Implementation Of The Double Exponential Smoothing Method In Determining The Planting Time In Strawberry Plantations

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Abstract. Strawberry is one of the important fruit commodities and is widely grown for some people in Bantaeng district to meet market demand. High rainfall is a challenge in strawberry due to climate and time dynamics, rainfall along with climate change, not only causes changes in the amount of rainfall but also causes a shift in the beginning of the rainy season and the beginning of the dry season. so often in the cultivation of plants such as strawberries it is difficult to adjust even too late to anticipate sudden and extreme changes in rainfall. The stages of this research began with collecting data obtained from observation, interviews and documentation. The research design used is UML which is designed in a structured manner consisting of use case diagrams, activity diagrams, sequence diagrams and class diagrams.software used in building this system is PHP and MySql for database processing. The algorithm used is Double exponential smoothing to predict rainfall, air temperature, and monthly wind speed for the next year using past data. The results of this study are that the system is able to provide recommendations for planting periods based on the prediction results of rainfall, air temperature, and wind speed based website. Based on the results of calculating the accuracy between the prediction results and actual data using the Mean Absolute Percentage Error (MAPE) , each has a forecasting error value of 30.69% for rainfall, air temperature 0.63%, wind speed 5.89%.

Keywords: Prediction; Strawberry; Double Exponential Smoothing, MAPE;

1 Introduction

Strawberry is one type of fruit that has high economic value, it is small, sweet, fresh, and has a unique appeal. Some farmers in highland areas with low temperatures have cultivated strawberry [1]. According to Cahyono in [2] Flowers on strawberry plants are arranged in bunches or bunches with long thorns (panucila) and grow at the top of strawberry plants containing a phytochemical compound called etlagid acid. It is a phenol compound that has the potential as an anti-carcinogen and anti-mutagen, can beautify the skin, make teeth white, eliminate bad breath, and improve brain power and vision [3]. Strawberry plants can grow on several types of soil, from sandy soil to clayey soil. Strawberries grow well in highlands because they technically require a cold and humid environment to grow with optimum temperatures between 17oC to 20oC, humidity 80% to 90%, sunlight 8 to 10 hours per day and rainfall ranging from 600 mm to 700 mm. per year. [4]. The characteristics of fluctuating rainfall greatly affect the life of living things, especially plants. Precipitation refers to the height at which

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rainwater falls on a flat area without evaporating, penetrating, or flowing [5]. Strawberry is one of the most important fruits and is widely cultivated by some people in Banten district to meet market demand and provide fruits for supporting tourism projects. This plant is a subtropical plant that adapts well to high altitudes with temperatures between 22°C and 28°C and high rainfall. Bantaeng Regency is a suitable area for strawberry cultivation because it has three-dimensional nature, namely mountainous hills, lowlands and coastal valleys, there are two seasons. namely the west and east monsoons. Planting times can change over time due to climate change as well as technological and socio-economic changes. The climate in this area is classified as a wet tropical climate. The altitude of the place from sea level 0 to 25 meters to more than 1,000 meters above sea level. Areas that have developed strawberry plantations in Bantaeng district are Bonto Tallasa Village and Bonto Lojong Village, Uluere District [7]. Data released by the Central Bureau of Statistics of Bantaeng Regency regarding strawberry production in Uluere District is shown in Table 1.

Table 1. Production data strawberry Uluere sub-district

Year	**Harvested Area** (Hectares)	**Planted Area** (Hectares)	Production (Kg)
2015	1	1	700
2016	1	1	200
2017	1	1	600
2018	1	1	300

Table 1 of strawberry production data shows that there was a decrease in production from even hundred kilograms in two thousand and fifteen, two hundred kilograms in two thousand and sixteen, six hundred kilograms in two thousand and seventeen, three hundred kilograms in two thousand and eighteen. The significant decrease in production was caused by high rainfall which made it difficult to grow clumps and flowers. As the fruit develops, the strawberry becomes blistered and rots. The quality of the strawberries is also unsatisfactory because the taste is not sweet and the size of the strawberries is small, this is certainly detrimental to farmers. Strawberry can be planted at any time, not tied to a specific time. However, in the strawberry planting process, it is necessary to pay attention to rainfall, if the rainfall is high it is not recommended to plant because it can affect the strawberry growth process. If the rainfall is normal, it is the right time to plant strawberries [8].

High rainfall is a challenge in the strawberry production system because of the dynamics of climate and time, rainfall which is in line with climate change, not only causes changes in the amount of rainfall but also causes a shift in beginning of rainy season and beginning of dry season. The characteristics of fluctuating rainfall greatly affect the life of living things, especially plants. This is in accordance with Pramudia's statement in [9] that rainfall has a very fluctuating and random nature, so that it is often difficult for plant cultivation such as strawberry to adjust and even late in anticipating sudden and extreme changes in rainfall.

Therefore, it is necessary to have a system that can determine the planting period for strawberries based on predictions of rainfall. One way to overcome the impact caused by shifting rainfall patterns is to use a prediction method, namely Double exponential smoothing to predict monthly rainfall for the next year using past rainfall data.

Research conducted by Riyadhul Fajri and Teuku Muhammad Johan, in 2017 "Implementation of Double Exponential Smoothing Forecasting in Cases of Child Violence at the Integrated Service Center for the Empowerment of Women and Children" provides an overview of the level of child violence [10]. The variables used in the system are the types of domestic violence/traumatic cases, abuse cases, kidnapping cases, rape cases and sodomy cases. Case

2014, 2015. Then it is processed using the Double exponential smoothing method by looking for the trend equation first and followed by finding the second smoothing and forecasting results, namely the type of violence in the following year, 2016.

Research conducted by Al Munandar and Sumiati, 2017, “Implementation of Linear Regression For Prediction of Monthly Rainfall” produces a regional climate classification of each region, the prediction process is carried out for the next twelve months [11]. Thus, the predicted data is the monthly rainfall pattern per region in Pandeglang district.

Research conducted by Syaefuddin Suhaedi, Evi Febriani, Habibi RPN, Ivan Ardiansyah. 2017, “ANN Back propagation for Forecasting and simulation hydroclimatology data.” using parameters of rainfall data, temperature data, air humidity data, wind speed data, solar radiation duration data to be predicted using backpropagation ANN, the simulation results of hydrological training data have an average accuracy rate of 96.61%, climatology training data accuracy level is 96, 32%, while the accuracy of hydrological data testing is 95.72%, climatological data testing is 96.19% [12].

Research conducted by Wahyudi Purnomo, Fitria Suryatini, Maya Delistiani 2020, "Controlling the Temperature and Humidity of the IoT-Based Strawberry Aeroponic System Using Fuzzy Logic" resulted in the average root temperature falling into the range of needs, namely 23.30C between the 18-300C range and average The average root moisture also falls into the range of needs, which is 89% between 85%-95%. The average root temperature falls into the range of needs, which is 21.50C between the range of 14-250C. Meanwhile, the average canopy humidity also falls into the range of needs, which is 93% between 85-95% [13].

Research conducted by Rizka Purmaya Sari, Ulla Delfana Rosiani, Arie Rachmat Syulistyo. 2020, “Implementation of the Linear Discriminant Analysis Method for Ripening Detection in Strawberries” resulted in testing the accuracy of the detection of the ripeness level of strawberries using the RGB to HSV color feature extraction method and threshold color segmentation [14]. 210 data samples were tested with 70 data with grade A category showing 60 correct data and 10 incorrect data with 85.71% accuracy, 70 data with grade B category showing 59 correct data and 21 incorrect data with 84.28% accuracy, and 70 data with grade C category shows 58 correct and 12 incorrect data with 97.14% accuracy.

Research conducted by Nina Mauliana Noor Fajriah, Yufiz Azhar, Gita Indah Marthasari. 2019, "Design of an Expert System for Diagnosing Strawberry Plant Diseases Using the Certainty Factor Method Based on WEB" by inputting the symptom confidence value of each symptom of a plant affected by a disease to be calculated using the certainty factor method to obtain the highest confidence value as a result of system diagnosis [15] .

2 Method/Design

In this research, the Unified Modeling Language (UML) aims to describe currently running systems according to a method using use case diagrams. Based on an analysis of a running system, the authors implement a Double Exponential Smoothing Method in determining strawberry harvest patterns based on precipitation forecasts to overcome the effects caused by changes in precipitation patterns. provide a solution to solve the problem. In this study, using historical rainfall data, the Unified Modeling Language (UML) was used to describe the system processes in the following use his case diagram.

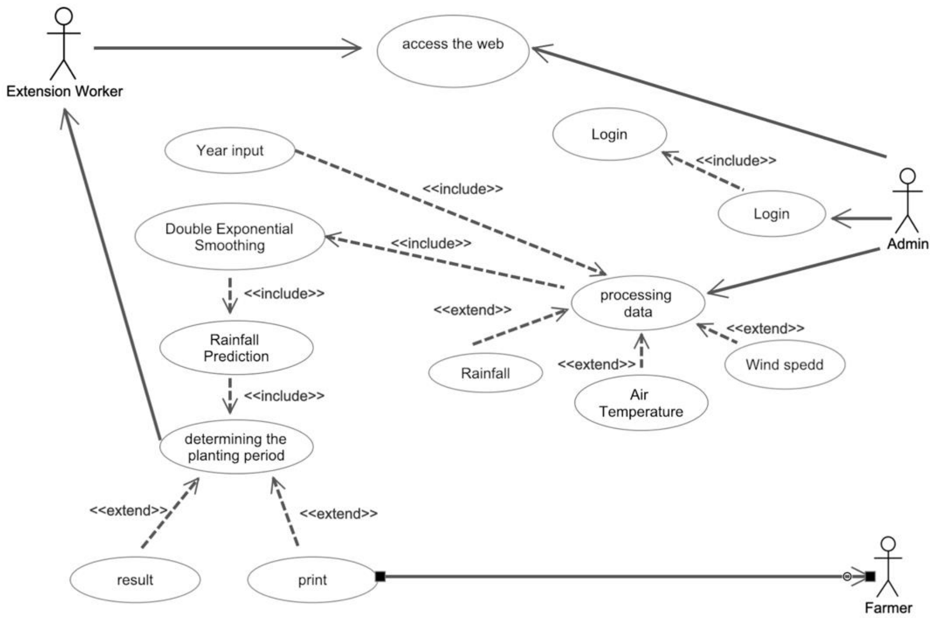


Fig. 1. Model process flow

2.1 Data collection

The research design used is UML which is designed in a structured manner consisting of use case diagrams, activity diagrams, sequence diagrams and class diagrams. Software used in building this system is PHP and MySql for database processing. In this study, data collection was carried out by taking data from the Meteorology, Climatology, and Geophysics Agency so that the system built was reliable and literature studies were carried out by collecting data and information obtained from system design books, programming books, journals and articles from the internet as well as information. Others related to the discussion in this research are strawberry, rainfall prediction, and planting period.

2.2 Metode Double Exponential Smoothing

The reason for using single or double exponential smoothing is that when the data contains a trend component, the smoothed values occur before the actual data. Therefore, for a single smoothed value, multiple smoothed values should be added to adjust the trend. A double exponential smoothing method that can be used to solve linear trends is Holt's two-parameter method. Holt's method does not smooth trend values directly by double smoothing, but performs trend smoothing processing with parameters different from the smoothing of the original data. If the data show a trend, double exponential smoothing is used. The formula for double exponential smoothing can be expressed as:

The Double Exponential Smoothing formula can be shown as follows :

$$S'_t = \alpha X_t + (1-\alpha) S'_{t-1}$$
$$S''_t = \alpha S'_t + (1-\alpha) S''_{t-1}$$
$$A_t = 2S'_t - S''_t$$
$$b_t = \alpha/((1-\alpha)) S'_t - S''_t$$
$$F_{t+m} = A_t + b_t$$

Information:

S'_t = value for 1 period t
S''_t = Smoothing value for 2 periods t
X_t = Actual data at time t
A_t = Interception in period t
b_t = trend value in period t
α = Smoothing constant
$F(t+m)$ = Forecast value for period t+1
m = Future period
α = Smoothing coefficient ($0 < \alpha < 1$)
β = Smoothing coefficient for trend ($0 < \beta < 1$)

2.3 Forecasting Accuracy Measure with Mean Percentage Error (MAPE)

Forecast results are not always accurate or often different from the actual situation (actual data). The difference between the forecast and the actual situation is called the forecast error. Assessing the accuracy of a forecasting period can be done by finding the difference in magnitude (measure of forecasting error) of forecasting data against actual data. By comparing the smallest error size, so that the forecast value can be used as a reference in determining future needs. The error measure is used to evaluate the value of the forecasting parameter. If there is actual data in the period and there are forecast results in the same period, the error that occurs can be defined as follows.

$Et = Xt - Ft$ (6)

So if there are n observation periods, there are n deviations. There are several methods available in statistics to test the size of prediction error. One of the methods used is MAPE (Mean Absolute Percentage Error). In other words, the mean absolute percentage error is the average of the total percentage errors between the actual data and the predicted data. The formula for MAPE can be found with the following formula :

$$MAPE = \sum_{t=1}^{n} \frac{|PE|}{n}$$

Percentage error is the percentage error of a forecast:

$$PE=(Xt-Ft)/Xt \ X \ 100$$

Where:

et = t-period error
Xt = t-period actual data
Ft = forecast value in t-period
N = number of time periods
PE = Percentage of error

2.4 Evaluation of Extraction Results and Cluster Quality

In this study, forecasting about bulk can be made with the selection of the best if the parameters are chosen based on the smallest Mean Absolute Percentage Error (MAPE) value, the first step that needs to be taken is to determine the initial smoothed value (single exponential value). After determining the result of the Single Exponential value, then the next step is to determine the double exponential value where later this value is used to produce recommendations for the right time to plant strawberries

3. Result and Discussion

Data on average air temperature, average wind speed and rainfall data in Bantaeng Regency, South Sulawesi used in this study were obtained from the Meteorological Agency Table 2, Climatology, and Geophysics Region IV where this using Double Exponential Smoothing, the system recommends good months for strawberry planting based on rainfall, temperature, and wind speed forecasts.

Table 2 shows that the data obtained are fluctuating, which indicates that the data is not constant. The data that has been presented has various data, this shows that the data contains an element of trend, so it can be analyzed using the Double Exponential Smoothing method. Forecasting from Double Exponential Smoothing uses one smoothing parameter, namely to smooth the actual data periodically. In determining the smoothing parameter whose magnitude is $0 < \alpha < 1$ by trial and error.

Table 2. Air temperature data, wind speed and rainfall data

					Rainfall							
Year	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
2016	308	166	369	306	139	247	238	20	179	136	357	273
2017	154	337	212	150	321	468	228	228	150	149	304	457
2018	497	312	178	0	346	0	399	30	0	0	340	0
2019	541	238	315	141	82	244	5	4	0	0	121	0
2020	323	134	245	236	313	307	242	59	118	135	73	185
					Air temperature							
Year	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
2016	19	19.3	19	18.8	19.6	18.9	18.4	18.8	19	19.3	19.4	19.5
2017	19.4	18	18.9	18.8	19.1	18.6	18	18.6	21.2	21.3	21.1	21.4
2018	20.5	20.4	21	21.1	20.9	20	19.9	19.5	21.7	21.4	21	21

2019	20.8	20.7	20.8	21.2	21.1	20	19.8	19.8	20.9	22.7	22.1	21.1
2020	21.2	21.5	21	20.7	21.2	20.6	19.9	20.7	21.2	21.6	22	21.5
						wind speed						
Year	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
2016	3.3	3.3	2.9	2.8	3	1.9	1.8	1.9	2	1.9	3.1	3.2
2017	6.5	8.6	3.5	3.7	4.3	3.4	5.1	5.8	4.9	4.7	3.7	5.3
2018	6.1	6.1	4.5	3.9	2.8	2.4	2.3	4.5	6	4.8	3.7	4.4
2019	5.8	3	3.9	3.9	4.3	4.6	4.5	4.6	4.8	3.1	2.4	1.3
2020	4.5	4.3	3.1	3.1	2.9	5	5.5	4.8	6	4.5	3.2	3.5

Data on average air temperature, average wind speed, average rainfall are entered into the system as original climate data, the data obtained from the Center for Meteorology, Climatology and Geophysics Region IV **Figure 2**.

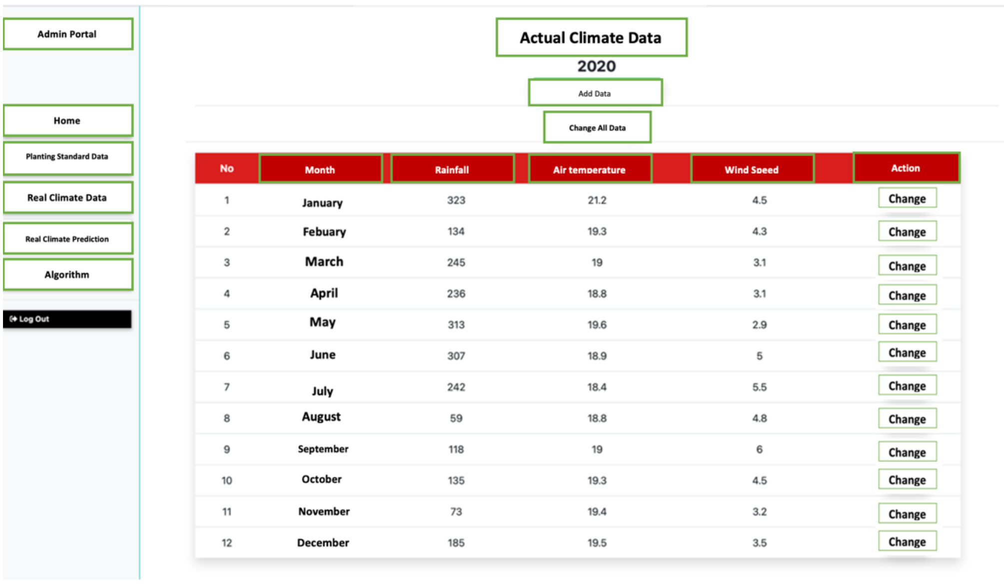


Fig. 2. Display of Actual/Original Climate Data

After entering the data, the next step is to select the best parameters based on the smallest mean absolute percent error (MAPE) values to make predictions for mass. Forecasts can be calculated using double exponential smoothing. Minimum parameter value obtained from mean absolute percent error (MAPE). Before predicting the planting period, first select the last year's data for determining the planting period in **Figure 3**.

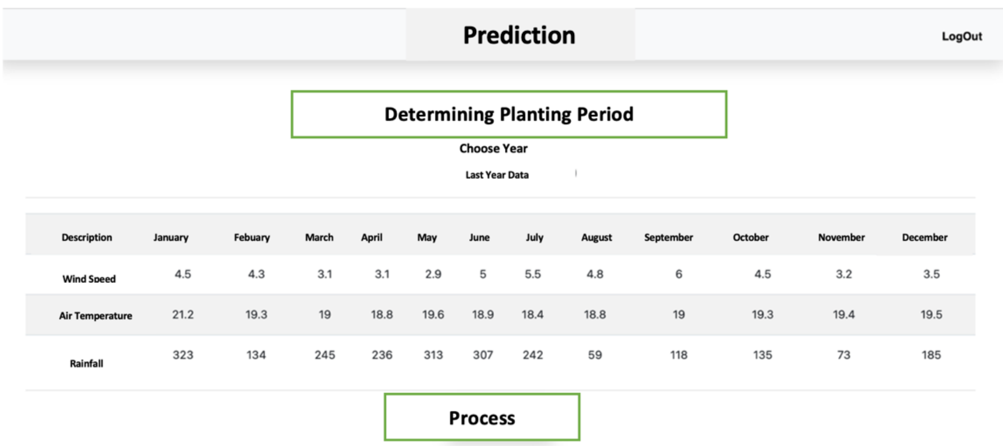
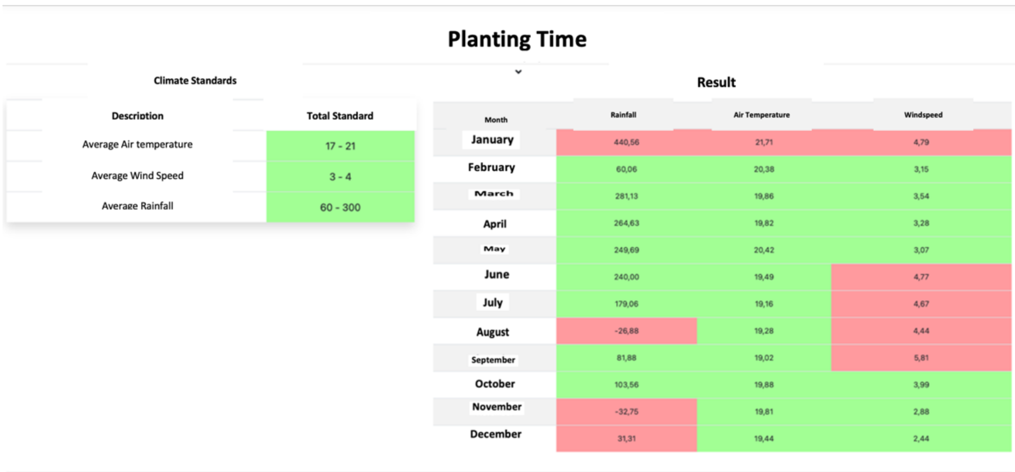


Fig. 3. Display of Planting Period Determination

After carrying out the process based on the data that has been entered into the system, a recommendation for the right month will be obtained for the planting period **Figure 4**.



Planting Time

Climate Standards

Description	Total Standard
Average Air temperature	17 - 21
Average Wind Speed	3 - 4
Average Rainfall	60 - 300

Result

Month	Rainfall	Air Temperature	Windspeed
January	440,56	21,71	4,79
February	60,06	20,38	3,15
March	281,13	19,86	3,54
April	264,63	19,82	3,28
May	249,69	20,42	3,07
June	240,00	19,49	4,77
July	179,06	19,16	4,67
August	-26,88	19,28	4,44
September	81,88	19,02	5,81
October	103,56	19,88	3,99
November	-32,75	19,81	2,88
December	31,31	19,44	2,44

Fig. 4. Recommendations for Determining the Planting Period

4. Conclusion

Compared to previous research, namely the Design of an Expert System for Diagnosing Strawberry Plant Diseases Using the 2019 using the Certainty Factor Method, the research conducted by the author is determining the planting period on strawberry plantations using the Double Exponential Smoothing method. This method is very suitable for processing existing and fluctuating data, such as the research on the Implementation of Double Exponential

Smoothing Forecasting in Cases of Child Violence at the 2017 Women and Children Empowerment Integrated Service Center which uses past data that is fluctuating.

This research has successfully applied the Double Exponential Smoothing method. The test results of this system indicate that this system has been made in accordance with the expected functionality and testing the value of forecasting errors on the data of rainfall, air temperature, wind speed using the Mean Absolute Percentage Error (MAPE) calculation each Precipitation has an alpha value of 0.5, temperature an alpha value of 0.4, and wind speed an alpha value of 0.3 as the best parameters because it shows the Mean Absolute value.

Furthermore, this research has also succeeded in providing recommendations for the right month for planting. As a continuation of this research and to obtain better results, further research will apply several other methods so that there is a comparison of accuracy with other methods and other climatic parameters can be added that support the determination of the strawberry planting period.

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