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CAPACITY EFFICIENCY IN IMPORT TEMPORARY WAREHOUSING COMPANY: STUDY CASE IN PT PERIGI

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Abstract

Capacity utilisation is one of the most important aspect in business. Low capacity utilisation means that the company does not use its resources efficiently to generate profit. In service industry, there are many researches that suggest the capacity utilisation has a direct contribution towards the company profit and forecasting is one of the most crucial factors when deciding the design capacity. This research was conducted to improve the Earning Before Tax for PT Perigi, an import temporary warehouse company, by proposing new capacity planning.

The results of the analysis conclude the most effective forecasting demand with PT. Perigi is the Winter Method since it has the smallest error among others. By using this model, the measure accuracy is as follows: MAPE = 29%, MAD = 1897, MSD = 8217194. Proposed capacity planning will be focused on achieving 80% of peak capacity utilisation, where it has the highest performance of EBT, among higher or lower capacity utilisation. By applying proposed capacity planning, PT Perigi can further improve their EBT by Rp 1.003.507.894, or 15.9% compared to the current capacity planning for the next two years.

Keywords: forecasting demand, winter method, capacity utilisation, capacity planning, earning before tax

1. Introduction

1.1 Background

In Indonesia itself, the tonnage of import is growing from year to year. From 2010 to 2018, the average of growth is at 5,7% per year (Badan Pusat Statistik, 2019). Although there was a stagnation in 2014 growth, but the overall trend shows that there is a constant growth. Moreover, as the E-commerce grows, cross-border transaction is expected to rise, which is estimated to hit USD 1 Trillion in 2021 (Scarcella, 2019).

Not only final goods that are ready to be consumed, raw material is also part of the import. In 2016, Indonesia imported 13.33% of raw material (World Bank, 2016). This is also because there is some raw material that is not produced locally, or unable to meet the demand. For example, in pharmaceutical industry, 95% of the raw material were imported because the infrastructure, such as factory and laboratories, is not sufficient enough (Danang, 2019).

To transport these goods, there are 4 ways of transportation mode to move physical goods: Rail, Road, Air, and Water (Zanjirani Farahani et al., 2011). Each have its own characteristics

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according to its function. But since Indonesia is an archipelago, almost all of import transportation mode were using either Air Freight or Ocean Fright. Import using Air Freight are intended for the goods that has high value and urgently needed, since it has low shipping time compared to the Ocean Freight. In China, Air Freight were mostly used for electronics, precision instrument, medicines, and other high-value items (Gong et al., 2018)

When individual/entities want to import goods to Indonesia, they are subject to scrutiny under Directorate General of Customs and Excise (*Direktorat Jenderal Bea dan Cukai*, or *Bea Cukai* for short), Indonesia customs enforcer, through Customs Clearance process. While goods are being checked, they are temporarily stored in a Temporary Warehouse. The warehouse itself is owned not by Bea Cukai, but rather by private entities that are authorized by Bea Cukai. PT Perigi is one of the few companies that operate the temporary warehouse in Soekarno Hatta International Airport in Jakarta, Indonesia.

Currently, the capacity utilisation of the warehouse is peaked only at 28.91%, which translated to using 28.910 kilograms of the warehouse capacity of 100,000 kilograms. This makes the capacity utilisation is far from efficient. According to study by Bahadir & Akdag (2019), by aiming to achieve 80-90% will results best performance for the company.

1.2 Literature Review

1. Lean Supply Chain Management

Lean philosophy uses several simple concepts and tools in every supply chain activity to eliminate waste. Such approaches can help supply chains overcome inefficiencies, diminish waste, and achieve sustainability. Lean is a systematic approach to defining and disposing of waste through quality improvement and service delivery in the pursuit of excellence.(Comm & Mathaisel, 2005). Lean can also be defined by integrating a system that is aimed to improve the capacity utilisation (Wu et al., 2015).

2. Capacity Management

Capacity is the number of units which can be kept, obtained, stored or generated in a given period by a facility. When deciding capacity, it is very often setting capital requirements and thus, determines a large portion of fixed costs. Capacity also defines whether the demand is met or whether the facilities are idle (Heizer et al., 2017). Meanwhile, In general, idle capacity exists due to the indivisibility of inputs (i.e., fixed factor) or decrease in demand for existing products, or volatility of demand for existing products. (Sahoo & Tone, 2009). Several factors are considered while determining capacity planning. According to Heizer et al., (2017), there are four special considerations for a good capacity decision, which accurate demand forecasting among the most important.

According to Heizer et al., (2017), Design capacity is the maximum theoretical output of a system under optimal conditions in a specified period. Determining the size of the facility, with the goal of achieving high utilisation rates and a good return on investment, is crucial (Heizer et al., 2017). If a capacity is too large toward the demand, some of it will sit unused and occur cost

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to current production. If a facility is too small, potential customers will be lost, thus, an opportunity cost will occur.

Hence, the state of peak utilisation in capacity management can be measured by:

$$Peak\ Capacity\ Utilization = \frac{Maximum\ Actual\ Output}{Design\ Capacity}$$

Equation1: $Determining\ Capacity\ Utilization\ of\ a\ System$

According to case study by Bahadir & Akdag (2019), the 80-90% of capacity utilisation in a container industry has the best Earning Before Taxes (EBT) compared to lower capacity utilisation rate and higher capacity utilisation rate (Bahadir & Akdag, 2019).

3. Time Series Forecasting

Time series analysis method is based on the historical data to make the forecast. They are based on the premise that experience of past demand is a strong predictor of potential demand. Such strategies are more effective because there are no major changes in the basic demand trend from one year to the next. Those are the easiest approaches to apply and can be a strong starting point for predicting demand. In this research, researcher will use four time-series analysis method that are based on previous study by Chopra, (2017). There are as follows: n-Moving Average in which n is the number of the desired month, Exponential Smoothing, Holt Model, and Winter Method.

Moving average forecast uses historical data in preceding years to predict demand in the upcoming period. Moving averages are useful if we can conclude that market demands are relatively stable over time (Heizer et al., 2017). The projected demand for the next duration is expressed mathematically with equation 2.

$$Moving\ Average = \frac{\Sigma\ Demand\ in\ previous\ n\ periods}{n}$$

Equation 2 Determining Next Demand using Moving Average

Simple Exponential Smoothing is one of the weighted moving average forecasting methods that uses alpha as a correction of the future demand. It expressed with equation 3.

$$L_0 = \frac{1}{N}\sum_{i=1}^{n} D_i$$

$$F_t + _1 = L_T$$

Equation 3: Determining Next Demand Data in Simple Exponential Smoothing

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After determining the demand for D_{t+1}, for Period $t+1$, it can be corrected with alpha, the estimate of the level is shown in the equation 4.

$$L_{t+1} = \alpha D_{t+1} + (1-\alpha)L_t$$

Equation 4: Determining Level in Simple Exponential Smoothing

Where D is the demand, α is a smoothing constant for the level, $0 < \alpha < 1$. The revised value of the level is a weighted average of the observed value of the level (D_{t+1}) in Period t + 1 and the old estimate of the level (L_t) in Period t

Holt's Method can be used if the demand is predicted to have a level and trend but no seasonality on the historical data. The determination of the estimated level and trend can be expressed using the following equation:

$$D_t = at + b$$

Equation 5: Determining Level and Trend initial estimate

Where a and b are variable, and for an estimating forecast demand for future periods is shown at the equation 6.

$$F_{t+n} = L_t + nT_t$$

Equation 6: Determining Next Demand Data using Holt's method

Where n is period, and finally to estimate the level and trends are demonstrated in the equation 7.

$$L_{t+1} = \alpha D_{t+1} + (1-\alpha)(L_t + T_t)$$

$$T_{t+1} = \beta (L_{t+1} - L_t) + (1-\beta)T_t$$

Equation 7: Determining Level and Trends in Holt's method

Where D is the demand, T is trend, α is a smoothing constant for the level, $0 < \alpha < 1$, β is a smoothing constant for the trend, $0 < \beta < 1$ (Chopra & Meindl, 2007)

Winter Method can be used if the historical data has component of demand: level, trend, and seasonal factor with a systematic demand formula. It can be calculated by:

$$F_{t+1} = (L_t + T_t)S_{t+1} \text{ and } F_{t+1} = (L_t + lT_t)S_{t+1}$$

Equation 8: Determining Next Demand Data using Winter Method

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In observing the demand for Period t + 1 the level of the estimate (L_{t+1}), trend (T_{t+1}), and seasonal factor (S_{t+1}) factors is revised by as follows in the equation 9.

$$L_{t+1} = \alpha\left(\frac{D_{t+1}}{S_{t+1}}\right) + (1 - \alpha)(L_t + T_t)$$

$$T_{t+1} = \beta(L_{t+1} - L_t) + (1 - \beta)T_t$$

$$S_{t+p+1} = \gamma\left(\frac{D_{t+1}}{L_{t+1}}\right) + (1 - \gamma)S_{t+1}$$

Equation 9:Determining Level, Trend, and Seasonal Factor in Winter Method

where a is a smoothing constant for the level, with 0 < a < 1; β is a smoothing constant for the trend, 0 < β < 1; and $\gamma$is a smoothing constant for the seasonal factor, which can be expressed by 0 < γ < 1.

Several methods can be used in to calculate the overall forecast error and disparity. These methods of calculation can be used to compare different forecasting method, as well as to monitor forecasts to ensure whether forecast method that is used is effective. In this case, the forecast error measurement method used are Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE).

Mean Absolute Deviation (MAD) can be used for estimating the standard deviation of the random component (Heizer et al., 2017). This value can be calculated by taking the sum of the absolute values of each forecast error, which can be indicated by deviations, and dividing by the number of periods (n), expressed in equation 10.

$$MAD = \frac{\Sigma \mid Actual - Forecast \mid}{n}$$

Equation 10: Determining Forecast Error using Mean Absolute Deviation

Mean Squared Error is another way to quantify an error in overall prediction. MSE is the sum of square variations between the values predicted and observed. Because of the square term, the MSE tends to accentuate large deviations. MSE can be expressed mathematically by the equation 11.

$$MSE = \frac{\Sigma\,(Actual - Forecast)^2}{n}$$

Equation 11: Determining Forecast Error using Mean Squared Error

Mean Absolute Percentage Error (MAPE) could be used to forecast errors when the the forecast result has significant seasonality and demand fluctuation from one-time frame to the next. In

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order to find MAPE, the disparity between actual and forecast is divided by the actual demand and multiplied by 100% (Chopra & Meindl, 2007). It can be expressed by the equation 12.

$$MAPE = \frac{\sum_{i=1}^{n} 100\,|Actual - Forecast|\,/\,Actual}{n}$$

Equation 12: Determining Forecast Error using Mean Absolute Percentage Error

2. Method

2.1 Research Design

This research is using mixed quantitative and qualitative approach, where quantitative is used to calculate historical data to project the demand for the next 2 years, while qualitative is used to adjust the forecasting result with external factors that might affect the demand.

2.2 Data Gathering

In this research, researcher uses both primary and secondary data. As for primary data, researcher use Interview and Observation directly at the company headquarters, which is located at Soekarno-Hatta International Airport. Primary data gathering, interview and observation, will consist of: Company Profile, Industry Summary (including import flow, regulation, taxation, etc), and Company Policy. Whereas for the secondary data, which is the company historical demand, will be available from 22 June 2019.

2.3 Data Analysis

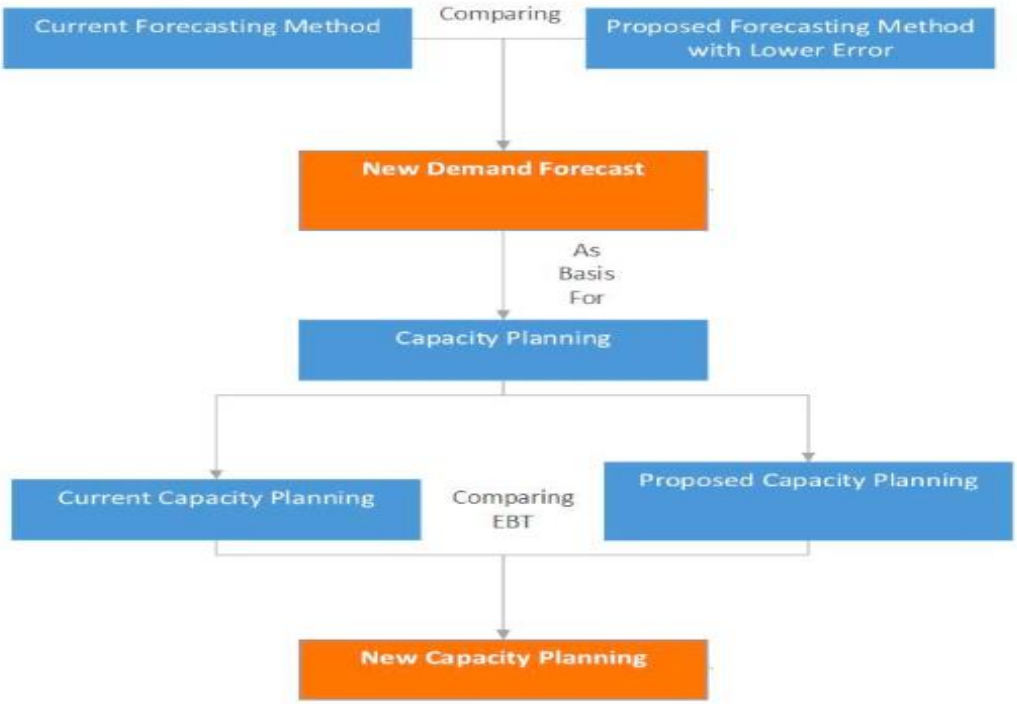

Figure 1: Research Framework

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The data analysis part will be segmented into two main parts, which is illustrated in the Figure 1. First, researchers wanted to know which forecast method has the lowest error, based on 3 parameters (MAD, MSE, and MAPE). After it is decided which forecast method is the most appropriate use for the warehousing data, this research will propose new capacity planning for the company to follow.

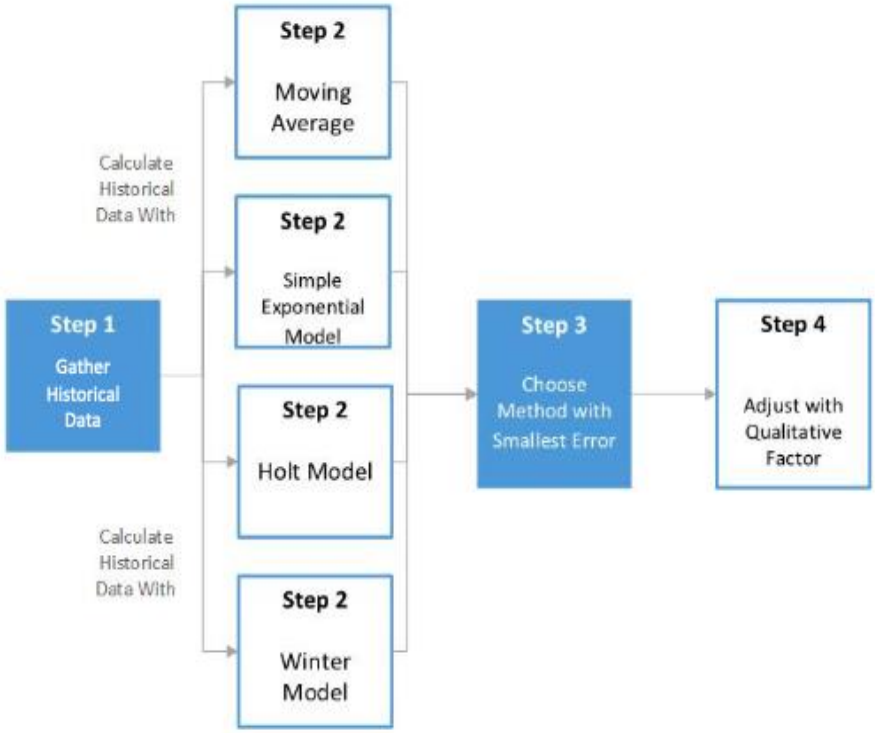

Figure 2 Detail of Forecasting Framework

The detail of the forecasting part of this study is illustrated in the Figure 2. First, this research will gather the historical data of the company, which will be provided by the company. Then, the data of the warehouse usage, is analysed to determine which one is the method that has the lowest error. After determining the most accurate forecasting method based on the historical data and measure accuracy, which was shown on the step 2 of the Figure 2, the forecast will be done with the help of Minitab software, then the data will be adjusted by qualitative factors.

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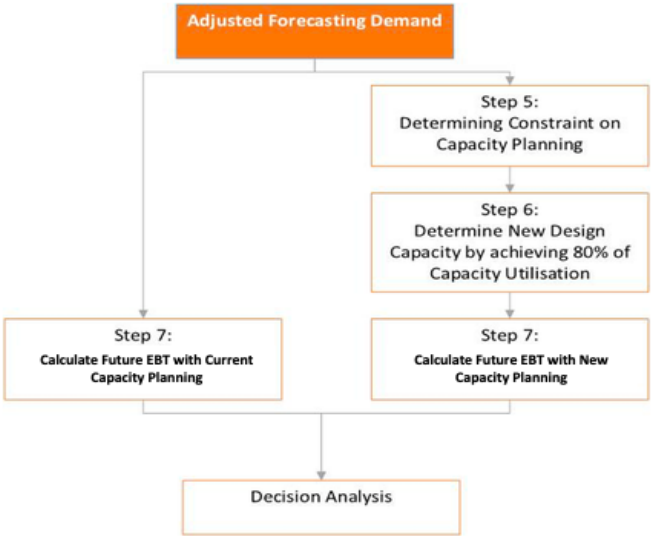

Figure 3 Detail of Capacity Planning Framework

The detail of the capacity planning part of this study is illustrated further in the figure 3. After determining the adjusted capacity's constraint which is based on the interview and the secondary data, this research will try to design a new capacity. The basis of the adjustment of the proposed capacity will be based on 80% peak utilisation of the design capacity. Then, it will be compared with the current capacity planning by comparing the Earning Before Tax (EBT) for the next 2 years.

3. Results and Discussion

3.1 Forecast Method Accuracy Measure

Table 1 Accuracy Measure Comparison of Each Method

Method	Error Measurement (Weekly, in Kilogram)			Error Measurement (Monthly, in Ton)		
	MAPE	MAD	MSE	MAPE	MAD	MSE
Company Model	N/A	N/A	N/A	35.31%	66.61	7453
Moving Average	29%	2209	12355217	11.5%	24.40335	1304.991289
Single Exponential Method	43%	2290	23544568	15.88%	30.58585	2316.2535
Holt's Method	54%	3343	25277218	18.62%	28.9637	1488.752616
Winter Method	**29%**	**1897**	**8217194**	**9.22%**	**21.7076**	**1119.046489**

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According to the Table 1, amongst the four, the method that has the smaller error compared to the company model is Winter Method for both weekly and monthly average daily demand accuracy measure. The monthly measurement is done because the company model did not have weekly estimate, so it has to be converted into monthly then it compared with other method in Time Series Forecast. The error value of this method was as follows: MAPE = 29%, MSE = 8217194, and MAD = 1897 for Weekly Average Daily Demand, MAPE 9.22%, MSE = 1119.04, and MAD = 28.96 for Monthly Average Daily Demand. This happens because the Winter Method considers the demand level, the trend and the season, and this approach will substantially reduce the error from the current one with the Alpha, Beta and Gamma.

3.2 Qualitative Factors

There are some irregular events that happened during the observation period and within next couple of years. This forecasting period has some modifier event, most notably the Coronavirus outbreak or COVID-19 which affects all industry, including logistics. Detail of the factors are shown in the Table 2.

Table 2 Qualitative Factors for the Forecasted Demand

#	Period	Demand	Reason
1	March to May for all upcoming years	+15%	Coronavirus is no longer categorised as pandemic
2	Two upcoming years	-10%	Worldwide economic slowdown

The Coronavirus negatively impact the international air freight industry by 15%, according to report by International Air Transport Association, (2020). This circumstance due to Covid-19 however, predicted to be gone at least at the end of the 2020, according to research conducted by Luo (2020), that stated world coronavirus will be vanished by December 2020. For two upcoming years, the United States is predicted to have recession, and the company predicts it will be affecting the company demand based on the expert judgement of the directors. This is in line with Bloomberg report that there will be a recession happen in near time in 2020 (Pickert et al., 2020). The company estimates that 10% of the demand will decline as it will be lower prior to economic expansion that happened before the coronavirus outbreak. This estimation is also similar with Indonesian import that plummeted around 8% during the 2009 financial crisis (Badan Pusat Statistika, 2019).

3.3 Forecast for next Two Years

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Table 3 Forecast Result for Two Upcoming Years

Month	Total Demand (in Kg)	Maximum Weekly Average Daily Demand (in Kg)
July 2020	205089.3	10138.5
August 2020	204368.4	8813.7
September 2020	242881.2	10794.15
October 2020	365852.7	12865.95
November 2020	352722.6	15792.75
December 2020	322118.1	16477.65
January 2021	536360.4	20780.55
February 2021	480251.7	21671.55
March 2021	613228.185	27055.935
April 2021	867071.25	30998.25
May 2021	747584.64	33703.74
June 2021	592639.2	31930.65
July 2021	756842.4	33585.3
August 2021	805509.9	37214.1
September 2021	801627.3	36836.55
October 2021	1130724.9	41322.6
November 2021	956688.3	44073.9
December 2021	1094696.1	47414.7
January 2022	747219.6	44815.5
February 2022	1113166.8	52774.2
March 2022	1328371.785	58275.1575
April 2022	1643193.945	62130.015
May 2022	1444492.575	64200.015
June 2022	1437039.9	62905.95
Total	18789741.18	

Table 3 shows that the forecast is done and simulated with the Winter Method for 104 weeks period, which is the basis to reflect the revenue calculation, using Minitab 19 software, and adjusted with Microsoft Excel for the qualitative factors and the conversion into the monthly format. This is the 4th step of this research. The peak of weekly average daily demand, which will happen on May 2022, will be the base of the calculation of peak capacity utilisation, then will be used for the constraints of designing new capacity planning.

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3.4 Constraint on Capacity Planning

Table 4 Constraint on Constructing Proposed Capacity Planning

#	Revenue Stream	Value
1	Warehouse Usage Fee	IDR 1,250 per Kilogram, per day
2	Average Office Rent Fee	IDR 4,878,000 per Square Meters, per year
3	Company Total Building Size	1200 Square Meters
4	Maximum New Design Capacity Area	800 Square Meters
5	1 Square Meters to Chargeable Weight Conversion	125 Kilograms
6	Construction Cost for New Office Space	IDR 3,000,000 per Square Meters

The warehouse fee is charged to the agents or customers that stored the goods in the company warehouse while waiting for Bea Cukai Clearance at Rp 1,250 per Kilogram, per day. The office rent fee is divided from total 5 tenants which on average revenue of Rp 4,878,000 per square meter per year. The alteration for capacity, which will be for additional office tenant usage as it is done by the company over the past period, based on historical data, takes around 3 weeks for construction. The investment for the new office space, will cost around Rp 3.000.000 per meters, this calculation is based on the construction of the tenant office that done earlier.

The reasoning of why the new capacity will be allocated for the office is the company is already doing this, thus the company simply has more experience to execute this. Aside from the internal factors, the demand for office space in Soekarno-Hatta International Airport is high.

3.5 Current Capacity Planning

Table 5 Detail of Current Capacity Planning

#	Capacity Allocation	Value
1	Warehouse Size	800 Square Meters
-	Maximum Chargeable Weight in Warehouse / Design Capacity	100.000 Kilograms
2	Office Size Leased for Tenant	243.6 Square Meters
3	PT Perigi Office Size	156.4 Square Meters

Table 5 shows the company allocation: 800 square meters, or roughly 2/3 of its maximum capacity for the warehouse, which can be converted into 100,000 kg of maximum storage weight. The rest of the building were allocated for the office purpose, with 243.6 square meters leased to five tenants, and 156.4 square meters were used as Perigi head office, including public space such as pantries and toilet.

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With the current planning, the peak capacity utilisation will be as follows:

$$Peak\ Capacity\ Utilization = \frac{Maximum\ Actual\ Output}{Design\ Capacity}$$

$$64{,}2\% = \frac{64200.15}{100000}$$

From the calculation above, it shows that the within the next 2 years, the company capacity utilisation will peak at 64,2%. This calculation is based on the peak weekly demand that shown in the table 3, which will happen, according to Winter Method, at May 2022 with maximum demand at 64,200 kilograms.

Table 6 Projected EBT with Current Capacity Planning over next 2 years

#	Revenue Stream	Value
1	Warehouse Usage Fees	IDR 23,487,176,475,00
2	Office Rent	IDR 2,148,000,000,00
Revenue		IDR 25.635.176.475,00
Cost		IDR (19.316.886.968,00)
Earning Before Tax		**IDR 6.318.289.507,00**
Peak Capacity Utilisation		**64.2%**

The calculation of EBT is shown in table 6. With current capacity planning, within the next 2 years, company is estimated to has a profit of Rp. 6.318.289.507,00, from both Warehouse Usage, and Office Rent. The cost is comprised from the biggest expenditure, in order from the biggest to the lowest: Salary Expenses, Building Rent Expenses, Forklift and Truck Rent Expenses, Interest Expenses, Permit Fees, Utilities Expenses, and Insurance Expenses.

3.7 Proposed Capacity Planning

$$Peak\ Capacity\ Utilization = \frac{Maximum\ Actual\ Output}{Design\ Capacity}$$

$$80\% = \frac{64200.15}{Design\ Capacity}$$

$$Design\ Capacity = 80{,}250$$

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Based on the design capacity that is calculated based on achieving 80% of peak capacity utilisation, the new capacity planning will be calculated with the design capacity of 80.250 kilograms, which will be equivalent to 642 Square Meters size of Temporary Warehouses. The differences between the current design capacity for the warehouse, 800 Square Meters, and the new design capacity, which will be at 158 Square Meters, will be allocated for the alteration. This is the 6th step of the research process

Table 7 Detail of Proposed Capacity Planning

#	Capacity Allocation	Value
1	Warehouse Size	642 Square Meters
-	Maximum Chargeable Weight in Warehouse / Design Capacity	80.250 Kilograms
2	Office Size Leased for Tenant	243.6 Square Meters
3	PT Perigi Office Size	156.4 Square Meters
4	New Office Size Leased for Tenant	158 Square Meters

This new capacity planning, which shown at Table 7, will allocate 642 square meters, or 54% of its maximum area available, which can be converted into 80.250 kg of maximum storage weight. The rest of the building were allocated for the office purpose, with 243.6 square meters leased to five tenants, and 156.4 square meters were used as Perigi head office, including public space including toilets and praying room. The new office space, which will be available for rent, is 158 Square Meters.

Table 8 Projected EBT with Proposed Capacity Planning over next 2 years

#	Revenue Stream	Value
1	Warehouse Usage Fees	IDR 23,487,176,475,00
2	Office Rent	IDR 2,148,000,000,00
3	New Office Rent	IDR 1,477,507,894,74
Revenue		IDR 27,112,684,369,74
Cost		-IDR 19,316,886,968,00
Investment in New Capacity		-IDR 474,000,000,00
Earning Before Tax		**IDR 7,321,797,401,74**
Peak Warehouse Capacity Utilisation		**80%**

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The table 8 shows the detail of the EBT calculation. With new capacity planning, within the next 2 years, company is estimated to has a profit of Rp. 7.321.797.401,74, from Warehouse Usage, Existing Office Rent, and New Office Rent for lease revenue. This is the step 7th of the research process. The cost is comprised of the biggest expenditure, in order from the biggest to the lowest: Salary Expenses, Building Rent Expenses, Forklift and Truck Rent Expenses, Interest Expenses, Permit Fees, Utilities Expenses, and Insurance Expenses.

There are three revenue streams in with the current capacity planning, the Warehouse Usage Fees itself, the current tenant, and the new tenant that is altered from the warehouse. With the current capacity planning, the company will have the peak capacity utilisation at 80%. The peak utilisation of the capacity, which will be happened on May 2022, at 64,200 kilograms. Investment for the new capacity, is based on the new office area that is available to be rented, 158 square meters, times with the construction cost of Rp 3,000,000 per square meter. As the qualitative constraint that finding can take on average a month, starting point of the new office rent will be at August 2020.

3.8 Capacity Planning Comparison

Table 9 Comparison Between Current and Proposed Capacity Planning based on EBT

#	Capacity Planning	Earning Before Tax
1	Current Company Model	IDR 6,318,289,507,00
2	**Proposed Capacity Planning**	**IDR 7,321,797,401,74**

Table 9 shows that the company is estimated to have Rp **6,318,289,507.00** for next two year of EBT if they are using the current model of capacity planning. If the company is choosing the new capacity planning, which is focused on 80% of peak capacity utilisation, they will have estimated EBT of **Rp 7,321,79,401.74** within two years. This will improve the company EBT by Rp 1,003,507,894, or 15.9% in percentage as an improvement in the capacity planning.

4. Conclusion

Based on the research, it suggested that Winter Method is the most accurate accuracy measure in forecasting the demand in import warehousing company. This is matched with the case study of forecasting an empty container volume in docking port in across California, where Winter Method has the lowest error among other forecasting method (Diaz et al., 2011).

After the demand for the next two years is forecasted using Winter Method and aiming for 80% of capacity utilization, the income (which is measured by Earning Before Tax) is improving by 15.9% in this study case. This is matched with the study by Yu et al., (2016) that higher capacity utilisation will result a better performance to the airline industry, which in this case is indicated by Earning Before Taxes.

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The study recommends that there should be a continuation of this research. The new capacity planning, can also be discussed with finance related field study, i.e. the Return on Investment, Net Present Value, IRR, etc.

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