# A review in the effectiveness of Malaysia's Movement Control Order (MCO) and its subsequent phases

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## Abstract

The effectiveness of movement control measures to prevent the spread of an epidemic due to a novel infectious pathogen where no vaccine is available has often been a subject of debate. Hence, this study investigates into the different phases of restrictions which Malaysia has imposed and its effectiveness. The study aims to determine whether the level of restrictions imposed in the country affect the rate of new cases of an epidemic. We have collected data in terms of daily new COVID-19 cases and plotted it with the different phases. In order to understand the dataset, we have used three models (Linear Regression, Polynomial Regression & Gaussian Non-linear Regression) to identify the differences of each phase. A comparison between the three models suggests that while the introduction of high levels of restrictions contributed to reducing the rate of new cases, the rate of new cases is still well over the predicted values, implying that there are still areas of improvement in terms of enforcing restrictions.

**Keywords**

Effectiveness; Phases of restrictions; Linear Regression; Gaussian; Polynomial Regression

# 1 Introduction

COVID-19, also known as SARS-CoV-2 has been announced by the World Health Organization as a global pandemic. The virus first had its outbreak beginning in Wuhan, China in December 2019, and has meanwhile affected countries worldwide. COVID-19 has shown to have a high rate of transmission and with the lack of immunity to the virus [1], it has since resulted in a large amount of infected cases and deaths worldwide. Globally, the World Health Organization (WHO) has reported that 12 million individuals have been infected, and it is responsible for more than 500, 000 deaths [2].

Malaysia's transmission begun on the 24th of January with imported cases comprising most of the cases [3]. The infections then escalated in number after the 14th of March, with the majority of positively tested cases linked to a religious gathering of an estimated 16000 people in the country. As of the 8th of July, the gathering was responsible for 3375 cases, which makes up to 38% of all the cases in Malaysia [4]. In an effort to prevent future fluctuations in new cases from happening in Malaysia, the local government has introduced the Movement Control Order (MCO) to limit social interactions between citizens [5].

In this study, we have investigated into the different phases of MCO, and evaluate the effectiveness of each phases in the effort to reduce the rate of transmission in Malaysia. The restrictions imposed during the MCO period is as such:

*Movement Control Order (MCO, Phase 1):*

- Prohibition of mass movements and gatherings across the country, including religious, sports, social and cultural activities.
- All non-critical services and businesses are to be closed, with an exception for supermarkets, public markets, grocery, and convenience stores that sell necessities.
- Restrictions for all Malaysians to travel abroad. Malaysians returning from other countries would be required to undergo a two-week quarantine period to determine the individual's health.
- Restriction in interstate travel
- Closure of all schools and education institution

*Conditional Movement Control Order (CMCO, Phase 2):*

CMCO was announced after the MCO phase in order to reopen the national economy through a controlled manner [6].

- Reopen most economic sectors and activities with standardized operation procedures (i.e. Keeping a record of customer name and telephone along with the date of visit)
- Activities involving large gatherings are still prohibited, however sports activities that do not involve body contact and does not exceed 10 people are allowed as long as social distancing is practiced.
- Interstate travelling is prohibited, except for work purposes or to return home after the MCO travel restriction.

*Recovery Movement Control Order (RMCO, Phase 3):*

With CMCO ending on the 9th of June, the country then enters into RMCO from the 10th of June to the 31st of August [7], which is then extended to the 31st of December, 2020 [8].

- Lifting of interstate travel
- Religious activities are now allowed, with strict restrictions and standard of procedures.
- Reopening of education institutions with standard of procedures to maintain social distancing
- Reopening of tourism businesses, with the number of crowds limited to 200 – 250 people.
- Reopening of most businesses while adhering standard of procedures (Wearing masks, temperature checks, providing hand sanitizers)

*Enhanced Movement Control Order (EMCO):*

For areas that have a high amount of reported positive cases, the government will enforce an enhanced movement control order (EMCO) for a two-week period [9]. This is done to contain and prevent the spread of virus outside of the area.

- All residents and visitors within the area are restricted from exiting their homes
- Non-residents and visitors outside the area are restricted from entering
- All businesses are shut down. Supplies are provided by authorities throughout the 14 days.
- All roads leading to the EMCO area are blocked

It is said that prevention is better than cure, and COVID-19 is no exception. Malaysia's ministry of health had decided to impose a partial lockdown (MCO) with the major spike in cases on the month of March, with the intention to curb the spread of the virus. After several weeks of strict interventions, the government has then moved into three other phases, with each phase's restrictions being more relaxed than the previous one. In order to move to a more relaxed phase, the WHO has included several criteria to achieve [10]:

- Objective evidence of controlled / contained COVID-19 transmission
- Established public health and health system capacities to identify, isolate, test, quarantine, and trace contacts
- Extensive effort made to minimize outbreak risks in high vulnerability settings (i.e. Homes for older people, mental health facilities and crowded residencies)
- Established standardized preventive measures in workplaces, including physical distancing, handwashing facilities and ensuring face masks are worn
- Manageable importation risks
- The community is conscious of the situation and is able to voice out, engage and participate in the transition of the phase

The transition of the phase from MCO to the next few phases would suggest that the listed criteria have been achieved. This study serves to validate the decision by evaluating the statistics that are collected throughout each phase.

To achieve the objectives of this study in evaluating the different phases of MCO, the following research question (RQ) must be answered:

**RQ**: Would the level of restrictions imposed in the country affect the rate of new cases of an epidemic?

This paper is organized as follows: Section 2 presents the material and methods, Section 3 provides theory employed in this study, Section 4 presents the results of this study and Section 5 discusses the findings of this study. Finally, Section 6 provides the conclusion which summarizes the thoughts and conveys the implications of this study.

# 2 Material and Methods

## 2.1 Data Sampling

The dataset of Malaysia's COVID-19 patients is obtained from the local health ministry (KKM) daily. KKM reports on confirmed and recovered COVID-19 patients, as well as deaths for the country. The data tabulated is measured from the 24th of January (Day 0) up to the 29th of August, 2020 (Day 219). The phases are as follows:

1. Pre MCO: Days 0 – 54 (24th Jan – 17th Mar)
2. MCO: Days 55 – 101 (18th Mar – 3rd May)
3. CMCO: Days 102 – 138 (4th May – 9th Jun)
4. RMCO: Days 139 – 219 (10th Jun – 29$^{th}$ August)

## 2.2 Instrument

In this study, we have decided to use Python, more specifically through Jupyter notebook for its options in visualizing data, which helps in interpreting and analyzing data. We have utilized several packages to complete this article. NumPy, SciPy and Pandas is used for the cleaning and manipulation of data. We have used scikit-learn (sklearn) for the statistical modelling of our data in this article. We used matplotlib to visualize the data, and statsmodels to validate the statistical models.

# 3 Machine Learning Models

For this study, we have decided to use a linear regression model to predict the trend of the COVID-19 pandemic as it is a commonly used type of predictive analysis. The reason why we have selected this model to support our research is because the regression estimates produced are able to explain the relationship between one dependent variable and one or more independent variables. The formula that is used in a linear regression model is:

$$\boldsymbol{Y = a + bX}$$

Where **Y** is the Dependent Variable (DV), **X** is the Independent V (IV), **a** is a constant and **b** is the gradient of the line [11], indicating the rate of transmission that happens over time.

On top of linear regression, we have also adopted a polynomial regression model for our dataset, with the following equation [12]:

$$\mathrm{y} = (\mathrm{c}0) + (\mathrm{c}1)\mathrm{x} + (\mathrm{c}2)\mathrm{x}^2 + \cdots + (\mathrm{cn})\mathrm{x}^{\mathrm{n}}$$

Where n is the degree of the polynomial and c is a set of coefficients.

Another model that we have used to display our results is the non-linear regression model. This is because a non-linear regression model is able to fit many more types of curves although it requires more effort both to find the best fit and to interpret the role of the independent variables. We have chosen to use a Gaussian formula [13]:

$$\boldsymbol{Y = a.e^{\left(-\frac{(X-b)^2}{2c^2}\right)}}$$

Where **a** represents the maximum curve value, **b** is the median of the curve, and **c** represents the standard deviation.

This is chosen as we believe that a Gaussian curve would best represent the dataset that we are using, where the rate of transmission will spike and decline as time passes.

As the hypothesis looks to identify the fluctuations in the rate of new cases between the different phases of MCO, we decided to isolate each phase when it is used in our linear regression model. This is done to allow for more detailed comparisons between the phases. As the non-linear model displays changes through time, we utilized the entire dataset to better understand the relationship throughout MCO.

# 4 Results

In this section, we will illustrate two groups of results: linear and polynomial regression ($5^{th}$ degree), and non-linear regression (Gaussian) and polynomial regression ($8^{th}$ degree).

$5^{th}$ Degree Polynomial is chosen for the analysis of each individual phases, as the sample size is reduced with each phase. With each data point carrying more weight due to the small sample size, we have decided that a $5^{th}$ degree polynomial regression model suits the data best, ensuring that the variance of the model is low where it doesn't overfit. An $8^{th}$ degree polynomial regression is chosen for the analysis of all phases of MCO as the larger amount of data would mean that the regression is less affected by data noise, while still being sensitive enough to fit the dataset, ensuring a low bias of the model.

## 4.1 Linear and Polynomial Regression

### 4.1.1 Pre-MCO

The linear model is: Y = -18.593 + 1.1293X, $5^{th}$ Degree Polynomial

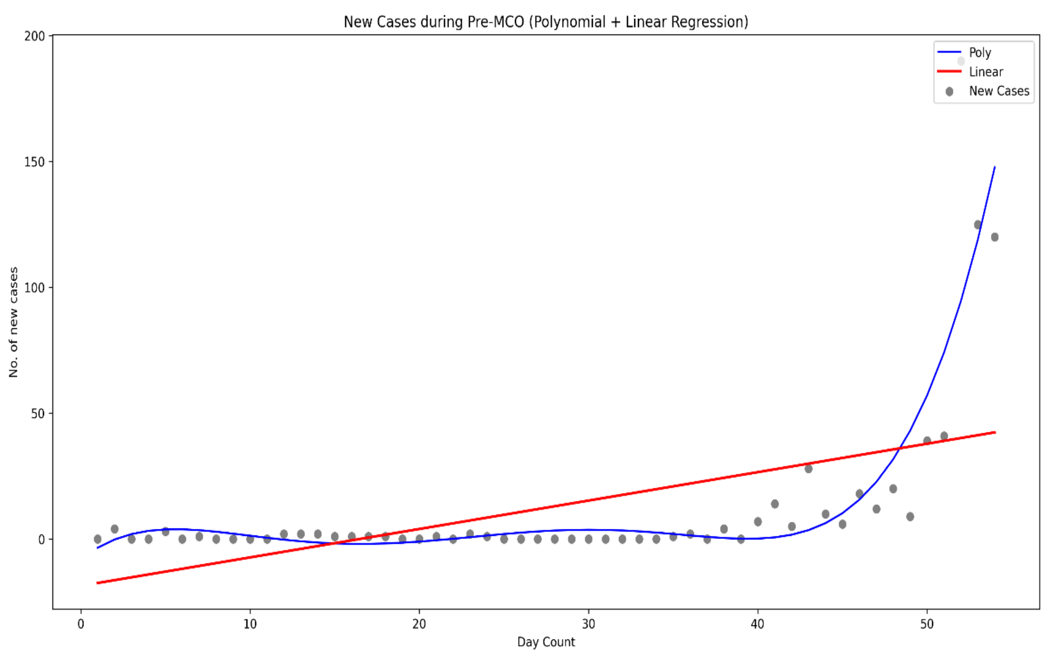


**Fig.1.** Linear regression of Pre-MCO phase.

```
============================== Pre - MCO Results =============================
                            OLS Regression Results
==============================================================================
Dep. Variable:      new_cases_malaysia   R-squared:                       0.265
Model:                             OLS   Adj. R-squared:                  0.251
Method:                  Least Squares   F-statistic:                     18.74
Date:                 Wed, 01 Jul 2020   Prob (F-statistic):           6.84e-05
Time:                         20:59:39   Log-Likelihood:                -259.05
No. Observations:                   54   AIC:                             522.1
Df Residuals:                       52   BIC:                             526.1
Df Model:                            1
Covariance Type:             nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        -18.5926      8.246     -2.255      0.028     -35.139      -2.046
day            1.1293      0.261      4.329      0.000       0.606       1.653
==============================================================================
Omnibus:                        62.004   Durbin-Watson:                   0.618
Prob(Omnibus):                   0.000   Jarque-Bera (JB):              406.965
Skew:                            3.137   Prob(JB):                     4.25e-89
Kurtosis:                       14.896   Cond. No.                         64.2
==============================================================================
```

**Fig. 2.** Regression statistics for Pre-MCO phase.

### *4.1.2 MCO*

The linear model is: Y = 313.37 + -2.4832X, 5$^{th}$ Degree Polynomial

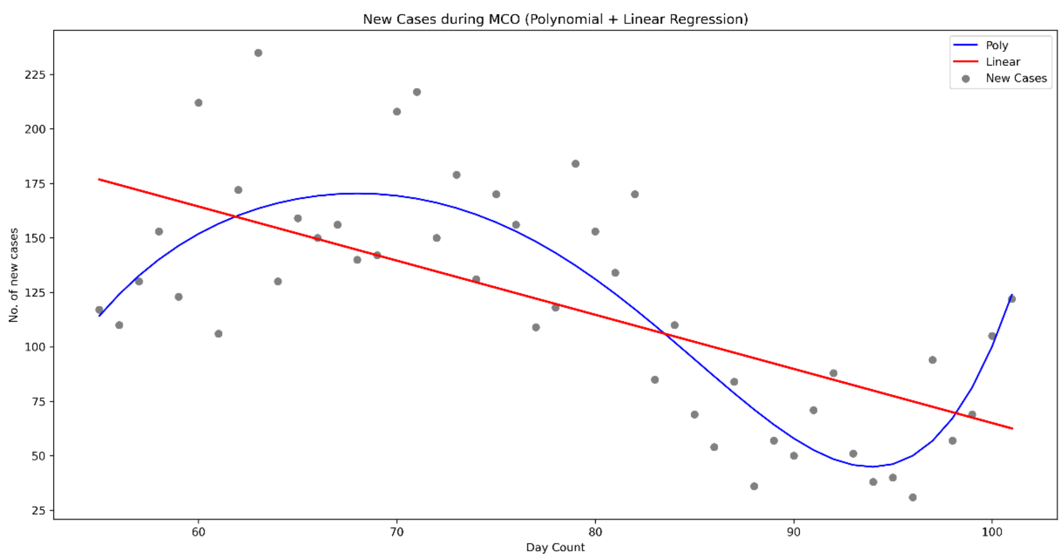


**Fig. 3.** Linear regression of MCO phase.

```
================================ MCO Results ================================
                            OLS Regression Results
==============================================================================
Dep. Variable:     new_cases_malaysia   R-squared:                       0.422
Model:                            OLS   Adj. R-squared:                  0.410
Method:                 Least Squares   F-statistic:                     32.90
Date:                Wed, 01 Jul 2020   Prob (F-statistic):           7.68e-07
Time:                        20:58:34   Log-Likelihood:                -239.35
No. Observations:                  47   AIC:                             482.7
Df Residuals:                      45   BIC:                             486.4
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        313.3730     34.273      9.143      0.000     244.343     382.403
day           -2.4832      0.433     -5.736      0.000      -3.355      -1.611
==============================================================================
Omnibus:                        3.559   Durbin-Watson:                   1.204
Prob(Omnibus):                  0.169   Jarque-Bera (JB):                2.277
Skew:                           0.335   Prob(JB):                        0.320
Kurtosis:                       2.154   Cond. No.                         462.
==============================================================================
```

**Fig. 4.** Regression statistics for MCO phase.

### *4.1.3 CMCO*

The linear model is: Y = -2.0171 + 0.47582X, 5th Degree Polynomial

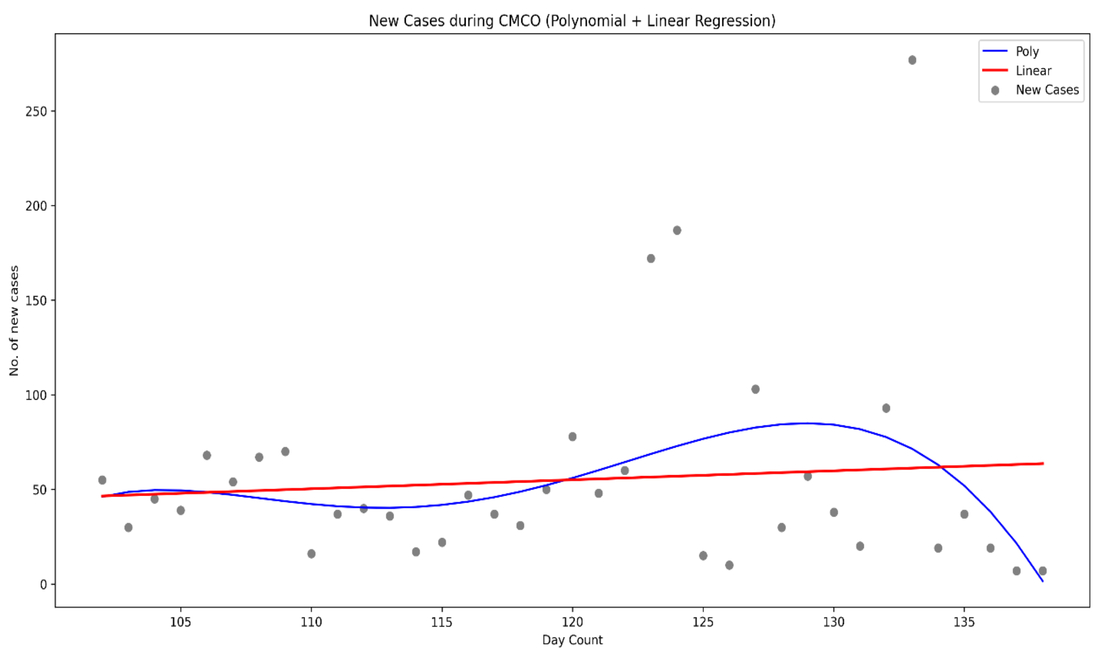


**Fig. 5.** Linear regression of CMCO phase.

```
================================ CMCO Results ================================
                            OLS Regression Results
==============================================================================
Dep. Variable:      new_cases_malaysia   R-squared:                       0.009
Model:                             OLS   Adj. R-squared:                 -0.019
Method:                  Least Squares   F-statistic:                    0.3197
Date:                 Wed, 01 Jul 2020   Prob (F-statistic):              0.575
Time:                         21:23:50   Log-Likelihood:                -199.51
No. Observations:                   37   AIC:                             403.0
Df Residuals:                       35   BIC:                             406.2
Df Model:                            1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         -2.0171    101.388     -0.020      0.984    -207.845     203.811
day            0.4758      0.842      0.565      0.575      -1.233       2.184
==============================================================================
Omnibus:                        35.143   Durbin-Watson:                   1.656
Prob(Omnibus):                   0.000   Jarque-Bera (JB):               90.344
Skew:                            2.333   Prob(JB):                     2.41e-20
Kurtosis:                        9.069   Cond. No.                     1.36e+03
==============================================================================
```

**Fig. 6.** Regression statistics for CMCO phase.

### *4.1.4 RMCO*

The linear model is: Y = 17.864 + -0.032136X, 5th Degree Polynomial

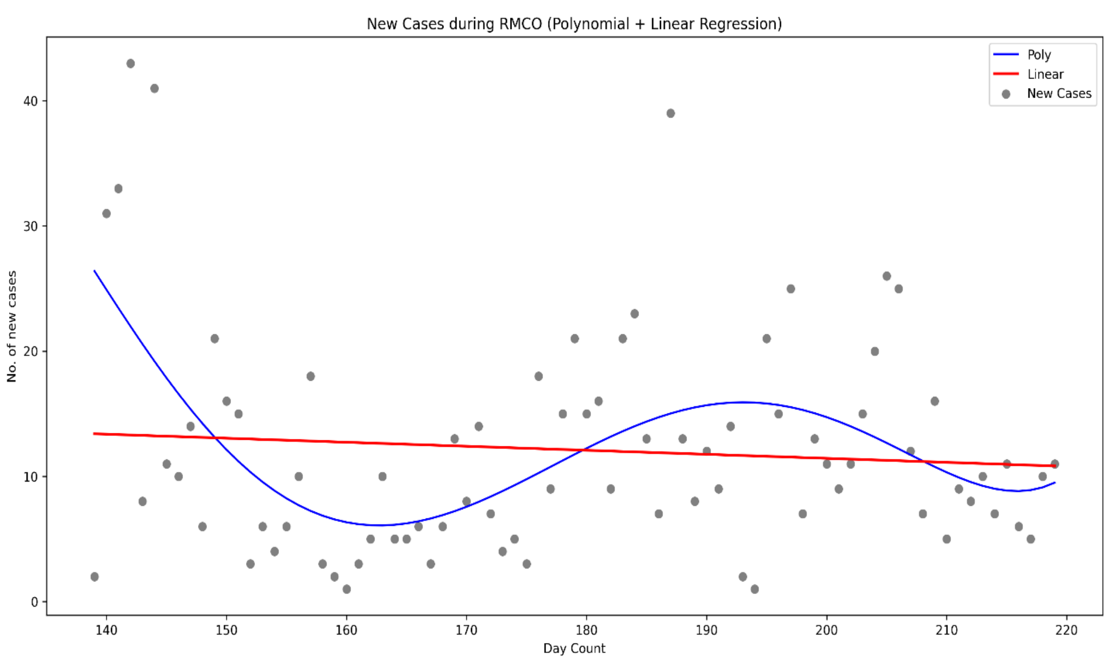

**Fig. 7.** Linear regression of RMCO phase.

```
================================ RMCO Results ================================
                           OLS Regression Results
==============================================================================
Dep. Variable:     new_cases_malaysia   R-squared:                       0.007
Model:                            OLS   Adj. R-squared:                 -0.005
Method:                 Least Squares   F-statistic:                    0.5685
Date:                Fri, 04 Sep 2020   Prob (F-statistic):              0.453
Time:                        15:47:28   Log-Likelihood:                -291.61
No. Observations:                  81   AIC:                             587.2
Df Residuals:                      79   BIC:                             592.0
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const         17.8635      7.694      2.322      0.023       2.549      33.178
day           -0.0321      0.043     -0.754      0.453      -0.117       0.053
==============================================================================
Omnibus:                       26.031   Durbin-Watson:                   1.473
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               38.738
Skew:                           1.375   Prob(JB):                     3.87e-09
Kurtosis:                       4.979   Cond. No.                     1.39e+03
==============================================================================
```

**Fig. 8.** Regression statistics for RMCO phase.

## *4.2 Non-linear Regression (Gaussian) and Polynomial Regression (8$^{th}$ Degree)*

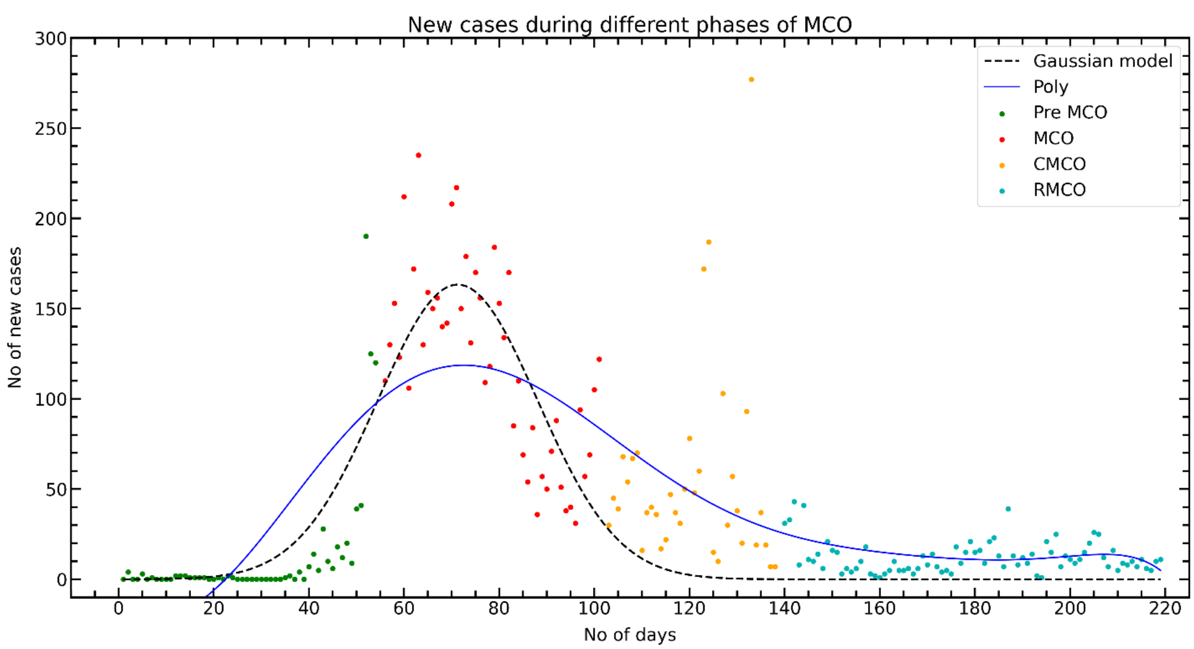


**Fig. 9.** The above regression model shows us the tabulated rate of new cases during the 4 phases of imposed levels of restrictions.

# 5 Discussion

## 5.1 Pre-MCO

Fig.1 displays the linear and polynomial regression of the new cases prior to the declaration of MCO. The linear regression line has a positive gradient and is sloping upwards, suggesting an increase in the rate of new cases with the lack of preventive measures in place. This is also reflected through the spike of the polynomial regression, where the regression line shows a sharp increase towards the end. The linear regression's gradient value (b = 1.1293) suggests a slow rate of transmission, which is reflective of the outbreak's infancy. However, the linear equation of the model, Y = -18.593 + 1.1293X is heavily affected by the large increase in values towards the end of this phase. This is due to the major increase in the number of new cases towards the end of this period. It is this major fluctuation in cases that the Malaysian government announced the movement control order. Correspondingly, this has also caused the $R^2$ value for the results (Fig. 2) to be low (26%). The P value (P < 0.028) from Fig. 2 suggests a valid correlation between the low level of restriction and the increase in the rate of new cases.

## 5.2 MCO

Fig. 3 displays the linear and polynomial regression of the new cases under the MCO period. The linear regression line has a negative gradient and is sloping downwards, suggesting a decrease in the rate of new cases with the newly preventive measures in place. The gradient's value (b = -2.4832) shows a high but decreasing rate of transmission. Although the overall rate of transmission is decreasing, there has been an increase in new cases towards the end of this phase. The linear equation of the model, Y = 313.37 + -2.4832X has a large variance in data, but the rate of new cases has seen to peak and decline towards the end of this phase, suggesting that the results of the restriction order is taking place. The $R^2$ value for the results (Fig. 4) is still not adequate (42%), however the P value (P < 0.000) suggests a valid correlation between the increased levels of restriction and the slow but gradual decrease in the rate of new cases.

## 5.3 CMCO

Fig. 5 displays the linear regression of the new cases after MCO, where the citizens are allowed to have reduced restrictions in movement. The linear regression line has a positive gradient and is sloping upwards, suggesting a slight increase in the rate of new cases with the reduced restrictions imposed. The gradient's value (b = 0.47582) shows low rate of transmission, which is reflective of the improved limitations for travel. However, the formula of the model, Y = -2.0171 + 0.47582X is largely influenced by outliers, as this phase has seen a sharp increase in imported cases (i.e. foreigners), which are also taken into consideration. The polynomial regression line contradicts the linear regression's line, where it shows a decrease in the rate of new cases towards the end of this phase. It is also affected by the outlying data, where it shows an upwards curve prior to decreasing. The $R^2$ value for the results (Fig. 6) are extremely low (0.9%), and the high P value ($P < 0.984$) makes it difficult to form a correlation between the level of restriction and the rate of new cases.

### *5.4 RMCO*

Fig. 7. displays the linear regression of the new cases under the current RMCO period. The regression line has a negative gradient and is sloping downwards, suggesting a slight decrease in the rate of new cases with the newly preventive measures in place. The gradient's value (b = -0.032136) shows a low and decreasing rate of transmission, which implies an optimal effectiveness of the different MCO phases. The formula of the model, Y = 17.864 + -0.032136X also has a large variance in data but is seen to be declining towards the end of this phase, suggesting that the restriction order has proven to be effective. The $R^2$ value for the results (Fig. 8) is low (0.7%), however the P value ($P < 0.023$) suggests a valid correlation between the improved levels of restriction and the continual decrease in the rate of new cases. The polynomial regression line suggests that while the overall number of new cases is stabilizing, there are still fluctuations in the number of new cases detected, where the regression increases after the drop and decreases towards the end.

### 5.5 Overview of all phases

Based on the Fig. 9, we can infer from the graph that the rate of new cases has peaked during the implementation of the four (4) phases of MCO. The values that are plotted above the curve suggests that it went beyond the predicted amount of cases, which happened due to the lack of preventive measures prior to the first phase. It then gradually shown improvement in the decrease on the number of new cases, implying that the implementation of the restriction is showing results. However, the actual values of the number of new cases post MCO (CMCO & RMCO) is still above the predicted model's range, which bring into question the effectiveness of the MCO. However, by cross checking the data with the linear and polynomial regression of each phase, it is clear that the number of new cases is stabilizing.

# 6 Conclusion

The COVID-19 pandemic has spread throughout the world within a few months, and it has brought sickness and death to citizens worldwide. In order to slow down the spread of the virus, governments worldwide have imposed restrictions in their countries in order to enforce social distancing. Malaysia has also enforced this through the implementation of the Movement Control Order (MCO). In order for Malaysia to prevent a major outbreak in the country, it is therefore important to have an effective implementation of MCO. The enforcement of MCO and its subsequent phases have still seen small fluctuations in the increase of new cases, from the end of MCO to CMCO. However, the overall number of new cases has decreased to a stable level as Malaysia enters the RMCO period, suggesting that the country has begun to adapt and adhere to the enforced rules.

There are several things that should be taken into consideration when looking into the article. The rate of new positive cases that are screened can exhibit major fluctuations, as the detections of a cluster would mean that all of the individuals who have interacted with a positive patient will have to be screened as well. The changes in the screening of the population, for instance the targeted screening of foreign workers that were laboring in red zones during May (CMCO phase), screened a total of 277 cases where 271 of them were foreigners [14]. The increased rate in testing [15] from 6210 during the start of MCO to 36812 tests after 100 days after MCO would also mean that the rate of detection in new cases would go up.

It is also worth noting how does Malaysia perform tests on the community. The distribution of COVID-19 testing on the community is not well distributed, where urban areas provide more testing opportunities in comparison to sub-urban and rural areas. This is seen where the majority of the confirmed cases are centralized in cities and towns such as Kuala Lumpur, Selangor and Negeri Sembilan [16]. While higher populations in the city would equate to a higher number of cases, the more rural states might have difficulty in accessing testing kits.

As it is currently not mandatory for citizens to perform testing for COVID-19, Malaysia's sampling only involves individuals who voluntarily test themselves after exhibiting symptoms, and those who have been in contact with a COVID positive individual. This also means that asymptomatic individuals would not be tested as they do not exhibit any moderate or serious symptoms that require them to do so. This might have an impact on the validity of the study in reflecting the actual population, as we are unable to understand the true extent of COVID-19's spread in the country due to the lack of testing.

The health ministry along with the frontline workers are working hard to ensure that the Malaysia is well prepared against the pandemic, and researchers are continuing to find ways to ensure that the citizens are minimally affected it. In the future, we hope that this research will serve as a stepping stone for the improvement of future implementations of movement restriction orders across the globe. We also hope that Malaysians continue to adhere to the instructions that are provided to ensure that the COVID-19 outbreak can come to its end as soon as possible.

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