REAGENT SAFETY STOCK ANALYSIS (A Case Study of Pharmaceutical Company in Bandung, Indonesia)

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Abstract

Inventory management is a system in which inventory management is carried out, things that include how inventory items are classified and how accurate inventory record keeping data can be maintained. Reagents in pharmaceutical companies, especially in the laboratory, can be said to be the main process of standardization of medicine. To optimize the standardization process in the laboratory, there needs to be a guarantee of the availability of reagents that can meet every standardization process requirement in the laboratory. PT XYZ is one of the leading pharmaceutical companies in Indonesia. Currently, this company is still trying to optimize the management of reagent raw materials, so that the problem of unavailability of materials can be avoided. This study aims to classify each reagent used by the

laboratory of PT. XYZ uses the ABC classification. This classification aims to find out the types of reagents that are the top priority of inventory managers. The next step is to carry out optimization of inventory policy on reagent materials that enter class A, namely by determining the value of safety stock and reorder points for each type of reagent. From the classification stage, it is produced that class A consists of 6 types of reagents, namely 11.3% of the 53 types of reagents managed by the company. Class B and Class C are 20 and 27 types of reagents, respectively. Obtained the amount of safety stock for each type of reagent in class A, which is 9 bottles for Acetonitrile,11 bottles for Methanol HPLC, 1 bottle for Alcohol Anhydrous. As for combititrant, HCL 37% and methanol dried, no safety stock is needed because demand is deterministic. With the safety stock value, the company can set a reorder point (ROP) for each type of reagent.

Keywords: ABC Classification, Inventory Management, Reagent, ROP, Safety Stock,

Introduction

In the pharmaceutical industry, the criteria for efficacy, safety, and quality in the manufacture of medicine must be met so that the medicine produced is safe in the hands of consumers. Checking the standardization in the manufacture of medicine is important to ensure that the medicine made is a high-quality medicine. PT XYZ is one of the companies engaged in pharmaceuticals in the Bandung region. PT XYZ has a wide range of medicinal products with various types of medicinal preparations. The standardization process in pharmaceutical companies is carried out to provide standards and inspections at the production stage and what if there are problems with quality. Standardization in the pharmaceutical industry aims to provide certainty that the product consistently has a quality that is following the purpose of its use, producing medicine that meets the requirements of efficacy and safety in the dose used for treatment. In the process of standardizing the manufactured medicine, various reagents are used to support the process of standardization of medicine.

A reagent is a substance that is added to a mixture to elicit a chemical reaction from the mixture. The reagent is required in the standardization process as a material for testing and analysis of chemicals in medicine, the use of these reagents becomes a major key in the implementation of the standardization process carried out in PT. XYZ laboratory. To support the smooth running of the standardization process and other production processes in every line of PT XYZ, there needs to be supply management of raw materials carried out by the company. The reagent contained in the standardization process of PT XYZ consists of 53 types of liquid reagents used, to be managed properly inventory policy should be classified on the reagent to find out which reagents are the top priority, so that on priority reagents special supervision is needed to control their inventory to ensure the availability of such reagents.

In the management of reagent inventory at PT XYZ, there are two main questions, namely how much is needed and when the goods should be ordered. It is important to know so that reagents can be available at the right amount and time. In determining the number of orders several uncertainties arise, namely demand uncertainty and lead time uncertainty. With this uncertainty, the process of determining the amount of reagent inventory cannot be done easily. Two possibilities can occur with the uncertainty of demand and lead time, namely stock out and overstock. Inventory policy that can be applied to optimize the control of reagent inventory in the laboratory department of PT XYZ. Several combinations of methods used as suggestions and proposals include: analysis of ABC classification, safety stock, and reorder point, or commonly known as 3 inventory control tools [1]

From the results of observations and identification conducted in the laboratory of PT XYZ, it was found that often the needs of reagents used in the standardization process were insufficient. This is due to the uncertain needs of reagents and also the purchase of reagent inventory that is done only looking at the needs of the previous period and does not include safety stock into the purchase calculation so that when the reagent runs out, no safety stock can be used. Because ideally the safety stock on reagents with a high level of use can be provided as best as possible. The method was chosen because based on the results of observations, the determination of the minimum value of a stock to reorder is based only on intuition and experience. Therefore, this study aims to analyze classifying reagents and inventory management for the most important types of reagents or class A based on scientific inventory control methods that have never been applied before to the laboratory department of PT XYZ.

Literature Review

According to the presentation [2] inventory is a technique related to the determination of the amount of goods that must be held to ensure smoothness in production operations, as well as establishing procurement schedules and the number of ordering goods that should be done by the company. There is a close relationship between the inventory system and operational activities in the implementation of the inventory system, there are three basic components of the inventory system that interact with each other, namely managers, suppliers, and users. This interaction will be reflected among others in the system of procurement mechanisms and procedures and fulfillment of goods called the inventor cycle. Generally, the inventory cycle is attached to 4 activities, namely needs planning, procurement programs, storage of goods, and the use of goods. [3, 4]

Based on [5] inventory has several functions as follows:

1. To provide a choice of goods in order to meet customer demand
2. To separate several stages from the production process.
3. To take advantage of the amount cut.
4. To avoid inflation and price increases.

Inventory control is the determination of an ordering policy in the sense of when the material needs to be ordered and how much is ordered optimally to be able to meet demand, or in other words, inventory control is an effort or activity to determine the optimal level with minimum inventory costs [6, 7] Decisions regarding how many and when to place an order, are a complex issue in inventory issues, especially when inventory needs consist of several types of items, with varied suppliers, non-uniform delivery times, different numbers of orders and a limited budget. Inventory control is a set of control policies to determine the level of inventory to be maintained, when orders to increase inventory should be made and how many orders should be held, the number or level of inventory needed varies for each factory company, depending on the volume of production, type of company and its process [8]

In inventory control, many methods can be used in analyzing inventory within a company. The use of one method based on inventory value analysis is the analysis of THE ABC classification. The ABC classification is widely used in the control of material and component inventories in factories, spare parts supplies, final product inventory in finished goods warehouses and others [9, 10]

Class A represents 70-80% of the total procurement value of goods and represents about 20% of the total inventory of goods, Class B represents 15-25% of the total procurement value of goods and represents about 30% of the total inventory of goods, and Class C represents 5-10% of the total procurement value of goods and represents about 50% of the total inventory of goods [5, 11]

Safety stock or also called safety supplies are supplies used in anticipation of the occurrence of stock out (shortage of supplies) or delays in coming on goods ordered

[12] Safety stock is the level of extra stock maintained to reduce the risk of stock outpability caused by supply and demand uncertainty [13]Adequate safety stock will allow business operations to run according to plan. Safety stock is held when there is uncertainty of demand, supply, or manufacturing results and serves as a guarantor of the risk of running out of stock [14, 15]

In a general sense reorder point is a certain position, point, level, or value of inventory owned by the company, at which point the relevant department in the company must immediately submit the purchase of goods to the department[9]In [13] reorder point is the level of inventory that triggers action to fill a certain inventory stock, or the minimum amount of goods the company stores before reordering. In short, reorder point is the point where you have to make a buy back to meet your needs. In reordering will certainly cause a time lag or lead time between the ordering process and receipt of goods. If there is no lead time, then the reoder point becomes zero, then at the same time the supply will become full again. In its realization, lead time with a value of zero never existed and occurred, it can be concluded that there will always be a time difference from the date of order of the goods and the date of receipt of the goods.[16]

According to[14] [17] in the management of inventory that is probabilistic, the safety stock model and reorder point that pay attention to uncertainty in lead time and demand are as follows:

1. Conditions with demand uncertainty, where lead time remains while demand varies.

$$SS = z_\alpha \sigma_d \sqrt{L} \quad (1)$$

$$ROP = \bar{d}L + SS \quad (2)$$

2. Conditions with lead time uncertainty, where demand remains while lead time varies.

$$SS = z_\alpha d \sigma_L \quad (3)$$

$$ROP = d\bar{L} + SS \quad (4)$$

3. Conditions with uncertainty of demand and lead time, where demand and lead time vary.

$$SS = z_\alpha \sqrt{\bar{L}\sigma_d^2 + \bar{d}^2\sigma_L^2} \quad (5)$$

$$ROP = \bar{d}\bar{L} + SS \quad (6)$$

4. Conditions with fixed demand and lead time, where the standard value of demand deviation and lead time is equal to zero. So that the safety stock is equal to zero, or it can be said that there is no need for a safety stock.

$$ROP = dL \quad (7)$$

The variables used in the calculation of safety stock and reorder points are as follows:

SS = safety stock
ROP = reorder point
σ_d = standard deviation of demand
σ_L = standard lead time deviation
z_α = the inverse value of the normal distribution at the α
α = service level, level of significance
$\bar{d}$ = average demand
$\bar{L}$ = average lead time

Methods

This research was conducted at PT. XYZ is engaged in pharmacy. The research approach used is quantitative research, where the research is obtained by statistical procedures. The research technique used is a type of descriptive research, where the study describes the data set obtained. The data source obtained is primary data, where the data is obtained directly from PT. XYZ through the relevant staff. The data obtained is data on the number of orders and arrival of liquid reagents and data on the use of liquid reagents. The data collection technique is done by direct interviews of staff related to data and observations about the average data on reagent usage every day. The data obtained is then processed data with the ABC classification method.

The stages for obtaining the ABC classification by[18, 19] are as follows:

1. Make a list of all reagents that will be classified along with the price of each reagent
2. Calculate the value of its usage within a certain period of time by multiplying the number of reagent usage by the purchase price of each reagent.
3. Determines the total number of reagents to find out the total usage value
4. Calculates the percentage of usage of each item from the share of each item with the total usage value of all reagents
5. Sort all the uses of each reagent from the largest procurement value to the smallest
6. Classify reagents based on grades A, B, C according to procurement of goods.

Then the calculation of safety stock and reorder points in class A to help avoid problems in the availability of reagents in PT. XYZ. The stages in calculating safety stock[19] and reorder pont according to (Hudori, 2018) are as follows:

1. Calculates the standard deviation in the lead time and demand of each reagent that falls into class A.
2. Calculating safety stock and reorder point with service level of 99%, with a significance level of α = 0.01 then the value$z_{\propto} = 2{,}576$ uses a formula that corresponds to lead time and demand conditions, namely as follows:

a. Conditions with uncertainty of demand and lead time, where demand and lead time vary.

b. Conditions with uncertainty lead time, where demand remains while lead time varies.

Results and Discussions

Every month PT. XYZ uses reagents that are used for the standardization process. The use of reagents every month is not fulfilled properly so that every mid-month the stock of reagents is insufficient. After the analysis it turns out that the cause is when determining the number of order requests and the time of ordering so as to inhibit the standardization process because the gene rea isinsufficient, then PT. XYZ must have sufficient reagent supply so that demand can be met. The use of reagents in PT. XYZ period January 2019 – June 2021 is indicated in table 1:

Table 1

Reagent Usage Data

No	Cube	item	Total	NO	Code	Item	Total
1	BT	I BUT ANOL	3	28	HCL37	HCL37%	59
2	DXN	1.4 DIOXANE	1	29	HP30	HYDROGEN PEROXIDE 30%	1
3	MET	2-METHOXY ETHEANOL	1	30	IPAT	IPA TEKNIS	1
4	PRO	2-PROPANOL	40	31	LISE	L-ISOLEUCINE	1
5	ACA	ACETIC ACID	32	32	MET	METHANOL	48
6	ACAG	ACETIC ACID GLACIAL	8	33	MANHY	METHANOL ANHYDROUS	60
7	ACE	ACETIC ONE	7	34	MDRED	METHANOL REIED	30
8	AC	ACET ONIT	576	35	MHPLC	METHANOL HPLC	924
9	AANHY	ALKHOL ANHYDROUS	114	36	NA65	NITRIC ACID 65%	1
10	AMAS5	AMMONIA SOLUTION 25%	6	37	NNDF	N,N DIMETHLYFORM AMIDE	8
11	AM25	AMMONIA 25%		38			
12	AMS25	AMMONIA SOLUTION 25%		39	NHXHPLC	N-HEPTANE HPLC	
13	BA	BENZYL ALKOHOL	3	40	NHXHPLC	N-HEPTANE HPLC	1
14	BPH10	BUFFER PH 10.0	1	41	OPA85	ORTHO PHOSPHHRIC ACID 85%	4
15	BPH9	BUFFER PH 9.0	3	42	OPA	ORTHO PHOSPHHRIC ACID	2
16	BPH7	BUFFER PH 7.0	2	43	PND	PYRIDINE	3
17	BPH4	BUFFER PH 4.0	3	44	PCLA	PERCHLORIC ACID	1
18	CL	CHLOROFORM	7	45	SA	PERCHLORIC ACID	2
19	CL	COMBITITRANT	28	46	TNBS	SUKFURIC ACID	2
20	CON84	CONDUCTIVITY 84 Ms/cm	1	47	TNBHS	TETRA N BUTULAMMONIUM HYDROXIDE	1
21	CSTD	CONDUCTIVITY STANDAR	1	48	THF	TETRAHYDROFURAN	2
22	DCM	DICHLORMETHANE	5	49	THFHPLC	TETRHYDROFURAN HPLC	4
23	DE	DIETHYL ETHER	3	50	TN	TOLUENE	2
24	DLFS	DIETHYLAMINE FOR SYNTHESIS	O	51	TRS	TRISTHYL AMINE FOR SYNTHESIS	12
25	DMS	DIMETHYLSULFOXIDE	1	52	TRFA	TRIFL UOROACETIC ACID	0
26	EHPLC	ETHYL HPLC	17	53		WATER FOR TOC	4
27	EA	ETHYL ACETATE	6	54			

Based on table 1, information on the use of reagents in the laboratory of PT. XYZ. Item reagent consists of 53 items for 3 consecutive years. The reagent with the most use is Methanol HPLC (MHPLC). It can be seen that the number of uses varies from each existing reagent, it is necessary to analyze the ABC classification so that the reagent can be classified based on the value of procurement costs. By knowing those classes, you can be known which items of inventory should get more intensive or serious attention than other items. The results of the ABC classification of 53 existing reagents can be seen in table 2.

Table 2

ABC Classification

No	ITEM	Value Rupiah	Value percentage	Accumulative value percentage	class
1	A CETONIRIL	Rp 255. 196.000	29,62	29,62	A
2	METHA NOL HPLC	Rp 188.420.000	21,87	51.49	A
3	ALKOHOL ANHYDROUS	Rp 81.121.344	9.42	60,91	A
4	COMPITITRANT	Rp 35.257.080	4,09	65,00	A
5	HC 137%	Rp 29.726.400	3,45	68,45	A
6	METHANOLDRIED	Rp 27. 027.720	3,34	71,59	A
7	ETHANOL HPLC	Rp 21.596. 000	2,51	74,10	**B**
8	N,N DIMET HYLFORMA MIDE	Rp21.198.000	2,46	76,65	**B**
9	METHA NOL ANHYDROUS	Rp 18.668.160	2,17	78,73	**B**
10	2- PROPANOL	Rp 13.960.050	1,62	80,35	**B**
11	TETRHYDROFURAN FOR HPLC	Rp 23.378.520	2, 71	83,06	**B**
12	A CETIC ACID	Rp 12.940.440	1,50	84,56	**B**
13	METHANOL	Rp 11.370.240	1,36	85,92	**B**
14	TETRA HYDROFURAN	Rp 9.76.000	1,13	87,06	**B**
15	BENXYL ALKOHOL	Rp 7.814.000	0,91	87,96	**B**
16	PYRIDINE	Rp 7.465.000	0,87	88,83	**B**
17	CHLOROFORM	Rp 6.797.250	0,79	89,62	**B**
18	ORTHO PHOSPHORIC ACID 85%	Rp 6.008.240	0,70	90,32	**B**
19	I BUTA NOL	Rp 5.485.250	0,64	90,95	**B**
20	PERCHLORIC ACID	Rp 5.224.050	0,61	91,56	**B**
21	TRIET HYLA MINE FOR SYNITHESIS	Rp 5.102.200	0,59	92,15	**B**
22	ETHYL ACETATE	Rp 4.381.720.	0,51	92,66	**B**
23	TERA NUTYLAMMONIUM HYDRROXIDE	Rp 4.179. 450	0,49	93,15	**B**
24	AMMINIUM SOLUTION 25%	Rp 3.923.800	0, 46	93,60	**B**
25	WATER FOR TOC	Rp 4.811.000	0,59	93,15	**B**
26	TETRA-N- BUTYLAMMONIUM SOLUTION	Rp 3.743.000	0,43	93,60	C
27	DICHLORMETHANE	Rp 3,663.900	0,43	94,16	C
28	DIETHYL ETHER	Rp 3.573.600	0,41	95,44	C
29	N-HEPTANE HPLC	Rp 3.440.000	0,40	95,83	C
30	A CETIC ACID GLA CIAL	Rp 3.328.000	0,39	96,22	C
31	BUFFER Ph 9.0	Rp 3,249.000	0,38	96,60	C
32	N-HEXA NE HPLC	Rp 3.063.522	0,36	96,95	C
33	ORTHO PHOSPHORIC ACID	Rp 2.994.000	0,35	97,30	C
34	ACETONE	Rp 2.892.000	0,34	97,64	C
35	DIMETHYLSUFPXIDE	Rp 2.737.840	0,32	97,95	C
36	N-HEPTANE	Rp 2.051.200	0,24	97,30	C
37	AMMINIA SOLUTION 25%	Rp 2.010.000	0,23	97,64	C
38	L-ISOLEUCINE	Rp 1.605.000	0,20	97,95	C
39	1.4 DIOXANE	Rp 1.400.000	0,19	9819	C
40	2-METHOXY ETHANOL	Rp 1.383.800	0,16	98,45	C
41	AMMONIA 25%	Rp 1605.000	0,16	98,19	C
42	SULFURIC ACID	Rp 1.063.400	0,12	99,26	C
43	HYDROGEN PEROXIDE 30%	Rp 1.007.000	0,12	99,37	C
44	TOLUENE	Rp 909.600	0,11	99,48	C

After the ABC classification, the results of reagents entered into class A as many as 6 reagents, class B as many as 20 reagents, and class C as many as 27 reagents. Further calculations will only be done on reagents that belong to Class A only. Data lead time booking reagent Class A at PT. XYZ for the period January 2019 to June 2021 is displayed in table 3.

Table 3

Reagent Booking Lead Time Data January 2019-June 2021

Ordering number	Ordering lead time					
	Acetonitrile	Methanol HPLC	Alcohol Anhydrous	Combititrant	Hcl 37%	Methanol Dried
1	9	15	8	21	16	37
2	13	11	5	15	32	95
3	11	12	8	26	40	99
4	12	13	14	10	41	99
5	13	15	15	15	24	69
6	13	8	9	22	22	65
7	10	10	14	14	25	
8	10	10	14	18	22	
9	11	14	8	11		
10	9	9	12			
Average	11.10	11.70	10.70	16.89	27.75	85.40
S.D	1.70	2.45	3,50	5.30	9.02	16.94

Data on daily needs of class A reagents at PT. XYZ period for March-June 2021 isdisplayed in table 4.

Table 4

Daily Reagent Needs Data for The Period March-June 2021 (Bottles)

No	Acetonitrile				Methanol				Alcohol anhydrous				comb titrant				HCL 37%				Methanol Dried			
	Mar	Apr	May	Jun	Mar	Apr	May	Jun	Mar	Apr	May	Jun	Mar	Apr	May	Jun	Mar	Apr	May	Jun	Mar	Apr	May	Jun
1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
2	2	0	0	4	2	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3	2	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	2	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	2	1	1	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
7	2	0	0	1	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	2	0	2	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	1	0	0	3	1	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	2	3	0	0	3	3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	2	2	0	0	2	2	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
14	1	2	0	1	3	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	1	2	0	1	2	2	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
16	2	2	0	2	4	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	1	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
20	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	2	0	0	0	3	1	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	2	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

23	2	2	3	0	2	0	0	2	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
24	2	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	2	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	1	2	0	0	0	4	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	3	0	0	2	3	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
29	0	1	0	2	0	0	0	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
30	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table. 4 Daily Reagent Needs Data for The Period March-June 2021 (Bottles)

The level of service established at PT. XYZ is 99%. With the level of significance of α = 0.01 and the value $z_{\propto} = 2{,}576$. Based on demand data and lead time in tables 3 and 4, then to set the safety stock and reorder point is classified into 3 conditions, namely:

a. Reagent acetonitrile and methanol HPLC have varies demand and also varies lead time with lead time details:

a) Acetonitrile: average= 11.10; std. deviation 1.60.
b) Methanol HPLC: average = 11.70; Std. Deviation = 2.45.

b. Anhydrous alcohol reagents have a fixed demand with a total of 4 bottles / month, but lead time varies because in lead time data this reagent has an average of 10.70 and a standard deviation of 3.50.

c. Reagent combititrant, HCl 37%, and methanol dried do not require safety stock because the demand is deterministic i.e., monthly demand can be known with certainty. For reorder points can be set considering the lead time value. Because the company sets the service level of 99% suggested the lead time value used is the maximum value. Lead time for reagent combititrant is 26 days, HCl 37% is 41 days, and methanol dried is 99 days.

Next is the stage of calculation of safety stock and reorder points for reagent acetonitrile, methanol HPLC, and alcohol anhydrous.

1. Acetonitrile with varies demand, varies Lead time

a. Safety stock calculated using formula (5)

$$SS = 2{,}576\sqrt{(11{,}10)(1{,}0)^2 + (0{,}75)^2(1{,}60)^2}$$
$$SS = 9{,}1221 = 9\ bottles$$

b. Reorder point calculated using formula (6)

$$ROP = (0{,}75)(11{,}10) + 9$$
$$ROP = 17{,}3250 = 17\ bottles$$

2. Methanol HPLC with varies demand, varies Lead time

a. Safety stock calculated using formula (5)

$$SS = 2{,}576\sqrt{(11{,}70)(1{,}16)^2 + (0{,}75)^2(2{,}45)^2}$$
$$SS = 11{,}2639 = 11\ bottles$$

b. Reorder point calculated using formula (6)

$$ROP = (0{,}75)(11{,}170) + 11$$
$$ROP = 19{,}7750 = 19\ bottles$$

3. Alcohol anhydrous with fixed demand, varies lead time

a. Safety stock is calculated using formula (3)

$$SS = (2{,}576)(0{,}14)(3{,}50)$$
$$SS = 1{,}2350 = 1\ bottles$$

b. Reorder point calculated using formula (4)

$$ROP = (0{,}14)(10{,}70) + 1$$
$$ROP = 2{,}498 = 2\ bottles$$

Conclusion

Analysis of ABC classification on this type of reagent can be used by PT XYZ to find out which reagents are the top priority. The reagent with classification A is carried out inventory policy optimization to ensure the availability of reagents, namely by determining the safety stock and reorder point. From the classification stage, it is produced that Class A consists of 6 types of reagents, namely 11.3% of the 53 types of reagents managed by the company. Class B and Class C are 20 and 27 reagents, respectively.

Obtained the amount of safety stock for each type of reagent in class A, namely 9 bottles for Acetonitrile, 11 bottles for Methanol HPLC, 1 bottle for Alcohol Anhydrous. And can be reordered point reagent when remaining 17 bottles of Acetonitrile, 19

bottles of Methanol HPLC, and 2 bottles of Alcohol Anhydrous. As for combititrant, HCL 37%, and methanol dried, no safety stock is needed because demand is deterministic. So that the company can assign a reorder point based on a maximum lead time value of 26 days for combititrant reagent, 44 days for HCL 37%, and 99 days for methanol dried reagent. This is based on the level of service set by the company at 99%.

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