

Analysis Of Demand Forecasting For Top Sales Products During The Month Of Ramadan In The Frozen Dairy Category Using The Single Exponential Smoothing (SES), Single Moving Average (SMA), And Double Moving Average (DMA) Methods

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Abstact

Demand patterns tend to change when entering seasonal periods such as Ramadan, so accurate demand forecasting is needed to ensure that the supply chain runs optimally. Hypermart Pakuwon Mall Yogyakarta experienced out of stock and overstock for several of its products at the start of Ramadan, indicating that more accurate forecasting results are needed to prevent this from happening again. This study aims to find the best demand forecasting method for Hypermart Pakuwon Mall Yogyakarta. This study compares demand forecasting methods for top-selling dairy frozen products during Ramadan using the Single Exponential Smoothing (SES), Single Moving Average (SMA), and Double Moving Average (DMA) methods. The forecasting results of each method are then measured using Mean Absolute Percentage Error (MAPE). If a forecasting method produces the smallest MAPE value, it can be said to be the best forecasting method. The results show that the Double Moving Average Order 12 method has the smallest MAPE value of 17.36%. In this case, the Double Moving Average Order 12 method is the best 2 method to use for forecasting com

Keywords: Demand Forecasting, Single Exponential Smoothing, Single Moving Average, Double Moving Average, Mean Absolute Percentage Error

INTRODUCTION

The supply chain is the key to the success of a business, especially in the retail sector, if it is managed well. Supply chain management is a useful tool for company operations that aims to determine the right quantity of goods to be produced and distributed at the right time, minimize costs, and satisfy customer demand (Aji, F., 2024).

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During seasonal periods like Ramadan, demand tends to experience a significant increase. According to the Central Statistics Agency and the Ministry of Trade (cited in BPOM, 2024), food consumption in Indonesia increased by 20-30% during Ramadan in 2024. This indicates the need for an accurate demand forecasting method to prevent overstocking and out of stock situations.

However, during the month of Ramadan, Hypermart Pakuwon Mall Yogyakarta experienced out-of-stock and overstock situations for certain products. This situation could be detrimental to Hypermart Pakuwon Mall Yogyakarta because out-of-stock situations can lead to decreased customer satisfaction and loss of loyalty (Ali, 2019), while overstock situations can cause excessive increases in inventory costs (Rizqi & Khairunisa 2021). Therefore, Hypermart Pakuwon Mall Yogyakarta requires accurate forecasting results to avoid such incidents in the future.

This study will select Kanzler Chicken Nugget Crispy 450gr as the sample product for forecasting. This selection is due to Kanzler Chicken Nugget Crispy 450g is the top-selling product during Ramadan 2025 in the frozen dairy category. After selecting the product sample, the product will be forecasted using the Single Exponential Smoothing (SES), Single Moving Average (SMA), and Double Moving Average (DMA) methods.

Based on the above issues, the problems can be outlined as follows: (1) What are the results of demand forecasting using the Single Exponential Smoothing (SES), Single Moving Average (SMA), and Double Moving Average (DMA) methods? (2) What is the number of forecasting errors from the results of forecasting the demand for top-selling products during Ramadan 2025 in the frozen dairy category for each forecasting method? (3) Which demand forecasting method is the best for Hypermart Pakuwon Mall Yogyakarta to use?

The objectives of this study are: (1) To conduct demand forecasting analysis using the Single Exponential Smoothing (SES), Single Moving Average (SMA), and Double Moving Average (DMA) methods (2) To analyze the forecasting error rate 3 for each method (3) To determine the best demand forecasting method for Hypermart Pakuwon Mall Yogyakarta to use.

LITERATURE REVIEW

Forecast

Forecasting is the science and art of predicting something that will happen in the future using historical data and projected using mathematical methods (Kusumawati, 2014). Forecasting serves as an alternative approach in statistics, even though the results of forecasting cannot be exactly the same as reality. Nevertheless, forecasting can be the basis for decision making because it is able to provide a fairly accurate picture of the future, so that better preparations can be made to face that future.



In the context of sales, forecasting is applied with the aim of helping a company or organization to carry out production planning, supply goods, and determine the right marketing strategy (Dewantara & Giovanni, 2023). This forecasting will help companies or organizations to avoid out of stock and overstock situations, increase the efficiency of inventory management and meet consumer demand.

According to Heizer et al. (2017: 109), there are three main types of forecasting that can be used in future operational planning. The following are the three main types of forecasting:

1) Technology Forecasting

This type of forecasting focuses on the level of technological advancement that is capable of creating attractive new products, which require the latest factories and equipment.

2) Demand Forecasting

This type of forecasting predicts demand for goods or services within a company. The focus of demand forecasting is to identify consumer desires and needs. This forecasting greatly influences operational decisions ranging from production systems, capacity, company scheduling, financial planning, marketing, to human resources. Therefore, data on actual demand is essential for the demand forecasting process.

3) Economic Forecasting

This forecasting is used to predict inflation rates, money supply, the start of housing construction, and as an indicator for other planning functions in business cycle management.

Single Exponential Smoothing (SES)

Single Exponential Smoothing is a forecasting method that uses a moving average technique and assigns weights to data using an exponential function (Santoso, A. B., et al., 2021). This method is one of the relatively simple moving average methods, making it easy to use and effective for medium- to long-term forecasting. The main characteristics of this method are the observation values that are given exponential weighting. The weighting value in this method is expressed in the form of alpha (α) with the condition $0 < \alpha < 1$. The following is the mathematical equation for single exponential smoothing:

$$f_{t+1} = \alpha * X_t + (1 - \alpha) * f_t \quad (1)$$

Description:

X_t : observation data for period t

f_t : forecast value for period t

α : smoothing constant



Single Moving Average (SMA)

According to (Alex, M. A. H., & Rahmawati, N., 2023), the single moving average method is a method used to forecast a value by calculating the average data from each of the last periods. The steps in this method are to calculate the average actual data from several periods. Forecasting using this method aims to reduce randomness in time series data, which can be achieved by calculating the average of several values together and eliminating positive and negative errors that can interfere with the data values. The following is the mathematical equation for the single moving average:

$$S_{t+1} = \frac{X_t + X_{t-1} + \dots + X_{t-n+1}}{n} \quad (2)$$

Description:

X_t : observation data for period t

n : time order

Double Moving Average (DMA)

The Double Moving Average (DMA) method is a moving average method that is able to overcome the weaknesses of the single moving average (SMA) method, which cannot handle trends that occur (Khairina, D. M., 2021). In the DMA method DMA method is able to modify trends in SMA data over a certain period. The basis of this method is to calculate the second moving average, which is to perform two consecutive average calculations in order to obtain a smoother data pattern and reduce short-term fluctuations. The following is the mathematical equation for the double moving average:

$$S'_t = \frac{X_t + X_{t-1} + \dots + X_{t-n+1}}{n} \quad (3)$$

After calculating the single moving average, the next step is to calculate the double moving average, which can be obtained from the result of the single moving average calculation, using the following mathematical equation:

$$S''_t = \frac{S'_t + S'_{t-1} + \dots + S'_{t-n+1}}{n} \quad (4)$$

The next step is to find the constant and coefficient values using the following mathematical equation:

$$a_t = 2 * S'_t - S''(t) \quad (5)$$

$$b_t = \frac{2}{n-1} (S'_t - S''_t) \quad (6)$$

The final step in this method is to calculate the magnitude of the forecast result by adding the constant and coefficient values as per the mathematical equation as follows:

$$f_{t+m} = a_t + b_{tm} \quad (7)$$

Description:

S'_t : single moving average (SMA)

S''_t : double moving average (DMA)



a_t : constant
 b_t : coefficient
 f_{t+m} : forecast
 n : time order

Mean Absolute Percentage Error (MAPE)

According to De Myttenaere et al., (2015) mean absolute percentage error is a tool used to measure the accuracy of forecasting in regression models by calculating the average absolute percentage difference between the forecast value and the actual value, making this measurement tool ideal for comparing performance between different scale datasets. The following is the mathematical equation for mean absolute percentage error:

$$MAPE = \sum_{i=1}^n \left| \frac{Y_t - F_t}{Y_t} \right| \times 100 \quad (8)$$

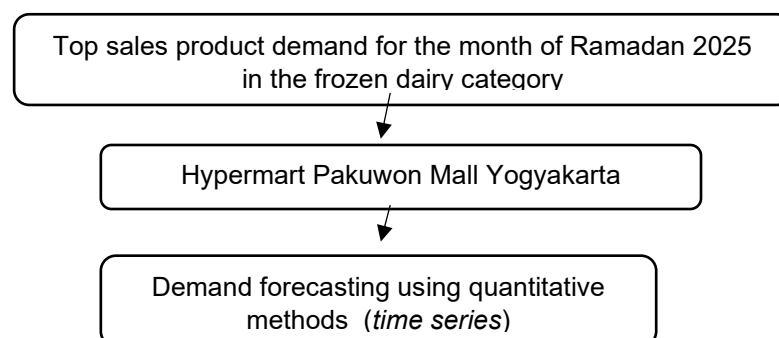
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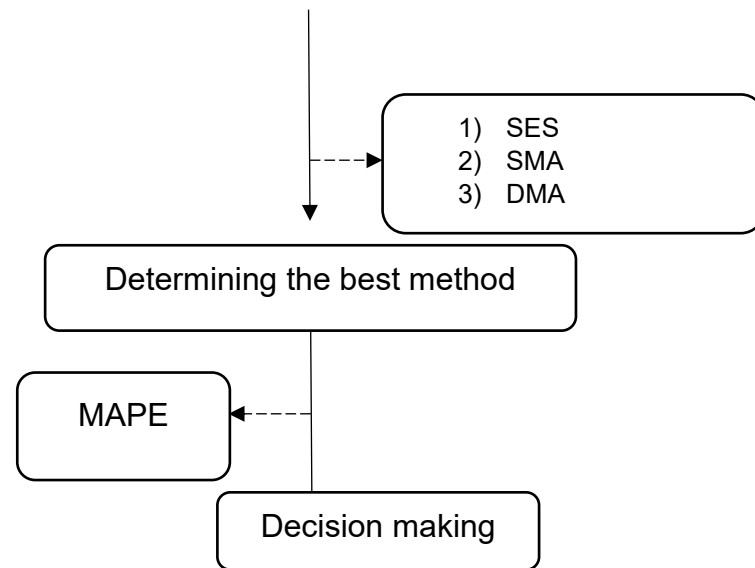
Y_t : actual demand in period t

F_t : demand forecast for period t

METHODOLOGY

This study uses a quantitative approach utilizing secondary data to determine the most accurate demand forecasting method. The research focused on the top-selling product during Ramadan 2025 in the frozen dairy category, namely Kanzler Chicken Nugget Crispy 450 g, with the data period from January 2023 to October 2025 as the unit of analysis. The data was obtained from the Hypermart Pakuwon Mall Yogyakarta database with the permission of the Store General Manager. moving average (DMA). Then, the forecasting results will be calculated using the mean absolute percentage error (MAPE). After obtaining the error value, the forecasting method with the smallest error value will be determined as the best forecasting method. For further clarification, this will be explained in the following framework:



**Figure 1 Framework**

RESULTS AND DISCUSSION

Data collection was carried out at Hypermart Pakuwon Mall Yogyakarta. This study used historical data on demand for Kanzler Chicken Nugget Crispy 450g products for the period January 2023 – October 2025. The following table shows the demand for Kanzler Chicken Nugget Crispy 450g products:

Table 1 Kanzler Chicken Nugget Crispy 450g Demand Data for the Period January 2023 - October 2025

Year	Month	Demand
2023	January	12
	February	406
	March	472
	April	805
	May	576
	June	472
	July	190
	August	384
	September	567
	October	472
	November	388
	December	535
2024	January	279
	February	409
	March	603
	April	420
	May	280

	June	269
	July	301
	August	255
	September	365
	October	265
	November	249
	December	279
2025	January	255
	February	209
	March	456
	April	207
	May	172
	June	149
	July	181
	August	187
	September	207
	October	204

Single Exponential Smoothing Calculation

The single exponential smoothing calculation results are obtained using formula (1). The error value is then calculated using the mean absolute percentage error accuracy measurement tool using formula (8). The α value used as a reference is 0.5. The following are the single exponential smoothing calculation results:

Table 2 Single Exponential Smoothing Method with Alpha 0.5

Period	Alpha	0,5	Error 0,5	MAPE 0,5 (%)
	Demand	Forecast Alpha (0,5)		
1	12	12,00	0,00	0,00%
2	406	12,00	394,00	97,04%
3	472	209,00	263,00	55,72%
4	805	340,50	464,50	57,70%
5	576	572,75	3,25	0,56%
6	472	574,38	-102,38	21,69%
7	190	523,19	-333,19	175,36%
8	384	356,59	27,41	7,14%
9	567	370,30	196,70	34,69%
10	472	468,65	3,35	0,71%
11	388	470,32	-82,32	21,22%
12	535	429,16	105,84	19,78%
13	279	482,08	-203,08	72,79%
14	409	380,54	28,46	6,96%
15	603	394,77	208,23	34,53%
16	420	498,89	-78,89	18,78%



17	280	459,44	-179,44	64,09%
18	269	369,72	-100,72	37,44%
19	301	319,36	-18,36	6,10%
20	255	310,18	-55,18	21,64%
21	365	282,59	82,41	22,58%
22	265	323,80	-58,80	22,19%
23	249	294,40	-45,40	18,23%
24	279	271,70	7,30	2,62%
25	255	275,35	-20,35	7,98%
26	209	265,17	-56,17	26,88%
27	456	237,09	218,91	48,01%
28	207	346,54	-139,54	67,41%
29	172	276,77	-104,77	60,91%
30	149	224,39	-75,39	50,59%
31	181	186,69	-5,69	3,15%
32	187	183,85	3,15	1,69%
33	207	185,42	21,58	10,42%
34	204	196,21	7,79	3,82%
AVERAGE				32,37%

Based on the calculation results using alpha 0.5, the MAPE value is 32.37%. This will then be compared with the results of calculations using other alphas, namely alpha 0.1 = 41.39%, alpha 0.2 = 36.97%, alpha 0.3 = 33.74%, alpha 0.4 = 32.79%, alpha 0.6 = 32.91%, alpha 0.7 = 33.60%, alpha 0.8 = 33.95%, and alpha 0.9 = 34.05%. The MAPE value of alpha 0.5 is the smallest compared to the others. So it can be said that alpha 0.5 is the best alpha value that can be used in the single exponential smoothing method.

Single Moving Average Calculation

The single moving average calculation uses formula (2). Then, the error value is calculated using the mean absolute percentage error accuracy measurement tool using formula (8). This study will use orders 3, 6, and 12. Order 6 will be used as a reference in the implementation of this method. The following are the results of the single moving average calculation:

Table 3 Single Moving Average Forecasting Method With Order 6

Period	Demand	SMA 6	Error SMA 6	MAPE 6 (%)
1	12	-	-	-
2	406	-	-	-
3	472	-	-	-
4	805	-	-	-
5	576	-	-	-
6	472	-	-	-
7	190	457,17	-267,17	140,61%

8	384	486,83	-102,83	26,78%
9	567	483,17	83,83	14,79%
10	472	499,00	-27,00	5,72%
11	388	443,50	-55,50	14,30%
12	535	412,17	122,83	22,96%
13	279	422,67	-143,67	51,49%
14	409	437,50	-28,50	6,97%
15	603	441,67	161,33	26,76%
16	420	447,67	-27,67	6,59%
17	280	439,00	-159,00	56,79%
18	269	421,00	-152,00	56,51%
19	301	376,67	-75,67	25,14%
20	255	380,33	-125,33	49,15%
21	365	354,67	10,33	2,83%
22	265	315,00	-50,00	18,87%
23	249	289,17	-40,17	16,13%
24	279	284,00	-5,00	1,79%
25	255	285,67	-30,67	12,03%
26	209	278,00	-69,00	33,01%
27	456	270,33	185,67	40,72%
28	207	285,50	-78,50	37,92%
29	172	275,83	-103,83	60,37%
30	149	263,00	-114,00	76,51%
31	181	241,33	-60,33	33,33%
32	187	229,00	-42,00	22,46%
33	207	225,33	-18,33	8,86%
34	204	183,83	20,17	9,89%
AVERAGE				31,40%

Based on the calculation results using order 6, the MAPE value is 31.40%. Then, this value will be compared with the MAPE values of orders 3 and 12. Order 3 produces a MAPE value of 33.95%. Meanwhile, order 12 produces a MAPE value of 39.34%. The MAPE value of order 6 produces the smallest value compared to orders 3 and 12. Therefore, order 6 is the best order that can be used in the single moving average method.

Double Moving Average Calculation

The results of the double moving average calculation use formulas (3), (4), (5), (6), and (7). Then, the error value is calculated using the mean absolute percentage error accuracy measurement tool using formula (8). This study will use orders 3, 6, and 12. Order 12 will be used as a reference in the implementation of this method. The following are the results of the double moving average calculation:



Table 4 Double Moving Average Forecasting Method With Order 12

Period	Demand	SMA 12	DMA 12	At	Bt	Ft	Error	MAPE 12
1	12	-	-	-	-	-	-	-
2	406	-	-	-	-	-	-	-
3	472	-	-	-	-	-	-	-
4	805	-	-	-	-	-	-	-
5	576	-	-	-	-	-	-	-
6	472	-	-	-	-	-	-	-
7	190	-	-	-	-	-	-	-
8	384	-	-	-	-	-	-	-
9	567	-	-	-	-	-	-	-
10	472	-	-	-	-	-	-	-
11	388	-	-	-	-	-	-	-
12	535	-	-	-	-	-	-	-
13	279	439,92	-	-	-	-	-	-
14	409	462,17	-	-	-	-	-	-
15	603	462,42	-	-	-	-	-	-
16	420	473,33	-	-	-	-	-	-
17	280	441,25	-	-	-	-	-	-
18	269	416,58	-	-	-	-	-	-
19	301	399,67	-	-	-	-	-	-
20	255	408,92	-	-	-	-	-	-
21	365	398,17	-	-	-	-	-	-
22	265	381,33	-	-	-	-	-	-
23	249	364,08	-	-	-	-	-	-
24	279	352,50	-	-	-	-	-	-
25	255	331,17	416,69	288,31	-11,67	276,63	-21,63	8,48%
26	209	329,17	407,63	254,70	-13,90	240,80	-31,80	15,21%
27	456	312,50	396,55	261,78	-12,25	249,53	206,47	45,28%
28	207	300,25	384,06	240,94	-13,01	227,93	-20,93	10,11%
29	172	282,50	369,63	230,87	-12,61	218,25	-46,25	26,89%
30	149	273,50	356,40	208,60	-13,44	195,16	-46,16	30,98%
31	181	263,50	344,48	202,52	-12,91	189,62	-8,62	4,76%
32	187	253,50	333,13	193,87	-12,66	181,21	5,79	3,10%
33	207	247,83	320,18	186,82	-12,12	174,70	32,30	15,61%
34	204	234,67	307,65	188,01	-10,88	177,14	26,86	13,17%
AVERAGE								17,36%

Based on the calculation results using order 12, the MAPE value is 17.36%. This value will then be compared with the MAPE values of orders 3 and 6. Order 3 produces a MAPE value of 57.87%, while order 6 produces a MAPE value of 28.17%. The MAPE value of order 12 is the smallest compared to orders 3 and 6. Therefore, order 12 is the best order that can be used in the double moving average method.

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CONCLUSION

Based on the data processing that has been carried out, the following conclusions can be drawn:

1. So, the results of the forecasting that produced the smallest error value based on the Mean Absolute Percentage Error calculation, namely for Single Exponential Smoothing, the smallest value was obtained at alpha 0.5 with an error value of 32.37%. For Single Moving Average, the smallest value is obtained at order 6 with an error value of 31.40%. For Double Moving Average, the smallest value is obtained at order 12 with an error value of 17.36%.
2. Based on the forecast for Kanzler Chicken Nugget Crispy 450gr products for the period January 2023 - October 2025, when using the Double Moving Average method, it produced the best forecast by obtaining the smallest error value compared to the Single Exponential Smoothing and Single Moving Average methods. This is proven by the fact that using the Double Moving Average method at order 12 produces an average MAPE value of 17.36%, which is smaller than the average MAPE value of the other methods.

It is recommended that Hypermart Pakuwon Mall Yogyakarta use this method while continuing to conduct periodic forecasting evaluations to adjust for any changes in patterns that may occur in the future.

Further research is recommended to conduct trials using other forecasting methods. This is to determine whether there are other forecasting methods that produce significantly better results than the double moving average method. It is also recommended to use historical data covering a longer period to obtain more stable forecasting results.

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