Abstract− The COVID-19 pandemic, caused by the SARS-CoV-2 virus, has created enormous worldwide health issues, particularly in Yogyakarta, Indonesia, a city with distinct socio-cultural dynamics and a crucial role in national education. Understanding how the virus spreads in this particular milieu is critical for successful public health responses. To simulate and investigate COVID-19 transmission dynamics in Yogyakarta, this work uses the Susceptible-Infected-Recovered (SIR) epidemiology model, enhanced by the Fourth Order Runge-Kutta (RK4) numerical approach. The RK4 technique improves the model's accuracy by providing precise numerical solutions to the differential equations governing disease transmission. The study identifies the optimal infection rate parameter ($\beta = 0.2037$) that minimizes the Root Mean Squared Error (RMSE) between the model's predictions and actual data. These findings offer critical insights into the local pandemic trajectory, which can directly support the government in tailoring public health strategies, assist researchers in refining epidemiological models, and guide the general public in understanding transmission risks. The methodologies and results from this study can also serve as a reference for similar epidemiological assessments in other regions.

Keywords: Covid-19, SIR-Model, Runge-Kutta, Yogyakarta, Disease