Time Series Forecasting of Nickel Sales in Nickel Mining Companies Listed on Indonesia Stock Exchange (IDX)

Farah Ayu Mufida[1]*, Nurafni Eltivia[2], Nur Indah Riwajanti[3]

[1)2)3)]*State Polytechnic of Malang*
Jl. Soekarno Hatta No.9, Malang, Indonesia
[1)]farahayumufida29@gmail.com
[2)]nurafni.eltivia@polinema.ac.id
[3)]nur.indah@polinema.ac.id

Abstract

This research aims to analyze nickel sales forecasting using time series forecasting with the help of Microsoft Excel and then compare the pattern between Nickel Mining Companies listed on IDX (Indonesia Stock Exchange). This research uses a quantitative descriptive study with a forecasting method. The data used is secondary data, which is sales data contained in the financial statements of nickel mining companies listed on the IDX (Indonesia Stock Exchange) from 2015-2023. There are a total of 43 data. The results of this study show that the highest sales forecast from PT Aneka Tambang Tbk's nickel sales is in quarter 4 of 2024 of IDR 16,4 trillion, and the lowest forecast is in quarter 1 of 2024 of IDR 3,4 trillion. On the other hand, the highest nickel sales forecast from PT Vale Indonesia Tbk is in the 4th quarter of 2024 of IDR 19,3 trillion, and the lowest forecast is in the 1st quarter of 2024 of IDR 4,3 trillion. The patterns formed on the forecasting plot graphs of the two companies tend to be the same. The sales trend and forecasting trend are also the same, there is an increase and show good business prospects and nickel sales.

I. INTRODUCTION

Indonesia is highly vulnerable to the impacts of climate change. This vulnerability is reflected through the increase in Indonesia's Global Climate Risk Index (CRI) ranking analyzed by Germanwatch over the past two decades. It is projected that by 2050, economic losses that may occur due to climate change will reach 1.4 percent of the current Gross Domestic Product (GDP) value. One of the causes of climate change is greenhouse gas emissions. In 2018, the transportation sector was the second largest contributor to GHG emissions in the energy sector, amounting to 26.4 percent or around 157,325 Gg CO2e with an average increase of 7.88 percent per year over the past decade [1].

Every country needs to adapt and mitigate climate change in its economic development. Indonesia has committed to reducing greenhouse gas emissions by 41 percent by 2030 with international support delivered on the occasion of the United Nations Framework Convention on Climate Change (UNFCCC) in July 2021 [2]. Therefore, there is a need for development in the energy sector, especially regarding transportation issues [3].

On the other hand, concerns about climate change, energy scarcity, and environmental sustainability cause the importance of renewable energy [3], [4]. Fuels used for motor vehicles are currently still dominated by fossil fuels. Burning fossil fuels will produce air pollution due to exhaust emissions, such as carbon monoxide (CO), nitrogen oxides (NOx), hydrocarbons (HC), SO2, and particulate matter (PM) which have a local impact and produce GHG emissions in the form of carbon dioxide (CO2) which has a global effect. Electric vehicles produce much less air pollution and are close to zero compared to vehicles based on internal combustion engines (ICE). Electric vehicles are suitable for tackling air pollution problems, especially in urban areas [5].

In general, battery-based electric vehicles have advantages compared to motor vehicles (internal combustion engines), namely that they can reduce air pollution and GHG emissions [5]. Cleaner energy generation and utilization solely depend on renewable machinery, including power stories batteries, solar photovoltaics (PV), electric vehicles (EV), wind turbines, etc., needing critical minerals as raw materials [6] as is known that for the manufacture of batteries three primary raw materials are required, namely nickel, lithium and cobalt. The mineral resources of Indonesia, along with those of many other developing nations, have attracted the attention of trading partners who

* Corresponding author

meet their material needs for the production and processing of renewable energy technologies [7]. As one of the largest producers of nickel in the world, Indonesia has benefited from an increase in investment in nickel mining and export promotions of this commodity [8]. Export is one of the most important economic activities for countries that adhere to the system the economy is open because exports provide the country foreign exchange that the country can use to pay foreign financing such as imports and foreign debt [9].

Therefore, it is necessary to know the business prospects, especially regarding nickel sales from nickel mining companies in Indonesia. Many nickel mining companies in Indonesia have stated that they have begun to contribute to the production of electric vehicles. Starting from selling nickel as a battery material for electric vehicles sold domestically and exported. To see the sustainability and growth of nickel sales, it can be done by forecasting sales.

Forecasting is useful to help implement things efficiently and effectively using qualitative scientific methods that are carried out systematically [10]. Sales forecasting or sales prediction is an action to predict or forecast how the condition or state of sales in the next few years with the aim of getting profits or profits and making sales data a few years ago as a benchmark to predict sales in the next few years [11]. Forecasting can be done by several methods [12]. One method of forecasting that can be done is the time series forecasting method. Time series forecasting is sensitive to changes in data because its methods are specifically designed to handle data that varies over time.

The difference this research and the previous research on the same topic by about analyzing the pandemic effect on time series prediction of demand and sales manufacturing product, namely plastic products in 2021 accompanied by the Covid 19 pandemic. The study used monthly data for 3 years [13]. Furthermore, there is research on the Autoregressive Integrated Moving Average Method to Forecast Sales at PT Hibex Indonesia and using sales data from July 2014 to December 2017 and using AIC, SIC, and MSE methods to compare and find the smallest error rate [14]. The last research focusing on Forecasting Analysis on the Impact of Pandemic Towards Cigarette Sales, forecasting is carried out using the moving average method and data used for 16 years [15].

Therefore, the purpose of this research is to forecast nickel sales from nickel companies to see future business prospects related to electric vehicles using the time series forecasting method, namely simple moving average, and calculate error rates using RMSE, MAD, and MAPE methods to see the accuracy of forecasting. In most time series analysis determining is quality or accuracy from the information or data obtained and the time or period of the data collected. The data used is 9-year quarter sales data.

II. METHODS

This research uses quantitative approaches and forecasting methods to determine future nickel sales in nickel mining companies listed on the Indonesia Stock Exchange. The population in this research is nickel mining companies that go public and listed on the Indonesia Stock Exchange (IDX). The sample of this study was determined by purposive sampling technique. Examples of criteria determined in sampling are as follows.

Table 1. Sampling Criteria

No.	Information	Sum
1	Nickel mining companies listed on the Indonesia Stock Exchange in 2015-2023	6
2	Nickel mining companies that have no business prospects related to electric vehicles	0
3	Nickel mining companies that do not have quarterly financial statements 2015-2023 and can be downloaded on the website of IDX.co, issuer, or company	-3
4	Nickel mining companies that do not report sales in quarterly financial statements for 2015-2023	-1
	Number of Research Samples	2

Based on the selection of sample criteria, research samples will be obtained and later the data can be accounted for. From the table above, the sample criteria are 2 companies. The following is a sample of 2 nickel mining companies listed on the IDX.

Table 2. Sample of Nickel Mining Companies

No.	Code	Company Name
1	ANTM	PT Aneka Tambang Tbk
2	INCO	PT Vale Indonesia Tbk

Source: IDX.co.id

This research uses secondary data obtained through the official website of the Indonesia Stock Exchange namely www.idx.com, https://emiten.kontan.co.id/, and the official website of the company namely https://antam.com/en, https://www.vale.com/in/indonesia. The search data used is nickel sales data in the form of nickel, ferronickel, or nickel matte ore in the quarterly financial statements for 2015-2023 because the longer the moving average will produce smoother moving averages [16]. Based on previous data, the Simple Moving Average (SMA) analysis

approach is utilized to make forecasts for the upcoming period utilizing the forecasting method. One type of MA is the Simple Moving Average (SMA), which can give indicators of strong trends and resistant support. [17]. To calculate the simple moving average method using the formula:

$$\mathbf{MA} = \frac{A_1 + A_2 + .. + A_n}{n}$$

A1 : Data Points

N : Number of time periods

Forecasting is done using Microsoft Excel. After that, it is necessary to calculate forecasting accuracy using Mean Absolute Deviation (MAD), Root Mean Square Error (RMSE), and Mean Absolute Percent Error (MAPE). Regardless of whether the forecasting results are higher or lower than reality, the mean absolute deviation (MAD) is the average of the outcomes of the difference between the actual data and the anticipated results over a specific period of time [18]. The difference between the actual value and the forecast, squared and divided by the number of forecasting time series, yields the MSE value. When the residual magnitude distributed consistently throughout the observation, MSE values are employed. [18]. MAPE is the average absolute value of the difference between the predicted value and the original value so that later the percentage of model error produced can be known [19].

The MAD calculation formula or formula is:

$$\mathbf{MAD} = \frac{\sum |y_i - \hat{y}_i|}{n}$$

y_i : Actual result value

$\hat{y}_i$: Value of forecasting result

n : Amount of data

The MSE calculation formula or formula is:

$$\mathbf{MSE} = \frac{1}{n} \sum_{i=1}^{n} (y_i - \hat{y}_i)^2$$

y_i : Actual result value

$\hat{y}_i$: Value of forecasting result

n : Amount of data

The RMSE calculation formula or formula is:

$$\mathbf{RMSE} = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (y_i - \hat{y}_i)^2}$$

y_i : Actual result value

$\hat{y}_i$: Value of forecasting result

n : Amount of data

The MAPE calculation formula or formula is:

$$\mathbf{MAPE} = \frac{1}{n} \sum_{i=1}^{n} \frac{\sum |y_i - \hat{y}_i|}{y_i} . \mathbf{100}\%$$

y_i : Actual result value

$\hat{y}_i$: Value of forecasting result

n : Amount of data

The research procedure for forecasting the sales of nickel mining companies on the Indonesia Stock Exchange is shown in the following figure.
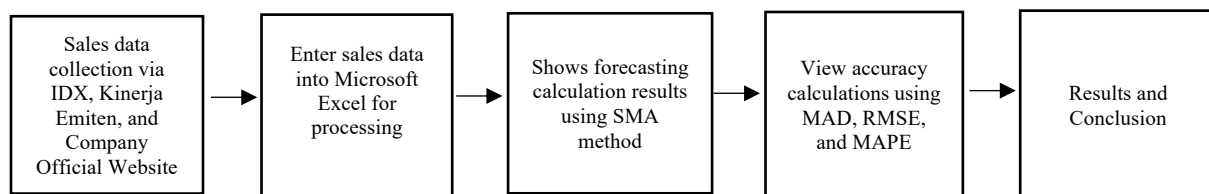
| Sales data collection via IDX, Kinerja Emiten, and Company Official Website | → | Enter sales data into Microsoft Excel for processing | → | Shows forecasting calculation results using SMA method | → | View accuracy calculations using MAD, RMSE, and MAPE | → | Results and Conclusion |

Figure 1. Research Procedure

III. RESULTS

The first step is to create a plot chart for nickel sales from PT Aneka Tambang Tbk and PT Vale Indonesia Tbk in 2015 quarter 1 to 2023 quarter 3 using Microsoft Excel software. This graph is useful for viewing stationary data. The results of nickel sales patterns from the two companies are as follows:

Table 3. Data Sales for Nickel of PT Aneka Tambang Tbk for 2015-2023 (IDR)

Year	Q	Sales
2015	1	813.888.326.000
	2	1.923.101.732.000
	3	2.137.410.694.000
	4	2.728.991.398.000
2016	1	363.607.657.000
	2	1.108.625.711.000
	3	1.742.552.509.000
	4	3.077.528.639.000
2017	1	388.726.825.000
	2	1.040.079.086.000
	3	2.696.140.058.000
	4	4.592.391.665.000
2018	1	1.535.039.738.000
	2	3.318.693.651.000
	3	5.758.074.380.000
	4	7.595.899.221.000
2019	1	2.007.541.979.000
	2	4.067.765.194.000
	3	6.104.924.113.000
	4	8.577.402.095.000
2020	1	965.950.956.000
	2	2.110.626.909.000
	3	3.928.330.074.000
	4	6.526.956.864.000
2021	1	2.179.340.377.000
	2	4.637.873.000.000
	3	7.596.108.970.000
	4	10.740.088.000.000
2022	1	3.479.890.000.000
	2	5.449.677.000.000
	3	8.475.272.000.000
	4	12.023.378.000.000
2023	1	4.185.630.000.000
	2	7.426.489.000.000
	3	10.095.756.000.000

Source: Processed Data
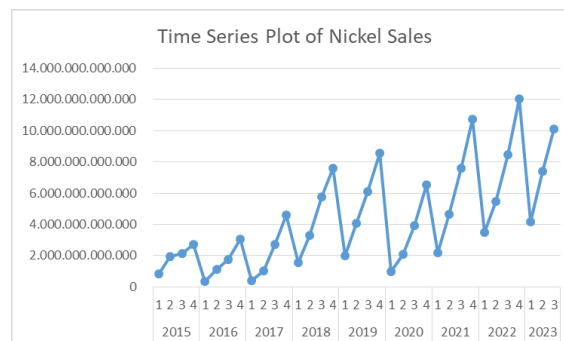
Figure 2. Time Series Plot of Nickel Sales PT Aneka Tambang Tbk 2015-2023
Source: Data Processed

Based on the nickel sales chart above, sales always increase and are highest in quarter 4 of each year and decline again in quarter 1 of each year. The lowest sales occurred in 2015 at IDR 2,7 trillion and the highest sales occurred in 2022 at IDR 12 trillion. Sales charts in 2015 and 2016 tend to have the same pattern. Sales have increased every year,

but there was a decrease in sales in the 4th quarter of 2020 with sales figures of IDR 6,5 trillion compared to the previous year, 2019 of IDR 8,6 trillion. Despite the decline in sales in 2020, nickel segment sales from PT Aneka Tambang Tbk have an increasing trend from 2015-2023.

Based on PT Aneka Tambang Tbk's annual report, PT Aneka Tambang Tbk's Royalty expense in 2020 reached IDR 421.34 billion, down by 11% from 2019 of IDR 472.79 billion. This is also in line with the decline in sales volume of ANTAM's nickel and bauxite ore commodities in 2020. In addition, the COVID-19 pandemic has greatly affected global demand for goods and services as well as mineral commodities and supply chains.

In 2022, the total sales of the nickel segment reached IDR 12 trillion which is the highest sales from 2015-2023. Ferronickel sales in 2022 reached 98% of the sales target, while nickel ore reached 70% of the sales target. To increase the added value of nickel reserves and resources, in line with the Company's business development plan, in 2022, ANTAM will initiate strategic partnerships and corporate actions to support the development of the EV Battery development ecosystem in the country.

Table 4. Data Sales for Nickel of PT Vale Indonesia Tbk for 2015-2023 (IDR)

Year	Q	Sales
2015	1	3.280.293.559.400
	2	6.342.171.295.200
	3	9.492.372.129.500
	4	12.226.595.166.500
2016	1	1.683.093.015.500
	2	3.821.456.382.900
	3	6.277.194.600.300
	4	9.043.526.683.100
2017	1	2.638.933.173.500
	2	4.518.906.967.900
	3	6.946.762.643.600
	4	9.743.160.187.800
2018	1	2.638.933.173.500
	2	5.799.615.118.700
	3	8.973.100.429.800
	4	12.027.732.730.000
2019	1	1.957.320.367.600
	2	4.524.526.825.000
	3	7.840.877.263.700
Year	Q	Sales
	4	12.106.875.180.400
2020	1	2.704.018.240.300
	2	5.579.248.600.900
	3	8.840.360.334.000
	4	11.839.537.184.800
2021	1	3.197.822.543.500
	2	6.424.084.969.900
	3	10.627.149.776.100
	4	14.756.753.915.800
2022	1	3.639.515.444.500
	2	13.527.553.380.900
	3	18.259.922.028.400
	4	12.023.378.000.000
2023	1	5.622.643.806.000
	2	10.201.929.403.900
	3	14.520.224.503.200

Source: Data Processed
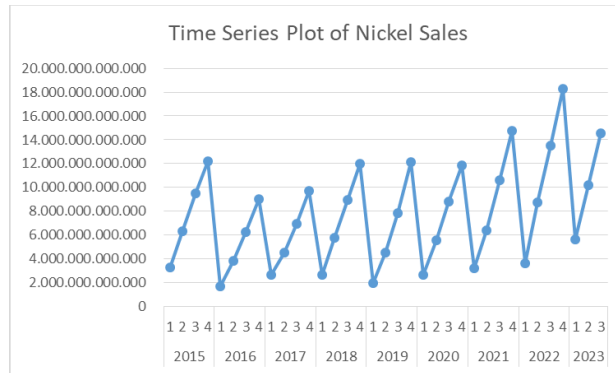
Figure 3. Data Sales for Nickel of PT Vale Indonesia Tbk for 2015-2023
Source: Data Processed

    Based on the nickel sales chart above, sales always increase and are highest in quarter 4 of each year and decline again in quarter 1 of each year. The lowest sales occurred in 2016 at IDR 9 trillion and the highest sales occurred in 2022 at IDR 18,2 trillion. Sales have increased every year, but there was a decrease in sales in Q4 of 2016 of IDR 9 trillion compared to 2015 of IDR 12,2 trillion. Meanwhile, in 2020 with sales figures of IDR 11,8 trillion compared to the previous year, namely 2019 of IDR 12,1 trillion. Despite the decline in sales in 2016 and 2020, nickel segment sales from PT Aneka Tambang Tbk have an increasing trend from 2015-2023.

    Based on PT Vale Indonesia Tbk's annual report, the decline in nickel sales in 2016 occurred due to the increasing selling price of nickel since the second quarter and the decline in the realization of the company's nickel selling price which reached 22% but this can be overcome by reducing production costs per ton by 14% compared to 2015. In 2020, the decline in nickel prices to the lowest level occurred in March 2020. In April 2020, a turning point for the nickel market began to be seen as many industries resumed operations in China. The movement in China's infrastructure sector increased the demand for nickel, and further increased the price of nickel on the world market. Although nickel prices have recovered, the average price over the year did not reach the level expected last year due to COVID-19. Meanwhile, in 2022, PT Vale Indonesia Tbk recorded positive achievements in financial performance, which was also driven by the high realization of nickel prices. During 2022, PT Vale recorded sales realization of 24% higher than sales realization in 2021 and even 21% higher than the 2022 target.

    Use one of the Excel application tools, regression, in the data analysis tools to determine the purpose of the moving average calculation. The moving average data, where the seasonal factor t is the period, serves as the foundation for the regression computation. Seasonality multiplied by trend is the method used to produce the results for forecasting, which is based on the regression results. The results of the sales forecast using the seasonal trend method with regression for nickel starting from quarter 4 of 2023 to quarter 4 of 2024, can be seen below.

Table 5. Result of Nickel Sales Forecasting in PT Aneka Tambang Tbk (IDR)

Year	Q	Actual	Forecast
2015	1	813.888.326.000	222.126.423.884
	2	1.923.101.732.000	586.182.488.245
	3	2.137.410.694.000	1.231.261.906.443
	4	2.728.991.398.000	2.174.791.603.964
2016	1	363.607.657.000	578.378.287.855
	2	1.108.625.711.000	1.257.248.439.907
	3	1.742.552.509.000	2.327.168.883.066
	4	3.077.528.639.000	3.758.174.604.750
2017	1	388.726.825.000	934.630.151.827
	2	1.040.079.086.000	1.928.314.391.568
	3	2.696.140.058.000	3.423.075.859.688
	4	4.592.391.665.000	5.341.557.605.537
2018	1	1.535.039.738.000	1.290.882.015.798
	2	3.318.693.651.000	2.599.380.343.229
	3	5.758.074.380.000	4.518.982.836.311
	4	7.595.899.221.000	6.924.940.606.323
2019	1	2.007.541.979.000	1.647.133.879.770
	2	4.067.765.194.000	3.270.446.294.891

| Year	Q	Actual	Forecast
	3	6.104.924.113.000	5.614.889.812.933
	4	8.577.402.095.000	8.508.323.607.109
2020	1	965.950.956.000	2.003.385.743.741
	2	2.110.626.909.000	3.941.512.246.552
	3	3.928.330.074.000	6.710.796.789.556
	4	6.526.956.864.000	10.091.706.607.895
2021	1	2.179.340.377.000	2.359.637.607.712
	2	4.637.873.000.000	4.612.578.198.214
	3	7.596.108.970.000	7.806.703.766.179
	4	10.740.088.000.000	11.675.089.608.682
2022	1	3.479.890.000.000	2.715.889.471.684
	2	5.449.677.000.000	5.283.644.149.875
	3	8.475.272.000.000	8.902.610.742.801
	4	12.023.378.000.000	13.258.472.609.468
2023	1	4.185.630.000.000	3.072.141.335.655
	2	7.426.489.000.000	5.954.710.101.536
	3	10.095.756.000.000	9.998.517.719.424
	4		14.841.855.610.254
2024	1		3.428.393.199.626
	2		6.625.776.053.198
	3		11.094.424.696.046
	4		16.425.238.611.040

Source: Data Processed
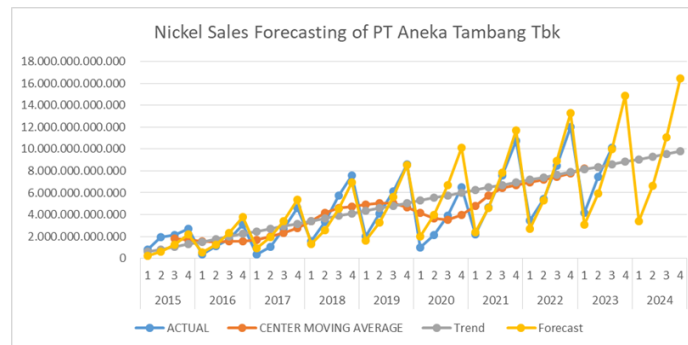
Figure 4. Result of Nickel Sales Forecasting PT Aneka Tambang Tbk
Source: Data Processed

Based on the chart above, nickel sales projections in 2023 and 2024 have the same pattern and will then increase. Sales in Q4 of 2023 are expected to reach IDR 14,8 trillion and in 2024 are expected to be IDR 16,4 trillion. In the annual report, PT Aneka Tambang Tbk said that the nickel segment sales target increased by 48% compared to 2022. Meanwhile, based on calculations, the estimated sales in 2023 increased by 39.47% compared to 2022 and the estimated nickel sales in 2024 will increase by 11% compared to the estimated sales in 2023.

The nickel ore sales target is in line with the growth outlook of the domestic nickel processing industry and takes into account the utilization rate and stability of ANTAM's ferronickel plant operations in Kolaka, Southeast Sulawesi as well as the production contribution of ANTAM's ferronickel plant in East Halmahera, North Maluku which will operate in the second half of 2023.

Table 6. Result of Nickel Sales Forecasting in PT Vale Indonesia Tbk (IDR)

Year	Q	Actual	Forecast
2015	1	3.280.293.559.400	1.930.089.593.623
	2	6.342.171.295.200	3.978.304.781.758
	3	9.492.372.129.500	6.497.408.039.898
	4	12.226.595.166.500	9.179.859.940.756
2016	1	1.683.093.015.500	2.189.654.572.220

Year	Q	Actual	Forecast
	2	3.821.456.382.900	4.495.918.071.930
	3	6.277.194.600.300	7.316.147.996.031
	4	9.043.526.683.100	10.301.288.439.698
2017	1	2.638.933.173.500	2.449.219.550.816
	2	4.518.906.967.900	5.013.531.362.103
	3	6.946.762.643.600	8.134.887.952.165
	4	9.743.160.187.800	11.422.716.938.641
2018	1	2.638.933.173.500	2.708.784.529.413
	2	5.799.615.118.700	5.531.144.652.275
	3	8.973.100.429.800	8.953.627.908.299
	4	12.027.732.730.000	12.544.145.437.584
2019	1	1.957.320.367.600	2.968.349.508.010
	2	4.524.526.825.000	6.048.757.942.448
	3	7.840.877.263.700	9.772.367.864.432
	4	12.106.875.180.400	13.665.573.936.526
2020	1	2.704.018.240.300	3.227.914.486.607
	2	5.579.248.600.900	6.566.371.232.621
	3	8.840.360.334.000	10.591.107.820.566
	4	11.839.537.184.800	14.787.002.435.469
2021	1	3.197.822.543.500	3.487.479.465.204
	2	6.424.084.969.900	7.083.984.522.793
	3	10.627.149.776.100	1.930.089.593.623
Year	Q	Actual	Forecast
	4	14.756.753.915.800	3.978.304.781.758
2022	1	3.639.515.444.500	6.497.408.039.898
	2	13.527.553.380.900	9.179.859.940.756
	3	18.259.922.028.400	11.409.847.776.700
	4	12.023.378.000.000	15.908.430.934.411
2023	1	5.622.643.806.000	3.747.044.443.801
	2	10.201.929.403.900	7.601.597.812.966
	3	14.520.224.503.200	12.228.587.732.833
	4		17.029.859.433.354
2024	1		4.006.609.422.398
	2		8.119.211.103.138
	3		13.047.327.688.967
	4		18.151.287.932.297

Source: Data Processed
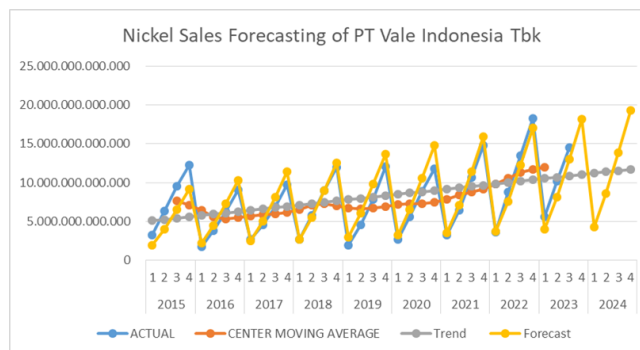
Figure 5. Result of Nickel Sales Forecasting PT Vale Indonesia Tbk
Source: Data Processed, 2023

Based on the chart above, nickel sales projections in 2023 and 2024 have the same pattern and will then increase. Sales in Q4 of 2023 are expected to reach IDR 18,1 trillion and in 2024 are expected to be IDR 19,3 trillion. In the annual report, PT Aneka Tambang Tbk said that the nickel segment sales target increased by 48% compared to 2022.

Meanwhile, based on calculations, the estimated sales in 2023 increased by 39.47% compared to 2022 and the estimated nickel sales in 2024 will increase by 11% compared to the estimated sales in 2023.

Based on calculations, PT Vale Indonesia Tbk's nickel sales forecast in 2023 will increase by 20% when compared to 2022 and nickel sales forecast in 2024 will increase by 6% when compared to 2023. PT Vale Indonesia Tbk said the most important device in electric vehicles is the battery, and one of the important components in the dominant battery technology used today is nickel. Thus, in the future, nickel has a key role because it is indispensable for the transition to clean energy options, so it will have an impact on increasing nickel demand.

Forecasting should provide information about a certain error rate, which means that the forecast should contain errors and it is important for the researcher to show how big the error is. The following is the error rate of nickel sales forecasting using MAPE method at PT Aneka Tambang Tbk and PT Vale Indonesia Tbk.

Table 7. Error Rate dari Peramalan Penjualan Nikel PT Aneka Tambang Tbk dan PT Vale Indonesia Tbk

No	Company	RMSE	MAD	MAPE
1	ANTM	1.088.291.797.148	810.285.267.786	33%
2	INCO	1.439.102.096.336	1.192.140.970.383	17%

Source : Data Processed

Based on the MAPE calculation above, the error rate of forecasting nickel sales at PT Aneka Tambang Tbk using RMSE is lower at 1,088,291,797,148 compared to PT Vale Indonesia Tbk at 1,439,102,096,336. Likewise, the error rate using MAD is lower at 810,285,267,786 compared to PT Vale Indonesia Tbk at 1,192,140,970,383. However, the error rate using the MAPE method is higher at 33% but still quite good compared to the nickel sales forecast at PT Vale Indonesia Tbk of 17% and is in the good category.

Sales of nickel from PT Aneka Tambang Tbk and PT Vale Indonesia Tbk are predicted to increase. This is in connection with the two companies starting to enter the realm of electric vehicles, even becoming suppliers of electric vehicle battery materials. Research on Analyzing the Pandemic Effect on Time series Prediction of Demand and Sales Manufacturing Product shows that sales have decreased during the covid 19 pandemic, but the demand for plastic products will increase from 2019-2021 although not significantly [13].

Furthermore, there is research on the Autoregressive Integrated Moving Average Method to Forecast Sales at PT Hibex Indonesia and using sales data from July 2014 to December 2017 and using AIC, SIC, and MSE methods to compare and find the smallest error rate [14]. The results of the study show that sales at PT Hibex Indonesia are expected to increase but very little. In addition, it is also mentioned that the ARIMA method is suitable for short-term forecasting instead of long-term because if it is for long-term data, the results tend to be flat. The last research focusing on Forecasting Analysis on the Impact of Pandemic Towards Cigarette Sales, forecasting is carried out using the moving average method and data used for 16 years. The research shows that sales forecasting results have decreased, especially in 2018-2020 [15].

This study can help other studies and earlier research to think about appropriate forecasting techniques based on available data. Time series forecasting works well for identifying patterns, seasonal variations, and trends in data. Furthermore, it can offer a summary of nickel sales opportunities, particularly to address the future need for battery materials for electric vehicles. Companies should continue implementing strategies to increase nickel sales, especially in becoming a supplier of electric vehicle battery materials.

IV. CONCLUSIONS

Data patterns reveal that demand and sales trend data is very dynamic, showing situations and trends. In forecasting using time series forecasting, the results show nickel sales in 2023 at PT Aneka Tambang Tbk increased by 39.47% compared to 2022 and then increased by 11% in 2024. Meanwhile, PT Vale Indonesia Tbk in 2023 is estimated to experience an increase in sales by 20% compared to 2022 and then experience an increase in sales by 6% in 2024 when compared to 2022. The highest sales forecast lies in Q4 2024, both PT Aneka Tambang Tbk at IDR 16,4 trillion and PT Vale Indonesia Tbk at IDR 19,3 trillion.

The error rate of forecasting nickel sales at PT Aneka Tambang Tbk using RMSE is lower at 1,088,291,797,148 compared to PT Vale Indonesia Tbk at 1,439,102,096,336. Likewise, the error rate using MAD is lower at 810,285,267,786 compared to PT Vale Indonesia Tbk at 1,192,140,970,383. However, the error rate using the MAPE method is higher at 33% but still quite good compared to the nickel sales forecast at PT Vale Indonesia Tbk of 17% and is in the good category. The completeness of this study has not carried out the incorporation of forecasting methods, including the selection method, so that further research can be carried out to combine the forecasting method in the selection method, which will allow better results from individual methods. The results of this nickel sales forecasting show good business prospects and nickel sales, so it is expected to be helpful for the company. Companies

should continue implementing strategies to increase nickel sales, especially in becoming a supplier of electric vehicle battery materials.

REFERENCES

[1] U. H. Triastuti, "Pengarusutamaan Rencana Program Mitigasi Perubahan Iklim dengan Pendekatan Kelembagaan di Kementerian Perhubungan," *War. Penelit. Perhub.*, vol. 34, no. 1, pp. 9–22, 2022, doi: 10.25104/warlit.v34i1.2094.

[2] H. Tri, S. Mulyani, and C. Octalica, "Keterkaitan Sustainability Report Dengan Kesiapan Implementasi Regulasi Pemerintah Melalui Peraturan Presiden No . 98 Tahun 2021 Tentang Penyelenggaraan Nilai Ekonomi Karbon PENDAHULUAN Pembangunan ekonomi dan Lingkungan hidup memang suatu dilema yang tid," pp. 79–86, 2021.

[3] R. Subekti, "Dan Penggunaan Energi Terbarukan," *J. RECHTS VINDING*, vol. 11, pp. 435–450, 2022.

[4] A. Sharif, M. S. Meo, M. A. F. Chowdhury, and K. Sohag, "Role of solar energy in reducing ecological footprints: An empirical analysis," *J. Clean. Prod.*, 2021, doi: 10.1016/j.jclepro.2021.126028.

[5] I. Fitriana, A. Sugiyono, and K. Akhmad, "Pengembangan Kendaraan Listrik Baterai di Indonesia: Peran dalam Mengurangi Emisi Energy System Optimization View project Energy for Indonesian transportation View project," *Semin. Nas. Teknol. Bahan Dan Barang Tek.*, no. November, pp. 140–145, 2020, [Online]. Available: https://www.researchgate.net/publication/346415238

[6] M. M. Islam, K. Sohag, S. Hammoudeh, O. Mariev, and N. Samargandi, "Minerals import demands and clean energy transitions: A disaggregated analysis," *Energy Econ.*, 2022, doi: 10.1016/j.eneco.2022.106205.

[7] M. Monirul Islam, K. Sohag, S. O. Mamman, and H. Herdhayinta, "Response of Indonesian mineral supply to global renewable energy generation: Analysis based on gravity model approach," *Geosci. Front.*, no. xxxx, p. 101658, 2023, doi: 10.1016/j.gsf.2023.101658.

[8] I. G. N. P. Widiatedja, "Indonesia's export ban on nickel ore: Does it violate the world trade organization (wto) rules?," *J. World Trade*, 2021, doi: 10.54648/trad2021028.

[9] A. R. Perwira, "Volume 20 Issue 2 (2023) Pages 179-188 KINERJA : Jurnal Ekonomi dan Manajemen ISSN : 1907-3011 (Print) 2528-1127 (Online) Daya saing ekspor produk kakao bernilai tambah tinggi Indonesia di sembilan negara Timur Tengah Export competitiveness of Indon," vol. 20, no. 2, pp. 179–188, 2023.

[10] E. Puspitasari, N. Eltivia, and N. I. Riwajanti, "Inventory Forecasting Analysis using The Weighted Moving Average Method in Go Public Trading Companies," *J. Appl. Business, Tax. Econ. Res.*, vol. 2, no. 3, pp. 266–278, 2023, doi: 10.54408/jabter.v2i3.160.

[11] Charles, J. M. Sianturi, E. Ardini, N. Sari, and B. Sembiring, "Sales Forecasting Information System Using The Least Square Contoh Penjualan Motor Yamaha," vol. 1, no. 2, 2020.

[12] N. Nurul, C. Caroline, A. Putri, and H. A. Rusyda, "Penerapan metode double moving average, brown, holt linear, dan arima pada harga penutupan saham," *J. Ekon. dan Manaj.*, vol. 18, no. 3, pp. 2021–375, 2021, [Online]. Available: https://journal.feb.unmul.ac.id/index.php/KINERJA/article/view/8578/1488

[13] N. Azizah, N. I. Riwajanti, N. Eltivia, and A. Efendi, "Analyzing the Pandemic Effect on Time series Prediction of Demand and Sales Manufacturing Product," *Proc. 2nd Annu. Manag. Bus. Econ. Conf. (AMBEC 2020)*, vol. 183, no. Ambec 2020, pp. 258–262, 2021, doi: 10.2991/aebmr.k.210717.052.

[14] E. Tan and I. Astuti, "Metode Autoregressive Integrated Moving Average untuk Meramalkan Penjualan," *EKOMABIS J. Ekon. Manaj. Bisnis*, vol. 1, no. 02, pp. 149–158, 2020, doi: 10.37366/ekomabis.v1i02.43.

[15] S. H. Sakdiyah, N. Eltivia, N. I. Riwajanti, and K. Ekasari, "Forecasting Analysis on the Impact of Pandemic Towards Cigarette Sales," *Proc. 2nd Annu. Manag. Bus. Econ. Conf. (AMBEC 2020)*, vol. 183, no. Ambec 2020, pp. 263–268, 2021, doi: 10.2991/aebmr.k.210717.053.

[16] N. L. A. K. Yuniastari and I. G. P. W. W. Wirawan, "Peramalan Permintaan Produk Perak Menggunakan Metode Simple Moving Average dan Exponential Smoothing," *J. Sist. dan Inform.*, 2014.

[17] Z. I. Z. A. A. Al Bahsan and K. Karmilasari, "Implementation of Multi-Criteria Moving Average Crossover Indicators As the Basis for Technical Analysis Decision Making At the Futures Exchange," *J. Manaj. Indones.*, vol. 19, no. 1, p. 91, 2019, doi: 10.25124/jmi.v19i1.1988.

[18] C. Heizer, Jay; Render, Barry; Munson, *Operation Management Sustainability and Supply Chain Management*. 2017.

[19] E. Ivan and H. D. Purnomo, "Forecasting Prices of Fertilizer Raw Materials Using Long Short Term Memory," *J. Tek. Inform.*, vol. 3, no. 6, pp. 1663–1673, 2022, doi: 10.20884/1.jutif.2022.3.6.433.