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Integrated Inventory Control Analysis through Demand Forecasting and Probabilistic Stock Modelling

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Abstract

This study addresses the problem of excess chicken egg inventory at agent warehouses caused by the mismatch between fluctuating demand and incoming supply, which frequently leads to product damage and financial losses. The research aims to design an inventory control policy based on demand forecasting and probabilistic inventory modelling to determine an ideal stock level. A quantitative approach is employed by first applying the two-period Moving Average method, which produces an MSE of 6.17 and a MAPE of 0.10 with a forecast of 65 crates for the ninth period, and then integrating these forecasts into a probabilistic inventory model at a significance level of $\alpha = 0.05$ to obtain a reorder point of 214 crates and a safety stock of 60 crates. The results show that this integrated approach enables the agent to trigger replenishment precisely when on-hand inventory reaches the reorder point, thereby maintaining an adequate service level while reducing overstock and the risk of spoilage. The combined use of a quantitative forecasting model and a probabilistic inventory framework constitutes the main contribution of this study, offering an integrated decision support scheme for determining both the optimal order timing and the appropriate buffer stock level in a perishable-goods context.

Keywords: Chicken egg inventory, demand forecasting, Moving Average, probabilistic model, reorder point and safety stock

INTRODUCTION

The production and price of broiler chicken eggs play a crucial role in the national food system because this commodity is a primary source of animal protein for the population and is highly sensitive to changes in market conditions. Fluctuations in chicken egg prices frequently occur, creating stockpiling problems for businesses when selling prices increase (Ilham & Saptana, 2019). This situation highlights the need to understand the factors influencing stockpiling in warehouses (Jadmiko et al., 2025).

The availability of chicken eggs exhibits a highly fluctuating pattern, both in terms of demand levels and price disparities, as well as supply capacity between regions (Hidayat et al., 2024; Santosa, Hidayat, & Siskandar, 2021). Egg price fluctuations are influenced not only by feed costs and production inputs, but also by supply instability and changes in consumer demand, which can lead to stockpiling and damage in warehouses (Xiyang et al., 2018). Analysis of the safety stock level can maintain product supply stability during times of increased or decreased market demand due to price fluctuations (Santosa, Hidayat, Siskandar, et al., 2021)

A quantitative approach based on product stock management is key to successfully reducing product buildup and stockouts in the warehouse (Ariyanti et al., 2025). Demand for chicken eggs and product delivery times from farmers fluctuate, so ideal safety stock management in the warehouse prevents product buildup (Ramadani, 2025; Santosa, Hidayat, & Siskandar, 2021). Safety stock analysis based on a probabilistic model that manages demand fluctuations and delivery lead times is an effective model for reducing stock buildup due to overordering from suppliers (Pulungan & Fatma, 2018; Silitonga et al., 2022).

Determining the ideal stock level is based on demand levels, production volumes, and product selling prices. Therefore, companies require model integration in inventory control management to prevent stock buildup (Batu Bara et al., 2023; Britania et al., 2024; Luju, 2023). The model for determining the safety stock level for chicken eggs at egg agents can provide information regarding the ideal order quantity from suppliers, thus enabling efficient ordering by business operators.

The novelty of this research is analyzing the safety stock of chicken eggs available at egg agents using a probabilistic method based on demand fluctuations and the lead time of chicken egg delivery from suppliers. A probabilistic inventory model to determine the reorder point and safety stock values was developed empirically so that it can provide input for business actors, namely egg agents, in maintaining the stability of the number of sustainable chicken egg orders from suppliers.

METHODS

The method used in this study is to use a probabilistic inventory model with the amount of demand and product delivery lead time from suppliers that fluctuate. The probabilistic inventory method is used when demand and production lead time have fluctuating data patterns so that the value of the Re-Order Point is the key to the success of ideal inventory (Maulidi & Listianti, 2023; Pramodya Utami & Mandala, 2024). The method used in the probabilistic demand model to determine the ideal amount of safety stock is as follows:

A. Demand Forecasting

The forecasting method uses moving averages and exponential smoothing, where this model will predict the ideal demand volume with the lowest forecast error rate. The forecasting model used is as follows:

A.1 Moving Average Method

The moving average method is used to predict the value of the next period by taking the arithmetic average of the actual data from the last few periods (Ren et al., 2016; Santosa et al., 2020). The formulation of the Moving Average method is as follows: (Pramodya Utami & Mandala, 2024)

$$MA = \frac{X_{K1} + X_{K2} + X_{Kp}}{N}$$

Whare:
X_{Kn} = Demand for the previous data period
n = Number of periods averaged

A.2 Exponential Smoothing Method

The Exponential Smoothing (ES) method is a time series forecasting technique that calculates the forecast as a weighted average of past observations, with the weights decreasing exponentially so that the most recent data has the greatest influence on the predicted value (Luh et al., 2019). The formulation of the ES forecasting method is as follows: (Oey & Ayrine, 2018; Santosa et al., 2022)

$$F_{t+1} = F_t + \alpha (Y_t - F_t)$$

dimana:
F_{t+1} = Data historis periode sebelumnya
F_t = Hasil peramalan tahun sebelumnya
Y_t = Permintaan tahun pertama
α = Nilai taraf nyata

B. Pengukuran Tingkat Error Peramalan

The selection of production quantities based on the two forecasting methods uses a comparison of the accuracy level values, namely Mean Square Error (MSE) and Mean Absolute Percentage Error (MAPE) (Pirmanto, 2024). Mean Square Error (MSE) is a method for determining the error level based on a measure of forecast accuracy that calculates the average square of the difference between the actual value and the forecasted value: (Marhama et al., 2025; Santosa et al., 2023)

$$MSE = \sum_{t=1}^{n} (At - Ft)2/n$$

Where:
A_t = Actual Data
Y_t = Forecast Data
n = Number of Data

Mean Absolute Percentage Error (MAPE) is a statistical measure that states the average magnitude of the forecast error in the form of a percentage of the actual value (Febriani & Febriani, 2022; Meliana & Suwarni, n.d.). The MAPE value can indicate whether the forecast results deviate from the actual data relatively, where the smaller the percentage, the higher the accuracy of the forecast model with the following formulation: (Rosida et al., 2023; Setaiawan, 2021)

$$MAPE = \frac{1}{n}\sum_{t=1}^{n} \left| \frac{Y - Yt}{Y} \right|$$

Where:
Y = Actual Data
Yt = Forecast Data
n = Number of Data

C. Probabilistic inventory control method

The probabilistic method of inventory control is used when daily demand or lead time is random and follows a normal distribution (Kunci, 2025; Nopriadi et al., n.d.). This probabilistic inventory control method allows companies to calculate the reorder point (ROP) and safety stock by considering the uncertainty of demand and lead time (Purnomo, 2021). The formulation of the ROP value in the probabilistic model is as follows: (Margono & Lestari, 2015; Pulungan & Fatma, 2018)

$$ROP = (X_d \times X_{Lt}) + Z_{(1-\alpha)} \times (\sqrt{(X_d \times \sigma_{lt}^2) + (X_{Lt}^2 \times \sigma_d^2})$$

dimana:
ROP = Re-Order Point
X_d = Average Demand
X_{lt} = Average Leadtime
σ_d = Standard deviation of demand
σ_{lt} = Standard deviation of leadtime
α = significance level

RESULTS AND DISCUSSION

Chicken egg demand data shows variations in the number of orders per crate across eight observation periods, reflecting the dynamics of consumer demand over time. Information about these changes in demand, when linked to variations in supplier delivery lead times, provides a critical basis for designing inventory policies, establishing safety stock, and determining reorder points to minimize the risk of overstocking or understocking. Data on chicken egg demand (crate) and delivery lead times are shown in Table 1.

Tabel 1 Demand Data and Supplier Delivery Lead Times

Period	Demand (Crates)	Leadtime (days)
1	54	3
2	74	3
3	68	2
4	70	2
5	75	2
6	53	3
7	66	2
8	64	2

Eight-period data shows that egg demand ranges from 53 to 75 crates per period. This pattern indicates fluctuating demand, with periods of high demand (74–75 crates) and periods of lower demand (53–54 crates). Inventory planning needs to take this fluctuation into account to prevent shortages or stock buildup in warehouses.

Chicken egg suppliers, namely laying hen farmers, require 2 to 3 days to ship their products, with most periods showing a lead time of 2 days and some periods reaching 3 days. This lead time variation is important in determining reorder points and safety stock, as a one-day delay can increase the risk of stockouts during peak demand, while ordering too early can potentially increase storage costs and risk damage to perishable eggs.

A. Forecast Demand

Chicken egg demand forecasting uses the two-period moving average method (MA=2), which is then evaluated by calculating the error, absolute value of the error, squared error, and percentage error for each observation period. This information provides a quantitative basis for assessing how well the moving average model is able to follow the actual demand pattern in crates, so it can be used as a reference in inventory planning and ordering decisions. The results of the demand forecast analysis using the moving average method can be seen in Table 2.

Tabel 2 Moving Average analysis results (n = 2)

Period	Demand (Crates)	MA = 2	Error	|Error|	|Error|2	Percentage Error
1	54	-	-	-	-	-
2	74	-	-	-	-	-
3	68	64	4	4	16	0,06
4	70	71	-1	1	1	0,01
5	75	69	6	6	36	0,08
6	53	73	-20	20	400	0,38
7	66	64	2	2	4	0,03
8	64	60	4	4	16	0,06
Forecast Result		65	-5	37	473	0,62

Based on the forecasting results using a Moving Average (MA) with n=2, the forecast value fluctuated between 60 and 73 cases according to changes in historical data from the previous two periods. This pattern indicates that the MA=2 method is quite responsive to short-term demand changes, although deviations still require attention when demand drops sharply.

Evaluation of model performance using |"Error"|, |"Error" |^2, and Percentage Error showed that the largest error contribution occurred in period 6, with an error of -20 cases and a squared error of 400, while other periods showed much smaller error values. In aggregate, the cumulative percentage error reached 0.62 with a sum of squared errors of 473, indicating that the MA=2 model produced a forecast accuracy level acceptable for operational contexts, with a demand forecast of 65 cases in the ninth period. The results of the error accuracy levels using the Mean Square Error (MSE) and Mean Absolute Percentage Error (MAPE) methods can be seen in Table 3.

Tabel 3 MSE and MAPE Moving Average Results

Error accuracy level	Result
MSE	78,83
MAPE	0,10

The MSE value of 78.83 indicates that the mean squared difference between actual and forecasted demand remains within tens of cases per period. Practically, this figure indicates that the moving average model used produces good deviation when demand changes occur, especially during periods with significant declines. The MAPE value of 0.10 (equivalent to approximately 10%) indicates that the relative error of the forecast to actual demand is within the acceptable range for operational purposes. The results of the chicken egg demand forecasting using the single exponential smoothing method with a smoothing parameter of $\alpha = 0.05$ for eight observation periods. The results of the analysis using the exponential smoothing method with $\alpha = 0.05$ are shown in Table 4.

Tabel 4 Exponential Smoothing Forecasting Results $\alpha = 0.05$

Period	Demand (Crates)	$\alpha =$ 0,05	Error	|Error|	|Error|2	Percentage Error
1	54	52	2	2	4	0,037
2	74	52	22	22	484	0,297
3	68	51	17	17	289	0,250
4	70	51	19	19	361	0,271
5	75	51	24	24	576	0,320
6	53	50	3	3	9	0,057
7	66	50	16	16	256	0,242
8	64	50	14	14	196	0,219
Forecast Result		50	117	117	2175	1,69

The second column contains actual demand data in cases, while the third column displays the forecast values for each period generated by the exponential smoothing equation, where the forecast values tend to move closer to the long-term average of around 50 to 52 cases and respond to gradual changes in demand. Based on the exponential smoothing forecast results, the forecasted demand is 50 cases. The error rate is measured using the MSE and MAPE values, which can be seen in Table 5.

Tabel 5 MSE and MAPE Exponential Smoothing Results

Error accuracy level	Result
MSE	217,5
MAPE	0,17

Based on the results of forecasting chicken egg demand using the Moving Average and Exponential Smoothing approaches, a comparison of demand levels was obtained based on the forecast error values obtained. The results of the comparison of error levels and demand volume can be seen in Table 6.

Tabel 6 Comparison of MAPE and MSE values

Tingkat Error	Moving Average	Exponential Smoothing
Jumlah Permintaan Telur (Peti)	65	50
Mean Square Error (MSE)	6,17	11,70
Mean Absolute Percentage Error (MAPE)	0,10	0,17

Based on the comparison table of the MA and ES forecasting methods, the lowest MSE and MAPE values are obtained from the Moving Average method, with an MSE value of 6.17 and a MAPE value of 0.10. Based on these conditions, the demand forecast value used in determining inventory planning is 65 cases. This result will be used as the demand quantity value to determine the Re-Order Point (ROP) value in the probabilistic inventory model.

B. Inventory Control Analysis

Inventory control analysis uses a probabilistic inventory model with fluctuating demand and lead times. Based on the identification results of egg agents, data related to demand and lead time fluctuations are obtained, as shown in Table 7.

Tabel 7 Demand Data and Leadtime

Period	Demand (Crates)	Lead Time (days)
1	54	3
2	74	3
3	68	2
4	70	2
5	75	2
6	53	3
7	66	2
8	64	2

Based on the data related to lead time and the number of requests, the average lead time value is 2.38 (XLt) and the demand forecast result is 65 crates (Xd). Based on this data, the standard deviation value of lead time (σlt) is 0.52 and the standard deviation of demand is (σd) is 8.28. Based on this value, the Re-Order Point value for ordering chicken eggs at chicken egg agents can be determined as follows:

$$ROP = (X_d \text{ x } X_{Lt}) + Z_{(1\text{-}0,05)} \text{ x } (\sqrt{(}\ X_d \text{ x } \sigma_{lt}^2) + (X_{Lt}^2 \text{ x } \sigma_d^2)$$

$$ROP = (65 \text{ x } 2,38) + 1,65 \text{ x } (\sqrt{(}65 \text{ x } 0,52^2) + (2,38^2 \text{ x } 8,28^2)$$

ROP = 214 crates

Based on the analysis of the ROP determination using the probabilistic method, the Re-Order Point (ROP) value was obtained at 214 crates. This condition indicates that within ten analysis periods, the egg agent can place a reorder from the supplier when the stock level in the warehouse reaches 214 crates. Based on this ROP result, the amount of safety stock can be determined, as can be seen in the following calculation:

Safety Stock (SS) = $1,65 \text{ x } (\sqrt{(}65 \text{ x } 0,52^2) + (2,38^2 \text{ x } 8,28^2)$

Safety Stock (SS) = 60 ccrates

Based on the Safety Stock analysis results, with an ROP of 214 crates, the egg agent has prepared a safety stock of 60 crates to guard against fluctuations in egg demand from consumers. The integration of ROP and Safety Stock based on demand forecasting methods allows egg agents to plan the ideal number of orders to chicken egg suppliers to prevent egg accumulation in the warehouse that causes egg damage

CONCLUSION

Based on the analysis results in determining the ROP and Safety Stock values, the demand forecast results are an important factor in identifying the availability of market demand. This forecasting method is used with an accuracy of MAPE = 0.10 indicating that the forecast results are acceptable because they are close to the actual demand data. These forecast results are used to determine the ROP and Safety Stock values where egg agents must order Back to the supplier in 8 periods is when the stock of chicken eggs in the warehouse with a safety stock level of 60 crates can maintain the ideal condition of eggs in the warehouse. Further research is to develop blockchain applications to maintain transparency and traceability in supply and demand management activities in the chicken egg supply chain.

REFERENCES

Ariyanti, G. I., Sabiqul Choir Rizky Ramadhan, & Hartatm Verani. (2025). *Optimasi Safety Stock dan Reorder Point untuk Mengurangi Stockout Produk Jadi di PT XYZ Jurnal Logic : Logistics & Supply Chain Center*. *04*(01), 12–19.

Batu Bara, Y. O., Anggriani, I., & Herlin. (2023). *Analysis Of Merchandise Inventory Control Using EOQ , ROP , SS Methods At Raffa Bengkulu Fruit Store Analisis Pengendalian Persediaan Barang Dagang Menggunakan*. *3*(2), 599–610.

Britania, R., Tjolleng, A., Putri, S. A., Teknik, F., & Nusantara, U. B. (2024). *Integrasi model inventori eoq dan*. 78–93.

Febriani, K., & Febriani, K. (2022). *Prediksi permintaan batu bara menggunakan machine learning*. 65–77.

Hidayat, A. P., Kartinawati, A., Santosa, S. H., Indrawan, P., Apriliani, F., Dardanella, D., Irawan, S., Yusri, D., Sinaga, A. R., Wijaya, H., & Pamungkas, G. Y. (2024). Distribution requirement planning for feed based on SMADISPRO software development. *E3S Web of Conferences*, *577*. https://doi.org/10.1051/e3sconf/202457703001

Ilham, N., & Saptana. (2019). *Fluctuations in the Chicken Egg Price and Its Determining Factors*. *17*(1), 27–38.

Jadmiko, M. W., Harsita, P. A., & Arifin, A. S. (2025). *Analisis Fluktuasi Harga Telur Ayam Ras di Provinsi Jawa Timur pada Periode Analysis of Fluctuations in Chicken Egg Prices in East Java Province for the Period*. *11*, 2437–2449.

Kunci, K. (2025). *MODEL EOQ PROBABILISTIK MULTI-ITEM Abstrak Penelitian ini mengembangkan model Economic Order Quantity (EOQ) probabilistik untuk beberapa item dengan keterbatasan ruang penyimpanan . Sementara penelitian sebelumnya membahas model persediaan dan memperkenalkan keterbatasan lahan penyimpanan sebagai kendala . Model dalam penelitian ini simpangan baku tertentu . Dengan metode pengali Lagrange , penelitian ini menghasilkan kuantitas pesanan*. *15*(1), 31–34.

Luh, N., Sri, W., Ginantra, R., Bagus, I., & Anandita, G. (2019). *Penerapan Metode Single Exponential Smoothing Dalam Peramalan Penjualan Barang*. *3*(September), 433–441.

Luju, E. (2023). *Analisis Pengendalian Persediaan Barang Dagang Dengan Menggunakan Metode EOQ (Economic Order Quantity) Pada PT. Sinar Fajar Mulia Maria Anjelica Agustha Seran Universitas Nusa Nipa*. *1*(4), 100–112.

Margono, S., & Lestari, Y. D. (2015). *Determine the appropriate inventory model in tang company*. *4*(4), 501–509.

Marhama, S., Sembiring, M. A., Sena, M. D., Informasi, S. S., Royal, U., Info, A., & Average, S. M. (2025). *Single Moving Average Method Forecasting to Predict Skincare Sales*. *8*(1), 51–58.

Maulidi, R., & Listianti, P. (2023). *Optimasi Pengendalian Persediaan dengan Metode Reorder Point dalam Pengembangan Aplikasi Kontrol Stok Berbasis Web*. *7*(1), 42–49.

Meliana, D., & Suwarni, P. E. (n.d.). *ANALISIS PERAMALAN PENJUALAN AIR MINUM DALAM KEMASAN 240ml PADA PT TRIJAYA TIRTA DARMA (GREAT) DENGAN METODE SINGLE MOVING AVARAGE DAN EXPONENTIAL SMOOTHING*.

Nopriadi, Nababan, & Lily Endang. (n.d.). *ODEL PERSEDIAAN PROBABILISTIK YANG MEMUAT VARIABEL LEAD TIME DENGAN PENDEKATAN DISTRIBUSI NORMAL*. *1*(2), 272–281.

Oey, E., & Ayrine, G. K. (2018). Penerapan Proses Dan Teknik Peramalan – Studi Kasus Di Manufaktur Transformer. *Jurnal Manajemen Industri Dan Logistik*, *2*(2), 106–115. https://doi.org/10.30988/jmil.v2i2.31

Pirmanto, D. (2024). Double Exponential Smoothing Forecasting Food Crop Yields Using Geographic Information Systems. *Jurnal Sisfokom (Sistem Informasi Dan Komputer)*, *13*(2), 179–185. https://doi.org/10.32736/sisfokom.v13i2.2069

Pramodya Utami, A. A. I. R., & Mandala, K. (2024). Analisis Perencanaan Produksi Agregat pada CV. Pelangi Rex's di Denpasar. *Ekonomis: Journal of Economics and Business*, *8*(1), 282. https://doi.org/10.33087/ekonomis.v8i1.1337

Pulungan, D. S., & Fatma, E. (2018). *Analisis Pengendalian Persediaan Menggunakan Metode Probabilistik dengan Kebijakan Backorder dan Lost sales*. *19*(1), 38–48.

Purnomo, A. (2021). *Analisis kebijakan persediaan dengan model q kasus*. *11*(01), 61–68.

Ramadani, L. (2025). *Analisis Risiko Rantai Pasok Telur Ayam Ras Menggunakan Metode Failure Mode and Effect Analysis (FMEA) di Parent Stock Aira & Syifa*.

Ren, Y., Suganthan, P. N., Srikanth, N., & Amaratunga, G. (2016). Random vector functional link network for short-term electricity load demand forecasting. *Information Sciences*, *367–368*, 1078–1093. https://doi.org/10.1016/j.ins.2015.11.039

Rosida, N. Z., Qamarudin, M. N. H., & Narendra, R. (2023). *Implementasi Metode Single Exponential Smoothing dalam Meramalkan Jumlah Kasus Kecelakaan Lalu Lintas di Blitar (Studi Kasus : Jumlah Kasus Kecelakaan Lalu Lintas di Wilayah Hukum Polres Blitar Kota)*. *1*(November), 24–31.

Santosa, S. H., Hidayat, A. P., & Siskandar, R. (2021). Safea application design on determining the optimal order quantity of chicken eggs based on fuzzy logic. *IAES International Journal of Artificial Intelligence*, *10*(4), 858–871. https://doi.org/10.11591/ijai.v10.i4.pp858-871

Santosa, S. H., Hidayat, A. P., & Siskandar, R. (2022). Raw material planning for tapioca flour production based on fuzzy logic approach: a case study. *Jurnal Sistem Dan Manajemen Industri*, *6*(1), 67–76. https://doi.org/http://dx.doi.org/10.30656/jsmi.v6i1.4594

Santosa, S. H., Hidayat, A. P., Siskandar, R., & Husyairi, K. A. (2023). Smart Production Planning Model for T-Shirt Products at Raensa Convection. *Jurnal Ilmiah Teknik Industri*, *22*(1), 49–57. https://doi.org/https://doi.org/10.23917/jiti.v22i1.21398

Santosa, S. H., Hidayat, A. P., Siskandar, R., & Rizkiriani, A. (2021). Effect of Selling Price on Demand for Chicken Eggs Using a Regression Approach. *Jurnal Sains Indonesia*, *2*(3), 106–112.

Santosa, S. H., Sulaeman, S., Hidayat, A. P., & Ardani, I. (2020). Fuzzy Logic Approach to Determine the Optimum Nugget Production Capacity. *Jurnal Ilmiah Teknik Industri*, *19*(1), 70–83. https://doi.org/10.23917/jiti.v19i1.10295

Setaiawan, I. (2021). *Jurnal Teknik Informatika, Vol. 13, No. 3, Agustus 2021*. *13*(3), 1–9.

Silitonga, R. Y. H., Saputra, V. A., & Khan, A. (2022). *Goods in Inventory Model Development*. *December*, 57–62. https://doi.org/10.56741/jnest.v1i02.120

Xiyang, S., Peng, G., Zhiyuan, W., & Zhusheng, L. (2018). Fuzzy multi-target distribution center location and inventory setting model and simulation solution. *2018 7th International Conference on Industrial Technology and Management, ICITM 2018*, *2018-Janua*, 314–319. https://doi.org/10.1109/ICITM.2018.8333968