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FORECASTING UNEMPLOYMENT IN INDONESIA USING WEIGHTED MOVING AVERAGE METHOD

Havid Syafwan[1*], Pristiyanilicia Putri[2], Mahdhivan Syafwan[3]
[1]Manajemen Informatika, Sekolah Tinggi Manajemen Informatika dan Komputer Royal
[2]Sistem Informasi, Sekolah Tinggi Manajemen Informatika dan Komputer Royal
[3]Matematika dan Ilmu Pengetahuan Alam, Universitas Andalas
email: havid_syafwan@yahoo.com

Abstract: Unemployment is a global economic issue that directly impacts human life in both developed and developing countries, especially in Indonesia, which, if ignored, will severely impact society's social dynamics. To overcome this problem, forecasts are made so that later, the government can take policies to control and suppress the unemployment growth rate. This research aims to predict unemployment in Indonesia in 2023 using the Weighted Moving Average method, widely used to determine the trend of a time series, which is part of one of the Time Series methods that gives different weights. The dataset used was obtained from the Central Statistics Agency (BPS) relating to unemployment data from 2000 to 2022 (23 years). To analyze the level of accuracy of the results of this unemployment forecast using the MAD, MSE, and MAPE methods. This research concludes that the Weighted Moving Average method can be applied in predicting unemployment in Indonesia in 2023. The results of this research are a prediction of the number of unemployed in Indonesia, as many as 8,874,942 people at a weight value of 3 (three) where the accuracy of the MAD value is 745786.1833, the MSE value is 948402050986.3 and MAPE is 8.28%.

Keywords: forecasting; unemployment; weigth moving average; indonesia

Abstrak: Pengangguran menjadi isu ekonomi global yang berdampak secara langsung terhadap tingkat kehidupan manusia di negara-negara yang sudah maju maupun yang sedang berkembang khususnya di negara Indonesia, yang jika diabaikan akan berdampak serius terhadap dinamika sosial masyarakat. Untuk mengatasi permasalahan tersebut dibuatlah peramalan agar nantinya pemerinta dapat mengambil kebijakan dalam mengendalikan dan menekan angka pertumbuhan pengangguran tersebut. Penelitian ini bertujuan untuk memprediksi pengangguran di Indonesia pada tahun 2023 menggunakan metode *Weighted Moving Average* dimana metode ini banyak digunakan untuk menentukan trend dari suatu deret waktu yang merupakan bagian dari salah satu metode *Time Series* yang memberikan bobot yang berbeda-beda. Adapun dataset yang digunakan diperoleh dari Badan Pusat Satatistik (BPS) berkaitan dengan data pengangguran dari tahun 2000 sampai dengan tahun 2022 (selama 23 tahun). Untuk menganalisa tingkat akurasi dari hasil peramalan pengangguran ini memakai metode MAD, MSE, dan MAPE. Kesimpulan dari penelitian ini yaitu dapat diterapkannya metode *Weighted Moving Average* dalam memprediksi pengangguran di Indonesia pada tahun 2023. hasil dari penelitian ini berupa prediksi jumlah pengangguran di Indonesia sebanyak 8.874.942 orang pada nilai bobot 3 (tiga) dimana akurasi nilai MAD sebesar 745786,1833, nilai MSE sebesar 948402050986,3 dan MAPE sebesar 8,28 %.

Kata kunci: peramalan; pengangguran; weigth moving average; indonesia

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INTRODUCTION

Indonesia has the fourth largest population in the world, where the population in 2023 will be 273.52 million people. With the large population in Indonesia, of course, it will have an impact on economic growth. The occurrence of inconsistencies in the current economic growth in Indonesia will undoubtedly impact various sectors of life, one of which is the employment sector, where the number of unemployed people is increasing. Unemployment is the working-age population who do not work or do not yet have a job [1]

The addition of unemployment will impact the community's social life, including increasing the number of poverty, many beggars, homeless people, and buskers. It can also affect the level of crime because of the difficulty in finding work. As a result, many people will commit crimes such as stealing, robbing, and so on to fulfill their lives. Thus it will impact difficulties in meeting subsistence needs so that with the increase in the number of unemployed people, it can trigger high crime cases, which are part of social dynamics [2] .

Therefore, it is necessary to predict unemployment in the future, which the government can later use in adopting a policy to control and suppress unemployment growth so that in the future, it can reduce poverty and criminal cases [3] [4]. We have examined problems related to unemployment before in predicting unemployment in North Sumatra using the Backpropagation method in 2016 [5] And in 2020 using the Double Exponential Smoothing method [6] . Further research has also been carried out regarding unemployment predictions in Asahan Regency using the same way, namely the Weighted Moving Average, where the results obtained are predictions of unemployment in 2021 [7].

The Weight Moving Average (WMA) method is a method that is widely used to determine the trend of a time series which is part of one of the Time Series methods. This method provides future predictions by utilizing previous data and assigning different weights to each data used [8].

The Weight Moving Average method is an improved form of the previous process, namely the Simple Moving Average (SMA), which gives greater weight to newer data than older ones. The weight factor is calculated from the time used in the time series data or the number of digits [9]. This method is widely used in predicting various fields, including the area of employment where one of the problems is unemployment.

From this description, will be developing the research on forecasting the number of unemployed in Indonesia in 2023 using the Weight Moving Average method, where data is obtained from the Central Statistics Agency (BPS) from 2000 to 2022. As for measuring the level of forecasting error in this research using MAD, MSE, and MAPE value [10].

METHOD

The Weighted Moving Average (WMA) method is a technique that is often used to identify trends from a specific time sequence. This technique is used for data whose changes are gradual. This technique involves new actual forecasting data to produce forecasted value estimates in the future. This method can be said to be more proportional to time-series data, namely data that changes over time. [9].

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The advantage of this WMA method is the calculation method's efficiency and the assignment of various weight values to each existing historical data. The assumption is that the most recent historical data has greater weight than older data, given the relevance of the most recent data in the forecasting process. Another advantage of this method is the flexibility in adjusting the weight values as needed, although determining the optimal weight can be challenging [11].

The mathematical equation of the Weighted Moving Average method is:

$$WMA = \frac{\sum(\text{data x } weights)}{\sum weights} \qquad (1)$$

Where:
Data = Actual data in period *t*
weights = Assessment according to the length of the period

Mean Absolute Deviation

The Mean Absolute Deviation (MAD) method evaluates forecasts using the sum of absolute errors to measure forecast accuracy by averaging the estimated errors (the absolute value of each error). The formula for calculating MAD is seen in Equation 2 below.

$$MAD = \frac{\sum_{t=1}^{n}|x_t - F_t|}{n} \qquad (2)$$

Mean Squared Error

Mean Squared Error (MSE) is another method for evaluating forecasting methods. Each error or remainder is squared. Then summed up and added to the number of observations. This method handles large forecasting errors by squaring them. This approach produces moderate errors that may be more effective at dealing with small errors, although they sometimes make a big difference. Mean Squared Error is the average of forecast errors squared, or if written in equation 3.

$$MSE = \frac{\sum_{t=1}^{n}(x_t - F_t)^2}{n} \qquad (3)$$

Mean Absolute Percentage Error

Mean Absolute Percentage Error (MAPE) is the average absolute percentage error where the calculation results from the absolute error value in each period, then divided by the actual data value and the absolute percentage error. The MAPE value can be calculated using the following equation 4.

$$MAPE = \left(\frac{100\%}{n}\right)\frac{\sum_{t=1}^{n}|x_t - F_t|}{x_t} \qquad (4)$$

Where eq (2), (3), and (4) is
x_t = Data actual in period *t*
F_t = Value of forecasting in period *t*
n = Data numbering
t = Periode of forecasting

In forecasting, to measure forecasting accuracy using the MAPE accuracy method, forecasting accuracy results are considered very good if it has a MAPE value of less than 10%. It is crucial to compare calculations with the smallest MAPE because the smaller the MAPE value indicates, the closer the forecasting results are to the actual value [6].

As for measuring the quality level of accuracy in MAPE, it can be seen in the following table:

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Table 1. The quality level of accuracy in MAPE

MAPE Value	Accuracy
MAPE ≤ 10%	High
10% < MAPE ≤ 20%	Good
20% < MAPE ≤ 50%	Reasonable
MAPE ≥ 50%	Low

RESULT AND DISCUSSION

Dataset for forecasting the number of unemployed in Indonesia in 2023 is using data from 2000 to 2022 (for 23 years) in Indonesia. The following table (Table 2) is a recap of historical data on the number of unemployed in Indonesia from the Central Bureau of Statistics (BPS).

Table 2. Unemployment Data in Indonesia for 2000-2022

Period	Year	Number of Unemployment	Period	Year	Number of Unemployment
1	2000	5813231	13	2012	7344866
2	2001	8005031	14	2013	7410931
3	2002	9132104	15	2014	7244905
4	2003	9939301	16	2015	7560822
5	2004	10251351	17	2016	7031775
6	2005	11011142	18	2017	7005262
7	2006	10932000	19	2018	7073385
8	2007	10011142	20	2019	7104424
9	2008	9394515	21	2020	9767754
10	2009	8962617	22	2021	9102052
11	2010	8319779	23	2022	8425931
12	2011	8681392			

From Table 2, unemployment data in Indonesia from 2000 to 2022 can be visualized in the following graphical form:

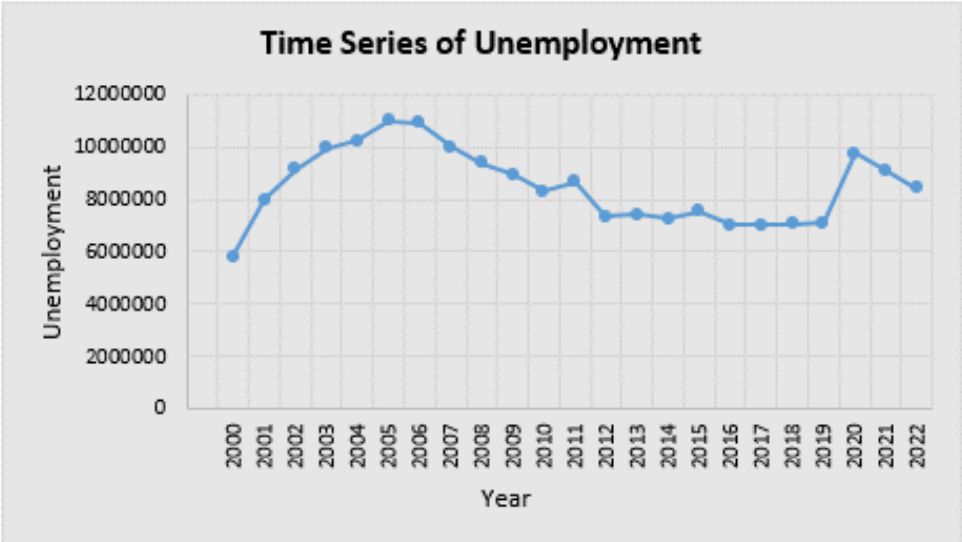

Image 1. Graph of Total Unemployment in Indonesia from 2000 - 2022

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The weight limits in the calculation process for forecasting the number of unemployed in Indonesia using the Weighted Moving Average method only use 3, 4, 5, and 6. The following is one of the manual calculation processes for forecasting unemployment in Indonesia using a weight value = 3:

WMA_4 = ((9132104*3) + (8005031*2) + (5813231 * 1)) / (3+2+1) = 8203267,5

WMA_5 = ((9939301*3) + (9132104*2) + (8005031 * 1)) / (3+2+1) = 9347857

WMA_6 = ((10251351*3) + (9939301*2) + (9132104 * 1)) / (3+2+1) = 9960793,167

WMA_7 = ((11011142 * 3) + (10251351 * 2) + (9939301 * 1)) / (3+2+1) = 10579238,167

…..

WMA_{24} = ((8425931 * 3) + (9102052 * 2) + (9767754 * 1)) / (3+2+1) = 8874941,833

The calculation process using the Weighted Moving Average method is carried out repeatedly for weight values of 4, 5, and 6, which are carried out on unemployment data in Indonesia.

The results of the recapitulation of unemployment forecasting with a weight value = 3 can be seen in Table 3:

Table 3. Actual and Forecasted Unemployment Data in Indonesia for 2000-2023

Period	Year	Number of Unemployment	Forecasting	Period	Year	Number of Unemployment	Forecasting
1	2000	5813231	-	13	2012	7344866	8607725.167
2	2001	8005031	-	14	2013	7410931	7952860.167
3	2002	9132104	-	15	2014	7244905	7600652.833
4	2003	9939301	8203267.5	16	2015	7560822	7316907.167
5	2004	10251351	9347857	17	2016	7031775	7430534.5
6	2005	11011142	9960793.167	18	2017	7005262	7243645.667
7	2006	10932000	10579238.17	19	2018	7073385	7106693
8	2007	10011142	10844939.17	20	2019	7104424	7043742.333
9	2008	9394515	10484761.33	21	2020	9767754	7077550.667
10	2009	8962617	9856304.833	22	2021	9102052	8430915.833
11	2010	8319779	9281337.167	23	2022	8425931	8991014.667
12	2011	8681392	8713181	**24**	**2023**		**8874941,833**

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From Table 3, actual unemployment data in Indonesia from 2000 to 2022 and data from forecasting calculations can be visualized in the following graphical form:

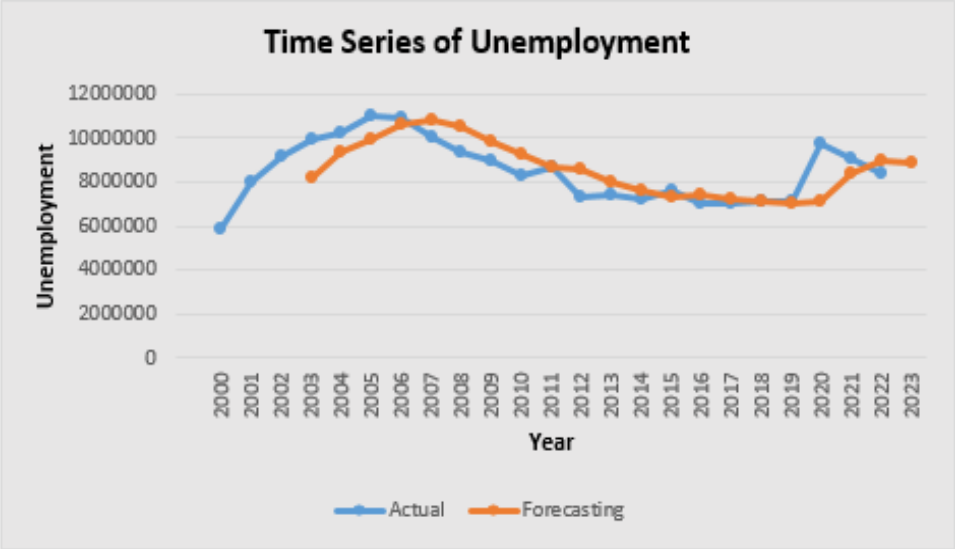

Image 2. Graph Comparison of Actual and Forecasted Data

After all forecasting results for each weight are obtained, then the calculation evaluation process is carried out using three accuracy methods, namely MAD, MSE, and MAPE. This evaluation is done for each weight value 3, 4, 5, and 6. So that from the calculation results of the three accuracy methods, the error values are obtained in Table 4 below:

Table 4. MAD,MSE, and MAPE Value

Weight Value	MAD	MSE	MAPE
3	**745786,1833**	**948402050986,3**	**8,28 %**
4	779477,7684	1013207741987,62	8,71 %
5	818729,1889	1128966470880,22	9,27 %
6	847724,2717	1159498397091,03	9,91 %

In Table 4, it can be seen that the best forecasting results for unemployment data are at a weight value of 3 which has a MAD value of 745786.1833, an MSE value of 948402050986.3, and a MAPE value of 8.28%, where the forecasting result for the number of unemployed in Indonesia in 2023 is 8874941.833 ~ 8874942 people.

CONCLUSION

Based on the results and discussion of the research that has been conducted on unemployment forecasting in Indonesia, it can be concluded that this unemployment forecast uses the Weight Moving Average method with forecasting accuracy methods, namely MAD, MSE, and MAPE as a method for calculating the percentage of errors. The results of this study are forecasting the number of unemployed in Indonesia in 2023, namely 8874942 people at a weight value of 3 with a MAD value

of 745786.1833, an MSE value of 948402050986.3 and a MAPE value of 8.28%. Forecasting ability is very high because the MAPE value is less than 10%.

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