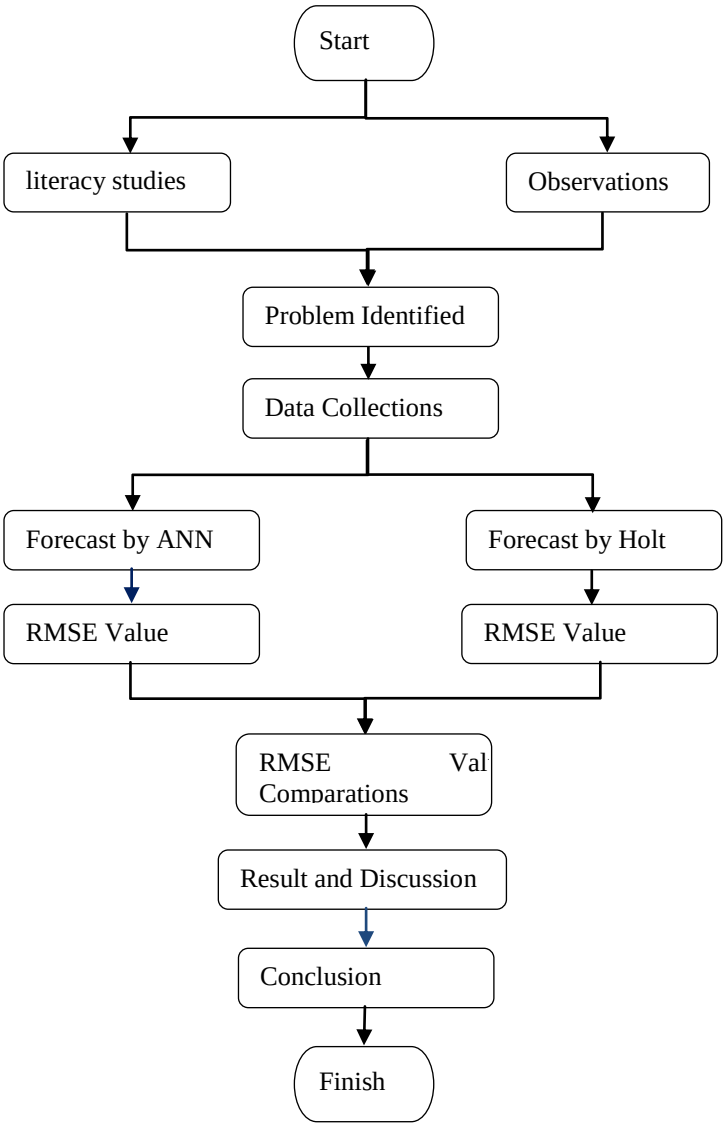

Figure 1. Flow chart

The process of working using rapidminer software. The following is the data that will be processed. The data to be processed has undergone a data transformation process. Data transformation is the process of changing data or merging data into an appropriate format for further processing of data mining [15].

Table 1. Datas Transformasi

No	Date	Normalization
1	Jan,01^{st},18	0,291228
2	Jan,02^{nd},18	0,045614
3	Jan,06^{th},18	0,259649
4	Jan,07^{th},18	0,015789
5	Jan,08^{th},18	0,075439
…	…	…
…	…	…

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969	Dec,30^{th},21	0,154386
970	Dec,31^{th},21	0,152632

The first step is to conduct field studies and literacy studies. Then do the formulation of the problem and data collection. Data preprocessing consists of three processes: checking missing values, normalizing data, and dividing data into instructions and testing data. Data transformation is carried out at the data normality test stage. Min-max normalization is used for data transformation. The linear transformation method on the initial data is known as the minimum-maximum standard [16]. Next, the parameters and architecture of the artificial neural network are determined. Momentum, learning rate, epoch, type of input and output, and activation function are used. After that, it means the data training process is finished. After the data reaches the maximum iteration and has a satisfactory value, the testing process will begin, which will produce a forecasted value. After knowing the level of accuracy or error, the roat mean square error value will be compared using the double exponential smoothing holt method.

The formula used for settlement with the double exponential smoothing holt method is:

$St = \alpha.Xt + (1- \alpha)(St-1 + Bt-1)$ …… (1)

$Bt = \beta(St – St-1) + (1- \beta)Bt-1$ ……..(2)

$Ft+m= St +Bt(m)$ ..……...…….(3)

Forecasting formula with double exponential smoothing holt method [6].
information:
α = Trend smoothing constant
B = Trend smoothing constant
St = smoothing level in period t
Xt = Time series data in period t
Ft+m = forecast for period t+m
m = Number of periods to be forecasted

RESULTS AND DISCUSSION

1. Input Data

The data used as input is sales data from 2018 to 2021. Meanwhile, in this study, the number of sales will be predicted, namely for 2022.

Table 2. Demand

No	Date	Sale
1	Jan,01^{st},18	44
2	Jan,02^{nd},18	86
3	Jan,06^{th},18	26
4	Jan,07^{th},18	183
5	Jan,08^{th},18	35
6	Jan,09^{th},18	59
7	Jan,14^{th},18	22
8	Jan,15^{th},18	161
9	Jan,16^{th},18	122
10	Jan,17^{th},18	23
11	…	…

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12	…	…
13	…	…
14	…	…
15	…	…
16	Dec,15^{th},21	64
17	Dec,16^{th},21	16
18	Dec,20^{th},21	214
19	Dec,21^{th},21	123
20	Dec,22^{th},21	23
22	Dec,23^{th},21	24
23	Dec,24^{th},21	145
24	Dec,27^{th},21	89
25	Dec,28^{th},21	84

2. *Data Pre-processing*

a. Missing Value Check

Checking for missing values needs to be done so that the data to be processed becomes more accurate and makes the processed data more accurate.

Table 3. *Missing Value Tested*

Variabel Name	*Valid*	*Missing*	Presentase *Valid*
Date	980	0	100%
Onion Crackers	980	0	100%

b. Data Normality Test

The normality test is carried out to find out whether a data is normally distributed or not. If the data to be tested is not normally distributed, data transformation will be carried out. The data transformation used in this study is min-max.

Table 4. Transformation Data *Min-Max*

No	Date	Normalized result
1	Jan,01^{st},18	0,06196
2	Jan,02^{nd},18	0,122478
3	Jan,06^{th},18	0,036023
4	Jan,07^{th},18	0,262248
5	Jan,08^{th},18	0,048991
…	…	…
…	…	…
979	Dec,29^{th},21	0,054755
980	Dec,30^{th},21	0,021614

c. Data Sharing

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Data division (data partition) is the process of separating data into 2 parts, namely training data used for model training and data testing for testing results. The comparison used in the distribution of this data is 70% for training data and 30% for testing data.

Table 5. *Training datas*

No	Date	Normalized result
1	Jan,01^{st},18	0,06196
2	Jan,02^{nd},18	0,122478
3	Jan,06^{th},18	0,036023
4	Jan,07^{th},18	0,262248
5	Jan,08^{th},18	0,048991
…	…	…
…	…	…
685	20-Oct-20	0,090778
686	21-Oct-20	0,053314

Table 6. *Testing Datas*

No	Tanggal	Hasil Normalisasi
1	Oct,22^{th},20	0,220461
2	Oct,23^{th},20	0,073487
3	Oct,24^{th},20	0,308357
4	Oct,26^{th},20	0,144092
5	Oct,27^{th},20	0,198847
…	…	…
…	…	…
293	Dec,29^{th},21	0,054755
294	Dec,30^{th},21	0,021614

d. Implementation with artificial neural network

The implementation of an artificial neural network using rapidminer software has the steps as shown below.

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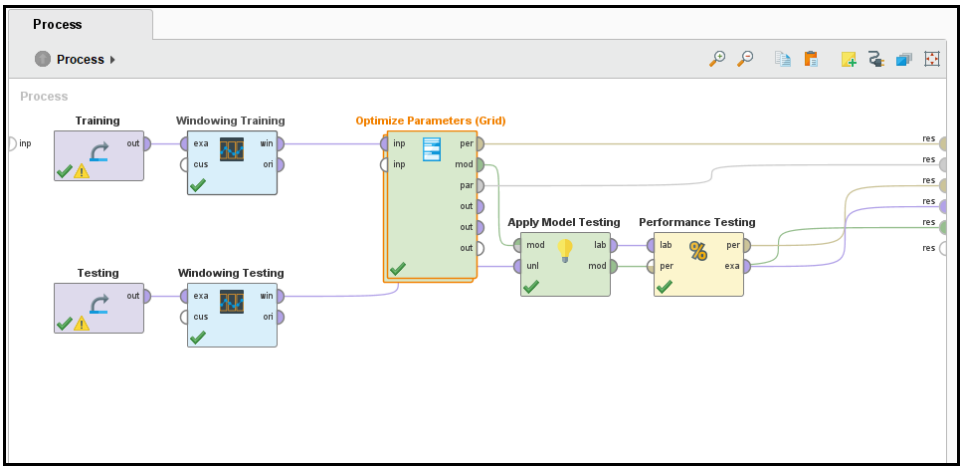

Figure 1. ANN proses flow

The parameters used to solve this problem are determining the learning rate, momentum, number of iterations (epoch), input and output and the type of activation function used.

Table 7. *Artificial Neural Network* Parameter

Parameter	Sum	Description
Input Layer	1	The input used is product sales data from January 2018 to December 2021. Data input in the Rapidminer software uses a windowing operator so that the input data will be 6 with 5 datas will produce attributes and 1 attribute data without windowing.
Hidden Layer	*Trial & Error*	*Default Software RapidMiner*
Output Layer	1 *Neuron*	Onion Crackers Sales Forecasting
Learning Rate	*Trial & Error*	0,1-0,9
Momentum	*Trial & Error*	0,1-0,9
Iterations (*Epoch*)	*Trial & Error*	500 *iteration* Maximal
Activation Functions	1	*sigmoid* Activation Functions

The output obtained from implementing the artificial neural network above is:

Table 8. Predictions result

Date	*Prediction*
Oct,27^{th},21	100
Oct,27^{th},21	100
Oct,27^{th},21	99
Oct,27^{th},21	100
Nov,01^{st},21	100
…	…
Dec,23^{th},22	53
Dec,24^{th},22	37
Dec,25^{th},22	71

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Dec,27^{th},22	113
Dec,28^{th},22	106

The forecasting results above, able to sales estimate of shrimp crackers in 2022 are 1,796, 2,404, 2,610, 2,315, 2,416, 2,409, 2,408, 2,310, 1,709, 1,801, 2,203 and 2,380 respectively. The following is a the parameter set values and the architectural design of the artificial neural network.

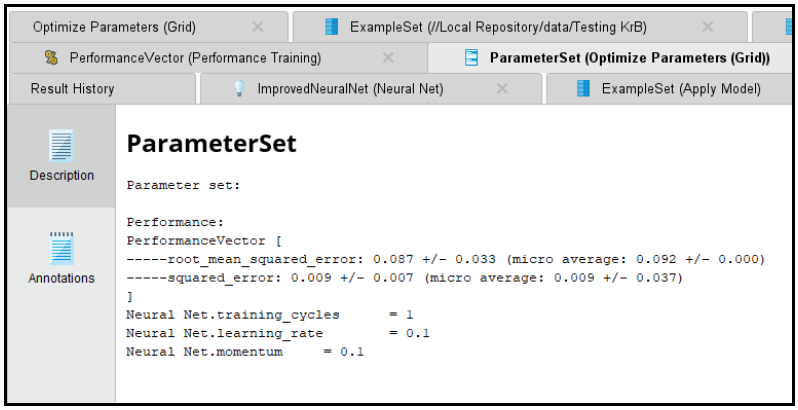

Figure 2. ANN *Parameter Set* Value

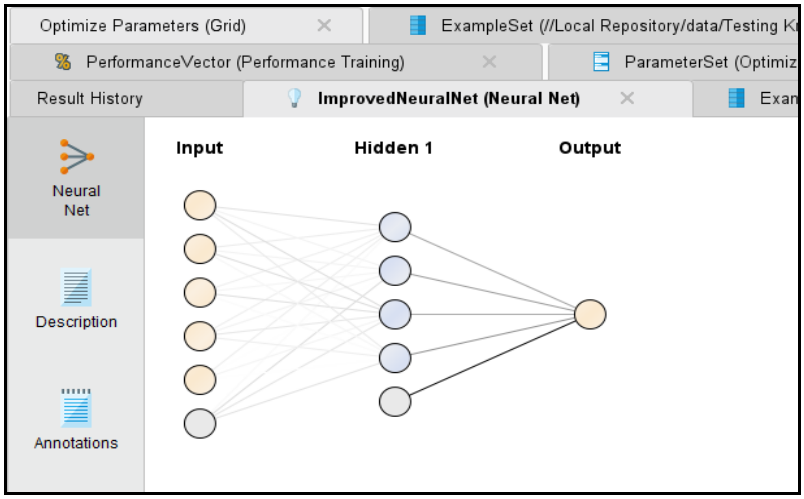

Figure 3. ANN Architect Design

It can be seen that the mean square error value of implementing the artificial neural network is 0.87 with a learning rate of 0.1, training cycles of 1 and momentum of 0.1. The number of artificial neural network architectures has 6 nodes as input, 1 hidden layer with 5 nodes and 1 output node.

3. Double Exponential Smoothing Holt Forecasting Method

The double exponential smoothing holt calculation uses 2 parameters, namely the alpha parameter as exponential smoothing and beta as trend smoothing. Alpha and beta values are 0.7 and 0.3 respectively.

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		Alfa	0,7						
		Gamma	0,3						
No	Month	Actual Data	Pemulusan Data (At)	Estimasi Trend (Tt)	Ft	E	[E]	E^2
1	Jan-18	1532	1532	-323				
2	Feb-18	1209	1209,00	-323,00	1209	0	0,00	0,00
3	Mar-18	1516	1327,00	-190,70	886	630	630,00	396900,00
4	Apr-18	2271	1930,59	47,59	1136	1135	1134,70	1287544,09
5	May-18	1384	1562,25	-77,19	1978	-594	594,18	353046,31
6	Jun-18	1477	1479,42	-78,88	1485	-8	8,06	65,01
7	Jul-18	1218	1272,76	-117,22	1401	-183	182,54	33319,21
8	Aug-18	1343	1286,76	-77,85	1156	187	187,46	35139,45
9	Sep-18	1377	1326,57	-42,55	1209	168	168,09	28253,17
10	Oct-18	1509	1441,51	4,69	1284	225	224,98	50615,13
11	Nov-18	1533	1506,96	22,92	1446	87	86,80	7534,25
12	Dec-18	1888	1780,56	98,13	1530	358	358,12	128248,95
13	Jan-19	2024	1980,41	128,64	1879	145	145,31	21114,79
14	Feb-19	1457	1652,61	-8,29	2109	-652	652,05	425167,19
15	Mar-19	1468	1520,90	-45,32	1644	-176	176,33	31090,72
16	Apr-19	1831	1724,37	29,32	1476	355	355,42	126323,11
17	May-19	1671	1695,81	11,95	1754	-83	82,69	6838,45
18	Jun-19	1170	1331,33	-100,98	1708	-538	537,76	289189,43
19	Jul-19	1086	1129,31	-131,29	1230	-144	144,35	20837,96

Figure 4. *Double Exponential Smoothing Holt*

Table 9. *Double Exponential Smoothing Holt forecasting*

No	Month	Forecasting
1	January	1652
2	February	1734
3	March	1816
4	April	1898
5	May	1980
6	June	2062
7	July	2144
8	August	2226
9	September	2308
10	October	2390
11	November	2472
12	December	2555

:

Error Value	
MSE	201303,44
RMSE	448,67
MAE	335,77

Figure 5. *Holt accurate error size*

CONCLUSION

The artificial neural network method has a smaller mean square error value when compared to using the double exponential smoothing holt method with a value of 0.87. While the double exponential smoothing holt method has a mean square error roat value of 448.67. In other words, the artificial neural network method has a better level of accuracy when used to predict the sale value of shrimp crackers in the next period.

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