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ORIGINAL ARTICLE

FORECASTING OF COVID–19 WITH AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) METHOD IN EAST JAVA PROVINCE

Peramalan Kasus COVID-19 dengan Menggunakan Metode Autoregressive Integrated Moving Average (ARIMA) di Provinsi Jawa Timur

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ABSTRACT

Background: The COVID-19 pandemic has had a major impact on the world's health system, including Indonesia. The national health system is facing challenges with increasing cases of COVID-19. With the forecasting of COVID-19 cases, it is hoped that it can be one of the references in dealing with COVID-19 and one form of mitigation in dealing with COVID-19. **Purpose**: This research aims to predict COVID-19 cases in East Java Province for the coming year using the Autoregressive Integrated Moving Average (ARIMA) method based on patient data from March 2020 to January 2022. **Methods**: This type of research is analytic. Forecasting future COVID-19 cases using the Autoregressive Integrated Moving Average (ARIMA) method based on COVID-19 data from March 2020 to January 2022. **Results**: Based on the results of ARIMA analysis, the best forecasting model for confirmed cases of COVID-19 is the model (1:0:1) with AIC values (14.22672), SIC (14.33357), while for cured cases is the model (1:2: 3) with the value of AIC (13.93054), SIC (13.03738), and for the case of death is the model (1:2:1) with the value of AIC (10.76105) and SIC (10.86790). **Conclusion**: From the results of this study, it is predicted that there will be an increase in COVID-19 cases in July 2022, January 2023 and June 2023.

ABSTRAK

Latar Belakang: *Pandemi COVID-19 berdampak besar pada system kesehatan dunia termasuk di Indonesia. Sistem kesehatan nasional menghadapi tantangan dengan meningkatnya kasus COVID-19. Dengan adanya prakiraan kasus COVID-19 diharapkan dapat menjadi salah satu acuan dalam menghadapi COVID-19 dan salah satu bentuk mitigasi dalam*

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*menghadapi COVID-19 **Tujuan:** Meramalkan kasus COVID-19 di Provinsi Jawa Timur dengan menggunakan metode Autoregressive Integrated Moving Average (ARIMA) berdasarkan analisis data bulan Maret 2020 sampai dengan Januari 2022. **Metode:** Jenis penelitian ini adalah analitik. Peramalan kasus covid 19 mendatang dilakukan dengan menggunakan metode Autoregressive Integrated Moving Average (ARIMA) berdasarkan data covid bulan Maret 2020 sampai dengan Januari 2022. **Hasil:** Berdasarkan hasil analisis ARIMA didapatkan bahwa model peramalan terbaik untuk COVID-19 terkonfirmasi adalah model (1:0:1) dengan nilai AIC (14.22672), SIC (14.33357), sedangkan untuk COVID-19 sembuh adalah model (1:2:3) dengan nilai AIC (13.93054), SIC (13.03738), dan kasus COVID-19 meninggal adalah model (1:2:1) dengan nilai AIC (10.76105) dan SIC (10.86790).**Kesimpulan**: Dari hasil penelitian ini diprediksi akan terjadi peningkatan kasus COVID-19 pada bulan Juli 2022, Januari 2023 dan Juni 2023.*

INTRODUCTION

The world is experiencing a global threat, and the COVID-19 pandemic was first discovered in December 2019 in Wuhan, China (1). The COVID-19 pandemic has had a major impact on world health, including in Indonesia (2). The World Health Organization (WHO) recorded 480,149,136 cases, involving 6,143,996 deaths worldwide (Case Fatality Rate (CFR) (4.60%) in March 2022. Widely known for the most COVID-19 cases in Southeast Asia, Indonesia reported 5,995,876 cases, with deaths reaching 154,570 (Case Fatality Rate (CFR) 2.80%) (3).

The COVID-19 pandemic has had a major impact on the world's health system, including that of Indonesia (4). One effort that needs to be made is to establish a COVID-19 prevention program. Forecasting the rate of COVID-19 infection has become vital for decision and policy makers worldwide. It is important to estimate this rate as accurately as possible using reliable scientific techniques. Forecasting the number of infections would assist policymakers in a specific region to assess their current healthcare capacity and decide which measures need to be taken to curb and control the spread of COVID-19 (5).

In epidemiology, it is common to use modeling techniques to predict the spread of infectious diseases. There are many types of modeling techniques that researchers have applied in predicting epidemics (6). The choice of the Autoregressive Integrated Moving Average (ARIMA) model is used because the data used are time-series data; ARIMA can also be used on stationary and non-stationary data (7). The ARIMA approach is flexible and can represent various time series characteristics (8). Time series forecasting models such as ARIMA are ordinary methods that provide clothes forecasts on time series data quickly (9). This method of investigation has been extensively functional because of its consistency and rapid application by numerous stakeholders (10). ARIMA has been used in the past to predict several disease outbreaks, such as Hemorrhagic Fever with Renal Syndrome (HFRS) (13), hand-foot-mouth disease (HFMD) (14), hepatitis (15), and the recently emerged COVID-19 virus (16) (5).

Case forecasting using ARIMA was previously conducted by Singh et al. (2020) to identify COVID-19 cases, deaths, and recovery in 15 countries with the highest number of COVID-19 cases. The results of this study indicate that the United States, Britain, Turkey, China, and Russia have experienced a relatively high increase in COVID-19 cases. Forecasting cases of COVID-19 with ARIMA were also reported by Anne & Jeeva (12), which states that, in April 2020, there was a 3-fold increase compared to the previous year. Based on the background description, researchers are interested in forecasting COVID-19 cases, especially in the East Java Province. This study aimed to predict COVID-19 cases in East Java Province using the Autoregressive Integrated Moving Average (ARIMA) method based on data analysis from March 2020 to January 2022. This research was conducted to support and complement previous research that did not cover all areas of the East Java Province.

METHODS

This analytical study uses quantitative forecasting. This study used a time series method. The time-series method is a forecasting method that analyzes the relationship between the variables to be estimated and the time variable (13). This method was used to predict the future using historical data. The data used in this study were weekly data on COVID-19 cases involving confirmed cases, recovered cases, and deaths in 38 districts/cities in East Java obtained from interviews with COVID-19 data management officers at the East Java Provincial Health Office from March 16, 2020, to January 31, 2022. (85 weeks) and then processed and analyzed using Eview 10. This study was conducted in May 2022. The independent variable in this study was the number of COVID-19 cases, whereas the dependent variable was forecasting. The ARIMA method was used in this study. The ARIMA method consisted of five stages:

a. Data Stationary Check

Stationary testing can be performed by correlating the autocorrelation function with the augmented Dickey (ADF) test. The data are considered stationary if the ADF value is less than 0.05.

b. Differencing Data

Non-stationary data should be analyzed by differencing using the Augmented Dickey-Fuller test (ADF).

c. The Identification of Temporary Model

Determination of the values of p, d, and q, where p is the order of autoregressive (AR), d is the degree of differencing, and q is the order of moving average. The p-value is obtained from the autocorrelation (AC) value, d is obtained from the differencing level, and q is obtained from the partial autocorrelation (PAC) value.

d. Diagnostic Test

This test was obtained from the Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC) values. The smaller the AIC and SIC values, the better the model.

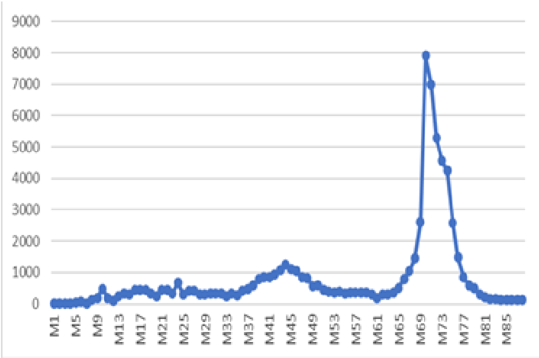
e. Forecasting

This forecasting was performed using the best model value based on the data analysis from March 2020 to January 2022.

This research was approved by the Health Research Ethics Commission (KEPK), Faculty of Dentistry, University of Jember (No:1556/UN25.8/KEPK/DL/2022).

RESULTS

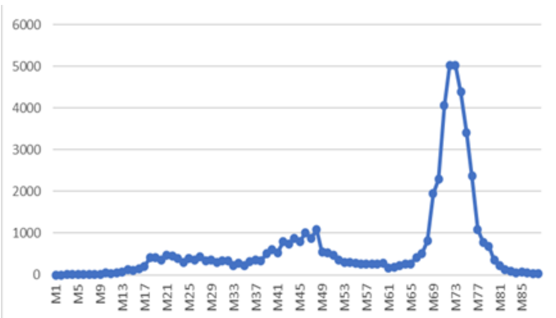
Based on the results of the study, it was found that the spread of COVID-19 in East Java Province was as follows (Figure 1).



Source: Data from *EViews*10; M1-M85= 2nd week of March, 2020 until 4th week of January, 2022

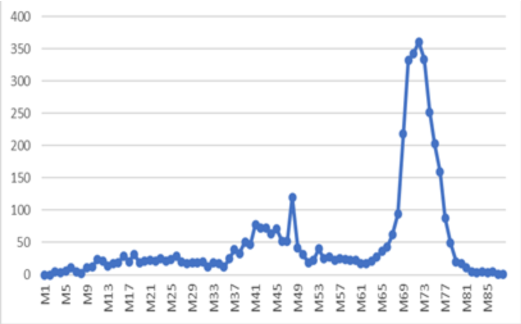
Figure 1. The graphic of COVID-19 confirmed cases in East Java

Figure 1, shows a significant increase from March 2020 to January 2022. The peak of confirmed cases is in the fourth week of December 2021. Meanwhile for Recovered cases of COVID-19 in East Java showed at Figure 2. Figure 2 shows a significant increase in recovered cases in the fourth week of December 2021 compared to the Deaths cases of COVID-19 in East Java, as shown in Figure 3.



Source: Data from *EViews*10

Figure 2. COVID-19 Recovered Cases in East Java



Source: Data from *EViews*10

Figure 3. The graphic of COVID-19 deaths cases in East Java

Figure 3 shows a significant increase from March 16, 2022, to January 31, 2022. The peak of confirmed cases occurred in the fourth week of December 2021.

Forecast Analysis

a. Data Stationarity Test

The test results were stationary using the Augmented Dickey-Fuller test results shown in Table 1. Based on the results of the stationarity test in Table 1, the confirmed data for COVID-19 were said to be stationary with a probability value of 0.02 (α = 0.05). The recovered cases of COVID-19 in East Java are listed in Table 2.

Table 1

The Results of Stationary-Augmented Dickey-Fuller test

		t-statistic	Prob*
Augmented Dickey-Fuller test statistic		-3.145464	0.0266
Test Critical values	1 % level	-3.501445	
	5 % level	-2.892536	
	10 % level	-2.583371	

*MacKinnon (1996) one-sided *p*-values

Table 2

Results of Stationary

		t-statistic	Prob*
Augmented Dickey-Fuller test statistic		-4.318667	0.0618
Test Critical values	1 % level	-3.502238	
	5 % level	-2.689879	
	10 % level	-2.498553	

*MacKinnon (1996) one-sided *p*-values

Based on the stationary test calculation results, the recovered COVID-19 data were non-stationary, with a probability value of 0.06 (0.05). Meanwhile, for death, see Table 3. The data on COVID-19 deaths are said to be non-stationary based on the results of the stationary test, with a probability value of 0.06 (0.05).

Table 3

The Results of Augmented Dickey-Fuller test

		t-statistic	Prob*
Augmented Dickey-Fuller test statistic		-3.437706	0.0610
Test Critical values	1 % level	-3.502238	
	5 % level	-2.782879	
	10 % level	-2.653553	

*MacKinnon (1996) one-sided p-values

b. Differencing Data

The unit root testing method in this study was carried out using Augmented Dickey–Fuller (ADF) test. The test results for the differencing stage are presented in Table 4.

Table 4

The Results of Differencing-Augmented Dickey-Fuller test

		t-statistic	Prob*
Augmented Dickey-Fuller test statistic		-3.437706	0.00
Test Critical values	1 % level	-3.502238	
	5 % level	-2.782879	
	10 % level	-2.653553	

Source: Data from *EViews* 10

Table 4 shows the probability value of COVID-19 recovered cases is 0.00 (α ≤ 0.05). Meanwhile, the case of death is shown in Table 5.

Table 5

The Results of Differencing-Augmented Dickey-Fuller Test

		t-statistic	Prob*
Augmented Dickey-Fuller test statistic		-2.366922	0.02
Test Critical values	1 % level	-4.327138	
	5 % level	-2.690579	
	10 % level	-2.8954253	

Source: Data from *EViews* 10

Table 5 shows that the probability value of COVID-19 deaths cases is 0.02 (α ≤ 0.05). The next step is identification of temporary Model.

c. The Identification of Temporary Model

After the data are stationary, the next step is to identify the temporary ARIMA model by determining the values of p, d, and q.

Table 6
Results of Autocorrelation (AC) and Partial autocorrelation (PAC) test on confirmed cases

	AC	PAC	Q-stat	Prob
1	0.941	0.941	86.660	0.000
2	0.815	-0.609	154.18	0.000
3	0.640	-0.298	195.57	0.000
4	0.450	0.098	216.24	0.000
5	0.274	0.158	224.01	0.000
6	0.132	0.049	225.83	0.000
7	0.026	-0.105	225.90	0.000
8	-0.055	-0.210	226.22	0.000
9	-0.111	0.054	227.54	0.000
10	-0.149	0.077	229.96	0.000
11	-0.174	-0.031	233.32	0.000
12	-0.189	-0.050	237.32	0.000
13	-0.199	-0.117	241.79	0.000
14	-0.203	0.001	246.52	0.000
15	-0.206	0.020	251.44	0.000
16	-0.206	0.000	256.41	0.000
17	-0.203	-0.055	261.32	0.000
18	-0.195	0.011	265.90	0.000
19	-0.183	-0.042	269.98	0.000
20	-0.165	0.020	273.37	0.000
21	-0.131	0.214	275.54	0.000
22	-0.093	-0.133	276.65	0.000
23	-0.041	0.100	276.86	0.000
24	0.012	-0.105	276.88	0.000
25	0.062	-0.003	277.39	0.000
26	0.095	-0.047	278.61	0.000
27	0.111	0.025	277.39	0.000
28	0.114	0.074	282.12	0.000
29	0.105	-0.010	283.66	0.000
30	0.087	-0.115	284.75	0.000
31	0.066	-0.030	285.38	0.000
32	0.066	0.071	285.66	0.000
33	0.019	-0.050	285.72	0.000
34	-0.006	0.039	285.72	0.000
35	-0.028	-0.061	285.84	0.000
36	-0.047	-0.013	286.19	0.000

Source: Data from *EViews* 10

Table 6 shows the appropriate amount of lag in model identification, namely, the maximum AR (1) and MA (3) for confirmed cases of COVID-19. The number of recovered COVID-19 cases in East Java is listed in Table 7.

Table 7 shows the appropriate amount of lag in model identification, namely, the maximum AR (1) and MA (3) for confirmed cases of COVID-19. The numbers of COVID-19 deaths in East Java are listed in Table 8.

Table 7
The Results of autocorrelation (AC) and partial autocorrelation (PAC) tests for recovered cases

	AC	PAC	Q-stat	prob
1	0.877	0.877	76.100	0.000
2	0.704	-0.277	125.75	0.000
3	0.551	0.025	154.45	0.000
4	0.395	-0.154	172.38	0.000
5	0.222	-0.168	177.47	0.000
6	0.090	0.007	178.30	0.000
7	-0.0.10	-0.014	178.30	0.000
8	-0.058	0.036	178.67	0.000
9	-0.103	-0.054	179.82	0.000
10	-0.32	-0.036	181.72	0.000
11	-0.147	-0.026	184.11	0.000
12	-0.157	-0.039	186.86	0.000
13	-0.163	-0.007	186.86	0.000
14	-0.164	-0.022	192.96	0.000
15	-0.167	-0.041	196.19	0.000
16	-0.165	-0.006	199.40	0.000
17	-0.164	-0.045	202.60	0.000
18	-0.159	-0.005	205.67	0.000
19	-0.152	-0.021	208.50	0.000
20	-0.139	0.004	210.88	0.000
21	-0.122	-0.012	212.76	0.000
22	-0.094	0.040	213.87	0.000
23	-0.061	-0.001	214.35	0.000
24	-0.022	0.036	214.41	0.000
25	0.016	0.001	214.44	0.000
26	0.060	0.054	216.04	0.000
27	0.091	-0.032	217.27	0.000
28	0.94	-0.072	218.40	0.000
29	0.090	0.026	219.98	0.000
30	0.081	-0.023	220.26	0.000
31	0.066	0.015	219.98	0.000
32	0.044	-0.010	220.26	0.000
33	0.019	-0.032	220.32	0.000
34	-0.003	-0.009	220.32	0.000
35	-0.026	-0.040	220.42	0.000
36	-0.044	0.0014	220.73	0.000

Source: Data from *EViews* 10

Table 8 shows the appropriate amount of lag in model identification, namely the maximum AR (1) and MA (3) for confirmed cases of COVID-19.

d. Diagnostic Test

This stage was carried out to obtain the best forecasting model, the ARIMA model, for predicting COVID-19 cases. The best ARIMA models are listed in Table 9.

Table 8
The Results of Autocorrelation(AC) and partial autocorrelation (PAC) test on death cases

	AC	PAC	Q-stat	Prob
1	0.936	0.936	86.810	0.000
2	0.819	-0.465	153.99	0.000
3	0.665	-0.240	198.75	0.000
4	0.491	-0.129	223.36	0.000
5	0.324	0.079	234.19	0.000
6	0.173	-0.011	237.33	0.000
7	0.048	0.000	237.58	0.000
8	-0.051	-0.056	237.86	0.000
9	-0.116	0.097	239.31	0.000
10	-0.158	-0.087	242.03	0.000
11	-0.179	-0.013	245.59	0.000
12	-0.195	-0.007	249.87	0.000
13	-0.208	0.046	254.76	0.000
14	-0.212	-0.001	259.90	0.000
15	-0.211	-0.143	265.09	0.000
16	-0.207	-0.050	270.15	0.000
17	-0.202	-0.035	274.99	0.000
18	-0.199	-0.081	279.76	0.000
19	-0.198	0.092	284.14	0.000
20	-0.170	0.036	287.70	0.000
21	-0.130	0.147	289.82	0.000
22	-0.085	-0.107	290.73	0.000
23	-0.047	-0.136	291.02	0.000
24	-0.005	0.115	291.02	0.000
25	0.035	0.082	291.19	0.000
26	0.068	-0.071	291.80	0.000
27	0.104	0.120	293.26	0.000
28	0.124	-0.167	295.39	0.000
29	0.112	-0.084	297.43	0.000
30	0.092	0.131	299.20	0.000
31	0.069	-0.044	300.42	0.000
32	0.039	0.011	301.15	0.000
33	0.039	-0.111	301.35	0.000
34	0.006	0.012	301.35	0.000
35	-0.026	0.061	301.46	0.000
36	-0.052	-0.008	301.88	0.000

Source: Data from *EViews* 10

Table 9
The Results of the Best ARIMA Model

p,d,q	AIC	SIC
COVID-19 confirmed 1:0:1	15.72454	15.83139
COVID-19 Recovered 1:2:3	13.93054	13.03738
COVID-19 Death 1:2:1	9.270538	9.377386

Source: Data from EViews 10

Table 9 shows that the best model for forecasting COVID-19 confirmed cases is model (1:0:1). The model for the COVID-19 recovered is (1:2:3). Eventually, model (1:2:1) is generated for forecasting COVID-19 deaths.

e. Forecasting

After generating the suitable ARIMA model, the final stage is forecasting or prediction. This study made predictions for confirmed COVID-19 cases between March 2020 and December 2023 (Figure 4). Figure 4 shows that the mean absolute percentage error (MAPE) value was 1.08 %. The prediction results for the number of confirmed cases per week are shown in Table 10.

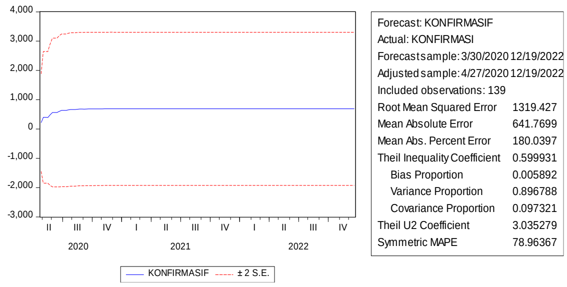
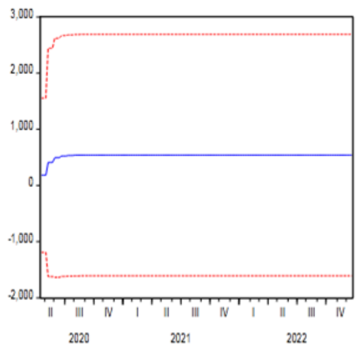


Figure 4. The Results of Forecasting COVID-19 Confirmed Cases

Table 10 shows, it can be seen that the prediction of confirmed cases of COVID-19 from the beginning of January 2022 to the end of December 2023. Significant increases are expected in July 2022, January 2023, and June. 2023. Meanwhile, recovered cases of COVID-19 in East Java showed in Figure 5. Figure 5 shows that the mean absolute percentage error (MAPE) value was 0.82 %. The prediction results for the number of recovered cases per week are shown in Table 11.



Source: Data from EViews10

Figure 5. The Forecasting Results of COVID-19 Recovered Cases

Table 10
The Results of Forecasting COVID-19 Confirmed Cases

Date	N of cases	Date	N of cases
05/02/2022	6.901	8/29/2022	6.951
05/09/2022	6.902	09/05/2022	6.952
5/16/2022	6.902	09/12/2022	6.957
5/23/2022	6.902	9/19/2022	6.959
5/30/2022	6.902	9/26/2022	6.959
06/06/2022	6.902	10/03/2022	6.959
6/13/2022	6.902	10/10/2022	6.959
6/20/2022	6.908	10/17/2022	6.959
6/27/2022	6.908	10/24/2022	6.959
07/04/2022	6.920	10/31/2022	6.965
07/11/2022	6.928	11/07/2022	6.968
7/18/2022	6.928	11/14/2022	6.970
7/25/2022	6.951	11/21/2022	6.978
08/01/2022	6.951	11/28/2022	6.978
08/08/2022	6.951	6/14/2023	7.148
8/15/2022	6.951	6/21/2023	7.148
8/22/2022	6.951	6/28/2023	7.152
12/05/2022	6.985	07/05/2023	7.152
12/12/2022	6.990	07/12/2023	7.152
12/19/2022	6.999	7/19/2023	7.152
01/04/2023	7.121	7/26/2023	7.157
01/11/2023	7.125	08/02/2023	7.157
1/18/2023	7.125	08/09/2023	7.157
1/25/2023	7.137	8/16/2023	7.157
02/01/2023	7.137	8/23/2023	7.157
02/08/2023	7.138	8/30/2023	7.157
2/15/2023	7.140	09/06/2023	7.157
2/24/2023	7.145	9/13/2023	7.157
03/01/2023	7.146	9/20/2023	7.157
03/08/2023	7.146	9/27/2023	7.183
3/15/2023	7.146	10/04/2023	7.183
3/24/2023	7.146	10/11/2023	7.183
3/29/2023	7.146	10/18/2023	7.187
04/05/2023	7.148	10/25/2023	7.187
04/12/2023	7.148	11/01/2023	7.187
4/19/2023	7.148	11/08/2023	7.196
4/26/2023	7.148	11/15/2023	7.196
05/03/2023	7.148	11/24/2023	7.196

(Continue)

Table 10
Continued

Date	N of cases	Date	N of cases
05/10/2023	7.148	11/29/2023	7.196
5/17/2023	7.148	12/06/2023	7.252
5/24/2023	7.148	12/13/2023	7.257
5/31/2023	7.148	12/20/2023	7.265
6/07/2023	7.148	12/27/2023	7.287

Table 11
The Forecasting Results of COVID-19 Recovered Cases

Date	N of cases	Date	N of cases
05/02/2022	5.408	8/29/2022	5.434
05/09/2022	5.408	09/05/2022	5.434
5/16/2022	5.408	09/12/2022	5.434
5/23/2022	5.408	9/19/2022	5.434
5/30/2022	5.408	9/26/2022	5.434
06/06/2022	5.408	10/03/2022	5.434
6/13/2022	5.408	10/10/2022	5.434
6/20/2022	5.408	10/17/2022	5.437
6/27/2022	5.408	10/24/2022	5.439
07/04/2022	5.415	10/31/2022	5.442
07/11/2022	5.418	11/07/2022	5.443
7/18/2022	5.431	11/14/2022	5.443
7/25/2022	5.434	11/21/2022	5.443
08/01/2022	5.434	11/28/2022	5.443
08/08/2022	5.434	6/14/2023	5.485
8/15/2022	5.434	6/21/2023	5.485
8/22/2022	5.434	6/28/2023	5.485
12/05/2022	5.443	07/05/2023	5.485
12/12/2022	5.443	07/12/2023	5.485
12/19/2022	5.443	7/19/2023	5.485
01/04/2023	5.443	7/26/2023	5.485
01/11/2023	5.443	08/02/2023	5.485
1/18/2023	5.470	08/09/2023	5.485
1/25/2023	5.470	8/16/2023	5.485
02/01/2023	5.475	8/23/2023	5.485
02/08/2023	5.478	8/30/2023	5.485
2/15/2023	5.485	09/06/2023	5.485
2/24/2023	5.485	9/13/2023	5.485

(Continue)

Table 11
Continued

Date	N of cases	Date	N of cases
03/01/2023	5.485	9/20/2023	5.485
03/08/2023	5.485	9/27/2023	5.485
3/15/2023	5.485	10/04/2023	5.485
3/24/2023	5.485	10/11/2023	5.485
3/29/2023	5.485	10/18/2023	5,485
04/05/2023	5.485	10/25/2023	5.485
04/12/2023	5.485	11/01/2023	5.485
4/19/2023	5.485	11/08/2023	5.485
4/26/2023	5.485	11/15/2023	5.485
05/03/2023	5.485	11/24/2023	5.485
05/10/2023	5.485	11/29/2023	5.485
5/17/2023	5.485	12/06/2023	5.492
5/24/2023	5.485	12/13/2023	5.492
5/31/2023	5.485	12/20/2023	5.498
6/07/2023	5.485	12/27/2023	5.512

Table 11 shows, it can be seen that the prediction of confirmed cases of COVID-19 from the beginning of January 2022 to the end of December 2023. Significant increases are expected in July 2022, January 2023, and June. 2023. Meanwhile, death cases of COVID-19 in East Java showed in Figure 6.

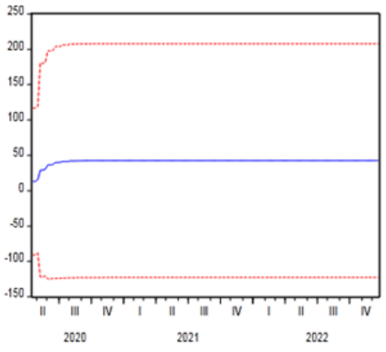


Figure 6. The Forecasting Results of COVID-19 death Cases

Figure 6 shows the root mean square error (RMSE) value of 0.75%. The prediction results for the number of recovered cases per week are shown in Table 12.

Table 12
The Forecasting Results of COVID-19 Deaths

Date	N of cases	Date	N of cases
05/02/2022	4,3	8/29/2022	4,3
05/09/2022	4,3	09/05/2022	4,3
5/16/2022	4,3	09/12/2022	4,3
5/23/2022	4,3	9/19/2022	4,3
5/30/2022	4,3	9/26/2022	4,3
06/06/2022	4,3	10/03/202	4,3
6/13/2022	4,3	10/10/2022	4,3
6/20/2022	4,3	10/17/2022	4,3
6/27/2022	4,3	10/24/2022	4,3
07/04/2022	4,3	10/31/2022	4,3
07/11/2022	4,3	11/07/2022	4,3
7/18/2022	4,3	11/14/2022	4,3
7/25/2022	4,3	11/21/2022	4,3
08/01/2022	4,3	11/28/2022	4,3
08/08/2022	4,3	6/14/2023	4,3
8/15/2022	4,3	6/21/2023	4,3
8/22/2022	4,3	6/28/2023	4,3
12/05/2022	4,3	07/05/2023	4,3
12/12/2022	4,3	07/12/2023	4,3
12/19/2022	4,3	7/19/2023	4,3
01/04/2023	4,3	7/26/2023	4,3
01/11/2023	4,3	08/02/2023	4,3
1/18/2023	4,3	08/09/2023	4,3
1/25/2023	4,3	8/16/2023	4,3
02/01/2023	4,3	8/23/2023	4,3
02/08/2023	4,3	8/30/2023	4,3
2/15/2023	4,3	09/06/2023	4,3
2/24/2023	4,3	9/13/2023	4,3
03/01/2023	4,3	9/20/2023	4,3
03/08/2023	4,3	9/27/2023	4,3
3/15/2023	4,3	10/04/2023	4,3
3/24/2023	4,3	10/11/2023	4,3
3/29/2023	4,3	10/18/2023	4,3
04/05/2023	4,3	10/25/2023	4,3
04/12/2023	4,3	11/01/2023	4,3
4/19/2023	4,3	11/08/2023	4,3
4/26/2023	4,3	11/15/2023	4,3
05/03/2023	4,3	11/24/2023	4,3
05/10/2023	4,3	11/29/2023	4,3
5/17/2023	4,3	12/06/2023	4,3

(Continue)

Table 12
Continued

Date	N of cases	Date	N of cases
5/24/2023	4,3	12/13/2023	4,3
5/31/2023	4,3	12/20/2023	4,3
6/07/2023	4,3	12/27/2023	4,3

The forecasting results highlight a decline in COVID-19 deaths from the beginning of February 2022 to the end of December 2023. After the prediction, only four deaths were reported monthly, showing a significant decrease in COVID-19 deaths in East Java.

DISCUSSION

It is crucial to generate consistent and appropriate forecasting models to assist health system administrations and other stakeholders in preventing the extra blowout of COVID-19. Time series forecasting models are statistical methods that provide clothed forecasts and have been extensively practical for the rapid trend of communicable sickness in rapid time (14). ARIMA models are predictive techniques that offer good forecasts and have been widely used for rapid trends in infectious diseases.

Over strict follow-up of all phases of the Box-Jenkins strategy, the ARIMA (1,0,1), ARIMA (1,2,3), and ARIMA (1,2,1) models for confirmed cases, recovered cases, and death cases, respectively, were selected as the best models for predicting COVID-19 cases in East Java Province. A time series analysis of COVID-19 provides the direction and movement of the epidemic and forecasts the probable progress of upcoming epidemics.

Based on the results of forecasting COVID-19 confirmed cases using the best model (1:0:1), the number of confirmed cases is predicted to increase in July 2022, January 2023, and June 2023. The mutations in SARS-CoV-2 subvariants BA.4 and BA.5 have spread to several regions in Indonesia since May 2022, and it was predicted that the peak associated with this sub-variant would occur in July 2022 (15). The high level of comorbidities experienced by patients also results in a high death rate. This is supported by research that states that comorbidities experienced by sufferers are one of the factors that can cause death (16,17).

The forecast COVID-19 with ARIMA method results can help the government handle and control COVID-19 in East Java by addressing the predicted increase in COVID-19 cases in July 2022, January 2023, and June 2023. Faradillah et al (18) stated that a program or strategy for preventing COVID-19 cases involves forming an organizational, program, and resource support strategy.

The ARIMA method is one of the methods that produces the most accurate forecasts. This method is mostly applied to epidemiological studies (19) state that the forecasting accuracy of the ARIMA model is better than that of other time series models. Triacca & Triacca (20) also mentioned that the ARIMA method is the best model for forecasting COVID-19 cases. Sahai et al (21), in their research entitled ARIMA modeling and forecasting of COVID-19 in the top five affected countries, stated that the results of their research showed that forecasting using the ARIMA method was effective for predicting COVID-19 infection. ARIMA is suitable for use with time-series data and produces forecasts that are accurate and flexible, but ARIMA is not suitable for forecasting using panel data.

CONCLUSION

Based on the results of this study, it is known that the highest case distribution is in the city of Surabaya, and it is predicted that there will be an increase in COVID-19 cases in East Java Province in July 2022, January 2023, and June. 2023.

Research Limitation

The limitation of this study is that it was not possible to make detailed predictions per district in East Java Province because the data used in this study were time series data. This study also could not compare the severity of cases based on the type of COVID-19 virus. This can be achieved by adding other variables, such as the type of COVID-19 virus and variable severity.

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