Jurnal Logistik Indonesia Vol. 8, No. 1, April 2024, pp. 74-86

Using Forecasting Methods to Increase the Accuracy of Container Demand Requirement: An Indonesian Case Study

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ARTICLE INFO

Article history
Received : 22-08-2024
Revised :29-08-2024
Accepted : 10-09-2024

Keywords :
Container;
Forecasting;
Linear Regression;
Quadratic;
Exponential;

ABSTRACT

PT Crieta Logistics ships goods in containers. In carrying out its business, the company often experiences lost sales which are caused by the unavailability of containers so that the orders can be fulfilled. From January to July 2022, PT Crieta Logistics experienced lost sales of 21, 9, 12, 34, 19, 4 and 2 TEUs respectively. Therefore, in this study forecasting the number of requests for containers at PT Crieta Logistics conducted to make decisions related to handling demand for containers in the coming period. This forecasting result served as a basic input to establish policies of container availability, such as whether to reorganize contracts with vendors or others. The forecasting is done using 3 methods, namely linear, quadratic, and exponential regression with historical data of 2 years from July 2020 to July 2022. In determining the most accurate forecasting method, the error value is calculated using the mean absolute percentage error (MAPE) method. In the linear regression method, the MAPE value is 9.5%, while in the quadratic method, the MAPE value is 9%, and in the exponential method, the MAPE value is 9.2%. The quadratic method was chosen as the method suitably used in forecasting the next 12 periods because it has the smallest MAPE value. Forecasting demand using the quadratic method produces 12,631 units of containers for the next 12 periods, from August 2022 - July 2023.

1. INTRODUCTION

According to the Head of the Central Statistics Agency, Indonesia experienced economic growth of 3.69 percent in 2021 [1]. This economic growth has made the industry in Indonesia increasingly develop; this development has a positive impact on logistics activities [2] in Indonesia. A study [3] demonstrated how logistics are crucial to maintaining and fostering economic growth in the sense that economic growth creates a strong need for logistics. The impact of this development is that the activity of shipping goods has increased, both individual shipping (customer to customer) and shipping carried out by companies (business to business). This shipping can use land or sea transportation. In making shipments in large quantities, containers are usually used to facilitate the shipping process so that supervision of goods during shipping can be carried out more easily. Companies that have a main business in shipping goods using containers will depend on the availability of containers [4], because they will only be able to make shipments when there are containers available. When there are no containers available, the company will lose customers or is often referred to as lost sales [5]. This will cause the company to lose income due to being unable to serve orders from customers. Lost sales are the unavailability of goods that cause the company to lose sales [6], which causes the company to lose income from the incident.

One of the companies engaged in logistics business, especially in shipping goods using containers, is PT Crieta Logistics that headquartered in Jakarta, Indonesia. In making a shipping order by this company, customers can choose a mode of transportation such as trucks, ships, and trains. When making an order, customers determine the number of containers to be used in shipping. Therefore, customers need to know their container needs before making a shipping order. Shipping carried out by PT Crieta Logistics can be executed when there are containers that can be used, so the company needs to ensure the availability of the containers first. But in practice there happened lost sales on customer orders due to container unavailability.

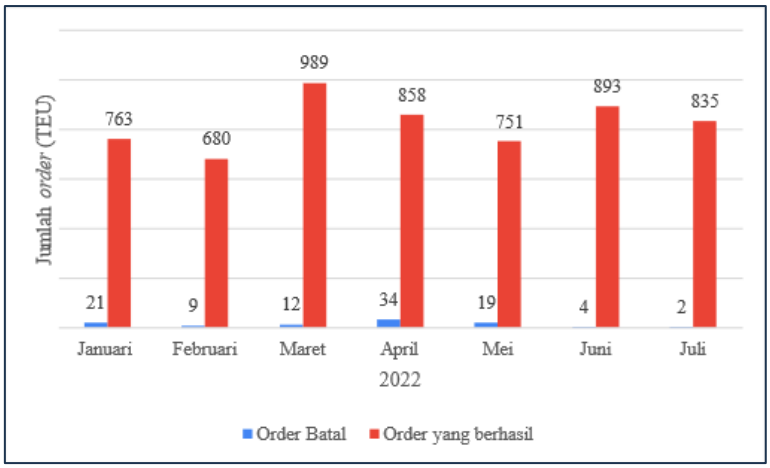

Fig. 1. Order history from January-July 2022.

Based on Figure 1, it is known that PT Crieta Logistics is still experiencing order cancellations due to the unavailability of containers when customers place orders, so that shipments cannot be made. In addition to the absence of containers during shipping, another thing that can cause order cancellations is that customers have not finished preparing the goods to be shipped so that order cancellations are made. Order cancellations are included in lost sales because the company loses the opportunity to complete orders from customers. The data is lost sales from the three modes of transportation available at PT Crieta Logistics, so that the research conducted considers the demand for containers in the three modes of transportation, namely trucks, trains and ships. In fact, when a company loses a customer, it will reduce the company's income. This is due to the lack of planning by PT Crieta Logistics for shipping preparations using containers, so the company must wait until containers are available to make shipments. When the duration of waiting for container availability does not match the shipping schedule desired by the customer, the order will be canceled. In handling shipping orders, the company only checks the availability of containers when there are customers who will make a shipment so that the company cannot anticipate customer orders when there are no containers available at the Container Depot.

Based on its business process, containers are very important in the continuity of customer goods delivery so that forecasting needs to be done with several methods so that the method that best suits the container demand data pattern can be found, thus the forecasting results can be more accurate. Because in real conditions the company does not apply forecasting, but the company only orders containers when an order comes in. The order is made immediately after the order is received. By planning the availability of containers, the company will be able to serve more customers. This planning can be done by collaborating with vendors in the contract so that PT Crieta Logistic can better regulate the use of containers.

It is known that the basis for forecasting container demand at PT Crieta Logistics is that containers are not available when customers place orders, resulting in lost sales because the company cannot make deliveries based on incoming orders. This causes the company to experience a decrease in revenue. The second problem is the development of industry which results in increased shipping activities. The shipments made certainly require containers so that there will be an increase in the need for containers. Based on these two things, it is necessary to forecast container needs so that it can help the company in making decisions related to container planning for shipping.

Based on the explanation above, the problem questions in this study are as follows:

1. What forecasting method has the smallest error value on historical data of PT Crieta Logistics demand?
2. How much is the number of container requests at PT Crieta Logistics in the next period to help the company in making decisions regarding evaluating contracts with vendors?

2. Literature Review

Forecasting

According to [7], in the decision-making process in operations management, forecasting is carried out as the basic input to be able to determine the capacity or inventory needed so that it can produce decisions that can plan the budget.

The role of forecasting according to (Makridakis & Wheelwright, 1998) is as follows.

1. Available resources can be scheduled

   This needs to be done because with scheduling in the fields of production, transportation, and other fields, it will be able to produce efficient use of resources.

2. Can provide additional resources

   With the waiting time or lead time in obtaining raw materials, recruiting new workers or purchasing new machines, the company can make forecasts in determining the quantity of resource needs in the future.

3. Can determine the resources needed

   In a company, it will determine the resources needed in the long term, the decisions to be taken depend on existing market opportunities, environmental factors and internal development of the company. In this case, the company makes forecasts to estimate resource needs so that it can make appropriate decisions.

Linear Regression Method

This method is used when past data has a graphical form like or tends to resemble a parabola [8]. In the linear regression method, there are dependent and independent variables. The dependent variable is what is measured in the study and the value of this variable will depend on the independent variable while the independent variable is the variable that affects the value of the dependent variable [9]. Based on this, it can be identified that in the linear regression method, the independent variable is the period because the value of the demand period will continue to increase over time without being influenced by anything, while the dependent variable is the amount of demand because as the period increases, the amount of demand will change in value.

Quadratic Method

This technique is applied when historical data resembles or has a graphical form like a parabola [8]. Quadratic method forecasting refers to using a quadratic model to predict future values based on historical data. This method is particularly useful when the relationship between variables appears to follow a parabolic trend, rather than a straight line. Quadratic forecasting is used for these conditions:

a. Nonlinear Trends: When data shows a clear parabolic trend, quadratic forecasting can capture the acceleration and deceleration effects better than linear models.

b. Short-term Forecasting: It is often useful for short-term forecasting where trends are evident, but long-term forecasts may require more complex models.

Quadratic forecasting provides a more nuanced approach than simple linear models by accounting for the curvature in trends [10], making it valuable for scenarios where relationships between variables are not purely linear.

Exponential Method

The exponential method is a forecasting method with a moving average by giving exponential (graded) weights to the latest data set so that the data set will receive a greater weight [11]. The exponential method of forecasting involves using exponential functions to model and predict future values based on historical data. This method is particularly useful when data shows a trend that grows or decays at a constant rate over time, which is not captured by linear or quadratic models. In exponential forecasting, the relationship between the period (or another independent variable) and the dependent variable is modeled using an exponential function. Exponential forecasting provides a

powerful tool for predicting future values in scenarios where changes follow a multiplicative or exponential pattern, offering insights into growth or decay processes that linear models may miss.

Mean Absolute Percentage Error (MAPE)

In forecasting using the MAPE method, the result is a measure of the error in the forecast when compared to the value of the data. A smaller MAPE value indicates a better level of forecasting accuracy [12], [13]. The following are variations in the forecasting results using the MAPE method.

a. The forecasting results are said to be very good when the MAPE value is <10%
b. The forecasting results are said to be good when the MAPE value is in the range of 10-20%
c. The forecasting results are said to be feasible when the MAPE value is in the range of 20-50%
d. The forecasting results are said to be bad when the MAPE value is more than 50%

Based on the MAPE value produced, MAPE is used when the value is less than 50% because if it is more than 50% it produces poor forecasting results [14].

3. THE PROPOSED METHOD

This research flow is formed so that the research process can be more focused, and the objectives of the research can be achieved. The research flow can be started from the problem identification stage and ends with drawing conclusions from the forecasting results that have been carried out. The explanation of the research flow above is as follows:

1. Problem identification

   At this stage, the identification of problems that occur in the company is carried out by creating a background that summarizes the formulation of the problem, objectives and scope of the research.

2. Literature study

   At this stage, information is searched for on forecasting methods that can be used in this study, so that the stages of demand forecasting and the data needed before forecasting demand will be known.

3. Data collection

   At this stage, the data needed to process data to forecast demand is collected. After this data is collected, an analysis will be carried out on the data so that the forecasting method that is suitable for the historical data pattern of demand can be determined.

4. Data processing

   At this stage, an analysis is carried out on the demand data pattern and after that a forecast is carried out using the exponential method, linear regression and quadratic

5. Forecast accuracy testing

   At this stage, the method with the best forecasting accuracy is selected by determining the error rate for each method and the method with the smallest error will be selected as the forecasting method for the next 12 periods.

6. Analysis of forecasting results.

   At this stage, the analysis of the data processing results that have been carried out is carried out by comparing the error calculations on each forecasting method, so that the method with the least error will be selected as the most suitable forecasting method for historical container demand data.

7. Conclusions and suggestions

   This stage is the last stage in this study, drawing conclusions is done by answering the research objectives that have been set in advance and providing suggestions for further research.

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4. RESULTS AND DISCUSSION

In this research that conducted at PT Crieta Logistics, historical data on container demand is needed for transportation modes, namely Train Cargo Expedition (EMKA), Sea Cargo Expedition (EMKL) and Land Expedition (LAND) in the period July 2020 to July 2022. The container demand data is as follows.

Table 1. Container Demand Data from July 2020 - July 2022

Month	Period (*t*)	Container Demand (TEU)
Jul 2020	1	646
Aug 2020	2	698
Sep 2020	3	718
Oct 2020	4	681
Nov 2020	5	620
Dec 2020	6	663
Jan 2021	7	630
Feb 2021	8	637
Mar 2021	9	684
Apr 2021	10	721
May 2021	11	509
Jun 2021	12	618
Jul 2021	13	725
Aug 2021	14	717
Sep 2021	15	779
Oct 2021	16	1025
Nov 2021	17	805
Dec 2021	18	954
Jan 2022	19	784
Feb 2022	20	689
Mar 2022	21	1001
Apr 2022	22	892
May 2022	23	770
Jun 2022	24	897
Jul 2022	25	837

R	R Square	Adjusted R Square	Std. Error of the Estimate
.650	.423	.397	5.713

Fig. 2. Linear data pattern analysis with SPSS.

Based on Table 1, we can see that the demand for containers at PT Crieta Logistics tends to increase from July 2020 to July 2022. According to [15], data that has a stationary pattern is data that fluctuates at a relatively constant average. We can also see that the container demand data does not have a stationary data pattern because the data does not fluctuate around its average. So, the moving average method is not suitable for use on data patterns that have seasonal or trend elements. The most suitable method to use is the method with a trend data pattern. Based on the results of the data pattern with SPSS in Fig. 2, 3, and 4, the most suitable method to use is the quadratic method because it has the largest R Square value, namely 0.429.

R	R Square	Adjusted R Square	Std. Error of the Estimate
.655	.429	.377	5.811

Fig. 3. Quadratic data pattern analysis with SPSS.

R	R Square	Adjusted R Square	Std. Error of the Estimate
.533	.284	.253	.721

Fig. 4. Exponential data pattern analysis with SPSS.

Forecasting Result with Exponential Method

Forecasting using the exponential method is carried out on container demand data from July 2020 to July 2022. The equation used in this method is as follows.

$$y' = a \times e^{b \times t} \quad (1)$$

The results of forecasting container demand in TEU as unit using the exponential method can be seen in the following Table 2.

Table 2. Forecasting Calculation Results Using the Exponential Method

Periode (*t*)	Actual (*y*)	ln*y*	*t* ln*y*	*t*^2	Estimated Value (*y*')
1	646	6.47	6.47	1	618
2	698	6.55	13.10	4	628
3	718	6.58	19.73	9	637
4	681	6.52	26.09	16	646
5	620	6.43	32.15	25	656
6	663	6.50	38.98	36	666
7	630	6.45	45.12	49	676
8	637	6.46	51.65	64	686
9	684	6.53	58.75	81	696
10	721	6.58	65.81	100	706
11	509	6.23	68.56	121	717
12	618	6.43	77.12	144	727
13	725	6.59	85.62	169	738
14	717	6.58	92.05	196	749
15	779	6.66	99.87	225	760
16	1025	6.93	110.92	256	771
17	805	6.69	113.74	289	783
18	954	6.86	123.49	324	794
19	784	6.66	126.62	361	806
20	689	6.54	130.70	400	818
21	1,001	6.91	145.08	441	830
22	892	6.79	149.46	484	842
23	770	6.65	152.87	529	855
24	897	6.80	163.18	576	868
25	837	6.73	168.25	625	880

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In forecasting using the exponential method, the first step is to search for the values of parameter *a* and *b*. The calculation of these parameters is as follows.

1. Parameter *b*

$$b = \frac{n \times \sum t \ln y - (\sum t \ln y)}{n \sum t^2 - (\sum t^2)}$$

$$b = \frac{(25 \times 2165{,}38) - 2165{,}38}{(325 \times 5525) - 5525}$$

$$b = 0{,}015$$

2. Parameter *a*

$$\ln a = \frac{\sum \ln y - b \sum t}{n}$$

$$\ln a = \frac{165{,}10 - (0{,}015 \times 325)}{25}$$

$$\ln a = 6{,}41$$

$$a = 609{,}4$$

After data processing, it was found that the parameter value *a* = 609.40 and *b* = 0.015. Then the container demand forecast will be carried out, an example of the calculation for *t* = 1 can be found below.

$$y' = 609{,}40 \times e^{0{,}015 \times 1}$$

$$y' = 618 \text{ TEU}$$

Forecasting Result with Quadratic Method

Forecasting using the quadratic method is carried out on historical container demand data starting from July 2020 to July 2022. Forecasting using the quadratic method is carried out using the following equation.

$$y' = a + bt + ct^2 \quad (2)$$

The results of forecasting container demand (units) using the quadratic method can be seen in the following Table 3.

Table 3. Forecasting Calculation Results Using the Quadratic Method

Period (*t*)	**Actual (*y*)**	***t*^2**	***t*^3**	***t*^4**	***t**y**	***t*^2*y**
1	646	1	1	1	646	646
2	698	4	8	16	1,396	2,792
3	718	9	27	81	2,154	6,462
4	681	16	64	256	2,724	10,896
5	620	25	125	625	3,100	15,500
6	663	36	216	1,296	3,978	23,868
7	630	49	343	2,401	4,410	30,870
8	637	64	512	4,096	5,096	40,768
9	684	81	729	6,561	6,156	55,404
10	721	100	1,000	10,000	7,210	72,100
11	509	121	1,331	14,641	5,599	61,589
12	618	144	1,728	20,736	7,416	88,992
13	725	169	2,197	28,561	9,425	122,525
14	717	196	2,744	38,416	10,038	140,532
15	779	225	3,375	50,625	11,685	175,275
16	1,025	256	4,096	65,536	16,400	262,400
17	805	289	4,913	83,521	13,685	232,645

Period (*t*)	**Actual (*y*)**	***t*^2**	***t*^3**	***t*^4**	***t**y**	***t*^2*y**
18	954	324	5,832	104,976	17,172	309,096
19	784	361	6,859	130,321	14,896	283,024
20	689	400	8,000	160,000	13,780	275,600
21	1,001	441	9,261	194,481	21,021	441,441
22	892	484	10,648	234,256	19,624	431,728
23	770	529	12,167	279,841	17,710	407,330
24	897	576	13,824	331,776	21,528	516,672
25	837	625	15,625	390,625	20,925	523,125

The period in the data starts from period 1, which is July 2020, and ends in period 25, which is July 2022. Forecasting using the quadratic method is carried out after searching for the parameter values. The calculation of the parameter values is as follows.

1. Parameter β

   $\beta = \left(\sum \mathrm{t}\right)^2 - \mathrm{n}\left(\sum \mathrm{t}^2\right)$

   $\beta = (325)^2 - 25(5525)$

   $\beta = -32500$
2. Parameter γ

   $\gamma = \left(\sum t^2\right)^2 - n\left(\sum t^4\right)$

   $\gamma = (5525)^2 - 25(2.153.645)$

   $\gamma = -23.315.500$
3. Parameter δ

   $\delta = \left(\sum t \sum y\right) - \left(n\left(\sum yt\right)\right)$

   $\delta = (325 \times 18700) - (25 \times 257.774)$

   $\delta = -366850$
4. Parameter θ

   $\theta = \left(\sum t^2 \sum y\right) - \left(n\left(\sum t^2 y\right)\right)$

   $\theta = (5525 \times 18.700) - (25 \times 4.531.280)$

   $\theta = -9.964.500$
5. Parameter α

   $\alpha = \left(\sum t \sum t^2\right) - \left(n\left(\sum t^3\right)\right)$

   $\alpha = (325 \times 5525) - (25 \times 105625)$

   $\alpha = -845.000$

After the parameters β, γ, δ, θ, and α are known, the next step is to calculate the parameters *a*, *b*, and *c* used in the forecasting equation using the quadratic method.

6. Parameter b

   $b = \dfrac{(\gamma \times \delta) - (\theta \times \alpha)}{(\gamma \times \delta) - \alpha^2}$

   $b = \dfrac{(-23.315.500 \times -366850) - (-9964500 \times -845000)}{(23315500 \times -366850) - (-845.000)^2}$

   $b = 3{,}05$
7. Parameter c

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$$c = \frac{\theta - (b - \alpha)}{\gamma}$$
$$c = \frac{-9964500 - (3{,}05 - (-845.000)}{-23.315.500}$$
$$c = 0{,}317$$

8. Parameter a

$$a = \frac{\sum y - b\sum y - c\sum t^2}{n}$$
$$a = \frac{18.700 - 3{,}05 \times 18700 - 0{,}317 \times 5525}{25}$$
$$a = 638{,}34$$

Based on the data processing carried out, it was found that the parameter values a = 638.34, b = 3.05 and c = 0.317. The following is an example of calculating container demand for t = 1.

$$y' = a + bt + ct^2$$
$$y' = 638{,}34 + 3{,}05(1) + 0{,}317(1)^2$$
$$y' = 642 \text{ TEU}$$

Forecasting Result with Linear Regression Method

In forecasting using the linear regression method, historical container demand data is used starting from July 2020 to July 2022. Forecasting using the linear regression method is carried out using the following equation.

$$y' = a + bt \quad (3)$$

The results of forecasting container demand (units) using the linear regression method can be seen in the following Table 4.

Table 4. Forecasting Calculation Results Using the Linear Regression Method

Periode (*t*)	**Actual (*y*)**	***t**y**	***t*^2**	***y*'**
1	646	646	1	613
2	698	1,396	4	624
3	718	2,154	9	635
4	681	2,724	16	646
5	620	3,100	25	658
6	663	3,978	36	669
7	630	4,410	49	680
8	637	5,096	64	692
9	684	6,156	81	703
10	721	7,210	100	714
11	509	5,599	121	725
12	618	7,416	144	737
13	725	9,425	169	748
14	717	10,038	196	759
15	779	11,685	225	771
16	1,025	16,400	256	782
17	805	13,685	289	793
18	954	17,172	324	804
19	784	14,896	361	816

Periode (*t*)	**Actual (*y*)**	***t**y**	***t*^2**	***y'***
20	689	13,780	400	827
21	1,001	21,021	441	838
22	892	19,624	484	850
23	770	17,710	529	861
24	897	21,528	576	872
25	837	20,925	625	883

Before getting the forecasting results using linear regression, the calculation of the parameter values *a* and *b* is first carried out. The calculation of these parameters is as follows.

1. Parameter b

$$b = \frac{n\sum t.y - \sum y}{n\sum t^2 - (\sum t)^2}$$

$$b = \frac{25 \times 257.774 - 18.700}{25 \times 5525 - (325)^2}$$

$$b = 11{,}29$$

2. Parameter a

$$a = \frac{\sum y}{n} - b\frac{\sum t}{n}$$

$$a = \frac{18.700}{25} - 11{,}29\left(\frac{325}{25}\right)$$

$$a = 601{,}26$$

Based on the results of the data processing, it was obtained that the value of *a* = 601.26 and *b* = 11.29. Both parameters will be used in calculating container demand using linear regression. An example of the calculation for *t* = 1 is as follows.

$$y' = a + bt$$
$$y' = 601{,}26 + 11{,}29(1)$$
$$y' = 613 \text{ TEU}$$

Forecast Error Calculation

After forecasting container demand using exponential, quadratic and linear regression methods, the forecast error calculation for each method is carried out using MAPE (Mean Absolute Percentage Error). The equation used in calculating the MAPE value in the forecasting method is as follows.

$$MAPE = \frac{\left|\sum \frac{Actual_i - Forecast_i}{Actual_i}\right|}{n} \quad (4)$$

Forecast error is calculated by comparing actual data and forecasted data for every method in this study. Based on calculation, the exponential method is classified in the very good forecasting category because the MAPE value is below 10%, that is 9.2%. Another forecast error calculation for quadratic method was conducted and we can find that the estimation values are very good since the MAPE value is below 10%, namely 9%. And for the linear regression method, MAPE calculation also shows that the predicted values are very good as error value produced is below 10%, exactly 9.5%. After calculating the MAPE value for each method, the method with the best accuracy will be selected based on the smallest MAPE value. The following Table 5 presents a recapitulation of the MAPE value for the forecasting methods used.

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Table 5. MAPE Calculation

No.	Forecasting Method	MAPE Value
1	Exponential	9,2%
2	Quadratic	9,0%
3	Linear Regression	9,5%

From Table 5, we can see that the exponential method has a MAPE value of 9.2%, the quadratic method is 9% while the linear regression method produces a MAPE value of 9.5% therefore it can be concluded that the forecasting method that has the smallest MAPE value is the quadratic method.

Another forecast error calculation conducted using Mean Absolute Deviation (MAD) that is to find the average absolute error. The results comparison the MAD for each forecasting method can be seen in the following Table 6.

Table 6. MAD Calculation

No.	Forecasting Method	MAD Value
1	Exponential	2,823
2	Quadratic	2,554
3	Linear Regression	2,892

Based on Table 6, it is found that the exponential method has a MAD value of 2,554, the quadratic method is 2,554, and the linear regression method is 2,892 therefore it can be concluded that forecasting method that has the smallest MAD value is the quadratic method. Forecast error calculation with 2 different methods gives the same result hence the quadratic method is the selected method for forecasting container demand for the next 12 periods.

Future Demand Forecasting

Based on the previous data processing, the method that has the best accuracy value is the quadratic method, so the next stage is to forecast container demand for the next 12 periods with the selected method. The following Table 7 shows the demand forecasting results.

Table 4. Container Demand Forecasting for Future Periods

Period	Estimated Values (TEU)
26	932
27	952
28	972
29	993
30	1,015
31	1,037
32	1,060
33	1,084
34	1,108
35	1,133

After obtaining the number of container requests for the next 12 periods, the forecast results are plotted into a graph in Figure 5 so that it will be easier to observe the forecast results. The forecast result graph can be seen below.

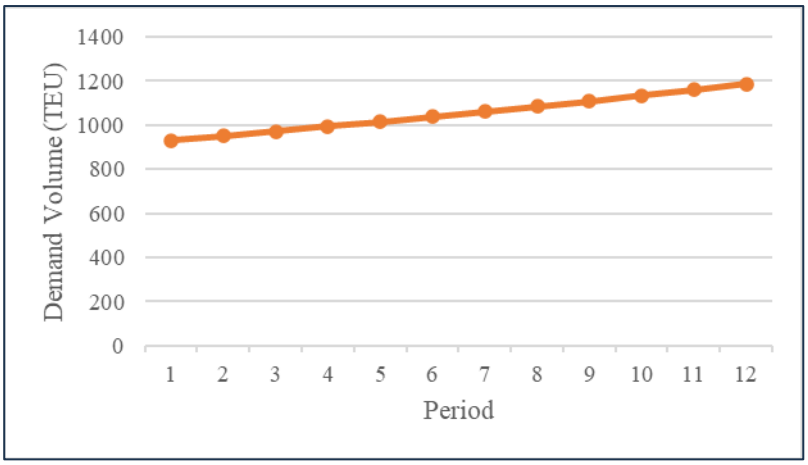

Fig. 5. Forecasting result graph with the selected method.

Based on demand forecasting using the selected method, it shows that container demand tends to increase for the next 12 periods, with a total container demand of 12,631 in all. Thus, the actual demand data pattern is similar to the forecast data pattern using the quadratic method, namely that both data patterns show an increase in container demand volume.

Research Implications

The research implications of this study highlight the importance of accurate demand forecasting in logistics management, particularly for companies like PT Crieta Logistics that rely heavily on container availability. The study demonstrates that selecting the appropriate forecasting method can significantly impact the company's ability to meet customer demand and minimize lost sales. By identifying the quadratic regression method as the most accurate forecasting tool with a MAPE value of 9%, the research provides a data-driven basis for PT Crieta Logistics to optimize its container inventory management. This can lead to better decision-making regarding vendor contracts and other policies to ensure container availability aligns with projected demand.

Moreover, the findings suggest that logistics companies can benefit from regularly revisiting and updating their forecasting models to adapt to changes in demand patterns. This proactive approach can enhance competitiveness by reducing instances of lost sales due to stockouts, ultimately contributing to improved customer satisfaction and financial performance.

5. CONCLUSION

Based on data processing and data processing analysis that has been done, the forecasting method that has the highest level of accuracy based on the lowest MAPE and MAD values is the quadratic method. Using this quadratic method, we can forecast container demand in the coming period sequentially starting from period 26 to 37 is 895, 906, 917, 929, 940, 951, 962, 974, 985, 996, 1,008, and 1,019 TEU. For further research, consideration of demand data with varying container sizes can be included so that the forecasting results will be more in accordance with the reality in the field.

REFERENCES

Rr. A. Y. Widyastuti, “BPS: Pertumbuhan Ekonomi Sepanjang Tahun 2021 Capai 3,69 Persen,” https://bisnis.tempo.co/read/1558217/bps-pertumbuhan-ekonomi-sepanjang-tahun-2021-capai-369-persen.

J.-F. Arvis *et al.*, *Connecting to Compete 2018: Trade Logistics in the Global Economy*. World Bank, Washington, DC, 2018. doi: 10.1596/29971.

M. Reza, “The Relationship between Logistics and Economic Development in Indonesia: Analysis of Time Series Data,” *Jurnal Teknik Industri*, vol. 15, no. 2, Dec. 2013, doi: 10.9744/jti.15.2.119-124.

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B. J. Cudahy, *Box Boats: How Container Ships Changed The World*. Fordham Univ Press, 2007.

B. Wirjodirdjo, A. G. Budianto, I. N. Pujawan, and I. Maflahah, "Container Yard Planning Layout Model Considering Demand and Lost Sale Container," in *Proceedings of the 2020 2nd international conference on management science and industrial engineering*, 2020, pp. 314–318.

K. K. Lai, K. Lam, and W. K. Chan, "Shipping Container Logistics and Allocation," *Journal of the Operational Research Society*, vol. 46, no. 6, pp. 687–697, 1995.

S. Gupta and M. K. Starr, *Production and Operations Management Systems*, vol. 4. CRC Press Boca Raton, 2014.

N. Luh *et al.*, "Peramalan Permintaan Produk Perak Menggunakan Metode Simple Moving Average dan Exponential Smoothing," 2014.

C. Andrade, "A Student's Guide to the Classification and Operationalization of Variables in the Conceptualization and Design of a Clinical Study: Part 1," *Indian J Psychol Med*, vol. 43, no. 2, pp. 177–179, Mar. 2021, doi: 10.1177/0253717621994334.

A. Ubaidillah and S. I. Kholida, "Forecasting of Computer Network Performance with Quadratic Equation," *MATEC Web of Conferences*, 2016, doi: 10.1051/conf/2016.

K. Nurfadilah, A. Sauddin, and W. Saputri, "Rice Production Forecasting Using Exponential Smoothing Method," *Eigen Mathematics Journal*, pp. 21–26, Jun. 2022, doi: 10.29303/emj.v5i1.127.

C. Kasemset, N. Sae-Haew, and A. Sopadang, "Multiple Regression Model for Forecasting Quantity of Supply of Off-season Longan," *Chiang Mai University Journal of Natural Sciences*, vol. 13, no. 3, pp. 391–402, 2014, doi: 10.12982/cmujns.2014.0044.

J. J. Montaño Moreno, A. Palmer Pol, A. Sesé Abad, and B. Cajal Blasco, "Using The R-MAPE Index as A Resistant Measure of Forecast Accuracy," *Psicothema*, vol. 25, no. 4, pp. 500–506, 2013, doi: 10.7334/psicothema2013.23.

M. Sari and I. Iftadi, "Selecting The Best Forecasting Method at PT Indaco Warna Dunia," 2023.

A. Raharja, W. Angraeni, and R. A. Vinarti, "Penerapan Metode Exponential Smoothing untuk Peramalan Penggunaan Waktu Telepon di PT Telkomsel Divre3 Surabaya," *Jurnal Sistem Informasi SISFO*, vol. 14, no. 2, pp. 1–9, 2010.