WEIGHT OPTIMIZATION *WEIGHTED MOVING AVERAGE* WITH *PARTICLE SWARM OPTIMIZATION* IN PREDICTION OF RUBBER PRODUCTION LEVELS

Dendy Fadhel Adhipratama[1], Irwan Budiman[2], Fatma Indriani[3], Radityo Adi Nugroho[4], Rudy Herteno[5]
[12345]Ilmu Komputer FMIPA ULM
Jl. A. Yani. KM 36 Banjarbaru, Kalimantan Selatan
Email : j1f114216@mhs.ulm.ac.id[1], irwan.budiman@ulm.ac.id[2], f.indriani@ulm.ac.id[3], raditYo.adi@ulm.ac.id[4],

ABSTRACT

Rubber is a mainstay commodity in the country, in 2014 Indonesia ranked second as the largest natural rubber producing country in the world. However, rubber production in Indonesia experiences uncertain ups and downs so it is necessary to predict it in order to benefit small farmers and the state. *Weighted Moving Average (* WMA) is a method for predicting time series data. However, the parameters on the WMA need to be optimized in order to get optimal weight results on the WMA and get accurate results. Algorithm *Particle Swarm Optimization* implemented to determine the weight value of the method *Weighted Moving Average* more optimal. PSO-WMA and WMA were carried out on three weights, namely from weighting 3 4 and 5 on rubber production data. So that the results of this study are WMA with 3 weights get 81% accuracy, 4 weight 80.5% and 5 weight 80.3%. And for PSO-WMA, the accuracy at weighting 3 is 81.4%, weighting 4 is 80.9% and for weighting 5 it is 81.6%. The test results of this study have the effect of the weight value on WMA in increasing the accuracy results.

Keywords: Rubber Production, Prediction, *Weighted Moving Average, Particle Swarm Optimization*

1. Introduction

The many methods of forecasting (*forecasting*), which is also supported by progress computer technology can assist companies in identifying future conditions the expected future. One method that is often used is a method *Weighted Moving Average*. The *Weighted Moving Average* method is a forecasting method use moving averages and have different weights for each historical data available past data, assuming that the most recent historical data are given greater weight than older historical data. Advantages of this method the weight value given can be adjusted. In determining the weight value the right one will affect the results of the accuracy of the Weighted Moving Average method the. But in fact according to research from Ade Abdul Gofur (2013) in determine a weight value only given the

desired value and To determine the optimal weight value has been very difficult. Then a weighting optimization is needed in order to determine a more optimal weight value. There are several techniques that can be used in determining the weight value of the WMA one of them is (*Particle Swarm Optimization*) PSO. In previous research conducted by Ali Ridla in 2018 states that the optimization algorithm *Particle Swarm Optimization* (PSO) can be used to determine weight values attribute in structured Artificial Neural Network (ANN) method Backpropagation. Based on the background description, related research will be carried out effect of the results of forecasting accuracy Weighted Moving Average after optimization weights using the Particle Swarm Optimization algorithm in forecasting rubber production rate. The type of data used in this study is time data series of rubber production at PT Darma Kalimantan Jaya in the form of production monthly from January 2013 to July 2019.

2. Research Methodology

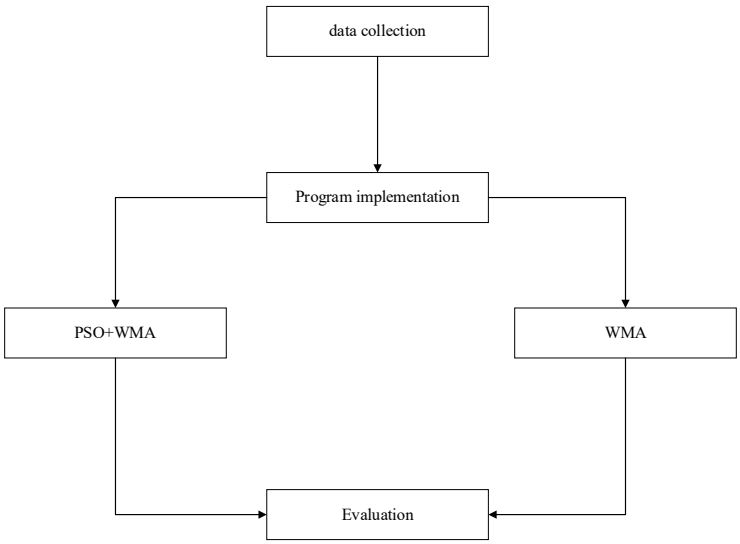

Figure 1. Research Flow

2.1 Data Collection

Data obtained after direct interviews with the rubber company manager PT Darma Kalimantan Jaya, the data used is in the form of monthly rubber production data fromJanuary 2013 to July 2019.

2.2 Implementation

The data is implemented by two algorithms including:

a. Weighted Moving Average

Weighted Moving Average (WMA) is a weighted moving average or which has weight. The *Weighted Moving Average* method is a method has a technique of giving weight to each of its historical data but deep giving the weight is given a

different value for each weight that is on historical data. Thus it is assumed that the most historical data end or historical data that is close to the data that you want to forecast to have weight value that is greater than the weight that exists in other historical data. Weight which is given must be in such a way as to conform to one another so that the whole number is the same. The formula for the *Weighted Moving Average* method is as follows:

$$\frac{Wt_{-1}At_{-1} + Wt_{-2}At_{-2} + \ldots + Wt_{-n}At_{-n}}{Wt_{-1} + Wt_{-2} + \ldots + Wt_{-n}}$$

Information :

Ft = forecasting data for future periods
Wt = Weight given for the time period –t
N = The number of periods averaged
At -1 = Actual number of the previous period to period –n

b. PSO + Weighted Moving Average

The data is also processed using the combined PSO algorithm with the Weighted Moving Average method which is the total weight of the WMA will be searched with several variations of the weights to determine the amount of that weight optimal and to find the optimal weight value will be optimized first previously with the PSO algorithm which consists of 20 particles and each particle consists of several variations in the number of weights and the weight value with each value on particles are determined the initial value from smallest to largest. Step off *Particle Swarm Optimization* and *Weighted Moving Average* methods as the following:

a. The first step is to initialize the value of the total weights in the *Weighted* method *Moving Average of* each value entered in the *Weighted* method *Moving Average* must be in order from smallest to largest.
b. Particle initialization, the initial velocity of each particle is 0
c. Evaluate each particle using the *Weighted Moving* method *Average*
d. Calculate the fitness value
$$\frac{1}{1 + MAPE}$$
e. Update the w value on the PSO
$$w = w_{max} - iter * \frac{w_{max} - w_{min}}{itermax}$$
f. Update C1 and C2
$$c_1 = \left(c_{1f} - c_{1i}\right) * \frac{iter}{itermax} + c_{1i}$$

$$c_2 = \left(c_{2f} - c_{2i}\right) * \frac{iter}{itermax} + c_{2i}$$

g. Update Velocity
$v'_{id} = w * v_{id} + c_1 * r_1 * (p_{id} - x_{id}) + c_2 * r_2 * (p_{gd} - x_{id})$
h. Position Update
$x'id = x'id + v'id$
i. Pbest update
j. Gbest update
k. Repeat from step (c- j) as many iterations as specified
l. If it has been repeated as many iterations as specified, the optimal value of the *Weighted Moving Average* method is obtained
m. Done

Description
w : inertia weight on the *Particle Swarm Optimization* method
The following is an example of a forecasting flowchart in the *Weighted Moving* method *Average* and *Particle Swarm Optimization*.

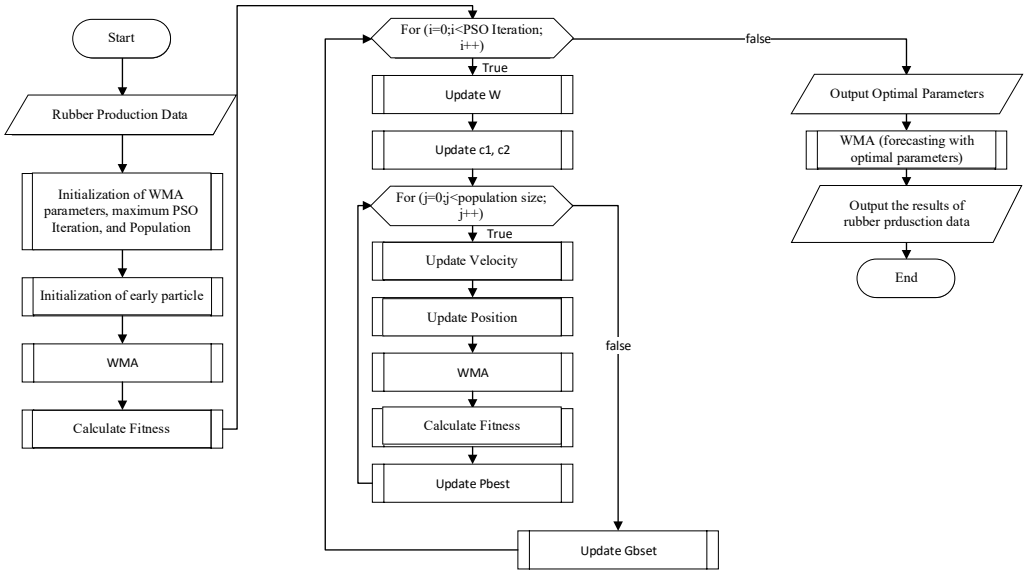

Figure 2. PSO + WMA Flowchart

2.3 Evaluation

After processing the data with 2 methods, it will be done comparison between the Weighted Moving Average method with the method combined between PSO and Weighted Moving Average as seen from the MAPE value if the mape value in one of the methods has a value the smaller the accuracy will be better.

2.4 Done

After obtaining the MAPE value of the two methods, which one will be seenwhich has the smallest MAPE value which would be the more suitable method in this research.

3. Results and Discussion

3.1 Results

The data used in this study is PT Darma's rubber production data Kalimantan Jaya in the period 2013 to August 2019 with the amount of data as many as 79 data. The following is an example of rubber production data at PT Darma Kalimantan Jaya. The data will be predicted using two methods, namely the *weighted moving average* method combined with the *Particle Swarm* method *Optimization* and comparison with the *Weighted Moving Average* method.

Table 1. Examples of data used

Year	Month	Production (Kg)
	January	1.580
	February	1.500
	March	1528
2014	April	1.317
	May	1.024
	June	1.513
….	….	….
….	….	….
….	….	….
….	….	….
	January	982
	February	1.067
	March	1.200
2019	April	1.581
	May	1.575
	June	1.287
	July	1.602

3.1.1 Calculations using the WMA + PSO method

The calculation using the WMA + PSO method uses 3 weights, 4 weighting and 5 weighting. Where the initial position values are as follows:

1. The starting position of the weighting 3

Table 2. weighting starting position 3

Particle	Value		
	1	2	3
1	0.1	0.2	0.7
2	0.7	0.9	1.1
3	1.3	1.5	1.7
4	1.9	2.1	2.3
5	2.5	2.7	2.9

6	3.1	3.3	3.5
7	3.7	3.9	4.1
8	4.3	4.5	4.7
9	4.9	5.1	5.3
10	5.5	5.7	5.9
11	6.1	6.3	6.5
12	6.7	6.9	7.1
13	7.3	7.5	7.7
14	7.9	8.1	8.3
15	8.5	8.7	8.9
16	9.1	9.3	9.5
17	9.7	9.9	10.1
18	10.3	10.5	10.7
19	10.9	11.1	11.3
20	11.5	11.7	11.9

2. The starting position of the weighting 4

Table 3. weighting starting position 4

Particle	Value			
	1	2	3	4
1	0.001	0.002	0.003	0.004
2	0.005	0.006	0.007	0.008
3	0.009	0.011	0.012	0.013
4	0.014	0.015	0.016	0.017
5	0.018	0.019	0.021	0.022
6	0.023	0.024	0.025	0.026
7	0.027	0.028	0.029	0.031
8	0.032	0.033	0.034	0.035
9	0.036	0.037	0.038	0.039
10	0.041	0.042	0.043	0.044
11	0.045	0.046	0.047	0.048
12	0.051	0.052	0.053	0.054
13	0.055	0,056	0.057	0.058
14	0.059	0.061	0.062	0.063
15	0.064	0,065	0.066	0.067
16	0.068	0.069	0.071	0.072
17	0.073	0.074	0.075	0.076
18	0.077	0.078	0.079	0.081
19	0.082	0.083	0.084	0.085
20	0.086	0.087	0.088	0.089

3. The starting position of the weighting 5

Table 4. weighting starting position 5

Partikel	Nilai				
	1	2	3	4	5
1	0.001	0.0025	0.003	0.004	0.0055
2	0.006	0.0075	0.008	0.0095	0.01
3	0.0015	0.0028	0.0038	0.0047	0.0058
4	0.06	0.07	0.08	0.09	1
5	0.001	0.002	0.03	0.045	0.5
6	0.0065	0.07	0.085	0.09	1
7	0.03	0.07	0.08	0.4	0.5
8	0.6	0.75	0.8	0.9	1
9	0.01	0.02	0.03	0.04	0.1
10	0.004	0.007	0.08	0.09	0.7
11	0.001	0.02	0.3	0.7	0.9
12	0.024	0.07	0.08	0.3	1
13	0.04	0.2	0.3	0.6	0.8
14	0.009	0.02	0.06	0.09	0.9
15	0.1	0.2	0.3	0.4	0.5
16	0.000	0.001	0.005	0.09	0.8
17	0.6	0.7	0.8	0.9	1
18	0.005	0.01	0.06	0.09	0.7
19	0.003	0.02	0.1	0.4	0.5
20	0.067	0.07	0.083	0.1	1

After optimization or iteration 50 times using the method *Particle Swarm Optimization* results in optimal forecasting and the optimal weights are as follows:

1. Results of optimal value and forecasting at weighting 3

Table 5. Mape weighting results 3

Weighting 3				
Method	Value 1	Value 2	Value 3	Mape
PSO+WMA	0,080394	0,745061	0,819019	18,624

Table 6. weighted results 3

actual data	forecasting data
2.048	1911,102
1.786	1780,95
1.927	1514,543
1.711	1456,922
1.294	1497,332

1.454	1473,921
...	...
...	...
1067	976,491
1200	1033,783
1581	1126,837
1575	1390,766
1287	1510,904
1602	1414,242

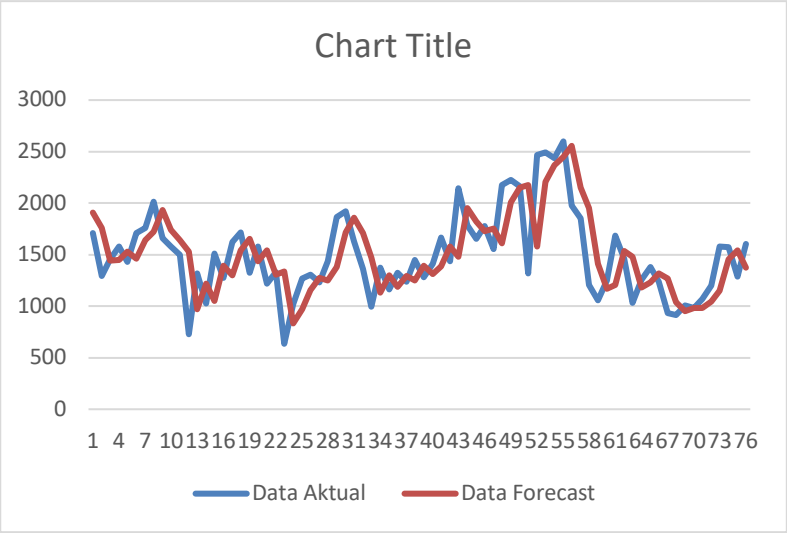

Figure 3.Graph of WMA + PSO at weighting 3

2. Results of optimal value and forecasting at weighting 4

Table 7. Mape weighting results 4

Weighting 4					
Method	Value 1	Value 2	Value 3	Value 4	Mape
PSO+WMA	-0,00011	0,001146	0,002146	0,003146	19,04

Table 8. weighted results 4

actual data	forecasting data
1711	1824,5
1294	1594,9
1454	1504,7
1581	1498,5
1430	1466,5
1712	1575,4

...	...
...	...
982	970,6
1200	1014
1581	1097
1575	1304
1287	1451
1602	1423,5

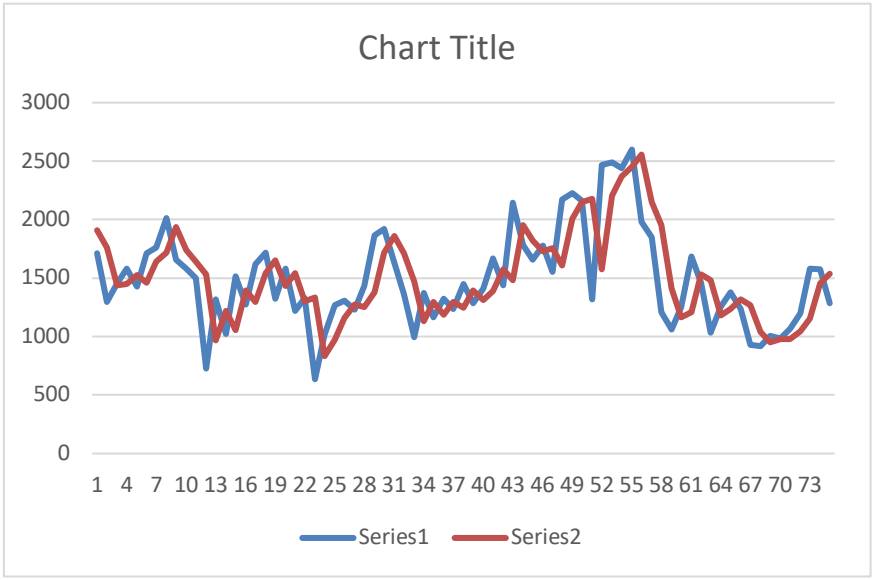

Figure 4. Graph of WMA + PSO under weighting 4

3. Results of optimal values and forecasting at weighting 5

Table 9. Mape weighting results 5

Weighting 5						
Method	Value 1	Value 2	Value 3	Value 4	Value 5	Mape
PSO+WMA	0,05778	0,151564	0,20659	1,094328	1,382494	18,325

Table 10. weighted results 5

actual data	forecasting data
1454	1537,795
1581	1443,239
1430	1526,181
1712	1487,324
1762	1574,097
...	...
...	...
1200	1019,788

1581	1118,227
1575	1357,27
1287	1512,027
1602	1407,994

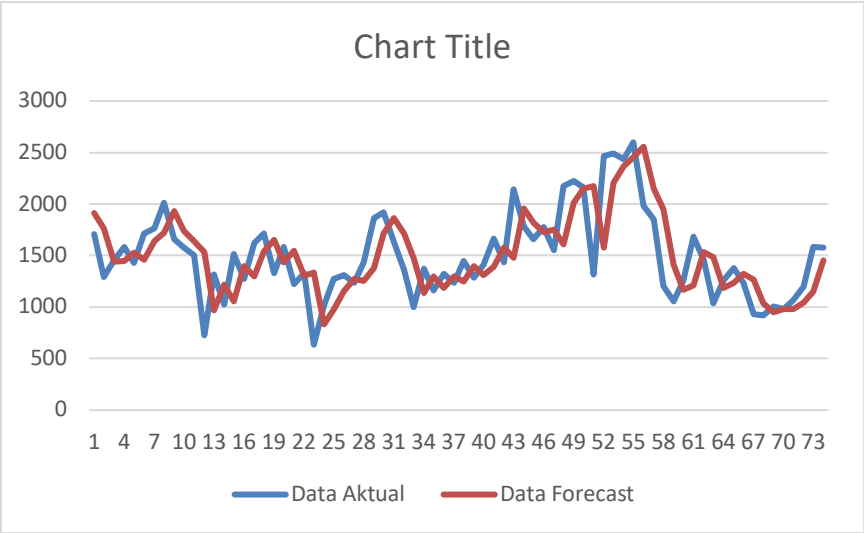

Figure 5.WMA + PSO graph at weighting 5

So that the optimal value results are obtained and Mape can be calculated. The accuracy of forecasting using WMA + PSO is as follows:

1. Accuracy of weight 3 = 100% - 18.624% = 81.376%
2. Accuracy of weight 4 = 100% - 19.04% = 80.96%
3. Accuracy of weight 5 = 100% - 18.325% = 81.675%

3.1.2 Calculation using WMA

Calculations using the WMA method also use 3 weights,4 weighting and 5 weighting. Where the value of the initial position and the result of the forecast is as follows :

1. Calculation of WMA using weight 3

Table 11. Mape weighting results 3 WMA

Weighting 3			
Value 1	Value 2	Value 3	Mape
0,1	0,2	0,7	18,994

Table 12. weighted results 3 WMA

actual data	forecasting data
1711	1910,9

1294	1761,7
1454	1440,7
1581	1447,7
1430	1526,9
1712	1462,6
...	...
...	...
1005	951,1
982	979,8
1067	980
1200	1043,8
1581	1151,6
1575	1453,4

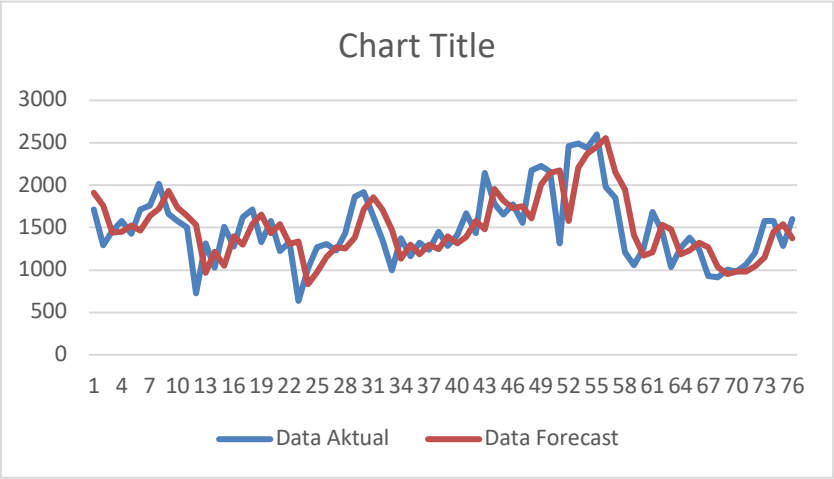

Figure 6.WMA forecasting graph using weight

2. Calculation of WMA using weight 4

Table 13. Mape weighting results 4 WMA

Weighting 4				
Value 1	Value 2	Value 3	Value 4	Mape
0,1	0,2	0,3	0,4	19,446

Table 14. weighted results 4 WMA

actual data	forecasting data
1711	1824,5
1294	1594,9
1454	1504,7
1581	1498,5
1430	1466,5

1712	1575,4
...	...
...	...
982	970,6
1067	1014
1200	1097
1581	1304
1575	1451
1287	1423,5

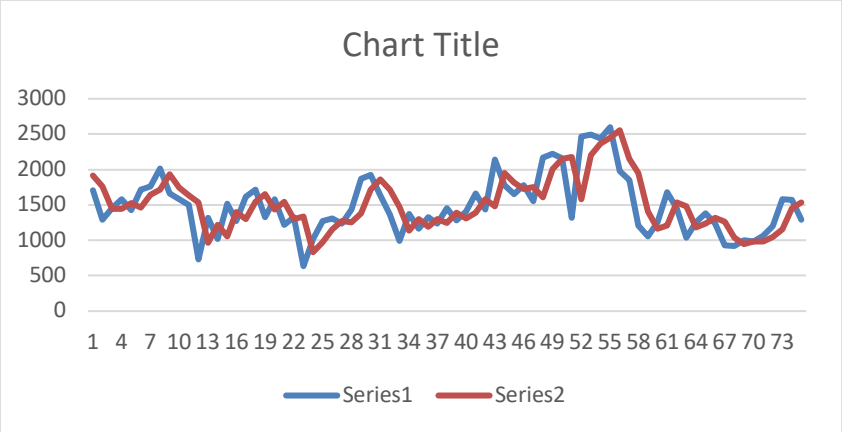

Figure 7.WMA forecasting graph using weight 4

3. Calculation of WMA using a weight of 5

Table 15. Mape weighting results 5 WMA

Weighting 5					
Value 1	Value 2	Value 3	Value 4	Value 5	Mape
0,1	0,2	0,3	0,4	0,5	19,678

Table 16. weighted results 5 WMA

actual data	forecasting data
1711	1647,67
1294	1547,93
1454	1530,13
1581	1475,67
1430	1548,33
1712	1637,6
1762	1780
...	...
...	...
916	1022,33

1005	985,13
982	1002,73
1067	1076
1200	1258,33
1581	1394,33
1575	1396,33

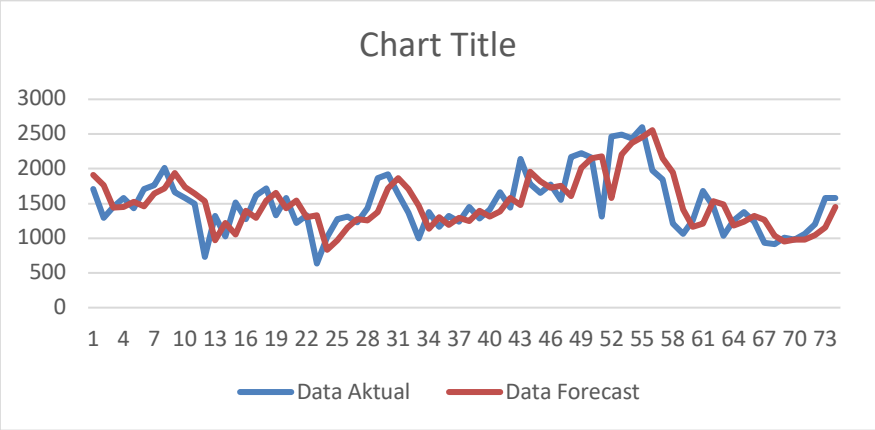

Figure 8.The graph of WMA calculation using weights 5

After the calculation is done using the *Weighted Moving Average* method by using the weightings of 3, 4 and 5, the accuracy of the three results is obtained the weighting is as follows:

1. Accuracy using a weighting of 3 = 100% - 18.994 = 81.006%
2. Accuracy using a weighting of 4 = 100% - 19.446 = 80.55%
3. Accuracy using a weighting of 5 = 100% - 19.678 = 80.332%

3.1.3 Comparison of accuracy results

The results of the calculation of the two methods are compared by looking at the mape level obtained if the mape level is smaller, the resulting accuracy will be more great anyway. So that the accuracy obtained can be found in a good method forecasting using data that has been researched. Here is a comparison of accuracy obtained from both methods and compared:

1. Comparison of weighting accuracy 3

Table 17. weighting ratio 3

Weighting 3					
Method	Value 1	Value 2	Value 3	Mape	Accuracy
PSO+WMA	0,080394	0,745061	0,819019	18,624	81,38%
WMA	0,1	0,2	0,7	18,994	81,01%

2. Comparison of weighting accuracy 4

Table 18. weighting ratio 4

Weighting 4						
Method	Value 1	Value 2	Value 3	Value 4	Mape	Accuracy
PSO+WMA	-0,00011	0,001146	0,002146	0,003146	19,04	80,96%
WMA	0,1	0,2	0,3	0,4	19,446	80,55%

3. Comparison of weighting accuracy 5

Table 19. weighting ratio 5

Weighting 5							
Method	Value 1	Value 2	Value 3	Value 4	Value 5	Mape	Accuracy
PSO+WMA	0,05778	0,151564	0,20659	1,094328	1,382494	18,325	81,68%
WMA	0,1	0,2	0,3	0,4	0,5	19,678	80,33%

4. Discussion

Based on the MAPE results obtained in this study, which are the results of the overall weighting in the *Weighted Moving Average* method that has been optimized by the *Particle Swarm Optimization* method shows the MAPE results tends to be smaller than the *Weighted Moving Average* method only. So that the results of the accuracy of the optimized *Weighted Moving Average* method with the *Particle Swarm Optimization* method at a weighting of 5 as much as 81.675%. while the *Weighted Moving Average* method uses a weighting of 5 as much as 80.322%. At 4 in the method of weighting *Weighted Moving Average* that has been optimized using the *Particle Swarm Optimization* method , the results are obtained the accuracy is 80.96% and at a weighting of 4 the *Weighted Moving Average* method the results obtained with an accuracy of 80.55%. While the 3 *weighted weighted moving* method *Average* that has been optimized with the *Particle Swarm Optimization* method is obtained the results of the accuracy of 81.376% and the weighting of 3 methods of *Weighted Moving Average* the results obtained were 81.006% accuracy.

5. Closing

5.1.1 Conclusion

From the research that has been done, the conclusions that can be drawn are as followsthe following:

1. The effect of the *Particle Swarm Optimization* method can optimize the weight valuein the *Weighted Moving Average* method on rubber

production data obtained results the optimal weight is from a weighting of 5 is 0.05778, 0.151564, 0.20659, 1.094328, and 1.382494.

2. The level of accuracy of the *weighted moving average* method that is optimized with *Particle Swarm optimization* method obtained the best accuracy results at a weighting of 5 with a MAPE of 18.325% and the accuracy value obtained by 81,675%.

5.1.2 Suggestions

The suggestions and suggestions that can be given based on this research are as followsthe following:

1. In a subsequent study using *Wighted Moving Average* that optimized with the *Particle Swarm Optimization* method with data different.
2. In further research, other optimization methods can be used optimize the weight value in the *weighted moving average* method.

References

[1] Rusmalawati, Furqon. 2018. *Forecasting Stock Prices Using the Method Support Vector Regression (SVR) With Particle Swarm Optimization (PSO)* . Journal of the development of Information Technology and Computer Science Vol. 2 No. 5.

[2] Ridla. 2018. Particle Swarm Optimization as a Determinant of Weight ValueArtificial Neural Network Based on Backpropagation for Level PredictionSales of Pertamina Lubricants. Vol 3 No 1.

[3] Erlin, Anggyi, Much. 2018. Forecasting Inflation Rate Using Support VectorRegression Bassed Particle Swarm Optimization . Scientific Journal ofInformatics, Vol. 5 No/1 Nov 2018.

[4] Akmal, 2018. Rubber Production Forecasting Using the Weighted MethodMoving Average . STMIK Royal - AMIK Royal. Pp. 133 - 138.