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Prediction of Elpiji Price using Artificial Neural Network

Eka Surya Gumilang
Universitas Islam Sultan Agung
Semarang, telp (024) 6583584 / fax (024) 6582455
e-mail: informasi@unissula.ac.id

Abstract

Elpiji cylinder (Liquefied petroleum gas) are basic life needs of the general public. Unfortunately for customers, unstable elpiji price in retailer. The Indonesian Government plays an important role for the Liquefied petroleum gas industry to give elpiji price stable for end user. This work use artificial neural network and backpropagation for prediction of elpiji price. Total of 1096 records collected from 2015 until 2017 were fed into the neural network models with nine variable for input data. There are inflation, elpiji Allocation, elpiji prices previous, the poor society (the poor, very poor, the near poor), and date (year, month, day). This data were used to evaluate prediction accuracy, and the price prediction results were found to be more accurate than those made by a method using only eight input variable. Root Mean Square Error (RMSE) nine variable 0.030959131, RMSE variable just 0.199884634, and the test result 0.121417236. The presented results were proved that this model can be used with good accuracy for the prediction elpiji price.

Keywords*: Artificial Neural Network, Backpropagation, Elpiji, Prediction, Root Mean Square Error*

1. Introduction

Elpiji cylinder (Liquefied petroleum gas) are basic life needs of the general public. Unfortunately for customers, unstable elpiji price in retailer. The Indonesian Government plays an important role for the Liquefied petroleum gas industry to give elpiji price stable for end user. To get information on fluctuations in LPG prices, not only rely on current prices, but also to make price information from time series. From this information , it can make an algorithm modeling prediction that illustrates how the information nature of the 3 kilogram elpiji. Predictions are useful for estimating what will happen in the future based on past data.

Solution for decision makers regarding the price of elpiji, required an effective and efficient method to predict the price of elpiji 3 kilograms, the author propose backpropagation neural network as a solution to predict.

The formulation of the problem is how to make an artificial neural network model to predicted the prices of elpiji in the city of Semarang for the future and what is the level of accuracy of predicted elpiji prices using back propagation neural network. The main research target is making a prediction model that can be used to predict the price of elpiji for the future. Knowing the level of accuracy of back propagation neural network on the predicted price of elpiji.

There have been many reports about the prediction using neural networks. The example are Prediction of vegetable price [1], Prediction for Apple Fruit Juice [2], Prediction of onion price [3], stock price prediction [4], financial time series forecasting [5], disease prediction [6] [7] [8]. Hence this paper give a short overview of the previous work.

Data mining is to discover or extract knowledge or data from large amount of database [9]. Data mining is grouped into several groups, including Association, Estimation, Prediction, Classification, and Clustering. An artificial neural network (ANN) is an information processing system that is designed to mimic human biological neural networks. artificial neural network is based on the human nerve model, but with a simpler part. This work using back propagation neural networks. This algorithm includes supervised learning methods and is designed in feedforward networks lots of layers. The training phasein the backpropagation method consists

of three phases, namely the advanced propagation phase, the backward propagation phase, and the weight change phase. These three phases are repeated continuously until the termination conditions are met.

2. Research Method

Divided into 5 steps, there are pre- processing data, input data, training model, testing model and evaluation.

Pre- processing data, data preparation is done by checking and repairing if the data contains empty data or *noise*. There are normalization data and wilcoxon test in this pre-processing step.

$$X' = \frac{X - Xmin}{X\max - Xmin} * (BA - BB) + BB$$

Information :
X ' = normalization
X = the value to be normalized
Xmin = lowest value
Xmax = highest value
BA = upper limit (1)
BB = lower limit (0)

Input data step, total of 1096 records collected from 2015 until 2017 were fed into the neural network models with nine variable for input data. Elpiji price is influenced by various factors, including inflation, elpiji Allocation, elpiji prices previous, the poor society (the poor, very poor, the near poor).The relationship between elpiji price and these factors is usually nonlinear. Neural networks have good advantages of solving the nonlinear problems.

Table 1 Data Collection

Method					
Data			**Prediction**		**Evaluation**
Price of elpiji previous			Artificial neural network		Accuracy (Root mean square error)
Elpiji allocation					
Inflation					
The poor society	the poor				
	the near poor				
	very poor				
Date	Year				
	Month				
	Day				

Training model, the first modeling design use 9 neuron in input layer, 1 hidden layer with 10 neurons (nodes), 1 output layer, function of binary sigmoid activation (logsig), leraning rate 0.01, and output use Sum Square Error (SSE).

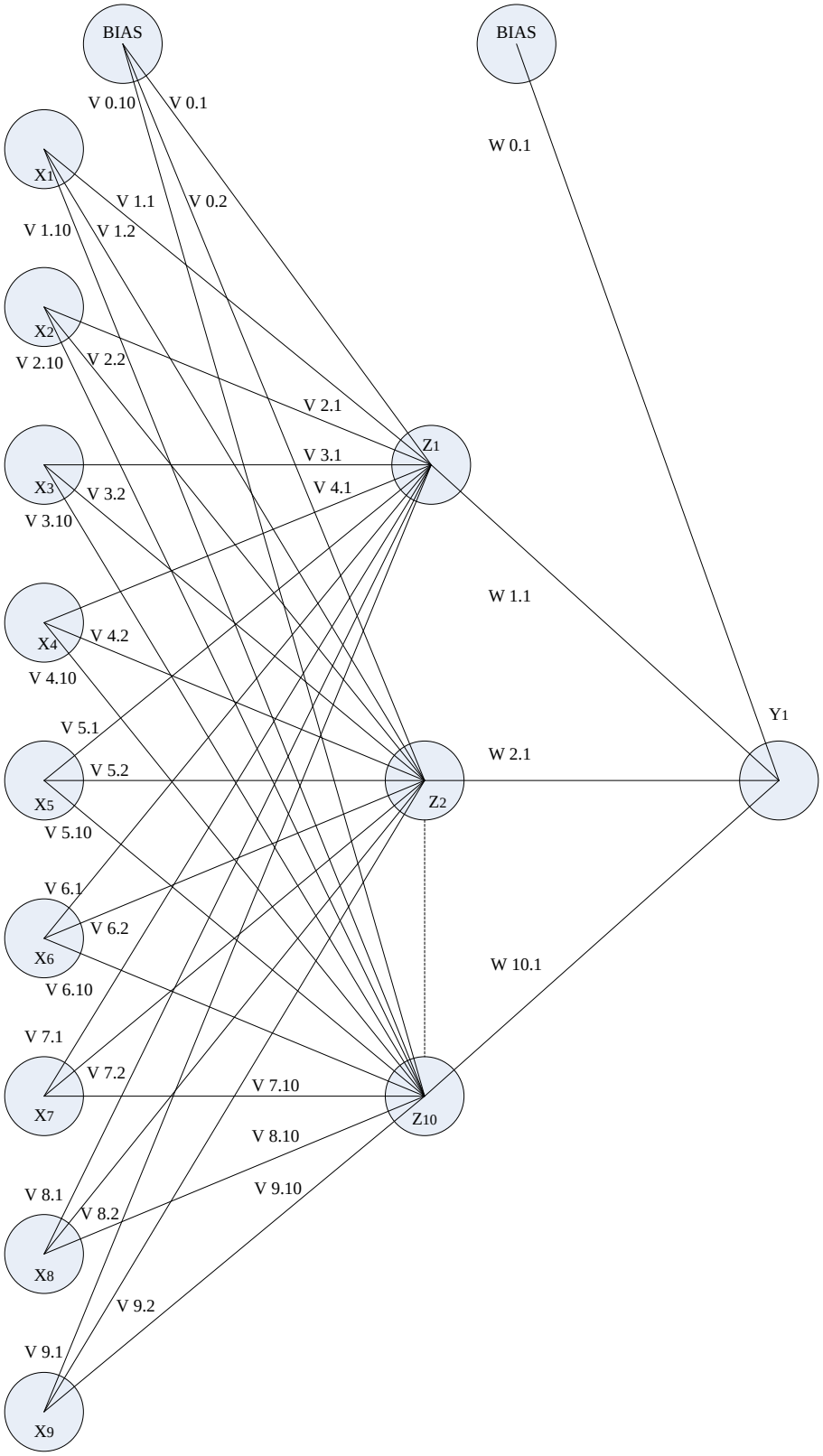

Figure 1 Network Architecture 9 - 10 - 1

Testing model, test the best result from training model. This step to test whether artificial neural networks work well, predict patterns data that will be generated with a small error rate.

Evaluation, calculation of errors is a measurement of how well a network learns, if comparing old pattern with new pattern, the pattern easily recognized [10]. In this work, the output produced from processing in matlab produces Sum Square Error :

$$RMSE = \sqrt{\frac{\sum_p \sum_j \left(T_{jp} - X_{jp}\right)^2}{n_p n_o}}$$

The prediction process is carried out using data and models that have been developed in the previous stage. Using the weights for each unit of the artificial neural network model is expected to get the minimum error value. In this stage the data denormalization process (post-processing) is carried out, which is the conversion of data obtained from the results of artificial neural network processes that have a range of 0 to 1 into data like the original value. Here is the formula for denormalization :

X' denormalization = X * (Xmax – Xmin) + Xmin

Information :

X ' = denormalization

X = *neural network output*

Xmax = the biggest value

Xmin = the smallest value

3. Results and Discussion

Here is a collection of data investigators her , presented in Table 2.

Table 2 Research Data

Year	Month	Day	Inflation	Near Poor	Poor	Very Poor	Allocation	Price Previous
2015	1	1	7.04%	319,842	54,028	108	49821	16,700
2015	1	2	7.04%	319,842	54,028	108	49821	16,700
2015	1	3	7.04%	319,842	54,028	108	49821	16,700
2015	1	4	7.04%	319,842	54,028	108	49821	16,700
2015	1	5	7.04%	319,842	54,028	108	49821	16,700
2015	1	6	7.04%	319,842	54,028	108	49821	16,700
2015	1	7	7.04%	319,842	54,028	108	49821	16,700
2015	1	8	7.04%	319,842	54,028	108	49821	16,700
2015	1	9	7.04%	319,842	54,028	108	49821	16,700
2015	1	10	7.04%	319,842	54,028	108	49821	16,700
2015	1	11	7.04%	319,842	54,028	108	49821	16,700
2015	1	12	7.04%	319,842	54,028	108	49821	16,700
2015	1	13	7.04%	319,842	54,028	108	49821	16,700
2015	1	14	7.04%	319,842	54,028	108	49821	16,700
2015	1	15	7.04%	319,842	54,028	108	49821	16,900
2015	1	16	7.04%	319,842	54,028	108	49821	16,900
2015	1	17	7.04%	319,842	54,028	108	49821	16,900
2015	1	18	7 . 04 %	319,842	54,028	108	49821	16,900
……	……	……	……	……	……	……	……	……
2017	12	30	3. 71 %	313,258	54,485	105	59311	17,400
2017	12	31	3.71%	313,258	54,485	105	59311	17,400

Preprocessing data

From 9 data, look for relationships between data x1, x2, x3, x4, x5, x6, x7 , x 8 and x 9 with target data, about effect on the output of neural network. Basic decision making for the Wilcoxon test:

1. asymp value. <0.05 then the hypothesis is accepted

2. the asymp value. Sig> 0.05 then the hypothesis is rejected

The results presented in table 3.

Table 3 Wilcoxon Signed Ranks Test

Variable	Asymp. Sig. (2-tailed)
Allocation	0,000
Day	0,000
Almost Poor	0,000
Previous Price	0 .788
Inflation	0,000
Poor	0,000
M onth	0,000
Extremely poor	0,000
Year	0,000

Table 3. The result of the Wilcoxon Signed Rank Test where there is 1 unacceptable data (Previous price) because the value is more than 0.05 and 8 variables are accepted, because of a value of 0,000 more smaller than <0.05. And the difference between the x variable and the target is concluded that there is an effect of using the x variable on output.

Table 4 Normalization data for training

Year	Month	Day	Inflation	Near Poor	Poor	Very poor	Allocation	Price Previous
0	0	0	1	1	0	1	0	0
0	0	0.0333	1	1	0	1	0	0
0	0	0.0666	1	1	0	1	0	0
0	0	0.1	1	1	0	1	0	0
0	0	0.1333	1	1	0	1	0	0
0	0	0.1666	1	1	0	1	0	0
0	0	0.2	1	1	0	1	0	0
0	0	0.2333	1	1	0	1	0	0
0	0	0.2666	1	1	0	1	0	0
0	0	0.3	1	1	0	1	0	0
0	0	0.3333	1	1	0	1	0	0
0	0	0.3666	1	1	0	1	0	0
0	0	0.4	1	1	0	1	0	0
0	0	0.4333	1	1	0	1	0	0
0	0	0.4666	1	1	0	1	0	0.1333
0	0	0.5	1	1	0	1	0	0.1333
0	0	0.5333	1	1	0	1	0	0.1333
0	0	0.5666	1	1	0	1	0	0.1333
….	….	….	….	….	….	….	….	….
0.5	1	1	0.0063	0	1	0	0.2994	0.2

Input Data

Normalization results are divided into two, 1 January 2015 until 31 December 2016 for training and 1 January 2017 until 31 December 2017 for testing. Target data for training and testing using elpiji sales price at that time.

Training

Training data is then processed using Matlab version 8.1 (nntool). Input data and target data are prepared for processing with the neural network type feed forward backpropagation, the training function uses the Levenberg-Marquardt, hidden layer (random from 9 to 20), the

performance function uses SSE which is later converted to RMSE, transfers function using binary sigmoid function (logig).

The process determines the number of neurons (nodes) in the hidden layer based on the RMSE results at the training stage using artificial neural networks, as shown in table 5.

Table 5 Training Results look for hidden

JST model			Leraning Rate	RMSE
Input	Hidden	Output		
9	9	1	0.1	0.034672481
9	10	1	0.1	0.03207924
9	11	1	0.1	0.033453681
9	12	1	0.1	0.035328862
9	13	1	0.1	0.034094545
9	14	1	0.1	0.032861105
9	15	1	0.1	0.033204616
9	16	1	0.1	0.035356798
9	17	1	0.1	0.035848451
9	18	1	0.1	0.032842549
9	19	1	0.1	0.032774409
9	20	1	0.1	0.030959131

Previously, a data linkage test had been carried out, between the input data and the target data using the Wilcoxon method, the results of 9 existing parameters, there was one parameter that did not pass the test. At this stage it will compare (determine) data between entries with 8 data or with 9 data. The process of determining the number of input layers based on the RMSE results at the training stage using artificial neural networks, as shown in table 6.

Table 6 Training Results look for the input layer

JST model			Leraning Rate	RMSE
Input	Hidden	Output		
9	20	1	0.1	0.030959131
8	20	1	0.1	0.199884634

Determine the learning rate, This process is the way to get the best training results by changing the nominal learning rate from 0.1 to 0.9. as shown in table 7.

Table 7 Training Results look for learning rates

JST model			Learning Rate	RMSE
Input	Hidden	Output		
9	18	1	0.1	0.030959131
9	18	1	0.2	0.031849068
9	18	1	0.3	0.026914938
9	18	1	0.4	0.033116285
9	18	1	0.5	0.031467086
9	18	1	0.6	0.036826458
9	18	1	0.7	0.034094007
9	18	1	0.8	0.031232621
9	18	1	0.9	0.032838677

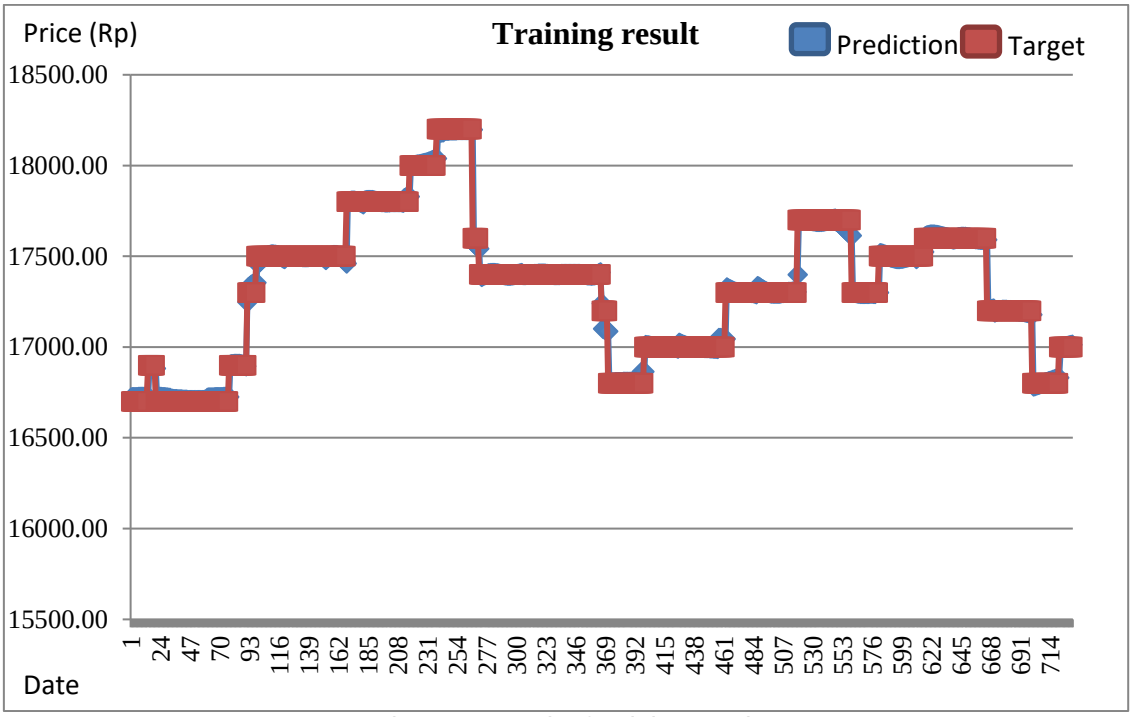

Figure 2. Graph of training result

The best modeling that results from the training process is then used for the testing process, as shown in table 8.

Table 8 Testing Results

JST model			Learning Rate	RMSE
Input	Hidden	Output		
9	20	1	0, 3	0.121417236

The prediction results are quite good, where there are some prediction results that are almost the same as the original value or price, even though the error value (0.121417236) obtained is no better than the results of the training (0.026914938).

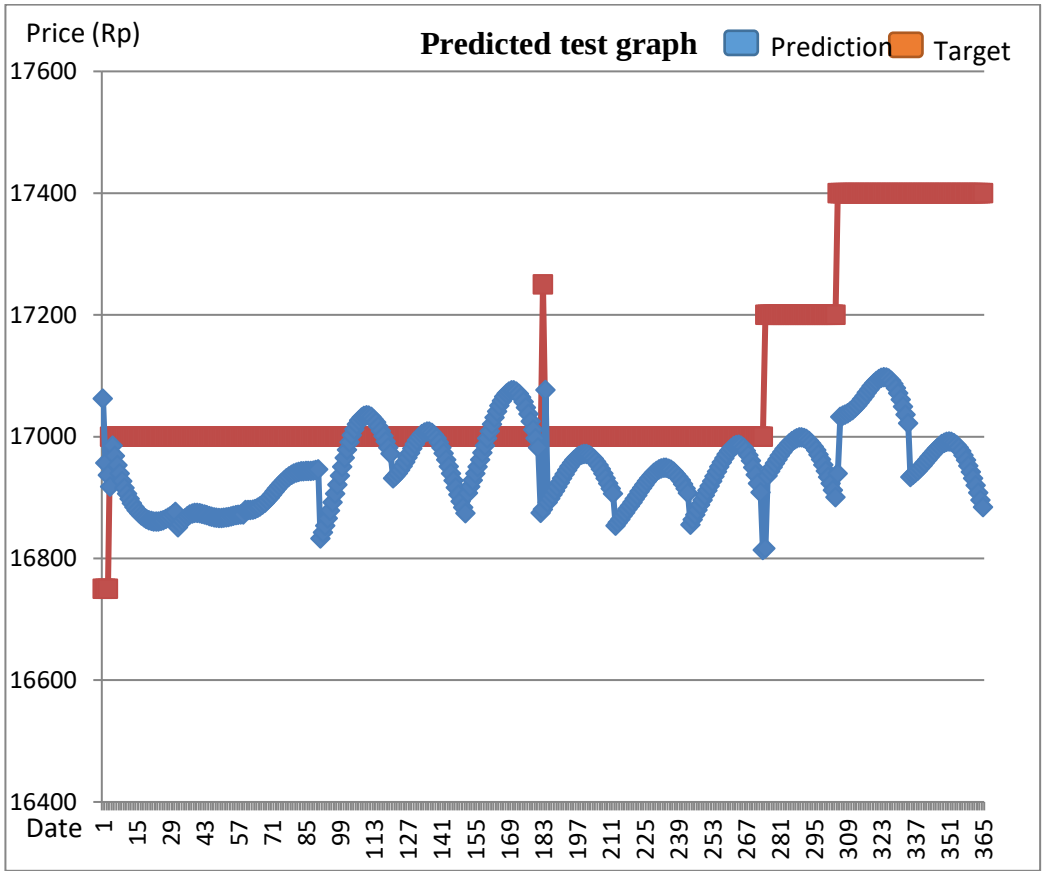

Figure 4. Predicted test graph

Research on predicting the price of 3 kilograms of elpiji using artificial neural networks is new. Based on the results of the training that has been done, a good result is a fairly small error value in the training phase which is 0.026914938 where the network architecture is very effective for the training process, with the best learning level is 0.3 input 9, the hidden layer is 20 neurons, The Output layer function is 1 and the activation is a binary sigmoid (logsig). Training to determine the number of inputs, between 8 and 9 neurons. The results obtained, 9 neurons 0,030959131 and 8 neurons 0,199884634. This proves that 9 neurons are better than 8 neurons with a considerable distance of error. Based on the results of the modeling, good results can be categorized for the training itself, allowing the testing process to be carried out with the modeling. The results of errors found from the process 0.121417236, the results are still quite good, but when compared with the results of training with testing has a considerable distance. This will be filled with predictions. Modeling has been done to determine the price of eliji in the city of Semarang for January 2018. The RMSE: 0.09450328 value is quite good, although it has not exceeded the value of training.

4. Conclusion

In this study, the LPG gas price prediction model uses backpropagation artificial neural networks. The best artificial neural network Derived from one layer with twenty neurons and learning rate of 0. 3 with a root mean square error of 0.026914938 and testing 0.1214. An optimal neural model can predict gas prices for the future.

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