Potato Inventory Cost Optimization Based On Shelf Life
(Case Study At CV. Bimandiri Lembang As A Supplier Of Retail Stores)

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Abstract

A potato is one of the vegetables which are perishable commodity that could not be stored for a long time without the support of adequate facilities. In the supply management of potatoes, more frequent orders mean make the cost of inventory greater. In contrast, rarely order makes lower ordering cost, but require the product shelf life longer. Economic Order Quantity (EOQ) is the method of calculating the number of orders that resulted in the optimal total cost. Inventory planning through EOQ method requires a trade-off between quantity and frequency of ordering and shelf life of potatoes. This study aims to determine the number and frequency of ordering based on the shelf life of potatoes in order to obtain the lowest total cost of inventory. This study begins with an attempt to reassure the shelf life of potatoes after harvest. Experimental method used to determine the shelf life of potatoes, where the parameters measured were weight loss, hardness, moisture content, and appearance of the skin. Observations were made every three days with three different lighting treatment that is storage the material: (1) exposed to direct sunlight, (2) are not directly exposed to sunlight, and (2) in a dark room. The number of the shelf life of potatoes are used as the deadline of the shelf life of potatoes in stock, the maximum number of orders and reorder point. Furthermore we performed the analysis using the framework of the implementation of the basic model of EOQ. The results showed that based on the data last three years the company should be able to make savings of Rp. 986,928.00 if the planned supply through the use EOQ *model with the order value in every month an average of 1.72 times of the actual order, so order frequency becomes less that of an average of 12 times to 5 times a month. In order to plan next year through the decomposition method and using the data of four years earlier, then the value of forecast supply requirement of 402 071 kg a year. This value is then decomposed into each month with an average of 33,506 Kg. Using the value of inventory cost components are the same then the average value obtained* EOQ *is 6,087 Kg and order frequency is 5 times a month*

Keywords: *Agro-based commodity inventory, EOQ on agrobased perishable product, order quantity, frequency of order*

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1. INTRODUCTION

There are many companies suppliers or distributors of fresh vegetable commodities to large retailers. Its activity is to gather the harvest of vegetables to farmers, handle it according to standards of quality, then packaged. Under certain conditions before it is packaged vegetables should be stored prior to delivery schedule to retailers. Storage activities as inventory is generally a venture capital that needs to be managed properly so that the costs can be minimized.

Inventories can be regarded as a waste of a company that should be reduced or even eliminated. On the other hand inventory can be considered as an asset of the company, because it can support the business process. Therefore, supply of materials must be managed properly so that the costs for supplies to be optimal (Herjanto, 2008).

Potatoes as a vegetable widely consumed commodities have a supply management constraints. The constraint is their incompatibility several conditions include the demand for nearly every day, the short life of the material, but the material supply of the farmers are seasonal so procured within a longer interval. When the harvest season, the results are abundant.

At the harvest seasons, the company easily get potatoes in large quantities, but if it is not immediately distributed the potatoes to rot because of the short life of the material. So there needs to be a match between the number of requests from the retailers to the amount of supply from farmers and supply ordering time, and is associated with the shelf life of potatoes. Therefore, we need proper inventory planning so that the company is able to meet the demand from the retailers.

Inventory planning method that is often used in manufacturing include: Lot for Lot (LFL), Periodical Order Quantity (POQ) and Economic Order Quantity (EOQ). The most logical method used in inventory planning potato is the EOQ method. The principle of the method EOQ is looking for quantity and point back to create a balance between the cost of the order and storage costs, so that the resulting total optimal inventory costs. Application of the method is possible because potatoes demand occurs every day, while the supply from the farmer cannot certainly always available. Whereas if you do the inventory of commodities in large quantities, it is constrained by the relatively short life of the material because of its perishable nature. These conditions resulted in this method cannot be applied just like that. Therefore, we need an inventory planning models based on the shelf life of the product. There are a number of assumptions in the application of the EOQ model. Such assumptions are as follows (Reid & Sanders, 2005): (1) Demand is known and constant, (2) Lead time is known & constant, (3) No quantity discounts are available, (4) Ordering (or setup) costs are constant, (5) All demand is satisfied (no shortages), (6) The order quantity arrives in a single shipment

This study aims to obtain supplies of vegetables planning model by applying the EOQ model that consider the shelf life of the stored materials. Management of vegetables such as potato trade commodities in CV Bimandiri used as a case study.

CV. Bimandiri is one of the company that supplies of vegetables and fruits are located in West Bandung. Current the company supply nearly 127 types of vegetables each day to some of the retail market in Bandung, Jakarta and Cirebon. Sources of vegetable raw materials derived from Lembang, Subang, Garut, Bandung, and Pangalengan. Raw materials obtained by means of cooperation with farmers and vegetable supplier. In order to provide the best service to consumers, the company continues to maintain the availability of vegetables of quality, in order to compete with similar companies.

The company classify potatoes as a commodity "Redlist", meaning the vegetable group are a top priority in the procurement of commodities. Potato is one of vegetables which have a relatively long shelf life when compared to other vegetables, such as leafy vegetables group, peppers, and cabbage. Therefore, the potato allows implemented an inventory planning using EOQ model in order to obtain a low total cost of materials and supplies to meet consumer demand.

2. METODOLOGY

This study begins with an attempt to reassure the shelf life of potatoes after harvest. Experimental method used to determine the shelf life of potatoes, where the parameters measured were weight loss, hardness, moisture content, and appearance of the skin. Observations were made every three days with three different lighting treatment that is storage the material: (1) exposed to direct sunlight, (2) are not directly exposed to sunlight, and (3) in a dark room. The number of the shelf life of potatoes are used as the deadline of the shelf life of potatoes in stock, the maximum number of orders and reorder point. Afterwards, is the analysis with basic EOQ model application framework.

Framework for analysis using the following steps:

1. Analyze the data from all retail commodity demand in a given period to process sales data last four years. For a forward requests using the method of forecasting.
2. Analyzing inventory costs by identifying all the components in the potato supply management primarily related to costs. Then, categorize inventory costs according to two groups: (1) The first group is a group of large value when the volume of material ordered greater, and (2) the second group is a group of smaller value when the volume of material to be ordered greater
3. A number of the equation used to calculate the cost of the group in the inventory are as follows:
   a. Ordering Cost:

      Co = fo*Op .....1)

   b. Holding Cost:

      Ch = Ri*Hp .....2)

   c. Total Inventory Cost:

      TC = Co+Ch = (fo*Op)+(Ri*Hp)

   where:

   TC = Total cost of inventory (Rp.)
   Co = Ordering cost (Rp.)
   Ch = Holding cost (Rp.)
   Fo = Order frequency
   Op = Cost per order (Rp./order)
   Ri = Average of inventory (Kg/month)
   Hp = Cost of storage (Rp./Kg-month)

4. Applying the basic EOQ models to determine the number and frequency of order. This calculation uses the actual demand data, the data in the form of demand forecasts, and data on the average cost of each component. The basic model EOQ in the form of the equation is (Reid & Sanders, 2005) :

$$EOQ = \sqrt{\frac{2\,DS}{H}} \quad \text{..... 3)}$$

   While the total cost of inventory using the equation:

$$TC = \left(\frac{D}{Q}S\right) + \left(\frac{Q}{2}H\right) \quad \text{..... 4)}$$

   where:

   EOQ = Economic Order Quantity (Kg)
   D = Demand per period (in case month)
   S = Setup cost (ordering cost) (Rp./order)
   H = Holding cost (Rp./Kg-month)
   Q = Quantity to be ordered (Kg)

5. Simulate manually using spreadsheets for inventory planning next year by calculating the value of EOQ and order frequency to obtain the minimum total inventory cost figures based on the data demand forecast. In order to supplement the results of the analysis carried EOQ calculation with attention to safety stock.

3. RESULT AND DISCUSSION

3.1. Analysis of Shelf Life Potatoes

3.1.1. Weight Loss

Observations shelf life of potatoes was conducted to determine how long the potatoes are still able to meet quality standards. According to Woodell et al (2009), the rate of decline in the quality of potatoes is influenced by temperature, light, and moisture. The factors that most influence the weight loss is the temperature, where the storage at a temperature above the ideal storage

temperature may accelerate the decline in the quality of potatoes including weight shrinkage. Figure 1 displays a graph of the three weight loss treatment differences in light intensity.

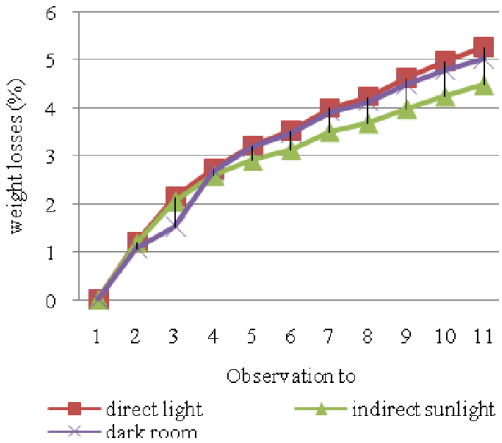

Figure 1. Percentage of weight losses in each treatment

Figure above shows that the best storage methods are safe with indirect light. Potato is very sensitive to exposure to direct sunlight, the condition can lead to the ambient temperature is relatively high storage space and a speckling of greenery on the potato that contains toxic so it is not suitable for consumption (*Asgar* and *Ashandi,* 1994).

Hardness of potatoes is one measure of the feasibility of sale to the consumer. Hardness is the amount of pressure needed to penetrate the surface of potatoes per unit area (Nasution et. al., 2012). Data potato hardness measurement results can be seen in Table 1.

Table 1. Hardness of potatoes in each treatment

Observation to	Hardness (Kg/cm^2) on treatment:		
	Direct light	Indirect light	Dark room
1	22	21	22
2	21	22	20
3	21	21	20
4	20	20	20
5	19	19	19
6	19	20	19
7	19	20	18
8	19	19	19
9	19	20	18
10	18	20	18
11	18	19	17

Source: processed data

Table one shows that there is a decrease of hardness potatoes in all treatments. However the best treatment is to store potatoes in conditions indirectly exposed to light and have good air circulation, which drops in hardness potatoes slower than the other two treatments. At the eleventh observation means potatoes have been stored for 30 days, the hardness of potatoes are still quite high. Potatoes at the end of this observation is still in good condition for consumption. However, based on the results of the preliminary study, the potatoes were still met company standards are potatoes that have been stored approximately 27 days. 27-day holding period is expressed as well as the time limit the shelf life of potatoes on the company.

3.1.2. Moisture

Figure 2 presents the moisture content measurement data of potatoes.

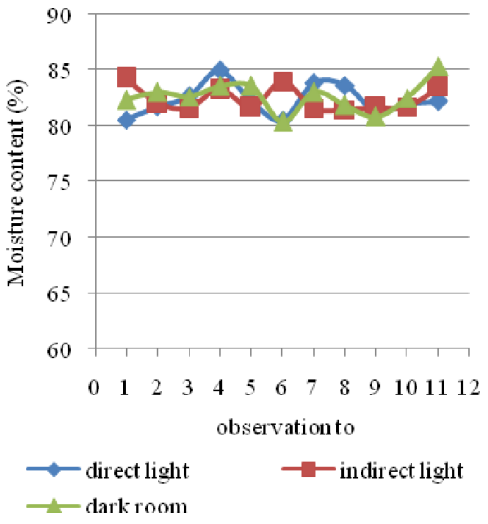

Figure 2. Percentage of Moisture Content in Each Treatment

The graph in Figure 2 shows that the moisture content of potato is not influenced by the shelf life of potatoes on all treatments that ranged from 80% to 85%. Potatoes do have a relatively long shelf life, which on the last day of observation of potatoes is still in good condition for consumption, although still relatively high moisture content

3.1.3. Physical Appearance

Physical appearance of the surface of potato including parameters for observation. Observation of the surface covering the appearance of patches of greenery and budding around the base of the bulbs. Damage to the potato began to arise in the third observation, where sample A treatment includes various patches of greenery on the surface of the skin, then the light is considered to have a major influence on the emergence of spots that result in loss of quality potatoes. Figure three presents a sample of potatoes which has patches of greenery.

Figure 3. Spotting greenery Potatoes on Third Observation (*Courtesy : Syarip,2014*)

Researchers also found that the growth of sprouts on the tuber. Figure 4 shows the appearance of the potato in the three treatments after being stored for six days.

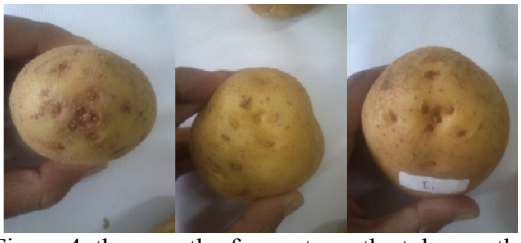

Figure 4. the growth of sprouts on the tuber on the third observation (*Courtesy : Syarip,2014*)

Represented by Figure 4, it appears that the sprouts that grow most are on treatment A, the method of storage with direct light. On storage with indirect light tends not found any sprouts growth, while the treatment of potato storage with dark light there is growth, but fewer sprouts. In subsequent of observation showed the same results, which over time, patches of greenery are increasingly available in potatoes stored in direct light conditions. Based on observations, the tubers are stored at conditions Exposure to sunlight has been reached in inadequate conditions or send of observation 8th after being stored for 21 days since the beginning of observation, whereas potatoes with two other treatments can last up of observation 10th or about 27 days of storage.

3.2. Demand for Potatoes by Consumers

potatoes became company procurement priorities because the demand is relatively high and sustainable. Fresh Potatoes obtained from farmers in Sukatani village, Cisurupan Sub-district, Garut. Procurement potatoes in bulk form, then do sorting and grading according to standards of consumer demand. Potatoes are grouped into three grades, namely:

1. Bulk or PM, the potato has a relatively diverse size and quality. Packaging used is waring bag with a capacity of 25-35 Kg /sacks or cardboard boxes with a capacity of 10kg/box.
2. Tess namely _ are large, consisting of 3-4 tubers/kg. Packaging used is polynet with a capacity of 1-2 Kg.
3. CF or FP namely _ which consists of 5 pieces/Kg packaged using a plastic bag with a capacity of 1kg.

Amount of procurement of potato every month is different and volatile. Data on the number of supply of potatoes obtained from the company in the last four years as shown in Table 2 below.

Table 2. The amount of supply of potatoes (Kg) during the years 1st to 4th

Month	year			
	1st	2nd	3rd	4th
Jan	23.968	38.732	26.204	44.558
Feb	19.512	30.852	20.348	20.166
March	22.205	35.683	29.053	27.592
April	14.782	29.102	38.458	36.792
May	12.411	32.744	43.357	32.687
June	15.989	28.599	41.297	34.215
July	28.661	19.225	65.540	73.250
Aug	22.655	29.786	40.050	16.325
Sept	24.227	17.559	18.553	27.212
Oct	30.684	25.380	22.580	9.656
Nov	45.901	24.916	28.364	15.383
Des	39.685	23.451	36.477	9.434

Source: Adapted from the company's data

3.3. Potatoes Warehouse Inventory Levels

Inventory levels for potatoes in the company can be used as a reference in the analysis of the inventory because it is used to calculate the cost of inventory. If inventory levels are average multiplied by the number of frequencies of orders to farmers and the company does not do safety stock are used to determine the amount of sales to the market after deducting the amount of loss during storage and processing. Table 3 and 4 presents information about the condition of potatoes supply activities of the company in year 1st to 4th.

Table 3. Data potatoes supply conditions in the company in Year 1st and Year 2nd

Month	Year 1st				Year 2nd			
	Freq. of order	Ave. of inventory	percentage of losses	percentage of BS	Freq. of order	Ave. of inventory	percentage of losses	percentage of BS
Jan	5	3.247	1,22	3,02	10	3.700	0,82	1,96
Feb	13	1.568	2,50	3,49	14	1.753	0,91	2,09
March	19	3.492	3,65	19,4	15	4.906	2,23	6,36
April	8	3.150	1,39	3,29	16	8.053	2,37	5,54
May	10	1.554	3,39	3,52	11	2.271	1,38	1,77
June	9	1.634	6,29	4,59	13	6.422	1,41	5,70
July	16	1.358	2,56	3,03	14	9.919	2,70	8,21
Aug	13	1.454	2,91	1,77	13	6.419	2,93	2,78
Sept	8	4.914	0,87	1,82	12	6.264	3,78	2,68
Oct	10	4.068	2,57	5,87	8	6.156	2,99	3,41
Nov	18	3.634	1,93	16,94	11	7.202	3,34	6,82
Dec	14	1.404	1,69	3,70	5	5.843	3,65	12,03

BS = Below Standard

Table 4. Data potatoes supply conditions in the company in Year 3rd and 4th

Month	Year 3rd				Year 4th			
	Freq. of order	Ave. of inventory	Percentage of losses	Percentage of BS	Freq. of order	Ave. of inventory	Percentage of losses	Percentage of BS
Jan	8	3.032	2,32	4,28	12	679	2,15	9,37
Feb	11	2.310	4,22	4,70	18	2.203	0,93	17,20
March	11	3.929	2,40	4,00	19	3.555	4,26	22,37
April	10	3.599	3,07	4,41	20	2.118	1,56	19,52
May	14	5.510	1,37	2,30	14	2.481	1,47	25,57
June	13	3.006	1,86	4,55	18	1.773	2,32	27,90
July	15	2.856	1,07	1,78	6	334	1,40	7,77
Aug	10	3.315	1,21	3,10	4	179	3,29	9,73
Sept	13	3.704	1,89	4,51	14	344	1,06	11,34
Oct	20	2.023	1,18	8,25	13	1.425	2,41	29,99
Nov	19	2.082	1,57	11,58	18	1.213	0,86	31,19
Dec	2	2.890	2,10	4,03	10	351	2,95	43,51

In Table **3** and 4 shows that the average inventory level and the number of orders each month has a fluctuating value. Procurement of non-scheduled is one of the problems in the company. Procurement that too often lead to an increase in the cost of the order so that the total inventory cost increases. In addition, potatoes are stored is reduced for their losses and substandard (below standard).Costs in Stock Potatoes

There are several types of costs associated with the activities of supply of raw materials. There are two types of costs are decisive in optimizing the total cost of inventory, the cost of ordering and storage costs of raw materials (Yanto, 2008).

Ordering and storage costs incurred by the company during the last 1 year are presented in Table 5

Table 5 Details of Storage Cost and Ordering Cost

Component	Cost	Total
Ordering Cost (Rp./order) :		
Calling	2.500	120.000
Expedition	105.000	
Fee	12.500	
Holding Cost (Rp./kg/month):		
Warehousing	18	215
Fee	175	
Electricity	2	
Cleaning service	20	

Source: Adapted from the company's data

3.4. Inventory Cost Comparison

Based on the data in Table 2, 3 and 4, we calculate the EOQ and frequency of messages per month using the equation XX. Then, calculated the cost of supplies per year from year 1st to 4th according to both EOQ calculation results and according to actual conditions. From these calculations can be compared to the total cost of inventory and calculated the difference between the total cost of inventory according to EOQ calculations by the calculation according to actual conditions. This difference represents a saving which can actually occur. The results of calculations are presented in Table 6 to Table 9

Table 6 . Total Inventory Cost Comparison between EOQ Base vs Actual Base Year 1st

Month	Procure-ment (Kg)	Actual Freq. Of order	Average stock (Kg)	% stored	EOQ (Kg)	Freq of order	Totalcost (Rp.)		Saving (Rp.)
							EOQ base	Actual base	
Jan	23.968	5	3.247	0,96	5.172	5	1.088.511	1.268.505	179.994
Feb	19.512	13	1.568	0,94	4.667	4	973.352	1.876.927	903.575
Mar	22.205	19	3.492	0,77	4.979	4	947.035	2.857.725	1.910.690
Apr	14.782	8	3.150	0,95	4.062	4	852.920	1.605.555	752.635
May	12.411	10	1.554	0,93	3.722	3	772.606	1.511.023	738.417
Jun	15.989	9	1.634	0,89	4.225	4	858.901	1.393.087	534.187
Jul	28.661	16	1.358	0,94	5.656	5	1.182.113	2.195.649	1.013.536
Aug	22.655	13	1.454	0,95	5.029	5	1.055.902	1.857.980	802.078
Sep	24.227	8	4.914	0,97	5.200	5	1.103.046	1.988.090	885.044
Oct	30.684	10	4.068	0,92	5.853	5	1.205.190	2.000.802	795.612
Nov	45.901	18	3.634	0,81	7.158	6	1.393.787	2.793.877	1.400.090
Dec	39.685	14	1.404	0,95	6.656	6	1.392.429	1.965.590	573.160
Total=	300.679	143				56	12.825.792	23.314.809	10.489.017
Ave. =	25.057	12				5	1.068.816	1.942.901	874.085

Table 7. Total Inventory Cost Comparison between EOQ Base vs Actual Base Year 2nd

Month	Procurement (Kg)	Actual Freq. Of order	Average stock (Kg)	% stored	EOQ (Kg)	Freq of order	Totalcost (Rp.)		Saving (Rp.)
							EOQ base	Actual base	
Jan	38.732	10	3.700	0,97	6.575	6	1.394.058	1.973.385	579.327
Feb	30.852	14	1.753	0,97	5.869	5	1.242.804	2.045.588	802.784
Mar	35.683	15	4.906	0,91	6.311	6	1.298.644	2.764.184	1.465.539
Apr	29.102	16	8.053	0,92	5.700	5	1.176.958	3.514.442	2.337.483
May	32.744	11	2.271	0,97	6.046	5	1.279.370	1.792.885	513.515
Jun	28.599	13	6.422	0,93	5.650	5	1.171.602	2.842.560	1.670.958
Jul	19.225	14	9.919	0,89	4.633	4	941.665	3.579.920	2.638.255
Aug	29.786	13	6.419	0,94	5.766	5	1.204.346	2.861.282	1.656.936
Sep	17.559	12	6.264	0,94	4.427	4	921.121	2.699.759	1.778.638
Oct	25.380	8	6.156	0,94	5.323	5	1.107.761	2.198.833	1.091.073
Nov	24.916	11	7.202	0,90	5.274	5	1.076.271	2.711.110	1.634.838
Dec	23.451	5	5.843	0,84	5.116	5	1.013.790	1.659.266	645.476
Total=	336.029	142				60	13.828.391	30.643.213	16.814.823
Average =	28.002	12				5	1.152.366	2.553.601	1.401.235

Table 8. Total Inventory Cost Comparison between EOQ Base vs Actual Base year 3rd

Month	Procure-ment (Kg)	Actual Freq. of order	Average stock (Kg)	% stored	EOQ (Kg)	Freq of order	Totalcost (Rp.)		Saving (Rp.)
							EOQ based	Actual based	
Jan	26.204	8	3.032	0,93	5.408	5	1.124.437	1.568.856	444.419
Feb	20.348	11	2.310	0,91	4.766	4	978.974	1.772.349	793.375
Mar	29.053	11	3.929	0,94	5.695	5	1.185.201	2.110.672	925.471
Apr	38.458	10	3.599	0,93	6.552	6	1.356.014	1.915.906	559.892
May	43.357	14	5.510	0,96	6.957	6	1.468.288	2.821.173	1.352.886
Jun	41.297	13	3.006	0,94	6.790	6	1.412.983	2.164.863	751.880
Jul	65.540	15	2.856	0,97	8.553	8	1.812.779	2.396.540	583.761
Aug	40.050	10	3.315	0,96	6.686	6	1.406.581	1.882.007	475.426
Sep	18.553	13	3.704	0,94	4.551	4	947.125	2.305.393	1.358.268
Oct	22.580	20	2.023	0,91	5.020	4	1.028.505	2.793.930	1.765.424
Nov	28.364	19	2.082	0,87	5.627	5	1.130.243	2.668.767	1.538.524
Dec	36.477	2	2.890	0,94	6.381	6	1.329.888	823.261	(506.627)
Total=	410.280	146				65	15.181.017	25.223.716	10.042.699
Ave.=	34.190	12				5	1.265.085	2.101.976	836.892

Table 9. Total Inventory Cost Comparison between EOQ Base vs Actual Base Year 4th

Month	Procure-ment (Kg)	Actual Freq. of order	Average stock (Kg)	% stored	EOQ (Kg)	Freq. of order	Totalcost (Rp.)		Saving (Rp)
							EOQ based	Actual based	
Jan	44.558	12	679	0,88	7.053	6	1.428.965	1.569.168	140.203
Feb	20.166	18	2.203	0,82	4.745	4	927.615	2.547.773	1.620.158
Mar	27.592	19	3.555	0,73	5.550	5	1.034.333	2.840.785	1.806.452
Apr	36.792	20	2.118	0,79	6.409	6	1.232.623	2.759.378	1.526.755
May	32.687	14	2.481	0,73	6.041	5	1.123.125	2.069.180	946.055
Jun	34.215	18	1.773	0,70	6.180	6	1.127.941	2.425.998	1.298.057
Jul	73.250	6	334	0,91	9.043	8	1.855.006	785.225	(1.069.781)
Aug	16.325	4	179	0,87	4.269	4	858.058	513.474	(344.584)
Sep	27.212	14	344	0,88	5.511	5	1.111.500	1.744.789	633.289
Oct	9.656	13	1.425	0,68	3.283	3	591.517	1.767.110	1.175.592
Nov	15.383	18	1.213	0,68	4.144	4	748.162	2.337.210	1.589.049
Dec	9.434	10	351	0,54	3.245	3	535.629	1.240.404	704.775
Total=	347.270	166				59	12.574.475	22.600.493	10.026.018
Ave=	28.939	14				5	1.047.873	1.883.374	835.502

From Table 6 through Table 9 shows that the magnitude of EOQ calculations make reservations using the average frequency of orders per month are becoming fewer as many as 5 times than the frequency of the actual order that as many as 12 times. This lowers the cost of the component cost of the booking. This means that the average duration of storage of potatoes approximately 6 days a month, which is far shorter than the limit of the shelf life of potatoes by 27 days. At the same tables presented the results of the calculation of total cost of inventory according to EOQ calculations and according to actual conditions per month. The table indicates that the ordering decision using EOQ calculation turned out to provide results that are significantly better than the actual condition. Therefore, if the inventory planning is based on the calculation of the total cost of inventory EOQ become more efficient and the quality of the potatoes still meet the requirements for an average time of stored potatoes only 6 days.

3.5. Application of EOQ Model in Inventory Planning

Model EOQ inventory planning applied to the following year. Therefore, the data in next year needs to be predicted in advance.

3.5.1. Forecasting Demand

Determining the method of forecasting is one important factor in inventory planning because the method used to estimate the number of future demand. Data demand for potatoes in the four previous periods have a

coefficient of variance of 0.62. The value is greater than 0.2, the data request is said to be non-stationary, or could be indicated its have pattern such as; seasonal patterns, a cyclical pattern, or trend patterns (*Makridakis,* et. al., 1994). Forecasting method used is the method of decomposition. First, performed annual forecasting using linear regression method, then calculate the monthly index using actual demand of four previous years as shown in Table 2. The results of the annual forecasting decomposed into forecasts per month using the monthly index.

Based on data in Table 2, the regression equation Y = 295 059 + 21402 * X where Y = forecast year-to-X. The numbers forecast demand for potatoes in the fifth year is 402 070 kg, by using the equation. Furthermore, these numbers are to be decomposed into a number forecast per month using the monthly index. The results of the forecast and monthly indexes are presented in Table 10

Table 10. The results of the forecast and Monthly Indexes Year 5th

Month	Monthly Index	Forecast Demand (kg)
Jan	0,10	38.916
Feb	0,07	26.574
Mar	0,08	33.201
Apr	0,08	33.719
May	0,08	34.027
Jun	0,08	33.921
Jul	0,13	52.592
Aug	0,08	31.021
Sep	0,06	25.774
Oct	0,07	26.177
Nov	0,09	34.200
Dec	0,08	31.949
Total =	1,00	402.070

The results of the fifth year forecasts are decomposed into each month is used to calculate the EOQ per month, so it can be known how the estimated total cost of inventory is based on EOQ method.

3.5.2. Total Inventory Cost Analysis using EOQ Method

Furthermore, we calculated of EOQ for forecasting demand for a fifth year. We obtained values suggested order quantity and frequency of orders per month, by using EOQ equations and component costs the same as in the previous year. EOQ calculation results, order frequency and total cost of inventory is presented in Table 11

Table 11. EOQ Calculation Results, Order Frequency, and Total Costs Year 5th

Month	Demand (Kg)	EOQ (Kg)	Freq. Of Order	Total Cost (Rp.)
Jan	38.916	6.591	6	708.531
Feb	26.574	5.446	5	585.495
Mar	33.201	6.088	5	654.441
Apr	33.719	6.135	5	659.526
May	34.027	6.163	6	662.532
Jun	33.921	6.153	6	661.499
Jul	52.592	7.662	7	823.673
Aug	31.021	5.885	5	632.591
Sep	25.774	5.364	5	576.615
Oct	26.177	5.406	5	581.105
Nov	34.200	6.179	6	664.214
Dec	31.949	5.972	5	641.983
Total =	402.071	Rate =	5	

As was explained earlier that the EOQ method has certain assumptions, which are relatively constant demand in each period. Fluctuations in demand that occurred on the actual condition can cause shortages when the demand rate is high, but on the other hand can also occur accumulation of raw materials at the time demand is relatively low. Therefore, companies need to consider the policy of safety stock, combined with changes in the value of the order where the order values is reduced if it turns out the actual demand prior period is lower than the demand forecast results and reverse the order value plus when actual demand prior periods is greater than the demand forecast results. So this model is a decision support for ordering per monthly.

Method can be applied by the company from the point of view of higher costs and lost sales. However, there are still some things that must be considered in the application of this method. EOQ method is only focused on the costs associated with the implementation of the inventory alone, as well as trying to determine the quantity and frequency of ordering that produces an optimal cost. In actual conditions, frequency of purchases of the company is quite often because the purchase is done in conjunction with other commodities. In addition, the company decided should always buy potatoes when available at farmers because of the supplying competition to similar companies in the procurement process. In order for this

method can be applied as a basis for planning and inventory control of potato it is necessary to the mutual bond that is where suppliers are given annual potato requirement plan for one year. This is done to avoid a supply shortage due to the competition get this commodity to its peers that are always available in the company.

4. SUMMARY

The results of this study are drafting an inventory planning provides the optimal total cost of inventory while considering factors shelf life of potatoes

The use of EOQ referring to the recorded data on supply, demand, costs in inventory management, and shelf life of commodities. EOQ method is used when determining the value of the order and then determine the order frequency. The calculations show that based on the data last three years the company should be able to make savings of Rp. 986,928.00 with the order value in every month an average of 1.72 times of the actual order, so order frequency becomes less that of an average of 12 times to 5 times a month. Thus, the potatoes stored in a warehouse just 6 days, while the limit shelf life of potatoes by 27 days.

This research should be continued by combining the inventory planning with other commodities because of the order usually in conjunction with other commodities. This will affect the amount of the order cost component. However, further research is also needed to consider factors retailer wishes about the shelf life of potatoes left over when the potatoes delivered to the retailer. Each retailer may require the remaining shelf life of potatoes differed according to the rate of sales to consumers.

There needs to anticipation stock at certain periods, for example during the Holy Month of Ramadan and other religious holiday because in that period occurred in high demand. Especially on a day of religious Muslims always forward eleven day period that cannot be plotted on the same specific month each year.

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