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# Analysis of Container Yard Capacity In North TPK Using ARIMA Method

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**Abstract.** North container terminal known as North TPK is container terminal located in Indonesia Port Corporation area serving domestic container loading and unloading. It has 1006 ground slots with a total capacity of 5,544 TEUs and the maximum throughput of containers is 539,616 TEUs / year. Container throughput in the North TPK is increasing year by year. In 2011-2012, the North TPK container throughput is 165,080 TEUs / year and in 2015-2016 has reached 213,147 TEUs / year. To avoid congestion, and prevent possible losses in the future, this paper will analyze the flow of containers and the level of Yard Occupation Ratio in the North TPK at Tanjung Priok Port. The method used is the Autoregressive Integrated Moving Average (ARIMA) Model. ARIMA is a model that completely ignores independent variables in making forecasting. ARIMA results show that in 2016-2017 the total throughput of containers reached 234,006 TEUs / year with field effectiveness of 43.4% and in 2017-2018 the total throughput of containers reached 249,417 TEUs / year with field effectiveness 46.2%.

## 1. Introduction

As a maritime country, Indonesia uses sea transportation as one of the most important modes of transportation. Sea transportation will be smooth as it is supported by good port conditions. Port serves key role in trading between countries, industries, and becomes locomotives of economic growth. One port operator that operates and dominates port business in Indonesia is Indonesia Port Corporation (IPC). IPC was previously known as PT. Pelindo II has developed into a more efficient port service company with modern equipment in every aspect of its operations [1] [2] [7].

IPC has contribution to providing port services to support the creation of cheaper, efficient and safe logistics costs. North TPK is a container terminal located at Port One IPC and has a responsibility to load and unload the domestic container [3]. Port performance depends on the activities in the yard and the availability of the facility in the wharf. If the activities on the yard goes smoothly, the performance of the port will be raise. Because of the activities on the yard has a high impact on the performance of the port, so the activities become the critical point to get higher port performance. The activities on the yard will be go smoothly when the demand of the port in still under the capacity of the yard. This research is expected to be an object to forecast the demand of Indonesian Port, Tanjung Priok, on North TPK yard by using Box-Jenkins ARIMA method [4] [5] [6].

The problems discussed in this research is the flow of the Ships and Containers in Terminal Operation II PT. Tanjung Priok Port, and the level of Yard Occupation Ratio in North TPK at PT Pelabuhan Tanjung Priok. This research is assumed the YOR that applied for the analysis is 80%. The Dwelling Time at container yard North TPK is three days. The maximum Tier on North TPK is 5.5 [6] [8] [9].



## 2. Methodology

### 2.1. Arima method

Autoregressive Integrated Moving Average (ARIMA) first time developed by George Box and Gwilym Jenkins in 1976, therefore ARIMA also called as Box-Jenkins models. ARIMA Model is also used for time series analysis and data forecasting. ARIMA is highly accurate for short term forecasting, but not so good for long term forecasting. Usually it will show flat or constant data forecasting for long period. ARIMA is a combination from Autoregressive (AR) and Moving Average (MA). ARIMA usually noted in the form of p, d, and q. Form p as degree of process ordo, d as differential ordo, and q as degree of MA process [10] [16][19].

ARIMA Model is a model that fully ignores the independent variable to make a prediction. ARIMA use the past and present dependent value to predict the value in the future accurately. ARIMA can be applied if time series observation statistically connected to each other (dependent). There are four steps in ARIMA Box-Jenkins Method i.e. identification, estimation, diagnostic check and forecasting [10] [11] [12] [13] [14].

### 2.2. Accuracy and forecasting error

Error calculation can be used to compare between a forecasting method to the other methods. And, it is also used to measure its confidence level. This calculation can be used to make sure the forecasting is going well (Heizer and Render 2009:177) in Savira M, Moeliono Nadya NK, (2014) [11]. The error test in this research using Mean Absolute Percentage Error (MAPE) as the indicator. MAPE is an indicator to show the performance or accuracy of the forecasting. MAPE counted as the mean of absolute differentiation between the prediction and actual value, the result is served as actual value percentage [15] [16]. The formula is shown below:

$$\text{MAPE} = \frac{\sum \text{Absolute percent error}}{n} \quad (1)$$

### 2.3. Formatting author affiliations

This is the flow chart of our research methodology (figure 1), and the flow chart of ARIMA Box-Jenkins method (figure 2): showing a few steps has to be done.

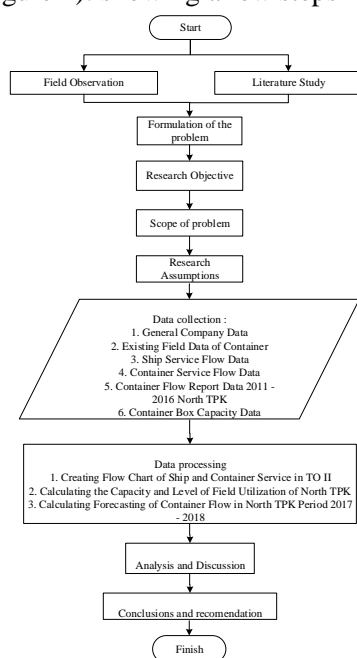


Figure 1. Research Flow Chart.

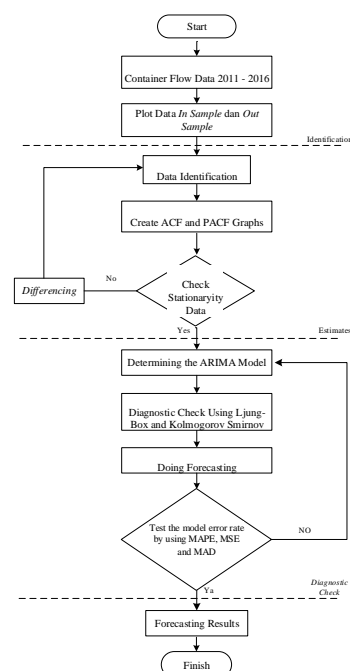


Figure 2. Flowchart of Research Method.

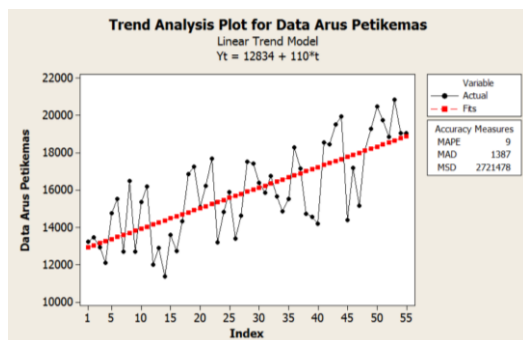
### 3. Result & discussion

This forecasting uses 60 data of throughput on North TPK since March 2011 until April 2016 shown in table 1.

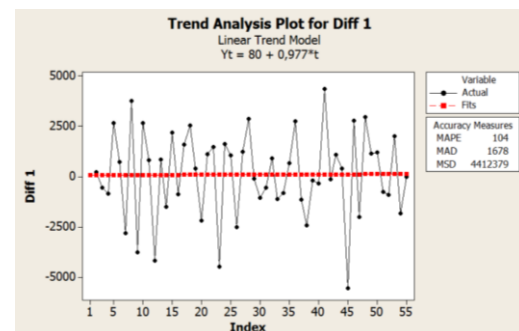
**Table 1.** Data Throughput of North TPK

Month	Period				
	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
April	13,252	12,023	13,204	14,855	14,402
Mei	13,481	12,892	14,841	15,533	17,191
June	12,945	11,384	15,913	18,299	15,183
July	12,115	13,589	13,394	17,169	9,041
Augustus	14,782	12,723	14,636	9,655	18,138
September	15,529	14,323	7,622	14,751	19,297
October	12,719	9,759	17,524	14,557	20,508
November	9,492	16,875	17,429	14,218	19,753
December	16,487	17,269	16,389	18,578	18,864
January	12,718	15,091	15,859	18,448	20,870
February	15,373	16,219	16,778	19,528	19,050
March	16,187	17,689	15,670	19,945	20,850
<b>TOTAL</b>	<b>165,080</b>	<b>169,836</b>	<b>179,259</b>	<b>195,536</b>	<b>213,147</b>

The first step is data identification. The 5 data was deleted because throughput gets down so fast makes the data cannot use. The data is separated in two, 33 data in sample and 22 data out sample. Figure 3 shown data plot of throughput on TPK Utara. Data plot showing un-stationer data, it needs data differencing, shown in figure 4.

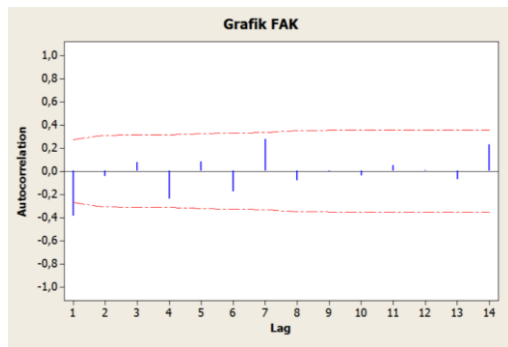


**Figure 3.** Graphic Trend Analysis Data Throughput.

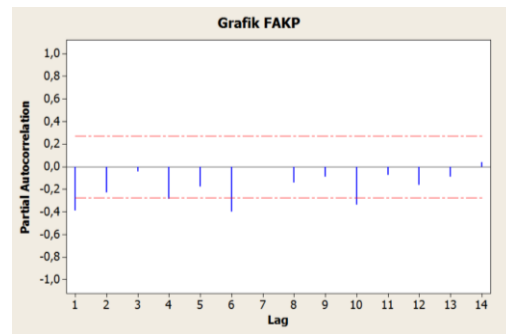


**Figure 4.** Graphic Trend Analysis Data Throughput Differencing.

After data differencing the data plot has been stationer, and then we make autocorrelation graphic, FAK, in figure 5 and partial autocorrelation graphic, FAKP, in figure 6. From FAKP graphic differencing 1, we can see lag 1, lag 2, lag 10 and lag 14 is cut through white noise line, but the graphic doesn't goes down but following Cygnus graphic.



**Figure 5.** Graphic Autocorrelation (FAK).



**Figure 6.** Graphic Partial Autocorrelation (FAKP)

The model that predicted by FAK and FAKP graphic is ARIMA (1, 1, 1). AR (1) because FAK is disconnected on the first lag, integrated (1) because the data get stationer after 1 time differencing and MA (1) because FAKP is disconnected on the first lag. On parameter estimation steps there are three model prediction of ARIMA i.e. (0,1,1), (1,1,0) and (1,1,1). We took the model with the smallest Mean Square, because the smaller the mean square the more accurate the prediction. The smallest MS is model (1,1,1) with 3,366,598. This is the output of Minitab model (1,1,1):

**ARIMA Model: Container Throughput**

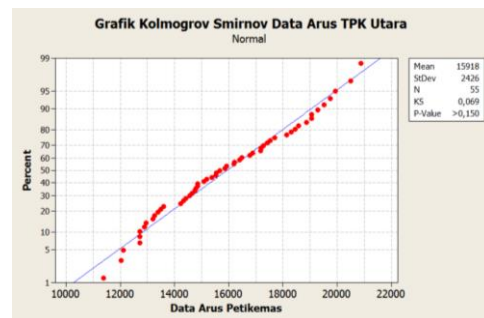
Estimates at each iteration				
Iteration	SSE	Parameters		
0	678501129	0.100	0.100	115.992
1	544473884	-0.050	0.250	126.375
2	522551991	0.045	0.400	114.821
3	496792953	0.124	0.550	104.998
4	466664540	0.189	0.700	95.678
5	432124621	0.247	0.850	82.912
6	396756049	0.292	1.000	62.311
7	381891489	0.142	0.995	93.893

Unable to reduce sum of squares any further  
Final Estimates of Parameters

Type	Coef	SE Coef	T	P
AR 1	0,2366	0,1920	1,23	0,223
MA 1	0,8227	0,1160	7,09	0,000

Differencing: 1 regular difference  
Number of observations: Original series 55, after differencing 54  
Residuals: SS = 175063102 (backforecasts excluded)  
MS = 3366598 DF = 52

Modified Box-Pierce statistic	(Ljung-Box)	Chi-Square		
Lag	12	24	36	48
Chi-Square	11,6	21,5	37,5	52,2
DF	10	22	34	46
P-Value	0,312	0,492	0,313	0,246



**Figure 7.** Graphic Kolmogorov Smirnov

Because all of the parameter on significant and residual model is meet the terms of white noise and distributed normally, ARIMA model (1,1,1) is the right model to the forecasting. Forecasting result showing total throughput in 2016-2017 reach 214,911 TEUs/Year and in 2017-2018 reach 229,125 TEUs/Year. The Table above showing the Yard Occupancy Ratio on North TPK in 2016-2017 reach 39,8% and in 2017-2018 reach 42,5%.

#### 4. Conclusion

Container yard on North TPK is able to accommodate 5,544 TEUs container and able to cater the throughput up to 539,616 TEUs/Year. Forecasting Model that we used to predict the throughput in 2016-2017 and 2017-2018 is ARIMA (1,1,1) with MS value 3,366,598 MAPE value 3.36972 with total throughput forecasted 214,911 TEUs in 2016-2017 with YOR 39,8% and 229,125 TEUs in 2017-2018 with YOR 42,5% these forecasting result in North TPK is showing that North TPK is still able to cater the throughput.

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