Optimizing Stainless Steel Inventory Management: An EOQ-Based Approach

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Abstract. *Production planning and inventory control is essential to every company in managing all the activities in the company to achieve greater goals and results. In a manufacturing company of stainless- steel product, production planning used team and leader decision based on the purchase order (PO) from customer without safety stock and re-order point. In deciding a basic optimal quantity in production, Economic Order Quantity (EOQ) method to find the basic optimal quantity order when purchasing material or supplying stock with minimize the wasted time and opportunities. Also, to create an emergency supply and pinpoint replenishment material, Safety Stock (SS) and Re-Order Point (ROP) could be the solution. The research scope of problem is focused on finding the optimal order quantity for production planning and inventory control with one of the products in the company as the sample, called item 1018 in a stainless-steel manufacturing company. By using Economic Order Quantity (EOQ) Method, the company could solve all problem regarding to production planning and managing inventory when supply is near stockout situation. The optimal of purchase order for Item 1018 is 145 units with 12 times frequency order. The safety stock for Item 1018 is 74 units and the reorder point is on 242 units. The total cost in table comparison total cost using EOQ and company's policy show that by using EOQ method, the company could save Rp 13.482.483 in a year. It's could be concluded with the result the company could use the EOQ, safety stock, and reorder point method to their production planning and inventory management control to monitoring the movement of inventory every day.*

Keywords: *Economic Order Quantity (EOQ), Inventory Control, Safety Stock, Re-Order Point, Production Planning.*

1 Introduction

In Supply chain operations, there are four categories of operations, there is plan, source, make, and deliver. In plan categories there is demand forecasting, product pricing, and inventory management [1]. Creating a plan needs an estimation, list of material price, and inventory control to achieve an effective production planning and achieve target and goals. Production planning and inventory control is essential to every company in managing all the activities in the company to achieve greater goals and results. Produc-

tion planning and inventory control purposes is to manage all transaction in the company with an optimal plan as their center operation to instruct all unit in synchronize between their role and relation with other unit in the company. If the company does not have an optimal plan, it could lead to emerging a risk of lacking material wasted time because waiting for material replenishment to arrive. This condition founded in this study case research at a manufacturing company of stainless-steel product in their production planning and inventory control management. The company is a company manufacturer of high-precision metal components, specialized in the production of precision metal turn parts and product assemblies for disk drive, aerospace, automotive, and electronics industries.

Production Planning and Control (PP&C) is the main control of all system and activities of all production, production planning also responsible for ensuring the availability all materials, assembling product in the right place, assembling product in the time, and accurate output quantities according to the schedule at the minimum possible costs [2].In the study case, the problems found that the company still have not an optimal production planning and inventory control. The problems are the company struggles in determining the basic optimal of quantity when purchasing material to the supplier in order to prevent the risk in losing production time. Another problem is lacking material because of external factors such as, sudden change of demand, longer lead time for material to arrive, and some material does not meet the company's standard requirement. Also, in the company have a plan in creating a safety stock to prevent those condition but still have not found a suitable solution.

EOQ model advantages is most of inventory model have the same or similar model that could be analyses with EOQ and EOQ model could show the standard need in each material before significantly increasing the amount of purchase order [3]. In deciding a basic optimal quantity in production, Economic Order Quantity (EOQ) method could be the one of the solutions to solve all problems relating to planning and managing goods. EOQ method could be used to find the basic optimal quantity order when purchasing material or supplying stock with minimize the wasted time and opportunities. From the economics perspective, EOQ could save some cost in purchasing material based on purchased quantity goods in one time by considering the demand of product from customer.

It has been proved by many previous researches about managing inventory control with EOQ method, it's proved that EOQ could minimize quantity and material cost. The total cost of inventory using EOQ method could be lower than the company's actual method which is implied that EOQ method could minimize the total cost of inventory [4]. EOQ method is efficient in manage production and inventory control and it's proven EOQ method could find the economic point purchase with the variable cost that must be incurred [5]. The result of EOQ method is more economical than the usual average raw material purchase order [6]. By using Economic Order Quantity (EOQ) Method, the company could solve all problem regarding to production planning and managing inventory when supply is near stockout situation. Also, the company could use this research as a reference to implementation in the company systematically and

detailed calculation. This research could contribution for expanding knowledge in supply chain management, especially in production planning and inventory control with the result of the research could be as the reference in literature about Economic Order Quantity (EOQ) Method on manufacturing company with make-to-order system. The research scope of problem is focused on finding the optimal order quantity for production planning and inventory control with one of the products in the company as the sample research, called item 1018. For a brief description, item 1018 in the company is a name given from the company for this specific product in order to make things easier to classify in the company's internal. Item 1018 is using a long flat stainless-steel as the raw material.

2 Theoretical and Literature Review

2.1 Theoretical Studies

Production Planning

Production planning is a crucial process in manufacturing systems, aiming to efficiently coordinate production activities, resource allocation, and material acquisition to meet customer demand economically that involves decisions on lot sizes, setup, workforce levels, and production sequencing [7]. Effective production planning enhances system efficiency, reduces cycle times, and improves customer satisfaction by ensuring timely delivery of quality goods [8]. It operates within a hierarchical framework, interacting with more detailed scheduling and control functions [9]. This interaction is crucial for managing disruptions and maintaining system performance [9]. Production planning methodologies have evolved, with various approaches developed to address the complexities of matching inputs to output requirements [10]. Overall, production planning serves as a vital tool for coordinating departmental activities, optimizing resource utilization, and improving organizational performance in manufacturing settings [8].

Production planning and control are the brain and nervous system of the production and responsible for the availability of all materials and part in assembly on the right time, place, and quantities according to the progress of operations in order to determine the predetermined schedules at the minimum possible costs [2]. Objectives of production planning and control [2]:

1. Minimize the idle times of men and machines.
2. Minimize inventory turnover.
3. Maximize the percentage of the commitments given to the customers.
4. Maximize the product quality and customer satisfaction.
5. Keep inventory levels low.
6. Provide long runs and low setup times.
7. Minimize bottleneck along the production flow.
8. Plan early indents to give enough lead time for the purchase of goods at optimal process.

From the objectives above, it concluded production plan purposes is to manage production activities included in the idle times of men and machines, in inventory management, quality and quantity goods, finding the optimal production plan for long runs with a low cost and setup times. Production plan also maximize company's production performance and minimize the high risk with a high damage as well to the company. In short, production planning is to keep company's performance optimal in all aspect of production to be productive in production and still gain profit with efficient material usage. With effective material usage, company could maximize other aspect outside of production from the remaining budget used for production planning.

Inventory Control.

Inventory is a name for keeping an amount of material or goods in warehouse in order to achieve efficient production or as a solution to any problem in production[2]. In inventory control, there are two main reasons inventory control needs to order items before customer demand them. First, there is lead-time or delivery time after ordering time. Second, to prevent high ordering cost, usually it's necessary to order in batches instead per unit [11]. Therefore, it's necessary to create planning in inventory control considering the lead time and ordering supply in order to prevent taking high risk loss.

Even though lead time already become one of the considerations in planning, sometimes there is still an occurrence delay time in lead time that could lead to a possibility production will finish more than the expected time. To enhance planning, one of the solutions to prevent losses in waiting lead time is creating a safety stock as an emergency supply[11]. With safety stock, any shortages material could be prevented by adding to any lacking quantities in production to continue its activity. Safety stock has a role to prevent any loses and possible negative situation to occurs by keeping an average amount of material or goods as an emergency supply to cover the lack amount of material, any material that damaged and not meet the standard requirement in the company.

Economic Order Quantity (EOQ)

EOQ was first develop by Ford W. Harris in 1913 to find a concept for finding an optimum order quantity to balance costs of holding stock and ordering small quantities frequently [12]. Economic Order Quantity (EOQ) is a method used in production planning as part of the continuous review in inventory system is monitored to be on optimal lowest and the quantity is ordered when replenishment is required [2]. Analysis using EOQ method could obtained an optimal purchase supply quantity by considering the purchase quantity and purchase frequency to get the minimum purchase cost [13]. In using Economic Order Quantity (EOQ), there is some of key assumption include [3], [14]:

1. Demand for an item is known, constant and uniform.
2. Lead time is known and constant.

3. Price per unit is constant and receipt of inventory is instantaneous and complete. In other word, the order arrives in one batch at one time.
4. inventory holding cost id based on average inventory and quantity discount are not possible.
5. ordering and setup cost are constant.
6. no backorder is allowed.

The various level for effective stock could be classified in the following [12]:

1. maximum stock level is when level stocks are not allowed to rise.
2. minimum stock level is when level stock are not allowed to fall.
3. reorder stock level is when level stock are in the level to replenishment supply in order to keep all material and goods fresh and avoided from being stock out.
4. average stock level is when level stock are in the middle quantity of stock between the maximum and minimum level.
5. danger stock level is when level stock below the minimum level which in the situation supply in inventory is running out or in stock out position.

The formula of EOQ is from model development of Total Annual Cost (TC) [15], which is the formula of Total Annual Cost is:

$$TC = DC + \left(\frac{D}{Q}\right) S + \left(\frac{Q}{2}\right) H$$

Description:
TC : Total annual cost
D : Annual Demand
C : Cost per unit
Q : Optimal quantity (EOQ)
S : Ordering cost
H : Annual holding cost

From the Total Annual Cost (TC), it could be produced the EOQ formula, Economic Order Quantity (EOQ) is formulated as [14]:

$$EOQ = \sqrt{\frac{2 \times DS}{H}}$$

$$EOQ = \sqrt{\frac{2 \times DS}{C \times i}}$$

Description:
EOQ : Economic order quantity for one-time order.
D : Annual demand
S : Order cost or setup cost if the material is manufactured
H : Holding cost per year

C : Item cost
i : Annual percentage holding cost

After determined EOQ value, it is recommended to create a reorder point as a pinpoint to replenish supply. Reorder point is when an inventory stock is reach in certain level to reorder again to prevent from a stock out situation by calculated between the average demand times with lead times in days [3]. With reorder point, replenishment planning could have an anticipation to recover or purchased another stock in the absolute time and could increase the productivity in a company. Re-Order Point formula structure combined with safety stock is [14]:

$$ROP = (d \times L) + SS$$

In order to find daily demand value is by using formula [14]:

$$d = \frac{D}{Number\ of\ working\ days\ in\ a\ year}$$

Description:
ROP : Re-Order point
D : Annual demand in unit
d : Daily demand in unit
L : Lead Time
SS : Safety Stock

Even though, there is not preventing enough from production lacking material because there is still a possibility an unexpected situation could occurs that out of the prediction, such as in the factor of lead time could be increasing due to the situation in real time whether if the material is not enough from the supplier and traffic cause while in the delivery process. There is one solution could prevent those external factors by creating an anticipation stock called safety stock. Safety stock is an extra inventory to against stockout situation as a limitation or protection in inventory control [12]. Safety stock or buffer stock could be a solution to prevent unexpected situation like [12]:

1. uncertainty in demand
2. degree of insurance
3. uncertainty in lead time and size of batch

To prevent a stockout situation because of uncertain demand or lead time could use probabilistic models in safety stock [14]. The standard deviation number (Z) could be search by using NORMSINV function in Excel to find the standard deviation number of percentage target service level [15]. The formula of Safety Stock used is:

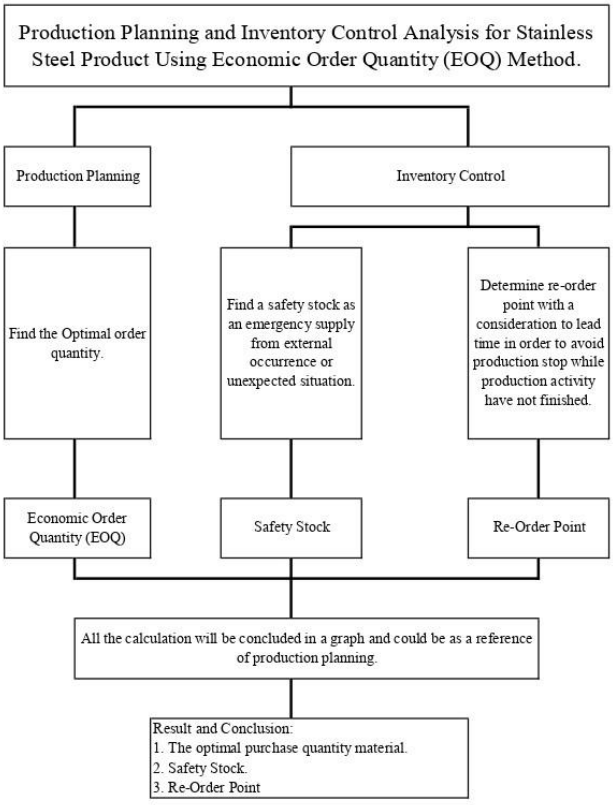
$$SS = Z \times \sigma_{dLT}$$

Description:
Z : Standard deviations number
σ_{dLT} : Standard deviation demand during lead time

2.2 Conceptual Framework

In this research framework, there is will have an explanation to the steps in research from the variable in this research and merge into variable involve in the research then determine the research problem in each variable and then move to the solution resulted from theory literature to the last step of produced a result and conclusion. The framework of this research is described in the Figure 1 below.

Fig. 1. Research Framework



In this research, there is variable in Production Planning and Inventory Control. It knows from the informant that in production planning there is a problem when customer wants to change the quantity of products whether it's increasing or decreasing the quantity. On the other side, in inventory control, it knows that there is have not created a safety stock as an emergency supply when the material is in stockout condition.

3 Research Method

3.1 Research Method

In this research will be using qualitative research method and study case as an approach with using some technique such as, interview, observation, and documentation to collect all data requirement in this research calculation method. Also, in this research will be using Economic Order Quantity (EOQ) Method as the Data Analysis Method to perform analyses data collected from data collection method in a research of finding an optimal inventory cost until determining the production planning times in purchasing, safety stock, and the reorder point.

The research location is done at a stainless-steel manufacture company in Batam, Kepulauan Riau. This research objective is on production planning and inventory control in determining the quantity of purchase order done in production department of manufacturing company of this research object. In this research, researcher choose informant or subject that have a relation to researches object with production planning and inventory control. As the agreement with the company, all the information related to this research will obtained from one of the employees in Human Resource Division as a hub to connect between the researcher and information regarding production planning and inventory control in the company. The reason is company have a limitation in giving information to researcher that some of the information is cannot be publish to the public. Therefore, information and data in this research is already changed from the original or accurate data by adding the value a little higher than the accurate data. Even though all data obtained is modified from the actual value, this research purpose is to test EOQ method with a purpose the method could be used for the company in help finding the optimal or stable production planning and inventory control. Data will be withdraw using Purposive Sampling with a determined range of one-year production and inventory data. The data will be used in this research is using a previous data in 2023 as the sample determination in this research and use sample from one of the products called item 1018 in the company.

Data Collection Techniques

In this research, data collection will be using triangulation data method in obtained data to increasing the accuracy of data by using more than one technique in collecting research data [16].The techniques in this research are interview, observation, and documentation to gain more detailed information. Source of data in this research have two types:

1. Primary Data

Primary data is information obtained thorough data collection technique using interview, observation and documentation technique. The target of the data collected will be all variables needed to operate data analysis technique used in this research which is

all variables involved in Economic Order Quantity (EOQ), Safety Stock (SS), and Re-Order Point (ROP) formula.

2. Secondary Data

Secondary Data is from documents that supported the Primary Data. Secondary Data role is as a support for an accuracy and actual data obtained from collected primary data.

Data Analysis Technique

In this data analysis researches will use Economic Order Quantity as the method to analysis data to find the result of this research's purposes. Economic Order Quantity (EOQ) is a calculation method to control raw material and determine the quantity or frequency order of raw materials to become economical that could prevent stockout or excess raw materials [14]. This research's purposes are to find the optimal order quantity in production planning and finding an optimal point for safety stock and re-order point. Economic Order Quantity (EOQ) is using ordering cost, annual demand, and holding cost as its variable which is a model development from total annual cost formula to determine the optimal order quantity [15].

Total annual cost is to find the total requirement cost needed to be fulfilled in a year by include annual purchase cost, annual ordering cost, and annual holding cost. The total annual cost could be a tool to know when the optimal order quantity is occurs at the point where ordering cost and holding cost is equal or have almost the same value [14], [15]. It will be shown in the calculation between ordering and holding cost is equal or with little difference value. When both costs are equal, it could be assumed that the quantity is optimal with a minimal cost.

To prevent a stockout situation because of uncertain demand or lead time could use probabilistic models in safety stock [14]. By using safety stock, company could prevent lacking material situation. In this research, safety stock uses a probability approach which is this probability only considers the possible running out of stock situation [15]. Probability model is to determine the possible stock out situation occurs according to its normal distribution. By using the probability model, company could know the optimal quantity to order by using the distribution data in inventory daily.

Re-Order Point have a role as the pinpoint value of replenishment time in inventory control for the company know when the best time is to repurchase stock [17]. The danger of stockout is only occurs during lead time, where between the time order is received and the time the material arrived [15]. Situation that could have negative impact during lead time like accident happen when the materials being transport could cause delay and effect the inventory fall to the danger or stock out situation. To prevent such event, formula of Re-Order Point will be combined with the safety stock. That way, Re-Order Point will be considered its daily output, lead time, and safety stock as the variable.

4 Result and Discussion

4.1 Data Analysis

Economic Order Quantity

The data obtained from the data collection in the company regarding of annual demand of item 1018 from January 2023 – December 2023 and from January 2022 – December 2022:

Table 1. Monthly Demand Item 1018 from 2022 and 2023

No	Month	Demand Item 1018 in 2022	Demand Item 1018 in 2023
1	January	0	0
2	February	0	0
3	March	0	0
4	April	30000	0
5	May	0	0
6	June	30000	0
7	July	95000	100000
8	August	30000	60000
9	September	0	0
10	October	0	0
11	November	0	180000
12	December	0	30000
Total		185000	370000

From Table 1, it could be seen that the demand from the year of 2022 have a similar quantity demand in 2023. Which mean it is found that the product is produced in every

year within the same amount material. It is as the assumption of EOQ, the demand quantity is constant and know thorough the year. In this research will be using data demand from Item 1018 in 2023. Item 1018 could be produces to 200 unit from 1 rod material with 8,0 mm long stainless steel. So, in order to find the total requirement material, it need to be converted from the demand of product needed to the material needed by each demand divided with the how many products could be produced with only one material. In this case, one material could produce 200 unit. So, all demand in month divided with 200 unit and it will be resulted into the material quantity needed in each month to fulfil all demand. The material quantity to produce from January 2023 – December 2023 in each month:

Table 2. Monthly Demand for Item 1018 Material from January 2023 – December 2023

No	Month	Item 1018 (Material)
1	January 2023	0
2	February 2023	0
3	March 2023	0
4	April 2023	0
5	May 2023	0
6	June 2023	0
7	July 2023	500
8	August 2023	300
9	September 2023	0
10	October 2023	0
11	November 2023	900
12	December 2023	150
	Total	1850

Ordering cost for one-time order from the result of data collection:

Table 3. Ordering Cost for Item 1018 Material

Cost Type	Item 1018
Transportation Cost	60.000/month
Ordering Cost (S)	Rp 60.000

Holding cost for one-time order from the result of data collection:

Table 4. Holding Cost for Item 1018 Material

Cost Type	Item 1018
Warehouse	Rp 15.000.000/month
Total	Rp 15.000.000

Holding cost (H) in per unit in one-year could be known by the percentage of storage cost percentage multiply with the material cost. Material cost done by the same method done with obtaining the ordering cost (S) and holding cost (H). The calculation of holding cost from January 2023 – December 2023 for Item 1018:

Table 5. Holding Cost for Item 1018 Material

Sample	Storage Cost (%)	Material Cost	Holding Cost (H)
Item 1018	15%	70.000	10.500

The usual percentage of storage cost is on the scale from 15% to 40%, storage cost below 15% is unlikely to use though but storage cost could exceed to 40% [14]. From data collection, researcher found that the company did not have a detailed documentation regarding the detail of storage cost, for the solution researcher will use an assumption based on the previous theory. With the all data collected from data collection for performing EOQ method. Next is to perform all data to the formula of EOQ. The calculation of Economic Order Quantity (EOQ) required annual demand (D), ordering cost (S) and holding cost (H):

Table 6. Economic Order Quantity (EOQ) Variables

Sample	Annual Demand (D)	Ordering Cost (S)	Holding Cost (H)
Item 1018	1850 unit	Rp 60.000	Rp 10.500

The calculation formula of Economic Order Quantity is:

$$EOQ = \frac{\sqrt{2}.D.S}{H}$$

$$EOQ = \frac{\sqrt{2.1850.60000}}{10500} \quad (1)$$

$$EOQ = 145\ unit$$

From the calculation of EOQ above, it's resulted that the optimal quantity order using EOQ formula is 145 units in each order. So, in each purchase order there will be needed 145 units to order and it is the optimal quantity. With this optimal quantity, the total cost of purchasing material could be suppressed into its minimal cost without causing losses and lacking materials in production. The calculation of total annual cost using EOQ method for material of Item 1018 is:

Table 7. Total Cost (TC) Variables

Product Name	Annual Demand (D)	Price per unit	Optimal Quantity (EOQ)	Ordering Cost (S)	Holding Cost (H)
Item 1018	1850 unit	Rp 70.000	145 unit	Rp 60.000	Rp 10.500

$$TC = DC + \frac{D}{Q}S + \frac{Q}{2}H$$

$$TC = 129.500.000 + 765.517 + 761250 \quad (2)$$

$$TC = Rp\ 131.026.767$$

According to the result calculation above, it's known the total annual cost of purchasing material in one year if using EOQ method is Rp 131.026.767. This total cost (TC) is show the requirement cost needed for one-year production. The optimal order quantity occurs at the point where the ordering cost and holding cost is equal or almost the same

[14], [15]. With the ordering cost is Rp 765.517 and with holding cost is Rp 761250. To compare both of the total cost between using EOQ method and company's policy, the total cost according to the company's policy is have to be calculated first. The calculation of the total cost according to company's policy is:

$$TC = (1850 \times 70.000) + (1850 \times 5) + 15.000.000 \quad (3)$$

$$TC = Rp\ 144.509.250$$

According to Equation 3, the total cost using company's policy is Rp 144.509.250. The calculation is from the variables of total demand in a year multiply with price per material which is from total demand of 1850 units and Rp 70.000 for the price. Total demand cost also multiplies with the frequency happen in a year which is resulted the total demand is 1850 units and with 5 times frequency. And lastly, the inventory cost for the warehouse is Rp 15.000.000. With those variables, the total cost is determined by summation all the variables.

Safety Stock

In this safety stock calculation will be used a standard deviation distribution formula to determine the company's safety stock. When using standard deviation distribution formula, it could be seen the quantity needed to have to avoid stockout situation. In the safety stock formula involve the standard deviation number of target service (Z) and standard deviation of demand during lead time (σ_{dLT}). These are the variable will be used in the safety stock formula:

Table 8. Safety Stock Variables

Target Service	Z	Standard deviation demand during lead time (σ_{dLT})	Lead Time (LT)
95%	1,64	45 units	28 days

The calculation formula of Safety Stock for material of Item 1018 is:

$$SS = Z \times \sigma_{dLT}$$

$$SS = 1{,}64 \times 45 \quad (4)$$

$$SS = 74\ units$$

From the calculation above, to prevent stocking out event, the safety stock has to be 74 units. With safety stock, company could avoid situation like stockout in the middle production and even risk of overload material in inventory.

Re-Order Point

Re-order point (ROP) is a method to determine the pin point of an ideal time to replenish material by considering its lead time in one-time order. . In Re-order point (ROP) formula, there is daily demand variable involved. The daily demand of material for Item 1018 is:

$$d = \frac{D}{Number\ of\ working\ days\ in\ a\ year}$$

$$d = \frac{1850}{296} \quad (5)$$

$$d = 6\ units$$

Table 9. Re-Order Point (ROP) Variables

Average Daily Demand (d)	Lead Time (LT)	Safety Stock (SS)
6 units	28 Days	74 units

$$ROP = (d\ \times LT) + SS\text{e}$$

$$ROP = (6\ \times 28) + 74 \quad (6)$$

$$ROP = 168 + 74$$

$$ROP = 242\ units$$

Inventory Parameters Graphic

In this section, it will be performed all resulted data analyses from EOQ, safety stock (SS), and reorder point (ROP) into an inventory parameters graphic. By combining them, company could easily see the inventory level by monitoring daily usage rate to know the current inventory level. So, the company could see the movement of material accurately. All the data calculation result will be combined and present it in an inventory parameters graphic.

Table 10. Data Analyze Result with EOQ, Safety Stock, and Re-Order Point

No	Analysis Method	Item 1018
1	Economic Order Quantity (EOQ)	145 units
2	Safety Stock (SS)	74 units
3	Re-Order Point (ROP)	242 units

Total Inventory	387 units

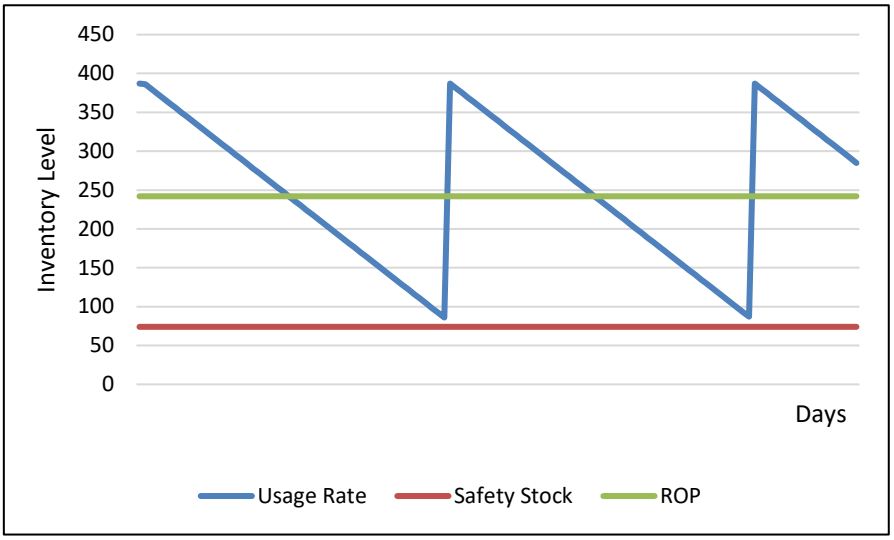


Fig. 2. Inventory Parameter with The Data Analyze Result

From the Figure 2, it's used the variable of EOQ, safety stock, and reorder point concluded into one graphic where the maximum of inventory is the result of EOQ, and reorder point combined which is resulted 387 units. The usage rate in the graphic is from the current inventory minus daily demand from reorder point and continuously with the next day stock until usage rate reach reorder point where the company will decide to make an order to supplier for another batch of material. So, the company will order 145 units to the supplier and waited 28 days until the material arrived. The reorder point is made by considering the lead time or waiting time until the material is arrived to the company. In that way, when the usage rate reach before 74 units which also marks the arrival of material replenishment, the inventory level will increase to its maximum inventory level.

However, in this graphic with the EOQ is on 145 units and reorder point is on 242 units, there will be not enough replenish material on time and the company have to reorder again after the material is arrive. Because in the 28 days of the material arrived, the material only replenishes until 231 units while the reorder point is 242 units. To fully replenish stock to its maximum inventory level, the company need to order at least 301 units to reach 387 units as the maximum of inventory level.

Comparison of Inventory Between Using EOQ Method and Company's Policy

In this summary, it is compared inventory control method between company's method and Economic Order Quantity (EOQ) Method. Studies consistently show that EOQ-

based methods outperform traditional company policies in terms of cost efficiency and inventory optimization. In the previous research, comparison of inventory control method is used to show the difference effect in the company. There is founded significant differences in re-order point calculations between company policy and EOQ method [18]. In the comparison EOQ, EOI, Min-Max, and company policy methods, with EOI showing the most minimal ordering frequency and inventory costs [19]. In a research demonstrated that the EOQ method is more effective for controlling steel raw material fabrication and reduces total inventory costs [20]. In another research confirmed EOQ's superiority, showing a substantial reduction in total inventory costs compared to company policy [21]. These studies collectively suggest that EOQ-based methods can significantly improve inventory management practices and reduce associated costs for companies across various industries. These are the comparison of inventory between using EOQ method and with company's policy:

Table 11. Comparison of Inventory Using EOQ and Company's Policy

Sample	Method	Purchase Order	Frequency	SS	ROP
Item 1018	Company's Policy	370 unit	5	-	-
	EOQ	145 unit	12	74 unit	242 unit

From the comparison table above, the difference between inventory using EOQ and without using EOQ could be seen. In Table 11, it shown that using EOQ method is more often than using the company's policy so it could be that the total purchase cost of the company is much higher than the holding cost. The reason is if the quantity of purchase order in small quantity with order frequency too often, it could cause the total purchase cost to become higher. On the other side, if the quantity of purchase order in big quantity with less often order frequency, it could cause the total holding cost to become higher [13].

Table 12. Comparison Total Cost between Using EOQ and Company's Policy

Product	Total Cost with company's policy	Total Cost with using EOQ	Cost Saving
Item 1018	Rp 144.509.250	Rp 131.026.767	Rp 13.482.483

From the table above, it could be concluded that the difference between the total cost in using the company's policy is higher than using the EOQ methods. This difference

show that using EOQ method could save cost to Rp 13.482.483 in a year. This difference says that EOQ method could save cost better than with the company's policy.

5 Conclusion and Suggestions

5.1 Conclusions

Purchase material for product Item 1018 according to inventory control from the company is not optimal yet. It's resulted that in table comparison using EOQ and company's policy that the holding cost is higher than the purchase cost by the difference between the result of using EOQ method and by the company's policy. Which is resulted, the company's policy purchase order is 370 unit in one order with 5 frequency in a year with no Safety Stock and Re-Order Point. Meanwhile, the Economic Order Quantity (EOQ) method show the purchase order is 145 unit per order with 12 frequency with 74 units of Safety Stock and 242 units of Re-Order Point. It is concluded not optimal because in the total cost calculation with optimal quantity shows that the variable between Ordering Cost (S) and Holding Cost (H) is with a little differences cost. The total cost in table comparison total cost using EOQ and company's policy show that by using EOQ method, the company could save Rp 13.482.483 in a year.

It's could be concluded with the result from data analysis, the company could use the EOQ, safety stock, and reorder point method to their production planning and inventory management control to monitoring the movement of inventory every day. It could also minimize the possibility of stockout situation and excess materials quantity in production. Also, it could minimize from production stopping in the middle of production because of delay in the delivery time.

In using inventory parameter graphic showed in Figure 2, it resulted that the relation between Economic Order Quantity (EOQ), Safety Stock, and Re-Order Point does not meet the expectation where the quantity will be fully replenished by the time the usage rate meet with the safety stock. The solution for the quantity to meet the maximum inventory level, the company have to order at least 301 units to reach 387 units of the maximum inventory level. Even though, if the company order for 301 units it is not the optimal quantity to order.

5.2 Suggestion

From the conclusion above, researcher wants to give recommendation to the company could use the EOQ, Safety Stock, and Re-Order Point to method help manage production planning and inventory control for the company to help in finding the optimal quantity order, monitoring inventory level, and until saving cost in purchasing material. Even though, when using the inventory parameter graphic, it's best to adjust with the real-time situation in the company at the moment because there is a possibility that unexpected occurrence could happen and researcher recommended that the company use the inventory parameter to track the inventory level because by using the parameter,

company could monitor easily the stock level every day. The implementation of company could use the EOQ method could be start with using SAP application in the company. SAP application is a software that could use to monitor, managing, and control inventory in one system. Also, SAP could be used to control to every division in the company and data in one system. By using this application, company could easily track the inventory control management and the current status inventory level. To enhance the SAP performances, company could settings their planning in the software by unlocking EOQ/SFT Model Determination Rules. By unlocking this feature, the system will automatically calculate the EOQ and Safety Stock, determine the specific minimum and maximum EOQ periods, until the Re-Order Point range coverage. Also, it could help to determine the Safety Stock by using target service level as it's the same as the formula used in this research and using normal distribution calculation.

For the next research about production planning and inventory control, researcher recommended to analyses in a different method like Fixed-Time Period model where the inventory counted at particular times that depends on the usage rate regarding inventory control as a combination to achieve the optimal purchasing order or to find how to minimize cost in more detailed calculation and refine management control that prevent any risk and losses condition. Fixed-Time Period model is a model uses a set interval time continuously. Different from Fixed-Order Quantity model in this research, Fixed-Time Period model is more focused on the amount of purchased quantity to prevent any kind of stockout situation within a set amount of time to replenish material. In Fixed-Time Period model is to analyses the optimal interval time to order while Fixed-Order Quantity model is to analyses the optimal order quantity to minimize the total cost when purchasing material. The Fixed-Time Period model could be use if the quantity is variable each time order is placed, the time to maintain is more efficient than using Fixed-Order Quantity model, and suitable for lower-cost items. This model will suitable if it used in a company with a lower-cost material and the material easy to find.

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