Bayesian Poisson Model for COVID-19 in West Java Indonesia

by Memed Sueb

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Abstract— COVID-19 is designated as a pandemic disease by WHO and has a pervasive impact, especially in Indonesia. In this paper, we use Bayesian Poisson with MCMC to analyze the COVID-19 incidence in West Java Province, Indonesia. Our objective is to attain more Bayesian posterior information knowledge from of the events throughout COVID-19. To measure the accuracy and effective of Bayesian MCMC, we use the Monte Carlo Standard Error (MCSE) and confirmed that the variable patient under surveillance = 0.2189884, cases+ = 2.3411325, rec+ = 8.4074448, and dead+ = 11.1542450, respectively.

Index Terms— Bayesian; MCMC; Poisson; COVID-19; Indonesia
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1 Introduction

Cases of the COVID-19 (Coronavirus disease 2019) due to SARS-CoV-2 coronavirus (previously named 2019-nCoV) incident were first detected in Wuhan, China at the end of December 2019 [1],[2]. In general, the coronavirus is found in animals and then changes to infect humans [3]. However, the COVID-19 signs and symptoms almost same as MERS (Middle East Respiratory Syndrome) due to MERS-CoV coronavirus in 2002 and 2012 [4], and SARS (Severe Acute Respiratory Syndrome) due to SARS-CoV coronavirus in 2003 [5].

The SARS-CoV-2 then spread throughout the world, initially WHO categorized the COVID-19 as an endemic case, and in 2020 it changed to pandemic status—recorded at the end of February 2020 the highest case of death in Italy. Efforts to stem within-population transmission rates will also have specific economic impacts [6]. A global response to prepare health systems worldwide is imperative.

The COVID-19 widely throughout the world. Based on data from the Coronavirus COVID-19 Global Cases by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)[7]. The Republic of China which initially had the

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most cases of COVID-19 is now ranked second and is shocking that America is ranked first in the COVID-19 case with a confirmed case of 85,840 per 26 March 2020. Earlier, Italy was declared as the country with the highest death rate in the COVID-19 cases [8],[9]. On march 9 2020, A Pregnant Woman with COVID-19 detected in Central America [10]. This is very worrying even though until now, no research claim that COVID-19 provides a risk for miscarriage. However, COVID-19 can transmit to infants in the womb [11],[4]. The occurrence of the COVID-19 case also affected other countries' economies, especially the Indonesia Rupiah (IDR) against the USD. Then as explained by forecasters. The USA needs to hold a congress to save they are $ 1 trillion economies. And it is also predicted that the U.S. Economic Slowdown In the coming months have the worst possibility [12].

The impact of COVID-19 is the more widespread exposure to unemployment in America. A record 3.3 million people filed claims for unemployment in the US last week as the COVID-19 pandemic shut down large parts of America's economy and the full scale of the impact of the crisis began to emerge [13]. At the same time, COVID-19 also had good impact on density pollution and serious impact on economy [14].

People would be more careful when buying goods or investing. COVID-19 also affects market projections. Investors can postpone investment due to unclear supply chains or due to changing market assumptions. In early March 2020, this virus began to enter the ASEAN region, especially in Indonesia[15]. Sadly, Indonesian people argue to have a good immune system to deal with COVID-19. Also, based on historical data from January 2020 to February 2020, no cases have occurred in Indonesia even though this disease has spread throughout the world and had severe impacts. This happens because of negligence and underestimates a vital thing. This is even worse when the Indonesian government does not close access to flights to and from China and other countries. There are some key considerations and recommendations for travelers to Southeast Asia, see,[16]. Other countries have given travel warnings, and several countries have closed accesses in and out of the country like Saudi Arabia bans locals from Umrah over coronavirus. In contrast, facilities for body temperature detection at international airports in Indonesia are very inadequate and make the initial detection of corona cases not going well. Making advance preparations for a pandemic may bring us significant short-term benefits, such as supporting basic health care, encouraging research and development, strengthening interregional cooperation and emergency response systems and biosafety management, and promoting the balanced development of health and security of the world in general [17].

The first COVID-19 case in Indonesia was discovered in March 2020 and the Indonesian president for the first time gave an appeal to the Indonesian people not to panic [18],[19]. The first case of COVID-19 in Indonesia is domiciled in Depok, West Java. Both of these people were found to be positive for COVID-19 because they interacted with Japanese citizens who were known to suffer from the disease. In addition, COVID-19 has a pretty severe impact on lung cancer. [20]. Radiological analysis of 81 patients in Wuhan found that COVID-19 pneumonia tends to manifest on lung CT scans as bilateral, sub pleural, ground-glass opacities with air Broncho grams, ill-defined margins, and a slight predominance in the right lower lobe. Furthermore, Old age, male sex, underlying comorbidities and progressive radiographic deterioration on follow-up CT might be risk factors for poor prognosis in patients with COVID-19 pneumonia [21]. In this paper, we use the Bayesian STAN [22] to get the posterior information of COVID-19 in West Java, Indonesia.

2. BAYESIAN

In very beginning, 1701 Thomas Bayes developed the Bayes theory [23]. He explains the probability for hypothesis from observation and also how to get the opportunity from an uncertainty. Bayesian is increasingly being used mainly in medical statistics and epidemiology [24]. Bayesian is used because in this case, the sample data is limited.

After all, it is already a public secret that research on health and epidemiology requires much time, and there are also special events or rare diseases that cannot be done by statistical modelling. The difference between Bayesian and frequentist is that in Bayesian, the most important thing is to describe a parameter, not the frequency of an event.

Then the priors of distribution become not just data, measuring uncertainty with credible intervals is different from frequentists that measure uncertainty with confidence intervals [25].The Bayesian approach is different from the classical statistical approach, which assumes that the parameter is an unknown value which is fixed. This approach is based on a subjective view of opportunity, uncertainty about something unknown parameter can be expressed using the opportunity rule through optimization of information from parameters prior and information from data probability function[26].

The prior distribution expresses the information available to the researcher before the data is entered into the analysis[27]. Therefore, the prior distribution used in Bayesian-based models must be determined before modelling. Basically, the Bayesian approach starts exactly the same as the usual classical regression analysis. The sampling model for observational data $y = y_1, y_1, \ldots, y_N$ and unknown parameter vector θ. This sampling model is usually given in the form of probability distribution$f(y|\theta)$. As a functionθ, as a probability function of Likelihood $L(\theta; y)$.

On the Bayesian approach θ not a fixed parameter but as a random number. This is implemented by adopting the distribution of opportunities for θ which summarizes information previously obtained but not related to data, which is called prior distribution. Like the possibility of a function that has parametersθ, priors also have parameters η which is often referred to as hyper parameters to find it from parameters in the probability function θ. Then, it is assumed hyper parameters η known, so the prior distribution can be written as follows $\pi(\theta) = \pi(\theta|\eta)$. The determination of prior distribution is very important in Bayesian-based models. However, in general, these prior distributions are unknown, so we need to specify prior distributions that will not affect posterior distribution. Usually, in cases like this are often used prior to non-informative distribution. However, not in all cases, the use of non-informative prior distributions results in the inference of posterior distribution to be valid because posterior distribution becomes improper due to improper prior distribution.

To simplify the Bayes inference process when there is no known information about parameters, the prior conjugate distribution is used. The prior conjugate distribution is a distribution that gives prior and posterior distribution from the same distribution family. Also, performing random sampling by conditional posterior distribution for each parameter and parameter estimation[28]. Then, calculating the conditional posterior mean of the parameters that are the focus of attention in the model and the process of drawing random samples from conditional posterior distribution involves complex integration and computation so that it is simulated with Markov Chain Monte Carlo (MCMC) [29]. The primary objective of the MCMC algorithm is to simulate examples of posterior distribution for the parameter [30]. Each example that is taken depends on the example that was taken previously, thus forming a Markov chain [31]. Markov chain is one of the most popular and powerful models to have been investigated by many researchers, particularly to analyze the stochastic behaviors[32]. Monte Carlo is used to approaching an expected value using the Markov chain example. Gibbs sampling can be applied if the distribution of probability is not explicitly known, but the conditional distribution of each parameter is known. Besides, The Gibbs sampling framework is to decompose the joint posterior distribution into conditional distribution for each parameter in the model; then the sample is taken from the process. The average of the parameters is used as a parameter estimator of the model. Gibbs sampling algorithm as follows

1. Set an initiation value $\theta_1, \theta_2, \dots, \theta_p$ to $\theta_1^0, \theta_2^1, \dots, \theta_p^0$.
2. For iteration

Generate $\theta_1^{(1)}, \theta_1^{(1)} \sim \pi(\theta_1 | \theta_2^{(0)}, \dots, \theta_p^{(0)}), y$

Generate $\theta_2^{(1)}, \theta_2^{(1)} \sim \pi(\theta_2 | \theta_1(0), \dots, \theta_p^{(0)}), y$

$\vdots$

Generate $\theta_p^{(1)}, \theta_p^{(1)} \sim \pi(\theta_p | \theta_1^{(0)}, \dots, \theta_{p-1}^{(0)}), y$

3. Repeat step 2 for as much m interaction
4. Get the posterior $\pi(\theta_1, \theta_2, \dots, \theta_p | y)$

3. ANALYSIS

To begin with, the cases of COVID-19 in Indonesia is increasingly worrying because the death rate has reached 8% in the second week of April 2020. It is noted that DKI Jakarta has the most positive cases in Indonesia. The first case in West Java province was recorded on March 08, 2020, with a total of 59 people in monitoring and four people under surveillance.

On the instructions of the governor of West Java, a rapid test was carried out on March 24, 2020.According to this, on March 25, 2020, there are a significant additional people under surveillance of 898. Until the second week of April 12, it was noted that a significant increase of 4320 people occurred on April 04, 2020, and the last recorded total people under surveillance in West Java was up to April 12 as many as 29,354 people. Shortly, the city of Bandung leads to the highest death rate and then followed by the city of Bogor and the city of Depok. In this paper, we only using the first 40 days COVID-19 cases. It is important to discuss first, the data on the number of cases on the *t* day is actually not real data. To get a results that a patient under surveillance of COVID-19 should be test and the results could be a week after the test.

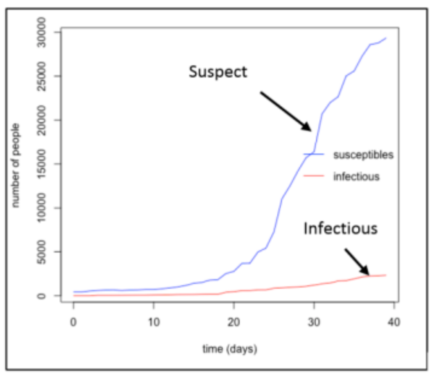


Fig. 1. Cases COVID-19 in West Java 40 days.

To begin with, we use MCMC optimization to get and do estimations and maximize likelihood functions. At the same time, we performing STAN [33]. To measure the uncertainty of a model, sufficient samples are needed [34]. Regarding this, we calculate a 95% Credible Interval. Thus, for any value in the interval the density function is equal to or higher than any value outside the interval[35]. In this case, it can be stated as:

$$f(y|\lambda) = \frac{\lambda^y e^{-\lambda}}{y!} \; ; E(Y) = Var\,(Y) = \lambda \tag{1}$$

$Y_i \sim Poisson(\lambda)$ with $\Gamma\,(a,b)$ prior λ and posterior.

$$\pi(\lambda|Y) \sim \Gamma(\mathrm{a} + \sum_{1}^{n} y_i, b + n) \tag{2}$$

If, we have more than 1 binary variable, we need to select it.

$$y_i|Z_i = k \sim i.i.d\; P(\lambda_k);\; \lambda_1 \sim \Gamma\,(a,b)\,;\, \lambda_2\, \Gamma\,(a,b) \tag{3}$$

Parameter $m \in \{1,2\}$ with an indication of our model. Then we can explain from prior information in uniform prior $P[m = k] = \frac{1}{2}$. On the model k can be explained by parameters θ_k and prior θ_k explained by π_k. The posterior distribution can be explained as:

$$P[m = k|y] \propto P[m = k] \int L(\theta_k|y)\pi_k\,(\theta_k) d\,\theta_k \tag{4}$$

The model of the Bayes can be stated in eq(5).

$$B_{21}(Y) = \frac{P[m = 2|y]\,/\,P[m = 1|y]}{P[m = 2]\,/\,p[m = 1]} = \frac{m_2(y)}{m_1(y)} \tag{5}$$

$$m_k(y) = \int_{\Theta_k} L(\theta_k|y)\pi_k\,(\theta_k) d\,\theta_k \tag{6}$$

Normalize the posterior constant in eq(7).

$$\pi\,(\theta_k|y)\pi_k \propto L(\theta_k|y)\pi_k(\theta_k) \tag{7}$$

With condition in eq(8),(9)and(10).

$$\int_0^\infty \lambda^{a-1} \exp -b\lambda\, d\lambda = \frac{\Gamma(\mathrm{a})}{b^a} \tag{8}$$

$$m_1(y) = \frac{b^2 \Gamma(\mathrm{a} + \sum y_i)}{\Gamma(\mathrm{a})(b+n)^{a+\sum y_i}} \tag{9}$$

$$m_2(y) = \frac{b^{2a}\, \Gamma(\mathrm{a} + \sum y_i^H)\, \Gamma(\mathrm{a} + \sum y_i^F)}{\Gamma(\mathrm{a})^2 + (\mathrm{b} + n_H)^{a+\sum y_i^H}\, (b + n_F)^{a+\sum y_i^F}} \tag{10}$$

Then, it can be written as:

$$\Im = \int h(x) g(x) dx \tag{11}$$

Shortly, g represents a density and $x_1, \dots, x_N \sim iid$ form g. lastly, we have the function below and can converge.

$$\Im_N^{MC} = \frac{1}{N} \sum h(x_i) \tag{12}$$

For example, we take a sample from the posterior $\pi_1(\theta_1|y)$ then it can be stated as.

$$E_{\pi_1}\left[\frac{1}{L(\theta_1|y)}\,|y\right] = \int \frac{1}{L(\theta_1|y)} \pi_1(\theta_1|y) d\theta_1 = \int \frac{1}{L(\theta_1|y)} \frac{\pi_1(\theta_1)L(\theta_1|y)}{m_1(y)}\, d\theta_1 = \frac{1}{m_1(y)} \tag{13}$$

Eq(14) represents the estimation $m_1(y)$ by MCMC or STAN.

$$\Im = \int \frac{h(x)g(x)}{\gamma(x)} \gamma(x) dx \tag{14}$$

Where, γ as a sample from$x_1, x_2, \dots, x_N \sim iid$.

$$\Im_N^{IS} = \frac{1}{N} \sum \frac{h(x_i)g(x_i)}{\gamma(x_i)} \tag{15}$$

The people under surveillance reach the Auxiliary median parameter 104.2, with MAD standard deviation 59.2 and sample average posterior predictive distortion from y with median PPD 502.8 and standard deviation 29.4 more fully explained in Figure 2. In the Poisson distribution, a discrete probability of an event is explained, if we know how often an event occurs, however, we do not know how many times it does not occur in an event[36],[37],[38]. Poisson distribution of positive event with Long tail to the right [26],[39]. However, approaching the normal distribution if λ is large. Data count is positive with a range of $0\ to\ \infty$ [40].

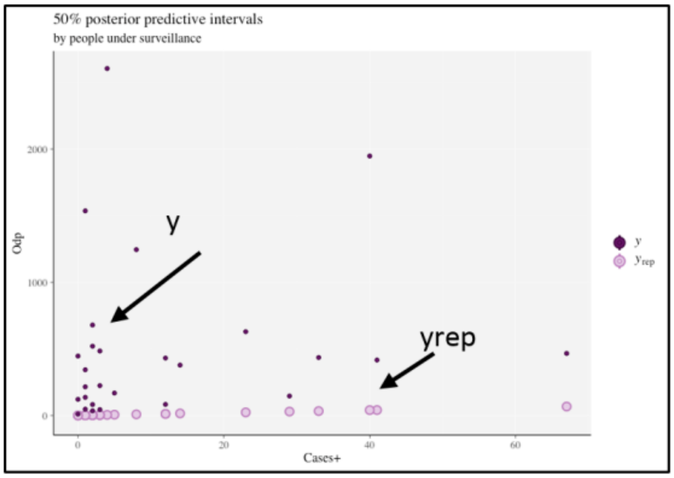


Fig. 2. 50% Posterior Predictive Interval.

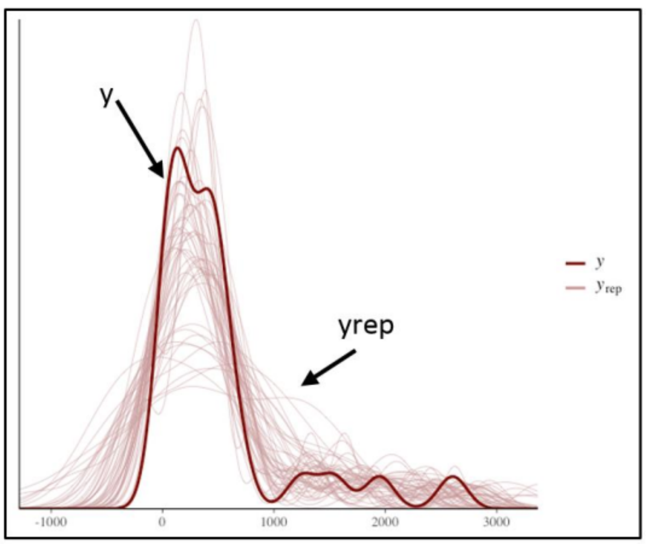


Fig. 3. *y* actual versus *yrep*.

Then, the power prior involves increasing the possibility of historical COVID-19 data on α_0 , represents the level of eligibility between the data transfer status of People under surveillance (ODP) to Patient under surveillance (PDP). In line with this, α_0 controlling the impact of historical data on posterior distribution. Furthermore, there are two versions of this apriori distribution depending on whether the α_0 parameter is considered fixed or random. When considered permanent, α_0 can be determined by experts who will decide the similarity between historical data and data from new tests, or with simulation studies. Let θ be a parameter vector of observation from the group control and $\pi_0(\theta)$ represents the beginning of the apriori distribution, that is, the prior distribution θ before individual historical data are examined D_C^H where not observed $\pi_0(\theta)$) for example it can be a product of a non-informative a priori independent distribution for each element θ. In our case, D_C^H representing the patient data of each COVID-19. Therefore, the power distribution before θ as:

$$\pi(\theta|D_C^H, \alpha_0) \propto L(\theta|D_C^H)^{\alpha_0}\pi_0(\theta) \tag{16}$$

α_0 is a constant constant so $0 \leq \alpha_0 \leq 1$.

$\alpha_0 = 0, \pi(\theta|D_C^H, \alpha_0) \equiv \pi_0(\theta)$ which means that historical data are not integrated into the apriori distribution. Also, $\alpha_0 = 1$, the same weight is given for possible historical data $L(\theta D_C^H)$ and possible data from $L(\theta D_C^N)$ a posterior distribution defined by:

$$\pi(\theta|D_C^N, D_C^H, \alpha_0) \propto L(\theta|D_C^N)\, \pi(\theta|D_C^H, \alpha_0) \tag{17}$$

D_C^N representing individual patient data and the size of θ depends from our distribution

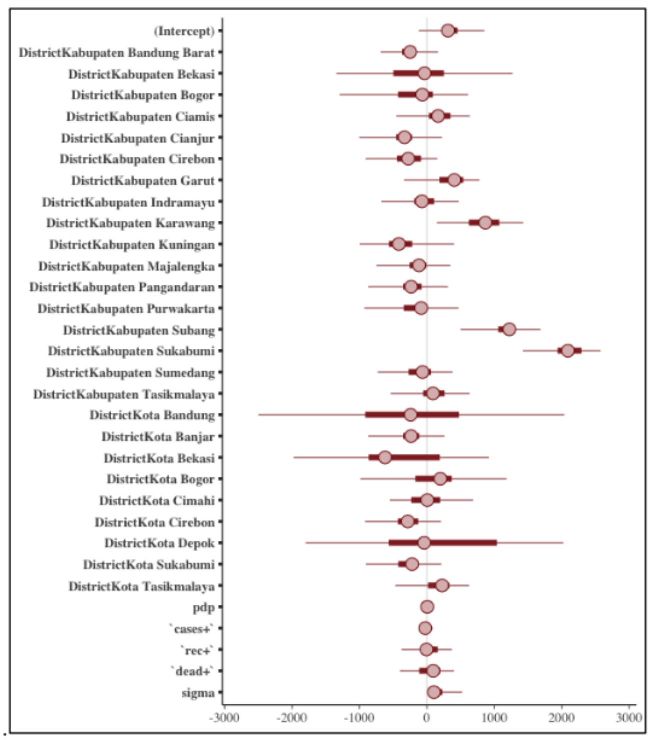


Fig. 4. Posterior.

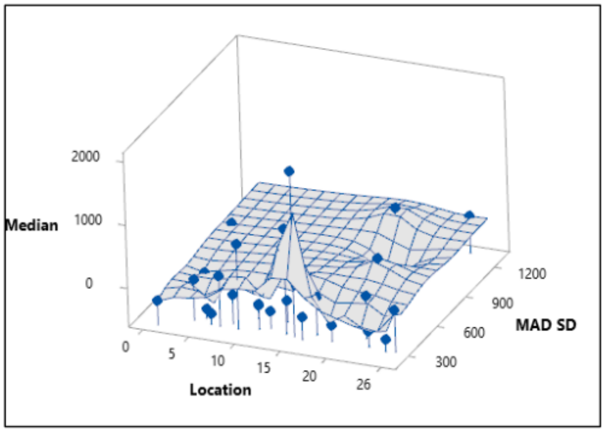
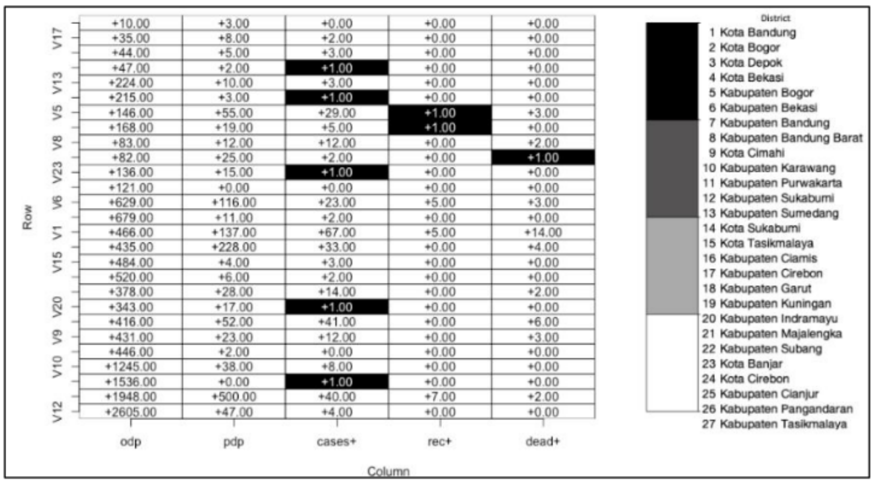


Fig. 5. Median and Median SD based on Location.



Row	odp	pdp	cases+	rec+	dead+
	+10.00	+3.00	+0.00	+0.00	+0.00
V17	+35.00	+8.00	+2.00	+0.00	+0.00
	+44.00	+5.00	+3.00	+0.00	+0.00
	+47.00	+2.00	+1.00	+0.00	+0.00
V13	+224.00	+10.00	+3.00	+0.00	+0.00
	+215.00	+3.00	+1.00	+0.00	+0.00
V5	+146.00	+55.00	+29.00	+1.00	+3.00
	+168.00	+19.00	+5.00	+1.00	+0.00
V8	+83.00	+12.00	+12.00	+0.00	+2.00
	+82.00	+25.00	+2.00	+0.00	+1.00
V23	+136.00	+15.00	+1.00	+0.00	+0.00
	+121.00	+0.00	+0.00	+0.00	+0.00
V6	+629.00	+116.00	+23.00	+5.00	+3.00
	+679.00	+11.00	+2.00	+0.00	+0.00
V1	+466.00	+137.00	+67.00	+5.00	+14.00
	+435.00	+228.00	+33.00	+0.00	+4.00
V15	+484.00	+4.00	+3.00	+0.00	+0.00
	+520.00	+6.00	+2.00	+0.00	+0.00
	+378.00	+28.00	+14.00	+0.00	+2.00
V20	+343.00	+17.00	+1.00	+0.00	+0.00
	+416.00	+52.00	+41.00	+0.00	+6.00
V9	+431.00	+23.00	+12.00	+0.00	+3.00
	+446.00	+2.00	+0.00	+0.00	+0.00
V10	+1245.00	+38.00	+8.00	+0.00	+0.00
	+1536.00	+0.00	+1.00	+0.00	+0.00
	+1948.00	+500.00	+40.00	+7.00	+2.00
V12	+2605.00	+47.00	+4.00	+0.00	+0.00

Fig. 6 Association.

Figure 6 represents the association size of COVID-19 events in West Java. It can be seen that for cases+ there are associations between the areas of Bekasi City, Bogor Regency, Purwakarta Regency, Indramayu Regency, and Cianjur Regency. Then for the recovery+ case, there are in Bandung and West Bandung regencies. Lastly, the death event was in Karawang district. The disease surveillance system noted that there were people with complaints of fever and cough that could not be treated with regular medication. This can be said as the first suspicion. So, it can be reported as suspect COVID-19 because the test results are still negative. To measure the accuracy and effective of Bayesian MCMC, we use the Monte Carlo Standard Error (MCSE) and confirmed that the variable patient under surveillance (pdp) = 0.2189884, cases+ = 2.3411325, rec+ = 8.4074448, and dead+ = 11.1542450, respectively. Nevertheless, the negative test results proved that some laboratories have not been able to detect precisely the incidence of COVID-19. This is proven by WHO that actually COVID-19 entered Indonesia around late January and early February 2020.Since the COVID-19 case occurred in Indonesia, the government has issued a policy to work at home. Until the end of March and people are not allowed to leave the house. Many Indonesians do not comply with this policy, making the number of positive cases in Indonesia increase very dramatically and significantly. On the healthcare facility side, the Indonesian government has prepared a hospital to handle the COVID-19 case. Figure 7 represents the distribution of hospitals in Indonesia. It can be seen that if the province entered the red color very worrying about the handling of COVID-19 with a minimal number of hospitals. Very recently during the writing of this brief, almost all the healthcare facilities in Indonesia complains about the lacking of the personal protective equipment for their healthcare professionals, including maskers, goggles, face shields, Hazmat (hazardous material) suits, gloves, and safety shoes. In healthcare facilities in Jakarta and Bali, the doctors must wear a raining coat to protect themselves from SARS-CoV-2 due to a lacking condition. Lots of hospitals and non-governmental organization, including healthcare association, made an open donation for personal protective equipment availability. The Indonesian government issued a policy through a ministry of health decision (HK.01.07/Menkes/104/2020) about Establishing a Novel Coronavirus Infection (SARS-CoV-2 Infection) as a Disease That Can Cause an Outbreak and its Mitigation Efforts.

Fig 7. Number of Hospital in Indonesia (data sources the Directorate General of Disease Prevention and Control, the Ministry of Health of the Republic of Indonesia).

4. Conclusion

In the regulation issued on February 4th, 2020, six points were decided. First, Novel Coronavirus Infection (COVID-19) as a disease that can cause an outbreak. Second, for the disease as referred to in the first point, the central government and regional governments make countermeasures that include: (a) risk communication and improved communication, information and health education to the public regularly including those who will be travelling to the affected area, with material especially on preventing the spread of disease through the practice of clean and healthy behavior and the anticipation of transmission; (b) make preparedness, detection, and response at the entrance of the country and in the region; (c) preparation of care and referral health care facilities as well as supporting facilities such as laboratories and health logistical materials needed along with their networks in an integrated and sustainable manner; and (d) implementation of coordination with cross-sectoral for the effectiveness and efficiency of efforts to combat Novel Coronavirus Infection (COVID-19). Third, all major units within the Ministry of Health conduct intensive communication with stakeholders, both at central and regional levels, following their duties and functions to prevent the spread of Novel Coronavirus Infection (COVID-19 Infection) in the territory of Indonesia. Fourth, all forms of funding in the context of prevention efforts as referred to in the second dictum are charged to the budget of the Ministry of Health, regional governments, and other legitimate sources of funding following statutory provisions. The fifth decision is the financing referred to in the fourth dictum, including for the cost of treatment for suspected cases reported before this Ministerial Decree comes into force regarding funding satisfied emerging infectious patients per statutory provisions. While the sixth is to decide this Ministerial Decree comes into force on the date of the stipulation. Regarding the cost of treatment for COVID-19 patients, the government will cover it through the Ministry of Health. In more detail, the Director-General of Budget of the Ministry of Finance recorded the budget included in the Ministry of Health expenditure post. The Indonesian government so far has given instructions to the Eijkman Institute for Molecular Biology for making the COVID-19 vaccine. Furthermore, the number of COVID-19 cases will increase significantly; shortly, the Indonesian government will carry out a Rapid virological diagnosis [41]. The number of positive cases predicts increased because some residents in Jakarta who were assumed to be carriers carried out-migration to several regions, especially to Wonogiri, Central Java. If the Indonesian government does not put this COVID-19 as a serious problem and the complete lockdown policy is implemented in a half measure, the Indonesia COVID-19 cases and mortality rates will be a very high end.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

AUTHOR CONTRIBUTIONS

T.Toharudin performed the supervision and provides the research grant. R.E. Caraka leads this study and has reviewed COVID-19 related kinds of literature,designed and developed the concept of all analysis prepared, writing, do the revision and edited the full manuscript. R.C. Chen performs the supervision. N.T.Nugroho provides health data. S.K.Tai provides the research grant.M. Sueb provides the research grant. I.G.N.M.Jaya edited the manuscript. R.S.Pontoh edited the manuscript. B.Pardamean provides the research grant.

REFERENCES

[1] L. E. Gralinski and V. D. Menachery, "Return of the coronavirus: 2019-nCoV,"

Viruses, vol. 12, no. 2, p. 135, 2020.

[2] Q. Han, Q. Lin, S. Jin, and L. You, "Coronavirus 2019-nCoV: A brief perspective from the front line," *J. Infect.*, vol. 80, no. 4, pp. 373–377, 2020.

[3] Y. Fan, K. Zhao, Z. L. Shi, and P. Zhou, "Bat coronaviruses in China," *Viruses*, vol. 11, no. 3, p. 210, 2019.

[4] D. A. Schwartz and A. L. Graham, "Potential Maternal and Infant Outcomes from (Wuhan) Coronavirus 2019-nCoV Infecting Pregnant Women: Lessons from SARS, MERS, and Other Human Coronavirus Infections," *Viruses*, vol. 12, no. 2, p. 194, 2020.

[5] R. H. Xu *et al.*, "Epidemiologic clues to SARS origin in China," *Emerg. Infect. Dis.*, vol. 10, no. 6, pp. 1030–1037, 2004.

[6] M. Beck and D. Tobin, "The 2019/2020 Novel Corona Virus Outbreak: An International Health Management Perspective," *Open Public Health J.*, vol. 13, pp. 52–54, 2020.

[7] "Coronavirus COVID-19 Global Cases by the Center for Systems Science and Engineering (CSSE)," *Johns Hopkins University*, 2020. .

[8] D. Fanelli and F. Piazza, "Analysis and forecast of COVID-19 spreading in China, Italy and France," *Chaos, Solitons Fractals Interdiscip. J. Nonlinear Sci. Nonequilibrium Complex Phenom.*, vol. 134, p. 109761, 2020.

[9] A. Remuzzi and G. Remuzzi, "COVID-19 and Italy: what next?," *Lancet*, vol. 2, pp. 10–13, 2020.

[10] L. I. Zambrano *et al.*, "A pregnant woman with COVID-19 in Central America," *Travel Med. Infect. Dis.*, p. 101639, 2020.

[11] "Coronavirus infection and pregnancy," *Royal College of Obstetricians and Gynaecologists*, 2020. .

[12] "U.S. Economic Slowdown In Coming Months Expected To Be Worst On Record," *National Public Radio*, 2020. .

[13] "US unemployment and employment statistics Record 3.3m Americans file for unemployment as the US tries to contain Covid-19," *The Guardian*, 2020. .

[14] R. E. Caraka *et al.*, "Impact of COVID-19 large scale restriction on environment and economy in Indonesia," *Glob. J. Environ. Sci. Manag.*, vol. 6, no. Special Issue (Covid-19), pp. 65–82, 2020.

[15] R. Djalante, J. Lassa, L. Nurhidayah, H. Van Minh, Y. Mahendradhata, and N. T. Ngoc, "The ASEAN's responses to COVID-19: A policy sciences analysis," *BayArXiv*, no. February 2020, p. 368, 2020.

[16] C. Biscayart, P. Angeleri, S. Lloveras, T. do S. S. Chaves, P. Schlagenhauf, and A. J. Rodríguez-Morales, "The next big threat to global health? 2019 novel coronavirus (2019-nCoV): What advice can we give to travellers? – Interim recommendations January 2020, from the Latin-American society for Travel Medicine (SLAMVI)," *Travel Med. Infect. Dis.*, vol. 33, pp. 17–20, 2020.

[17] X. Pan, D. M. Ojcius, T. Gao, Z. Li, C. Pan, and C. Pan, "Lessons learned from the 2019-nCoV epidemic on prevention of future infectious diseases," *Microbes Infect.*, vol. 22, no. 2, pp. 86–91, 2020.

[18] R. Djalante *et al.*, "Review and analysis of current responses to COVID-19 in Indonesia: Period of January to March 2020," *Prog. Disaster Sci.*, vol. 6, p. 100091, 2020.

[19] R. Djalante, R. Shaw, and A. DeWit, "Building resilience against biological hazards and pandemics: COVID-19 and its implications for the Sendai Framework," *Prog. Disaster Sci.*, 2020.

[20] S. Tian, W. Hu, L. Niu, H. Liu, H. Xu, and S.-Y. Xiao, "Pulmonary Pathology of Early-Phase 2019 Novel Coronavirus (COVID-19) Pneumonia in Two Patients With Lung Cancer," *J. Thorac. Oncol.*, 2020.

[21] H. Shi *et al.*, "Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study.," *Lancet. Infect. Dis.*, vol. 20, no. 4, pp. 425–434, 2020.

[22] P. C. Bürkner, "brms: An R package for Bayesian multilevel models using Stan," *J. Stat. Softw.*, 2017.

[23] "El teorema de Bayes," *Rev. Educ. Matemática*, 2011.

[24] C. Joyner, C. McMahan, J. Baurley, and B. Pardamean, "A two-phase Bayesian methodology for the analysis of binary

phenotypes in genome-wide association studies," *Biometrical J.*, vol. 62, no. 1, pp. 191–201, 2019.

[25] P. Dellaportas, J. J. Forster, and I. Ntzoufras, "On Bayesian model and variable selection using MCMC," *Stat. Comput.*, 2002.

[26] R. E. Caraka *et al.*, "Variational Approximation Multivariate Generalized Linear Latent Variable Model in Diversity Termites," *Sylwan*, vol. 164, no. 1, pp. 161–177, 2020.

[27] M. Masjkur and H. Folmer, "Bayesian estimation of linear and nonlinear mixed models of fertilizer dosing with independent normally distributed random components," in *IOP Conference Series: Earth and Environmental Science*, 2017.

[28] I. G. N. M. Jaya, H. Toharudin, and A. S. Abdullah, "A Bayesian spatial autoregressive model with k-NN optimization for modeling the learning outcome of the junior high schools in West Java," *Model Assist. Stat. Appl.*, vol. 13, no. 3, pp. 207–219, 2018.

[29] C. Andrieu, N. De Freitas, A. Doucet, and M. I. Jordan, "An introduction to MCMC for machine learning," *Mach. Learn.*, 2003.

[30] I. G. N. M. Jaya, B. Tantular, Zulhanif, and B. N. Ruchjana, "MCMC Algorithm for Bayesian Heterogeneous Coefficients of Panel Data Model," in *Journal of Physics: Conference Series*, 2019, p. 012014.

[31] I. G. N. M. Jaya, B. Tantular, and Y. Andriyana, "A Bayesian approach on multicollinearity problem with an Informative Prior," in *Journal of Physics: Conference Series*, 2019, p. 012021.

[32] N. Masseran, "Markov Chain model for the stochastic behaviors of wind-direction data," *Energy Convers. Manag.*, vol. 92, no. 1, pp. 266–274, 2015.

[33] J. K. Kruschke, *Doing Bayesian data analysis: A tutorial with R, JAGS, and Stan, second edition*. 2014.

[34] I. G. N. M. Jaya and H. Folmer, "Bayesian spatiotemporal mapping of relative dengue disease risk in Bandung, Indonesia," *J. Geogr. Syst.*, vol. 22, no. 1, pp. 105–142, 2020.

[35] I. G. N. M. Jaya, B. B. Ruchjana, A. S. Abdullah, and Y. Andriyana, "Monitoring the underlying probability of daily rainfall occurrence in West Java over space and time by means: A bayesian spatiotemporal model approach," *Int. J. Geoinformatics*, vol. 14, no. 4, pp. 27–37, 2018.

[36] R. R. M. Tajuddin, N. Ismail, and K. Ibrahim, "Several two-component mixture distributions for count data," *Commun. Stat. Simul. Comput.*, vol. 0, no. 0, pp. 1–12, 2020.

[37] R. R. M. Tajuddin, N. Ismail, and K. Ibrahim, "A four-parameter negative binomial-Lindley distribution for modeling over and underdispersed count data with excess zeros," *Commun. Stat. - Theory Methods*, pp. 1–13, 2020.

[38] R. Herliansyah and I. Fitria, "Latent variable models for multi-species counts modeling in ecology," *Biodiversitas*, 2018.

[39] R. E. Caraka *et al.*, "Ecological Show Cave and Wild Cave : Negative Binomial Gllvm ' s Arthropod Community Modelling," *Procedia Comput. Sci.*, vol. 135, pp. 377–384, 2018.

[40] J. Niku, W. Brooks, R. Herliansyah, F. K. C. Hui, S. Taskinen, and D. I. Warton, "Efficient estimation of generalized linear latent variable models," *PLoS One*, vol. 14, no. 5, pp. 1–20, 2019.

[41] S. Amrane *et al.*, "Rapid viral diagnosis and ambulatory management of suspected COVID-19 cases presenting at the infectious diseases referral hospital in Marseille, France, - January 31st to March 1st, 2020: A respiratory virus snapshot.," *Travel Med. Infect. Dis.*, p. 101632, 2020.

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