International Journal of Engineering Research And Management (IJERM)
ISSN: 2349- 2058, Volume-07, Issue-07, July 2020

"BREAK THE OUTBREAK"-COVID 19

Anusha M S, Nishanth S, Revanasiddappa M

***Abstract*— The World Health Organization (WHO) has declared global emergency due to the pandemic outbreak of coronavirus. Rising incidents of COVID-19 among majority of the countries is an increasing concern to all of our heaths. It is important that we all know about this deadly virus and its behavior to hence prevent us from acquiring it.The purpose of this paper is to investigate about the COVID-19 and to prepare a futuristic model to prevent such outbreaks. Using graphical analysis and mathematical modeling this study analyzed the trends of COVID-19 in all the provinces of China, where the virus originated from. The obtained results are compared and we get a definitive value of the number of confirmed, cured and death cases so far in China. It was found that the COVID-19 disease has an 80% recovery rate. It is likely to affect older people and persons with chronic illness. A unique similarity was observed between COVID-19 and SARS [Severe Acute Respiratory Syndrome], which had an outbreak in 2003. This study definitely answers questions regarding the symptoms of the disease and how it spreads. It also gives a clear image of the number of people witnessing it. This disease still does not have a definitive cure. Further studies are needed to establish the same.**

***Index Terms*— COVID-19; Mathematical modeling; SIR; Data visualization; Pandemic; Compartmental models; Social distancing; Rate of contact; mathplotlib; Basic reproduction number**

I. INTRODUCTION

The COVID -19 outbreaks is an unprecedented global public health challenge. This pandemic originated in Wuhan, Hubei province of China. From there it has traversed all over the globe affecting more than half a million. This deadly virus has taken the lives of around three lakh people and has spread to close to 200 countries. On December 31 of last year, Chinese authorities alerted the World Health

Organization of an outbreak of a novel strain of coronavirus causing severe illness, which was subsequently named SARS-CoV-2. It started with a simple pneumonia which went on to become fatal claiming the lives of around three thousand citizens. This virus attacks the respiratory system in turn taking over a person's immunity hence creating a compromised immunity situation for the patient. It spreads as easily as common cold and hence is spreading very fast. It is very hard to recognize the symptoms in early stages therefore many humans become victims for transmitting the disease.

Manuscript received August 08, 2020

Anusha M S, B.Tech, Dept. of Computer Science and Engineering, PES University, Bangalore, Karnataka, India
Nishanth S, B.Tech, Dept. of Computer Science and Engineering, PES University, Bangalore, Karnataka, India
Revanasiddappa M, Dept. of Engineering Chemistry, PES University, Bangalore, Karnataka, India

In some cases it is so grave that the symptoms barely show and when the patient gets to know it becomes too late for any form of treatment. Coronavirus are enveloped RNA viruses at cause respiratory illness of varying severity from common cold to fatal pneumonia. There are 7 types of coronaviruses known to cause diseases in humans. Out of these 7, three of them are very fatal and have caused deadly outbreaks in the 21st Century. This are- SARS-CoV 2: is a novel coronavirus that is identified as the cause of COVID-19 that began in Wuhan, China. MERS-CoV: caused an outbreak of Middle East Respiratory Syndrome (MERS) in 2012. SARS-CoV: was identified in 2003 as the cause of Severe Acute Respiratory Syndrome (SARS).

II. METHODOLOGY

Mathematical Modeling- Mathematical model allows us to extrapolate from current information to future predictions and more importantly, to quantify the uncertainty in these predictions. Mathematical model and the underlying statistics are the key elements to predict the future for epidemic outbreaks. These tools will help in estimating future outbreaks and more importantly, controlling the outbreaks. In this paper we will examine the progress of the virus in all provinces of China and use that information to predict its behavior. Compartmental models are used to predict epidemic diseases. In this case, we use the compartmental model –SIR type. This type is the most basic type of compartmental model.

SIR model:

The model we have adopted has 3 compartments, namely" Susceptible – Infectious-Recovered". We assume that the whole population of size N has been divided into three categories of people-The ones who are susceptible to the infection(S), the ones who are already infected (I) and the ones who are either recovered or dead i.e. removed from the infection (R). Here to solve this model, we make some assumptions- This disease is not going to last for a very long period and hence the population will remain constant over the time of the epidemic. The rate of infected is directly proportional to the contact between the susceptibles and the infected i.e. more the physical contact between the people in the first two compartments of the model, more people will end up in the 2nd compartment. People move at a constant rate from the second to the third compartment in this model i.e. the infected die or recover at a constant rate. Based on our assumptions, we can formulate these equations-

$$\frac{dS}{dt} = -ISr \quad (i)$$

Where r= rate of transmission,
S=susceptibles, I=infected

This equation obeys the second assumption. If the rate of infected is increasing because of contact rate (r), then the rate of susceptibles will automatically decrease (hence the negative sign).

$$\frac{dI}{dt} = ISr - aI \quad (ii)$$

This equation obeys second assumption. Here' a' stands for the recovery rate or death rate. Hence the rates of infected decrease as people move from second compartment to the third one. To determine that rate we have introduced a constant –'a'.

$$\frac{dR}{dt} = aI$$

Here the rate is positive as the removed part of the population is increasing. To solve these three differential equations, we need the initial values. So let's assume that

S=S'
I=I' and
R=0(because initially nobody is recovered or dead)
S+I+R=N (constant population)

$$\frac{d(S + I + R)}{dt} = 0$$

We can conclude that S<S' (because dS/dt is negative)

$$\text{therefore}, \frac{dI}{dt} = I(S'r - a)$$

$$S' > \frac{a}{r} \text{ and } \frac{a}{r} = \frac{1}{q} \quad \text{where q is the contact ratio.}$$

Contact ratio is the fraction of the population that comes into contact with an infected person during the period when they are infectious.

Basic Reproduction Number (R_0)- Is a measure to tell whether the infection will grow exponentially, die out or remain constant? So it is important to find the R_0 value for our model. If- $R_0>1$, then one infected individual is spreading it to more than one person hence the infection will grow exponentially and will become an epidemic like this particular case of COVID-19. $R_0<1$, then one infected individual is infecting less than one person on average and the infection will die out soon. $R_0=1$, then one infected person is infecting only one other person and this disease will become an endemic. Here,

$$R_0=rS_0/a$$

To see how badly the infection will spread we need to figure out the maximum infected in the population at any given time. Now let's try and find out I_{max} for the infection. To do so, we need to divide (ii) by (i). On doing so, we get-

$$\frac{dI}{dS} = \frac{ISr - aI}{-ISr}$$

$$\frac{dI}{dS} = -1 + \frac{a}{Sr}$$

$$\frac{dI}{dS} = -1 + \frac{1}{qS}$$

When the above equation is equal to zero, I_{max} is found. We can see that the above equation will be equal to 0 when S=1/q. So we integrate the above equation directly and substitute S by 1/q to get

$$Imax = I' + S' - \frac{1}{q}(1 + \ln(S'q))$$

I'+S' gives the total population initially. Since COVID- 19 is a new pandemic that nobody is aware of, everyone is susceptible to it. Hence the first two terms in the equation gives the total initial population. The next term completely depends on the contact ratio of the model. The total population equation goes as-

$$R + S + I = S' + I'$$

So our next question after figuring out the maximum number of infected population (I_{max}) would be – When will this outbreak end? Or When will the total number of infected (I) become zero? To answer this, we need to determine how many people may acquire this disease. For this, we need to rearrange terms in the total population equation to find the R at the end of the outbreak i.e. R (end).

$$R(end) = -S(end) + S' + I' \quad \text{we get this here as } I = 0$$

All terms are known here except S (end) and S (end) value depends on q (contact ratio). It depends inversely i.e. number of susceptible people left at the very end of the outbreak in the population S (end) will be less when the contact ratio is large which bad news is as number of people left in the population will be very less. Most of the population will be in the infected sphere and would have got the infection or COVID-19.Hence to prevent this we must practice distancing to lessen the contact ratio so as to increase the number of people left in our population at the end of the outbreak. We need to practice staying indoors to defeat this virus until a cure is found.

III. RESULTS AND DISCUSSIONS

Data Visualization- Using the mathematical model built by us we have statistically determined the spread of this disease in all the provinces of China. This rampage that has made us prisoners in our own house started in Wuhan, Hubei province. All of the statistics is done till 3rd March. Using the tools of matplotlib, pandas library and python coding, the researchers have plotted some graphs on jupyter notebook. The researchers have done some calculations and plotted these graphs on jupyter notebook using python programming language.

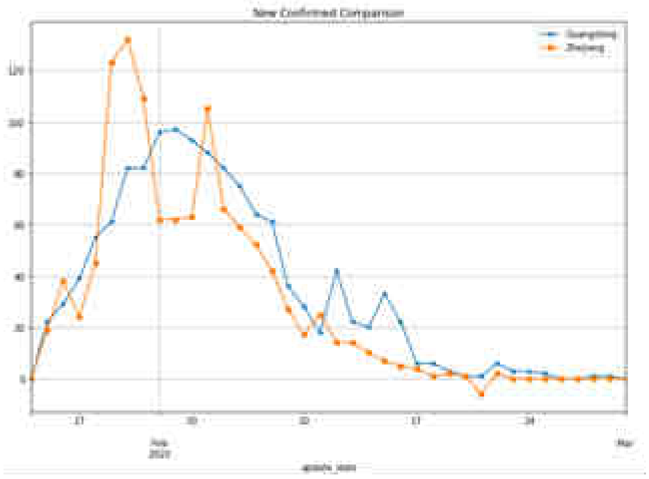

Fig. 1 - Comparison of New Confirmed Cases Daily In Guangdong Province and the Zhejiang Province for the Month of February 2020

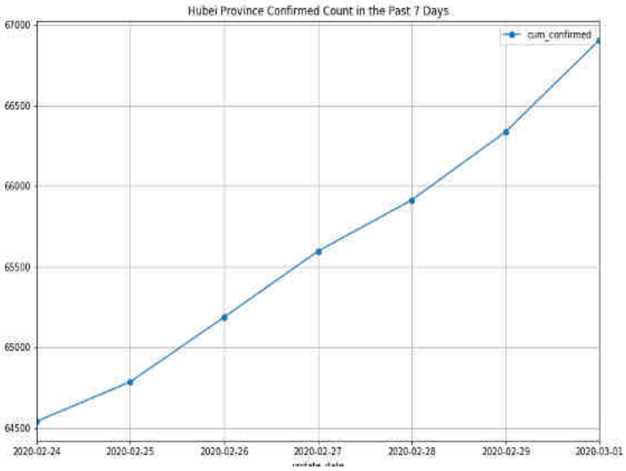

Fig. 2: Number of confirmed cases of COVID-19 between 24th February and 3rd March 2020 in the Hubei Province

Table 1: The data of number confirmed, cured and dead cases in the Hubei province.(Using this data, the above graph has been plotted). This data is between 24th February and 3rd March 2020.

Update date	Cum_ confirmed	Cum_ cured	Cum _dead	New_ confir med	New_ cured	New_ dead
2020-02-24	64540	16751	2495	456.0	1408.0	149.0
2020-02-25	64786	18971	2563	499.0	2223.0	68.0
2020-02-26	65187	20969	2615	401.0	1998.0	52.0
2020-02-27	65596	23383	2641	409.0	2414.0	26.0
2020-02-28	65914	26403	2682	318.0	3020.0	41.0
2020-02-29	66337	28993	2727	423.0	2590.0	45.0
2020-03-01	66907	31536	2761	570.0	2543.0	34.0

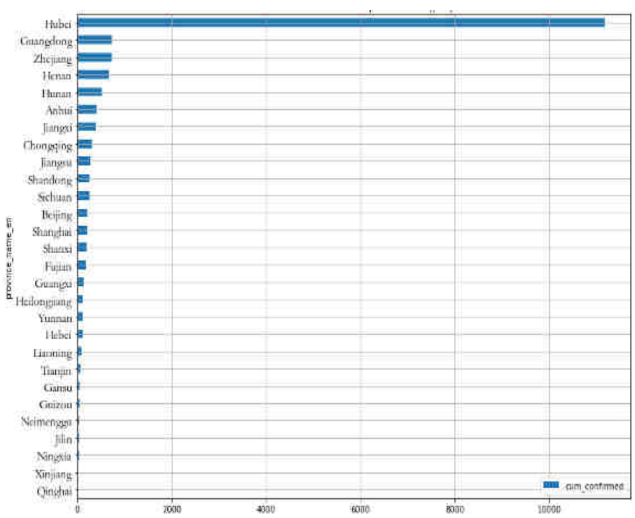

Fig. 3: The mortality rates of all the provinces in China are compared i.e. confirmed count of COVID-19 cases are compared all over China's provinces. This is up to date till 3rd March 2020.

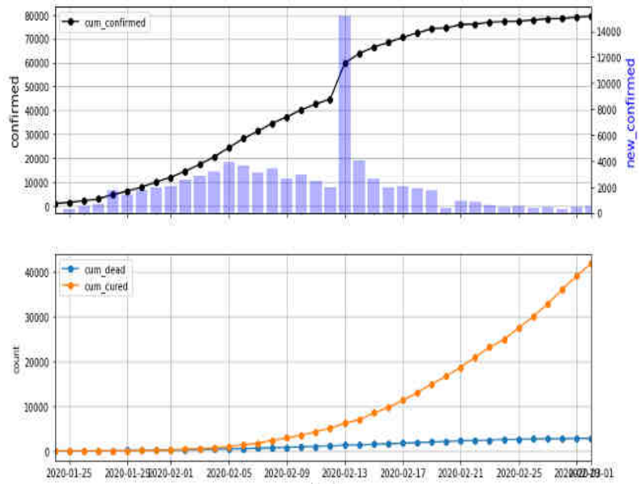

Fig.4: The overall cured, confirmed and dead in China form when the epidemic broke out till 3rd of March, 2020.

IV. CONCLUSION

People everywhere are constantly bombarded by fake news, fake numbers and rumors to scare them and cause unnecessary panic all over. This research paper is designed and written to give the real numbers and analyze it for our understanding. The model depicted strongly that the spread of the disease is largely due to the effective contact rate of the infected population as well as symptomatic and asymptomatic carriers of individuals within the entire population The model tells us that to reduce the impact of the outbreak we need to decrease the contact ratio as much as possible, which is exactly what the current social distancing refers to. In addition to this, the model is structured on the basis of assumptions which may or may not be true. These assumptions were made during the course of the epidemic and hence may not be accurate. Keeping all these thoughts into account, it is fair to say that the primary result remains unaffected by the assumptions. That primary result is to lessen the contact rate between individuals in the population. This must be implemented by everyone in order to fight this outbreak or break the outbreak as the title suggests.

Mathematical modeling has helped us to figure out what are the main reasons for the spread of this epidemic and how it can be controlled. It gives us an insight on the repercussions of not following social distancing. The current situation in countries like USA and Italy are the examples for that. We need to maintain safe distance from everyone until this infection comes under control.

ACKNOWLEDGMENT

The authors whole heartedly acknowledge and thank all the authors and publishers whose content has been referred in this paper. We would also like to express our profound gratitude to the PES University for encouragement and cooperation which had helped in the successful completion of this study.

REFERENCES

[1] Andrew Rambaut, 2020, COVID-19 Coronavirus has a natural origin, Science Daily, 17th March 2020
[2] COVID-19 Dashboard by the center for systems science and Engineering (CSSE) at Johns Hopkins University (JHU) 2020
[3] Dennis L. Kasper; Anthony S. Fauci, 2017, Harrison's Infectious Diseases, 3e, Access Biomedical Science, McGraw-Hill
[4] Dominic Otoo, Patrick Opoku, Sebil Charles, Asekiya Prince Kingsley, 2020, Infectious Disease Modeling, Vol. 1, Pages 42-60
[5] M J Keeling, L Danon, 2009, British Medical Bulletin, Mathematical modeling of infectious diseases, Vol. 92, Issue 1, Dec., Pages 33-42
[6] Nathan D. Wolfe, Claire Panosian Dunavan & Jared Diamond, 2007, Origins of major human infectious diseases, Nature, Vol. 447, pages 279-283
[7] Qianying Lin ,Shi Zhao ,Daozhou Gao,Yijun Lou,Shu Yang, Salihu S. Musa, Maggie.H.Wang, Yongli Cai, Weiming Wang, Lin Yang, Daihai He, 2020, A conceptual model for the coronavirus disease 2019 (COVID-19) outbreak in Wuhan, China with individual reaction and governmental action, International Journal of Infectious Diseases, pages 1-6
[8] Society for Industrial and Applied Mathematics, the Mathematics of Infectious Diseases | SIAM Review, Vol. 42, No. 4, 599–653
[9] https://www.github.com/jianxu30/Cov2019_analysis/
[10] https://www.ijidonline.com/article/S1201-9712(20)30117-X/fulltext, 19th March,8:20pm
[11] https://www.sciencedirect.com/science/article/pii/S2468042719300399#sec8, 25th March,3:40pm