Arab Journal of Basic and Applied Sciences

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tabs20

Modelling lock-down strictness for COVID-19 pandemic in ASEAN countries by using hybrid ARIMA-SVR and hybrid SEIR-ANN

Maharani A. Bakar, Norizan Mohamed, Danang A. Pratama, M. Fawwaz A. Yusran, Nor Azlida Aleng, Z. Yanuar & L. Niken

To cite this article: Maharani A. Bakar, Norizan Mohamed, Danang A. Pratama, M. Fawwaz A. Yusran, Nor Azlida Aleng, Z. Yanuar & L. Niken (2021) Modelling lock-down strictness for COVID-19 pandemic in ASEAN countries by using hybrid ARIMA-SVR and hybrid SEIR-ANN, Arab Journal of Basic and Applied Sciences, 28:1, 204-224, DOI: 10.1080/25765299.2021.1902606

To link to this article: https://doi.org/10.1080/25765299.2021.1902606

Published online: 19 May 2021.

ARAB JOURNAL OF BASIC AND APPLIED SCIENCES
2021, VOL. 28, NO. 1, 204–224
https://doi.org/10.1080/25765299.2021.1902606

University of Bahrain

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

OPEN ACCESS

Check for updates

Modelling lock-down strictness for COVID-19 pandemic in ASEAN countries by using hybrid ARIMA-SVR and hybrid SEIR-ANN

Maharani A. Bakar[a], Norizan Mohamed[a], Danang A. Pratama[a], M. Fawwaz A. Yusran[a], Nor Azlida Aleng[a], Z. Yanuar[b] and L. Niken[c]

[a]Faculty of Ocean Engineering Technology and Informatics, Universiti Malaysia Terengganu, Kuala Terengganu, Malaysia; [b]Department of Electrical and Electronic, Faculty of Engineering, Universiti Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia; [c]Department of Mathematics, Universitas Jenderal Soedirman, Purwokerto, Indonesia

ABSTRACT

ASEAN, include Indonesia, Malaysia, Philippines, Singapore, and Thailand, are the countries with ongoing transmission of SARS-COV-2, the virus that causes COVID-19. The confirmed cases in Indonesia and Philippines are the highest ranks among other ASEAN countries such as Malaysia, Thailand, and Singapore. To reduce the spread of the pandemic COVID-19, each country has implemented the lock-down policy differently, depending on its economic situation. Therefore, the study of the impact of lock-down across the world, particularly in ASEAN countries, is still relevant to do. In this study, we developed the lock-down model in ASEAN countries by using hybrid ARIMA-SVR and hybrid SEIR-ANN. The first hybrid is based on the time series model ARIMA, with the revision of the error is by using SVR. The second hybrid is based on the classical model of infectious diseases, SEIR, which we revise on the prediction part by using ANN. The hybrid is intended to revise the individual prediction model. The data collected per country was started from January 20, 2020 to August 5, 2020. The periods of lock-down in this study are divided into three, namely no lock-down, implemented lock-down, and the new normal periods. The strictness levels of lock-down were predicted for 60 days ahead. The results showed that the hybrid ARIMA-SVR had smaller RMSE compared with individual ARIMA, similarly, hybrid SEIR-ANN predicted S, E, I, and R more accurately compared with individual SEIR model. It has been also found that the lock down was most effectively implemented in Thailand, Singapore, and Malaysia, whereas Indonesia and Philippines were inefficient countries to enforce the restriction. It is indicated by the number of cases increased significantly during the restriction periods in both countries.

ARTICLE HISTORY
Received 9 October 2020
Revised 21 February 2021
Accepted 2 March 2021

KEYWORDS
ANN; ARIMA; COVID-19; hybrid model; Lock-down; SEIR; SVR

Introduction

Since identified firstly in Wuhan, China, in the late of December 2019 (World Health Organization (WHO), 2020) and was declared as a global pandemic by WHO, the number of confirmed cases throughout countries in the world per today, this paper was written, reached 32,429,965 with the total deaths was 985,823. Particularly, the number of COVID-19 cases across ASEAN countries were as follows: Indonesia (271,339 confirmed cases, 10,308 deaths), Malaysia (10,769 confirmed cases, 133 deaths), Thailand (3,376 confirmed cases, 58 deaths), Philippines (153,660 confirmed cases, 2,242 deaths), and Singapore (55,580 confirmed cases, 27 deaths). Demographically, Indonesia is significantly larger than Malaysia, Thailand, Philippines, and Singapore, which causes the rapid spread of the coronavirus in that country. What we concern on those is to how they implemented the lock-down during the pandemic to reduce the spread of the coronavirus.

The fatality rate in Indonesia is the highest among ASEAN countries, which reached 3.8% of the total cases, according to Johns Hopkins University. Philippines, on the other hand, although has high numbers of confirmed cases, but the fatality rate is quite low, which are 1.7% respectively. In fact, other ASEAN countries have already had a normal graphic of daily cases (see Figure 1). The mortality rate in Indonesia might be directly due to deaths among infected people increased significantly with daily basis, and indirectly due to the incapability of the health care system to handle the patient who is becoming infected by the COVID-19. The economic, social, and politic situation in that country could also contribute the mortality rate (World Health Organization (WHO), 2020).

To reduce the spread of COVID-19 massively, WHO advised to all countries to isolate their countries totally (World Health Organization (WHO),

CONTACT Maharani A. Bakar maharani@umt.edu.my

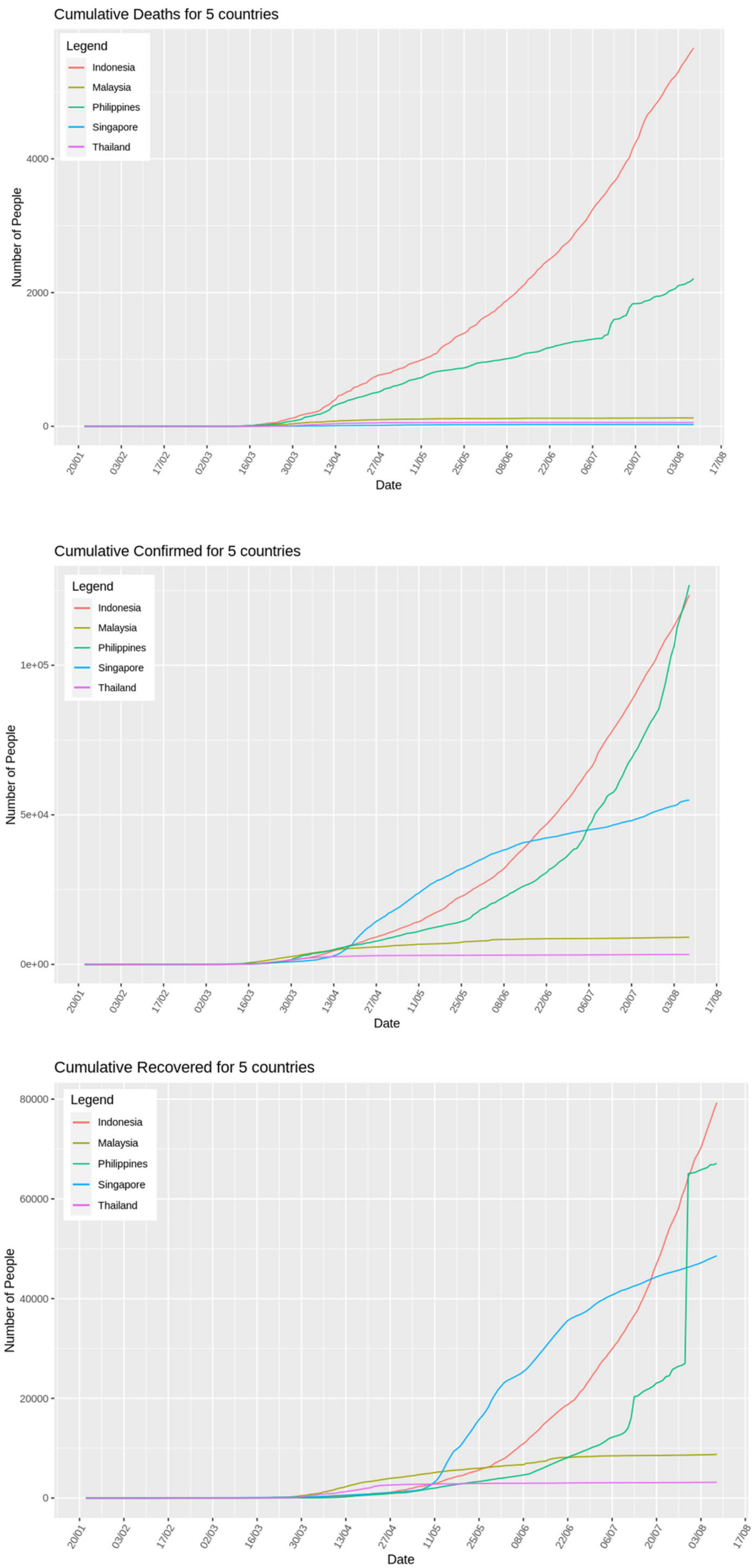

Figure 1. Accumulative data COVID-19 for 5 ASEAN countries: Indonesia, Malaysia, Philippines, Singapore, and Thailand (https://github.com/owid/covid-19-data/tree/master/public/data).

2020). In Malaysia, for instance, the government declared the movement control order (MCO) which restricted mass movements and gathering across the country, closed totally religious and business premises, restricted for Malaysians to travel abroad and across any state, prohibited all tourists and foreign visitors, and did closure to all schools, universities, and all government and private premises. The MCO is put into practice with the first phase on 18th March 2020 to the third phase in mid of May (Teks Perutusan Khas, 2020). Recently, Malaysia government implemented Recovery MCO (RMCO) where people live with a new normal which implements the standard health regulation (Teks Ucapan Pelaksanaan Perintah Kawalan Pergerakan Pemulihan, 2020; Ong, 2020).

Although was reluctant to implement initially, Indonesia government ultimately declared large-scale social restrictions (LSSR), or *Pembatasan Sosial Berskala Besar* (PSBB) (Ong, 2020), in the beginning of April 2020. Similar scenario to Malaysia, the officials enforced closing of all schools, entertainment sites, and worships locations. The LSSR was extended by Transition LSSR (TLSSR) which started in June 5 ("PP Nomor 21 Tahun", 2020; Nasruddin & Haq, 2020).

In other ASEAN countries such as Singapore, the local lock-down is called circuit breaker (CB), where it aims to break the COVID chain. It has been firstly launched by 7th April 2020, applied until 1st May, continued with the name of relaxed circuit breaker (RCB) which effectively applied from 2nd May to 19th May. In Philippines, the initial lock-down was called Metro Manila Community Quarantine (CQ), implemented on 15th March 2020 which covers 16 cities. It was then expanded to other Luzon islands and called Luzon enhanced community quarantine (ECQ) which covers the entire of the country. In Thailand, the Prime Minister, Prayut Chan-o-cha, declared a state of emergency which was effectively started on 26th March 2020. It was a local lock-down which went by the term “curfew”. It effectively started on 3rd April 2020.

There were several model predictions of the novel coronavirus that have been done during the outbreak, including the ones with interventions such as lock-down (Dickens et al., 2020) and social distancing. This study aims to learn the lock-down strictness levels used in the classical time series model for prediction, ARIMA (Wei, 2006), and the infectious diseases of SEIR model (Pengpeng, Shengli, & Peihua, 2020). Furthermore, we combine the two models with respectively support vector regression (SVR) (Wang, 2005) and artificial neural networks (ANN) (Cortes & Vapnik, 1995), in order to improve their accuracy of forecasting COVID-19. Although the hybrid ARIMA-SVR has been used for the outbreak prediction recently, however, the discussion of such a prediction is still challenging, in our point of view, particularly the one with including the lock down strictness levels in the model. Another thing, we compared five ASEAN countries with the respective levels of lock down strictness. Furthermore, we propose SEIR-ANN which has significant results.

Materials and methods

Data sets are taken generally from ourworldindata.org (https://github.com/owid/covid-19-data/tree/master/public/data), in addition for Indonesia COVID-19 is obtained from kawalcovid19.id (http://kcov.id/daftarpositif). All the data for three case types (confirmed, deaths, and recovered) were recorded from 22nd January 2020 until 5th August 2020. Figure 1 illustrated the accumulate data sets of confirmed, deaths, and recovered. The time period, were divided into three phases: before any preventive measures were issued by the country (phase 1), during the full preventive measures (phase 2), and a relaxed phase or the new normal phase (phase 3).

From the original data sets, which contains some variables such as total population, daily and total confirmation cases, daily and total deaths, daily and total COVID-19 test taken, we extract following on four compartments of S, E, I, and R. Hence, the values of quarantined SEIR model (Sq, Eq, and H) are determined by using certain formula. For prediction purposes, the extracted data sets are divided into the train data sets and test data sets. The proportion of both train and test is set arbitrary based on how large is our data set (Géron, 2019). Here, we set 80:20 based on our trial and error and thus the optimum results are obtained.

Hybrid ARIMA-SVR model

Many scientists used the hybrid ARIMA-SVR for obtaining better accuracy of the prediction. In fact, the adaptive ARIMA is suitable for linear data sets only, thus its combination with SVR would more flexible to handle the non linear data sets. As appeared in (Zhang et al., 2019), for instance, the authors employed the hybrid for patient emergency flow prediction. Furthermore, the hybrid ARIMA-SVR has been investigated to forecast the multiscale standard precipitation indices (SPIs) (Dehe et al., 2020), where the authors compared it with the single ARIMA model. This hybrid has been also discussed in (Solis et al. 2020) for general COVID-19 prediction. Here, we employed the hybrid ARIMA-SVR to fit the COVID-19 model with addition to include the lock down strictness levels, which are no lock-down, lock down, and post-lock-down (new normal). In fact, we compare the lock down implementation in the five

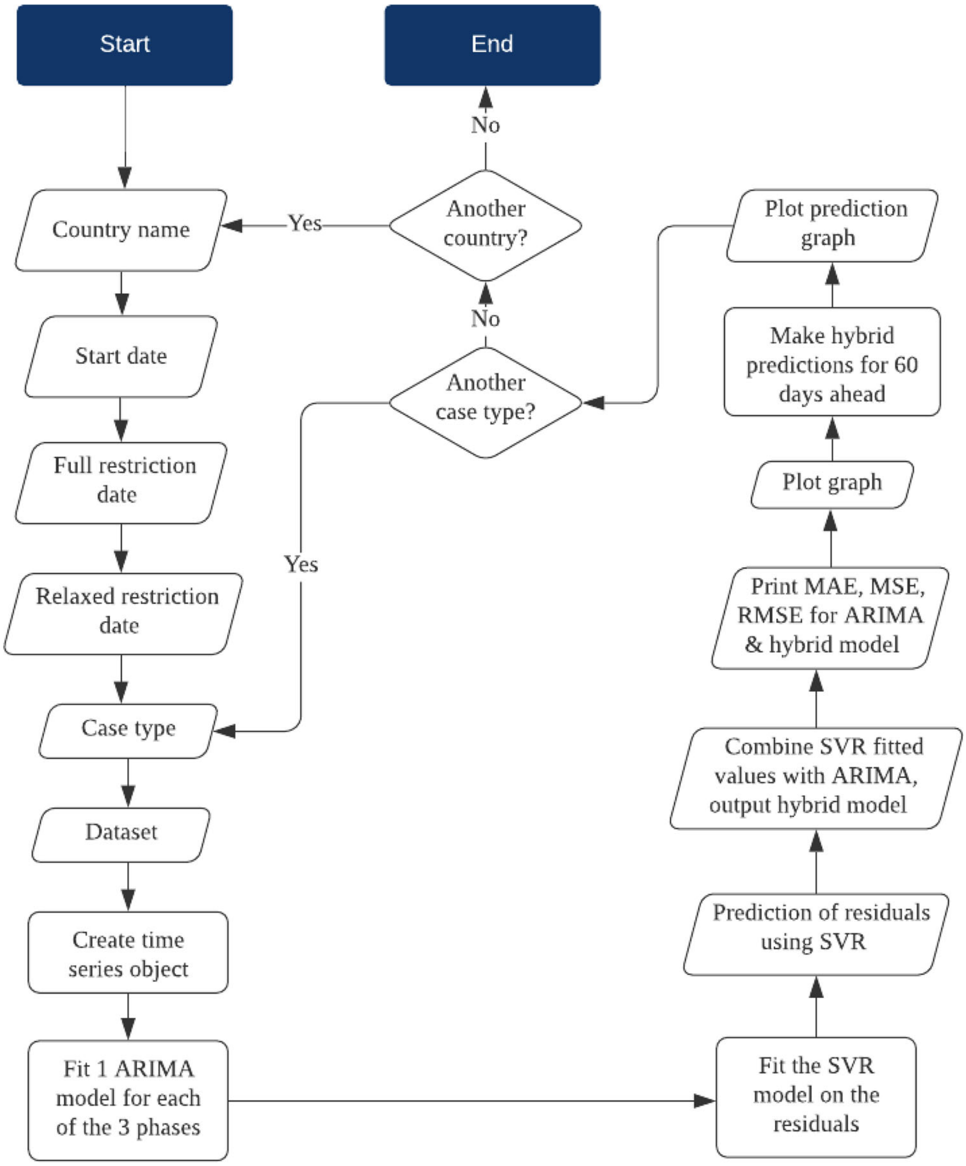

Figure 2. Hybrid ARIMA-SVR Algorithm for COVID-19 prediction.

ASEAN countries mentioned in the previous section. The further detail of some steps of fitting the COVID-19 model is as follows.

1. Fitting data sets by using ARIMA(*p, d, q*)

According to [29], parameters p (autocorrelation), d (differencing) and q (moving average)are calculated by using formula

$$\varphi_p(B)(1-B)^d\dot{Z}_t = \theta_q(B)a_t \ \varphi_p(B) = 1 - \varphi_1 B - \varphi_2 B^2 - \cdots - \varphi_p B^p, \quad (1)$$

with

$$\theta_q(B) = 1 - \theta_1 B - \theta_2 B^2 - \cdots - \theta_q B^p,$$

where $\dot{Z}_t$ is a stationary time series data in period t; B is a backward shift operator; $\varphi_p(B)$ and $\theta_q(B)$ are regular autoregressive and moving average polynomials of orders p and q respectively; $(1-B)^d$ is the non-seasonal differencing operator; a_t is a white noise process with mean zero and constant variance (Asteriou & Hall, 2011). In the case of COVID-19 data sets, the parameters p, d, and q may be tweaked due to the nature of different countries statistics.

2. Computing the model residuals

The residuals (ε_t) of the time series data (x_t) and ARIMA model predictions (a_t) is calculated by

$$\varepsilon_t = x_t - a_t \quad (2)$$

3. Revising the ARIMA residuals by using the SVR method

Denote f be kernel function of radial-basis, the SVR residual fitting model (n_t) is obtained by

$$n_t = f(\varepsilon_t) + \Delta t \quad (3)$$

where Δt is the random error.

4. Combining residuals of ARIMA and SVR

The complete hybrid model (Z_t) for forecasting is obtained by following formula

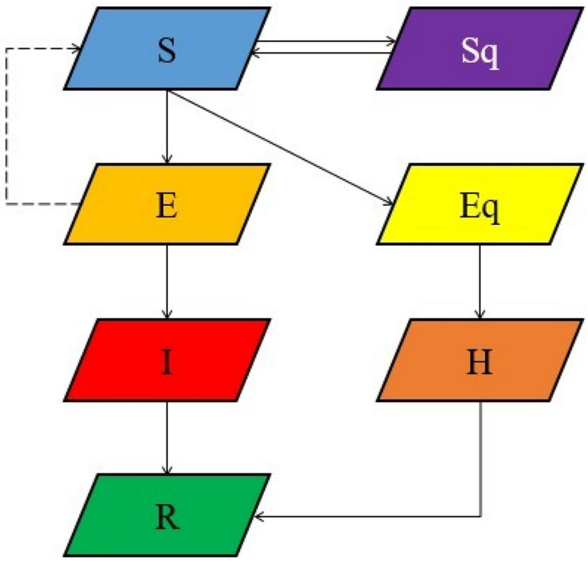

Figure 3. SEIR model scheme.

$$Z_t = a_t + n_t. \quad (4)$$

As mentioned above, this study aims to acknowledge the contribution of the strictness of lock-down, thus the fitting and prediction models are divided into three phases following on the periods of lock-down in the five ASEAN countries including Indonesia, Malaysia, Philippines, Singapore, and Thailand. Hence, for each phase, the single ARIMA and the hybrid model are fitted and forecasted up to 60 days ahead. This will show the effectiveness of the preventive measures taken by the country and will predict whether the deaths, recovered or confirmed rates will decrease, stay the same or increase. Detail of the hybrid ARIMA-SVR algorithm is illustrated as follows (Figure 2).

Hybrid SEIR-ANN model

SEIR model is the most popullar model to predict the infectious desease, including to predict the outbreak of corona virus. The famous four compartments of SEIR model consist of Susceptible (S), which are healthy people but susceptible to be infection; Exposed (E), is a group of people or population suspected of being infected because they have travel to a vulnerable area, or have been in contact with an infected person, but have not been proven to be infected; Infected (I), is the population that has been infected; and Recovered (R), the population that has recovered (Rustan, 2020).

For the extended SEIR model, we include additional sub-categories of group people such as S_q (Susceptible Quarantined), E_q (Exposed quarantined), and H (Hospitalized or Infected Quarantined). Diagram below illustrates the current situation of the outbreak in SEIR model (Figure 3).

Table 1. Definition of modelling parameters.

Parameter	Description
c	Contact rate
β	Probability of Transmission
θ	Ratio of transmission of E to be I
λ	1/quarantine duration
q	Quarantined ratio
σ	1/incubation time
α	Death rate
δ_I	Quarantine rate of I
γ_I	Recovery rate of I
δ_q	Transformation rate from E to H
γ_H	Recovery rate of H

Then each compartment has following the differential equation:

$$\frac{dS}{dt} = -[c\beta + cq(1-\beta)]S(I+\theta E) + \lambda S_q \quad (8)$$

$$\frac{dE}{dt} = c\beta(1-q)S(I+\theta E) - \sigma E \quad (9)$$

$$\frac{dI}{dt} = \sigma E - (\delta_I + \alpha + \gamma_I)I \quad (10)$$

$$\frac{dS_q}{dt} = c\beta(1-q)S(I+\theta E) - \lambda S_q \quad (11)$$

$$\frac{dE_q}{dt} = c\beta q S(I+\theta E) - \delta_q E_q \quad (12)$$

$$\frac{dH}{dt} = \delta_I I + \delta_q E_q - (\alpha + \gamma_H)\mathrm{H} \quad (13)$$

$$\frac{dR}{dt} = \gamma_I I + \gamma_H H \quad (14)$$

The explanation of the parameters used by SEIR model above is as in Table 1.

The value of each parameter was determined from the actual data, for instance, β was calculated from the total number of infection rate divided by total number of people (Hashim, Alsuwaidi, & Khan, 2020), quarantined ratio determined by all quarantined people divided by total number of population, etc. Quarantined duration was 14 days, and inqubation time was 3 days which all determined by the latest research (Pengpeng et al., 2020). All of those parameters are added by one additional categorical parameter namely health protocol which indicates whether the corresponding country do the preventive measure or not.

All parameters obtained by using SEIR model is put in the ANN framework (Géron, 2019; Purnama, 2019) to proceed the prediction section. Thus the hybrid SEIR-ANN model was combined to find the better fitting model and the more accurate prediction than the single SEIR model. The scenarios that we implemented in this section remains the same as discussed previously, where for each phase of lock-down periods, the SEIR model is fitted and hence continued by the hybrid SEIR-ANN to forecast the number of people who are suspected, exposed, infected, and recovered up to 60 days ahead. This will show the effectiveness of the preventive

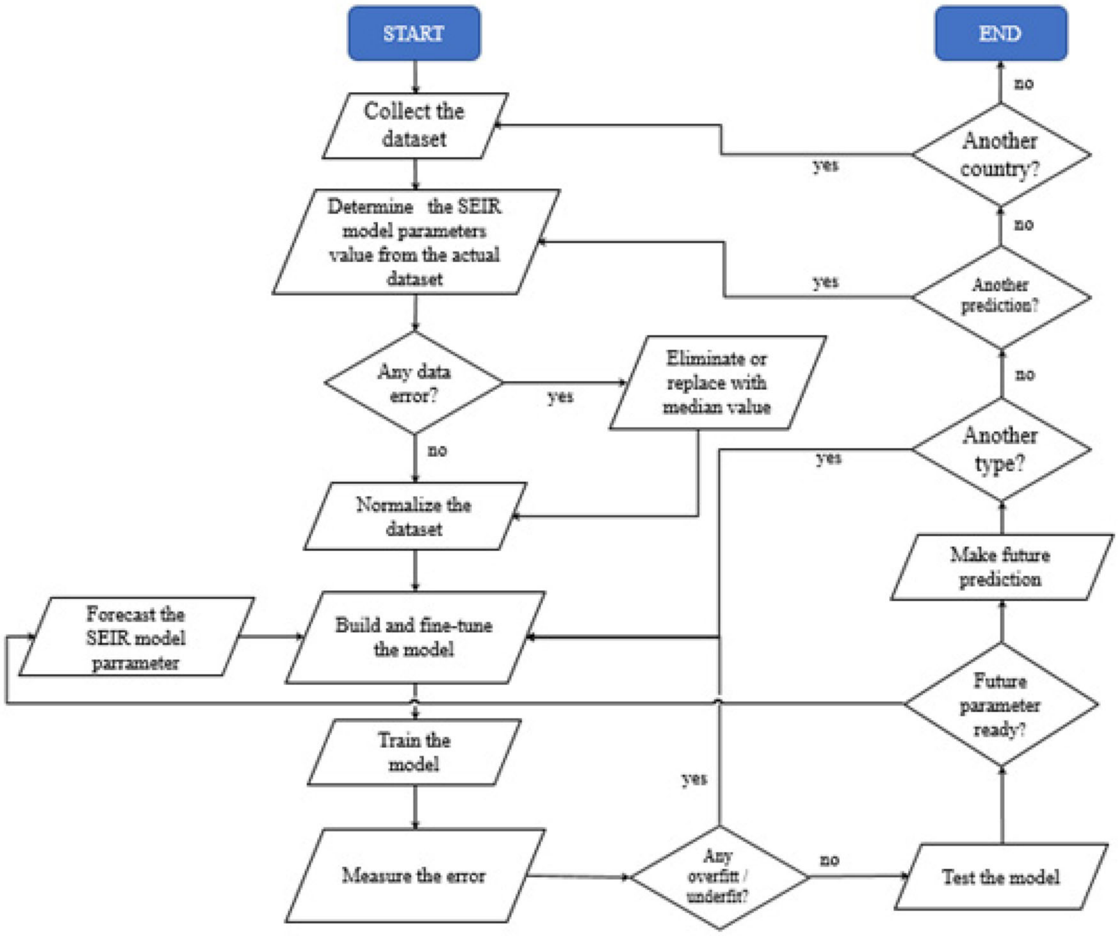

Figure 4. The scenario lock-down modelling with various strictness levels using hybrid SEIR-ANN model.

measures taken by the country. Detail of the hybrid SEIR-ANN algorithm is illustrated as follows (Figure 4).

Results and discussion

Hybrid ARIMA-SVR model for COVID-19 forecasting

In this section, we presented the fitting model and forecasting model of confirmed, deaths, and recovered cases of COVID-19 of five ASEAN countries, namely Indonesia, Philippines, Malaysia, Singapore, and Thailand. The comparison of the three phases of lock-down was reported. We included Philippines, Singapore, and Thailand in this study with intents to look at general pattern of the effect of the strictness levels of lock-down in COVID-19 model. Note here, the local lock-down implementation in Philippines, Singapore, and Thailand can be seen in (World Health Organization (WHO), 2020; Ministry of Health, 2020; Limos, 2020). To evaluate the hybrid model and compare its significance with traditional ARIMA modelling, three metrics were measured: MAE (mean absolute error), MSE (mean squared error), and RMSE (root mean squared error) (Willmott, Matsuura, & December, 2005):

$$MAE = \frac{1}{N}\sum_{t=1}^{N}|x_t - z_t| \quad (8)$$

$$MSE = \frac{1}{N}\sum_{t=1}^{N}(x_t - z_t)^2 \quad (9)$$

$$RMSE = \sqrt{\frac{1}{N}\sum_{t=1}^{N}(x_t - z_t)^2} \quad (10)$$

where N is the number of time series points, x_t is the actual value at time t and z_t is the fitted model's forecast at time t. The results of fitted model and forecasting model for 60 days ahead of COVID-19 for confirmed, deaths, and recovered trends are presented in Figures 5–7 respectively. Furthermore, the accuracy of each model is recorded in Tables 2–4 respectively.

Hybrid SEIR-ANN model for COVID-19 forecasting

As mentioned in the previous section, the hybrid SEIR-ANN model used the parameters of SEIR as an input that used by ANN to forecast. Thus, the S, E, I, and R data were obtained and fitted by the proposed hybrid model. Here, we used the COVID-19 data from two countries only, i.e., Indonesia and

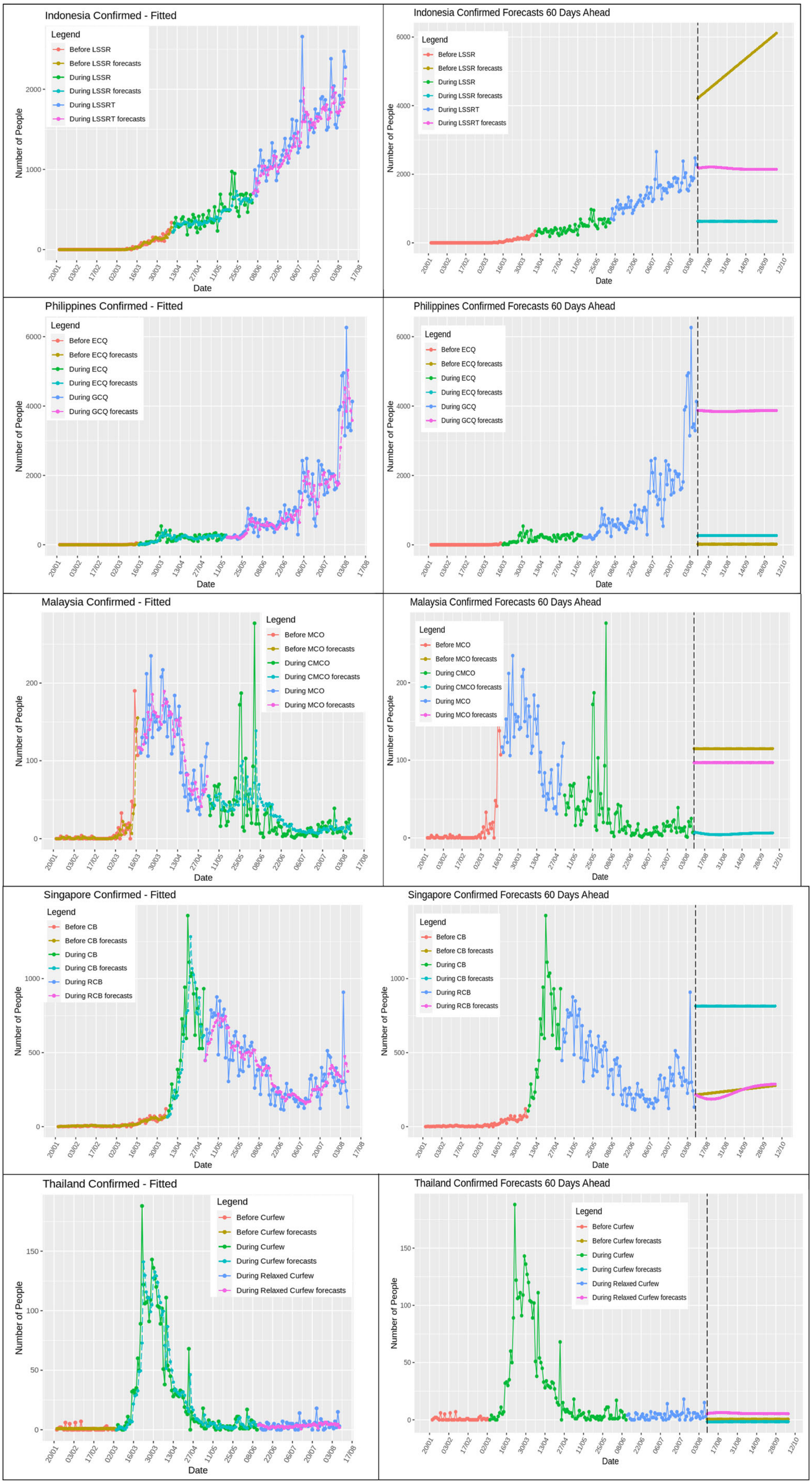

Figure 5. Fitting hybrid ARIMA-SVR model (left side) and forecasting for 60 days ahead using hybrid ARIMA-SVR model (right side) for **confirmed cases** of COVID-19 in five countries of ASEAN. It can be seen that the most strictness of lock-down would reduce the confirmed cases significantly as shown in graphs of Thailand, Malaysia, and Singapore, whereas Indonesia and Philippines were the highest risk of COVID-19 spread.

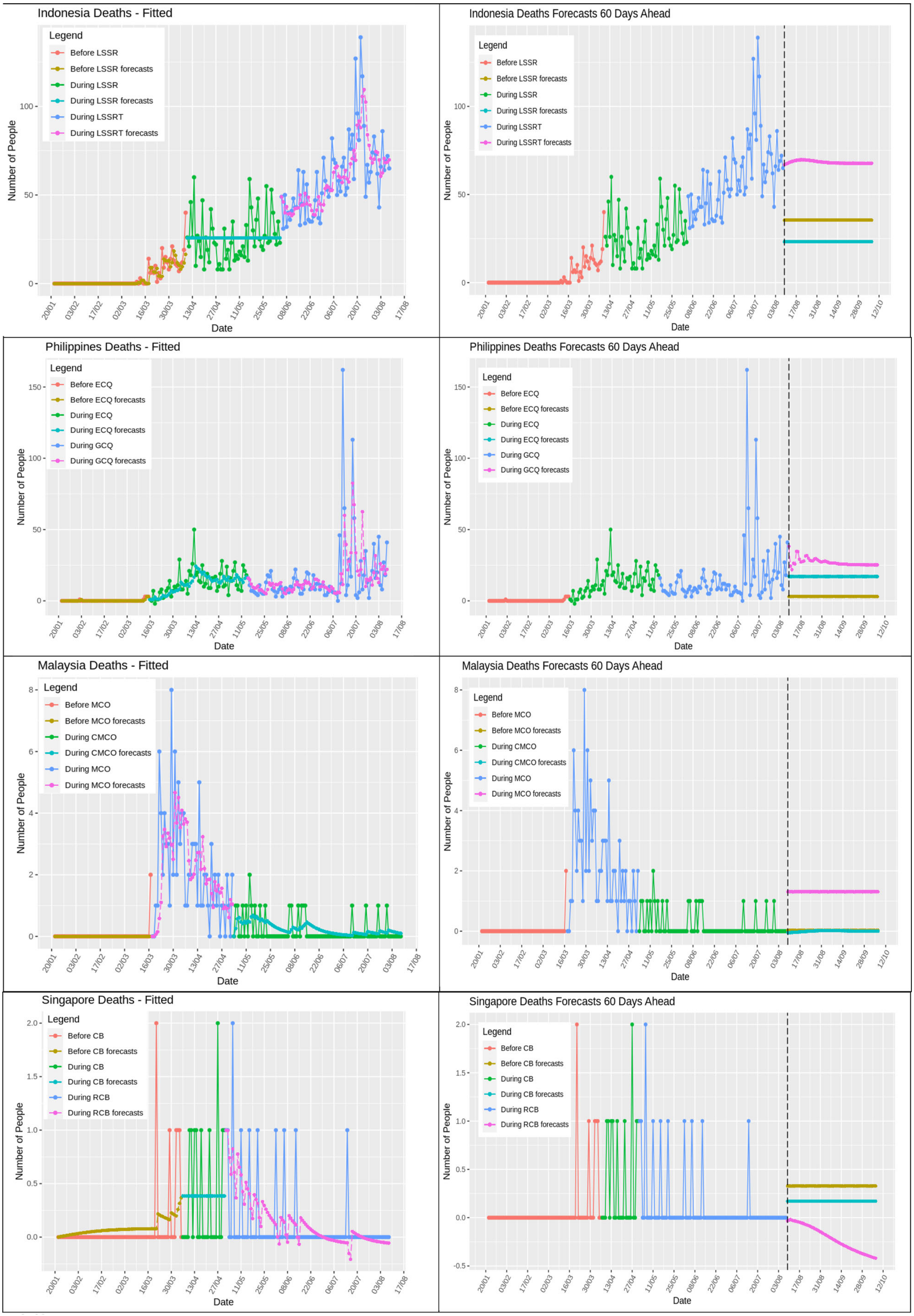

Figure 6. Fitting hybrid ARIMA-SVR model (left side) and forecasting for 60 days ahead using hybrid ARIMA-SVR model (right side) for **deaths** of COVID-19 in five countries of ASEAN. The same story as the confirmed case above, that Indonesia and Philippines have a high risk of deaths, compared with other three countries, even doesn't have death cases since months ago.

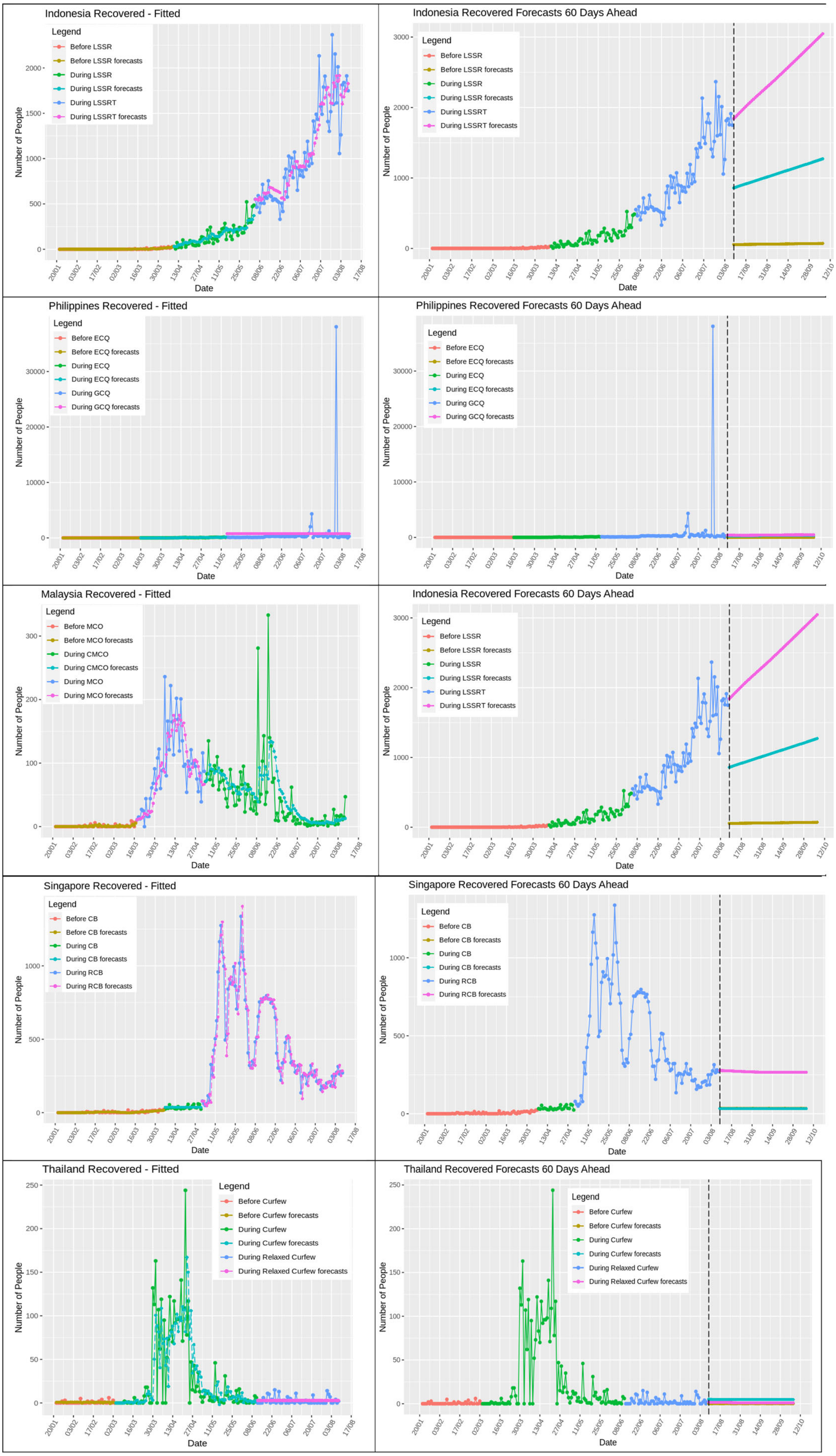

Figure 7. Fitting hybrid ARIMA-SVR model (left side) and forecasting for 60 days ahead using hybrid ARIMA-SVR model (right side) for **recovered cases** of COVID-19 in five countries of ASEAN.

Table 2. Performance of normal ARIMA model and hybrid model for Covid-19 **confirmed cases** in the 5 countries.

		MAE		MSE		RMSE	
Phase	Country	ARIMA	Hybrid	ARIMA	Hybrid	ARIMA	Hybrid
1	Indonesia	10.119	10.614	359.442	333.737	18.959	18.268
	Malaysia	7.253	7.407	491.641	484.146	22.173	22.003
	Singapore	6.721	5.874	110.518	98.954	10.513	9.948
	Philippines	1.901	1.764	21.908	18.924	4.681	4.350
	Thailand	1.209	0.979	3.214	3.573	1.793	1.890
2	Indonesia	90.168	89.859	15147.06	14843.74	123.073	121.835
	Malaysia	28.094	26.183	1283.312	1154.050	35.823	33.971
	Singapore	153.230	138.634	45708.08	38693.07	213.795	196.706
	Philippines	65.402	63.219	7776.248	7910.543	88.183	88.941
	Thailand	9.839	9.101	356.808	341.679	18.889	18.485
3	Indonesia	180.623	171.704	64954.16	59163.94	254.861	243.236
	Malaysia	19.111	17.038	1226.346	1196.090	35.019	34.585
	Singapore	88.214	81.901	15990.99	15621.42	126.456	124.986
	Philippines	382.7109	377.430	369332.3	362178.4	607.727	601.813
	Thailand	2.475	2.416	12.805	12.229	3.578	3.497

Table 3. Performance of ARIMA model and hybrid model for Covid-19 **deaths** in the 5 countries.

		MAE		MSE		RMSE	
Phase	Country	ARIMA	Hybrid	ARIMA	Hybrid	ARIMA	Hybrid
1	Indonesia	1.708	1.827	17.702	16.431	4.207	4.053
	Malaysia	0.036	0.057	0.071	0.070	0.267	0.264
	Singapore	0.141	0.098	0.091	0.105	0.301	0.323
	Philippines	0.093	0.110	0.130	0.126	0.360	0.355
	Thailand	N/A	N/A	N/A	N/A	N/A	N/A
2	Indonesia	10.434	9.119	174.986	178.299	13.228	13.353
	Malaysia	1.132	1.109	2.626	2.419	1.621	1.555
	Singapore	0.530	0.380	0.314	0.349	0.560	0.590
	Philippines	5.892	5.715	64.124	63.324	8.001	7.958
	Thailand	N/A	N/A	N/A	N/A	N/A	N/A
3	Indonesia	12.35046	12.27771	292.8901	282.3079	17.11403	16.80202
	Malaysia	0.321	0.248	0.178	0.190	1.62	1.555
	Singapore	0.193	0.149	0.103	0.102	0.322	0.319
	Philippines	9.671	9.258	420.914	430.537	20.516	20.749
	Thailand	N/A	N/A	N/A	N/A	N/A	N/A

Table 4. Performance of hybrid ARIMA-SVR model for Covid-19 **recovered cases**.

		MAE		MSE		RMSE	
Phase	Country	ARIMA	Hybrid	ARIMA	Hybrid	ARIMA	Hybrid
1	Indonesia	1.947	1.553	10.109	9.103	3.017	3.180
	Malaysia	1.018	1.043	3.143	2.967	1.773	1.723
	Singapore	2.859	2.593	18.315	18.235	4.280	4.270
	Philippines	0.037	0.054	0.037	0.036	0.192	0.190
	Thailand	1.063	0.840	2.004	2.068	1.415	1.438
2	Indonesia	49.102	46.076	4452.913	4279.602	66.730	65.419
	Malaysia	28.228	27.057	1518.922	1358.639	38.973	36.860
	Singapore	9.101	7.730	125.864	119.646	11.219	10.938
	Philippines	11.463	10.436	253.468	251.069	15.921	15.845
	Thailand	17.102	16.827	1157.556	1135.055	34.023	33.691
3	Indonesia	181.054	169.704	61468.78	60425.7	247.929	245.816
	Malaysia	22.905	20.355	1953.236	1994.071	44.195	44.655
	Singapore	75.951	74.935	13450.33	13234.51	115.976	115.041
	Philippines	993.011	755.590	16640373	16654932	4079.261	4081.046
	Thailand	3.014	2.549	15.947	17.425	3.993	4.174

Malaysia. All the data for the three case types were recorded from 25th January 2020 until 13rd August 2020 for Malaysia, and 2nd March 2020 until 11rd September 2020 for Indonesia. The time period, as mentioned in previous sections, were divided into three types: before any preventive measures were issued by the country (phase 1), during the full preventive measure (phase 2), and a relaxed phase (phase 3). For the first phase, Malaysia and Indonesia contact rates were set as 6.47 and 7.67, respectively. It means that one person in Malaysia interacts with other 7 people (1 Indonesian interacts with 8 others) approximately each day and they do not perform any health protocol (Rustan, 2020; Mahmud & Lim, 2020). In phase 2, Malaysia contact rate was 2.91, while Indonesia contact rate was set as 3.45 (Asteriou & Hall, 2011; Willmott et al., 2005),, and the health protocol performed well here. In phase 3, the contact rates of the two countries were assume become normal, or 6.47 for Malaysia and 7.67 for

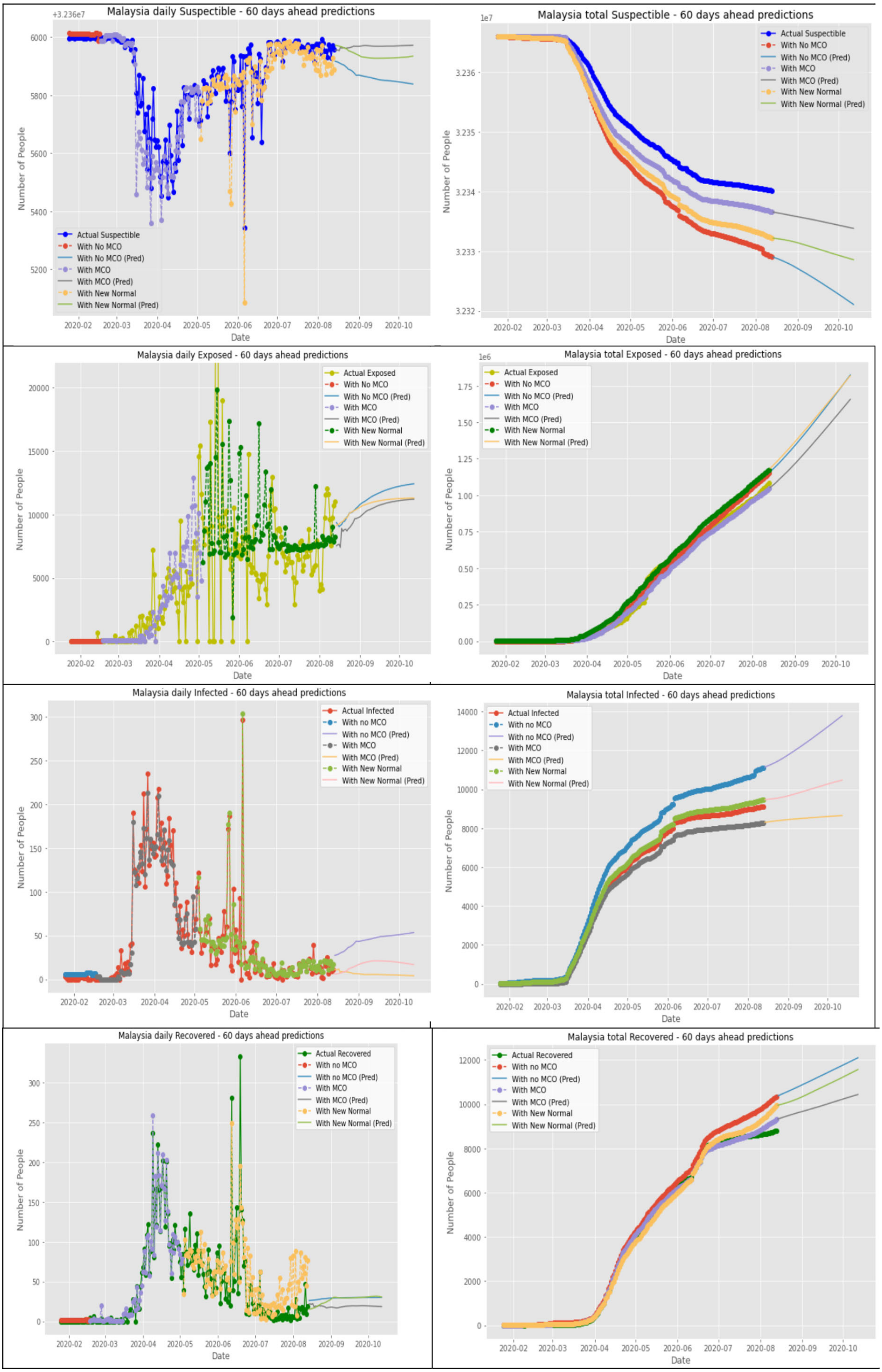

Figure 8. Daily prediction of Malaysia Covid-19 cases by using hybrid SEIR-ANN model (left side) and the total cases prediction (right side).

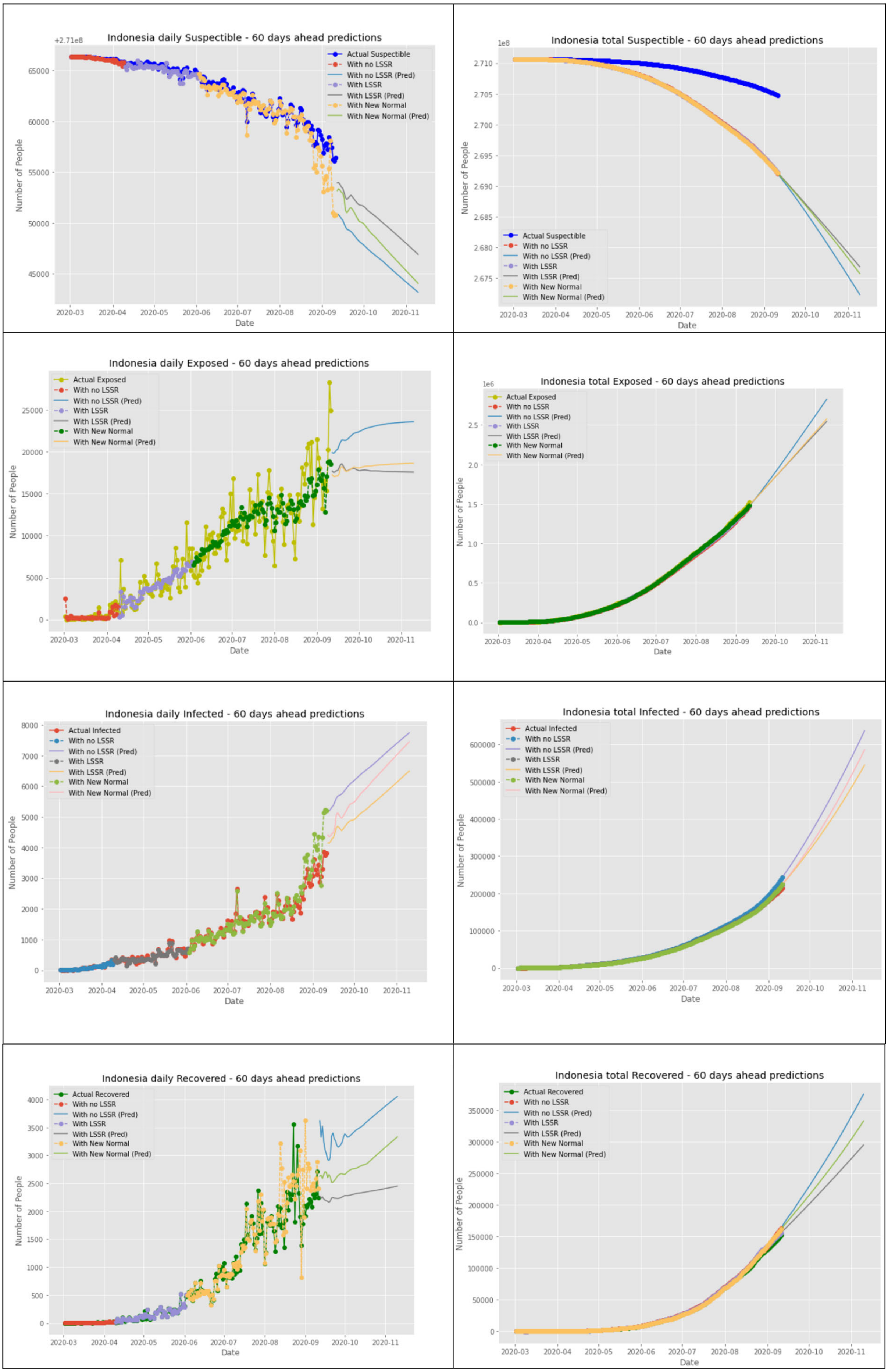

Figure 9. Daily prediction of Indonesia Covid-19 cases by using hybrid SEIR-ANN model (left side) and the total cases prediction (right side).

Table 5. Performance of hybrid SEIR-ANN model for Covid-19 Malaysia cases.

		MAE		MSE		RMSE	
Phase	Model	Train Set	Test Set	Train Set	Test Set	Train Set	Test Set
1	Suspectible	61.56	59.72	10495.12	12125.55	102.45	110.12
	Exposed	2915.25	1863.68	89280192	7347632	9448.82	2710.65
	Infected	9.91	14.54	296.24	1621.23	17.21	40.27
	Recovered	47.05	26.41	5430.04	787.03	73.69	28.05
2	Suspectible	36.22	17.77	4694.79	466.70	68.52	21.60
	Exposed	2895.09	1952.01	86628216	7743344	9307.43	2782.69
	Infected	5.56	15.47	74.73	1247.53	8.65	35.32
	Recovered	48.87	19.17	5654.06	460.58	75.19	21.46
3	Suspectible	48.51	28.97	7112.67	1417.94	84.34	37.65
	Exposed	2862.91	1831.8	85561456	5466493	9249.94	2338.05
	Infected	8.08	6.11	170.73	73.58	13.07	8.58
	Recovered	45.05	26.11	4939.74	1150.43	70.28	33.92

Table 6. Performance of hybrid SEIR-ANN model for Covid-19 Indonesia cases.

		MAE		MSE		RMSE	
Phase	Model	Train Set	Test Set	Train Set	Test Set	Train Set	Test Set
1	Suspectible	321.84	2873.49	166506.77	11353133.71	408.05	3369.44
	Exposed	1089.89	2680.38	2499162.25	11056043	1580.87	3325.06
	Infected	65.89	300.79	7744.34	143410.06	88	378.70
	Recovered	24.02	431.21	1536.91	259066.09	39.20	508.99
2	Suspectible	225.30	1820.10	86753.84	5002367.34	294.54	2236.60
	Exposed	1054.21	2685.96	2337452	10372579	1528.87	3220.65
	Infected	41.99	768.02	3681.59	867067.56	60.68	931.16
	Recovered	43.06	496	4227.51	385986.69	65.02	621.28
3	Suspectible	212.23	2016.23	78726.72	6914692.25	280.58	2629.58
	Exposed	1056.82	2798.18	2381209.5	12822692	1543.12	3580.88
	Infected	44.20	185.73	4101.75	56392.64	64.04	237.47
	Recovered	15.51	400.72	647.24	312733.41	25.44	559.23

Indonesia, but people performs health protocol. All of the model of the three phases of Malaysian and Indonesia were recorded in Figures 8 and 9 respectively, while the validity of the models presented in Tables 5 and 6 respectively.

Discussion

As we can see from the above results, the standard errors of the hybrid ARIMA-SVR model are generally lower than a single ARIMA model, so the hybrid model performed better and made more accurate predictions. Also, we can observe that cordon-sanitaire (restriction) orders of all countries have a significant impact at decreasing the number of confirmed cases and deaths while also improving recovery rates. Based on the 60-day-ahead forecasts of the hybrid model, had each country continued their full lockdown, the numbers affected by the virus will decrease faster than with a relaxed restriction order.

In general, the hybrid SEIR-ANN model performed accurately to predict the susceptible, exposed, infected, and recovered trend of COVID-19, with small values of RMSE in three phases. These values of all prediction models can be seen in Tables 5–9. There are several trend differences of the five countries in each classes of susceptible (S), exposed (E), infected (I), and recovered (R). In Malaysia, the trend of S prediction tended to slightly decrease for 60 days ahead, similar as in Philippine, and Thailand, whereas in Indonesia and SIngapore, it dropped significantly, It happened to all three phases. It is understandable that by the nature, S is obtained by subtracted the total population from the total E, I, and R. In contrast, the trend of E, I and R increased dramatically in Indonesia for the next 60 day's prediction for all three phases. Differently, in Malaysia, the trend of E, I, and R showed dropped significantly for the second and the third phase of local lock-down. Based on our observation of what has happened in Indonesia and Malaysia, that the lock-down was not implemented strictly to all areas of Indonesia where crowded still appeared during the controlled movement and the penalties were not really given to people who against the rules. This situation was extremely contrast with what was done in Malaysia, where the country implemented fully lock-down. It is, however, not our authority to discuss more detail regarding the community behaviour during the lock-down, we just concerned on the strictness level of the lock-down implemented.

Conclusion and limitation

We have implemented the hybrid ARIMA-SVR and hybrid SEIR-ANN models for forecasting COVID-19 in terms of the lock-down implementation. The first hybrid model was used to predict the confirmed, deaths, and recovered cases of pandemic COVID-19

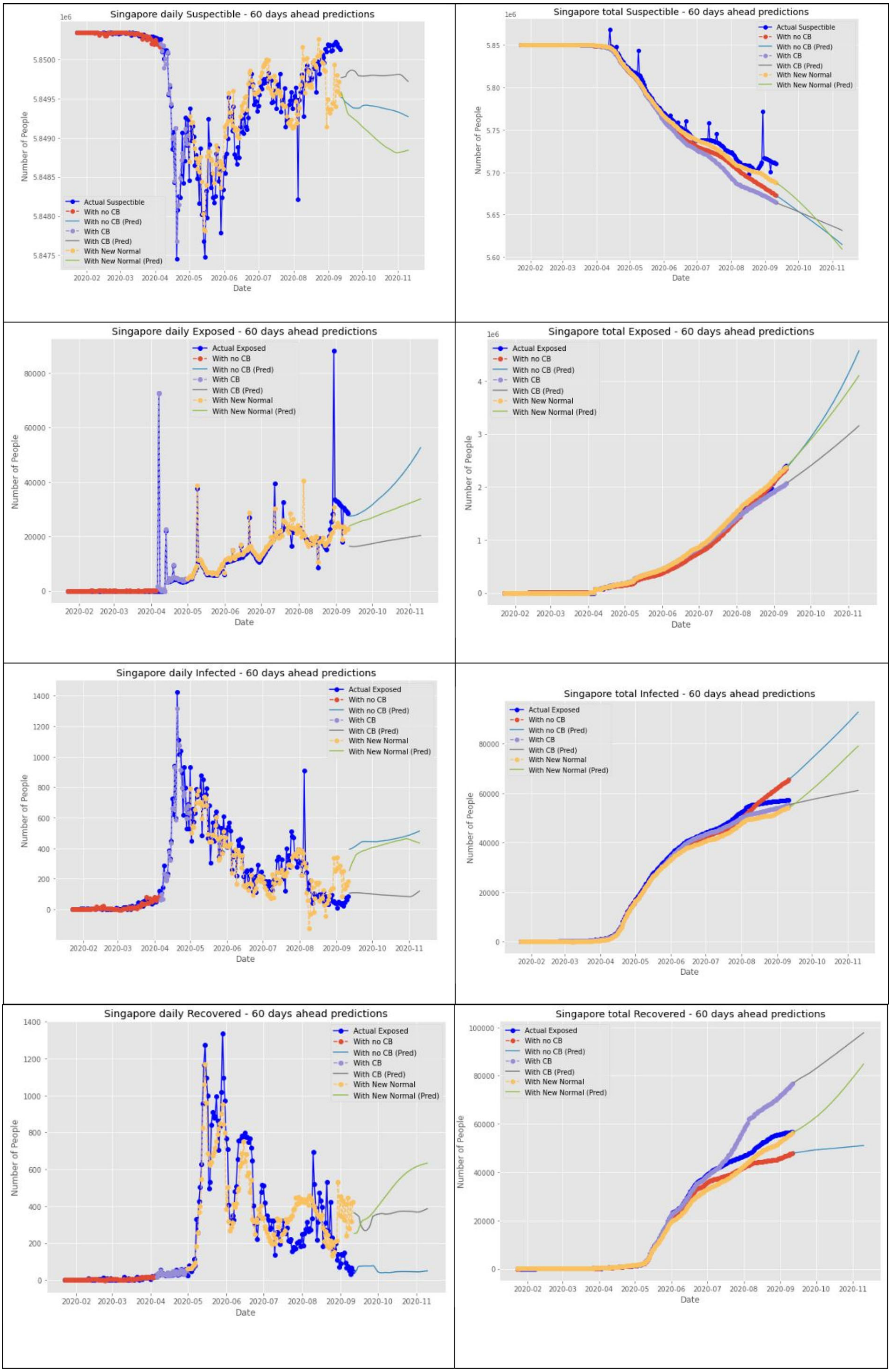

Figure 10. Daily prediction of Singapore Covid-19 cases by using hybrid SEIR-ANN model (left side) and the total cases prediction (right side).

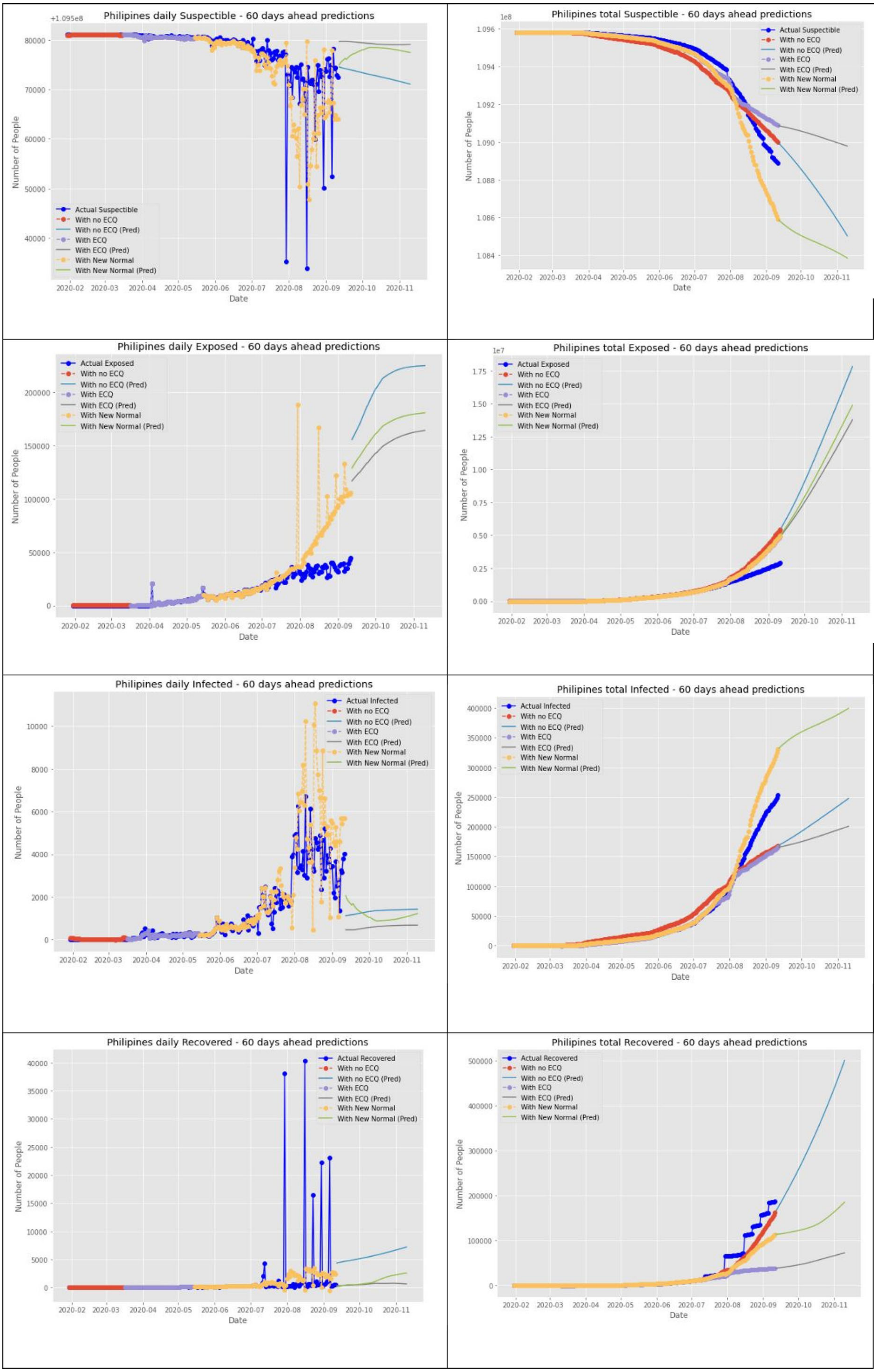

Figure 11. Daily prediction of Philipines Covid-19 cases by using hybrid SEIR-ANN model (left side) and the total cases prediction (right side).

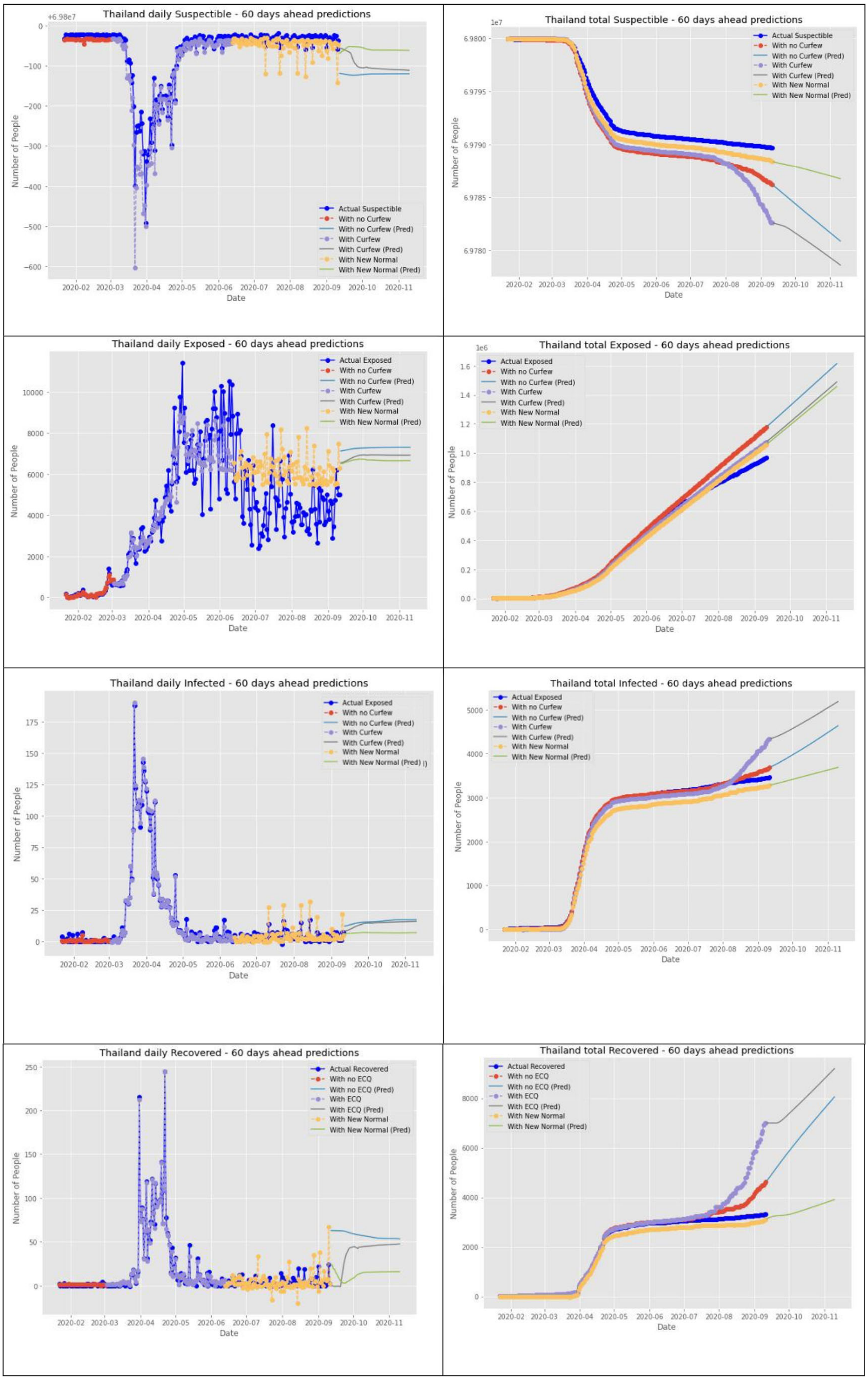

Figure 12. Daily prediction of Thailand Covid-19 cases by using hybrid SEIR-ANN model (left side) and the total cases prediction (right side).

in five ASEAN countries including Indonesia, Malaysia, Philippines, Thailand, and Singapore, whereas the second hybrid model was used to predict the susceptible, exposed, infected, and recovered people of the novel coronavirus. Based on both model results, the highest level of lockdown

Table 7. Performance of hybrid SEIR-ANN model for Covid-19 Singapore cases.

		MAE		MSE		RMSE	
Type	Model	Train Set	Test Set	Train Set	Test Set	Train Set	Test Set
1	Suspectible	710.02	6102.73	3026184.13	56062583.23	1740	7487.49
	Exposed	98.59	440.50	25321.63	255778.61	159.13	505.75
	Infected	39.22	139.01	4148.54	41258.59	64.41	203.12
	Recovered	38.65	173.11	5124.93	52032.43	71.59	228.11
2	Suspectible	685.13	7604.69	3524258.62	85565172.82	1877.31	9250.14
	Exposed	85.25	341.63	23651.40	164037.67	153.79	405.02
	Infected	36.42	38.49	3954.61	6035.85	62.88	77.69
	Recovered	55.51	323.66	21575.75	175369.63	146.89	418.77
3	Suspectible	613.51	4566.08	1626972.00	45461111.27	1275.53	6742.48
	Exposed	111.26	336.59	32395.37	197430.84	179.99	444.33
	Infected	38.09	61.45	3401.92	13807.21	58.32	117.50
	Recovered	56.42	179.99	9554.90	44247.08	97.75	210.35

Table 8. Performance of hybrid SEIR-ANN model for Covid-19 Philipines cases.

		MAE		MSE		RMSE	
Type	Model	Train Set	Test Set	Train Set	Test Set	Train Set	Test Set
1	Suspectible	815.75	2408.09	4331562.29	33852450.86	2081.24	5818.29
	Exposed	636.07	1371.91	1072008.5	28560891.99	1035.37	5344.24
	Infected	161.12	200.50	98245.38	591972.43	313.44	769.39
	Recovered	80.40	226.43	144316.89	4018928.71	379.89	2004.72
2	Suspectible	461.57	1953.57	2621929.98	24089233.55	1619.24	4908.08
	Exposed	387.85	1957.83	564447.66	38237688.93	751.29	6183.66
	Infected	109.74	341.42	68248.97	579487.53	261.24	761.24
	Recovered	50.25	159.35	106154.95	4381486.83	325.81	2093.20
3	Suspectible	500.95	2042.47	2573505.28	27554481.72	1604.21	5249.24
	Exposed	445.57	2988.03	976839.83	57852815.38	988.35	7606.10
	Infected	92.06	332.07	63362.76	657754.16	251.72	811.02
	Recovered	64.95	211.30	87965.35	4606062.57	296.58	2146.17

Table 9. Performance of hybrid SEIR-ANN model for Covid-19 Thailand cases.

		MAE		MSE		RMSE	
Type	Model	Train Set	Test Set	Train Set	Test Set	Train Set	Test Set
1	Suspectible	989.91	2476.70	2289534.21	7588135.47	1513.12	2754.66
	Exposed	20.09	39.82	1342.37	2342.62	36.63	48.40
	Infected	1.72	4.74	6.39	34.67	2.53	5.89
	Recovered	2.66	10.20	47.71	480.74	6.91	21.93
2	Suspectible	903.58	1756.16	1934873.13	4034830.01	1390.99	2008.69
	Exposed	19.89	114.12	1301.92	23117.65	36.08	152.04
	Infected	1.46	20.05	5.31	673.22	2.30	25.95
	Recovered	3.05	32.87	71.19	4529.51	8.44	67.30
3	Suspectible	957.46	1849.05	2051665.04	4377031.43	1432.36	2092.13
	Exposed	16.05	16.68	794.92	484.29	28.19	22.01
	Infected	1.99	2.16	9.42	17.63	3.07	4.20
	Recovered	3.07	3.98	43.14	81.80	6.57	9.04

strictness, would decrease the confirmed cases and deaths, and highly improves recovery rates. This is followed by partial or relaxed lockdown, and then no preventive measures at all. Based on the results above, Thailand, Singapore, and Malaysia were the most efficient countries to implement the lock down, it is indicated by the decrease number of infected people in the countries. On the other hand, Indonesia and Philippines were inefficient countries to enforce the lock down since the confirmed cases increased during and after the lock down enforcement.

There are limitations regarding the prediction model of COVID-19 using hybrid SEIR-ANN. First, the values of error are not small enough, it is due to the dataset used insufficiently large, only total of 202 data for Malaysia and 194 total for Indonesia. Second, we just limited to use 2000 epoch, where theoretically, the more epoch used, the better the error, though it would take more time to predict. Third, we found the overfitting, that the model trained of the data was too well on the training set, but lack at the testing data, although we have handled this situation by implementing dropout and regularization techniques. Lastly, there were some outliers data in Malaysia COVID-19 data set included in the model, however it is not our scoup to discuss the outliers data.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research is supported financially by Universiti Malaysia Terengganu .

References

"PP Nomor 21 Tahun 2020". (2020). (PDF) (*in Indonesian*). Government of Indonesia. Retrieved 15 April 2020.

Asteriou, D., & Hall, S. G. (2011). ARIMA Models and the Box–Jenkins methodology. In *Applied econometrics* (pp. 265–286, 2nd ed.). Palgrave MacMillan. ISBN 978-0-230-27182-1

Cortes, C., & Vapnik, V. N. (1995). Support-vector networks" (PDF). *Machine Learning*, *20* (3), 273–297. CiteSeerX 10.1.1.15.9362. doi:10.1007/BF0099401

Dehe, X., Qi, Z., & Yan, D. (2020). Application of a Hybrid ARIMA-SVR model based on the SPI for the forecast of drought – A case study in Henan Province, China. *Journal of Applied Meteorology and Climatology*. *59*, 1239–1259. doi:10.1175/jamc-d-19-0270.1

Dickens, B. L., Koo, J. R., Lim, J. T., Park, M., Quaye, S., Sun, H., … Cook, A. R. (2020). Modelling lockdown and exit strategies for COVID-19 in Singapore. *The Lancet Regional Health - Western Pacific*, *1*, 100004. doi:10.1016/j.lanwpc.2020.100004

Géron, A. (2019). *Hands-on machine learning with Scikit-learn, keras, and tensorflow*. Canada: O'Reilly Media Inc.

Hashim, M. J., Alsuwaidi, A. R., & Khan, G. (2020). Population risk factors for COVID-19 mortality in 93 countries. *Journal of Epidemiology and Global Health*, *10*(3), 204–208. doi:10.2991/jegh.k.200721.001

Limos, M. A. (2020). "What is ECQ, EECQ, Lockdown, and Partial Lockdown?" esquiremag.ph/life/health-and-fitness/what-is-ecq-lockdown-and-partial-lockdown-a00293-20200420-lfrm. Retrieved May 4, 2020.

Mahmud, A., & Lim, P. Y. (2020). "Applying the SEIR model in forecasting the COVID-19 trend in Malaysia: A preliminary study". Archived from the original on 17 August 2020. Retrieved 25 September 2020.

Ministry of Health. (2020). Singapore, continued stringent implementation and enforcement of circuit breaker measures [Internet]. Retrieved from https://www.moh.gov.sg/news-highlights/details/continued-stringent-implementation-enforcement-of-circuit-measures. [cited April, 14 2020].

Nasruddin, R., & Haq, I. (2020). Pembatasan Sosial Berskala Besar (PSBB) dan Masyarakat Berpenghasilan Rendah. *Jurnal Sosial dan Budaya Syar'i*, *7*, 639–648. Retrieved from http://journal.uinjkt.ac.id/index.php/salam/article/view/15569.

Ong, L. C. (2020). "The Recovery MCO – Prevention and Control of Infectious Desease (Measure Within Infected Local Areas) (No. 7) Regulations 2020". Lawyers Who Know Asia. Retrieved from https://www.christopherleeong.com/media/3959/200611_client_update_-_rmco_-final-clo.pdf.

Pengpeng, S., Shengli, C., & Peihua, F. (2020). "SEIR Transmission dynamics model of 2019 nCoV coronavirus with considering the weak infectious ability and changes in latency duration". Archived from the original on 17 June 2020. Retrieved 25 September 2020.

Purnama, B. (2019). *Pengantar machine learning*". Bandung: Informatika.

Rustan, H. L. (2020). "The Outbreak's Modelling od Coronavirus (Covid-19) using The Modified SEIR Model in Indonesia". Archived from the original on 7 August 2020. Retrieved 26 September 2020.

Singh, S., Parmar, K. S., Sidhu, J. S. M., Kaur, J., Peshoria, S., & Kumar, J. (2020). Study of ARIMA and Least Square Support Vector Machine (LS-SVM) models for the prediction of SARS-COV-2 confirmed cases in the most affected countries. *Journal of Chaos, Solitons, and Fractals*, *139, 110086*.

Solis, J. F., Jose Enrique, O. V., Juan, J. G., Joaquin, P. O., Guadalupe, C.-V., & Sanchez, J. P. (2020). "The Hybrid Forecasting Methods SVR-ESAR for COVID-19", Preprint. doi:10.1101/2020.05.20.20103200

Teks Perutusan Khas. (2020). Speech By YAB Tan Sri Dato' Haji Muhyuddin Bin Haji Mohd Yasin, Malaysia Prime Minister [Internet]. Retreived from https://www.moe.gov.my/en/muat-turun/teks-ucapan-dan-slide/tu2020/3352-teks-ucapan-yab-pm-mengenai-covid-19-18032020/file. [cited March 18, 2020]

Teks Ucapan Pelaksanaan Perintah Kawalan Pergerakan Pemulihan. (2020). Speech By YAB Tan Sri Dato' Haji Muhyuddin Bin Haji Mohd Yasin, Malaysia Prime Minister [Internet]. Retreived from https://www.pmo.gov.my/2020/06/teks-ucapan-pelaksanaan-perintah-kawalan-pergerakan-pemulihan-pkpp/. [cited June 7, 2020].

Wang, L. (2005). *Support vector machines: Theory and applications*. Netherland: Springer.

Wei, W. W. S. (2006). *Time series analysis, univariate and multivariate methods* (2nd ed.). New York: Pearson, Addison Wesley.

Willmott, C. J., Matsuura, K., & December, 1. (2005). Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance. *Climate Research*, *30*, 79–82. doi:10.3354/cr030079

World Health Organization (WHO). (2020). Coronavirus Disease 2019 (COVID-19) Situation Overview International [Internet], WHO International, Retrieved from https://covid19.who.int. [cited August 6, 2020].

World Health Organization (WHO). (2020). Novel Coronavirus (2019-nCOV) Situation Report - 1 January 2020. WHO.

World Health Organization (WHO). (2020). Coronavirus Disease 2019 (COVID-19) Situation Overview In Malaysia [Internet]. WHO Malaysia. Retrieved from https://www.who.int/docs/default-source/wpro---documents/countries/malaysia/coronavirus-disease-(covid-19)-situation-reports-in-malaysia/situation-report-malaysia-23-april-2020-final.pdfA. [cited August 6, 2020]

World Health Organization (WHO). (2020). Novel Coronavirus (2019-nCOV) Situation Report-46, WHO, January 2020.

World Health Organization (WHO). (2020). Coronavirus Disease (COVID-19) Situation Report 1 Philippines, WHO Philippines, 9 March.

Zhang, Y., Luo, L., Yang, J., Liu, D., Kong, R., & Feng, Y. (2019). A Hybrid ARIMA-SVR approach for forecasting emergency patient flow. *Journal of Ambient Intelligence and Humanized Computing*, *10*(8), 3315–3323. Springer-Verlag Germany. Retrieved from. doi:10.1007/s12652-018-1059-x

Appendix

Table of prediction using ARIMA-SVR.

DAYS	ARIMA-SVR 60 DAY PREDICTIONS CONFIRMED				
DAYS	INDONESIA	MALAYSIA	SINGAPORE	PHILIPPINES	THAILAND
1	9389.48	114.8972	387.1875	18.1749	0.180369
2	9421.62	114.8972	388.2619	18.1749	0.180369
3	9453.759	114.8972	389.3362	18.1749	0.180369
4	9485.899	114.8972	390.4106	18.1749	0.180369
5	9518.039	114.8972	391.4849	18.1749	0.180369
6	9550.178	114.8972	392.5592	18.1749	0.180369
7	9582.318	114.8972	393.6336	18.1749	0.180369
8	9614.458	114.8972	394.7079	18.1749	0.180369
9	9646.597	114.8972	395.7823	18.1749	0.180369
10	9678.737	114.8972	396.8566	18.1749	0.180369
11	9710.877	114.8972	397.9309	18.1749	0.180369
12	9743.016	114.8972	399.0053	18.1749	0.180369
13	9775.156	114.8972	400.0796	18.1749	0.180369
14	9807.296	114.8972	401.154	18.1749	0.180369
15	9839.436	114.8972	402.2283	18.1749	0.180369
16	9871.575	114.8972	403.3026	18.1749	0.180369
17	9903.715	114.8972	404.377	18.1749	0.180369
18	9935.855	114.8972	405.4513	18.1749	0.180369
19	9967.994	114.8972	406.5257	18.1749	0.180369
20	10000.13	114.8972	407.6	18.1749	0.180369
21	10032.27	114.8972	408.6743	18.1749	0.180369
22	10064.41	114.8972	409.7487	18.1749	0.180369
23	10096.55	114.8972	410.823	18.1749	0.180369
24	10128.69	114.8972	411.8974	18.1749	0.180369
25	10160.83	114.8972	412.9717	18.1749	0.180369
26	10192.97	114.8972	414.046	18.1749	0.180369
27	10225.11	114.8972	415.1204	18.1749	0.180369
28	10257.25	114.8972	416.1947	18.1749	0.180369
29	10289.39	114.8972	417.2691	18.1749	0.180369
30	10321.53	114.8972	418.3434	18.1749	0.180369
31	10353.67	114.8972	419.4177	18.1749	0.180369
32	10385.81	114.8972	420.4921	18.1749	0.180369
33	10417.95	114.8972	421.5664	18.1749	0.180369
34	10450.09	114.8972	422.6407	18.1749	0.180369
35	10482.23	114.8972	423.7151	18.1749	0.180369
36	10514.37	114.8972	424.7894	18.1749	0.180369
37	10546.51	114.8972	425.8638	18.1749	0.180369
38	10578.65	114.8972	426.9381	18.1749	0.180369
39	10610.79	114.8972	428.0124	18.1749	0.180369
40	10642.93	114.8972	429.0868	18.1749	0.180369
41	10675.07	114.8972	430.1611	18.1749	0.180369
42	10707.21	114.8972	431.2355	18.1749	0.180369
43	10739.35	114.8972	432.3098	18.1749	0.180369
44	10771.49	114.8972	433.3841	18.1749	0.180369
45	10803.63	114.8972	434.4585	18.1749	0.180369
46	10835.77	114.8972	435.5328	18.1749	0.180369
47	10867.91	114.8972	436.6072	18.1749	0.180369
48	10900.05	114.8972	437.6815	18.1749	0.180369
49	10932.19	114.8972	438.7558	18.1749	0.180369
50	10964.33	114.8972	439.8302	18.1749	0.180369
51	10996.46	114.8972	440.9045	18.1749	0.180369
52	11028.6	114.8972	441.9789	18.1749	0.180369
53	11060.74	114.8972	443.0532	18.1749	0.180369
54	11092.88	114.8972	444.1275	18.1749	0.180369
55	11125.02	114.8972	445.2019	18.1749	0.180369
56	11157.16	114.8972	446.2762	18.1749	0.180369
57	11189.3	114.8972	447.3506	18.1749	0.180369
58	11221.44	114.8972	448.4249	18.1749	0.180369
59	11253.58	114.8972	449.4992	18.1749	0.180369
60	11285.72	114.8972	450.5736	18.1749	0.180369

DAYS	ARIMA-SVR 60 DAY PREDICTIONS DEATHS				
DAYS	INDONESIA	MALAYSIA	SINGAPORE	PHILIPPINES	THAILAND
1	35.45619	0.02722833	0.3279267	3.023514	0.014429
2	35.45619	0.02722833	0.3279267	3.023514	0.014429
3	35.45619	0.02722833	0.3279267	3.023514	0.014429
4	35.45619	0.02722833	0.3279267	3.023514	0.014429
5	35.45619	0.02722833	0.3279267	3.023514	0.014429
6	35.45619	0.02722833	0.3279267	3.023514	0.014429
7	35.45619	0.02722833	0.3279267	3.023514	0.014429
8	35.45619	0.02722833	0.3279267	3.023514	0.014429
9	35.45619	0.02722833	0.3279267	3.023514	0.014429

(*continued*)

Continued.

DAYS	ARIMA-SVR 60 DAY PREDICTIONS DEATHS				
DAYS	INDONESIA	MALAYSIA	SINGAPORE	PHILIPPINES	THAILAND
10	35.45619	0.02722833	0.3279267	3.023514	0.014429
11	35.45619	0.02722833	0.3279267	3.023514	0.014429
12	35.45619	0.02722833	0.3279267	3.023514	0.014429
13	35.45619	0.02722833	0.3279267	3.023514	0.014429
14	35.45619	0.02722833	0.3279267	3.023514	0.014429
15	35.45619	0.02722833	0.3279267	3.023514	0.014429
16	35.45619	0.02722833	0.3279267	3.023514	0.014429
17	35.45619	0.02722833	0.3279267	3.023514	0.014429
18	35.45619	0.02722833	0.3279267	3.023514	0.014429
19	35.45619	0.02722833	0.3279267	3.023514	0.014429
20	35.45619	0.02722833	0.3279267	3.023514	0.014429
21	35.45619	0.02722833	0.3279267	3.023514	0.014429
22	35.45619	0.02722833	0.3279267	3.023514	0.014429
23	35.45619	0.02722833	0.3279267	3.023514	0.014429
24	35.45619	0.02722833	0.3279267	3.023514	0.014429
25	35.45619	0.02722833	0.3279267	3.023514	0.014429
26	35.45619	0.02722833	0.3279267	3.023514	0.014429
27	35.45619	0.02722833	0.3279267	3.023514	0.014429
28	35.45619	0.02722833	0.3279267	3.023514	0.014429
29	35.45619	0.02722833	0.3279267	3.023514	0.014429
30	35.45619	0.02722833	0.3279267	3.023514	0.014429
31	35.45619	0.02722833	0.3279267	3.023514	0.014429
32	35.45619	0.02722833	0.3279267	3.023514	0.014429
33	35.45619	0.02722833	0.3279267	3.023514	0.014429
34	35.45619	0.02722833	0.3279267	3.023514	0.014429
35	35.45619	0.02722833	0.3279267	3.023514	0.014429
36	35.45619	0.02722833	0.3279267	3.023514	0.014429
37	35.45619	0.02722833	0.3279267	3.023514	0.014429
38	35.45619	0.02722833	0.3279267	3.023514	0.014429
39	35.45619	0.02722833	0.3279267	3.023514	0.014429
40	35.45619	0.02722833	0.3279267	3.023514	0.014429
41	35.45619	0.02722833	0.3279267	3.023514	0.014429
42	35.45619	0.02722833	0.3279267	3.023514	0.014429
43	35.45619	0.02722833	0.3279267	3.023514	0.014429
44	35.45619	0.02722833	0.3279267	3.023514	0.014429
45	35.45619	0.02722833	0.3279267	3.023514	0.014429
46	35.45619	0.02722833	0.3279267	3.023514	0.014429
47	35.45619	0.02722833	0.3279267	3.023514	0.014429
48	35.45619	0.02722833	0.3279267	3.023514	0.014429
49	35.45619	0.02722833	0.3279267	3.023514	0.014429
50	35.45619	0.02722833	0.3279267	3.023514	0.014429
51	35.45619	0.02722833	0.3279267	3.023514	0.014429
52	35.45619	0.02722833	0.3279267	3.023514	0.014429
53	35.45619	0.02722833	0.3279267	3.023514	0.014429
54	35.45619	0.02722833	0.3279267	3.023514	0.014429
55	35.45619	0.02722833	0.3279267	3.023514	0.014429
56	35.45619	0.02722833	0.3279267	3.023514	0.014429
57	35.45619	0.02722833	0.3279267	3.023514	0.014429
58	35.45619	0.02722833	0.3279267	3.023514	0.014429
59	35.45619	0.02722833	0.3279267	3.023514	0.014429
60	35.45619	0.02722833	0.3279267	3.023514	0.014429

DAYS	ARIMA-SVR 60 DAY PREDICTIONS RECOVERED				
DAYS	INDONESIA	MALAYSIA	SINGAPORE	PHILIPPINES	THAILAND
1	98.15834	5.507662	34.10349	0.01839986	0.3663051
2	98.42930	5.507662	34.10349	0.01839986	0.3663051
3	98.70026	5.507662	34.10349	0.01839986	0.3663051
4	98.97122	5.507662	34.10349	0.01839986	0.3663051
5	99.24218	5.507662	34.10349	0.01839986	0.3663051
6	99.51314	5.507662	34.10349	0.01839986	0.3663051
7	99.78410	5.507662	34.10349	0.01839986	0.3663051
8	100.05506	5.507662	34.10349	0.01839986	0.3663051
9	100.32602	5.507662	34.10349	0.01839986	0.3663051
10	100.59698	5.507662	34.10349	0.01839986	0.3663051
11	100.86794	5.507662	34.10349	0.01839986	0.3663051
12	101.13890	5.507662	34.10349	0.01839986	0.3663051
13	101.40986	5.507662	34.10349	0.01839986	0.3663051
14	101.68082	5.507662	34.10349	0.01839986	0.3663051
15	101.95178	5.507662	34.10349	0.01839986	0.3663051
16	102.22275	5.507662	34.10349	0.01839986	0.3663051
17	102.49371	5.507662	34.10349	0.01839986	0.3663051
18	102.76467	5.507662	34.10349	0.01839986	0.3663051
19	103.03563	5.507662	34.10349	0.01839986	0.3663051
20	103.30659	5.507662	34.10349	0.01839986	0.3663051

(*continued*)

Continued.

DAYS	ARIMA-SVR 60 DAY PREDICTIONS RECOVERED				
DAYS	INDONESIA	MALAYSIA	SINGAPORE	PHILIPPINES	THAILAND
21	103.57755	5.507662	34.10349	0.01839986	0.3663051
22	103.84851	5.507662	34.10349	0.01839986	0.3663051
23	104.11947	5.507662	34.10349	0.01839986	0.3663051
24	104.39043	5.507662	34.10349	0.01839986	0.3663051
25	104.66139	5.507662	34.10349	0.01839986	0.3663051
26	104.93235	5.507662	34.10349	0.01839986	0.3663051
27	105.20331	5.507662	34.10349	0.01839986	0.3663051
28	105.47427	5.507662	34.10349	0.01839986	0.3663051
29	105.74523	5.507662	34.10349	0.01839986	0.3663051
30	106.01619	5.507662	34.10349	0.01839986	0.3663051
31	106.28715	5.507662	34.10349	0.01839986	0.3663051
32	106.55811	5.507662	34.10349	0.01839986	0.3663051
33	106.82908	5.507662	34.10349	0.01839986	0.3663051
34	107.10004	5.507662	34.10349	0.01839986	0.3663051
35	107.37100	5.507662	34.10349	0.01839986	0.3663051
36	107.64196	5.507662	34.10349	0.01839986	0.3663051
37	107.91292	5.507662	34.10349	0.01839986	0.3663051
38	108.18388	5.507662	34.10349	0.01839986	0.3663051
39	108.45484	5.507662	34.10349	0.01839986	0.3663051
40	108.72580	5.507662	34.10349	0.01839986	0.3663051
41	108.99676	5.507662	34.10349	0.01839986	0.3663051
42	109.26772	5.507662	34.10349	0.01839986	0.3663051
43	109.53868	5.507662	34.10349	0.01839986	0.3663051
44	109.80964	5.507662	34.10349	0.01839986	0.3663051
45	110.08060	5.507662	34.10349	0.01839986	0.3663051
46	110.35156	5.507662	34.10349	0.01839986	0.3663051
47	110.62252	5.507662	34.10349	0.01839986	0.3663051
48	110.89348	5.507662	34.10349	0.01839986	0.3663051
49	111.16445	5.507662	34.10349	0.01839986	0.3663051
50	111.43541	5.507662	34.10349	0.01839986	0.3663051
51	111.70637	5.507662	34.10349	0.01839986	0.3663051
52	111.97733	5.507662	34.10349	0.01839986	0.3663051
53	112.24829	5.507662	34.10349	0.01839986	0.3663051
54	112.51925	5.507662	34.10349	0.01839986	0.3663051
55	112.79021	5.507662	34.10349	0.01839986	0.3663051
56	113.06117	5.507662	34.10349	0.01839986	0.3663051
57	113.33213	5.507662	34.10349	0.01839986	0.3663051
58	113.60309	5.507662	34.10349	0.01839986	0.3663051
59	113.87405	5.507662	34.10349	0.01839986	0.3663051
60	114.14501	5.507662	34.10349	0.01839986	0.3663051