

A Comparison between Triple Exponential Smoothing and Monte Carlo Methods in the Prediction of Chicken Business Profit at Poultry Farm Livestock of Jatipuro District

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Abstract. With a prediction of profits, farmers can anticipate if the next harvest has experienced a slight profit or failed to harvest and so that farmers still have business capital and they do not experience a stable cage (bankrupt). This research objective is comparing two kind prediction method. Methods to be compared are Triple Exponential Smoothing and Monte Carlo methods. To find out the value of the compatibility of the two methods used MAPE (Mean Absolute Percentage Error) which can find out the percentage of the error value. This method are used for farmers financial management in predict their profit. To implement both methods, past data are used, namely the previous harvest profit data. Result of this study, by using Triple Exponential Smoothing method produces a MAPE value of 12.10% with a value of $\alpha = 0.3$ and the Monte Carlo method produces a MAPE value of 40.58%.

1. INTRODUCTION

Based on the 2017 Jatipuro profile which was endorsed by the Head of the Communication and Information Office of Karang Anyar Regency, the occupation of residents aged 10 years and over in 2016 were 817 breeders or around 25% of the total population. One type of animal breeding that is carried out by the Jatipuro community is a broiler breeding. Based on observations that have been made, there are about 15 broiler breeders in this area. From those 15 broiler breeders, interviews were conducted to dig up information about the difficulties faced to obtain the maximum benefit from the business. Based on the results of interviews conducted on 10 samples of breeders, information was obtained that the obstacles faced by these farmers were that they could not make predictions of profits from their business in the future. This is caused by the lack of knowledge about mathematical calculations to predict its benefits. The new breeders can find out the benefits if the harvest time arrives. Without a prediction of the benefits, those chicken breeders will have difficulty in managing their finances. This matter can have an impact on future breeding operations for harvesting that will not be optimal or may even suffer losses, so those breeders cannot continue their farming business due to lack of capital.

In predicting those profits, many methods would be match for this study. By the data that we have gathered, they are monthly based reports. Based on that type of data, we choose Triple Exponential Smoothing and Monte Carlo in predicting these profits. they are very common in predicting periodically data. Triple Exponential Smoothing is a method used to predict data that might occur in the future based



on past data that is processed by weighting method. In addition to Triple Exponential Smoothing, Monte Carlo is also a method used for forecasting by using random samples from existing data. Both methods are the approaches that can make predictions from data that are seasonal (irregular). The data targeted in this study are financial data in the form of profit data for each chicken farm harvest in the previous harvest season. Thus, this research will use Triple Exponential Smoothing and Monte Carlo methods to forecast future farmers' benefits.

2. RESEARCH METHODOLOGY

The steps of this research will be conveyed using a mindmap such as the following:

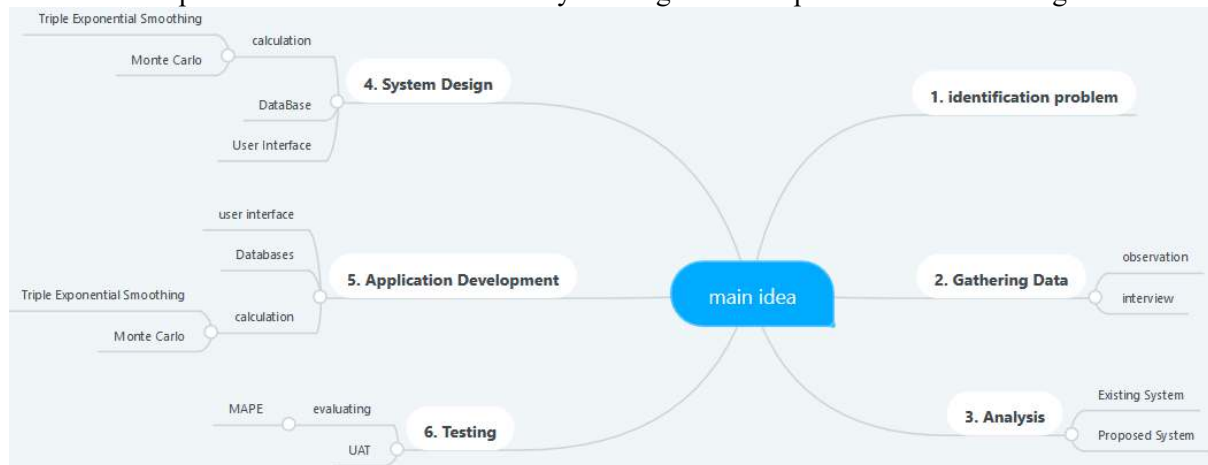


Figure 1. Research mind map

They are six steps according to figure 1 to complete this study. First step are to identify what kind problem we got and second steps to define what kind data does we need to gather base on the problem. For gathering the data we need to direct observe and do some interviews to the breeders. Next step are to analysis existing systems and define to new way to provide predictive information to breeders. It is very important to define Triple Exponential Smoothing and Monte Carlo Algorithm to programable language and define some other requisite such as user interface and databases. fourth step are to develop the application dan finally after developing the application, we done some test related to compared algorithm.

In designing calculation for forecasting we were using 2 kind method with MAPE method to evaluate. Those method are Triple Exponential Smoothing and Monte Carlo, that also very common in prediction method. In the Exponential Smoothing method, basically past data is processed by weighting exponentially downward to the value of older observations or newer values given a relatively greater weight than the value of older observations. In this Exponential Smoothing method, we have considered random, trend and seasonal influences on past data to be processed.

The equation needed for quadratic smoothing is more complicated than the form of single smoothing and linear equations. Nevertheless, these forecasts can follow the quadratic trend changes.[6]

The formula used for triple exponential smoothing is[4]:

$St' = \alpha Xt + (1 - \alpha) St-1'$	(1) Information :
$St'' = \alpha St' + (1 - \alpha) St-1''$	(2) $St' =$ single exponential smoothing value
$St''' = \alpha St'' + (1 - \alpha) St-1'''$	(3) $St'' =$ double exponential smoothing value
$at = 3 St' - 3 St'' + St-1'''$	(4) $St''' =$ triple exponential smoothing value
$bt = \alpha/2(1 - \alpha)^2 [(6-5\alpha) St' - (10 - 8\alpha) St'' + (4 - 3\alpha) St''']$	(5) $at =$ average value for period t
$ct = \alpha^2/(1 - \alpha^2)[St' - 2 St'' + St''']$	(6)
$F t+m = at + bt m + \frac{1}{2} ct m^2$	(7)
	(8)

Monte Carlo method is numerical analysis that involving the experiment sample of randomized number. [14]

$$\frac{n}{N} = \int_s^w f(x)dx / [i(w - s)] \quad (9)$$

The average absolute error percentage or Mean Absolute Percentage Error (MAPE) is calculated by finding the absolute error of each period, then dividing it by the observation value in that period and finally averaging this absolute percentage.[5] The formula for calculating MAPE is(10):

$$MAPE = \frac{100\%}{n} \sum \left| \frac{y - y'}{y} \right| \quad (10)$$

3. RESULT

3.1 Calculation of the Triple Exponential Smoothing Method

In this method, the data used are breeder harvest data from 2013 to 2014. Where in the Triple Exponential Smoothing method calculation, there is a smoothing constant symbolized by alpha (α) where the value of α is between 0 to 1. To find the value of α , the formula is used mean absolute percentage error (MAPE), with a value of $\alpha = 0.1$ to $\alpha = 0.9$ so that the MAPE value is obtained:

Table 1. MAPE calculation result

α	MAPE	α	MAPE
0.1	27.03%	0.6	26.15%
0.2	18.38%	0.7	36.29%
0.3	12.10%	0.8	49.19%
0.4	15.13%	0.9	67.59%
0.5	19.05%		

(a)

(b)

From the results of the table 1, it can be concluded that the smallest MAPE is with a counterfeiting constant value $\alpha = 0.3$ with a MAPE value of 12.10%. To predict the next profit value using the value $\alpha = 0.3$.

Table 2. MAPE Calculation Result

Harvest Period	St'	St''	St'''	at	bt	ct	Prediction (F)	PE	APE
1	25,400,000.00	25,400,000.00	25,400,000.00	25,400,000.00	0.00	0.00			
2	29,648,000.00	26,674,400.00	25,782,320.00	34,703,120.00	3,249,720.00	382,320.00	Rp38,144,000	3.58	3.58
3	37,163,600.00	29,821,160.00	26,993,972.00	49,021,292.00	7,431,642.00	829,332.00	Rp56,867,600	-3.96	3.96
4	38,377,520.00	32,388,068.00	28,612,200.80	46,580,556.80	4,667,554.80	406,576.80	Rp51,451,400	-24.85	24.85
5	47,170,064.00	36,822,666.80	31,075,340.60	62,117,532.20	8,799,972.30	844,911.00	Rp71,339,960	-5.40	5.40
6	50,173,644.80	40,827,960.20	34,001,126.48	62,038,180.28	6,395,631.48	462,646.08	Rp68,665,135	-20.08	20.08
7	58,512,551.36	46,133,337.55	37,640,789.80	74,778,431.24	8,993,744.12	713,877.44	Rp84,129,114	-7.90	7.90
8	69,972,535.95	53,285,097.07	42,334,081.98	92,396,398.63	12,595,508.63	1,053,628.86	Rp105,518,722	-9.11	9.11
9	75,032,025.17	59,809,175.50	47,576,610.04	93,245,159.04	9,361,797.11	549,235.87	Rp102,881,574	-18.48	18.48
10	71,092,417.62	63,194,148.13	52,261,871.47	75,956,679.91	505,761.73	-557,266.63	Rp76,183,808	-23.08	23.08
11	67,547,192.33	64,500,061.39	55,933,328.44	65,074,721.26	-3,932,076.40	-1,013,804.45	Rp60,635,743	-2.30	2.30
12	54,528,034.63	61,508,453.36	57,605,865.92	36,664,609.72	-13,319,358.79	-1,998,919.50	Rp22,345,791	7.47	7.47
13	57,054,624.24	60,172,304.63	58,375,797.53	49,022,756.38	-5,999,612.37	-902,605.86	Rp42,571,841	32.37	32.37
14	54,617,236.97	58,505,784.33	58,414,793.57	46,749,151.49	-5,443,020.76	-730,935.57	Rp40,940,663	16.33	16.33
15	56,292,065.88	57,841,668.80	58,242,856.14	53,594,047.39	-1,753,938.48	-210,933.47	Rp51,734,642	14.06	14.06
16	51,947,446.12	56,073,401.99	57,592,019.89	45,214,152.27	-4,242,577.33	-478,898.81	Rp40,732,126	2.58	2.58
17	55,872,212.28	56,013,045.08	57,118,327.45	56,695,829.06	854,886.05	177,143.80	Rp57,639,287	11.37	11.37
18	58,619,548.60	56,794,996.13	57,021,328.05	62,494,985.44	2,728,198.48	376,693.05	Rp65,411,530	-0.59	0.59
19	71,332,484.02	61,156,242.50	58,261,802.39	88,790,526.94	11,271,527.29	1,337,473.73	Rp100,730,791	0.26	0.26
20	69,312,738.81	63,603,191.39	59,864,219.09	76,992,861.35	4,316,984.46	361,942.37	Rp81,490,817	-26.15	26.15
								MAPE	12.10

As following result from table 2, formula for predicting profits with the triple exponential smoothing method like lemma (8) in *at* is the value of *at* at the 20th harvest, *bt* is the value of *bt* at the 20th harvest,

ct is the value of CT at the 20th harvest, m is a prediction for how many harvests, for example we predict for the next harvests then Calculations for the next harvests are:

$$\begin{aligned} Ft + m &= at + bt (m) + \frac{1}{2} ct (m^2) \\ F20 + 2 &= at + bt (2) + \frac{1}{2} ct (2^2) \\ &= 76,992,861.35 + \{(4,316,984.46) * (2)\} + \{\frac{1}{2} * (361,942.37) * (2^2)\} \\ &= 86,350,715 \end{aligned}$$

The predicted value of profits for the next harvests uses the value $\alpha = 0.3$ of **Rp. 86,350,715**.

3.2. Calculation with Monte Carlo

In the calculation using the Monte Carlo method the data used is the same data as the data used in the Triple Exponential Smoothing method, namely breeders' harvest data from 2013 to 2014. In making a prediction using the monte carlo calculation there are several steps, namely:

1. Looking for the lowest value of the actual data the lowest value = 24,150,000
2. Look for the highest value from the actual data highest value = 100,996,009
3. Look for the value of the profit interval for 10 intervals
interval distance = (highest value - lowest value) / 10
= (100,996,009 - 24,150,000) / 10 = 7,684,600
4. Then make a profit interval with 7,684,600, so we get a Monte Carlo prediction value:

Table 3. Monte Carlo Prediction Value

Random	Prediction (Rp.)	Random	Prediction (Rp.)
0.2	43.361.502	0.98	97.153.709
0.66	66.415.305	0.37	58.730.704
0.24	43.361.502	0.67	66.415.305
0.44	58.730.704	0.56	66.415.305
0.3	51.046.103	1	97.153.709
0.33	51.046.103	0.89	89.469.108
0.69	66.415.305	0.9	97.153.709
0.79	66.415.305	0.77	66.415.305
0.74	66.415.305	0.83	81.784.507
0.69	66.415.305	0.62	66.415.305

(a)

(b)

Based on table 3, we provide the randomize number to been used for Monte Carlo calculation instead and the prediction value, the harvest value will be calculated against the MAPE value to produce:

Table 4. MAPE value with Monte Carlo

Harvest Period	Profit (Rp.)	Random	Prediction (Rp.)	PE = (x-F)/x*100	APE = absolute PE
1	25.400.000	0.2	43.361.502	-70.71	70.71
2	39.560.000	0.66	66.415.305	-67.88	67.88
3	54.700.000	0.24	43.361.502	20.73	20.73
4	41.210.000	0.44	58.730.704	-42.52	42.52
5	67.686.000	0.3	51.046.103	24.58	24.58
6	57.182.000	0.33	51.046.103	10.73	10.73
7	77.970.000	0.69	66.415.305	14.82	14.82
8	96.712.500	0.79	66.415.305	31.33	31.33
9	86.837.500	0.74	66.415.305	23.52	23.52
10	61.900.000	0.69	66.415.305	-7.29	7.29
11	59.275.000	0.98	97.153.709	-63.90	63.90
12	24.150.000	0.37	58.730.704	-143.19	143.19
13	62.950.000	0.67	66.415.305	-5.50	5.50
14	48.930.000	0.56	66.415.305	-35.74	35.74
15	60.200.000	1	97.153.709	-61.38	61.38

Harvest Period	Profit (Rp.)	Random	Prediction (Rp.)	PE = $(x-F)/x \times 100$	APE = absolute PE
16	41.810.000	0.89	89.469.108	-113.99	113.99
17	65.030.000	0.9	97.153.709	-49.40	49.40
18	65.030.000	0.77	66.415.305	-2.13	2.13
19	100.996.000	0.83	81.784.507	19.02	19.02
20	64.600.000	0.62	66.415.305	-2.81	2.81
MAPE = $AVG(\sum APE)$					40.56

As following table 4, the calculation above using the Monte Carlo method, the MAPE value of 40.56% is obtained. To make predictions for the next 2 harvests, the Monte Carlo method is used to find a random value 2 times between 0 to 1 using the help of excel, and obtained as the following table:

Table 5. Monte Carlo random prediction value result

Harvest	Random Value
1	0.67
2	0.66

From the table 5, we get the random value for the next 2 harvests is **0.66**. The predictive value of **0.66** goes into interval 6 which has a middle value of 66,415,305. So, the profit prediction using the Monte Carlo method (9) for the next 2 harvests is Rp. **66,415,305**.

3.3 Prediction Report Comparison

This chart deliver a comparison between Triple Exponential Smoothing method and Monte Carlo Method with the existing data.

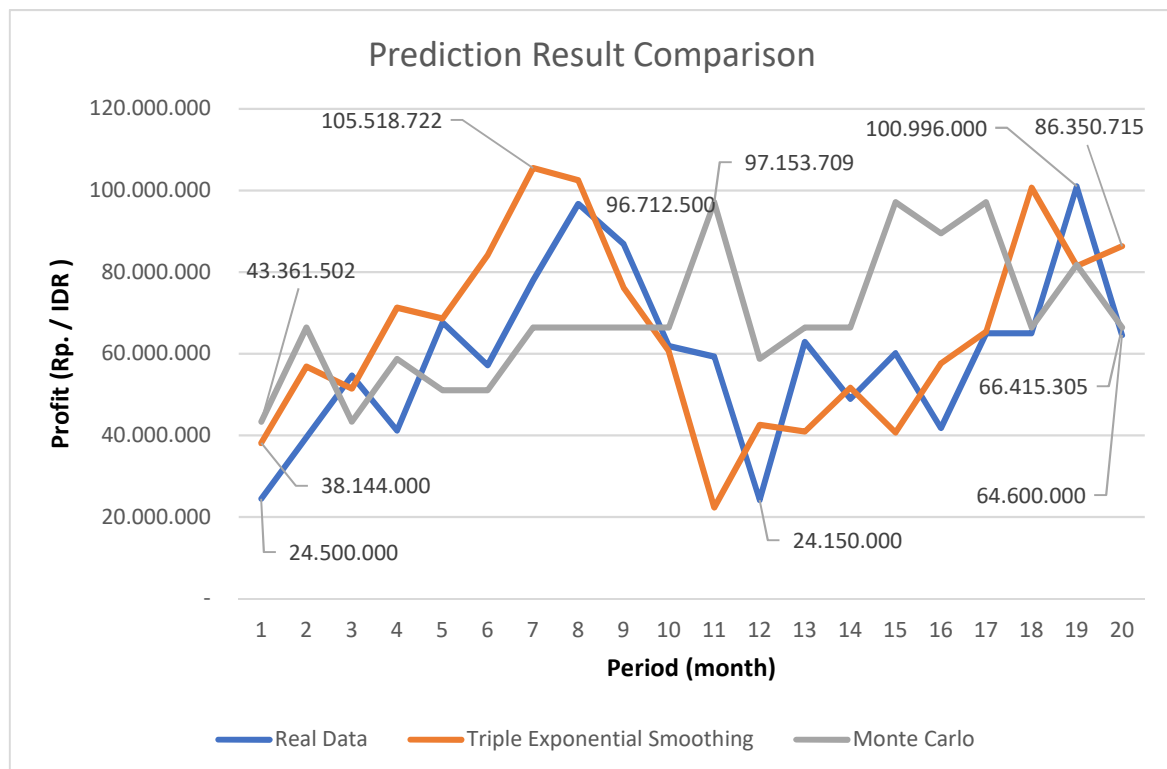


Figure 1. Triple Exponential smoothing and Monte Carlo prediction result

4. Conclusions

From the results of the predictions comparing the two methods the following conclusions are obtained result of profit prediction for the next harvest periods is that the profit prediction using Triple Exponential Smoothing method is Rp. 86,350,715, and profit prediction using the Monte Carlo method is Rp. 66,415,305. Difference between the two methods' profit prediction is Rp. 19,935,410. From the calculation of the Mean Absolute Percentage Error (MAPE), the Triple Exponential Smoothing method produces a **MAPE** value of **12.10%** with a value of $\alpha = 0.3$ and the Monte Carlo method produces a **MAPE** value of **40.58%**.

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