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Prediction of the Epidemic Peak of Coronavirus Disease in UAE, 2020

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***ABSTRACT**: In 1927, the Susceptible Infected and Recovered (SIR) Mathematical Modelling Originally, studied by Kermack and McKendrick (A contribution to the mathematical theory of epidemics' in the Proceedings of the Royal Society London Ser. A). the paper became a classic in infectious disease epidemiology and has been cited innumerable times. Using the data offered by Ministry of Health and Prevention, to determine the coefficient in the system of Ordinary Differential Equations that represent the United Arab Emirates' SIR Mathematical Modelling of COVID-19, using Microsoft Excel, and consequently solve and graph the solution of it using Matlab Software. The idea may be extended to the website calculator or a Mobile App. giving the Infection Rate Ro and the Contact Ratio q, then up to this result the Maximum percentage of population expected to be infected.*

***KEYWORDS**: COVID-19, Mathematical Modelling, Susceptible, Infection Rate, Contact Ratio.*

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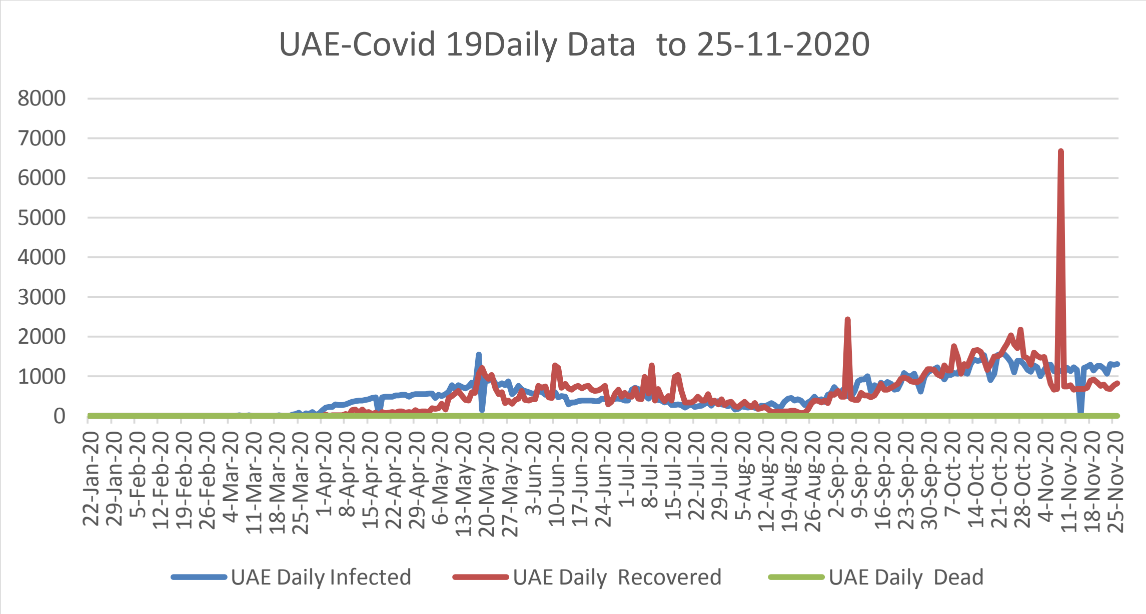
I. INTRODUCTION

The pandemic of Coronavirus disease 2019 (COVID-19), that caused by Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) since it first noticed in early of 2020 has caught global attention in both developing and developed countries. The epidemic did not stop to that limit, but it combined by a dramatic increase in the number of confirmed cases around the world. The World Health Organization (WHO) as a pandemic has announced the COVID-19 disease on March 11, 2020 [1]. Moreover, the SARS-CoV-2 pandemic contributed significantly to human destruction, paralyzing economic activities and an unprecedented increase in morbidity and mortality. At the time of writing this report (June 2020), pandemic-19 is responsible for the deaths of about nine million people worldwide [2].

In the United Arab Emirates, the first case of COVID -19 reported on January 29, 2020 with a steady increase in the number of laboratory-confirmed COVID-19 cases [3]. Covid-19 can infect people of all ages; however, current research shows that elderly people and patients with chronic diseases are more vulnerable to becoming severely ill if they are infected with the virus. Quarantines restricts the activities of healthy people for a period as determined by competent medical authorities. United Arab Emirates Health Ministry website supply Covid-19 information and awareness in text and videos. The effect of human mobility and control measures on the COVID-19 epidemic in China studied by [7]. It shows that the drastic control measures implemented in China substantially mitigated the spread of COVID-19. Consequently, intensive control measures, including travel restrictions, have been implemented to limit the spread of COVID-19 all over the world. The estimated total number worldwide of death until Sept 9, 2020 is 823,249 less than the Spanish Flue in 1918, the estimated number of deaths was at least 50 million worldwide [8].

The Ministry of Health and Prevention, in UAE stressed its aim to continue expanding the scope of testing nationwide to facilitate the early detection of coronavirus cases and carry out the necessary treatment. For instant, on Tuesday August 29, announced that it conducted 88,803 additional COVID-19 tests over the past 24 hours. The total number of conducted tests until September 1 is 7,177,430 with diagnosed cases 70,805, recovered cases 61,491, active cases 8,930, and 431 death. The data in [3], January 22 to November 25, 2020, the weekly data is accumulated in Fig(1):



Fig(1)

II. METHODS

In [4], prediction of the Epidemic Peak of Coronavirus Disease in Japan, where the well-known SIER – model (the susceptible, infective, exposed, and removed populations at time t). Here the simpler SIR-model applied to the data from January 22 to November 25, 2020 as well as the Numerical Central First Order Derivative for S(t), I(t), and R(t), the susceptible, infected, removed populations at time t (the sum of the Recovered and Dead). Using Microsoft Excel, the value of the infection rate R_0 and the maximum percentage of expected infected in UAE population, $I_{Maximum}$ are calculated daily and weekly.

III. MODEL

In 1927, the well-known SIR Mathematical Modelling, originally by [5], thanks to Kermack and McKendrick published a paper 'A contribution to the mathematical theory of epidemics' in the Proceedings of the Royal Society London Ser. A. The paper became a classic in infectious disease epidemiology and has been cited innumerable times. Roy Anderson reprinted it, with a discussion, in a special issue 'Classics of theoretical biology' (part two) in the Bulletin of Mathematical Biology [6].

$$\frac{dS}{dt} = -rSI, \qquad (1)$$

$$\frac{dI}{dt} = rSI - aI\,, \qquad (2)$$

$$\frac{dR}{dt} = aI, \qquad (3)$$

where S(t), I(t), R(t) and r is denote the susceptible, infected, removed populations at time t (the sum of the Recovered and Dead) and the transition rate, respectively. Their values at the starting time t=0 denoted by $S(0) = S_0,\ I(0) = I_0,\ R(0) = 0$. The ratio q is called the contact ratio and the ratio

$$q = \frac{r}{a}, \qquad (4)$$

$$R_0 = \frac{rS_0}{a} = qS_0, \qquad (5)$$

called the Infection Rate, the number of people each infected person passes the virus on to, on average. If it is 2 then 10 infected people would pass it onto 20 others. Nevertheless, if is 0.5 then 10 infected people pass it onto 5 others. If $R_0 > 1$, then there could be a "second peak" in cases and this is what everyone are trying to avoid. This R_0 plays the major rule in the spread of the epidemic increasing (if $\frac{dI}{dt} < 0$). Matlab cannot find the explicit theoretical solution of SIR. So, to find the numerical centered first derivative for R, S, and I with a step equal to 1 (one day for the daily data and one week for the weekly data). Then the Least Square Method used to determine the coefficient r and a in (2) and (3). Dividing (1) by (2), we get the Ordinary Differential Equation

$$\frac{dI}{dS} = \frac{rSI - aI}{-rSI} = \frac{1}{qS} - 1. \qquad (6)$$

The theoretical solution of this Ordinary Differential Equation is

$$I + S - \frac{1}{q}\ln(S) = I_0 + S_0 - \frac{1}{q}\ln(S_0) \qquad (7)$$

The maximum number $I_{Maximum}$ occurs when $\frac{dI}{dS} = 0$ or $q = \frac{1}{S}$, therefore

$$I_{Maximum} = I_0 + S_0 - \frac{1}{q}(1 + \ln(qS_0)) = I_0 + S_0 - \frac{1}{q}(1 + \ln(R_0)), \qquad (8)$$

$I_{Maximum}$ is clearly depends on the contact ratio q and $R_0 = q \times S_0$. Using the daily data for susceptible, infected and death provided by [3]. Using the numerical central first derivative, to get the numerical values of $\frac{dI}{dt}$, and $\frac{dR}{dt}$ to use the least square method to compute, up to the date t

$$a = \frac{\sum R'}{\sum I}, \qquad r = \frac{\sum I' + a \sum I}{\sum IS}. \qquad (9)$$

IV. RESULTS

On October 7, 2020, using the weekly calculation, where $r = 1.12501 * 10^{(-08)}$, $a = 0.058709282$, $Io = 5$, $S_0 = 9882275$, $R_0 = 0$, . The solution of the SIR-Model (1), (2), and (3), found by the following Matlab codes Fig (1), note that $S = x(1)$, $I = x(2)$, $R = x(3)$:

```
f = @(t,x) [-1.12501*10^(-08)*x(1)*x(2); 1.12501*10^(-08)*x(1)*x(2)- 0.058709282*x(2); 0.058709282*x(2)]
[t,xa]=ode45(f,[0 1000], [9882275.0  5.0  0.0]); plot(t,xa(:,1))
 hold on
 plot(t,xa(:,2),'k')
 plot(t,xa(:,3),'r')
 hold off
```

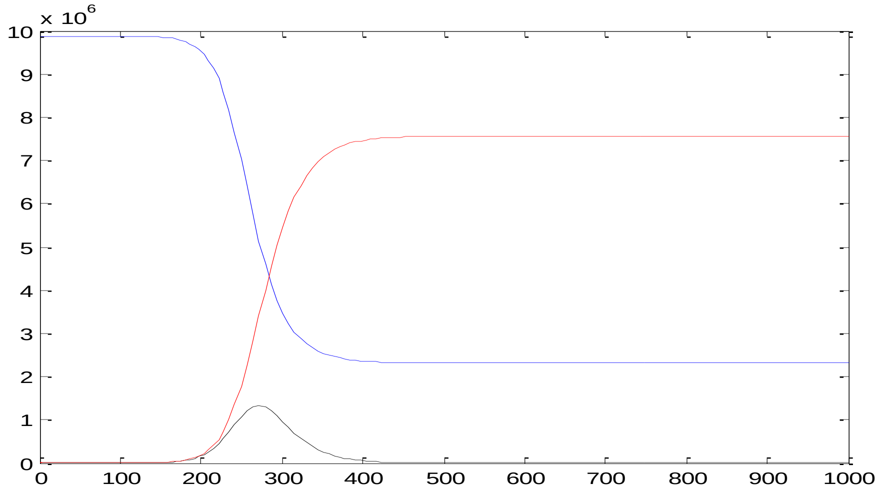


Fig (2a)

On October 7, 2020, using the weekly calculation, where a= 0.055836049 and r=1.01333*10^(8)

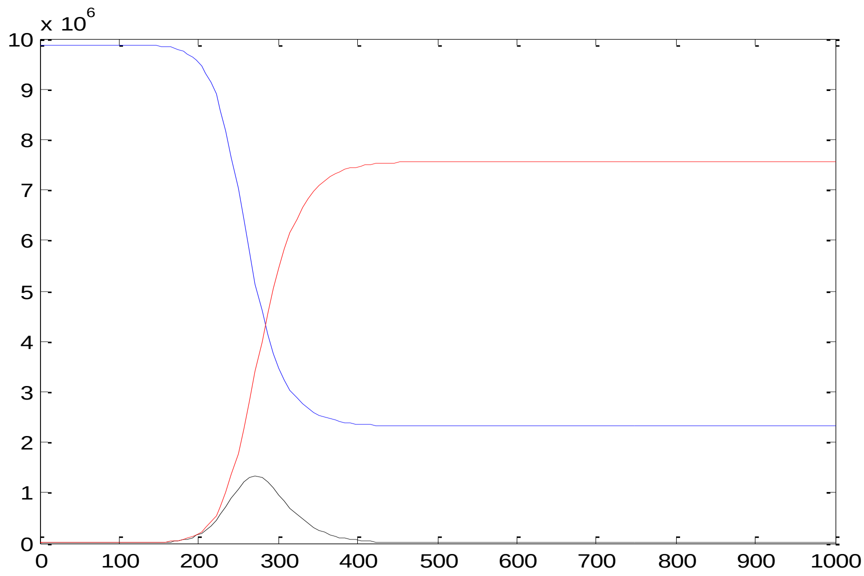


Fig (2b)

On November 18, 2020, using the weekly calculation, where a= 0.022317591, and r= 5.65665E-09

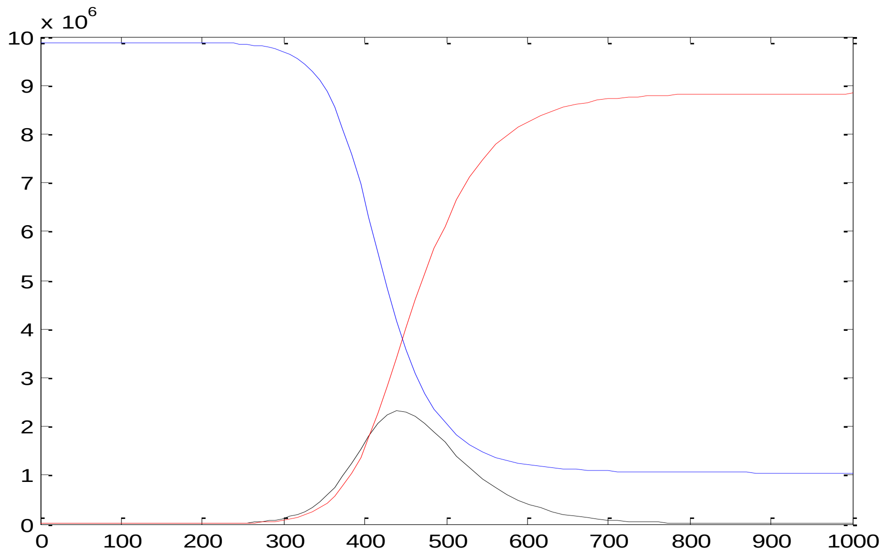


Fig (2c)

The blue curve is the population, which has not yet had the disease S, the black curve is the infected population I and the red curve is the population, which has recovered R.

The incubation period for COVID-19, which is the time between exposure to the virus (become infected) and symptom onset, is, on average, 5-6 days. However, it can be up to 14 days. During this period, also known as the "pre-symptomatic" period, some infected persons can be contagious. Therefore, transmission from a pre-symptomatic case can occur before symptom onset [5]. As the occupation period is around two weeks, so within this, we calculate the values this of R_0 and the maximum estimated infected percentage of the UAE's population as shown in Fig (3), Fig (4), Fig (5), and Fig (6)

Daily Calculation:

As the daily results are too many, selected days chosen

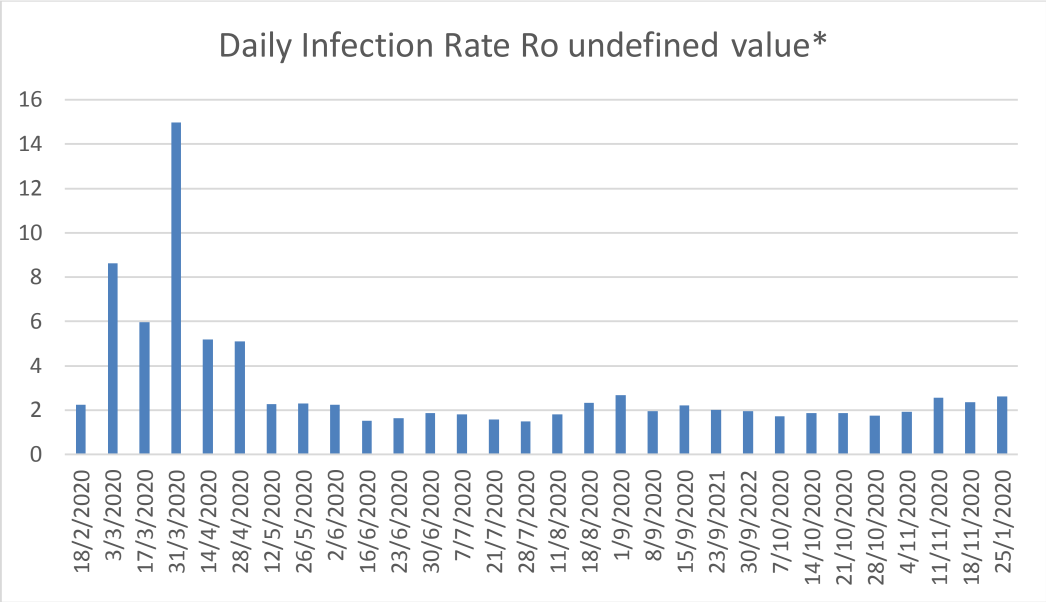


Fig (3)

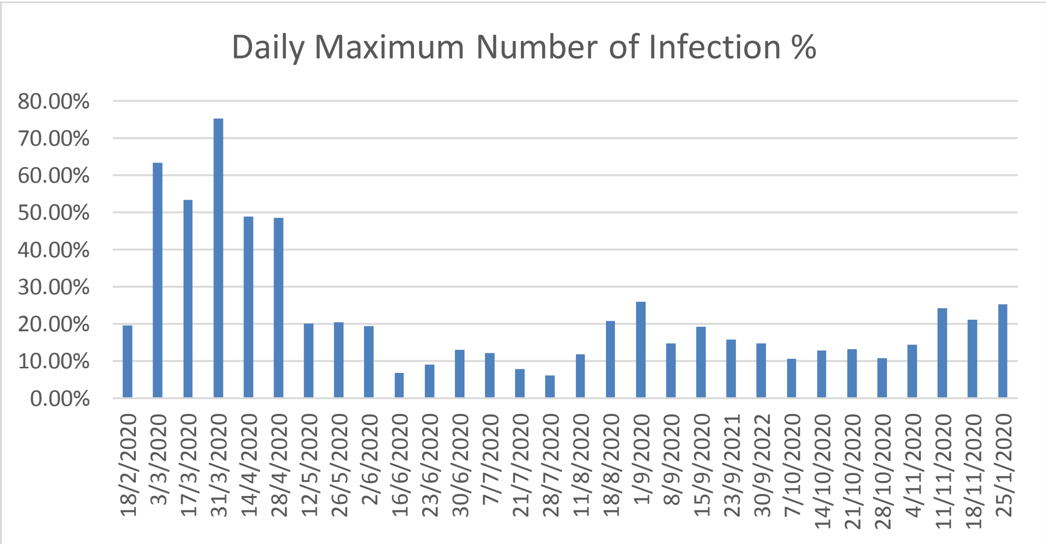


Fig (4)

Weekly Calculation: Selected weeks chosen

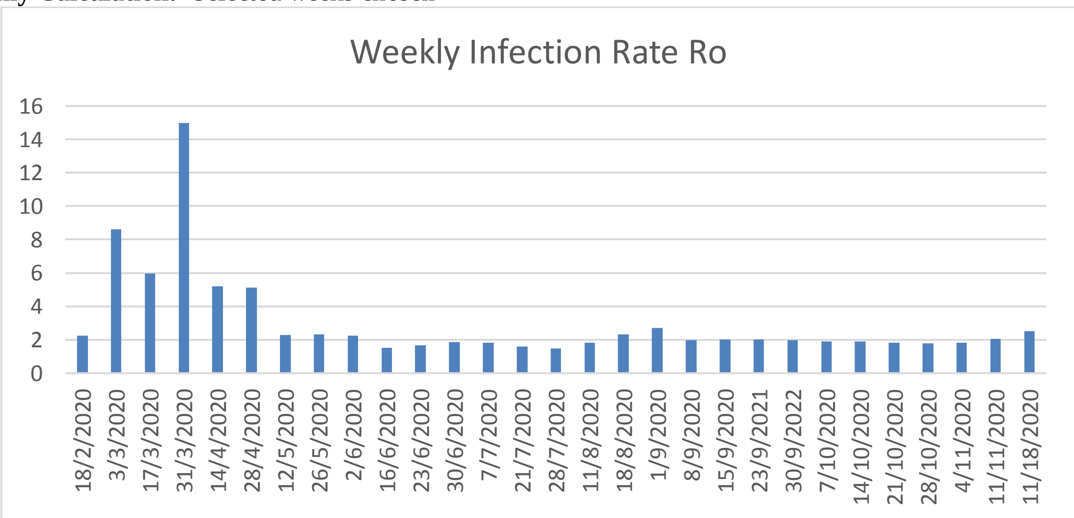


Fig (5)

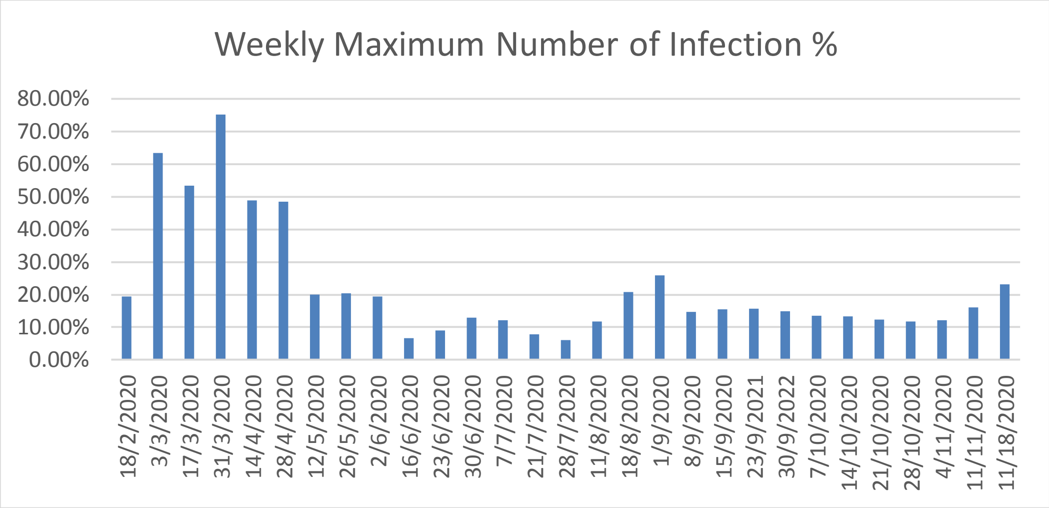


Fig (6)

On June 24, 2020, the break down announced, and also after the beginning of the academic year on August 23, 2020, so more contact and consequently the infection rate increased R_0 and the estimated percentage of the maximum number of infected $I_{Maximum}$. The significant increase of the before May 12, 2020 due to the lack citizens' awareness of Covid-19.

Now for question, "How long will the epidemic last?" and why on June 24, the break down announced in United Arab Emirates. Back to a differential equation involving time in (1). Plugging in the formula for I as a function of S from (7), we get

$$\frac{dS}{dt} = -rS(-S + \frac{1}{q}\ln(S) + C)\,, \qquad (10)$$

where,

$$C = I_0 + S_0 - \frac{1}{q}\ln(S_0). \qquad (11)$$

To solve this differential equation using separation of variables, write

$$T_{end} = \int_{S_0}^{S_T} \frac{dS}{rS^2 - \frac{rS}{q}\ln(S) - rSC} = \int_{S_0}^{S_T} \frac{dS}{rS^2 - aS\ln(S) - rSC}. \qquad (12)$$

Unfortunately, we do not know an antiderivative for the right side: there probably is not a formula for it and theoretically, the time of the epidemic is infinite unless there is no infection, the infected people becomes zero for at least more than the occupation period of Covid-19.

For Daily Calculation on Sept 1, 2020, we get the coefficient$\mathrm{a} = 0.014791101, \mathrm{r} = 2.40989\mathrm{E}-09,$ and$\mathrm{q} = \mathrm{a/r} = 0.0061376664495\ \mathrm{E}+09$, therefore $C = I_0 + S_0 - \frac{a}{r}\ln(S_0) = -\,8.8973\ \mathrm{E}+07$.

So by (12),

$$T_{end} = \int_{9819857}^{9882275} \frac{dS}{2.40989\mathrm{E}{-09}\,S^2 - 0.014791101\,S\ln(S) - 2.40989\mathrm{E} - (2.40989\mathrm{E}{-09})(-\,8.8973\mathrm{E}{+007})\,S} \qquad (13).$$

Using the following Matlab command:

```
syms S; int(1/(2.40989 * 10^(-09) * S^2 - 0.014791101 * S * log(S) - (2.40989 * 10^(-09)) *
(- 8.8973 * 10^(+007) ) * S), S, 9819857,9882275)
```

The Matlab result is NaN (which means the result is not a number) which is also the same result for the weekly-accumulated data.

V. CONCLUSION:

Following the Health Protocols, reduce the risk of raising both the contact ratio and the infection rate. Conduct more short time result Covid-19 tests helps in controlling the infection. The contact ratio, the infection rate, and the Expected percentage of UAE's population goes down with the tight restrictions and up after the breakdown on Jun 24, 2020 and at the begging of the academic year on August 23, 2020. The answer for the question, "How long will the epidemic last?" is unknown up to the used data. Awareness of the epidemic diseases must be increased nationwide and globally in different ways. Using Technology helps life to carry on and reduce the risk and consequently the contact factor.

REFERENCES

[1]. Clinical management of severe acute respiratory infection (SARI) when Covid-19 disease is suspected. Interim guidance, World Health Organization. Available from: https://www.who.int/internal-publications-detail/clinical-management-of-severe-acuterespiratory- infection-when-novel-coronavirus-(ncov)-infection-is-suspected%0A

[2]. World health organization. WHO Coronavirus Disease (COVID-19) Dashboard. Available from: https://covid19.who.int/

[3]. National Emergency Crisis and Disaster, First Middle East cases of coronavirus confirmed in the UAE, http://covid19.ncema.gov.ae/

[4]. Prediction of the Epidemic Peak of Coronavirus Disease in Japan, Toshikazu Kuniya, Journal of Clinical Medicine, 2020, 9, 789; doi:10.3390/jcm9030789. www.mdpi.com/journal/jcm

[5]. A contribution to the mathematical theory of epidemics, W.O. Kermack and A.G. McKendrick, Proc. R. Soc. Lond. Ser. A 115 (1927), pp. 700–721. https://royalsocietypublishing.org/doi/10.1098/rspa.1927.0118

[6]. A contribution to the mathematical theory of epidemics in classics of theoretical Biology, W. O. Kermack and A. G. McKendrick, (part two), Bull. Math. Biol. 53 (1991), pp. 33–55. *https://link.springer.com/article/10.1007/BF02464423#citeas*

[7]. The effect of human mobility and control measures on the COVID-19 epidemic in China, Moritz U. G. Kraemer, Chia-Hung Yang , etal, *Science* 01 May 2020, Vol. 368, Issue 6490, pp. 493-497.

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