Turkish Journal of Computer and Mathematics Education Vol.12 No. 7 (2021), 2759-2767

Research Article

Inventory Management of Broilers in PD Mugi Jaya Using Economic Order Quantity (EOQ) and Silver Meal Method

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Article History: Received: 11 January 2021; Revised: 12 February 2021; Accepted: 27 March 2021; Published online: 16 April 2021

Abstract: PD Mugi Jaya is one of the business units in the field of chicken procurement in Bandung. Products produced in the form of chicken sent to various restaurants in Bandung. PD Mugi Jaya can distribute 5,000 chickens to restaurants that become customers and sell the type of chicken in retail in Bandung. The need to evaluate the inventory procurement strategy in 2021 in order to obtain a minimum total cost. The evaluation begins by determining the data patterns formed from the request data from September 2019 to December 2020. The pattern formed is a random pattern, which is then done forecasting demand 2021 with the method of forecasting that has the smallest error value. The preferred forecasting method is the Double Exponential Smoothing method with a MAPE value of 43.6%. The forecasting results are processed by the method of procurement of lot sizing (existing), Economic Order Quantity (EOQ), and Silver Meal supplies. The method that managed to obtain the minimum total cost is the Silver Meal method with a total cost of Rp 23,725,500.

Keywords: Inventory management, double exponential smoothing, silver meal

INTRODUCTION

Inventory for various sectors of the manufacturing industry or non-manufacturing has an important role in determining the amount of production costs and the amount of profit earned. Inventory is an important part of production and sales planning. The presence of inventory causes the company to provide inventory costs, the more economical the level of ordering in inventory, the more optimal the cost of inventory that must be spent by the company [1]. Over time, inventory management becomes more complicated due to increasing uncertainty in running a business, to overcome the elements of uncertainty and complexity, several methods are used to manage inventory from the start of inventory methods and computational techniques where both are used as an alternative to include uncertainty in human judgment into calculations [2].

Pd. Mugi Jaya is a chicken distributor located in Cileunyi which was established on November 10, 1997. Pd. Mugi Jaya specializes in kampung chicken. In a month PD. Mugi Jaya can distribute 5000 chickens to restaurants that become customers and also sell kampung chicken in retail in Bandung [3]. Currently, the company wants to evaluate the inventory ordering strategy used to meet demand in 2021. Therefore, a comparison of inventory procurement methods is carried out with the aim of finding the minimum total cost to meet inventory in 2021.

LITERATURE REVIEW

Management of Inventory

Inventories are a collection of goods that are kept in one location and will be used for specific purposes. Raw materials, supporting materials, materials in process, and finished goods are all included in production inventories. The cost of supplies is determined by the quantity and size of supplies provided. Because inventory is immovable goods that cannot be used, it can also be considered a source of idle funds. In the supply chain, inventory serves as the foundation for product flow. In a small business, inventory can be managed manually [2]. Without good inventory management, a low-cost strategy will never be achieved [4]. Inventory management is a strategy for determining the amount of inventory that must be held to keep production flowing efficiently, as well as the procurement schedule and number of orders that the company must place.

Forecasting

Inventory management strategy is required to meet business goals. Forecasting is done using historical data from the company. Forecasting is a complicated process that necessitates a combination of skills and experience. It also necessitates historical data and sufficient knowledge, as forecasting can influence future decisions [5]. Forecasting is a critical tool for businesses to use when making strategic decisions. The collection of relevant data in the form of information, and the selection of the right forecasting technique that will make the best use of the data information obtained, are the two main things that must be considered in the process of making accurate forecasting [6]. Time series data is a type of variable that consists of data that is collected, recorded, or observed

over a period of time [7]. Time series data is influenced by four factors. Economic data is prone to fluctuations or variations over time, which are referred to as time series variations. The trend factor (trend factor), cyclical fluctuation, seasonal variation, and the influence of random (irregular / random influences) are the most common causes of variation [8].

Forecasting is a process that aims to predict or forecast all aspects of an industries or business's production, supply, demand, and economic use. Companies use three different types of forecasting to plan future operations, including the following [4]:

1. Economic forecasting is concerned with the business cycle and predicts the rate of inflation, the amount of money in circulation, and other planning indicators.
2. Technology forecasting is concerned with the level of technological advancement that can lead to the development of new, more appealing products.
3. A demand forecast is an estimate of how much a company's product or service will be in demand.

Many demand forecasting models have been developed to accurately predict future real product demand, which is used to plan the supply chain efficiently[9]. Moving Average, Double Exponential Smoothing, and Linear Regression are among the forecasting methods used.

a. Single Moving Average

Single Moving Average (SMA) is a computational method for analyzing time series that involves constructing a series of averages from different subsets of the entire series in order to reflect long-term trends in the data. Time series values fluctuate greatly due to periodic and irregular changes, making it difficult to show a developmental trend. The moving average method can be used to remove the influence of these factors in order to analyze and predict long-term trend sequences [10]. A simple moving average can be calculated using the following formula [11]:

$$SMA = \frac{P_M + P_{M-1} + \cdots + P_{M-(n-1)}}{n} \qquad (1)$$

b. Double Exponential Smoothing

The Double Exponential Smoothing (DES) method smooths out trend values and predicts exponential smoothing by using different parameters from the original series. Appropriate for predicting data trends. To account for trends, the DES method incorporates a trend factor into the equation. Double Exponential Smoothing (DES) is a method for creating a stable and regular time series [12]. The following is the formula for Double Exponential Smoothing [13]:

$$S_t = a\, y_1 + (1 - a)(S_{t-1} + T_{t-1}) \quad (2)$$
$$T_t = y\,(S_t + S_{t-1}) + (1 - y)T_{t-1} \quad (3)$$
$$\gamma 1(k) = S_t + kT_t \quad (4)$$

c. Linear Regression

Linear regression is a model that studies the relationship between one or more independent variables, denoted by X, and the dependent variable Y. Simple linear regression is used when there is only one independent variable, X, and multiple linear regression is used when there are more than one independent variable [14]. Time series linear regression is a function that combines one response variable (Y) with one or more predictor variables (X), both of which are time dependent. The time series linear regression model can be described in general as follows [15]:

$$Y_t = B_0 + B_1 X_{i0} + B_2 X_{i2} + \cdots + B_{p-1} X_{i,p-1} + E_i \qquad (5)$$

d. Accuracy Value Measurement

All forecasting methods have some level of uncertainty, and including the element of error (error) in the formulation of a time series forecasting can assist in determining the best forecasting method. The magnitude of forecasting deviation is affected not only by the element of error, but also by the inability of a forecasting model to recognize other elements in the data series. The magnitude of the deviation from forecasting results may be due to a large number of unexpected factors (outliers) for which no forecasting method is capable of producing accurate forecasts, or it may be due to the forecasting method's inability to accurately predict the trend, seasonal component, or cycle component. Which could be present in the data series, implying that the method used is ineffective.[16]. The error value, calculated using the smallest error comparison analysis of Mean Absolute Error (MAE), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE), is used to determine the forecasting method (MAPE). The following is the formula for the three calculation errors [13]:

$$MAPE = \frac{\Sigma|Actual-Forecasting|}{n} \quad (6)$$

$$MSE = \frac{\Sigma(Actual-Forecasting)^2}{n} \quad (7)$$

$$MAE = \frac{\Sigma(Absolute\ Error\ Percentage)}{n} \quad (8)$$

It is possible to use the Mean Absolute Percentage Error. Both to check the least squares method's predicted results and to rule out the possibility of using other methods [17].

Management of Inventory and Procurement

Inventory is a significant component in which every company must focus in order to set itself apart from its competitors. People's expectations for each product change as the demand for various types of products increases around the world. A company's supply chain and inventory must be given special attention if it is to survive in the long run. To reduce product costs and improve quality by lowering failure rates, more research is needed [18].

Economic Order Quantity (EOQ), Period Order Quantity (POQ), Lot Sizing, Lot for Lot, Silver Meal, and several other methods can be used in the Procurement Inventory strategy. Each method has its own set of characteristics and is unique in its application. However, in the Procurement Inventory strategy, a method that is as accurate and efficient as possible is required.

1. Economic Order Quantity

The Economic Order Quantity (EOQ) is a great tool for internal control, and it should be used to track finished goods, work-in-progress, and material inventories. It regulates inventory purchases and storage in order to maintain a steady flow of production while avoiding excessive inventory investment. The following formula can be used to calculate simple economic order quantity [19]:

$$EOQ = \frac{\sqrt{2\ x\ A\ x\ O}}{C} \quad (9)$$

with:

EOQ : Economic Order Quantity
A : Annual demand in units
O : Cost incurred to place a single order
C : Carrying cost per unit per year

2. Silver Meal

The Silver Meal method, also known as the SM method, was created by Edward Silver and Harlan Meal and is based on the cost period. The number of periods in which additional orders increase is used to determine the average cost per period. When the average cost of the first period rises, more orders are placed. If the order is received at the start of the first period and will suffice until the end of period T [20]. The Silver Meal method's criterion is that the lot size chosen must be able to reduce the total cost per period to the lowest possible level. Silver Meal based methods, such as Silver-Meal based heuristics, can be developed to analyze two options for meeting customer demand. [21]. The Silver Meal method seeks out the most cost-effective average cost per period [22]. The following is the main equation:

$$\frac{TRC(T)}{T} = \frac{C+Ph\Sigma_{K=1}^{T}(k-1)Rk}{T} \quad (10)$$

With:

C : Ordering cost per period
T : Addition time in period
P : Purchase cost per unit
TRC (T) : Total relevant cost in Period T
Ph : Holding cost per Period
Rk : Demand level of Period

3. Lot Sizing

In companies that implement Supply Chain management into their systems, the optimal lot-sizing policy in the supply chain (SC) plays an important role. A good lot size policy will help you manage and control the costs of

your Supply Chain inventory. The company is able to reduce additional costs and provide added value to consumers by managing the lot size on the Supply Chain. [23].

RESEARCH METHODOLOGY

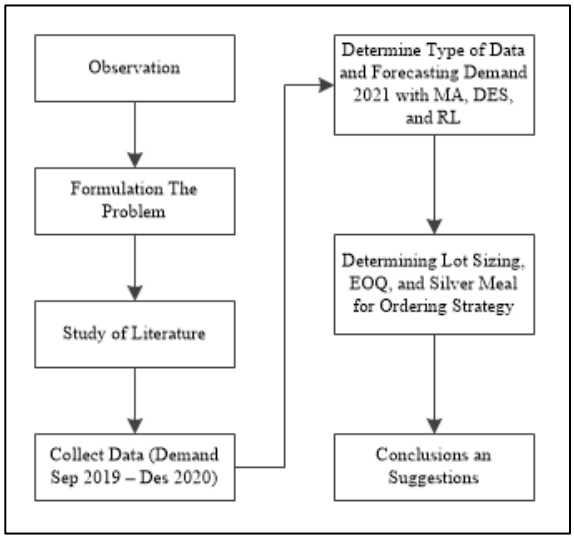

Figure 1. Research Methodology

Figure 1 is the steps taken in conducting this research. Here is a description of each of these points:

1. Observation

Observations were made directly at PD Mugi Jaya through an interview process with one of the employees at the company. The data collected is descriptive with a quantitative approach.

2. Formulation The Problem

The problem is that the booking schedule is not well organized, causing the chicken to accumulate in the freezer. The current booking strategy is to lot sizing 300 chickens. The need for a strategy evaluation to find the total minimum cost of procurement in 2021.

3. Study of Literature

To conduct this research conducted literature studies on knowing the patterns of data obtained, determining suitable forecasting methods based on the value of errors, and conducting comparisons of procurement strategies.

4. Collect Data

The data collected in the form of chicken meat demand data from September 2019 to December 2020. The data is the primary data obtained from the company's data recap. The data is then presented in tables and graphs to see the pattern of data to be processed. The study used help applications such as Minitab, Eviews 11, and SPSS.

5. Determine Type of Data and Forecasting Demand with DMA Method

Determination of data patterns is done to determine the type of request data obtained, from the data is done query forecasting in 2021 using the appropriate method. Adjustment of the selected forecasting method is viewed based on the smallest error value. In this study the accuracy of the selected error value is Mean Absolute Percentage Error (MAPE) because the MAPE value corresponds to the problem being examined.

6. Determine Lot Sizing, EOQ, and Silver Meal.

The ordering strategy to meet demand by 2021 is completed using Lot Sizing, EOQ, and Silver Meal methods. Lot Sizing method is used to customize the booking technique in the previous period. The use of the EOQ method is based on searching for the most economical number of bookings. While the use of silver meal method refers to the frequency of ordering that can affect the cost of saving.

7. Conclusions and Suggestions

At the end of the study will be taken the selection of methods of ordering cut chicken that produces lower costs to then be used as input material for the company and further research.

RESULTS AND DISCUSSION

The data obtained from the results of the study is data on the demand for cut chicken in PD Mugi Jaya during the period of September 2019 to December 2020. The data is in the form of primary data obtained from PD Mugi Jaya. Table 1 is a data of chicken cut requests grouped into Weekly Periods. The resulting plot is shown in Figure 1.

Table 1. Demand for Cut Chicken Period Sep 2019 – Dec 2020 (Weekly)

Week	Demand	Week	Demand	Week	Demand	Week	Demand
1	1047	18	747	35	802	52	475
2	1064	19	1024	36	537	53	487
3	973	20	1130	37	33	54	365
4	1074	21	1073	38	352	55	394
5	884	22	967	39	464	56	381
6	980	23	1075	40	615	57	481
7	1023	24	1032	41	423	58	450
8	1007	25	865	42	489	59	591
9	880	26	862	43	291	60	560
10	962	27	629	44	513	61	470
11	1014	28	335	45	398	62	557
12	915	29	264	46	474	63	515
13	980	30	423	47	529	64	414
14	1003	31	343	48	317	65	448
15	1123	32	498	49	621	66	553
16	1232	33	544	50	510	67	391
17	1121	34	668	51	645	68	437

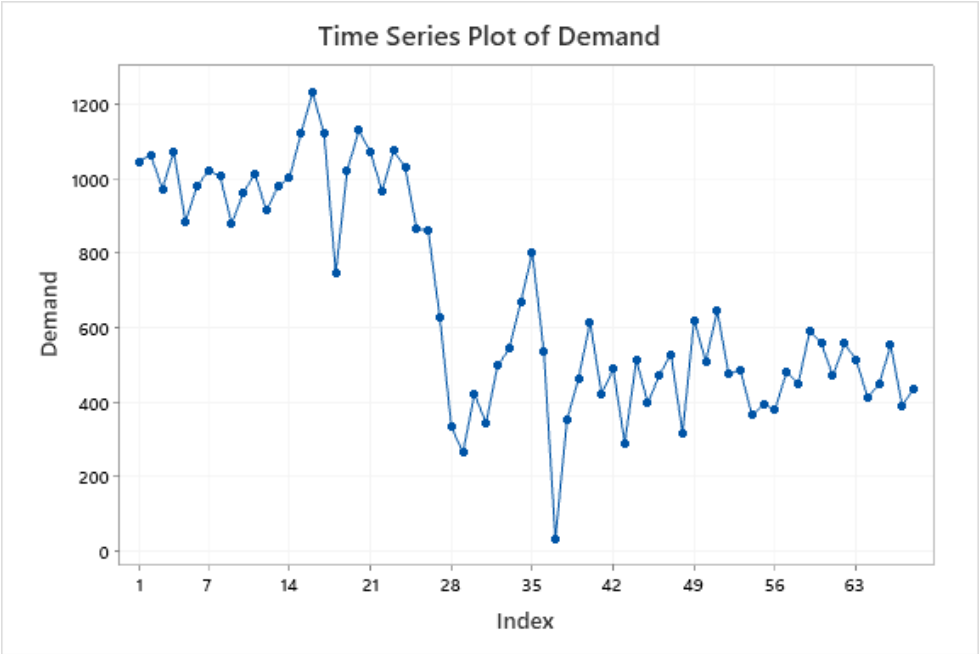

Figure 1. Plot Data Request Chicken Cut Period Sep 2019 – Dec 2020 (Weekly)

The data patterns we have need to be known to determine or choose the method of forecasting, because forecasting is a projection of past data into the future. The pattern of data of the period that has occurred will have an effect on the forecasting for the next period.

Null Hypothesis: DEMAND has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.386244	0.1494
Test critical values:	1% level	-3.531592	
	5% level	-2.905519	
	10% level	-2.590262	

Figure 2. ADF Test Results of Chicken Cut Demand Period Sep 2019 – Dec 2020 (Weekly)

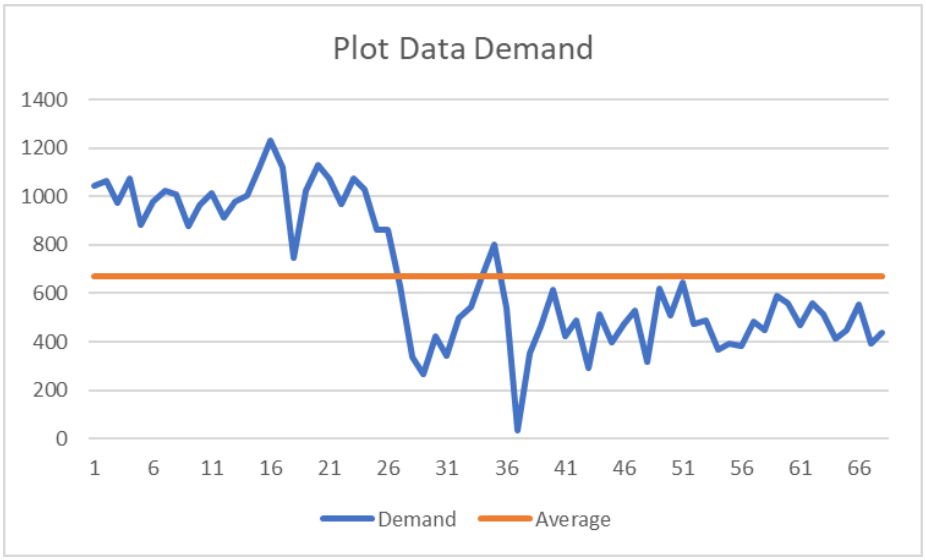

Figure 3. Plot Data Request Chicken Cut Period Sep 2019 – Dec 2020 (Weekly) to Average

ADF Test can show a stationary data [25]. Based on the ADF test value in Figure 2, showing that the request data of the cut chicken is non-stationary data, since the absolute t-statistical value in the ADF Test is smaller than the critical value of the ADF in a table of a certain degree of significance [26], it does not have a horizontal pattern. This is explained in Figure 3. The data is not stationary indicating that there is a trend and seasonality in the data pattern [27].

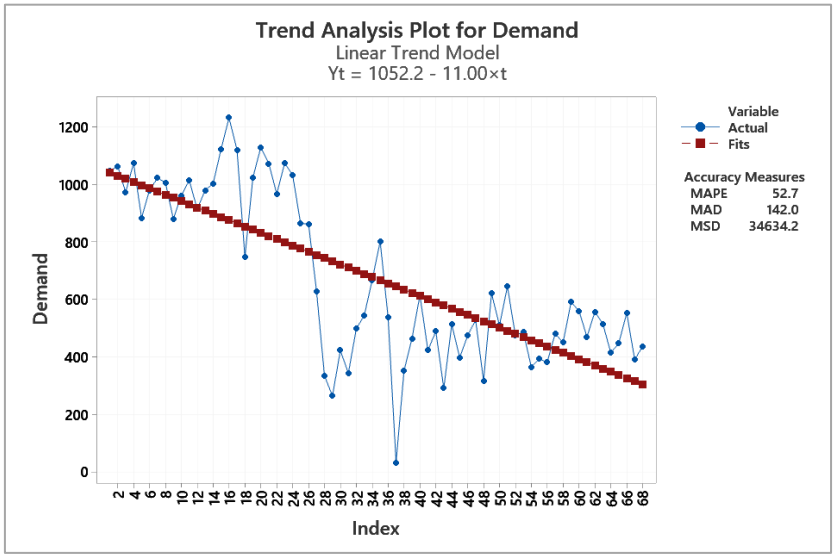

Figure 3. Fitted Line Plot Request Chicken Cut Period Sep 2019 – Dec 2020 (Weekly)

Figure 3 shows the results that the distribution of chicken cut demand data is not entirely around the linear trend line. There is data that fluctuates away from the trend line. So the data does not have a trend pattern. Visually there are also no seasonal patterns in the data, due to the absence of repeated patterns of change [28]. The data pattern also does not form sinusoid patterns or waves so it is not a cyclic data pattern, so the data pattern of the request can be concluded to have an eratic or random pattern, because the pattern of the data can not be described by other patterns, fluctuations in demand are also unclear [29].

Based on the explanation above can be concluded that the demand for cut chicken has a random data pattern. Therefore, the forecasting methods that may be suitable for such data patterns are as follows:

1. Moving Average method because the method can be used for conditions where each data at different times has the same weight so that random fluctuations can be muted with the average [30].
2. Double Exponential Smoothing method because the rationale of the single and double smoothing exponential method is that the smoothing value will be present at the time before the actual data if there is a trend component in the data. The Double Exponential Smoothing method is very efficient for forecasting time series data without any assumptions of specific statistical distributions [31].

3. Linear Regression Method because this method is popular for a variety of problems [32].

Table 2. Accuracy of Forecasting Results

Forecasting	MAPE	MAE	MSE
Moving Average (MA)	71.6	172.5	223.3
Double Exponential Smoothing (DES)	43.6	121.5	23477.9
Linear Regression	52.7	141.9	34634.9

Table 2 shows the error results of the three forecasters. The table shows that the forecasting suitable for this cut chicken data is the Double Exponential Smoothing method because it has the smallest MAPE value. MAPE value is used as a reference for accuracy value because the variable forecasting demand of cut chicken is very influential in evaluating the accuracy of forecasting conducted. In addition MAPE can provide clues as to how big the forecasting error is compared to its actual value [33]. The forecasting results of the DES method are shown in Table 3.

Table 3. Double Exponential Smoothing Method Forecasting Results

Week	Forecast	Week	Forecast	Week	Forecast	Week	Forecast	Week	Forecast	Week	Forecast
69	430	78	385	87	340	96	296	105	246	114	207
70	425	79	380	88	335	97	291	106	241	115	202
71	420	80	375	89	330	98	286	107	236	116	197
72	415	81	370	90	325	99	281	108	231	117	192
73	410	82	365	91	321	100	276	109	226	118	187
74	405	83	360	92	316	101	271	110	221	119	182
75	400	84	355	93	311	102	266	111	216	120	177
76	395	85	350	94	306	103	261	112	211	121	172
77	390	86	345	95	301	104	256	113	207	122	167

The results of forecasting the demand for cut chicken in 2021 are then processed to determine production inventory planning. The variable that affects procurement planning in 2021 consists of an order fee of Rp 531,000 and a handling fee of Rp 1,100, as well as an on-hand amount of 413 chickens. Used 3 methods of procurement planning in chicken ordering strategy. The method is the Lot Sizing method as the method used today. Economic Order Quantity (EOQ) and Silver Meal as a comparison method.

Table 3. Total Costs Incurred for Inventory Planning 2021

Method	Lot Size	2021
Lot Sizing (Existing)	300 pcs	Rp 34,256,400
EOQ	538 pcs	Rp 32,093,400
Silver Meal	Refer to Table 4 – 5.	Rp 23,725,500

Silver Meal has the smallest total cost compared to other methods it is shown in Table 3. The method is lower Rp 10,530,900 from existing and lower Rp 8,367,900 than EOQ method. The results of silver meal method inventory planning are shown in Tables 4 and 5.

Table 4. Inventory Planning 2021 Using Silver Meal Method (Week 1 – Week 27)

Periode	***0***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
GR		430	425	420	415	410	405	400	395	390	385	380	375	370	365	360	355	350	345	340	335	330	325	321	316	311	306	301
SR		413																										
PAB_1		-17	420	0	-415	0	-405	0	-395	0	-385	0	-375	0	-365	0	-355	0	-345	0	-335	0	-325	0	-316	0	-306	0
NR		17	0	0	415	0	405	0	395	0	385	0	375	0	365	0	355	0	345	0	335	0	325	0	316	0	306	0
POR_C		862	0	0	825	0	805	0	785	0	765	0	745	0	725	0	705	0	685	0	665	0	646	0	627	0	607	0
POR_L	862	0	0	825	0	805	0	785	0	765	0	745	0	725	0	705	0	685	0	665	0	646	0	627	0	607	0	587
PAB_2		845	420	0	410	0	400	0	390	0	380	0	370	0	360	0	350	0	340	0	330	0	321	0	311	0	301	0

Table 5. Inventory Planning 2021 Using Silver Meal Method (Week 28 – Week 54)

Periode	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**
GR	296	291	286	281	276	271	266	261	256	251	246	241	236	231	226	221	216	211	207	202	197	192	187	182	177	172	167
SR																											
PAB_1	-296	0	-286	0	-276	0	-266	0	-256	0	-246	0	-236	0	-226	0	-216	0	-207	0	-197	0	-187	0	-177	0	-167
NR	296	0	286	0	276	0	266	0	256	0	246	0	236	0	226	0	216	0	207	0	197	0	187	0	177	0	167
POR_C	587	0	567	0	547	0	527	0	507	0	487	0	467	0	447	0	427	0	409	0	389	0	369	0	349	0	167
POR_L	0	567	0	547	0	527	0	507	0	487	0	467	0	447	0	427	0	409	0	389	0	369	0	349	0	167	0
PAB_2	291	0	281	0	271	0	261	0	251	0	241	0	231	0	221	0	211	0	202	0	192	0	182	0	172	0	0

CONCLUSION

This research succeeded in determining the method of procurement planning for chicken supplies conducted by PD Mugi Jaya for 2021. Data on the demand for cut chicken in 2021 was obtained from the results of forecasting using the Double Exponential Smoothing method. Forecasting is based on weekly historical data from September 2019 to December 2020 that has a random data pattern.

Table 6. Comparison Breakdown of Existing Methods, EOQ, and Silver Meal

Parameters	Method		
	Lot Sizing	EOQ	Silver Meal
Total Inventory (pcs/year)	8454	14694	8535
Order Quantity (order/year)	47	30	27
Total Holding Cost (Rp/year)	Rp 9,299,400	Rp 16,163,400	Rp 9,388.500
Total Setup Cost (Rp/year)	Rp 24,957,000	Rp 15,930,000	Rp 14,337,000
Total Cost (Rp/year)	Rp 34,256,400	Rp 32,093,400	Rp 23,725,500

Table 6 shows a breakdown of the comparison between the three methods. It shows that the preferred procurement planning method is the Silver Meal method because it produces the minimum total cost of Rp 23,725,500. So the use of silver meal method is an inventory procurement strategy that can be applied by the company for 2021.

There is no denying that chicken is an easily damaged ingredient. Therefore, the effects of such resilience or expiry factors need to be considered. These considerations can be taken into account for further research to find an inventory procurement strategy taking into account expiry factors.

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