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Crude Oil Inventory Control with Min-Max Method in PT ABCD

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Abstract
PT ABCD is one of the oil industry sectors tasked with managing oil and gas mining. In producing their products, they need the main raw material, which is crude oil. To maintain the continuity of the company's operations, it's necessary to have a minimum number of raw materials available in storage tanks to prevent stockouts. However, the raw materials stored in inventory also have a maximum so that overstock does not occur. In this study, calculations will be carried out regarding the minimum and maximum amount of inventory at PT ABCD so that the company can determine inventory correctly, and based on the results of calculations using the Min-Max method, the company will not experience stock-outs or overstock. In addition, this study used sensitivity analysis and comparative analysis between actual conditions and the application of the Min-Max method. The optimal results obtained for the minimum inventory value are 387MB (X), 373MB (Y), and 400MB (Z). The maximum inventory value is 710MB (X), 696MB (Y), and 752MB (Z). From the results of the Min-Max method, the order quantity is 324MB (X), 323MB (Y), and 352MB (Z). The order frequency is 7 times for each grade.

Keywords: *Crude Oil, Inventory, Min-Max Methods, Optimal*

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I. INTRODUCTION

PT ABCD is an Indonesian state-owned petroleum industry that manages oil and gas mining. Oil processing is carried out in seven refineries spread throughout Indonesia. PT ABCD produces Asphalt, Base Oil, Petrochemicals (Paraxylene and Benzene), Non-fuel (LPG, Lube Base, Paraffinic, etc.), and Molten Sulfur for infrastructure development needs. PT ABCD was established to produce fuel and non-fuel products to meet increasing domestic demand and reduce dependence on foreign fuel supplies. PT ABCD requires the main raw material for its production: Crude Oil (crude oil). This raw material has 3 grades, which are X, Y, and Z. Before being processed into BBM products, Crude Oil must be processed first so that it becomes pure oil.

PT ABCD, in making its products, must process Crude Oil quickly and continuously. In addition, there is product diversification, which X Crude, Y Crude, and Z Crude. Then, the delivery of ordered raw materials also has a lead time. If the arrangement of raw material supplies is not well coordinated, the production process can result in delays. More specifically, if the supply of raw materials is short of stock, the production process will experience problems, and demand cannot be fulfilled. Conversely, if the supply of raw materials is overstocked, it can result in a buildup of raw materials in the holding tank, hindering the crude oil processing process.

Inventory is raw materials, products in process, and finished goods considered as part of the business assets that are ready or will be ready to be sold [1]. Inventory held by the company may be damaged before use [2]. Inventory control is one of the activities in a sequence of activities that are closely linked to each other in all the company's production operations in accordance with what has been planned in advance in terms of time, quantity, quality, and cost [3]. The inventory that must be controlled is raw materials. Raw materials are materials that form a complete part of the finished product, where in obtaining raw materials, the company not only incurs costs in the amount of the purchase price of the raw materials but also incurs purchasing costs, warehousing, and other acquisition costs [4].

PT ABCD has experienced stockouts and overstocks, which will only occur in 2022. The company's policy to date is to use a minimum inventory value of 300 MB and a maximum inventory of 900 MB per grade.

Therefore, PT ABCD wants to know the level of supply or procurement for each type of Crude Oil. This company will apply the min-max method to find a good minimum and maximum inventory value so that overstock and stockout do not occur.

The Min-Max Stock method is a method of inventory control by controlling the minimum and maximum amount of inventory by arranging plan orders to prevent stockouts or overstock [5]. If the maximum and minimum levels have been set, then when the inventory reaches the minimum level, an order for raw materials must be made to place the inventory at the maximum level. This is done to avoid the amount of inventory that is too large or too small. This method determines how much minimum stock must be in the storage tank to meet production quantity capacity and what the maximum stock of raw materials in the storage tank is so that waste does not occur.

Research on raw material inventory control using the Min-Max method has been carried out in journals and final assignments. The first of them is a journal entitled "Application of the Min-Max Method for Minimizing Stockout and Overstock of Raw Material Supplies." Rachmawati & Lentari (2022) in a journal entitled "Application of the Min-Max Method for Minimizing Stockout and Overstock of Raw Material Supplies," discusses controlling raw material inventories using the Min-Max method [6]. The object of this research is inventory control on O-rings and Diaphragm Retainers. The method and tools used are the Min-Max method, where the first step is to find the safety stock value. Then, the calculation is continued by finding the minimum and maximum stock values, as well as the reorder level. The study results show that companies need to consider using the Min-Max Stock method because the final stock using this method is much smaller than the company's actual ending stock and will not experience a stockout.

Nugroho (2020), in research entitled "Planning Raw Material Requirements Using the Min-Max Stock Method," discusses controlling raw material supplies using the Min-Max method. [7]. The object of this research is to control the supply of Jenang Mirah raw materials. The method and tools used are the Min-Max method, where the first step is to find the safety stock value. Then, the calculation continues by finding the minimum and maximum stock values and the reorder level. The research results show that companies need to consider using the Min-Max Stock method because the ending stock using this method is much smaller than the company'sactual ending stock and will not experience a stockout.

Alvona Vergianti (2017), in research entitled "Planning Raw Material Inventory Needs in the Car Body Repair Process Using the Min-Max Method," discusses controlling raw material supplies using the Min-Max method [5]. The object of this research is inventory control of non-painting raw materials. The method and tools used are the Min-Max method, where the first step is to find the safety stock value. Then, the calculation continuesby finding the minimum and maximum stock values and the reorder level. The research results show that companies need to consider using the Min-Max Stock method because the ending stock using this method is muchsmaller than the company's actual ending stock and will not experience a stockout.

Putri & Ulkhaq (2017), in the Journal entitled "Analysis of Raw Material Inventory Control for 120 Gram Duplex Paper Using the Min-Max System Method at PT Jaya Aflaha, Batam," discusses controlling raw materialsupplies using the Min-Max method. [8]. The object of this research is procuring raw materials for foodboxes, namely 120-gram duplex paper. The research was conducted in the goods procurement section at PT Jaya Aflaha, where direct observations and interviews with the company owner were conducted. The method and tools used arethe Min-Max method, where the first step is to find the safety stock value. Then, the calculation continues by finding the minimum and maximum stock values and the reorder level. After that, proceed with sensitivityanalysis with the maximum inventory multiplier factor. The research results show that companies need to considerusing the Min-Max Stock method because the ending stock using this method is much smaller than the company'sactual ending stock.

Kinanti et al. (2016), in a journal entitled "Analysis of Raw Material Inventory Control Using the Min-Max Method (Case Study of PT. Djitoe Indonesia Tobacco)," discusses raw material inventory control using the Min-Max method [9]. This research's object is to control cigarette raw materials, especially tobacco. Themethod and tools used are the Min-Max method, which begins with analysis using a fishbone diagram. Then, the calculation continues to find the safety stock, minimum and maximum stock values, as well as the reorder level. The research results show that companies need to consider using the Min-Max Stock method because the ending stock using this method is much smaller than the company's actual ending stock and will not experience a stockout.

Yedida & Ulkhaq (2015), in the Journal entitled "Planning Raw Material Inventory Requirements at

CV Endhirga Prima Using the Min-Max Method" discuss controlling raw material supplies using the Min-Max Method [10]. The object of this research is the company's raw material inventory to prevent overstock or stockout. The research began with a preliminary study to get to know the condition of the company and find out the problems faced through interviews and direct observation. The method and tools used are the Min-Max method, where the first step is to find the safety stock value. Then, the calculation continues by finding the minimum and maximum stock values and the reorder level. The research results show that companies need to consider using the Min-Max Stock method because the ending stock using this method is much smaller than the company's actual ending stock.

Based on the background description, it can be concluded that the problem at PT ABCD is how to determine the correct inventory level and reorder point for Crude Oil at PT ABC, so as to minimize the occurrence of overstock and stockouts in Crude Oil as raw material for PT ABCD products using the Min-Max method.

II. LITERATURE REVIEW

2.1 Inventory

Inventory is a stock of materials or stock of goods used to facilitate production or to fulfill customer demand [11]. Inventory is a stock of physical goods, both basic materials, semi-finished goods, and finished goods, held at a certain location and period [12]. Inventory is a stock of materials that exist at a certain time or real assets that can be seen, measured, and calculated or can also be expressed as idle resources waiting to be processed further [13]. Based on the three definitions according to the experts above, it can be concluded that inventory is a stock of materials or goods at a certain time and location, which is an idle resource for further processing to meet customer demand.

The inventory function is important in an effort to improve company operations. There are three functions of inventory, namely [14].

a. Decoupling Function. This function allows companies to meet consumer needs without depending on goods suppliers.
b. Economic Lot Sizing Function. This function collects inventory so that the company can produce and use all existing resources in sufficient quantities, aiming to reduce costs per unit of product.
c. Anticipation Function. This function is used because companies often experience uncertainty in the delivery time of goods from other companies, so they need safety stock.

Inventory system costs are all expenses and losses that arise due to inventory. Inventory costs can be grouped into four types of costs, namely purchasing costs, procurement costs, holding costs, and shortage costs [15].

2.2 Inventory Control

Inventory control is a very important thing for a company because, without proper inventory control, the company will experience internal problems in meeting consumer needs both in the form of goods and services produced by the company [16]. Inventory control is one of the activities in a sequence of activities that are closely linked to each other in all the company's production operations in accordance with what has been planned in advance in terms of time, quantity, quality, and cost [3]. Optimal inventory is the number of goods stored at the highest, best, and most profitable levels. This means not using the largest numbers but prioritizing efficiency because optimal inventory considers limiting factors to obtain optimal levels [17]. The following are inventory control factors:

a. Safety Stock
   Safety stock determines inventory control [18]. The company must have safety stock to minimize stock out; overstock in the company too will increase raw material storage costs [19].
b. Reorder Point
   Reorder point is the limit of the quantity of raw material supplies that exist at any time the order must be re-ordered [20] or raw material reorder point.
c. Lead Time
   Lead time is the time or range of the company place an order until the raw material arrives and is accepted by the company [21].

2.3 Raw Material

Every company needs raw materials in its production process to produce a product. These raw materials will be processed and processed to produce products that have selling value. Raw materials are materials that form a complete part of the finished product, where in obtaining raw materials, the company not only incurs costs in

the amount of the purchase price of the raw materials but also incurs purchasing costs, warehousing, and other acquisition costs [4].

2.4 Min-Max Method

Min-Max is an inventory control method by determines the minimum and maximum amount of inventory that can be stored and safety stock [22]. In other research, this method was able to save inventory costs each period [23]. Min-Max Method Stock in its use is based on the assumption that Raw material inventory exists at two levels, namely level, minimum, and maximum levels [24]. If minimum and maximum levels of raw materials have been set, then when the inventory reaches the level minimum, raw material orders must be made back to put inventory on level maximum [25]. Application of the Min-Max Stock method used so that the warehouse can know the minimum and maximum inventory of raw materials that must be available to avoid wasting costs [26].

2.5 Sensitivity Analysis

Sensitivity analysis aims to evaluate the impact of parameters drawn [27]. Sensitivity analysis can assist decision-makers in determining whether performance measures remain within acceptable limits or not. This can also help them understand the importance of various parameters of things in this situation [28]. Sensitivity analysis is an analysis carried out to calculate a new optimum solution caused by the multiplier factor from the maximum inventory formula without having to calculate it again from the start. The results of changing this multiplier factor can be compared by finding the lowest average final stock, which can minimize the risk of overstock and minimize the costs incurred.

III. METHOD

The research carried out belongs to the descriptive study category because the problems with the research object are clearly and systematically illustrated based on actual data related to inventory control that has not been optimal. This type of research is a combination of quantitative and qualitative. Qualitative data was collected by observation and interviews with sources from the Supply Chain & Distribution section. Quantitative data collection was carried out by requesting historical data on Crude Oil processing for 1 year, starting from January - December 2022, storage tank capacity, and data regarding lead times.

The research was conducted in January - March 2023 at PT ABCD. The research begins with field studies and literature studies related to the company's business processes to determine the general condition of the company. Then, proceed with the identification and formulation of the problem. After that, it is continued with the determination of research objectives where the objectives have been set, namely optimal Crude Oil inventory control. Data collection was carried out by collecting historical data in 2022, supporting data such as storage tank capacity, and data regarding lead times obtained from interviews and field observations. Data processing begins with making actual throughput diagrams to describe the flow of raw materials in storage tanks, which are then processed using the Min-Max method to obtain inventory planning. After calculating, an analysis is carried out in the form of a sensitivity analysis and a comparative analysis between the actual conditions and the Min-Max method. Finally, conclusions are drawn according to the research objectives regarding Crude Oil inventory control, and suggestions are also given by the author for further research.

IV. RESULT AND DISCUSSION

4.1 Crude Oil Actual Throughput Diagram

Table 1 recapitulates final stock, maximum inventory, and total Crude Oil tank capacity for each grade at PT ABCD in 2022.

Table 1 Recapitulation of Crude Oil Stock Movements in 2022 (MB Unit)

Period	X			Y			Z		
	Final Stock	Max Stock	Total Tank Capacity	Final Stock	Max Stock	Total Tank Capacity	Final Stock	Max Stock	Total Tank Capacity
Jan	1033,77	900	1181,90	664,92	900	1117,71	1001,38	900	1672,89
Feb	1096,90	900	1181,90	722,00	900	1117,71	1070,36	900	1672,89
Mar	1125,28	900	1181,90	760,24	900	1117,71	1104,95	900	1672,89
Apr	944,92	900	1181,90	569,64	900	1117,71	867,26	900	1672,89
May	1211,91	900	1181,90	851,80	900	1117,71	1070,34	900	1672,89
Jun	1130,20	900	1181,90	772,31	900	1117,71	964,77	900	1672,89
Jul	1043,70	900	1181,90	688,07	900	1117,71	881,80	900	1672,89
Aug	1035,14	900	1181,90	678,57	900	1117,71	871,14	900	1672,89
Sep	1050,61	900	1181,90	695,22	900	1117,71	890,32	900	1672,89
Oct	1060,71	900	1181,90	705,09	900	1117,71	899,53	900	1672,89

Nov	1235,75	900	1181,90	863,11	900	1117,71	1084,71	900	1672,89
Dec	1120,09	900	1181,90	733,19	900	1117,71	951,56	900	1672,89

Based on Table 1, a throughput diagram was created, which is shown in Figure 1, to find out whether there will be overstock or stock out in 2022.

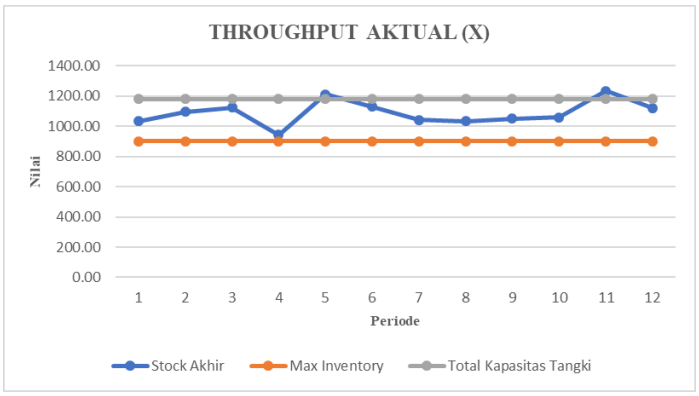

Figure 1. Throughput of Crude Oil X Stock

Figure 1 shows that the final stock of Crude Oil X in each period of 2022 exceeded the maximum inventory set by the company. In May and November, the Crude Oil storage tank capacity for grades X also exceeded.

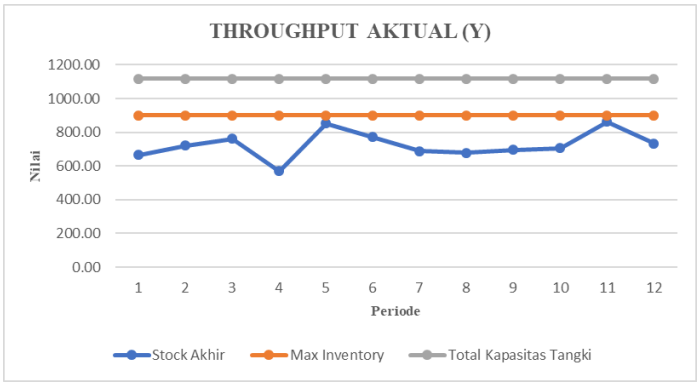

Figure 2. Throughput of Crude Oil Y Stock

Figure 2 shows that the final Crude Oil Y stock in each period of 2022 does not exceed the maximum inventory set by the company. However, in May and November the final stock is almost close to the maximum inventory value set by the company.

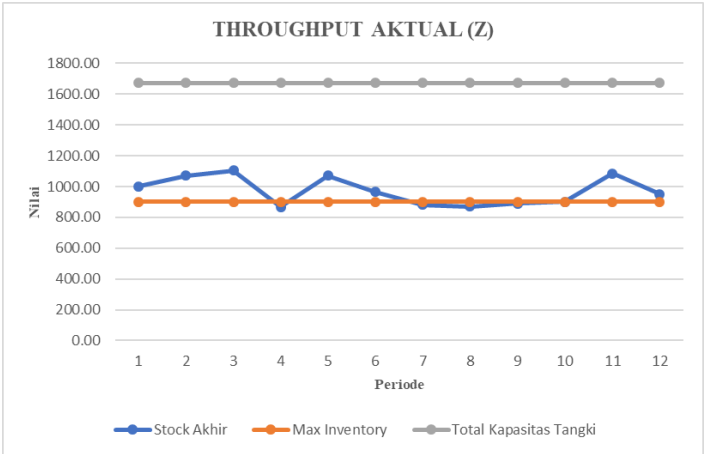

Figure 3. Throughput of Crude Oil Z Stock

Figure 3 shows that the final stock of Crude Oil Z in January, February, March, May, and November exceeded the maximum inventory set by the company.

4.2 Inventory Calculation with The Min-Max Method

4.2.1 Safety Stock

Crude Oil X safety stock based on historical data in 2022 with a lead time of 5 days or 0,161 months can be calculated as follows.

Average Usage $= 2006{,}033$

Maximal Usage $= 2396{,}817$

$SS = (Maximum\ Usage - T)\ x\ LT$

$SS = (2396{,}817 - 2006{,}033)$ x $0{,}161$

$SS = 63{,}030$ MB

Where,

T : Average Usage

LT : Lead Time

SS : Safety Stock

In Table 2, shows a recapitulation of safety stock based on historical data in 2022 with a lead time of 0,161 months.

Table 2. Recapitulation of Safety Stock

Safety Stock	X	Y	Z
	63,030 MB	49,081 MB	47,943 MB

From the results of the Safety Stock calculation, the Safety Stock values are as shown in Table 2 for Crude Oil X of 63,030 MB, Crude Oil Y of 49,801 MB, and Crude Oil Z of 47,934 MB.

4.2.2 Minimum Inventory

Crude Oil X minimum inventory based on historical data in 2022 and the results of safety stock with a lead time of 5 days or 0,161 months can be calculated as follows.

Average Usage $= 2006{,}033$

Min Inventory $= (\text{T x LT}) + \text{SS}$

Min Inventory $= (2006{,}033 \text{ x } 0{,}161) + 63{,}030$

Min Inventory $= 386{,}583$ MB

Where,

T : Average Usage

LT : Lead Time

SS : Safety Stock

Table 3, shows a recapitulation of minimal inventory based on historical data in 2022 and the results of safety stock with a lead time of 0,161 months:

Table 3 Recapitulation of Minimum Inventory

Minimum Inventory	X	Y	Z
	386,583 MB	373,129 MB	399,855 MB

The results of the minimum inventory calculation show the minimum inventory value in Table 3: Crude Oil X is 386.583 MB, Crude Oil Y is 373.129 MB, and Crude Oil Z is 399.855 MB.

4.2.3 Maximum Inventory

Crude Oil X maximum inventory based on historical data in 2022 and the results of safety stock with a lead time of 5 days or 0,161 months can be calculated as follows.

Average Usage $= 2006{,}033$

Max Inventory $= 2 \text{ x } (\text{T x LT}) + \text{SS}$

Max Inventory $= 2 \text{ x } (2006{,}033 \text{ x } 0{,}161) + 63{,}030$

Max Inventory $= 710{,}137$ MB

Where,

T : Average Usage
LT : Lead Time
SS : Safety Stock

Table 4, shows a recapitulation of the maximum inventory based on historical data in 2022 and the results of safety stock with a lead time of 0,161 months:

Table 4 Recapitulation of Maximum Inventory

	X	Y	Z
Maximum Inventory	710,137 MB	696,457 MB	751,767 MB

The results of the maximum inventory calculation show that the maximum inventory value for Crude Oil X is 710.137 MB, Crude Oil Y is 696.457 MB, and Crude Oil Z is 751.767 MB.

4.2.4 Order Quantity

Based on the results of the minimum and maximum stock calculations, the calculation of the amount ordered in one order (Q) for Crude Oil is carried out. The following is the calculation of the amount ordered in one order (Q) for Crude Oil X:

$$\mathrm{Q} = \mathrm{Max\ Inventory} - \mathrm{Min\ Inventory}$$
$$\mathrm{Q} = 710{,}137 - 386{,}583$$
$$\mathrm{Q} = 323{,}554\ \mathrm{MB}$$

Table 5, shows a recapitulation of order quantity based on historical data in 2022:

Table 5 Recapitulation of Quantity Order

	X	Y	Z
Quantity Order	323,554 MB	323,328 MB	351,912 MB

The results of the order quantity calculation are shown in Table 5. The value of the order quantity per order for Crude Oil X is 323.554 MB, Crude Oil Y is 323.328 MB, and Crude Oil Z is 351.912 MB.

4.2.5 Order Frequency

Based on the results of the calculation of the order quantity, the frequency calculation is carried out for orders of Crude Oil in one year. The following is the calculation of the frequency of orders for Crude Oil X:

$$\mathrm{F} = \frac{\mathrm{Total\ N}eeds}{\mathrm{Q}}$$
$$\mathrm{F} = \frac{24072{,}393}{323{,}554}$$
$$\mathrm{F} = 74\ \mathrm{orders\ in\ one\ year}$$

Table 6, shows a recapitulation of order frequency based on historical data in 2022:

Table 6 Recapitulation of Order Frequency

	X	Y	Z
Order Frequency	74 times/year	74 times/year	74 times/year

The results of the order frequency calculation are shown in Table 6. The value of the order frequency for Crude Oil X, Crude Oil Y, and Crude Oil Z is the same, namely 74 times/year.

4.3 Min-Max Crude Oil Throughput Diagram

Table 7 recapitulates the final stock, maximum inventory, and total Crude Oil tank capacity for each grade from the calculation results of the min-max method.

Table 7 Recapitulation of Final Stock, Maximum Inventory, and Total Tank Capacity with Min-Max Method (MB Unit)

Period	X			Y			Z		
	Final Stock	Max Stock	Total Tank Capacity	Final Stock	Max Stock	Total Tank Capacity	Final Stock	Max Stock	Total Tank Capacity
Jan	658	710	1182	643	696	1118	716	752	1673
Feb	465	710	1182	448	696	1118	505	752	1673
Mar	402	710	1182	383	696	1118	434	752	1673
Apr	402	710	1182	382	696	1118	434	752	1673
May	662	710	1182	640	696	1118	716	752	1673
Jun	663	710	1182	640	696	1118	716	752	1673
Jul	599	710	1182	574	696	1118	645	752	1673
Aug	535	710	1182	509	696	1118	575	752	1673
Sep	536	710	1182	509	696	1118	575	752	1673
Oct	472	710	1182	443	696	1118	505	752	1673
Nov	473	710	1182	443	696	1118	505	752	1673
Dec	410	710	1182	379	696	1118	434	752	1673

Based on Table 7, a throughput diagram was created which is shown in Figure 4 to find out whether there are still overstocked or out of stock.

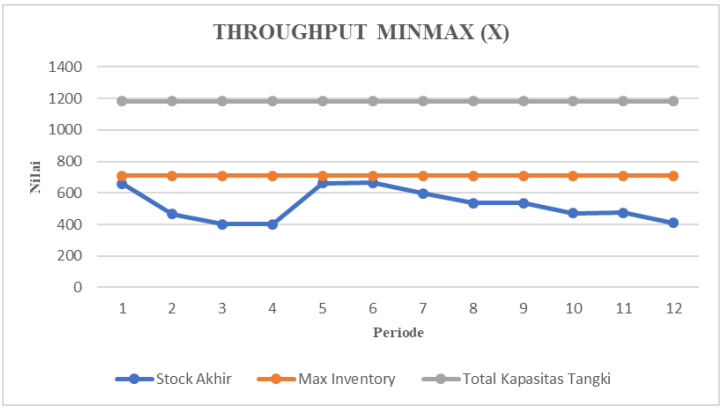

Figure 4 Throughput of Crude Oil X Stock

Figure 4 shows that the final stock of Crude Oil X in each period using the Min-Max method does not exceed the maximum inventory, and none exceeds the storage tank capacity.

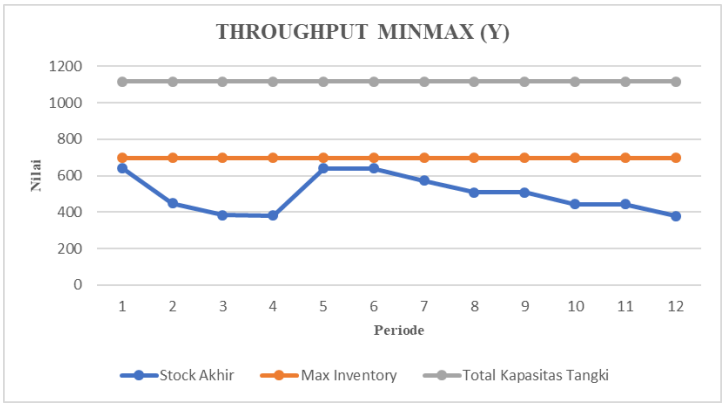

Figure 5 Throughput of Crude Oil Y Stock

Figure 5 shows that the final Crude Oil Y stock in each period using the Min-Max method does not exceed the maximum inventory, and none exceeds the capacity of the storage tank.

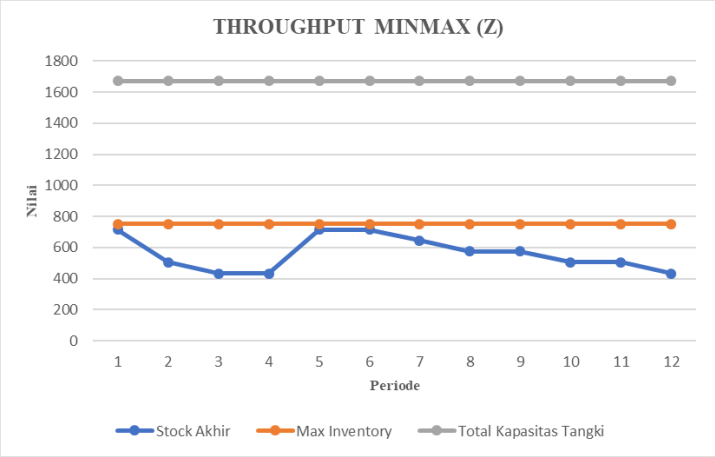

Figure 6 Throughput of Crude Oil Z Stock

Figure 6 shows that the final stock of Crude Oil Z in each period using the Min-Max method does not exceed the maximum inventory, and none exceeds the capacity of the storage tank.

4.4 Sensitivity Analysis

Sensitivity analysis is an analysis performed to calculate the new optimal solution caused by the multiplier factor of the maximum inventory formula without having to recalculate from the beginning. The results of changing this multiplier can be compared by finding the lowest average final stock, which can minimize overstock risk and minimize costs incurred. Maximum inventory is the maximum limit allowed to store stock in storage tanks. The equation used in the calculations that have been made to find the maximum amount of inventory is 2 x (Average Usage x Lead Time) + SS. In this equation, it is not yet known whether the maximum inventory amount has resulted in a minimal average ending stock. Therefore, it is necessary to have a sensitivity analysis by changing the multiplier in the maximum inventory quantity equation. Table 8 shows the recapitulation of the maximum inventory sensitivity analysis.

Table 8. Sensitivity Analysis

Grades	Multiplier Factor	Maximum Inventory (MB)	Q (MB)	Order Frequency (per year)	Average Final Stock (MB)
X	2	710	324	74	523
	2,5	872	485	50	604
	3	1034	647	37	604
Y	2	696	323	74	499
	2,5	858	485	50	580
	3	1020	647	37	580
Z	2	752	352	74	563
	2,5	928	528	50	651
	3	1104	704	37	651

Table 8 shows that the greater the multiplier factor used, the greater the maximum amount of inventory that must be stored in the storage tank. This aligns with research findings (Putri & Ulkhaq, 2017), which discuss the Analysis of 120 120-gram duplex Paper Raw Material Inventory Control Using the Min-Max System Method at PT. Jaya Aflaha, Batam, with the object being raw materials at PT Jaya Aflaha. The average ending stock with a multiplier factor of 2 is the lowest average stock, so the maximum inventory allowed to be stored in storage tanks is 710 MB for X grades, 696 MB for Y grades, and 752 MB for Z grades. Table 9 shows that comparison of the most optimal min-max policies compared to the company policies that are currently in effect.

Table 9. Recapitulation of Company Policy and Min-Max Method

No	Parameter	*Min-Max*			Company Policy
		X	Y	Z	
1	Safety Stock	63 MB	50 MB	48 MB	0
2	Minimum Inventory	387 MB	373 MB	400 MB	300 MB
3	Maximum Inventory	710 MB	696 MB	752 MB	900 MB

4	Quantity Order (Q)	324 MB	323 MB	352 MB	Different for each
5	Order Frequency	6/months	6/months	6/months	9/months

Based on Table 9, which compares company policies and the Min-Max method, it can be concluded that if the company uses the Min-Max method to control Crude Oil inventory, there will be no stockouts or overstocks.

4.5 Comparative Analysis of The Company's Actual Conditions and Recommendations

Based on the results of interviews with PT ABCD's Supply Chain and Distribution staff, information was obtained about the actual conditions at the company, which include frequent stockouts and overstocks. PT ABCD, in dealing with this, usually mixes Crude Oil between grades. However, PT ABCD said that mixing between these grades should be avoided, which will result in suboptimal product yields in the end. The suggestion that researchers can give based on the results of previous calculations is to make inventory control by determining safety stock, minimum, and maximum inventory, and determining the number of orders and frequency of orders using the Min-Max method, which can minimize the possibility of stock outs or overstocks. This proposal aligns with the findings from research (Yedida & Ulkhaq, 2015), which discusses Planning for Raw Material Supply Requirements at CV Endhigra Prima with the Min-Max Method, with the object being raw materials at CV Endhigra Prima. However, for the proposed improvement regarding Crude Oil inventory control with the Min-Max method at PT ABCD there is an additional suggestion regarding the SOP design.

Proposed improvements regarding inventory control using the Min-Max method can be carried out in the following stages:

1. Determine the value of Crude Oil safety stock for each grade.
   Determining the value of safety stock is intended to anticipate if the company experiences a shortage of raw materials at any time, so that the production process can continue to run smoothly. Safety stock is needed by companies to deal with eventualities that occur, which:
   - Suppliers deliver products late or don't ship at all.
   - Storage tank damage or maintenance occurs.
   - There is a possibility of an unexpected increase in demand for the company.
2. Determine the minimum inventory value for each grade.
   Determination of the minimum inventory value or reorder point is carried out to meet the amount of inventory needed in the production process. If the reorder point is set too low, the supply of materials or goods will run out before replacement supplies are received, so production can be disrupted or customer requests cannot be met. However, if the re-supply point is set too high when new supplies arrive, while there is still plenty of inventory in the tank, this situation results in wastage of costs and excessive investment. Several factors influence the determination of ROP, namely the level of demand, lead time, and uncertainty in the level of demand and waiting time for replenishment.
3. Determine the maximum inventory value for each grade.
   Determination of the maximum inventory value to be the limit of raw materials that are allowed to be stored in storage tanks. This is done so that there is no overstock in Crude Oil.
4. Determine the quantity order value and order frequency for each grade.
   Determination of the value of the quantity order is carried out to determine the amount of Crude Oil that needs to be ordered to replenish inventory. The number of order frequencies can be used as a scheduling plan for when to buy Crude Oil in one month or one year.

PT ABCD must carry out operational activities, especially in inventory control, in accordance with established procedures. Standard Operating Procedure (SOP) becomes a tool used as a reference for procedures or work guidelines for employees so that the activities carried out are in accordance with existing procedures. The following is a draft SOP for inventory control of Crude Oil as a raw material at PT ABCD:

Company Logo	***STANDARD OPERATING PROCEDURE***	
	CRUDE OIL SUPPLY CONTROL PROCEDURE	No. Document:
		Revision :
		Effective Date:
		Page :

a. Objective

Ensuring that every amount of Crude Oil inventory in storage tanks has been properly recorded and monitored.

b. Scope

The process includes of planning production, scheduling Crude Oil orders, checking Crude Oil stocks, and Crude Oil processing.

c. Responsibility

Inventory stock is responsible for the smooth control of Crude Oil supplies.

d. Procedure Description

Flow Chart

e. Attachment

Approved by:	Checked by:	Made by:
Officer Name	Officer Name	Officer Name
Position	Position	Position

Figure 7. Inventory Control SOP Draft (1)

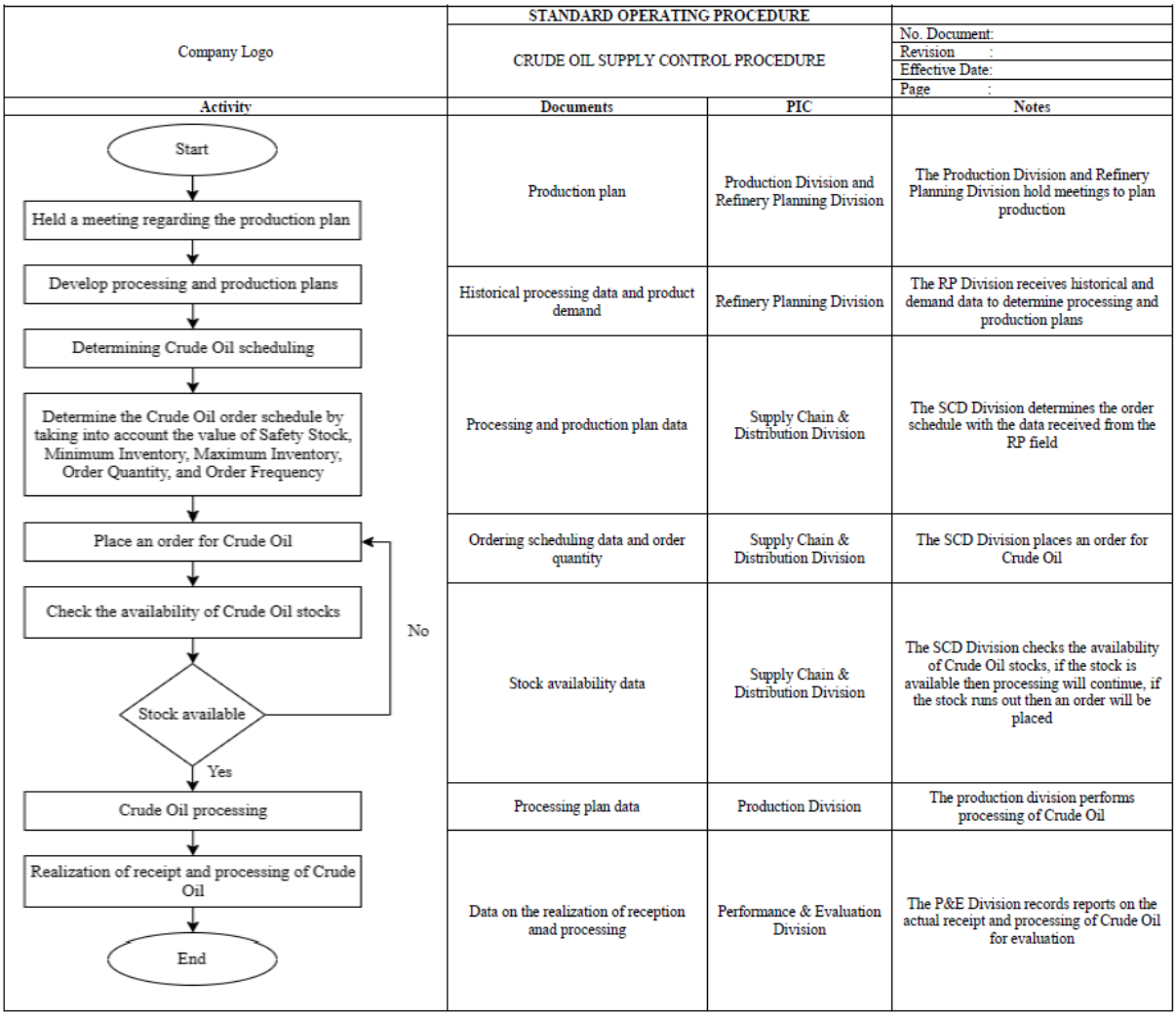

Figure 8. Inventory Control SOP Draft (2)

V. CONCLUSION

It was observed Following are some conclusions that can be drawn based on the research, namely the optimal inventory quantity has been obtained based on the minimum-maximum inventory when compared with the actual inventory. The minimum inventory value is 387MB (X), 373MB (Y), and 400MB (Z). The maximum inventory value is 710MB (X), 696MB (Y), and 752MB (Z). From the results of the Min-Max method, the order quantity is 324MB (X), 323MB (Y), and 352MB (Z). The order frequency is 7 times for each grade. PT ABCD can apply the Min-Max method in controlling Crude Oil inventory to reduce or overcome overstock and stock out. There are suggestions that can be given by the author based on the research that has been done, namely that research should use more detailed lead time values, which will later affect the safety stock equation approach used so that the results of these calculations can be compared with the results of this study.

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