



Original Article

Forecasting and Planning for Material Control in the Medical Device Industry

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Abstract:

PT. XYZ is a company operating in the electromedical sector that has supported many domestic medical devices in recent years. The demand for electromedical equipment seen from sales data is very volatile and difficult to predict, apart from that 70% of the requests received come from government institutions. The problem is compounded by the absence of a forecasting policy so that production activity planning is not optimal. Product inventory that is not accompanied by careful calculations will result in overstock and stockout which can increase total costs and reduce service levels. In carrying out its business PT. XYZ implements an existing inventory management policy which is carried out by ordering product components in large quantities but there is no clear reorder point. So this research will observe the product components CMS-600 PLUS, ECG-1200G, TENSIONE, ECG-300G, SON-C, SON-B, SON-PRO, USG PROMAX, PROMIST-3, MED-01, ECG- 100G, and ULTRAMIST then proposed the Croston and Syntetos-Boylan Approximation (SBA) forecasting method to estimate possible demand in the future and then continuous review inventory management policies (s, S) and (s, Q) to determine the maximum reorder point value, stock and order quantity. After that, a Monte Carlo simulation was carried out to see and compare existing policies with improvement policies based on total cost and service level variables. Next, a sensitivity analysis was carried out to determine the robustness of the simulation model to changes in uncertainty. The results obtained are recommendations for a continuous review (s, Q) policy with total cost savings of IDR 22,206,322,981 and an increase in service level of 1.36% to 99.98% compared to the existing policy.

Keywords: Croston, syntetos-boylan approximation, continuous review (s, S), continuous review (s, Q), Monte Carlo simulation



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Introduction

PT XYZ is a domestic company engaged in manufacturing medical devices located in Osowilangun, Surabaya. Products produced by PT. XYZ has approximately 251 products with 36 categories. Apart from having many types of products, PT. XYZ has varied and fluctuating product demand. This request means that simple planning is only enough to fulfill part of the order. The inability to carry out forecasting adds to the problems that make companies overwhelmed in predicting demand, managing production activities, and ensuring stock availability, causing overstocks and stockouts ([Silver et al., 2016](#)). Figure 1 shows the sales graph or demand graph for 12 types of product components at PT. XYZ can be seen in the sales graph for the past 1.5 years experiencing uncertainty at all times.

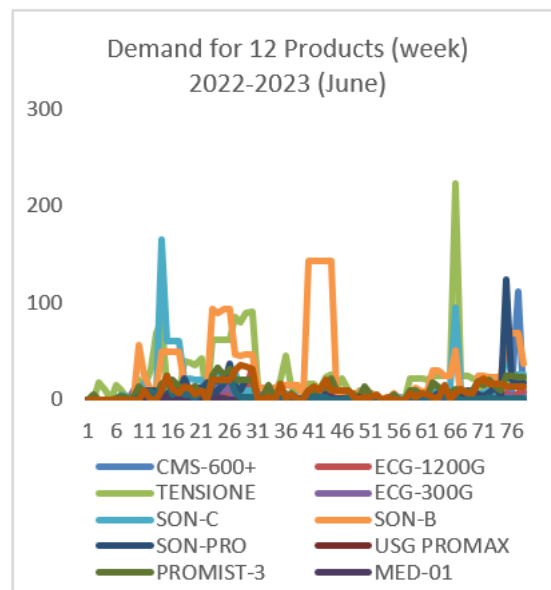


Figure 1. Demand for 12 Products (week) 2022-2023 (June)

To meet customer demands and reduce the occurrence of loss sales PT. XYZ always tries to maintain and adjust its production activities. One factor is managing, maintaining, and determining the quantity and quality of product components stored in the inventory warehouse. The storage value can reach a percentage of up to more than 25% of the total value of the company's assets. Every service or manufacturing company needs storage because it will reduce the risk of customer demand not being met ([Pujawan & Mahendrawathi, 2017](#)).

At PT. XYZ's inventory management process is carried out by the Production Planning and Inventory Control (PPIC) section by updating stock for product components. PPIC will look at the warehouse stock report and then match the existing components with the assembly formula ([Chopra et al., 2016](#)). When the availability of products that can be produced is less than the number of purchase orders (PO) received, an order will be placed with the supplier ([Kovačević et al., 2020](#)). After comparing stock data and PO data, the shortage data is forwarded to the purchasing department for further processing and obtaining approval from the main director to make import purchases. The lead time for component delivery takes 2 to 3 weeks, after which it will be received by the warehouse and the suitability of the components will be calculated regarding the quantity and quality of the components ordered. After all are declared to

have passed testing by the QC, the components will be stored in the warehouse according to each product type (Sohrabpour et al., 2021).

The number of electromedical products that have been produced bought and sold is approximately 140, but currently, there are approximately 50 products that are still active and frequently ordered. Some products include CMS-600 PLUS, ECG-1200G, TENSIONE, ECG-300G, SON-C, SON-B, SON-PRO, USG PROMAX, PROMIST-3, MED-01, ECG-100G, and ULTRAMIST. These products are ordered to suppliers in the form of assembly components in 'sets' so that the quantity of products can be produced as many as the 'set' ordered. In the last 1.5 years from 2022-2023 June, the demand and assembly graph for these products can be seen in Figure 2.

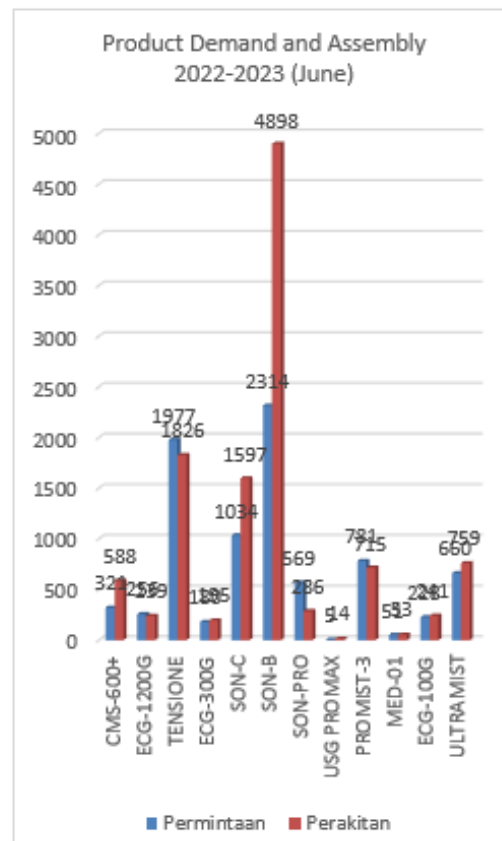


Figure 2. Product Demand and Assembly 2022 - 2023 (June)

It can be seen that the comparison between demand and product assembly has quite a difference. Many more SON-B products were assembled than the total quantity requested, this shows that the purchase of product components exceeds the estimated needs and makes storage costs high. Apart from overstock problems, stockout problems also occur in several products such as ECG-1200G, TENSIONE, SON-PRO, and PROMIST-3. These products have an assembly quantity that is less than demand, this indicates that there is unfulfilled demand which causes losses and a decrease in service level values even though this calculation has not been applied to PT.XYZ. With the existing storage management policy, PT. XYZ will be in an uncertain and ineffective state because all decisions are based on inaccurate data processing and rely solely on intuition. Large orders for product components are made without accurate forecast calculations, so excessive or repeated purchases often occur which will incur inventory costs. This can happen because PT. XYZ does not yet have a good inventory management

system such as safety stock, reorder point, maximum capacity, and several component orders (Tersine, 1994; Taha, 2017). From this existing condition, it is necessary to have inventory management that can minimize the occurrence of overstock, and stockout and minimize storage costs so that the desired service level value is obtained (Bueno et al., 2020).

In this research, forecast calculations will be carried out using the Croston and Syntetos-Boylan Approximation (SBA) methods by the type of demand from the results of product component classification using the Average Demand Interval (ADI) and Coefficient of Variations (CV) methods (Sirisha et al., 2023). Next, calculations are carried out related to inventory policy using the continuous review method (s, S) and (s, Q), the results of which will be compared with the existing inventory policy using Monte Carlo simulation to find out which policy is the most effective and efficient, especially in terms of total cost and service level resulting from.

Methods

This research methodology consists of literature studies, field studies, data collection and data processing, ADI-CV calculations, forecasting calculations, forecasting accuracy calculations, comparison of forecasting results, calculation of total inventory costs, comparison of total inventory costs, Monte Carlo simulation, analysis and interpretation of results, conclusions (Baskhara, 2022).

Classification

Classification can be calculated using the Average Demand Interval (ADI) and Coefficient of Variations (CV) value parameters.

$$ADI = \frac{\sum_{i=1}^N ti}{N} \quad (1)$$

$$CV = \sqrt{\frac{\sum_{i=1}^N (\varepsilon i - \varepsilon)^2}{N}} \quad (2)$$

$$\varepsilon = \frac{\sum_{i=1}^N \varepsilon i}{N} \quad (3)$$

With:

N = number of periods without the value 0

ti = the interval between 2 consecutive non-0 demand periods

Forecasting and Errors

The Croston and Syntetos-Boylan (SBA) approach is very useful in forecasting demand for goods with irregular time intervals, such as demand for rare goods or goods with sporadic demand patterns. The Croston method calculation consists of two main stages:

a. Calculation of Actual Demand Levels

$$\text{If } D_t > 0; \quad Z_t = \alpha * D_t + (1 - \alpha) * Z_{t-1} \quad (4)$$

$$\text{If } D_t = 0 \quad Z_t = Z_{t-1} \quad (5)$$

With:

Z_t = estimated actual demand at the time t

D_t = actual demand at the time t

Z_{t-1} = estimated actual demand at time t-1
 α = smoothing constant that can be selected according to needs (usually between 0.1 to 0.3)

b. Calculation of Time Intervals Between Requests

If $q_t > 0$;

$$q_t = 1 \quad (6)$$

If $q_t = 0$

$$q_t = q_{t-1} + 1 \quad (7)$$

If $P_t > 0$;

$$P_t = \alpha * q_t + (1 - \alpha) * P_{t-1} \quad (8)$$

If $P_t = 0$;

$$P_t = P_{t-1} \quad (9)$$

$$F_t = \frac{Z_t}{P_t} \quad (10)$$

With:

I_t = the time interval between actual requests at time t

t = the time when the actual request occurs

I_{t-1} = the time interval between actual requests at time t-1

α = smoothing constant that can be selected according to needs (usually between 0.1 to 0.3)

Meanwhile, for the SBA, it is as follows:

$$F_t = (1 - \frac{\alpha}{2}) \frac{Z_t}{P_t} \quad (11)$$

Measurement of forecast error

a. Mean Squared Error (MSE)

$$A_t = |E_t| \quad (13)$$

$$MAD_n = \frac{1}{n} \sum_{t=1}^n A_t \quad (14)$$

With:

E_t = data error

n = lots of data

b. Mean Absolute Deviation (MAD)

$$A_t = |E_t| \quad (13)$$

$$MAD_n = \frac{1}{n} \sum_{t=1}^n A_t \quad (14)$$

With:

A_t = absolute error

E_t = data error

n = lots of data

Inventory Management

a. Continuous Review (s,Q)

In this system, the quantity (Q) ordered is a fixed quantity when inventory falls to reorder points or lower. The following are the steps for calculating the system (s, Q):

Step 1

$$Q_0 = \sqrt{\frac{2Kr}{h}} \quad (15)$$

Step 2

$$F(k) = \frac{\pi r - hQ_0}{\pi r} \quad (16)$$

Step 3

$$N(k) = \sigma_L \cdot E(k) \quad (17)$$

$$\sigma_L = \sigma \cdot \sqrt{L} \quad (18)$$

Step 4

$$Q_1 = \sqrt{\frac{2Kr(K + (\pi N(k)))}{h}} \quad (19)$$

Step 5

$$|Q_1 - Q_0| < \varepsilon \quad (20)$$

If $|Q_1 - Q_0| < \varepsilon$ go to step 6, if not, go back to step 2

Step 6

$$s = \mu + k\sigma_L \quad (21)$$

$$\sigma_L = \sigma \cdot \sqrt{L} \quad (22)$$

With:

Q_0	=	order quantity
Q_1	=	order quantity taking into account $N(k)$
r	=	number of requests
$F(k)$	=	demand probability
π	=	backorder costs
K	=	message cost
h	=	holding costs
k	=	safety factor
$N(k)$	=	the size of the inventory shortage
σ_L	=	standard deviation of demand during lead time
$E(k)$	=	partial expectation
ε	=	0,1
s	=	reorder point
σ	=	standard deviation of demand
μ	=	mean demand
L	=	lead time

b. Continuous Review (s,S)

Replenishment is also carried out when inventory falls to the reorder point or lower. However, unlike the (s, Q) system, the replenishment quantity in this system varies and is not fixed to increase the quantity to point S. The following are the calculation steps for the (s, S) system:

Step 1

$$Q_0 = \sqrt{\frac{2Kr}{h}} \quad (23)$$

Step 2

$$F(k) = \frac{\pi r - hQ_0}{\pi r} \quad (24)$$

Step 3

$$SS = k \cdot \sigma_L \quad (25)$$

$$\sigma_L = \sigma \cdot \sqrt{L} \quad (26)$$

Step 4

$$\text{Step 5} \quad s = \mu + SS \quad (27)$$

$$S = Q + s \quad (28)$$

With:

Q = order quantity

SS = safety stock

Monte Carlo Simulation

In this simulation, it is necessary to determine the probability distribution of each variable to be studied. The assumptions used are that demand is normally distributed and lead time is constant. Meanwhile, in PT XYZ conditions, the distribution of demand data and lead time is not constant. So this Monte Carlo simulation will be used as a test of the calculations carried out in the previous subchapter, where the simulation will adjust to fluctuating demand and non-constant procurement lead times ([Ghobbaret and Friend., 2002](#)).

Results

Calculating the percentage of total storage costs to determine the storage costs for product components per unit of time is obtained from the sum of storage costs, insurance costs, capital costs, and loss costs. Next, the percentage results are multiplied by the product component costs to obtain storage costs as in Table 1 and Table 2.

Table 1. Percentage of total storage costs

Total Storage Cost	Percentage
Storage Cost	1,63%
Insurance Cost	1%
Capital Cost	13,73%
Loss Cost	0,39%
% Cost/Product/Year	16,75%

Table 2. Storage costs/product components

Storage costs		
Product	Month	Year
CMS 600 PLUS	Rp789.696	Rp9.476.361
ECG-1200G	Rp177.703	Rp2.132.443
TENSIONE	Rp39.313	Rp471.764
ECG-300G	Rp93.885	Rp1.126.620
SON-C	Rp16.046	Rp192.562
SON-B	Rp5.884	Rp70.610
SON-PRO	Rp93.803	Rp1.125.643
USG PROMAX	Rp1.628.591	Rp19.543.100
PROMIST-3	Rp32.800	Rp393.605
MED-01	Rp270.583	Rp3.246.996
ECG-100G	Rp52.797	Rp633.569
ULTRAMIST	Rp9.445	Rp113.343

Storage costs		
Product	Month	Year
Total	Rp3.210.551	Rp38.526.623

Next, determine the product classification based on historical demand data using ADI-CV to determine the type of demand so that you can determine a suitable method for forecasting calculations at the next stage as in Table 3 and Table 4.

Table 3. ADI-CV analysis classification results

Product	ADI	CV	Classification
CMS-600+	2,00	10,51	Lumpy
ECG-1200G	0,63	2,38	Erratic
TENSIONE	0,16	1,62	Erratic
ECG-300G	0,70	2,09	Erratic
SON-C	0,32	3,40	Erratic
SON-B	0,26	1,67	Erratic
SON-PRO	0,44	4,30	Erratic
USG PROMAX	14,60	14,79	Lumpy
PROMIST-3	0,18	0,71	Erratic
MED-01	1,36	2,18	Lumpy
ECG-100G	0,63	3,38	Erratic
ULTRAMIST	0,39	1,14	Erratic

Table 4. Forecast methods based on component classification categories

Category	Method
Smooth Demand	Exponential Smoothing
Lumpy Demand	Croston and SBA
Erratic Demand	Croston and SBA
Intermittent Demand	Croston and SBA

From Table 3 and Table 4 it can be concluded that all types of product categories are lumpy and erratic demand, which means the forecasting methods used are Croston and SBA as in Table 5 is an example of forecasting calculations for CMS-600 PLUS product components then the final determination of method selection is seen from the error value by comparing MSE and MAD as in Table 6.

Table 5. Calculation of CMS-600 PLUS component forecasting using the Croston and SBA methods

No	Actual Demand	0,3			Croston F_t	SBA F_t
		Z_t	Q_t	P_t		
1	0	1	1	1	1	1
2	0	1	2	1	1	1
3	0	1	3	1	1	1
4	0	1	4	1	1	1
5	0	1	5	1	1	1
6	2	2	1	1	2	2
7	1	2	1	1	2	2

No	Actual Demand	0,3			Croston	SBA
		Z_t	Q_t	P_t	F_t	F_t
8	0	2	2	1	2	2
9	1	2	1	1	2	2
10	0	2	2	1	2	2
....						
78	0	43	2	1	43	37

Table 1. Forecasting Accuracy Test with the Croston and SBA Methods

Product Components	α	Croston		SBA	
		MSE	MAD	MSE	MAD
CMS-600+	0,3	131,3	7,1	125,2	6,5
	0,5	112,4	6,0	103,0	5,2
	0,7	125,7	5,5	96,7	4,7
	0,9	162,1	5,0	94,9	4,4
ECG-1200G	0,3	29,4	3,5	23,9	3,2
	0,5	25,0	2,7	18,9	2,5
	0,7	26,1	2,3	16,7	2,3
	0,9	30,2	1,9	16,5	2,2
TENSIONE	0,3	478,3	12,7	514,5	13,1
	0,5	268,4	8,9	384,3	11,3
	0,7	124,6	5,7	342,7	10,8
	0,9	43,3	2,8	376,5	11,9
ECG-300G	0,3	11,3	2,7	8,5	2,5
	0,5	5,7	1,7	4,5	1,6
	0,7	6,4	1,7	4,4	1,6
	0,9	6,0	1,6	4,6	1,5
SON-C	0,3	267,9	7,5	286,3	7,1
	0,5	144,6	5,3	203,6	5,5
	0,7	61,1	3,7	167,9	5,4
	0,9	15,9	2,1	175,4	6,2
SON-B	0,3	564,4	16,2	625,4	16,4
	0,5	235,2	9,2	410,3	12,3
	0,7	78,1	4,8	388,0	11,9
	0,9	12,7	2,0	499,7	13,8
SON-PRO	0,3	112,1	5,0	119,6	4,5
	0,5	63,9	3,5	87,1	3,5
	0,7	27,6	2,5	68,8	3,2
	0,9	6,1	1,4	66,1	3,5
USG PROMAX	0,3	0,9	0,9	0,6	0,8
	0,5	0,9	0,9	0,5	0,7
	0,7	0,9	0,9	0,4	0,6
	0,9	0,9	0,9	0,3	0,5
PROMIST-3	0,3	31,6	4,4	31,2	4,3
	0,5	15,5	3,0	24,3	3,8
	0,7	9,9	2,3	26,4	4,0
	0,9	6,5	1,4	35,6	4,7
MED-01	0,3	7,7	2,5	5,3	2,0
	0,5	2,7	1,4	1,5	1,0
	0,7	2,7	1,4	1,1	0,9
	0,9	2,7	1,4	0,9	0,8
ECG-100G	0,3	16,7	3,4	14,1	3,0
	0,5	6,9	2,0	7,7	1,8
	0,7	4,6	1,6	6,8	1,6

Product Components	α	Croston		SBA	
		MSE	MAD	MSE	MAD
ULTRAMIST	0,9	3,7	1,3	8,4	1,6
	0,3	43,2	4,3	39,2	4,3
	0,5	30,0	3,3	30,3	3,8
	0,7	23,7	2,5	29,9	3,9
	0,9	22,1	1,9	36,4	4,4

In Table 6, forecasting accuracy tests are carried out using MSE and MAD so that the forecast method is determined using the smallest error value. For CMS-600+, ECG-300G, USG PROMAX, and MED-01 products use the SBA method and the rest use the Croston method. After that, policy parameters were calculated and policy results were compared using Monte Carlo simulation to get the best results based on total costs and service levels as in Table 7 – Table 12.

Table 7. Existing policy parameters

Product Components	Minimal Stock	Q
CMS 600 PLUS	5	250
ECG-1200G	10	100
TENSIONE	100	300
ECG-300G	10	100
SON-C	100	1700
SON-B	200	800
SON-PRO	50	263
USG PROMAX	5	25
PROMIST-3	100	500
MED-01	2	20
ECG-100G	10	50
ULTRAMIST	100	200

Table 8. Recapitulation of continuous review parameter calculations (s, S)

Product Components	Reorder Point (s)	Maximum Stock (S)
CMS 600 PLUS	53	58
ECG-1200G	24	34
TENSIONE	164	240
ECG-300G	16	28
SON-C	110	177
SON-B	196	363
SON-PRO	66	86
USG PROMAX	1	1
PROMIST-3	52	93
MED-01	5	8
ECG-100G	24	42
ULTRAMIST	50	120

Table 9. Recapitulation of continuous review parameter calculations (s, Q)

Product Components	Reorder Point (s)	Order Quantity (Q)
CMS 600 PLUS	72	18
ECG-1200G	32	14
TENSIONE	216	101
ECG-300G	20	14
SON-C	138	87
SON-B	241	199
SON-PRO	88	32
USG PROMAX	1	0
PROMIST-3	65	49
MED-01	6	4
ECG-100G	30	21
ULTRAMIST	58	77

Table 10. Comparison of simulation results of total costs from existing policies and selected policies

Product Components	Total Cost	Service Level
CMS-600+	Rp43.475.891.470	98,24%
ECG-1200G	Rp6.762.673.593	100,00%
TENSIONE	Rp8.729.691.804	91,61%
ECG-300G	Rp3.574.555.507	100,00%
SON-C	Rp4.606.195.321	100,00%
SON-B	Rp2.496.548.692	99,79%
SON-PRO	Rp7.694.065.264	100,00%
USG PROMAX	Rp4.387.270.489	100,00%
PROMIST-3	Rp5.161.649.832	100,00%
MED-01	Rp2.136.235.658	96,12%
ECG-100G	Rp1.806.272.993	97,71%
ULTRAMIST	Rp480.402.838	100,00%
Total & Average	Rp91.311.453.460	98,62%

Table 11. Recapitulation of simulation results for improving continuous review inventory management policies s, S

Product Components	Total Cost	Service Level
CMS-600+	Rp76.442.371.382	100,0%
ECG-1200G	Rp15.783.702.865	100,0%
TENSIONE	Rp18.367.386.032	93,3%
ECG-300G	Rp6.250.047.541	100,0%
SON-C	Rp3.794.408.097	98,9%
SON-B	Rp4.120.918.291	100,0%
SON-PRO	Rp17.845.715.319	100,0%
USG PROMAX	Rp6.970.207.012	96,3%

Product Components	Total Cost	Service Level
PROMIST-3	Rp8.020.941.100	100,0%
MED-01	Rp4.486.237.038	100,0%
ECG-100G	Rp3.559.504.264	98,3%
ULTRAMIST	Rp1.794.704.743	100,0%
Total & Average	Rp167.436.143.684	98,9%

Table 12. Recapitulation of simulation results for improving continuous review inventory management policies s, Q

Product Components	Total Cost	Service Level
CMS-600+	Rp30.003.248.716	100,00%
ECG-1200G	Rp6.570.972.119	100,00%
TENSIONE	Rp8.585.443.014	98,69%
ECG-300G	Rp2.920.477.653	100,00%
SON-C	Rp2.713.576.472	99,86%
SON-B	Rp2.342.591.978	100,00%
SON-PRO	Rp6.389.435.367	100,00%
USG PROMAX	Rp2.107.474.253	93,75%
PROMIST-3	Rp4.019.901.401	100,00%
MED-01	Rp2.103.394.135	100,00%
ECG-100G	Rp1.772.701.467	98,86%
ULTRAMIST	Rp352.022.217	100,00%
Total & Average	Rp69.881.238.792	99,26%

Table 10 - Table 12 are the results of the Monte Carlo simulation for all inventory management policies. The results obtained are that the Continuous Review s, Q policy produces the lowest total cost of Rp. 69,881,238,792 with the highest service level of 99.26%. Meanwhile, other policies have higher total costs and lower service levels. The existing policy is caused by higher holding costs and stockout costs due to storing too many product components in the warehouse, but on the other hand, it cannot meet demand because supplies have run out for a certain time. Meanwhile, the Continuous Review s,S policy is caused by order costs and unit costs that are too high due to the process of ordering quite a lot of products.

Retesting was carried out to determine the policy's resilience to uncertainty by providing a margin of error of $\pm 20\%$. The policy chosen is Continuous Review s, Q with a comparison of the results of existing conditions and improvement policies in Table 13 and Table 14.

Table 13. Comparison of total cost simulation results from existing policies and selected policies

Product Components	Total Cost	
	Existing	Selected Policy
CMS-600+	Rp43.475.891.470	Rp29.529.900.845
ECG-1200G	Rp6.762.673.593	Rp6.514.974.376
TENSIONE	Rp8.729.691.804	Rp8.558.955.756
ECG-300G	Rp3.574.555.507	Rp2.905.224.944
SON-C	Rp4.606.195.321	Rp2.596.296.308
SON-B	Rp2.496.548.692	Rp2.342.591.978
SON-PRO	Rp7.694.065.264	Rp6.320.857.690
USG PROMAX	Rp4.387.270.489	Rp2.173.293.824
PROMIST-3	Rp5.161.649.832	Rp3.969.857.015
MED-01	Rp2.136.235.658	Rp2.081.414.468
ECG-100G	Rp1.806.272.993	Rp1.764.344.549
ULTRAMIST	Rp480.402.838	Rp347.418.727
Total & Average	Rp91.311.453.460	Rp69.105.130.480

Table 14. Comparison of service level simulation results from existing policies and selected policies

Product Components	Service Level		s	Q
	Existing	Selected Policy		
CMS-600+	98,24%	100,0%	56	18
ECG-1200G	100,0%	100,0%	24	14
TENSIONE	91,61%	99,98%	260	122
ECG-300G	100,0%	100,0%	16	14
SON-C	100,0%	99,73%	110	87
SON-B	99,79%	100,0%	241	199
SON-PRO	100,0%	100,0%	70	32
USG PROMAX	100,0%	100,0%	2	1
PROMIST-3	100,0%	100,0%	52	59
MED-01	96,12%	100,0%	4	4
ECG-100G	97,71%	100,0%	36	21
ULTRAMIST	100,0%	100,0%	46	77
Total & Average	98,62%	99,98%		

Table 13 and Table 14 show the positive results of policy improvements from implementing selected policies Continuous Review s, Q. The selected policy can increase the service level value by 1.36% and reduce total costs by IDR 22,206,322,981 compared to the existing policy.

Conclusion

The data collection experiment was carried out using 4 α values (0.3, 0.5, 0.7, and 0.9) which shows that the greater the α value, the smaller the error produced. The error calculation uses the MSE and MAD methods so that 4 product components (CMS-600 PLUS, ECG-300G, USG-PROMAX and MED-01) are obtained using the SBA method and 8 product components (ECG-1200G, TENSIONE, SON-C, SON- B, SON-

PRO, PROMIST-3, ECG-100G, and ULTRAMIST) using the Croston method.

All product component policies use the continuous review method (s, Q) with details CMS-600 PLUS s 56 and Q 18, ECG-1200G s 24 and Q 14, TENSIONE s 260 and Q 122, ECG-300G s 16 and Q 14, SON-C s 110 and Q 87, SON-B s 241 and Q 199, SON-PRO s 72 and Q 30, USG-PROMAX s 2 and Q 1, PROMIST-3 s 52 and Q 59, MED-01 s 4 and Q 4, ECG-100G s 36 and Q 21, and ULTRAMIST s 46 and Q 77.

In the selected policy recommendations, based on simulations using the s, Q continuous review policy, it was found that service level achievement for all components was above 95% with an average service level of 99.98%. The average service level achieved for the selected policy is 1.36% higher than the existing policy and saves costs of IDR 22,206,322,981.

Suggestion

The suggestions that can be given for further research in the future are:

1. Use a periodic review policy to see whether the results obtained are more optimal when compared to continuous reviews.
2. Enter capacity calculations or lot sizes for ordering and shipping product components for inventory management policies.

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