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Sales Forecast for Aromatic Dwarf Coconut: A Case Study of Hutan Melintang in Perak

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ABSTRACT

Aromatic Dwarf Coconut known as Compact Dwarf coconut is a well-known plant in Malaysia, especially in Hutan Melintang, Perak. Forecasting the sales of Aromatic Dwarf Coconut should be apply innovatively to increase the production of the Aromatic Dwarf Coconut compared with the traditional accounting technique. Revenue's Data of Aromatic Dwarf Coconut generated from Jabatan Pertanian Teluk Bharu, Hutan Melintang, Perak from the year 2015 to the year 2019 shows that the sales of Aromatic Dwarf Coconut increased every month and every year. The objectives of this research are; 1) to forecast the sales of Aromatic Dwarf Coconut using Artificial Neural Network (ANN) and Linear Algebra and 2) to compare these two methods which are gives the minimize error interpreted by Mean Square Error (MSE). This research used secondary data of State Departments of Agriculture, Jabatan Pertanian Teluk Bharu tested with Artificial Neural Network (ANN) and Linear Algebra model to forecast the sales of Aromatic Dwarf Coconut for 2020. The findings show that the result from the forecast sales for the 1st quarter of Linear Algebra method is higher than ANN. Based on the MSE result, the ANN method shows minimized error which is more accurate rather than the Linear Algebra method. Forecasting methods such as ANN and Linear Algebra were able to assist the company to predict the sales of Aromatic Dwarf Coconut in the future.

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1. Introduction

Coconut or its scientific name as Cocos Nucifera (*C. Nucifera*) is a vital fruit tree for a certain country. They agreed one of the natural resources in certain tropical countries like coconut palm as an economic plant to generate income of countries [1]. The research in [2] found that Asia's countries were largest production of coconut. The production contributed to world's coconut production about 83.8 per cent.

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There are varieties of Coconut like Tall, Dwarf, Compact Dwarf and Semi-Tall coconut but Dwarf coconut are the easiest fruit can be found in a certain country. However, this study focuses on Aromatic Dwarf Coconut or namely as Aromatic Green Dwarf.

Some leaders often used traditional accounting techniques, such as cost-volume-profit analysis, as well as financial planning and budgetary control, to seek a long-term solution to the issue of maximizing profits. There are some leaders still apply accounting techniques such as instinct and trial and error assumption that tend to get failure in prediction. As a result, it will be contributed to a reduce in productivity that could cause the company to lose. A study on the sales forecasting of Aromatic Dwarf Coconut will overcome these problems. The objectives of this research are to forecast the sale of Aromatic Dwarf Coconut using Artificial Neural Network (ANN) and Linear Algebra and to compare these two methods which are gives the minimize error interpreted by Mean Square Error (MSE). The sales data from 2015 until 2019 were collected from State Departments of Agriculture, Jabatan Pertanian Teluk Bharu, located in Hutan Melintang, Perak as secondary data to achieve the objectives of this study.

2. Literature Review

2.1 Aromatic Dwarf Coconut

Aromatic Dwarf Coconut is one of the famous varieties of coconut in certain countries. It is a great fruit with a taste of coconut water and delicious sweetmeat. The substance in this coconut is 2-ACETYL-1-PYRRO: INE (2-AP) as be founded in Jasmine rice and Pandan leaves. Producer of coconut products should focus on new development of coconut products like detergent (bath soap and laundry soap), processed foods (coconut oil and coconut vinegar) and other new products rather than concentrate on the production of traditional product such as fresh coconut water, coconut milk and so on [3]. Currently, the decreasing in producing new products of coconut forced the new product development of coconut in agro-industry in urgently [4].

2.2 Artificial Neural Network (ANN)

Based on [5], the ANN could be described as an array of basic machines called neurons that are highly connected. According to [6], ANN is generally expressed as a network consisting of many straightforward processors (neurons) that are enormously interlinked, parallel operating, and learning from experience. ANN is used for processing information and recognition of trends. The roots are the working mechanism of the human brain. There are neurons that are processing components of this system, such as human minds, and they are linked in an organised way. Neurons interpret the information and convert it (inputs) into outputs. The relationship between these neurons generated dependent data [7]. Therefore, when the inputs have close relationships (strong), it is possible to obtain relevant data.

According to [8] ANN is a significant process forecasting for researchers and professionals. Researchers in [9] Agreed the neural network approach offers better categorization, great management of complex underlying relationships, and greater at exclamation. ANN has a high versatility in modelling and flexibility since they can operate the learning process. In other words, findings in [10] suggest new input data for ANN and can change its parameters for improvement.

The study from [11] proposed prediction foreign currency exchange rates using ANN. Traders may use predictive information on their own or with other available analytical tools, such as Neural Networks, to suit their trading style, risk propensity, and capitalization. This paper focused only on two currencies that are the value of the Japanese Yen against the US dollar. Real business, news releases, economic statistics, and technical analysis are the factors that make currencies fluctuate (chart theory). Second, the application of a process fault diagnosis. A realistic heat exchanger of continuous stirred tank reactor equipment is being tested as a test case on this paper. The model is studied under 14 noisy calculations and 10 failure conditions. [12] They consider the key element analysis visualizes the configuration of different categories of faults.

2.3 Linear Algebra

Around 4000 years ago, the people of Babylon knew how to solve a simple 2x2 system of linear equations with two unknowns. The basic equation $ax + b = 0$ is a common problem for people. The power and advancement of linear algebra was not attained until the end of the 17th century. The concept arose from determinants, values linked to a square matrix, studied at the end of the 17th century by the calculus creator, Leibnitz [13].

In the 19th century, Gauss developed a method to solve a system of linear equations. His research dealt primarily with linear equations, and the concept of matrices or their notations had yet to be introduced in. His contributions dealt with equations of varying numbers and variables as well as conventional pre-19th-century works; Euler, Leibnitz, and Cramer [13].

The power of Linear Algebra is widespread in the mathematical world as it provides a valuable basis for many principles and practices. Some of the things that Linear Algebra uses are to solve linear format systems, to find the least square line that is best suited for predicting future results or finding trends, and to use the expansion of the Fourier series to solve partial differential equations.

According to [14], this study used linear algebra for input-output and inter-industry analysis. Inter-Industry Analysis creates an environment in which the user can predict the consumption and demand for a system. This can reflect what happens to an economy when adjusting the consumption matrix when the relative cost of producing one good in terms of other products will alter both internal and final demand.

Linear Algebra can be used in other applications such as traffic flow. [15] used Linear Equations (Gauss-Jordan elimination) in their research paper for the Four One-Way Network in Kumasi, Ghana. The study looked at how many vehicles should be allowed to run smoothly on four one-way streets. In order to minimise the heavy traffic flow, the researchers found that 155vph used routes A and B, 276vph used routes A and D, and 240vph used routes C. The researchers recommended that there be exclusive public transport lanes, that traffic regulations and traffic engineers be applied and that they be adjusted in line with the results of this paper.

3. Methodology

The secondary data consists about monthly sales data of Aromatic Dwarf Coconut from 2015 to 2019 generated by Jabatan Pertanian Teluk Bharu, Hutan Melintang, Perak. This study implements two approaches which are ANN through Alyuda NeuroIntelligence software and the Linear Algebra by Microsoft Excel.

3.1 Artificial Neural Network (ANN)

Figure 1 describe the fundamental process of the ANN in forecasting. Preliminary data analysis and data pre-processing are very important for the optimal forecasting results. Designing the model involved selecting the suitable features with the appropriate ANN hyper-parameters setting.

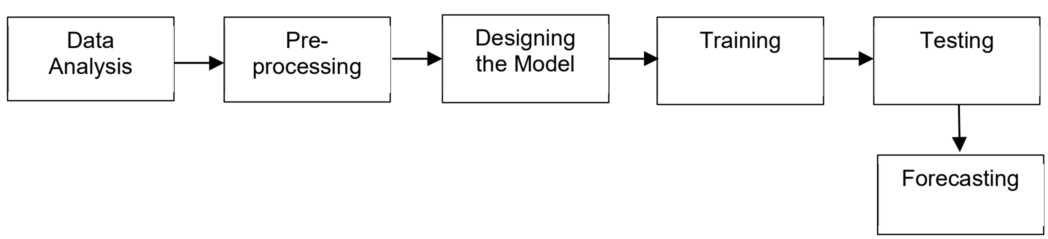

Figure 1. The steps of formulating the ANN model.

Step 1: Data Analysis

The monthly sales data for Aromatic Dwarf Coconut from 2015 to 2019 were stored in Text Document (.txt) and imported into Alyuda NeuroIntelligence software. The data selected time series mode with a period of 12 due to seasonal data in the monthly data pattern shown in Figure 2. The Period parameter is very important to show performance of the neural network. The data was then partitioned into three parts which were training set, validation set, and testing set. Missing values, column parameter and unnecessary data have been modified.

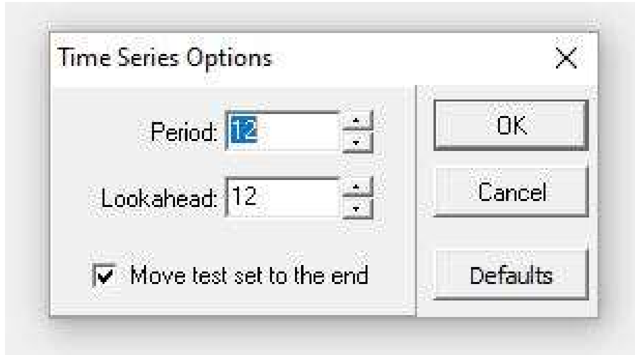

Figure 2. Time Series Option

Step 2: Pre-processing

The second step is pre-processing data. the data scaled to a range such that the output data used range [0,1]. In the meantime, the input data will be linearly scaled to [-1,1]. Data will also be balanced by adding 0.1 in every variable to make data more accurate.

Step 3: Designing the model

The network architecture is generated to develop and will be choose the most appropriate input layer model. The best model chosen was based on the R-Squared, the AIC, and so on. As a result, the input activation, error, and output function were generated. The total nodes of hidden layer can be identified using Kolmogorov's Superposition Theorem.

Step 4: Training

This study may choose to use all algorithms, or a few algorithms or a single algorithm from seven algorithms. As a result, the study selected Conjugate Gradient Descent (CDG) shown in Figure 3 below. The data performed the "Train" command for the Conjugate Gradient Descent algorithm because it is a general-purpose training algorithm of choice.

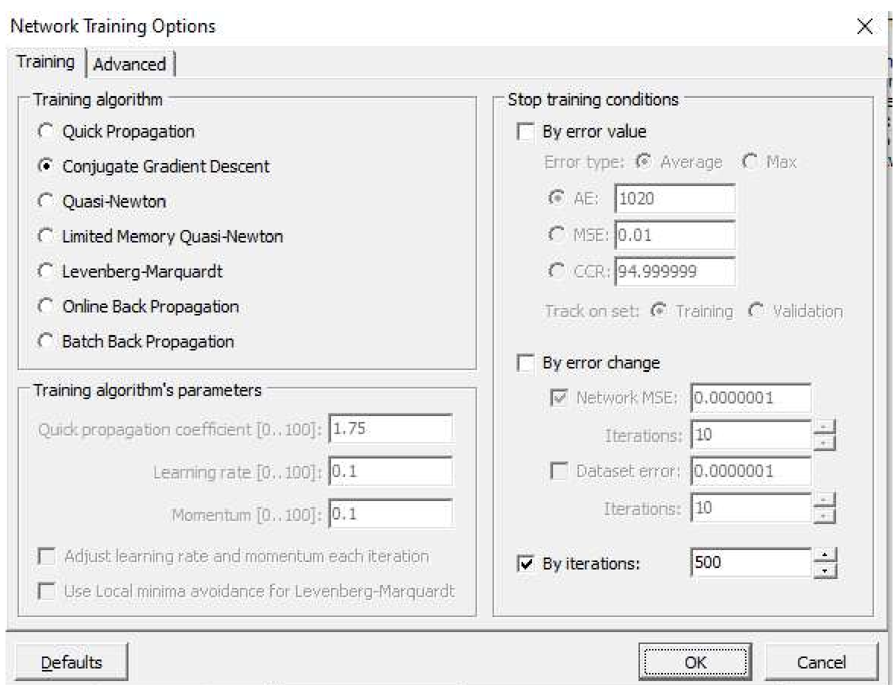

Figure 3. CGD algorithm

Step 5: Testing

This step shows the trained network will be tested and validated. The output will be generated and from this, Absolute Error measure is calculated. The Mean Square Error (MSE) is calculated manually using Absolute Error values.

Step 6: Forecasting

The study forecasted 12-ahead in this step for year 2020. Response Graph shows that a line graph with input columns for the network output values. The graph shows the line of forecasted values, too.

3.2 Linear Algebra

As seen in Figure 4, there are three important procedures for formulating Linear Algebra. The first is calculating the estimated trend, then determining the Adjusted Seasonal Index and lastly is getting the forecast values.

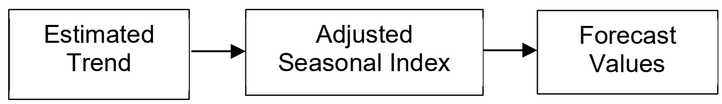

Figure 4. Steps for formulating Linear Algebra

Step 1: Estimated Trend

Data sales from the year 2015 to the year 2019 showed in Microsoft Excel software. Before calculating the estimated trend, another column in the name of 't' inserted from 1 for January 2015 to 60 for December 2019. The TREND function returns the values along a linear trend, and it fits a straight line. As a result, the study found trend line equation and the parameters a_0 and b.

Step 2: Adjusted Seasonal Index

The procedure to determine the Adjusted Seasonal Index is as the following steps:

- Identify the average or mean sales for each year.
- Find Unadjusted Seasonal Index by divided the monthly sales with their respective annual mean.
- Next, the mean of Unadjusted Seasonal Index is divided by total mean and multiply by 12 to determine the Adjusted Seasonal Index.

Step 3: Forecast Values

The study combined a linear trend equation with Adjusted Seasonal Index. The new equation is given by the following Equation (1):

$$\hat{y} = (a_0 + bx) \times Adjusted\ Seasonal\ Index \quad (1)$$

where $\hat{y}$ is the forecast value, x is the months, a_0 is the trend value in the base year and b is the annual average growth of the trend value.

3.3 Calculating Mean Square Error (MSE)

This study used the Mean Square Method (MSE) to achieve the second objective of this study, which was to measure the error of two methods using MSE. MSE is used to determine the best predictive method or model. The MSE can be calculated as Equation (2).

$$MSE = \sum_t^n \frac{{e_t}^2}{n} \quad (2)$$

where:

e_t: $y_t - \hat{y}_t$
y_t: Actual value in time t
$\hat{y}_t$: Predicted value in time t
n: Total observations

4. Results and Discussions

4.1 Artificial Neural Network

In this part, the results are given in accordance to each of ANN steps; data analysis, pre-processing, designing the model, training, testing and forecasting.

Step 1: Data Analysis

The step-ahead value is twelve since the sub-objective of this study aims to forecast the sales of Aromatic Dwarf Coconut for the next twelve months in 2020. Out of 48 rows accepted for neural network, 34 Training set (70.83%), 7 values for Validation set (14.58%), and 7 values for Test Set (14.58%) shown in Table 1.

Table 1. Summary of Data Analysis

Data Partition Results		
	Record	**Percent (%)**
Training Set	34	70.83
Validation Set	7	14.58
Test Sett	7	14.58

Step 2: Pre-processing

Table 2 shows a summary of the pre-processing data after analysis of the data in Step 1. The minimum and maximum sales for both columns are the same as for 19100.8 and 3400. The mean and standard deviation are also the same as 26979.25 and 4703.256277. The inputs were 13 columns with 12 sales lags and "Sales" due to the 12-period in Step 1 and the output column is only one that was "Sales: next".

Table 2. Summary of Pre-Processing Data

Pre-Processing Data		
	Input Column	**Output Column**
Encoded into	13 columns	1 column
Scaling Range	[-1…1]	[0…1]
Min	19100.8	19100.8
Max	34000	34000
Mean	26979.25	26979.25
Standard Deviation	4703.256277	4703.256277
Scaling Factor	0.000134	0.000067

Step 3: Designing the model

The total nodes are 13 and the total number of hidden nodes is 27. The "Search Architecture" button is design to find the best neural network design based on the input and output values. The best neural network architecture is [13-14-1] with the number of nodes in the input layer being 13 and the number of nodes in the hidden layer being 14. A fitness value of 0.00152, the lowest test error of 445.587586, and the highest of correlation and R-Squared of 0.999851 and 0.999673 shown in Table 3.

Table 3. Search Architecture

ID	Architecture	Number of Weights	Fitness	Test Error	Correlation	R-Squared
1	[13-2-1]	31	0.001084	922.525208	0.845848	0.703418
2	[13-33-1]	496	0.001271	787.073242	0.76992	0.579318
3	[13-21-1]	316	0.001266	789.714966	0.755284	0.554551
4	[13-13-1]	196	0.001363	733.780334	0.978762	0.954096
5	[13-8-1]	121	0.001247	802.184692	0.757663	0.568141
6	[13-17-1]	256	0.001108	902.807007	0.987173	0.974204
7	[13-11-1]	166	0.001256	796.807007	0.992313	0.983884
8	[13-15-1]	226	0.000991	1009.086243	0.771761	0.53653
9	**[13-14-1]**	**211**	**0.00152**	**445.587586**	**0.999851**	**0.999673**

Step 4: Training

Table 4 shows the output of Conjugate Gradient Descent (CGD) training network. The absolute training error was 1.757488 and was 2269.572013 for validation. In the Training Neural Network, iteration number was 501 repetitions of a training process to generate sequence of outcomes. The correlation was 0.975305 and 0.950977 in R-Squared for training process.

Table 4. CGD's Result

Conjugate Gradient Descent		
Parameters	Training	Validation
Absolute Error	1.757488	2269.572013
Network Error	2.29E-07	0
No of Iteration	501	
Training Speed	227. 727243	
Correlation	0.975305	
R-Squared	0.950977	

Step 5: Testing

The correlation r of sales of Aromatic Dwarf Coconut was 0.976971, which is closer to 1. This indicates a strong positive relationship between the target and the output. The correlation of determination R^2 was 0.95337 shows that the percentage of output variation explained by the model was 95.337% while the other was due to other factors shown in Figure 5. The Figure 6 is the graph that shows the output values follow the target values. As a result, when target values increase, output values also increase. It is directly proportional to the output values.

Summary

	Target	Output	AE	ARE
Mean:	28819.405714	28884.501991	431.910728	0.016315
Std Dev:	4086.162624	4061.557934	763.335355	0.032629
Min:	19648	19782.082813	7.222204	0.000285
Max:	34000	33829.195043	3084.698639	0.14951

Correlation: 0.976971
R-squared: 0.95337

Figure 5. Summary of Testing

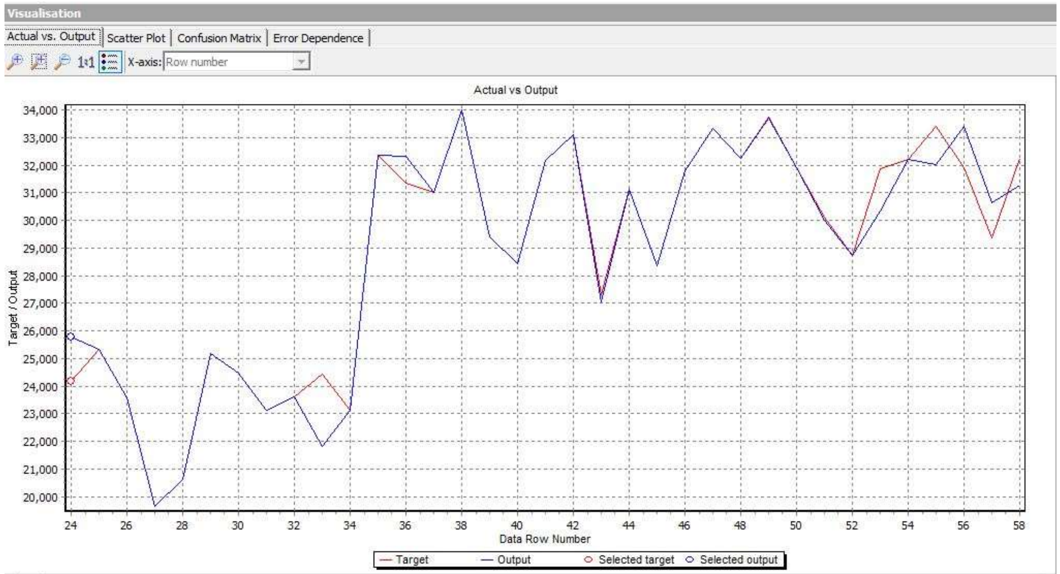

Figure 6. Graph of Actual Vs Output

Step 6: Forecasting

The Figure 7 illustrates the trends in Aromatic Dwarf Coconut's forecast sales for the year 2020, which will increase in the first month after the fall in the next month. Later, it continued to increase and reached the highest sales peak in June 2020 at RM 32914.33, but then decreased until the end of 2020. The lowest sale in October 2020 is RM 29,585.53. Sales are increasing slowly, and they are also falling slowly.

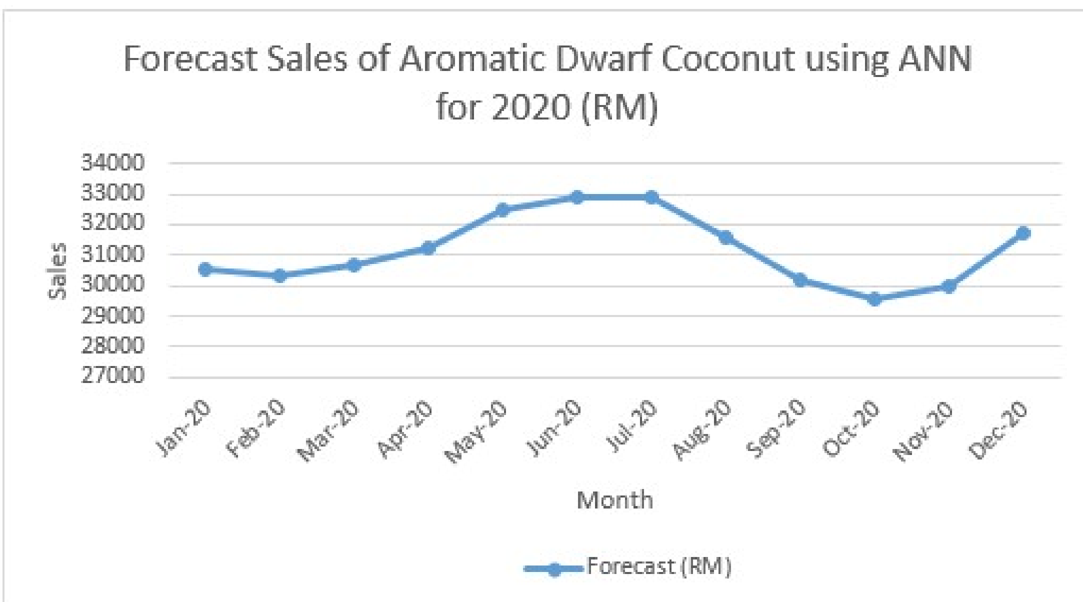

Figure 7. The graph of Forecast Sales Aromatic Dwarf Coconut using ANN

Table 5. Forecast Values using ANN

Month	Forecast (RM)
January 2020	30517.19
February 2020	30338.36
March 2020	30678.25
April 2020	31207.43
May 2020	32505.06
June 2020	32914.33
July 2020	32874.70
August 2020	31605.42
September 2020	30179.15
October 2020	29585.53
November 2020	29992.47
December 2020	31722.47

4.2 Linear Algebra

Step 1: Estimated Trend

The equation (3) is calculating the trend line as:

$$\text{Estimatedtrendvalue} = 19248 + 227.91x \quad (3)$$

where trend value in the base year is 19248 and the annual average growth of value trend is 227.91. Figure 8 shows the sales of Aromatic Dwarf Coconut in orange color and estimated trend of Aromatic Dwarf Coconut in grey color. Both graphs are available from the year 2015 to the year 2019. The estimated trend is continuously increasing linearly every year.

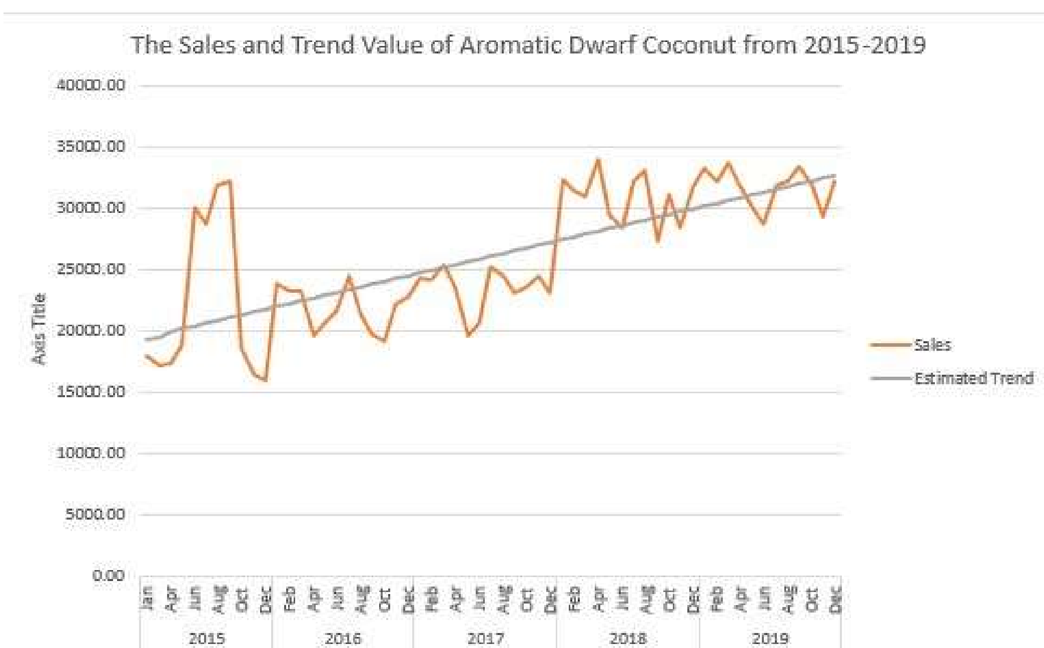

Figure 8. Sales Vs Trend Values

Step 2: Adjusted Seasonal Index

Table 6 shows the results of the average annual sales.

Table 6. Yearly Average Sales

Year	Yearly Average Sales (RM)
2015	21981.45
2016	21830.48
2017	23465.67
2018	30869.53
2019	31751.40

Second, the calculated Unadjusted Seasonal Index using for example in January 2015 given by 0.82. Finally, the result of the Adjusted Seasonal Index. The Adjusted Seasonal Index will be used later to find the forecast value. The Adjusted Seasonal Index is determined by finding the mean of Unadjusted Seasonal Index first then divided by five years to get the Adjusted Seasonal Index. The result of Adjusted Seasonal Index is given in Table 7.

Table 7. Adjusted Seasonal Index

Months	Adjusted Seasonal Index
January	1.01
February	0.98
March	1.01
April	0.96
May	0.91
June	1.01
July	1.11
August	1.11
September	1.06
October	0.95
November	0.93
December	0.96

Step 3: Forecast Values

Figure 9 below shows that the graph of forecast sales of Aromatic Dwarf Coconut for 2020. It shows the pattern of forecast sales continues to increase over months, but will fall over at certain months with the highest sale being on August 2020 at RM3,8567.90 and the lowest sale in May 2020 at RM30,996.60.

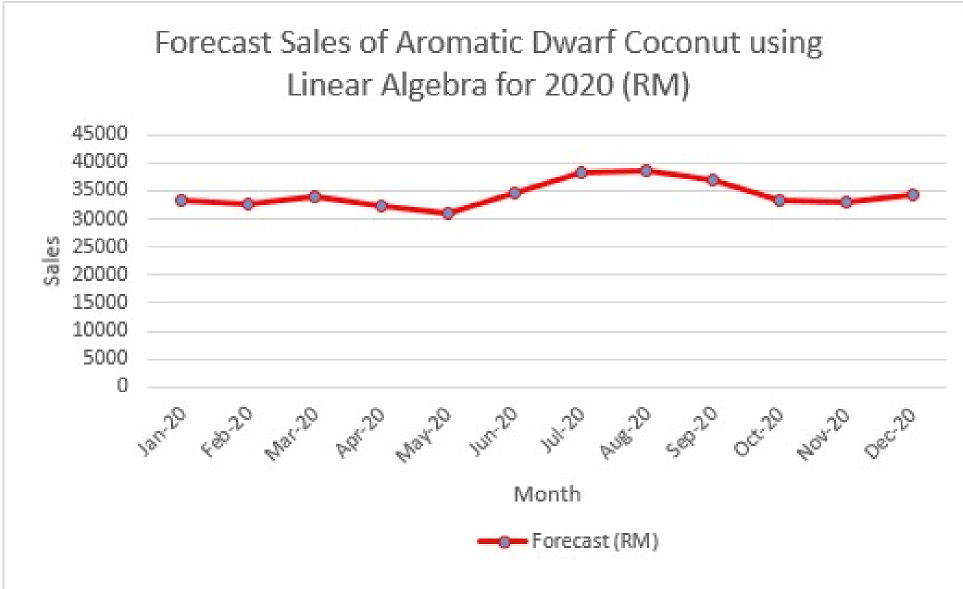

Figure 9. Graph Forecast Sales using Linear Algebra

Table 8. Forecast Values for Linear Algebra

Month	Forecast (RM)
January 2020	33482.00
February 2020	32710.90
March 2020	33942.40
April 2020	32480.90
May 2020	30996.60
June 2020	34633.00
July 2020	38314.90
August 2020	38567.90
September 2020	37072.20
October 2020	33441.60
November 2020	32949.50
December 2020	34231.20

4.3 Mean Square Error (MSE) for Artificial Neural Network

Table 9 shows the result of the sum of the error square for ANN is 19,839,024.01357 and its MSE is 566,829.2575.

Table 9. MSE of ANN

Sum of e^2	19,839,024.0136
MSE	566,829.2575

4.4 Mean Square Error (MSE) for Linear Algebra

This study took the least square error (e^2) among these percent to measure the MSE and apply Eq. (4) with $n = 60$. The Mean Square Error for Linear Algebra is presented in table 10.

Table 10. MSE of Linear Algebra

Month	Percent (100%)	e^2
Jan 2015-Jun 2019	Training 90%	110955728
July 2019-Dec 2019	Testing 10%	12158824.70
	Sum of e^2	123114552.70
	MSE	2051909.21

5. Conclusion and Recommendation

Based on the result of MSE from Artificial Neural Network (ANN), which is 566,829.2575 shows the minimal error while the MSE result from Linear Algebra is given by 2,051,909.21 approved that the objective of this study is fulfilled.

The result of the forecast sales for Artificial Neural Network (ANN) for the 1st quarter from January to April 2020 is given by RM30,685.30. Meanwhile, by referring to the result of the forecast sales for Linear Algebra, the 1st quarter from January to April 2020 shows RM40,903.2. Hence, forecast sales for the 1st quarter of Linear Algebra method is higher than ANN.

However, the methods that can be used for forecasting were limited to two methods to compare the MSE value. Several methods can be used to compare which methods are the best forecasted method, for example Holt's Method, Fuzzy Time Series, and Double Exponential Smoothing. It will implement MSE error measurement while other error measurements such as Root Mean Square Error (RMSE) or Mean Absolute Percentage Error (MAPE) to determine the lowest error with precise forecasts. Some other researchers may use other algorithms in Artificial NeuroIntelligence to get a result that more reliable, or a correlation value that is approximate to one.

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Conflict of Interest

The authors declare no conflict of interest in the subject matter or materials discussed in this manuscript.

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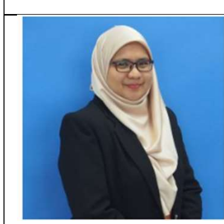
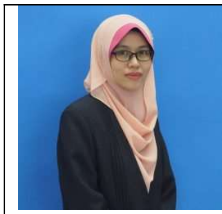
	Siti Sarah binti Raseli is a senior lecturer at the Department of Mathematics and Statistics, Universiti Teknologi MARA Perlis branch. She graduated with a Master’s degree in Mathematics from Universiti Sains Malaysia. She has published several papers such as Circumference Determination and Data Extraction of Two-Dimensional Circle, Boundary Extraction Of 2d Image and Detection of the Corner Points from a Map.	Drafting article and results discussion.

	Norpah Binti Mahat is a senior lecturer at the Department of Mathematics and Statistics, Universiti Teknologi MARA Perlis branch. She graduated with a Master's degree in Mathematics from Universiti Sains Malaysia. Her expertise is in the field of Fuzzy and Neural Networks.	Design the Methodology
	Siti NorSuhada binti Abdul Razak work at Logistic Coordinator, BDP InternationalGraduated with Bachelor of Science (Hons.) Management Mathematics from Faculty of Computer and Mathematical Sciences, Universiti Teknologi Mara Perlis Branch.	Data collection of Aromatic Dwarf Coconut was held at Jabatan Pertanian Teluk Bharu, Perak from 2015 to 2019.