APPLICATION OF ARTIFICIAL NEURAL NETWORK BACKPROPAGATION FOR PREDICTING THE AVAILIBILITY OF PREMIUM FUEL (CASE STUDY: PREDICTION OF PREMIUM FUEL AVAILIBILITY ON SPBU GALALA AMBON)

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ABSTRACT

This study aims to predicting the availability of premium fuel using pattern recognition techniques named neural network with backpropagation method. Neural network is used to give solution for many problem, including taking a decision from the training data. Neural network can be applied to various specific fields of human life. In this study, Neural Network is used to predict the availability of premium fuel using backpropagation method. The data which is used in this study consist of 48 data, where 36 data (years 2012-2014) as training and 12 data (years 2015-2016) as testing. The result shows that the availability of premium fuel in 2017 for 12 months with the prediction results availability in January 2017 is 337490 kL and December 2017 is 344120 kL. It can be seen that the prediction results to be achieved fully met with a small error rate and the level of accuracy 83.33% where the results of the testing data showed the value of Mean Square Error for prediction the availability of premium fuel in 2017 is 0.6038255667 and also to the process of training produces the best network architecture with hidden layer 20 10 5 1 neurons and the best training algorithm by using learning rate 0.74 with MSE 0.00100. Thus, Backpropagation method is pretty well in predicting the availability of fuel.

Keywords: *Backpropagation, neural network, premium fuel*

1. Introduction

Fuel (BBM) is a commodity that plays an important role in all economic activities, especially as fuel for motor vehicles. Fuel at Gas Stations (SPBU) Galala Ambon consist of several types, namely Diesel, Premium (gasoline), Pertalite and Pertamax, while

Premium fuel is widely used for people activity [1-2]. Prediction of fuel existence has always been an important part of an efficient planning at filling the Gas Stations in Galala Ambon. By utilizing the advancement of technology and information at this time, a system of neural networks in predicting the availability of fuel can be designed. This paper provides a study which is expected to predict correctly the detail of fuel distribution planning particular on Gas Stations Galala Ambon in 2017 by using Artificial neural networks (ANN).

Artificial neural networks were first introduced Waffen Mc Culloch and Walter Pitts in 1943. These neural networks were introduced as biological neural models and as a concepts of parts on circuits capable that to perform computational tasks. The network has weights set to perform simple logic functions. Artificial Neural Network (ANN) is one of the artificial representations of the human brain that always tries to simulate the learning process of the human brain [3-7].

Artificial neural networks can be used in data mining processes. Backpropagation neural network needs to be given some limiting function so that the process can be directed for the need of logical relation formation. The result of implementation of limiting function is seen that the first process of learning is not disturbed and the extraction of logic value can be done (Budiyanto, 2000). According to Arif Jumarwanto, (2009), ANN is created as a generalization of the mathematical model of human understanding based on information processing assumptions occurring on a simple element called neurons. The signals flowing between nerve cells through a simple connection, each connection having corresponding weights.

ANN has some network architecture that is often used in various applications. The ANN architecture, such as: Single Layer Network, Multilayer Net Network, Competitive Layer Network (Sukma Puspitorini, 2012). In addition, backpropagation network model is a learning or training technique of supervised leaning that most widely used. This method is one of the most excellent methods of dealing with the problem of recognizing complex patterns. In the backpropagation network, each unit in the input layer corresponds to each unit in the hidden layer. Each unit in the hidden layer is connected to each unit in the output layer. This network consists of many layers (multilayer network) [8].

2. Method

This type of research is a case study, by using Backpropagation method in Artificial Neural Networks to predict the availability of premium fuel at supply Gas Stations Galala Ambon. Data that used in this research is secondary data that obtained from SPBU Galala Ambon. These data is about the availability of premium fuels per month from 2012-2016, and some literature related to determining the availability of premium fuel.
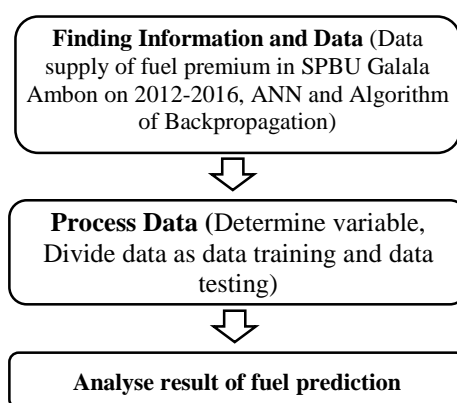
<div align="center">

┌─────────────────────────────────┐
│ **Finding Information and Data** (Data │
│ supply of fuel premium in SPBU Galala │
│ Ambon on 2012-2016, ANN and Algorithm │
│ of Backpropagation) │
└─────────────────────────────────┘
⬇
┌─────────────────────────────────┐
│ **Process Data** (Determine variable, │
│ Divide data as data training and data │
│ testing) │
└─────────────────────────────────┘
⬇
┌─────────────────────────────────┐
│ **Analyse result of fuel prediction** │
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Figure 1. Procedure of Research.

3. Results and Discussion

In this study, we used only one variable, which is the amount of filling premium fuel. The availability data of premium fuel from SPBU Galala Ambon. Monthly Data is recap over the last five years from the year 2012 to 2016. There are three phase in this research process to get the output, namely the training phase, the testing phase and the prediction phase. To get the results, necessary parameter input system for pattern formation is formed as follows.

> *Net Size*: *Input Layer*: 12 neuron
>
>   *Hidden Layer*: 20 neuron 10 neuron 5 neuron and 1 neuron
>
>   *Output Layer*: 1 neuron
>
> Max *epoch* / iteration: 5000
>
> *Goal* (*MSE*): 0.001

Next, the data are grouped into 2 section, such as: 36 data for training (years 2012-2014) and 12 data for testing (years 2015-2016), and obtained the following analysis. For

each variation of learning rate (α) value, the amount of maximum iterations is similar to the number of iterations (epoch) 5000, as presented in the following Table 1.

Table 1. The Result Analyze of Training and Testing.

No.	α	*Epoch*	*MSE*	Time	Training result		Testing result	
					Recognize data	Accuracy	Recognize data	Accuracy
1	0.71	950	0.000996	0:00:27	35	97.22%	10	83.33%
2	0.72	1807	0.00100	0:00:52	35	97.22%	10	83.33%
3	0.73	1523	0.000993	0:00:43	35	97.22%	7	58.33%
4	**0.74**	**696**	**0.00100**	**0:00:22**	**35**	**97.22%**	**10**	**83.33%**
5	0.75	1328	0.000997	0:00:37	35	97.22%	5	41.67%
6	0.76	826	0.000995	0:00:24	35	97.22%	8	66.67%
7	0.77	2363	0.000996	0:01:08	35	97.22%	10	83.33%
8	0.78	1535	0.000997	0:00:45	35	97.22%	10	83.33%
9	0.79	2016	0.000998	0:00:59	35	97.22%	10	83.33%

Based on Table 1 above, the best result in the process of training and testing is when α (learning rate) equals to 0.74, with maximum iterations (epoch) 696 where the mean square error (MSE) is 0.00100 and the level of data accuracy is 97.22% for the training phase and 83.33% for the testing phase.

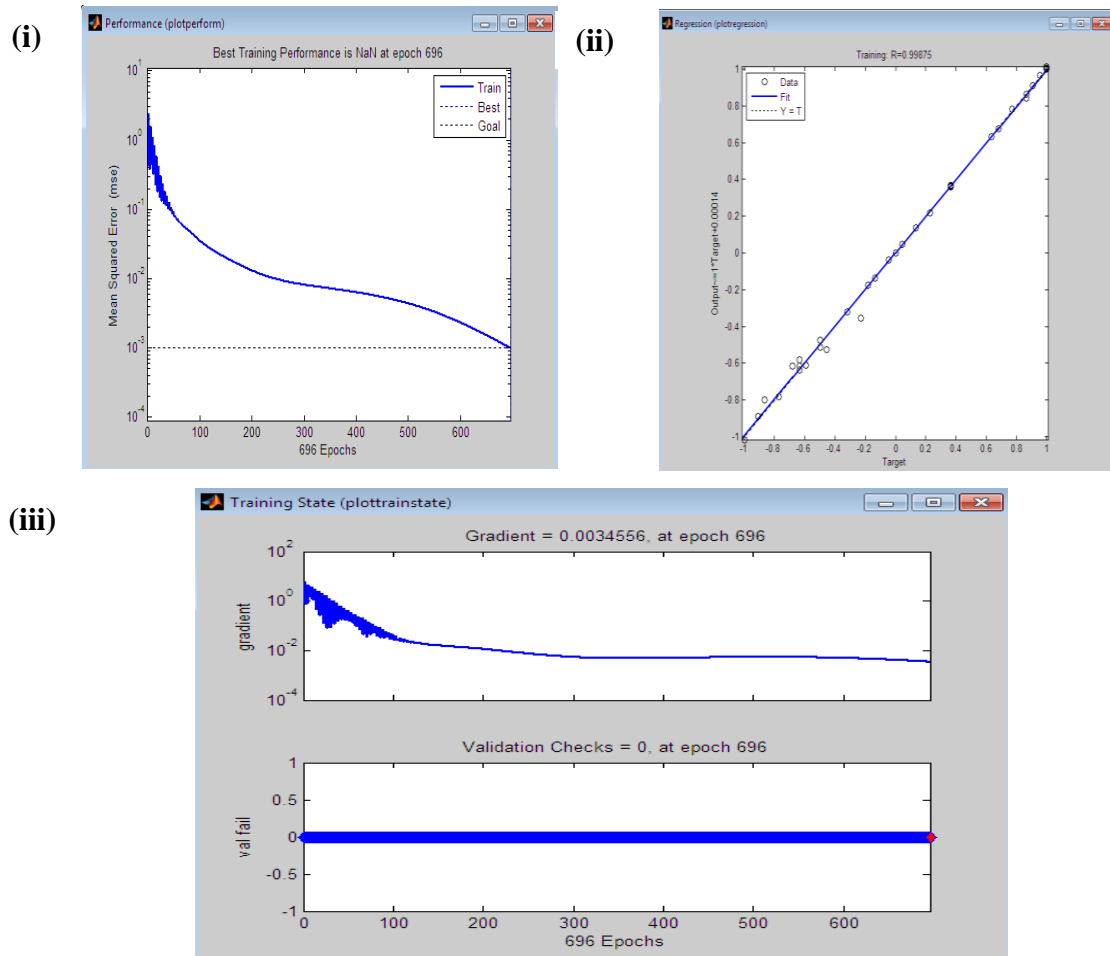**Figure 2.** Progress Neural Network Training.

Figure 3. Analysis result of Neural Network for example (**i**) plot perform, (**ii**) Plot regression and (**iii**) plot training state.

Figure 3 (i) shows the learning process at every epoch. In this process, the iteration is stopped at the epoch to 696, due to the limit of the desired epoch has been reached with the MSE = 0.00100, where the MSE appears when the training is completed in accordance with the specified iteration. Figure 3 (ii) shows the relationship between output network and target in the training data network. From the training data for a match between the outputs network and target, obtained correlation coefficient (R) is 0.99875 where for the best results is 1. The value of correlation coefficient shows that the network is able to predict well in according to the data. Figure 3 (iii) shows the train state with a gradient 0.0034556 and validation checks is zero on 696 iteration.

Table 3. Data of Training Results (year 2012-2014).

No	Target	Prediction	Error	No	Target	Prediction	Error
1	510000	510130	0.0133	19	405000	405930	0.0928
2	395000	394740	0.0264	20	340000	339870	0.0135
3	520000	520200	0.0195	21	375000	374860	0.0142
4	505000	505170	0.0172	22	410000	409880	0.0115
5	515000	516440	0.1444	23	415000	415160	0.0157
6	450000	450020	0.0016	24	390000	390570	0.0566
7	425000	424900	0.0104	25	345000	342560	0.2444
8	450000	449720	0.0283	26	300000	298330	0.1671
9	485000	484400	0.0602	27	355000	353510	0.1486
10	520000	520530	0.0534	28	340000	342400	0.2399
11	415000	414930	0.007	29	360000	352040	0.7965
12	450000	449930	0.0067	30	315000	321980	0.6981
13	480000	479380	0.0617	31	335000	342370	0.7372
14	435000	433860	0.1142	32	310000	312370	0.2371
15	520000	521180	0.1184	33	325000	323810	0.119
16	505000	502810	0.2188	34	355000	357580	0.2583
17	495000	495960	0.0958	35	340000	345930	0.5925
18	450000	450200	0.0205	36	385000	371200	1.3799

From the network training, obtained the value $MSE = 0.120988413$. This means that the network is able to learn well to produce the desired target.

Figure 6. Graphic of Training Result.

Figure 6 presents the comparison between the target (o) and the output network (*) in the training data with $\alpha = 0.74$. It can be seen that most of the network outputs and targets close to each other (almost have the same position), where there are 35 of (*) and (o) which are adjacent to each other and only one of (*) and (o) is far. Therefore, the results of training with $= 0.74$ is good.

Table 4. Data of Testing Results (year 2015-2016).

No	Target	Prediction	Error	No	Target	Prediction	Error
1	345000	337490	0.751	7	310000	301540	0.846
2	335000	343820	0.882	8	315000	317780	0.278
3	330000	321930	0.807	9	300000	307310	0.731
4	330000	324380	0.562	10	325000	310580	1.442
5	325000	328780	0.378	11	345000	343960	0.104
6	310000	314390	0.439	12	355000	344120	1.088

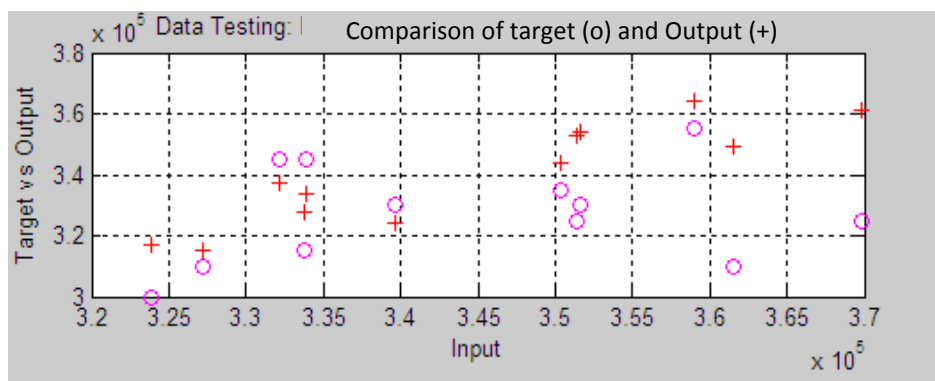Meanwhile, from the testing of the network, we get the $MSE = 0.603825667$.

Figure 7. Graphic of testing result.

Next, Figure 7 shows a comparison between the target (o) to the network output (+) at the data testing $\alpha = 0.74$ from 12 data that have testing.

Prediction Results

Based on the results of visualization of graphs, it can be seen that the results of the data pattern recognition by Neural Networks Backpropagation would be better if using a smaller error rate. This proves that a powerful Artificial Neural Networks in recognizing

patterns of data provided. This means, the smaller error of desired targets, will be smaller of deviations forecast results. Therefore, the accuracy of forecasting models of network training results can be higher. Here is the results predicted availability of premium fuel in 2017. The prediction results are shown in the following table.

Table 5. Predicted Availability Results on 2017 (in kL).

Period	Predicted availability
January	337490
February	343820
March	321930
April	324380
May	328780
June	314390
July	301540
August	317780
September	307310
October	310580
November	343960
December	344120

From Table 5, the result shows that the availability of premium fuel in 2017 is not much different from previous years.

4. Conclusion

It can be conclude that, predicted outcome to be achieved fully with a small error rate with MSE of testing result is 0.603825667 and the level of data accuracy is 97.22% for the training phase and 83.33% for the testing phase. Moreover, the predicted availability of premium fuel in 2017 are in range 301540 KL until 344120 KL.

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