1. Introduction

China first announced the etiology of pneumonia on December 31, 2019. The initial cause was detected in Wuhan, Hubei Province, China. Since the discovery of these cases, 44 pneumonia patients have been recorded from December 31, 2019, to January 3, 2020. The World Health Organization (WHO) received information about the outbreak's cause from Chinese health authorities on January 11-12, 2020. The outbreak was caused by exposure to a type of seafood at a market in Wuhan. WHO officially announced that the outbreak was a pandemic, named COVID-19 or Coronavirus, on March 11, 2020 [7]. COVID-19, or Coronavirus, is a group of viruses from the subfamily Orthocoronavirinae in Coronaviridae and the order Nidovirales [13].

According to the website Indonesia.go.id, the COVID-19 virus first entered Indonesia on March 2, 2020. The number of infected individuals was 2, residing in Depok. The first case was suspected to have originated from contact with a Japanese national. As cited from the website Corona.Jakarta.go.id, the total confirmed cases of COVID-19 spread in Jakarta until April 2, 2023, amounted to 1,547,000 positive cases. From the data on COVID-19 cases in Jakarta, it can be observed that the accumulation of positive cases from the onset of COVID-19 in Jakarta until April 2, 2023, is very significant.

The spread of the COVID-19 virus, or Coronavirus, has caused severe problems across all aspects of life. This ranges from a significant threat to public health, resulting in fatalities, the emergence of social issues due to restrictions on social interactions, to economic problems [8]. Therefore, this situation cannot be left unaddressed. One of the government's measures to reduce the spread of the COVID-19 virus is implementing Large-Scale Social Restrictions or known as PSBB policy in Indonesia. The positive impact of this policy is its ability to suppress the confirmed transmission rates of COVID-19 in the community. However, implementing this policy also has negative consequences, such as people being laid off from their jobs due to limited outdoor activities, a decrease in buying and selling transactions in the community, and reduced income despite high expenses. Additionally, individuals who rely on daily wages experience economic downturns as their income decreases, with some having no income at all [6]. Due to these negative impacts, the PSBB policy cannot be continuously implemented, especially in the DKI Jakarta area. DKI Jakarta serves as the capital city of Indonesia, where all government activities and economic centers are located. Therefore, finding ways to simulate the spread of COVID-19 is necessary.

In response to the impact of COVID-19, simulating its spread is crucial to assist governments and health authorities in formulating effective strategies. These simulations predict trends, identify critical points, and evaluate the impacts of interventions such as vaccination, social restrictions, and mask usage. Furthermore, simulations enable resource optimization and the swift implementation of evidence-based policies, which are critical elements in formulating responsive and effective health policies to combat the pandemic.

This research utilizes a mathematical model known as the SIR model. The SIR model consists of three compartments: Susceptible (S), which represents individuals susceptible to being infected by the COVID-19 virus; Infectious (I), which represents individuals who have been infected with COVID-19; and Recovered (R), which represents individuals who have recovered from COVID-19. The SIR model is characterized by two parameters : infection transmission rate (β) and recovery rate (γ).

This research employs the fourth-order Runge-Kutta method to observe the dynamics of COVID-19 spread. The Runge- Kutta method was chosen because it does not require derivative calculations and exhibits significantly smaller errors than other methods. The utilization of the fourth-order Runge-Kutta method with the SIR model has previously coducted in examining the dynamics of COVID-19 transmission in Maluku. This was investigated by Rizki F et al., with the conclusion drawn that over the next 20 months, there would be 69,269,987.75 susceptible individuals (S), 19,166,834.54 infected individuals (I), and 850,941.85 recovered individuals (R) [10]. It is important to note that their study did not employ optimization methods in simulating the spread. Meanwhile, this research adds optimization methods with the aim of obtaining higher model evaluation scores and improving result precision.