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Implementation of Incident Forecasting Using Moving Average and Exponential Smoothing Methods at Shared Services ICT PT Pertamina (Persero)

Fadly Febrian[1], Ravi Salim[2]
[1]Master of Management Information System, Gunadarma University, Depok, West Java, Indonesia-16424
[2]Master of Management Information System, Gunadarma University, Depok, West Java, Indonesia-16424
Email address: [1]fadli10.ff(at)gmail.com, [2]ravi(at)staff.gunadarma.ac.id

Abstract— *Information technology (IT) has become a significant role in operational needs in supporting an organization's business. Good utilization and management are required to improve IT services. Data analysis activities in IT service management have a significant role in generating information that assists in decision-making. The Shared Services ICT Division of PT Pertamina (Persero) uses the Information Technology Infrastructure Library (ITIL) framework as a guideline for the governance and management of IT services in holding and sub-holding companies. Incident management and Service Desk are part of the service management practices in the ITIL framework. Each incident ticket report has a service level agreement (SLA) that has to be fulfilled by the support staff to resolve the incident. The forecasting process is needed to produce predictions of future incidents. Incident prediction can help make decisions by analyzing similar problems that will occur. The forecasting method used in this study is the time series forecasting methods: Single Moving Average, Double Moving Average, and Single Exponential Smoothing. The data used is the incident data on five categories of IT services that are often reported by customers to the service desk of the Shared Services ICT department every month from January 2021 to December 2021. Determining the best forecasting method is considering the minor error of each forecasting method used. The error value obtains by using the Mean Forecast Error (MFE), Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE) methods.*

Keywords— *Forecasting, Prediction, Incident Management, Time Series, Moving Average, Single Exponential Smoothing, Mean Absolute Percentage Error*.

I. INTRODUCTION

Information technology (IT) has become a significant role in operational needs in supporting an organization's business. Good utilization and management are required to improve IT services. Data analysis activities in IT service management have a significant role in generating information that assists in decision-making. Data analysis has become a primary and vital need to improve the business competitiveness of an organization or company. Philosophically, information technology service management is an IT management method that is centered on the customer perspective. Currently, several organizations apply standards for managed IT services to provide value that is very beneficial to the organization's business development. Infrequently, the utilization of IT in an organization is unperceived optimally by the organization due to having difficulty managing it.

PT Pertamina (Persero) attempts to improve IT services for operational needs in supporting an organization's business. PT Pertamina (Persero) adheres to customer-focused behavior's is oriented to the customer's interest, and stands committed to providing the best service to customers. The Shared Services ICT Department of PT Pertamina (Persero) uses the Information Technology Infrastructure Library (ITIL) framework as a guideline for the governance and management of IT services in holding and sub-holding companies.

Incident management and ServiceDesk are part of service management practices in the ITIL framework (Aditya, 2019) and are managed by a Business Supporting Organization - Shared Services which is the object of this research. Each incident ticket report has a service level agreement (SLA) that must be fulfilled by the support staff in resolving the incident. The results of observing monthly incident data reported by customers found tickets with breached status, namely SLAs that were unfulfilled. In addition, tickets with state open also find are tickets that had not responded. That matter reduces the quality of service provided and violates the Customer-Focused. An incident like this causes by human error or lack of resources.

The forecasting process is needed to produce predictions of future incidents. Incident prediction can help make decisions by analyzing similar problems that will occur. Forecasting is done by using information from the past and present to identify conditions or expected future events (Lusiana & Yuliarty, 2020). The forecasting method used in this research is the time series forecasting method. The three different methods of time series forecasting method used are the Moving Average method and the Single Exponential Smoothing method. To test which methods are the most accurate in the incident data forecasting process, namely by using the Mean Forecast Error (MFE), Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE) methods. Forecasting incident data expects to help Business Support - Shared Services organizations generate information that can play a role in making decisions for IT service management.

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II. LITERATURE REVIEW

A. Research Study

Several studies related to time series forecasting methods conducted by previous researchers. Research on quantitative forecasting using the time series method was conducted by (Chua & Tumibay, 2020) using the Exponential Smoothing method with various models using different alpha values in monthly crime data analysis. Each type of crime incident indicates the need for different alpha values to be used. A study conducted by (Bachri, 2019) used the Single Moving Average method, resulting in the forecasting where the divorce rate within the next four months would increase compared to the next three months. Another research by (Lusiana & Yuliarty, 2020) uses three methods used in forecasting, namely the Exponential Method, Exponential Smoothing with "α = 0,1" and Exponential Smoothing with "α = 0,2" which then evaluates the three methods by calculating the error value in forecasting.

Research by (Kusuma, 2021) predicted the amount of poverty in the future using the Single Moving Average method and refined again using the Double Moving Average method, where the error rates to the value resulting from the combination of the two methods are "3.47%" the difference from the total actual real. The following research by (Samuel, 2020) used the time series forecasting method validated using the minor error value so that in the forecasting method for goods demand, there are six type items should be forecasted using the linear methods, four type items should be forecasted using the linear method quadratic, and one type items should be forecasted using the simple moving average method.

Research by (Chaerunnisa, 2021) in predicting future sales, uses the Double Exponential Smoothing and Moving Average forecasting methods. The results show a comparison of the accuracy and the smallest error value in each method. Furthermore, another study conducted by (Hajjah, 2021) the error analysis of forecasting the demand for an item using the Moving Average and Exponential Smoothing methods. The Moving Average method is used for forecasting three-month and five-month periods, while the Exponential Smoothing method uses the parameter "$a = 0.1; 0.5; 0.7; 0.9$". The error analysis used is Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE).

B. Forecasting

Forecasting is using previous data of a variable or a set of variables to estimate future values (Stephanie, 2012). Forecasting has a significant role in a company because forecasting is the basis of a production plan, which is also related to inventory. Therefore, selecting the right forecasting method is one of the important factors in determining to forecast.

Forecasting has several stages or steps that implemented. There are three stages involved in the design of a forecasting method:

- Analyze past data, this step aims to get a view of the pattern from the data concerned.
- Choosing the method that will be used, there are various methods available according to their needs. The choice of method can affect the forecast results. Forecast results are measured by calculating error or the smallest error. Therefore, there is no one-size-fits-all forecasting method.
- The transformation process from past data used the selected method. If necessary, changes will be made as needed.

In general, forecasting methods can be classified into two categories, namely qualitative and quantitative (Mason. & Lind, 1999). Qualitative forecasting is forecasting based on qualitative data in the past, for example on consumer tastes for a product or surveys on consumer loyalty. The results of the qualitative development are based on subjective estimates and expert opinions.

Quantitative forecasting is based on past quantitative data obtained through statistical and mathematical observations of previous values. This method is based on statistical principles has a high level of accuracy or can minimize errors, is also more systematic, and is more popular in its use. Classification of forecasting methods can be seen in Figure 1.

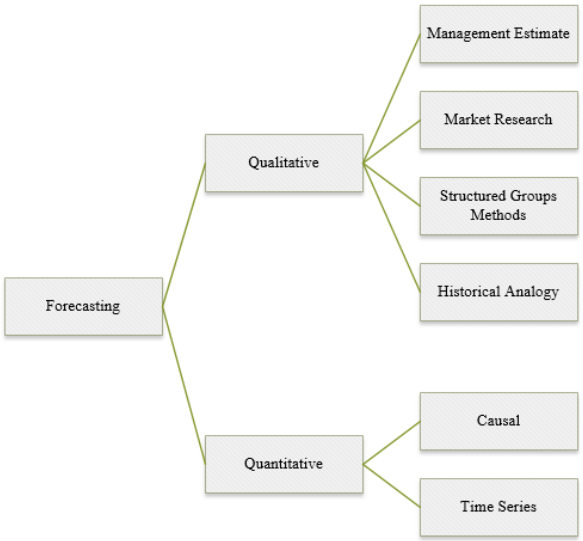

Fig. 1. Forecasting Methods

C. Single Moving Average

Single moving average (SMA) is a forecasting method that uses the average of several recent data to forecast the future period. Using the SMA method, the time series of the original data is converted into a moving average data series that is smoother and less dependent on oscillations making it more likely to show underlying trends or cycles in data patterns over time. SMA develops a model based on the average calculation results from most studies using the equation (Makridakis & Wheelwright, 1999):

$$S_t = \frac{1}{m} \sum_{i=t-m+1}^{t} X_i \quad (1)$$

Forecasting process of smoothing results with the equation:

$$F_t = S_{t-1} \quad (2)$$

D. Double Moving Average

Forecasting using the double moving average (DMA) method is the second moving average calculation to reduce systematic errors that occur when a single moving average is

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used on trending data. After carrying out the smoothing process in two stages, then be forecasted with the moving average using the equation (Makridakis & Wheelwright, 1999).

First stage smoothing:

$$S_{1,t} = \frac{1}{m} \sum_{i=t-m+1}^{t} X_i \quad (3)$$

Second stage smoothing:

$$S_{2,t} = \frac{1}{m} \sum_{i=t-m+1}^{t} S_{1i} \quad (4)$$

The forecasting process of the 2-stage smoothing results is obtained by the equation:

$$F_{2,t+5} = A_t + B_t m \quad (5)$$

A_t and B_t obtained from the following equation:

$$A_t = 2\,S_{1,t} - S_{2,t} \quad (6)$$

$$B_t = \frac{2}{m-1}(S_{1,t} - S_{2,t}) \quad (7)$$

E. Single Exponential Smoothing

Single Exponential Smoothing (SES) is being used in conditions where the weight of the data in one period is different from the data in the previous period and forms an Exponential function. This method reduces the problem of data distortion because there is no need to save historical data anymore. The effect of the size is in the opposite direction to the effect of entering the number of observations. This method constantly follows any trend in the actual data because all it can do is do nothing more than adjust future forecasts by a percentage of the last error. Determining is close to optimal requires several tries, the value lies between 0 and 1 The forecasting process is obtained by the equation (Makridakis & Wheelwright, 1999):

$$F_{t+1} = aX_t + (1 - a)F_t \quad (8)$$

F. Evaluation of Forecasting Methods

Every forecast does not have a 100% accuracy rate because the forecast must contain errors. Therefore, to find out the forecasting method with a high level of accuracy, it is necessary to calculate the error rate in a forecast. The smaller the error generated, the better the forecast (Makridakis & Wheelwright, 1999). Forecasting errors affect decisions in two ways, namely errors in choosing forecasts techniques and errors in evaluating the success of forecasting utilization.

Methods that can be used to measure forecasting errors are Mean Forecast Error (MFE), Mean Squared Error (MSE), Mean Absolute Percentage Error (MAPE), and Mean Absolute Deviation (MAD). MFE is the average error, MSE is a measure of forecast deviation and does not consider whether the error is negative or positive, MAPE calculates forecast error using a percentage, and MAD is the average absolute error generated using equations. Forecasting error calculations can be generated using the following equation (Makridakis & Wheelwright, 1999):

$$\text{MAE} = \frac{\sum (X_t - F_t)/n}{n} \quad (9)$$

$$\text{MSE} = \frac{\sum (X_t - F_t)^2}{n} \quad (10)$$

$$\text{MAPE} = \left(\frac{100}{n}\right) \sum \left| X_t - \frac{F_t}{X_t} \right| \quad (11)$$

$$\text{MAD} = \frac{\sum (X_t - F_t)/n}{n} \quad (12)$$

X_t : Actual Data at time (t)

f_t : Forecasting data on time (t)

n : Amount of data

III. RESEARCH METHODS

The method used based on the type of information managed is a quantitative method, where the method aims to develop theories related to analysis using mathematical methods. Quantitative forecasting methods are used in this study by prioritizing the patterns of historical data owned or time series forecasting. The model summarizes the patterns in the data and shows a statistical relationship between the previous value and the current value of the observed variable. Then, the model is used to project patterns of the data onto the future to assist leaders in determining a policy (Chua & Tumibay, 2020). The flow chart of the research stages can be illustrated in the following Figure 2.

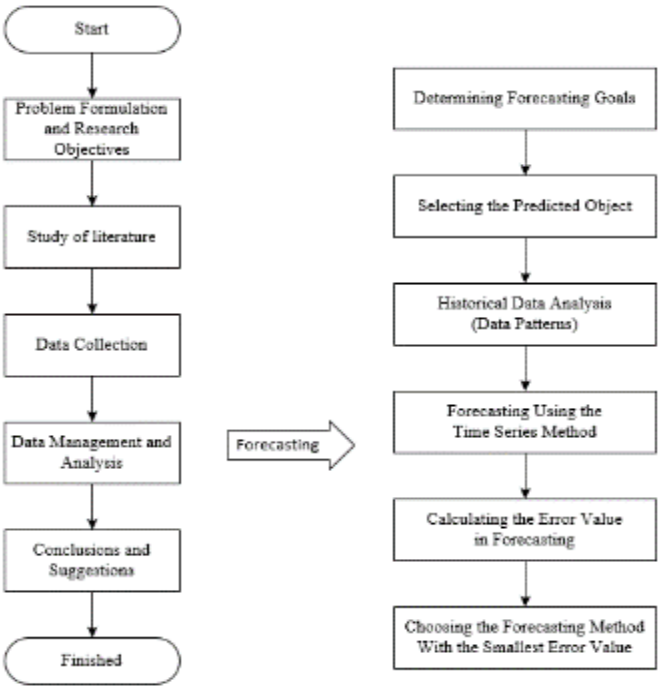

Fig. 2. Step of Research

The research steps begin with the formulation of the problem and research objectives obtained from observations on the object of research. Next, do a literature study. Then perform data processing and analysis by applying to forecast and calculating the smallest error in each forecasting method. Then evaluate the forecasting results and make conclusions and suggestions.

A. Data Collection

The data are obtained from the Service Desk at the Shared Services ICT Department of PT Pertamina (Persero). A Service Desk is a functional unit consisting of a number of individuals responsible for handling various events related to IT services, usually via telephone, web interface, or events related to IT infrastructure that was reported automatically. Servicedesk is an important part of the IT department of an organization and functions as a Single Point of Contact (SPOC) for all IT service users.

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In ITIL terminology, an incident is defined as an unplanned issues to IT services or a decrease in the quality of IT services or a Configuration Items (CI) failure that has not yet impacted IT services. Incident management includes any event that disrupts or has the potential to disrupt service. It also events that are communicated directly by the user, either through the Service Desk or through the interface between tools from event management to incident management. The incident management process can be seen in Figure 3.

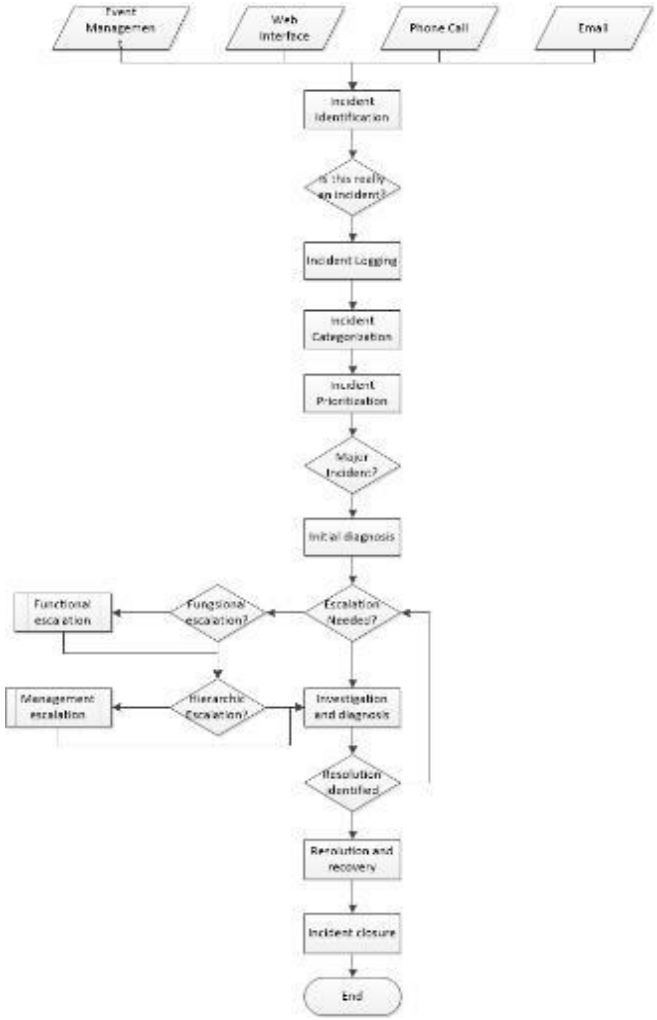

Fig. 3 Incident Management

B. Incident Service Category

Data is obtained from customer complaints to the Service Desk as a Single Point of Contact via telephone, emails, and applications (self-service). Customer complaints in the form of problems or incidents in various events related to IT services. The data used is incident data in five service categories that are often reported by customers every month. The five service categories can be described in Table I.

C. Data analysis

The period for collecting incident data in five service categories that are frequently reported by customers is from January to December 2021. The data is used as historical data for the process of forecasting incidents in the future. The number of incident data can be seen in Table II.

TABLE I. Incident Service Category

No	Service Categories	Description
1	*End User Services*	Incident on supporting work devices such as desktop devices and desktop software
2	*Facility Management*	Incident found in office facilities
3	*Network and Telephony*	Incident found on computer network, telephone, or telecommunications-related networks
4	*Non-ERP Application Maintenance Services*	Incident on non-ERP software or applications used by the organization
5	*Security and Authorization*	Incident or requests related to access and authorization on Non ERP, Internet and Network Security Operations applications

TABLE II. Incident Data

Period	a	b	c	d	e
Jan	2155	345	605	1628	536
Feb	1814	617	630	1348	523
Mar	1441	687	360	2410	413
Apr	2290	932	695	2745	885
May	1843	731	718	1717	590
Jun	1939	605	786	2424	1002
Jul	1454	271	626	1988	749
Aug	1670	441	587	1429	706
Sep	2049	463	759	2357	1037
Oct	2648	636	848	1853	961
Nov	2431	726	991	1754	836
Des	2313	558	811	1916	912

a : End User Services
b : Facility Management
c : Network and Telephony
d : Non-ERP Application Maintenance Services
e : Security and Authorization

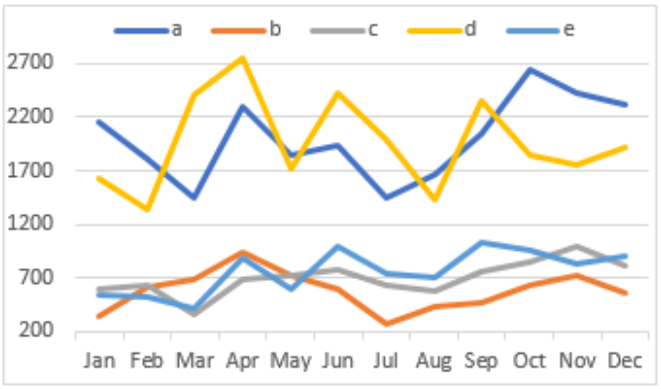

Fig. 4. Pattern of Incident Data

An important step in choosing an appropriate time series method for forecasting is to consider the type of data pattern, so that the most appropriate method with that pattern can be tested (Makridakis & Wheelwright, 1999). The data pattern for the five categories of incident services for the period January – December 2021 can be seen in Figure 4.

Based on Figure 4, it can be seen that incident reporting has fluctuated. Data on five categories of incident services for the period January – December 2021 produces a horizontal pattern where the data value fluctuates around a constant average value.

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Such a series is stationary to the mean value. For this reason, the method that can be used for forecasting is the time series model, while the types of time series forecasting methods used are the Moving Average and Single Exponential Smoothing methods.

IV. Result and Discussion

A. Moving Average

This method is called a moving average because each time new observational data is available, a new average is calculated and used as a forecast. The Moving Average methods used in forecasting incident data are the Single Moving Average and Double Moving Average methods. The dataset used in forecasting is incident ticket reports with five categories that are often reported by customers every month.

The step-in forecasting using the Single Moving Average (SMA) forecasting method to predict incident data are carrying out a smoothing process and then forecasting with a moving average of "$m = 3$" refer to "(1)" with the following calculations.

Forecasting Incident "End User Services" using SMA,

$$S_t = \frac{1}{m}\sum_{i=t-m+1}^{t} X_i$$
$$S_3 = \frac{1}{3}\sum_{i=3-3+1}^{3} X_i = \frac{1}{3}(X_1 + X_2 + X_3)$$
$$S_3 = \frac{1}{3}(2155 + 1814 + 1441)$$
$$S_3 = 180.3$$

Forecasting process of smoothing results refer to "(2)":

$$F_t = S_{t-1}$$
$$F_4 = S_{4-1}$$
$$F_4 = S_3$$
$$F_4 = 180.3$$

Forecasting results using Single Moving Average method for "End User Services" incident data can be seen in Table III.

TABLE III. Forecasting Results using SMA

Month (t)	Incident End User Services (X)	Smoothing (St) m=3	Forecast (Ft)
1	2155		
2	1814		
3	1441	1803.3	
4	2290	1848.3	1803.3
5	1843	1858.0	1848.3
6	1939	2024.0	1858.0
7	1454	1745.3	2024.0
8	1670	1687.7	1745.3
9	2049	1724.3	1687.7
10	2648	2122.3	1724.3
11	2431	2376.0	2122.3
12	2313	2464.0	2376.0

Forecasting using Double Moving Average (DMA) method is the second moving average calculation to reduce systematic errors that occur when a single moving average is used on trending data. After carrying out the smoothing process in two stages, the forecasting can be carried out.

Forecasting Incident "End User Services" using DMA,

First stage smoothing refer to "(3)":

$$S_{1,t} = \frac{1}{m}\sum_{i=t-m+1}^{t} X_i$$
$$S_{1,3} = \frac{1}{3}\sum_{i=3-3+1}^{3} X_i = \frac{1}{3}(X_1 + X_2 + X_3)$$
$$S_{1,3} = \frac{1}{3}(2155 + 1814 + 1441)$$
$$S_{1,3} = 180.3$$

Second stage smoothing refer to "(4)":

$$S_{2,t} = \frac{1}{m}\sum_{i=t-m+1}^{t} S_{1i}$$
$$S_{2,5} = \frac{1}{3}\sum_{i=5-3+1}^{3} S_{1i} = \frac{1}{3}(S_{1,3} + S_{1,4} + S_{1,5})$$
$$S_{2,5} = \frac{1}{3}(1803.3 + 1848.3 + 1858)$$
$$S_{2,5} = 1836.6$$

Forecasting process of the 2-stage smoothing results refer to "(5)":

$$F_{2,t+5} = A_t + B_t m$$
$$F_{2,5+1} = A_5 + B_5(1)$$
$$= 1879.4 + 21.4\,(1) \qquad = 1900.9$$

A_t and B_t are obtained from refer to "(6), (7)":

$$A_t = 2\,S_{1,t} - S_{2,t} \qquad B_t = \frac{2}{m-1}(S_{1,t} - S_{2,t})$$
$$A_5 = 2\,S_{1,5} - S_{2,5} \qquad B_5 = \frac{2}{3-1}(S_{1,5} - S_{2,5})$$
$$= 2\,S_{1,5} - S_{2,5} \qquad = 1858 - 1836.6$$
$$= 2 * 185 - 1836.6 \qquad = 1858 - 1836.6$$
$$= 1879.4 \qquad = 21.4$$

Forecasting results using Double Moving Average method for "End User Services" incident data can be seen in Table IV.

TABLE IV. Forecasting Results using DMA

t	X	(S1,t) m=3	(S2,t) m=3	At	Bt	F2,t
1	2155					
2	1814					
3	1441	1803.3				
4	2290	1848.3				
5	1843	1858.0	1836.6	1879.4	21.4	
6	1939	2024.0	1910.1	2137.9	113.9	1900.9
7	1454	1745.3	1875.8	1614.9	-130.4	2251.8
8	1670	1687.7	1819.0	1556.3	-131.3	1484.4
9	2049	1724.3	1719.1	1729.6	5.2	1425.0
10	2648	2122.3	1844.8	2399.9	277.6	1734.8
11	2431	2376.0	2074.2	2677.8	301.8	2677.4
12	2313	2464.0	2320.8	2607.2	143.2	2979.6

B. Single Exponential Smoothing

The dataset used in forecasting is incident ticket reports with five categories that are often reported by customers every month, using smoothing constant (α) "0.1 to 0.9" with the following calculations, refer to "(8)":

$$F_{t+1} = aX_t + (1 - a)F_t$$
$$F_3 = 0.1 * 1441 + (1 - 0.1)\,2155$$
$$F_3 = 2120.9$$

Forecasting results using Single Exponential Smoothing (SES) method for "End User Services" incident data can be seen in Table V.

C. Forecasting Error Test

Methods that can be used to measure forecasting errors are Mean Forecast Error (MFE), Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE). Forecasting error tests on the Single Moving Average (SMA), Double Moving Average (DMA), and Single Exponential Smoothing (SES) methods with "α = 0.1 to 0.9"

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can be seen as follows, refer to "(9,10,11,12)":

TABLE V. Forecasting Results using SES

t	Incident (X)	F_t (0.1)
1	2155	
2	1814	2155.0
3	1441	2120.9
4	2290	2052.9
5	1843	2076.6
6	1939	2053.3
7	1454	2041.8
8	1670	1983.0
9	2049	1951.7
10	2648	1961.5
11	2431	2030.1
12	2313	2070.2

$$\text{MFE} = \frac{\sum (X_t - F_t)}{n}$$
$$X_4 - F_4 = 2290 - 1803.3 = 486.7$$
$$= \frac{486.7+(-5.3)+81.0+(-570.0)+(-75.3)+361.3+923.7+308.7+(-63.0)}{9}$$
$$= 160.9$$
$$\text{MAD} = \frac{\sum (X_t - F_t)}{n}$$
$$X_4 - F_4 = 2290 - 1803.3 = 486.7$$
$$absolut = 486.7$$
$$= \frac{486.7+5.3+81.0+570.0+75.3+361.3+923.7+308.7+63.0}{9}$$
$$= 319.4$$
$$\text{MSE} = \frac{\sum (X_t - F_t)^2}{n}$$
$$(X_4 - F_4)^2 = (2290 - 1803.3)^2 = 236844.4$$
$$= \frac{236844.4+28.4+6561+324900+5675.1+130561.8+853160.1+95275.1+3969}{9}$$
$$= 184108.3$$
$$\text{MAPE} = \left(\frac{100}{n}\right) \sum \left| X_t - \frac{F_t}{X_t} \right|$$
$$\frac{|Error|_4}{X_4} \text{x } 100 = \frac{486.7}{2290} \text{x } 100 = 21.3$$
$$= \frac{21.3+0.3+4.2+39.2+4.5+17.6+34.9+12.7+2.7}{9} = 15.3$$

The forecasting method that produces the smallest error value will be the method used in forecasting. The results of calculating the error value in the forecasting method used for incident forecasting of "End User Services, Facility Management, Network and Telephony, Non-ERP Application Maintenance Services, Security and Authorization" can be seen in Tables VI to X.

TABLE VI. Incident End User Services Forecasting Error Value

Forecasting Methods	MFE	MAD	MSE	MAPE
SMA-3	160.9	319.4	184108.3	**15.3**
DMA-3	7.2	496.0	342959.2	24.5
SES (α = 0.1)	**-55.0**	357.7	167851.6	19.2
SES (α = 0.2)	-1.8	351.7	167229.3	18.5
SES (α = 0.3)	21.9	337.7	164427.0	17.6
SES (α = 0.4)	30.5	324.2	162141.6	16.9
SES (α = 0.5)	31.5	**317.4**	**161596.9**	16.5
SES (α = 0.6)	29.0	320.0	162851.3	16.6
SES (α = 0.7)	25.1	324.8	165662.8	16.9
SES (α = 0.8)	21.0	342.8	169960.8	17.7
SES (α = 0.9)	17.3	359.1	176034.8	18.5

TABLE VII. Incident Facility Management Forecasting Error Value

Forecasting Methods	MFE	MAD	MSE	MAPE
SMA-3	4.5	187.3	58934.3	39.4
DMA-3	**-17.2**	294.6	100359.7	66.3
SES (α = 0.1)	154.5	202.7	61949.8	33.1
SES (α = 0.2)	100.2	184.3	53154.4	32.9
SES (α = 0.3)	71.9	181.1	49589.2	34.0
SES (α = 0.4)	56.0	174.5	47031.5	33.6
SES (α = 0.5)	45.9	**169.7**	44608.8	**32.9**
SES (α = 0.6)	38.5	171.1	42254.3	33.1
SES (α = 0.7)	32.5	174.4	40105.0	33.9
SES (α = 0.8)	27.4	174.8	38331.4	34.0
SES (α = 0.9)	23.1	173.0	**37099.7**	33.7

TABLE VIII. Incident Network and Telephony Forecasting Error Value

Forecasting Methods	MFE	MAD	MSE	MAPE
SMA-3	85.9	149.2	25679.3	**19.5**
DMA-3	**-12.3**	212.5	49007.6	28.7
SES (α = 0.1)	87.8	139.6	28659.4	20.7
SES (α = 0.2)	73.2	132.8	24985.9	20.2
SES (α = 0.3)	61.3	**128.7**	23291.2	20.0
SES (α = 0.4)	51.7	132.4	**22774.5**	20.7
SES (α = 0.5)	43.8	136.3	22933.4	21.4
SES (α = 0.6)	37.3	138.9	23481.0	21.9
SES (α = 0.7)	31.6	140.1	24273.0	22.1
SES (α = 0.8)	26.7	139.9	25263.8	22.2
SES (α = 0.9)	22.5	138.7	26484.7	22.1

TABLE IX. Incident Non-ERP Application Maintenance Forecasting Error Value

Forecasting Methods	MFE	MAD	MSE	MAPE
SMA-3	-16.5	348.3	198711.9	17.4
DMA-3	**-66.3**	**274.4**	**121370.8**	**13.5**
SES (α = 0.1)	213.5	379.4	254618.0	17.7
SES (α = 0.2)	130.2	387.2	247648.1	18.7
SES (α = 0.3)	85.3	413.3	253264.8	20.4
SES (α = 0.4)	60.8	434.9	264081.9	21.7
SES (α = 0.5)	46.9	454.7	278800.4	22.9
SES (α = 0.6)	38.5	474.2	297277.3	23.9
SES (α = 0.7)	33.2	494.3	319645.6	25.0
SES (α = 0.8)	29.8	515.0	346110.3	26.0
SES (α = 0.9)	27.6	535.5	376817.8	27.1

TABLE X. Incident Security and Authorization Forecasting Error Value

Forecasting Methods	MFE	MAD	MSE	MAPE
SMA-3	94.4	153.5	41768.6	16.8
DMA-3	**-36.0**	**193.4**	44246.8	22.5
SES (α = 0.1)	178.6	203.1	61730.9	23.8
SES (α = 0.2)	132.6	156.8	46415.1	18.3
SES (α = 0.3)	101.5	139.0	40564.8	**16.4**
SES (α = 0.4)	80.3	140.8	**39052.8**	16.9
SES (α = 0.5)	65.5	148.1	39838.4	18.1
SES (α = 0.6)	55.0	155.9	42102.2	19.3
SES (α = 0.7)	47.3	163.9	45540.6	20.4
SES (α = 0.8)	41.6	174.1	50102.2	21.8
SES (α = 0.9)	37.3	187.3	55889.3	23.5

Forecasting five types of incident services produces different smallest error values, Single Moving Average method for forecasting "End User Services" and "Network and Telephony" incident data, Single Exponential Smoothing "α = 0.5" method for forecasting "Facility Management" incident data, Double Moving Average method for forecasting "Non-ERP Application Maintenance Services" incident data, and Single Exponential Smoothing "α = 0.3" method for forecasting "Security and Authorization" incident data.

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D. Forecasting Results

The results of data forecasting Incident "End User Services" using the Single Moving Average method for the next one month period are obtained from the following calculations refer to "(2)",the data plot of forecasting results can be seen in Figure 5.

$F_t = S_{t-1}$
$F_{13} = S_{13-1}$
$F_{13} = S_{12}$
$F_{13} = 2464.0$

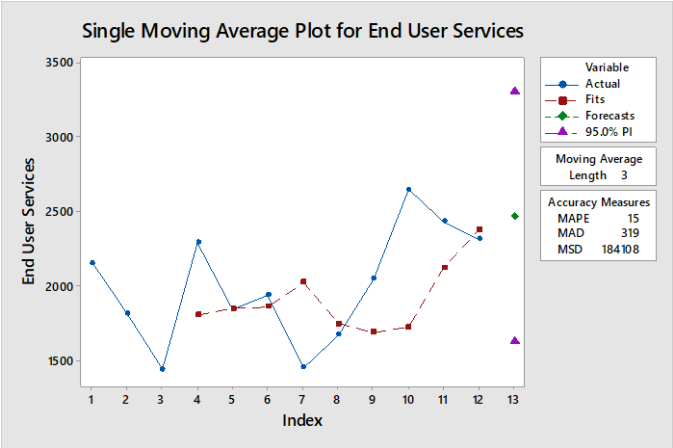

Fig. 5. End User Services Forecasting Data Plot

The results of data forecasting Incident "Facility Management" using the Single Exponential Smoothing "α = 0.5" method for the next one month period are obtained from the following calculations refer to "(8)", the data plot of forecasting results can be seen in Figure 6.

$F_{t+1} = aX_t + (1 - a)F_t$
$F_{12+1} = aX_{12} + (1 - a)F_{12}$
$F_{13} = 0.5 * 558 + (1 - 0.5)\ 637.0$
$F_{13} = 597.5$

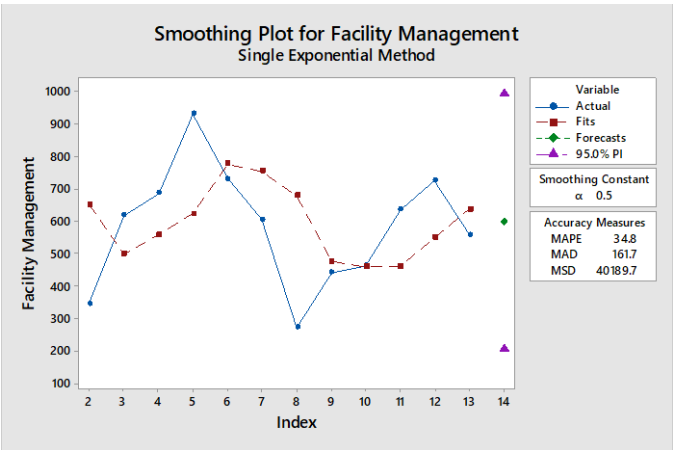

Fig. 6. Facility Management Forecasting Data Plot

The results of data forecasting Incident "Network and Telephony" using the Single Moving Average method for the next one month period are obtained from the following calculations refer to "(2)", the data plot of forecasting results can be seen in Figure 7.

$F_t = S_{t-1}$
$F_{13} = S_{13-1}$
$F_{13} = S_{12}$
$F_{13} = 883.3$

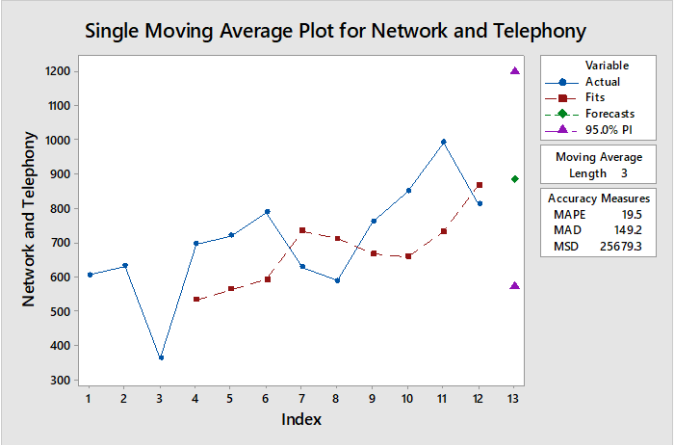

Fig. 7. Facility Management Forecasting Data Plot

The results of data forecasting Incident "Non-ERP Application Maintenance Services" using the Double Moving Average method for the next one month period are obtained from the following calculations refer to "(5)":

$F_{2,t+1} = A_t + B_t m$
$F_{2,12+1} = A_{12} + B_{12}(1)$
$F_{2,13} = 1779.1 + (-61.9) * 1$
$= 1717.2$

The results of data forecasting Incident "Security and Authorization" using the Single Exponential Smoothing "α = 0.3" method for the next one month period are obtained from the following calculations refer to "(8)", the data plot of forecasting results can be seen in Figure 8.

$F_{t+1} = aX_t + (1 - a)F_t$
$F_{12+1} = aX_{12} + (1 - a)F_{12}$
$F_{13} = 0.5 * 558 + (1 - 0.5)\ 637.0$
$F_{13} = 597.5$

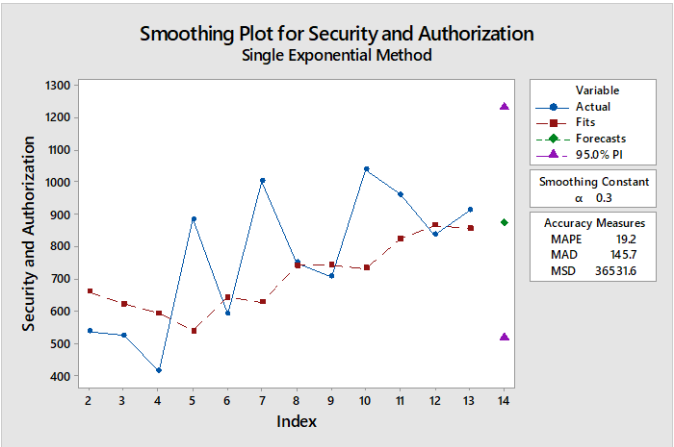

Fig. 8. Security and Authorization Forecasting Data Plot

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V. CONCLUSION

Implementation of Single Moving Average (SMA) "$m = 3$" forecasting method, Double Moving Average (DMA) "$m = 3$" and Single Exponential Smoothing (α) "0.1 to 0.9" for data forecast five types of service incidents that are frequently reported by customers every month from January to December 2021 on Service Desk - Shared Services ICT. Determining the best forecasting method is considering the minor error of each forecasting method used. The error value obtains by using the Mean Forecast Error (MFE), Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE) methods.

Based on the error analysis, conclusions can be drawn forecasting five types of incident services produces different smallest error values, Single Moving Average "$m = 3$" method for forecasting "End User Services" and "Network and Telephony" incident data, Single Exponential Smoothing "α = 0.5" method for forecasting "Facility Management" incident data, Double Moving Average "$m = 3$" method for forecasting "Non-ERP Application Maintenance Services" incident data, and Single Exponential Smoothing "α = 0.3" method for forecasting "Security and Authorization" incident data. The results of the forecasting analysis produce predictive information on incident ticket data in the future and play a role in making decisions for IT service management.

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