PRESS RELEASE: THE MATHEMATICS BEHIND EXTENDING THE MALAYSIAN MCO RULING

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Ever since time immemorial, mathematics has played multiple roles in ensuring man makes the best decision possible. As mentioned in the award winning book "*Mantik dan Etnomantik*" by Dr. Mat Rofa Ismail, mathematics is the bridge between physical sciences and the metaphysical needs of man. That is, one utilizes mathematics in order to achieve metaphysical elements such as sense of existence, happiness, managing resources, determining cost and profit and others. Basic arithmetic operators addition/subtraction/multiplication/division has enabled man to conduct his business engagements properly. But it does not end there. The work by Sun Tzu in the 3rd century AD which gave rise to the Chinese Remainder Theorem is now deployed within modern cryptographic security. Muḥammad ibn Mūsā al-Khwārizmī developed algebra via quadratic equations to resolve distribution of inheritance via the Islamic legal code (Fara'id). Modern man has utilized quadratic equations in multitude of ways. Isaac Newton developed calculus through his studies on rate of change. Engineering is indebted to him. During World War 2, mathematicians made huge contributions. Among them were in the field of cryptology – mathematicians at Bletchley Park, United Kingdom were tasked to break German codes; and Operational Research – a scientific method of providing quantitative basis for decisions regarding certain operations. The list goes on and on.

COVID-19 has engulfed humanity in a manner that might be incomprehensible to the untrained man. Contagious outbreak is not alien in human history. Recent history has recorded (among others) the London plague (1665-1666), London cholera (1865), Bombay plague (1906), Spanish flu (1918-1920) and SARS (2002-2004). In the early 20th century, it became evident to man that in order to fully understand the dynamics of the outbreak, a "model" of some sort which could facilitate logistic readiness became more pertinent. In 1927, Kermack and McKendrick published *A contribution to the mathematical theory of epidemics* in the Proceedings of the Royal Society. This seminal work is based on the assumption that a population consists of susceptible, infectious and recovered individuals. Hence, the term known as the SIR model.

The SIR model inputs precise numbers of individuals in each compartment at a particular time as a function of t (time): $S(t)$, I(t) and $R(t)$. Underlying the SIR model is a system of ordinary differential equations (ODE). By solving the ODE one obtains information such as the transmission rate β, recovery rate γ, and the important variable $R_0 = \beta/\gamma$. The variable R_0 states the number of secondary infections stemming directly from the first case in a susceptible population. When $R_0 > 1$, one infected individual will

on average infect > 1 person in total. When $R_0 = 1$, we are right at the threshold between an epidemic and not. Finally, when $R_0 < 1$, one infected individual will on average infect < 1 person in total. Thus, it is the target to have mechanisms to achieve $R_0 < 1$. As disclosed by Datuk Seri Dr. Noor Hisham bin Abdullah, Director General of Health of the Malaysian Ministry of Health (MOH) on 11 April 2020, Malaysia is approaching $R_0 = 1$. This significant improvement is due to among others – the Movement Control Order (MCO), better social distancing etiquettes and hygienic practices.

Other than "mathematical" methodologies to understand SIR, graphs can be used for public understanding. The following are SIR graphs produced by the Institute for Mathematical Research, Universiti Putra Malaysia (INSPEM, UPM) and the Institute for Medical Research, MOH (IMR, MOH) utilizing publicly available COVID-19 dataset provided by MOH between 25 January and 31 March 2020 (Figure 1). By further extrapolating the SIR curve until 125 days and compare it with actual dataset till 30 April 2020, we will observe the accuracy of the developed SIR model (Figure 2). The anomaly on 29 April 2020 is the cluster of 72 students returning from Indonesia. On that day, there were only 22 local cases. Furthermore, the COVID-19 outbreak in Malaysia will see a sharp decline – on the premise that Malaysians remain disciplined in these trying times.
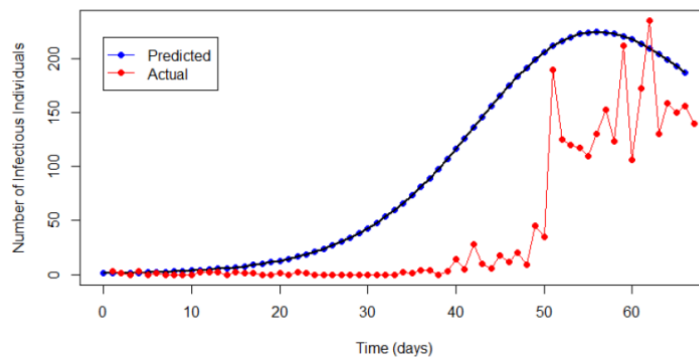

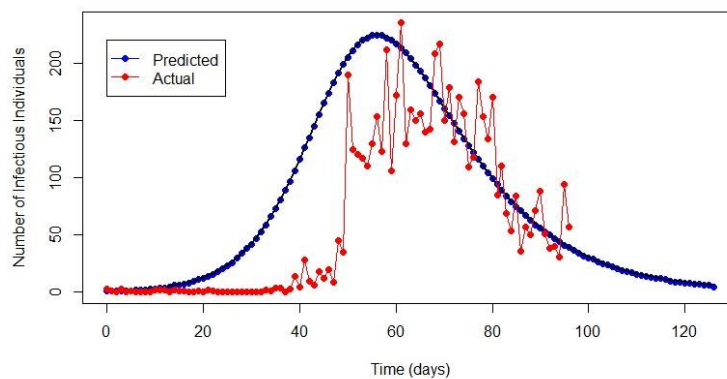Figure 1: Actual vs Predicted Infectious Counts Trend

Figure 2: 125 Days Trajectory of Infectious Counts

Every citizen has their role and responsibility to ensure Malaysia goes through these turbulent times with little damage as possible. The decision by the government to extend the MCO is a wise decision and is in parallel with the Malaysian COVID-19 SIR model produced by INSPEM, UPM and IMR, MOH. Let us persevere together and God willing, In Sha Allah, Malaysia will get back up on her feet by second half of May 2020.