EAI Endorsed Transactions
on e-Learning

Research Article EAI.EU

Comparison of SES and SMA Method Against Production Level Property of Fabrication Precision Engineering and Its Effect on Production Planning (Case Study PT X)

Via Rensi Novita Alfa Reza[1], Ancala Laras Putri[2]

[1]Student, Politeknik Negeri Batam, viarensinovita@gmail.com
[2]Lecturer, Politeknik Negeri Batam, ancala@polibatam.ac.id

Abstract

One of the goals of forecasting is to be able to predict the data needed in the future, one of which is the data on demand for the amount of production in a company. PT X is a manufacturing company based on demand or custom. This leads to uncertainty in the use of required materials, so proper forecasting is needed to estimate the material stock requirements. This study used single exponential smoothing and single moving average methods with quantitative approaches to aluminum materials. By calculating forecasting using these two methods, it is possible to find the best method for use by PT X. Based on the test, the SES method has the smallest error rate so it can be used to analyze the data, with α=0.8 yielding a forecast in the 13th month of 308.71408 pcs.

Keywords: Forecasting, SES, SMA, Aluminum

Received on 13 August 2023, accepted on 04 September 2023, published on 27 September 2023

doi: 10.4108/eetel.3709

*Corresponding author. Email: viarensinovita@gmail.com

1. Introduction

To support the increase in the 4.0 technology revolution, especially industrial automation, companies in the field of industrial automation will need many components to build a machine. To realize a component with a specific design according to the needs of the machine, a process is required, namely fabrication. Fabrication can be defined as manual processing or automatic processing of raw materials using tools used in the manufacturing industry [4].

PT X is a company that focuses on manufacturing various types of high-precision parts, nozzles, and custom-made, located in Batam, Riau Islands. In production, PT X uses several machines in its production, such as CNC, milling, lathe, and grinding.

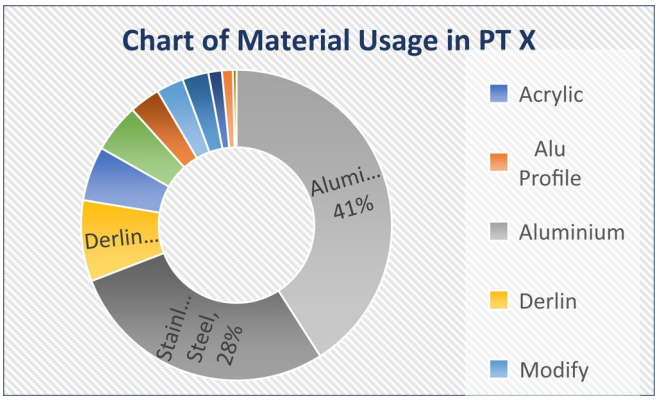
In PT X, the supply of material stocks tends to be by estimating the most needs by just looking at what material stocks are starting to run low, not from detailed forecasting calculations, so it is not uncommon for purchased materials to fill the warehouse and become assets that take time to melt them.

According to [9] of Singkong Srikandi Chip, by calculating forecasting using single exponential smoothing techniques, forecasting provides business owners with the benefit of determining how many stocks of goods should be available at any time.

In previous studies by [1] in PT Y, which is a company focused on tea sales, it can be seen that by performing a single moving average method, it can calculate the number of flavored tea variants to be produced, allowing the company to avoid excess or deficiency of the product.

Forecasting in this research is short-term forecasting performed regularly and repeatedly using internal data in the form of daily, weekly, or monthly data using quantitative techniques and performed in detail.

Based on the problems PT X experienced, this study calculates stock forecasting by comparing the results of the study to other studies. The method uses a single exponential smoothing method and a single moving average method against aluminum material. The selection of aluminum materials is due to the company's data, the use of aluminum materials influences 41% throughout 2022. This study will also compare the two methods to determine which forecasting method is most appropriate for a deeper study by PT X and provide results that can determine the direction of manufacturing production of fabrication precision engineering in PT X, referring to previous studies.



2. Literature Review

2.1. Forecasting

According to [6], forecasting is the art and science of predicting what will happen in the future. Forecasting can be done by placing data in the past and projecting it into the future using a systematic calculation method. Forecasting is considered a scientific approach. A prognosis always acts as the basis for any choices made regarding future events [3].

2.2. Single Exponential Smoothing (SES)

The single exponential smoothing method is a method that uses the latest data to repeat continuous calculations. Each of these information data can be represented by the α symbol. Symbols can be defined freely, to reduce the burden of forecast inaccuracy. The value of the graduation constant can be determined by the terms $0 < 1 < 1$.

Low α values are appropriate for data whose movement is stable. When responsive data or demand changes have a large enough movement, a larger yang value is more appropriate to use. To find yang the correct value, a trial-and-error process with various numbers is required to determine which value has the lowest error score.

The formula for single exponential smoothing is as follows:

$$Ft = F_{t-1} + \alpha\,(A_{t-1} - F_{t-1}) \quad (1)$$

Description:

Ft = Periodic forecasting value

F_{t-1} = Estimated forecast from the previous period

α = Constanta Exponential Smoothing

A_{t-1} = Period t- observation data.

2.3. Single Moving Average (SMA)

This method can be defined as a forecasting strategy that involves retrieving a set of observational data by searching the mean value of actual data and projecting the data for future periods.

This technique can be used if historical data do not have a seasonal trend component or influence [11]. The purpose of the single-moving average method is to eliminate the recording in a time series. This goal can be achieved by taking the mean in the data and eliminating possible positive and negative errors [11].

Here's the equation for the Single Moving Average:

$$F_{t+1} = \frac{A_t + A_{t-1} + A_{t-n+1}}{N} \quad (2)$$

Description:

At = Periodic t observation data

N = Number of time series used

F_{t+1} = Period forecast value t+1

N = Period used

2.4. Accuracy of Forecasting Results

2.4.1 Mean Absolute Deviation (MAD)

MAD is the result of reducing the actual value and forecasting from each subsequent period rather than summing up the results without regard to the results of forecasting larger or smaller actual data. The formula MAD is as follows:

$$MAD = \Sigma \frac{(At - Ft)}{n} \quad (3)$$

Description:

At = Actual request at period t

Ft = Forecasting at period t

N = Number of forecasting periods involved

2.4.2 Mean Square Error (MSE)

Mean Square Error is a calculation used to determine the error of the rank of the mean value. The MSE is derived by adding the square of all forecasting errors in each period and dividing the total number of forecasting periods by the number of forecasting periods. The MSE formula is as follows:

$$MSE = \Sigma \frac{(At-Ft)2}{n} \quad (4)$$

Description:

At = Actual request at period t

Ft = Forecasting at period t

N = Number of forecasting periods involved

2.4.3 Mean Absolute Percentage Error (MAPE)

Mean Absolute Percent Error is the result of subtracting actual and predictive values from absolute values and dividing them by actual per-period. MAPE's formula is as follows:

$$MAP = \left(\frac{100}{n}\right) \Sigma \, At \frac{Ft}{At} \quad (5)$$

Description:

At = Actual request at period t

Ft = Forecasting at period t

N = Number of forecasting periods involved

2.5. WINQSB or QSB Software

QSB software is software used in Windows operating systems with troubleshooting functions for business and management operations research. To perform forecasting, a menu feature that can be used in WINQSB is the Forecasting and Linear Program menu. Users can enter actual data from previous periods to obtain predictions of future data.

3. Methods

This study is an exploratory descriptive study with a quantitative approach. Descriptive research is intended to explain a problem's cause and describe a current situation. This study aims to explain a variable and to compare production forecasting methods of fabrication precision engineering and its effect on production planning.

4. Results and Discussion

Research data used in this study were obtained through PT X's daily progress data on aluminum material demand from January 2022 to December 2022. Data are shown in table 1 below:

Table 1. PT X Aluminum Material Usage Data for 2022

No	Month	Demand (pcs)
1	Jan	240
2	Feb	1526
3	Mar	424
4	Apr	568
5	May	384
6	Jun	195
7	Jul	127
8	Aug	331
9	Sep	308
10	Oct	301
11	Nov	309
12	Dec	435
Average		**429**

(Source: PT X Data, 2022)

The data above are obtained from PT X, which will then be calculated with a value of $\alpha = 0.8$ for the single exponential smoothing method and divided into 5 periods for the single moving average method. The calculations will be done manually first and then will be compared with the WINQSB software application to prove the accuracy of the calculations manually performed.

4.1. Single Exponential Smoothing Forecasting Calculation

Calculation of forecasting using the single exponential smoothing method is performed using formula (1) by calculating the accuracy of MAD, MSE, and MAPE errors using formulas (3), (4), and (5), which give the following calculation results.

Table 2. Calculation Results of Aluminum Material Forecasting Single Exponential Smoothing Method

No	Month	Demand (pcs)	Forecasting
1	Jan	240	240
2	Feb	1526	240
3	Mar	424	1268,8
4	Apr	568	592,96
5	May	384	572,992
6	Jun	195	421,7984
7	Jul	127	240,35968
8	Aug	331	149,671936
9	Sep	308	294,7343872
10	Oct	301	305,3468774
11	Nov	309	301,8693755
12	Dec	435	307,5738751
13			308,714775
14			409,742955

(Source: Microsoft Excel Processing Result, 2023)

Table 3. Forecasting Calculations with MAD, MSE, and MAPE Errors

No	Month	Demand (pcs)	Ft	MAD	MSE	MAPE
1	Jan	240	240			
2	Feb	1526	240	1286	1653796	84%
3	Mar	424	1268,8	1065,4	1183741,5	142%
4	Apr	568	592,96	718,58667	789368,68	96%
5	May	384	572,992	586,188	600956	84%
6	Jun	195	421,7984	514,31008	491052,31	91%
7	Jul	127	240,35968	447,48501	411351,99	90%
8	Aug	331	149,67194	409,46259	357284,55	85%
9	Sep	308	294,73439	359,93797	312645,97	75%
10	Oct	301	305,34688	320,42785	277909,63	67%
11	Nov	309	301,86938	289,09813	250123,75	61%
12	Dec	435	307,57388	274,40067	228861,36	58%
13			308,71478			
14			409,74296			

(Source: Microsoft Excel Processing Result, 2023)

The calculation results for the forecasted demand amount for the next two months were 308.714775 pcs and 409.742955 pcs. The results for this calculation are shown in Table 3 number 12. Other results shown are the number of errors in Table 3 number 12, with MAD 274,4006712, MSE 228861.3592, and MAPE 58%.

Calculating single exponential smoothing method forecasting using WINQSB can be done by including the data previously found in Table 1 into the WINQSB system. Next, the forecast calculation results for the next month will be listed in forecast numbers 13 and 14 in Table 4.

Table 4. Calculation Results of SES Method Aluminum Material Forecasting with WINQSB

(Source: WINQSB Processing Result, 2023)

07-18-2023 Month	Actual Data	Forecast by SES	Forecast Error	CFE	MAD	MSE	MAPE (%)	Tracking Signal	R-square
1	240								
2	1526	240	1286	1286	1286	1653796	84,27261	1	
3	424	1268,8	-844,8	441,2	1065,4	1183742	141,759	0,4141167	
4	568	592,96	-24,96002	416,2399	718,5867	789368,7	95,97076	0,5792481	0,8421303
5	384	572,992	-188,992	227,2479	586,188	600956	84,28224	0,3876707	0,6547824
6	195	421,7984	-226,7984	0,4495239	514,3101	491052,3	90,68717	8,740329E-04	0,5531982
7	127	240,3597	-113,3597	-112,9102	447,485	411352	90,44924	-0,2523217	0,5609053
8	331	149,6719	181,3281	68,41791	409,4626	357284,6	85,3539	0,167092	0,6504447
9	308	294,7344	13,26563	81,68353	359,938	312646	75,22305	0,2269378	0,6603694
10	301	305,3469	-4,346863	77,33667	320,4279	277909,7	67,02539	0,2413544	0,6641505
11	309	301,8694	7,130615	84,46729	289,0981	250123,8	60,55361	0,2921751	0,6689199
12	435	307,5739	127,4261	211,8934	274,4007	228861,4	57,71177	0,7722044	0,6822366
13		409,5148							
14		409,5148							
CFE		211,8934							
MAD		274,4007							
MSE		228861,4							
MAPE		57,71177							
Trk.Signal		0,7722044							
R-square		0,6822366							
		Alpha=0,8							
		F(0)=240							

If analyzed, manual single exponential smoothing method forecasting and forecasting results using WINQSB software, the same amount of forecasting is 409 pcs. Then, the results of errors generated through manual methods and WINQSB were also the same, 274,4007 for MAD, 228861.4 for MSE, and 57.71177 or 58% for MAPE. With the data comparison results, it is possible to manually infer the forecasting calculation of the single exponential smoothing method through the correct methods and formulas.

4.2. Single Moving Average Forecasting Calculation

The calculation of forecasting using the single moving average method is performed using formula (2) with the calculation of the accuracy of MAD, MSE, and MAPE errors using formulas (3), (4), and (5) giving the following results.

Table 5. Calculation Results of Aluminum Material Forecasting Single Moving Average Method

No	Month	Demand (pcs)	Forecasting
1	Jan	240	
2	Feb	1526	

No	Month	Demand (pcs)	Forecasting
3	Mar	424	
4	Apr	568	
5	May	384	
6	Jun	195	628,4
7	Jul	127	619,4
8	Aug	331	339,6
9	Sep	308	321
10	Oct	301	269
11	Nov	309	252,4
12	Dec	435	275,2
13			336,8
14			338,25

(Source: Microsoft Excel Processing Result, 2023)

Table 6. Forecasting Calculations with MAD, MSE, and MAPE Errors

No	Month	Demand (pcs)	Ft	MAD	MSE	MAPE
1	Jan	240				
2	Feb	1526				
3	Mar	424				
4	Apr	568				
5	May	384				
6	Jun	195	628,4	433,4	187835,6	222%
7	Jul	127	619,4	462,9	215146,7	305%
8	Aug	331	339,6	311,467	143455,8	204%
9	Sep	308	321	236,85	107634,1	154%
10	Oct	301	269	195,88	86312,06	125%
11	Nov	309	252,4	172,667	72460,64	108%
12	Dec	435	275,2	170,829	65757,13	97%
13			336,8			
14			338,25			

(Source: Microsoft Excel Processing Result, 2023)

The calculation results for forecasted demand amounts for the next two months were 336.8 pcs and 338.25 pcs. The results of this calculation are shown in Tables 6 numbered 13 and 14. Other results shown are the number of errors in table 6 number 12, with MAD 170,8285714, MSE 65757,12571, and MAPE 97%.

Table 7. SMA Method Aluminum Material Forecasting Results with WINQSB

07-18-2023 Month	Actual Data	Forecast by 5-MA	Forecast Error	CFE	MAD	MSE	MAPE (%)	Tracking Signal	R-square
1	240								
2	1526								
3	424								
4	568								
5	384								
6	195	628,4	-433,4	-433,4	433,4	187835,6	222,2564	-1	
7	127	619,4	-492,4	-925,8	462,9	215146,7	304,9865	-2	
8	331	339,6	-8,600006	-934,4	311,4667	143455,8	204,1904	-3	
9	308	321	-13	-947,4	236,85	107634,1	154,198	-4	
10	301	269	32	-915,4	195,88	86312,06	125,4846	-4,673269	
11	309	252,4	56,60001	-858,8	172,6667	72460,65	107,6234	-4,973745	
12	435	275,2	159,8	-699,0001	170,8286	65757,13	97,49657	-4,091822	
13		336,8							
14		336,8							
15		336,8							
16		336,8							
17		336,8							
CFE		-699,0001							
MAD		170,8286							
MSE		65757,13							
MAPE		97,49657							
Trk.Signal		-4,091822							
R-square									
		m=5							

(Source: WINQSB Processing Result, 2023)

The single moving average method forecasting calculation using WINQSB software can be done by including the actual data previously found in Table 1 in the WINQSB system. Furthermore, the following month's forecast results will be listed in forecast numbers 13 and 14 in Table 7.

Based on the forecasting results of the single moving average method manually and the forecasting results using WINQSB software, the same number of forecasts is 338 pcs. Then, the results of errors generated through manual methods and WINQSB were also the same, with 170.8286 for MAD, 65757.13 for MSE, and 97.49657 or 97% for MAPE. With the results of the data comparison, it is possible to conclude that the forecasting calculation of the single moving average method manually is through the correct way and formula.

4.3. Comparison of Forecasting Results for SES Methods and SMA Methods

Data that will be used to determine the most precise method to consider by PT X is data from Table 3 for the following methods, which are derived from the following data:

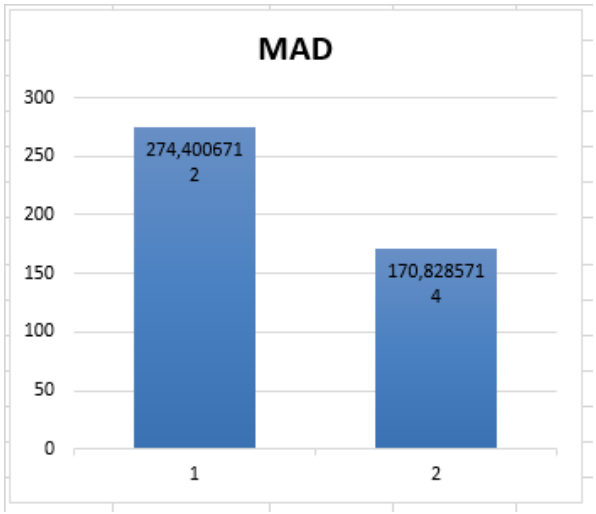
Table 8. SES and SMA Forecasting Results

Metode	Forecasting (Ft)	MAD	MSE	MAPE
SES	307,5738751	274,4006712	228861,3592	58%
SMA	275,2	170,8285714	65757,12571	97%

(Source: Microsoft Excel Processing Result, 2023)

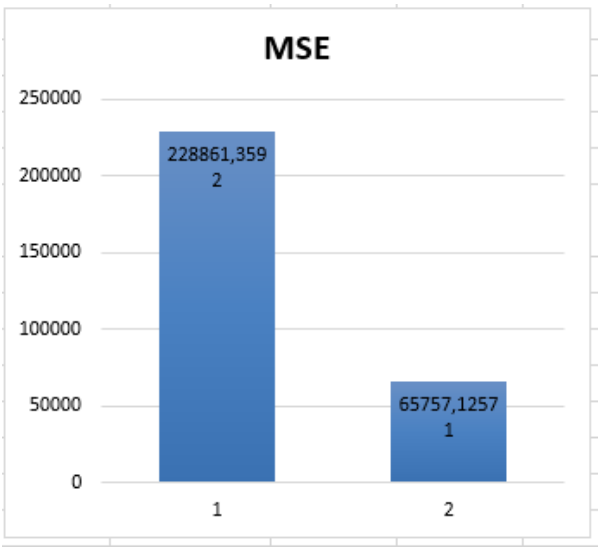
The table above is the result of calculating the manufacturing demand for manufacturing precision fabrication of aluminum materials using the single exponential smoothing method and the 12th-month single moving average, with the forecasting results for the next period in the Forecasting (Ft) column. Using MAD, MSE, and MAPE, the comparison of the MAD, MSE, and MAPE diagrams shows the following single exponential smoothing and single moving average methods:

Table 9. Comparison of MAD on SES Methods and SMA Methods



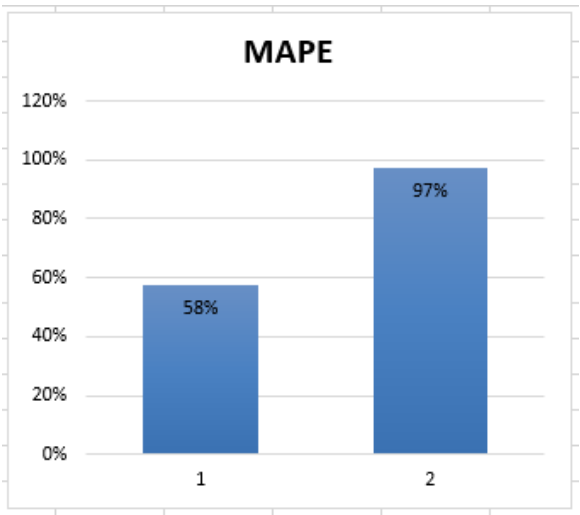
(Source: Microsoft Excel Processing Result, 2023)

Table 10. Comparison of MSE on SES Methods and SMA Methods



(Source: Microsoft Excel Processing Result, 2023)

Table 11. Comparison of MSE on SES Methods and SMA Methods



(Source: Microsoft Excel Processing Result, 2023)

The three diagrams above state that number 1 is the SES method and number 2 is the SMA method. From the SES method, it is shown that the number of errors is 274,4006712 (MAD), 228861.3592 (MSE), and 58% (MAPE). From the SMA method, it is shown that the number of errors is 170.8285714 (MAD), 65757,12571 (MSE), and 97% (MAPE).

In this study, researchers want to find the smallest error value, in Table 9 number 2 (single moving average) in MAD has the smallest error value of 170.828571. For MSE, the number 2 (single moving average) also has the smallest value of 65757,12571. However, in MAPE, number 1 (single exponential smoothing) has the smallest error value of 58%. The lower the MAPE value is generated, the ability of the forecasting method used can be said to be good, and vice versa. (Y. Zhang, Han, Pan, Xu, & Wang, 2021).

Based on the MAPE values described above, it can be seen that using single exponential smoothing as a forecasting method is a better method than the single moving average method and is more suitable for use in manufacturing precision fabrication of aluminum materials in PT X.

4.4. The Effect of Forecasting on Production Planning

Based on data obtained from PT X, it can be seen that the use of aluminum material in the production department at PT X accounts for 41% of the influence throughout 2022. This makes aluminum the most widely used material by PT X, so it needs to be done thorough planning to minimize the company's losses in overstocking.

From the calculation of the forecasting done before, Forecasting can benefit business operators because it will

minimize losses caused by excess or shortage of material stocks. By performing the forecasting, the company can determine the estimated number of incoming requests, so that it can prepare the necessary things in planning. This is by the forecasting function according to Assauri (2008), which can help in the supervision of inventory so that material stocks, so will not be too large or too small, and also help in the supervision of stock purchases.

5. Conclusions and Suggestions

5.1. Conclusions

Research results show that the single exponential smoothing method's forecasting results in an estimate of 307.5738751 and in the 14th month it yields an estimate of 409.74296, with an error MAD of 274,4006712, an error MSE of 228861,3592, and an error MAPE of 58%.

Research results show that the single moving average forecasting method results in an estimate of 275.2 and the 14th month produced an estimate of 338.25, with MAD error calculation of 170.8285714, MSE error calculation result of 65757,12571, and MAPE error calculation of 97%.

Comparison of forecasting results between single exponential smoothing and single moving average methods shows that single exponential smoothing methods are more appropriate for PT X. This is based on the MAPE error calculation results between the two methods, which show that the MAPE value by single exponential smoothing method is less than the MAPE value of single moving average method, which is 58% while the MAPE value of single moving average method has 97%.

5.2. Suggestions

It is hoped that the data used to perform forecasting calculations are the latest data because it is to ensure the accuracy of forecasting results that will occur in the future. A prediction can be confirmed to be true when the predicted time has come. In this study, the more appropriate forecasting method to apply is the single exponential smoothing method, which is because forecasting using observation data with monthly demand distances is quite contrasting. Based on the results of the study, the researchers recommend performing forecasting calculations using the latest data, then identifying the data, and then performing forecasting calculations, because forecasting calculations can have an impact on planning, one of them being material stock planning.

The researchers suggest PT X to be able to review and try to apply forecasting calculations using the single exponential smoothing method. Next, the researchers advised PT X to try to calculate forecasting using different methods to find the most accurate forecasting method as required by PT X.

References

[1] **Journal Article:** Andriana, A. D., & Susanto, R. (2017). Peramalan Jumlah Produksi Teh Menggunakan Metode. *Prosiding SAINTIKS FTIK UNIKOM*.

[2] **Journal Article:**Anis, Nandiroh, & Utami. (2007). Optimasi Perencanaan Produksi dengan Metode Goal Programming. *Jurnal Teknik Industri*, 133 - 143.

[3] **Book:** Assauri, S. (1984). *Teknik Model Peramalan.* Jakarta: Universitas Indonesia.

[4] **Article:** Daniarsyah, A. (2021, Februari 12). *Fabrikasi dalam Industri - Definisi, Jenis, Proses, dan Contoh Produknya*. Diambil kembali dari WIRA: https://wira.co.id/fabrikasi-adalah/

[5] **Book:** Ginting, R. (2007). *Sistem Produksi.* Yogyakarta: Graha Ilmu.

[6] **Book:** Heizer, J., & Render, B. (2011). *Manajemen Operasi Edisi Sembilan.* Jakarta: Salemba Empat.

[7] **Book:** Herjanto, E. (2008). *Manajemen Operasi Edisi Ketiga.* Jakarta: Grasindo.

[8] **Journal Article:** Hudaningsih, N., Utami, S. F., & Jabbar, W. A. (2020). Perbandingan Peramalan Penjualan Produk AKNIL PT Sunthi Sepuri Menggunakan Metode Single Moving Average dan Single Exponential Smoothing. *Jurnal JINTEKS*, 15 - 22.

[9] **Journal Article:** Indah, D. R., & Rahmadani, E. (2018). Sistem Forecasting Perencanaan Produksi. *Jurnal Penelitian Ekonomi Akuntansi (JENSI)*, 10 - 18.

[10] **Book:** McKinsey & Company. (2019). *Otomatisasi dan Masa Depan Pekerjaan di Indonesia.* Jakarta: Mckinsey & Company.

[11] **Journal Article:** Nurlifa, A., & Kusumadewi, S. (2017). Sistem Peramalan Jumlah Penjualan Menggunakan Metode Moving Average pada Rumah Jilbab Zaky. *Jurnal INOVTEK Polbeng*.

[12] **Journal Article:** Saiful, M. A. (2021). Perbandingan Single Exponential Smoothing Dan Metode Single Moving. *Prosiding SAINTIKS FTIK UNIKOM*.

[13] **Journal Article:** Santiari, N. L., & Rahayuda, I. S. (2021). Analisis Perbandingan Metode Single Exponential Smoothing dan Single. *Jurnal Informatika Universitas Pamulang*, 312 - 318.

[14] **Journal Article:** Sitorus, N. S., Siagian, Y., & Aulia, R. (2021). Penerapan Metode SMA untuk Peramalan Tingkat Produksi Tanaman Pangan di Dinas Pertanian. *Journal of Computer*, 27 - 32.

[15] **Book:** Sugiyono. (2017). *Metode Penelitian Kuantitatif, Kualitatif.* Bandung: CV Alfabeta.

[16] **Journal Article:** Thahirah, F. S., Barus, M. D., & Mustafa. (2021). Single Exponential Smoothing: Analisis Forecasting dalam unyuPerencanaan Produksi (Studi Kasus PT Food Beverages Indonesia). *Seminar of Social Sciences Engineering & Humaniora*, 199 - 212.