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Inventory Forecasting Analysis using The Weighted Moving Average Method in Go Public Trading Companies

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Keywords **:** *Inventory, Forecasting, Weighted Moving Average Method*

Abstract: This research aims to analyze inventory forecasting using the weighted moving average method and then compare the trading companies' patterns. The research method used is quantitative descriptive with secondary data of inventory in the period 2018-2022 which provide quarterly. This research uses the weighted moving average method to calculate forecasting of inventory by Microsoft Excel data analysis techniques. This research shows the highest inventory forecasting on PT Sumber Alfaria Trijaya Tbk (AMRT) occurs in the first quarter of 2023 with the amount of 10.537.541 and the lowest forecasting occurs in the second quarter in 2023 with the amount of 10.431.677. The highest inventory forecasting on PT Erajaya Swasembada Tbk (ERAA) occurs in the second quarter of 2023 with the amount of 6.443.525 and the lowest forecasting in the fourth quarter of 2023 with the amount of 6.418.659. The highest inventory forecasting on PT United Tractors Tbk (UNTR) occurs in the third quarter of 2023 with the amount of 12.239.422 and the lowest forecasting in the first quarter of 2023 with the amount of 12.050.681. Based on the study's results, the tracking signal value at AMRT was 2,17, ERAA was 0.01, and UNTR was -0.08. The three companies' results prove that the weighted moving average can be used to determine inventory forecasting for the next period because the tracking signal value is still within the control limits of ±4. This result will be useful for trading companies to manage risk and make a decision about the business plan for anticipating overstock inventory that may arise in the future. Previous research related to the analysis and comparison of inventory forecasting is minimal, so the results of this research can be contributed to further research by developing its limits.

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Introduction

Each type of company has its characteristics. The characteristics of a trading company are found in its main activity, namely buying goods with the aim of resale. Trading companies do not carry out the production process. Goods purchased are sold directly without any changes (processing) first. Profit is calculated by deducting sales proceeds from purchasing costs and operating costs. The accounting activities carried out by trading companies are calculating the cost of goods sold and profit and loss statements based on the inventory account.

Inventory is the main asset of a trading company, so the company needs control over its inventory so that its operational activities run well. Companies can meet market needs with reasonable inventory control. The company can guarantee the smooth flow of goods and maintain the stability of the company. Thus, the company can provide the best service to customers by ensuring the availability of the goods they need. One of these control is inventory forecasting. Companies can reduce the procurement of goods that may need to follow market needs with inventory forecasting so that no accumulation of excess goods turns out to be less attractive to customers. The company can also estimate the amount of inventory needed to avoid shortages.

Therefore, this research analyzes inventory forecasting using the weighted moving average method and compares the company's trading patterns. The authors conducted research on trading companies, namely PT Sumber Alfaria Trijaya Tbk (AMRT), PT Era Swasembada Tbk (ERAA), and PT United Tractors Tbk (UNTR). As a go-public company, trading companies must forecast inventory. It is beneficial for companies to convince investors that the company can maintain the company's sustainability through good operations. This research will be helpful for trading companies to manage risk and make decisions about business plans to anticipate losses due to shortages or overstock inventory that may arise in the future.

Previous research related to analysis and comparison of inventory forecasting in several company, especially trading companies, is very limited. Previous research have generally focused on inventory forecasting and control issues in a two-stage supply chain, forecasting inventory in one company, and creating an inventory forecasting system. Babai et. al (2013) addresses inventory forecasting and control issues in a two-stage supply chain (e.g., manufacturer and retailer), taking into account system performance under ARIMA (0,1,1) demand process. This study highlights the need to distinguish between performance forecasting accuracy and that associated with forecasting utility. This study's assessment was carried out analytically and empirically, the benefits associated with predicting information sharing between retailers and manufacturers. In addition, Yulia (2017) regarding inventory forecasting using the Weighted Moving Average method and the Double Exponential Smoothing method using 2016 sales data. Both of these methods have a Mean Square Error value. Where the error value of the Weighted Moving Average is 0.114 and the error value of the Mean Square Error is 6.12, the smallest error value is the best method for estimating inventory. Latif and Herdiansyah (2022) conducted research that aimed to design and build web-based applications using the Weight Moving Average and Double Exponential Smoothing methods. The results of the two methods were compared to find out which forecasting results

had the smallest error value, where the smallest error value can be used for future inventory. So, in this research, the author uses the Weighted Moving Average (WMA) method in calculating inventory forecasting because the result of this method will be more accurate because more relevant data is given a higher weight in forecasting. The results of the forecasting that has been done are tested using the Mean Absolute Deviation (MAD) and a tracking signal to determine the accuracy of the forecast in estimating the actual value.

Theoretical Framework

A. Inventory

Inventory of goods is an important activity for the company, because inventory is a major element in the trade sector (Setiyanto, Nurmaesah, & Rahayu, 2019). According to Swasono and Prastowo (2021), inventory is an asset owned by a company and available for sale for business purposes. Merchandise inventory is goods held by the company for resale. When viewed from the meaning of inventory is an important factor in a trading company, because inventory determines the company's operating activities. Inventory is one form of profit investment that can be expected through future sales (Ramdhany & Kurnia, 2016).

B. Forecasting

Heizer and Render (2015) define forecasting as the art and science of predicting future events. Forecasting is an estimate of demand or needs in the future based on historical time series data. Activities carried out periodically form a period or have an irregular or seasonal pattern and can be used as a reference for making forecast calculations in the future (Bayuarta & Garison, 2021). Forecasting is useful to help implement things efficiently and effectively using qualitative scientific methods that are carried out systematically. An act of releasing a product must have the mindset to reduce pending orders (Aji & Sugiyanto, 2021).

C. Weighted Moving Average

The moving average model uses many new actual demand data to produce an estimated future demand value (Nugroho, 2017). The Weighted Moving Average (WMA) method is suitable for using time series data, namely, data that changes from time to time (Palmitraazzah et al., 2017). WMA forecasting method is a development of the moving average method with additional weight in the calculation. WMA is an average that is calculated by giving values in a data set that is more influenced by data attributes, whereas the average calculation is done by weighting. In simple terms, WMA is a moving average that is given a weight for each data. The advantage of WMA is that each historical data is given a different load value, and in the latest data, the load value is getting bigger, the forecast will be more accurate because more relevant data is given a higher weight in forecasting (Solikin & Hardini, 2019).

Research Method

This research uses a descriptive quantitative research method. Based on the source, the data used in this research is secondary data. The data collection method in this study is

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documentation, in which researchers obtain data from the company's website. The data needed in this research is the 2018-2022 Quarterly Financial Report.

The population in this research is trading companies that go public. This research sample is the trading companies' inventory in the 2018-2022 quarterly financial reports. The researcher chose PT Sumber Alfaria Trijaya Tbk as a retail company that sells daily needs, PT Era Swasembada Tbk as a mobile service distributor company, and PT United Tractors Tbk as a heavy equipment distributor company. The selection of companies is based on the following criteria: 1) Companies publish quarterly financial reports for the 2017-2021 period in full; 2) The company's financial statements are easily accessed through the company's website.

The steps taken in this research were; 1) collecting data from the company's website, 2) entering inventory data and calculating inventory forecasting using excel, 3) conducting error tests on inventory forecasting results, 4) analyzing and comparing the results of calculations each company, and 5) make conclusions. As stated in the introduction, in this research, the researcher used the weighted moving average method in forecasting calculations. Determining the weight is subjective, depending on the experience and opinion of the data analyst, for example, whether the last observation is more likely to be weighted or vice versa. If the opportunity for weighting is more significant in the last observation, then the weighted factor will be more significant in the final period than in the initial period. The longer the period, the greater the weight of the most recent data. The formula of the calculation weighted moving average method is as follows:

$$Weighted\ Moving\ Average = \frac{\sum(weighted\ in\ n\ period)\ (profit)}{\sum weight}$$

After calculating the forecast, it is necessary to calculate the tracking signal to determine the reliability of the forecasting results. The tracking signal measures the deviation's magnitude to calculate the error deviation from the forecast. The Tracking signal value is a reference that the forecasting method used is appropriate or not to calculate the existing data. If the tracking signal value exceeds the existing control limit, +4 or -4, the forecasting results cannot be used to predict future results. However, if the tracking signal value is below the upper control limit and lower control limit, the value from the forecasting method can be used as a reference or basis for further production activities. The tracking signal is obtained from the Running Sum of Forecast Error (RSFE) divided by Mean Absolute Deviation (MAD). Therefore, it is necessary to calculate the MAD before calculating the tracking signal. The formula of MAD formula and tracking signal are as follows:

$$MAD = \sum \frac{absolute\ of\ the\ forecast\ error}{n}$$

$$Tracking\ Signal = \frac{RSFE}{MAD}$$

Note:

n = period

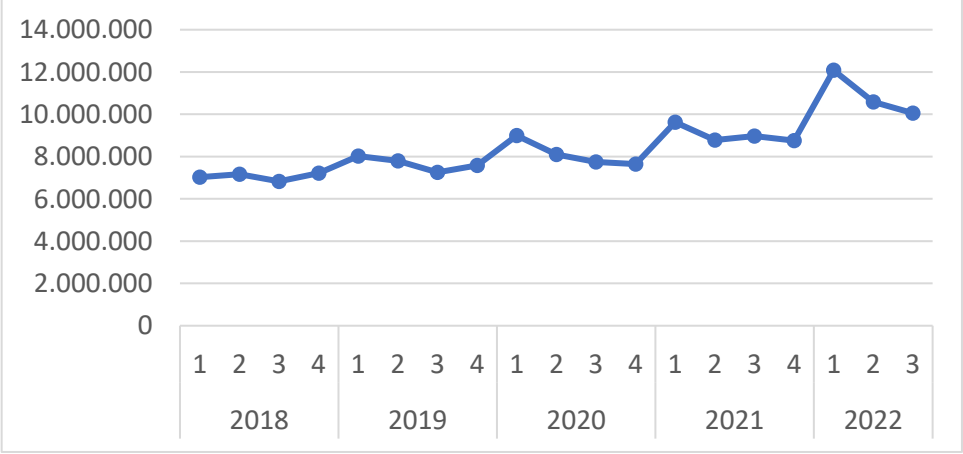
Result and Discussion

The first step in this research is to collect inventory data on object research, namely PT Sumber Alfaria Trijaya Tbk (AMRT), PT Erajaya Swasembada Tbk (ERAA), and PT United Tractors Tbk (UNTR) first quarter of 2018 to third quarter of 2022. Inventory data is shown in table 1 as follows:

Table 1. Inventory Data (in a million rupiah)

Year	Q	AMRT	ERAA	UNTR
2018	1	7.030.603	5.233.324	8.072.214
	2	7.166.353	5.415.804	9.669.841
	3	6.828.741	6.469.454	12.356.001
	4	7.221.444	6.794.576	13.617.869
2019	1	8.029.049	6.062.523	12.317.847
	2	7.800.789	4.632.330	12.368.604
	3	7.247.984	3.455.345	11.763.390
	4	7.577.090	3.693.371	11.014.020
2020	1	8.998.160	3.745.710	11.021.938
	2	8.099.327	3.255.207	9.785.097
	3	7.741.560	4.100.126	9.153.719
	4	7.640.169	3.259.497	8.002.357
2021	1	9.627.693	5.060.681	6.580.931
	2	8.784.173	4.904.268	6.584.759
	3	8.965.408	3.796.038	7.573.513
	4	8.755.334	3.931.609	9.454.035
2022	1	12.080.467	6.197.981	9.721.747
	2	10.579.377	6.528.908	11.147.883
	3	10.059.658	6.683.223	13.815.831

Source: Data processed (2022)



Source: Data processed (2022)

Figure 1. Inventory Data AMRT for 2018-2022

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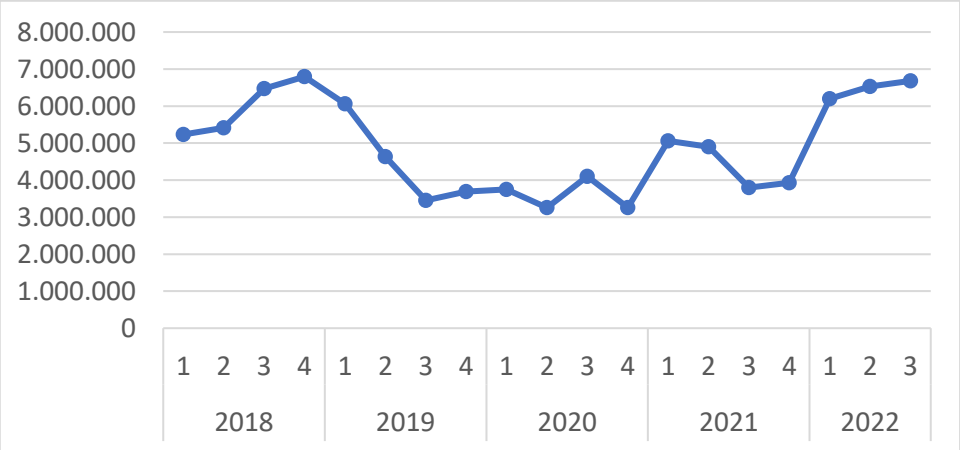
Above is a chart of supplies at AMRT from the 1st quarter of 2018 to the 3rd quarter of 2022. Inventory at AMRT has increased at the beginning of each year and has decreased in the second quarter. The increase in the second quarter only occurred in 2018, initially from 7,030,603 to 7,166,353. In the second to third quarters of 2018, 2019, and 2020, inventories decreased slightly. However, in the fourth quarter of 2018 and 2019, it experienced an increase. The decline until the fourth quarter only occurred in 2020. In 2021, inventories increased from the second to third quarters and decreased in the fourth quarter. Inventory increased significantly at the beginning of 2022, amounting to 3,325,133 and decreased in the second and third quarters.

Based on the calculations in the financial statements, inventories in AMRT are higher compared to the 2nd to fourth quarters due to a large amount of allowance for obsolescence. At the end of the year, namely in the 4th quarter, the allowance for obsolete inventory is more significant than in other quarters, especially the first quarter. In calculating the allowance for inventory obsolescence, management has reviewed the condition of the inventories at the end of the year, that this amount is sufficient to cover possible losses that may arise. In addition, stocks in the AMRT consist of food and non-food items, with food stocks at the beginning of the year being more than in other quarters.

Inventory in AMRT from 2018 to 2022 tends to have the same pattern and has not experienced a significant decrease or even increase. It proves that AMRT could survive amid the Covid-19 pandemic, which harmed the economy. AMRT made adjustments in running the company's operations in facing the challenges of the pandemic. AMRT focuses on providing the best service to consumers. One of the things done is the development of online shopping through the Alfagift application. Therefore, AMRT received the Best Issuer of the Bisnis Indonesia Award 2021 in the Primary Goods Retail Trade Sector Company Category, held by the Bisnis Indonesia daily.



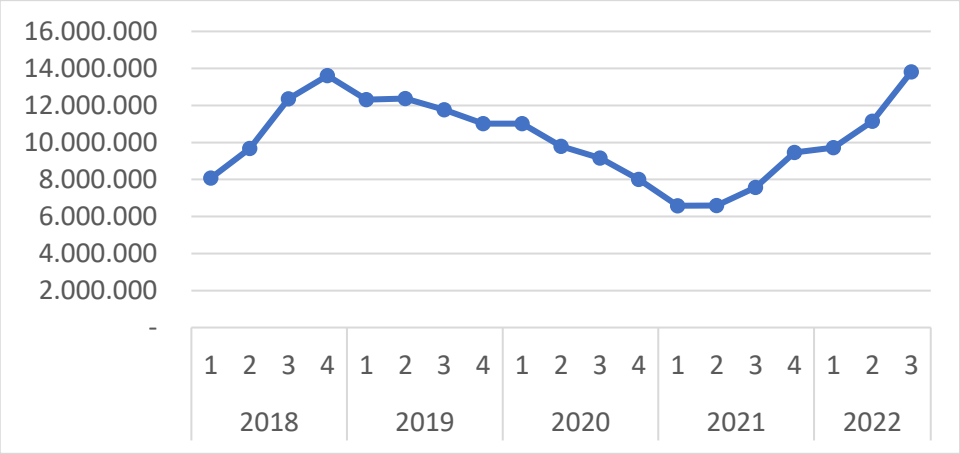
Source: Data processed (2022)

Figure 2. Inventory Data ERAA for 2018-2022

Inventories in ERAA are highly volatile. From 2018 to 2019, inventories experienced a significant increase, especially in the second to third quarters. However, in 2019, inventory at

ERAA experienced a considerable decline until the third quarter. At the beginning of 2019, the inventory was 6,062,523; in the third quarter, it was 3,455,345. Inventories increased slightly from the third quarter to the fourth quarter. In the fourth quarter into early 2020, inventories stabilized. Inventory has increased and decreased throughout 2020. The decline occurred in the second quarter and fourth quarter. The increase from the end of 2020 to the beginning of 2021 was relatively high, 1,801,184. The decline occurred again until the third quarter and increased in the fourth quarter. A very significant increase occurred at the beginning of 2022, namely 3,325,133. During 2022, inventory in ERAA has increased.

There are several types of inventory in ERAA, namely phones and tablets, computers and other electronic equipment, operator products, spare parts, electronic vouchers, starter packs, physical vouchers, accessories, and others. During the pandemic, supplies at ERAA decreased, especially for phones and tablets. Meanwhile, the supplies most purchased during this pandemic are computers, accessories, vouchers, and SIM cards, due to changes in people's lives where almost all activities are carried out online. With an increase in supplies in 2022, we can see that ERAA has survived the Covid-19 pandemic. The method used by ERAA in dealing with a pandemic tends to be different from other companies. ERAA continues to expand by opening hundreds of new outlets during a pandemic as part of Erajaya's omnichannel business strategy. Hundreds of outlets are expected to reach more consumers from various regions.



Source: Data processed (2022)

Figure 3. Inventory Data UNTR for 2018-2022

Inventories at UNTR increased in the first quarter to the fourth quarter of 2018, amounting to 5,545,655. However, supplies at UNTR continued to decline until early 2021. In the first quarter of 2019, inventories at UNTR were 12,317,847, a decrease of 1,300,022. Inventories continued to decline until early 2021. Inventories in the first quarter of 2021 amounted to 6,580,931, lower than at the beginning of 2018. An increase occurred again in the first quarter of 2021 to 2022, with a significant increase exceeding the highest peak of inventories in the fourth quarter of 2018, namely 13,815,831.

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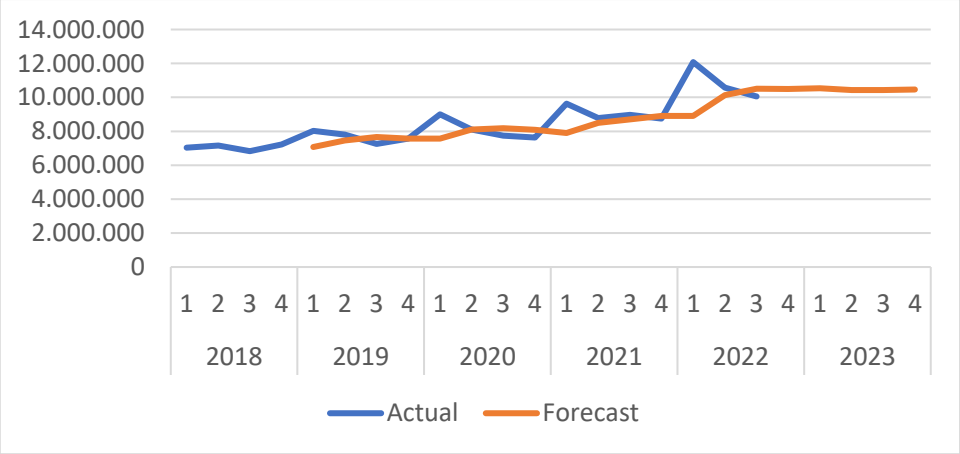
A significant decrease occurred during the Covid-19 pandemic. This pandemic certainly impacts projects that require workers to work directly and cannot be carried out online, so many projects are temporarily halted. Of course, UNTR as a heavy equipment distributor, experienced this impact. However, UNTR has been able to survive until now and has increased from 2021 to 2022. In 2021, many projects were carried out again, so supplies at UNTR increased significantly. The inventories that experienced the most impact of this increase and decrease were spare parts, heavy equipment, and coal. Heavy equipment experienced the most significant decrease, namely 74% and coal experienced the highest increase.

Table 2. Result of Inventory Forecasting in AMRT (in a million rupiah)

Year	Q	Actual	Forecast	MAD	Tracking Signal
2018	1	7.030.603			
	2	7.166.353			
	3	6.828.741			
	4	7.221.444			
2019	1	8.029.049	7.073.531	955.518	1,00
	2	7.800.789	7.460.436	1.125.695	1,15
	3	7.247.984	7.656.193	1.046.350	0,85
	4	7.577.090	7.567.385	1.009.105	0,89
2020	1	8.998.160	7.568.294	1.272.730	1,83
	2	8.099.327	8.102.067	1.448.024	1,61
	3	7.741.560	8.179.395	1.510.686	1,25
	4	7.640.169	8.083.763	1.502.233	0,96
2021	1	9.627.693	7.898.217	1.687.823	1,88
	2	8.784.173	8.501.373	1.864.575	1,85
	3	8.965.408	8.704.167	2.032.939	1,83
	4	8.755.334	8.910.971	2.160.273	1,65
2022	1	12.080.467	8.911.360	2.511.794	2,68
	2	10.579.377	10.130.286	2.845.177	2,52
	3	10.059.658	10.503.499	3.104.518	2,17
	4		10.489.303		
2023	1		10.537.541		
	2		10.431.677		
	3		10.437.759		
	4		10.461.045		

Source: Data processed (2022)



Source: Data processed (2022)

Figure 4. Result of Inventory Forecasting AMRT

Table 2 shows the results of inventory forecasting at AMRT using the WMA method for four quarters. That starting from forecasting the first quarter of 2019, it was 7.073.531, while the actual inventory was 8.029.049. Based on these calculations, the forecast for December for the 4th quarter is 10.489.303, the first quarter for January 2023 is 10.537.541, the second quarter is 10.431.677, the third quarter is 10.437.759, and the fourth quarter is 10.461.045. After forecasting, the results of the forecast are tested for error rates. The result of the tracking signal value is 2,17.

Table 3. Result of Inventory Forecasting in ERAA (in a million rupiah)

Year	Q	Actual	Forecast	MAD	Tracking Signal
2018	1	5.233.324			
	2	5.415.804			
	3	6.469.454			
	4	6.794.576			
2019	1	6.062.523	6.265.160	202.637	- 1,00
	2	4.632.330	6.298.853	1.035.898	- 1,80
	3	3.455.345	5.677.550	2.054.387	- 1,99
	4	3.693.371	4.663.799	2.806.239	- 1,80
2020	1	3.745.710	4.046.670	3.317.541	- 1,62
	2	3.255.207	3.760.597	3.742.642	- 1,57
	3	4.100.126	3.510.005	3.961.982	- 1,33
	4	3.259.497	3.735.092	4.185.936	- 1,37
2021	1	5.060.681	3.559.449	4.193.319	- 1,01
	2	4.904.268	4.147.667	4.123.566	- 0,85
	3	3.796.038	4.541.824	4.134.293	- 1,03
	4	3.931.609	4.327.782	4.176.247	- 1,11
2022	1	6.197.981	4.198.377	4.057.931	- 0,65
	2	6.528.908	4.908.310	3.840.760	- 0,26
	3	6.683.223	5.636.883	3.586.630	0,01
	4		6.264.719		

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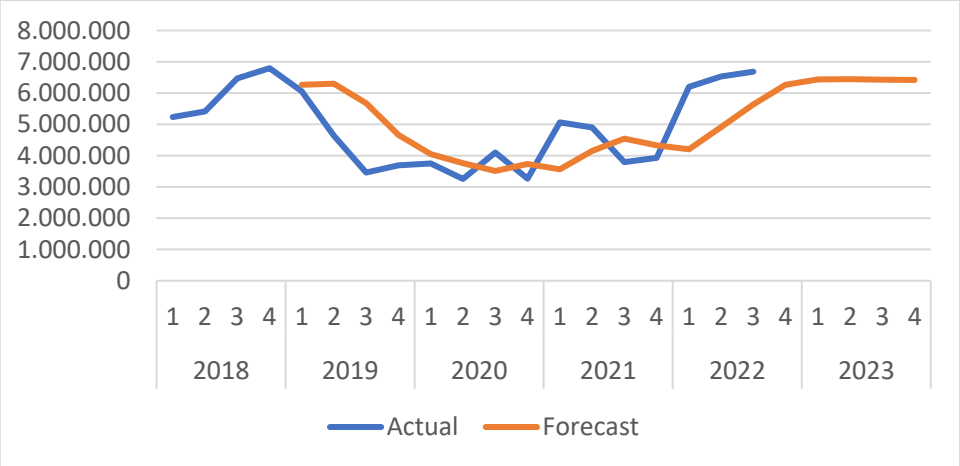
Year	Q	Actual	Forecast	MAD	Tracking Signal
2023	1		6.436.434		
	2		6.443.525		
	3		6.429.606		
	4		6.418.659		

Source: Data processed (2022)



Source: Data processed (2022)

Figure 5. Result of Inventory Forecasting ERAA

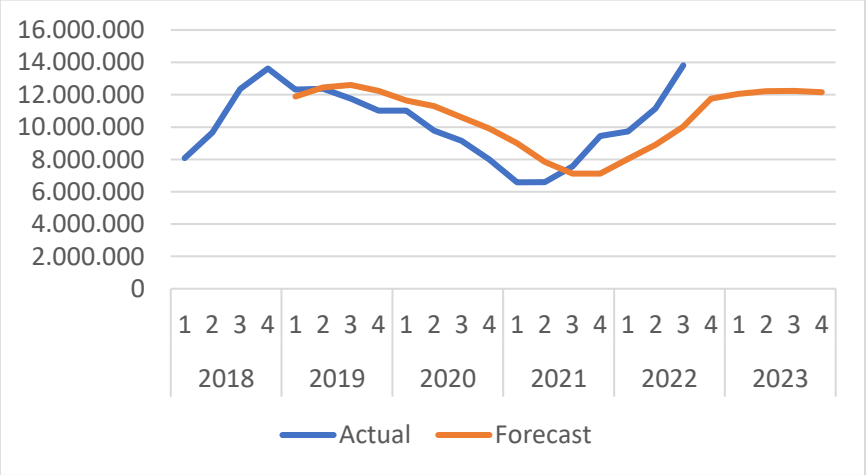
Table 3 shows the results of inventory forecasting at ERAA using the WMA method for four quarters. Starting from forecasting, the first quarter of 2019 was 6.265.160, while the actual inventory was 6.062.523. Based on these calculations, the forecast for December for the 4th quarter is 6.264.719, the first quarter for January 2023 is 6.436.434, the second quarter is 6.443.525, the third quarter is 6.429.606, and the fourth quarter is 6.418.659. After forecasting, the results of the forecast are tested for error rates. The result of the tracking signal value is 0,01.

Table 4. Result of Inventory Forecasting in UNTR (in a million rupiah)

Year	Q	Actual	Forecast	MAD	Tracking Signal
2018	1	8.072.214			
	2	9.669.841			
	3	12.356.001			
	4	13.617.869			
2019	1	12.317.847	11.895.138	422.710	1,00
	2	12.368.604	12.450.684	381.670	0,89
	3	11.763.390	12.601.970	420.430	-1,18
	4	11.014.020	12.241.294	746.628	-2,31
2020	1	11.021.938	11.640.131	1.065.986	-2,20
	2	9.785.097	11.302.520	1.531.794	-2,52
	3	9.153.719	10.599.763	2.071.093	-2,56
	4	8.002.357	9.902.806	2.713.123	-2,66

Year	Q	Actual	Forecast	MAD	Tracking Signal
2021	1	6.580.931	9.006.272	3.481.962	-2,77
	2	6.584.759	7.842.333	4.222.790	-2,58
	3	7.573.513	7.124.026	4.788.060	-2,18
	4	9.454.035	7.121.255	5.064.720	-1,60
2022	1	9.721.747	8.028.713	5.168.584	-1,24
	2	11.147.883	8.898.088	5.096.910	-0,82
	3	13.815.831	10.023.836	4.781.993	-0,08
	4		11.760.450		
2023	1		12.050.681		
	2		12.226.362		
	3		12.239.422		
	4		12.149.859		

Source: Data processed (2022)



Source: Data processed (2022)

Figure 6. Result of Inventory Forecasting UNTR

Table 4 shows the results of inventory forecasting at UNTR using the WMA method for four quarters. That starting from forecasting the first quarter of 2019, it was 11.895.138, while the actual inventory was 12.317.847. Based on these calculations, the forecast for December for the 4th quarter is 11.760.450, the first quarter for January 2023 is 12.050.681, the second quarter is 12.226.362, the third quarter is 12.239.422, and the fourth quarter is 12.149.859. After forecasting, the results of the forecast are tested for error rates. The result of the tracking signal value is -0,08.

Conclusion

Visualization of inventory graphs for each company shows different levels of fluctuation. Inventory at AMRT has increased at the beginning of each year (in the first quarter) and decreased in the second quarter. Meanwhile, in ERAA, inventories fluctuated wildly. At first, ERAA experienced an increase but then experienced a significant decrease and experienced

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ups and downs afterward. Unlike the others, at first, UNTR experienced a drastic decline but was able to increase again, exceeding the highest supply of the previous period.

Based on the research results, using the Weighted Moving Average method can calculate inventory forecasts in AMRT, ERAA, and UNTR for the next period. Inventory forecast for the next period in AMRT of 10.489.303 for December 4th quarter, the first quarter of January 2023 of 10.537.541, the second quarter of 10.431.677, third quarter of 10.437.759, and fourth quarter of 10.461.045. Inventory forecasting ERAA on December 4th quarter of 6.264.719, the first quarter of January 2023 was 6.436.434, the second quarter was 6.443.525, the third quarter was 6.429.606, and the fourth quarter was 6.418.659. Meanwhile, inventory forecasting UNTR in December 4th quarter of 11.760.450, the first quarter of January 2023 of 12.050.681, the second quarter of 12.226.362, the third quarter of 12.239.422, and the fourth quarter of 12.149.859.

From the results of each company's forecasting to determine the error rate of the resulting predictions, the authors look for the tracking signal value for each company used in this study as follows:

Table 5. Result of Tracking Signal

Company	Actual
AMRT	2,17
ERAA	0,01
UNTR	-0,08

Source: Data processed (2022)

Table 5 shows that the tracking signal value in AMRT is 2,17, ERAA is 0,01, and UNTR is -0,08. So UNTR has the smallest tracking signal value of -0,08. From the comparison of the three companies, it can be concluded that to know the prediction of the next period's inventory, the company can use the WMA method because by using this method, the tracking signal value is still within the control limits, namely, ±4.

This research is limited to data for five years, from the 1st quarter of 2018 to the 3rd quarter of 2022 and using one method, namely WMA. The author suggests further research to add data in the calculation to make the results more accurate and add forecasting methods for comparison.

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