priyadarshini engineering college

COVID-19
CASE ANALYSIS

October 11,2023

Phase 2

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Data analysis covid-19 cases analysis

Abstract

Corona Virus Disease- 19 (COVID-19) was first time reported in Wuhan, China. This disease has covered more than 200 countries till May 2020. World Health Organisation (WHO) has declared COVID-19 as Public Health Emergency of International Concern (PHEIC) on 30 January 2020. COVID- 19 causes severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which was progressive earlier in China but now in maximum countries. Therefore, the different online platform are used which provides the latest update of confirmed corona cases throughout the globe for the analysis of data. The aim of data analysis for CIVID-19 is to aware of the community against the infectious disease and forecast the COVID-19 confirmed cases, deaths, and recoveries through the data analysis methods. Different models are also used to study the behavior of the disease. The models help to forecast the patterns of public sentiments on health information with both the political and economical influence of the spread of the virus. Data analysis methods which are used are Exploratory Data Analysis (EDA) in which the number of confirmed cases, death, and recovered data are recorded, model like Susceptible-Exposed-Infectious-Recovered (SEIR) model is used to predict the time and the rate taken for the spreading up of disease throughout the globe. A statistical model can also be used to compare the data among different countries to make humans aware of the infection.

Keywords: 2019-nCoV, SARS-CoV-2, Coronavirus, COVID-19, data analysis, visualization.

I. INTRODUCTION

The outbreak of the new disease in Wuhan, China was caused by novel Coronavirus (2019-nCoV) [1]. This disease is a form of pneumonia. Coronavirus belongs to the *Orthocoronavirinae* subfamily. The first case was observed at the Chinese Center for Disease Control and Prevention (CDC) on 12 December 2019 and was considered as a non-SARS novel coronavirus [2]. The family to which Coronavirus belongs is *Coronaviridae* which consists of a large, single RNA strand of plus sign [3]. Viruses of these family show the symptoms of common cold, diarrhea in human beings. In the year 2003, it was seen the outbreak of coronavirus i.e. severe acute respiratory syndrome coronavirus (SARS-CoV) [4]. In December 2019 at Wuhan, China's symptoms closely resembled the same as pneumonia [5].

Several cases of approximately 1974 were confirmed in China according to the council information office in Beijing, China's capital on 26th January, 2020. Virus started spreading in many other countries like the

so to take some serious action for the control and prevention from the disease. World Health Organisation (WHO) on 30 January 2020 declared that Coronavirus Disease was an outbreak emergency of international concern after the attack of H1N1 in 2009, the emergence of Ebola virus in 2014, polio in 2014 and Zika virus in 2016 [6] [29]. Finally, on 11 February 2020, World Health Organization (WHO) gave the name of the novel disease which was caused by the corona virus as Corona Virus Disease- 19 (COVID-19) [7] [32]. Record maintenance on 24 February 2020 showed that more than 78, 000 patients were suffering from COVID-19 throughout many countries. The maximum patients were from China according to the World Health Organization (WHO) which were approximately 77,000 and 2500 death [8]. According to the World Health Organization (WHO) the rest of the countries reported 2000 confirmed cases and 300 deaths as on 7 March 2020. In Wuhan, China lockdown orders of all the trains, fights and public transport were passed on 23 January 2020. The exact origin of COVID-19 was not reported but through different researches, it was seen that coronavirus possibly has originated from the bat. According to the Centers for Disease Control and Prevention (CDC), the novel disease COVID-19 was transmitted from person to person through droplets, and the symptoms seen were fever, shortness of breath, and cough which was seen after 14 days [9].

The International Committee on Virus Taxonomy replaced the name of 2019-nCoV as SARS-CoV-2 (severe acute respiratory coronavirus-2 syndrome) [10]. The outbreak of novel SARS-CoV-2 was increasing at an alarming rate in China as global intimidating as pandemic throughout the World. Different methods were used to analyze data regarding epidemiology which were exploratory data analysis (EDA) methods and visualization model. These two methods showed the awareness among the communities and were noticed according to the data analysis that the government, health workers and the public have to cooperate throughout the World to prevent the spreading of the COVID-19 [11].

Data was collected from different sources from different countries regarding COVID-19 [12]. The maximum data related to COVID-19 was available at Google, WHO, CDC, ECDC, NHC of the PRC, JHU CSSE, DXY, QQ websites [13]. With the help of these data from different sources helped to analyze the people getting affected by COVID-19 and the rate of recovery and deaths were also analyzed daily. The dataset was recorded from 22 January 2020. Dataset was analyzed to record the death, survival, recovery, and people who were affected by COVID-19.

The very first data suggested that males of age above years were at higher risk of infection with COVID-19.

According to two other well-known diseases which are caused by coronavirus i.e SARS and MERS (Middle East

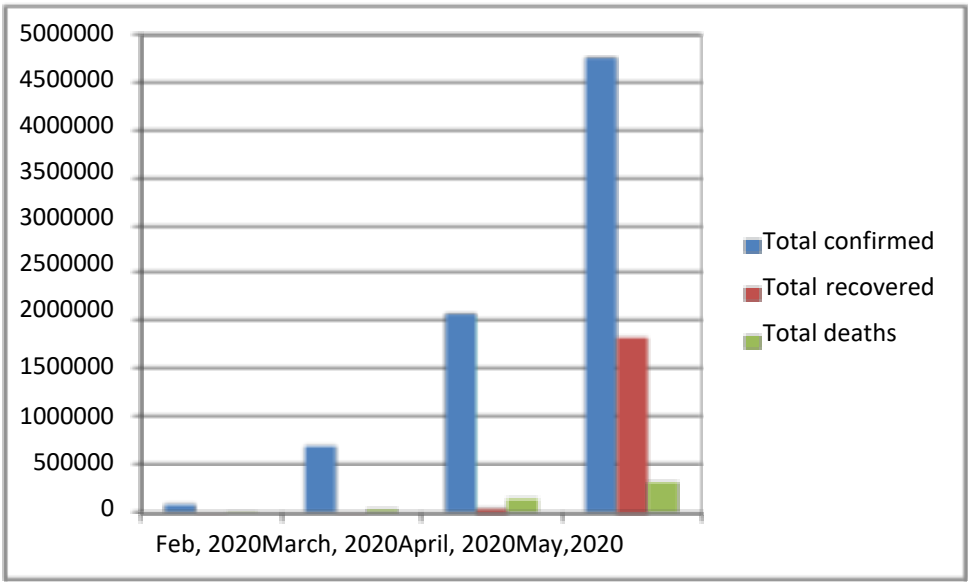

Fig. 1: Outbreak trends over time

A. *Data Source*

Data related to COVID-19 was retrieved from verified sources like Google, WHO DingXiangYuan, a website that is authorized by the Chinese government [16]. These sites provide information about the confirmed COVID-19 cases, the number of people recovered from the disease and the number of deaths that took place by infection of the virus [17].

B. *Data Visualization*

The retrieved data from different sites can be used to track the status of the corona [16]. The data collected from a different source can be seen in the table 1 [15]. The updates from the different countries can be seen through the different countries' COVID-19 portal or WHO [18].

C. *Exploratory Data Analysis (EDA)*

Exploratory Data Analysis is used to analyze data and visualize the dataset provided by different sources regarding the emergence of the disease. The exploratory data analysis was used to record the dataset of the outbreak of COVID-19 throughout the World [19]. The first dataset was visualized and analyzed between 22 January 2020 to 10 March 2020. It was seen that the rate of people affected by COVID-19 was more from China than the rest of the World, the few affected countries were neighbors of China. After 10 March 2020 more than 30 countries and 32 states in China were affected by COVID-19 [20]. Outside China not many deaths were reported, only ten death reports were noticed until 11 March 2020. It was noticed that the rate of recovery was more than the rate of deaths and by 15 May 2020, more than 200 countries were affected by the corona. Table I shows the number of confirmed cases, the number of deaths and the number of survival till 17th May 2020 [15].

TABLE I

Sr.No.	Country	Total confirmed	Total Recovered	Total Deaths
1	USA	1,510,286	339,578	90,178
2	Russia	281,752	67,373	2,631
3	Spain	277,719	195,945	27,650
4	UK	240,161	135	34,466
5	Brazil	233,511	89,672	15,662
6	Italy	224,760	122,810	31,763
7	France	179,365	61,066	27,625
8	Germany	176,450	153,400	8,027
9	Turkey	148,067	108,137	4,096
10	Iran	120,198	94,464	6,988
11	India	92,239	35,603	2,911
12	Peru	88,541	28,272	2,523
13	China	82,947	78,227	4,633
14	Canada	75,864	37,819	5,679
15	Belgium	55,280	14,630	9,052
16	Saudi Arabia	54,752	25,722	312
17	Mexico	47,144	31,848	5,045
18	Netherlands	43,995	3	5,680
19	Chile	41,428	18,014	421
20	Pakistan	40,151	11,341	873
21	Ecuador	32,763	3,433	2,688
22	Qatar	32,604	4,370	15
23	Switzerland	30,587	27,400	1,881
24	Sweden	30,143	4,971	3,679
25	Belarus	29,650	9,932	165
26	Portugal	29,036	4,636	1,218
27	Singapore	28,038	8,342	22
28	Ireland	24,048	19,470	1,533
29	UAE	23,358	8,512	220
30	Bangladesh	22,268	4,373	328
31	Poland	18,394	7,451	919
32	Ukraine	18,291	5,116	514
33	Indonesia	17,514	4,129	1,148
34	Romania	16,871	9,890	1,104
35	Israel	16,607	12,884	271

36	Austria		14,56	629
37	Japan	766	3	725
38	Colombia	657	10,33	562
39	Kuwait	276	8	112
40	South Africa	1223	3,587	261
41	Philippines	765	4,093	824
42	Dominican	877	6,478 23,6,73256	428
43	Republic Egypt	977	2,950	612
44	S. Korea	1226	9,888	262
45	Denmark	345	9,227	547
46	Serbia	1226	4,713	230
47	Panama	1666	6,080	269
48	Czechia	1128	5,422	297
49	Norway	1459	32	232
50	Argentina	1908	2,569	366
51	Australia	1008	6,367	98
52	Bahrain	5577	2,774	12
53	Malaysia	2776	5,571	113
54	Algeria	6088	3,409	542
55	Morocco	5000	3,645	192
56	Afghanistan	1977	778	169
57	Finland	9776	5,000	298
58	Kazakhstan	657	3,090	34
59	Moldova	2679	2,344	207
60	Ghana	8639	1,754	29
61	Nigeria	8668	1,472	176
62	Oman	6726	1,465	22
63	Armenia	6869	1,925	60
64	Luxembourg	6628	3,699	104
65	Bolivia	1553	473	165
66	Hungary	1665	1,396	451
67	Azerbaijan	1266	2,015	39
68	Iraq	233	2,126	121
69	Cameroon	976	1,567	140
70	Thailand	1224	2,856	56
71	Greece	552	1,374	162
72	Uzbekistan	763	2,213	11
73	Guinea		1,133	16
74	Honduras		278	138

75	Senegal	2,480	973	25
76	Bosnia and	2,290	1,436	133
77	Herzegovina Sudan	2,289	222	97
78	Croatia	2,226	1,936	95
79	Bulgaria	2,211	598	108
80	Ivory Coast	2,061	987	25
81	Cuba	1,872	1,495	79
82	Iceland	1,802	1,786	10
83	North	1,792	1,293	101
84	Macedonia	1,774	938	63
85	Estonia	1,763	138	33
86	Guatemala	1,541	997	56
87	Lithuania	1,499	1,433	21
88	New Zealand	1,494	1,163	28
89	Slovakia	1,466	273	104
90	Slovenia	1,455	270	61
91	DRC	1,357	148	55
92	Somalia	1,338	462	27
93	El Salvador	1,331	950	4
94	Djibouti	1,322	0	36
95	Tajikistan	1,320	244	11
96	Gabon	1,312	627	18
97	Mayotte	1,138	804	14
98	Kyrgyzstan	1,078	58	4
99	Maldives	1,056	1,024	4
100	Hong Kong	1,037	807	45
101	Tunisia	1,008	662	19
102	Latvia Guinea-	969	26	4
103	Bissau	964	538	9
104	Sri Lanka	946	715	31
105	Albania	914	515	17
106	Cyprus	911	247	26
107	Lebanon	889	689	51
108	Niger	887	301	50
109	Kenya	860	494	52
110	Mali	853	551	10
111	Costa Rica	782	604	51
112	Burkina Faso	778	198	11
	Paraguay			

113		761	615	51
114	Andorra	753	188	7
115	Zambia	733	558	19
116	Uruguay Diamond	712	651	1
117	Princess *	695	425	3
118	Georgia	654	201	1
119	San Marino	607	404	2
120	Jordan Equatorial	594	22	4 7
121	Guinea Malta	553	454	0
122	Jamaica	517	121	9
123	Tanzania	509	183	21
124	Sierra Leone	505	141	32
125	Venezuela	504	241	10
126	Chad	474	111	50
127	Réunion	443	354	0
128	Taiwan	440	395	7
129	Palestine	381	335	2
130	Haiti	358	29	20
131	Benin	339	83	2
132	Isle of Man	335	285	24
133	Mauritius	332	322	10
134	Cabo Verde	328	84	3
135	CAR	327	13	0
136	Montenegro	324	311	9
137	Vietnam	320	260	0
138	Ethiopia	317	113	5
139	Madagascar	304	114	1
140	Togo	298	99	11
141	Nepal	295	36	2
142	Rwanda	289	178	0
143	Sao Tome and Principe	235	4	7
144	Uganda	227	63	0
145	Liberia	226	120	21
146	Eswatini	202	72	2
147	French Guiana	197	125	1
148	Martinique	192	91	14
149	Faeroe Islands	187	187	0

150	Myanmar	182	96	6
151	Guadeloupe	155	109	13
152	Gibraltar	147	145	0
153	Brunei	141	136	1
154	Mozambique	137	43	0
155	Mongolia	136	21	0
156	Bermuda	123	73	9
157	Cambodia	122	122	0
158	Yemen	122	1	18
159	Guyana	117	43	10
160	Trinidad and	116	107	8
161	Tobago Aruba	101	93	3
162	Monaco	96	87	4
163	Bahamas	96	42	11
164	Cayman Islands	94	55	1
165	Barbados	86	67	7
166	Liechtenstein	82	55	1
167	Libya	65	28	3
168	Malawi	65	24	3
169	French	60	59	0
170	Polynesia Syria	51	36	3
171	Angola	48	17	2
172	Macao	45	43	0
173	Zimbabwe	44	17	4
174	Mauritania	40	7	4
175	Eritrea	39	39	0
176	Saint Martin	39	30	3
177	Puerto Rico	39	1	2
178	Guam	32	0	1
179	Antigua and	25	19	3
180	Barbuda Nicaragua	25	7	8
181	Timor-Leste	24	24	0
182	Botswana	24	17	1
183	Gambia	23	12	1
184	Grenada	22	14	0
185	Bhutan	21	5	0
186	Laos	19	14	0

187	New Caledonia	18	18	0
188	Saint Lucia	18	18	0
189	Belize	18	16	2
190	Fiji	18	15	0
191	St. Vincent Grenadines	17	14	0
192	U.S. Virgin	17	0	0
193	Islands Dominica	16	15	0
194	Curaçao	16	14	1
195	Namibia	16	13	0
196	Saint Kitts and	15	1	0
197	Nevis Burundi	15	4	1
198	Turks and Caicos	12	7 10	1
199	Vatican City	12	2	0
200	Greenland	11	11	0
201	Montserrat	11	10	1
202	Seychelles	11	10	0
203	Comoros	11	3	1
204	Suriname	10	9	1
205	Papua New Guinea	8	8	0
206	British Virgin	8	6	1
207	Islands Western	6	6	0
208	Sahara	6	6	0
209	St. Barth	3	3	0
210	Anguilla	2	0	0
211	Kosovo	1	0	0
	Lesotho			

D. *Visual Exploratory Data Analysis (EDA)*

Visual Exploratory Data Analysis (EDA) is a method used to analyze the rate at which COVID-19 was spreading throughout the globe. In this method, the data was analyzed through a map that helps an individual to understand the epidemiological nature of COVID-19 as shown in Fig. 2. According to the data, it was noticed that China reported the highest rate of cases confirmed with COVID-19 and the highest death rate by the virus (Till 17 March 2020) followed by Italy [21]. EDA provides a piece of good knowledge about the time taken by the virus to spread throughout the globe. The data analysis through EDA is also useful in analyzing the behavior of the disease. EDA helps in understanding the situation of the COVID-19. The data for COVID-19 is available at URL

http://samratdey.me/visualization.html and by 15 May 2020, it was seen that highest number of corona cases were reported by USA and Russia followed by Spain [15].

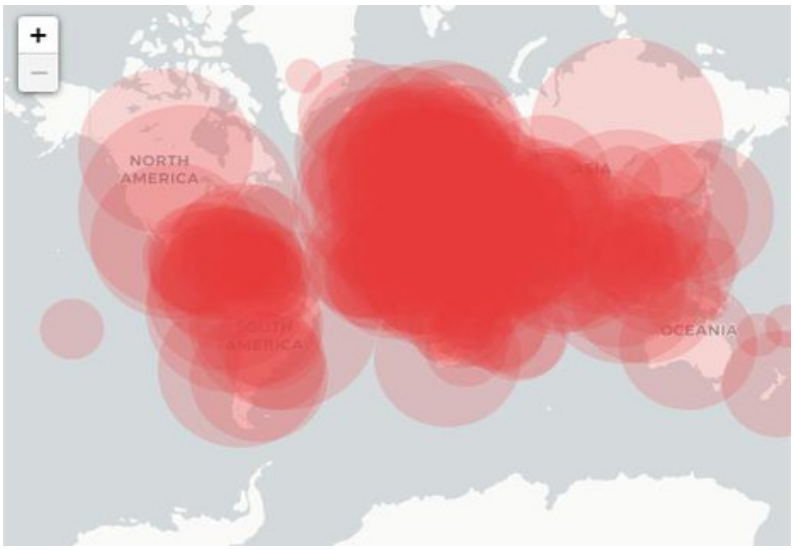

Fig. 2**:** World map of affected region, where the darker red regions in the map predict number of infected cases [15]

E. *Predictive Modeling – SEIR Model*

Susceptible-Exposed-Infectious-Recovered (SEIR) model is used to predict the time and the rate taken for the spreading up of disease throughout the globe. In this modeling method, real-time data is collected and visualized to forecast the rate of increasing cases for COVID-19 [22]. SEIR model predicts according to the previous data provided to forecast the number of cases that may take place in the future, it also predicts the death rate that may occur in the future because of COVID-19. SEIR model is designed to analyze and classify the news into positive and negative sentiments [31]. The result of news on the behavior of peoples both economically and politically. The properties of Susceptible-Exposed-Infected-Removed (SEIR) system is used to study the outbreak of COVID-19 throughout the World [23]. SEIR is considered to be the model for simulation studies for the disease spreading, where parameters are Susceptible (S), Exposed (E), Infections (I) and Recovered (R). In Susceptible (S), people may or may not have infection were considered, in Exposed (E), people who were incubated after encountering of the virus, in Infections (I) people after incubation showing symptoms were kept and in Recovered (R) parameter it refers to the state where no one is infected with the disease or disease-free people [30].

The parameters in SEIR models are as follows:-

1. Beta is represented for the rate of spread, which is the rate at which disease is transmitted between a susceptible and infectious person.
2. The incubation rate is given by sigma, in which incubation to the individual is given and the rate is being recorded in which an individual will get infected. The duration of incubation given is 5 days.
3. Recovery rate is given by gamma, in this, the average duration of the recovery from the infection is recorded.
4. After the recovery phase, recovered candidates are kept under the removed phase [24] as shown in Fig. 3.

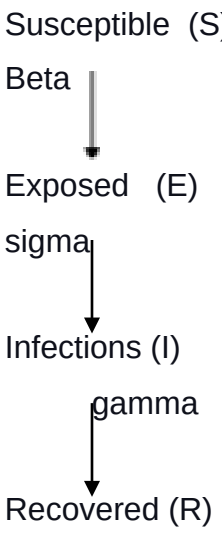

Fig. 3: SEIR Model

F. *Sentiment Analysis*

Sentiment analysis is done to keep a record of data which is neither too long nor too short and it is the result of the SEIR predictive model [25]. Sentiment analysis consists of a summary containing a description of more than eight words of the trained model [26] [27].

G. *Statistical challenges of analyzing COVID-19 data*

After the outbreak of COVID-19 in Wuhan, China, the statistical model plays a major role in comparing the number of confirmed COVID-19 cases, the number of recoveries and the number of death rate that is taking place throughout the globe as shown in Fig. 4, Fig. 5 and Fig. 6 respectively. The statistical model compares the data from origin i.e China to the data of different countries with respect to time in the form of a bar graph. The data from different countries of the confirmed cases are recorded from the very start of the outbreak of the disease. The separate data is maintained in a statistical model for the cases which are recovered from the infection and the number of deaths caused by COVID-19. The two protocols are maintained under in which closed COVID-19 cases are recorded which are as follows:-

1. International Severe Acute Respiratory and Emerging Infection Consortium (ISARIC) (isaric.tghn.org)
2. Lean European Open Survey on SARS-CoV-2 Infected Patients (LEOSS) (leoss.net).

For COVID-19 patients, the most important clinical endpoints are the record of intensive care, invasive ventilation, and survival. The less relevant endpoint is supportive oxygen. According to these two endpoints data can be analyzed on a statistical model that will be dependent on time. The data is further collected from ISARIC and LEOSS to analyze data in the standard protocol [28].

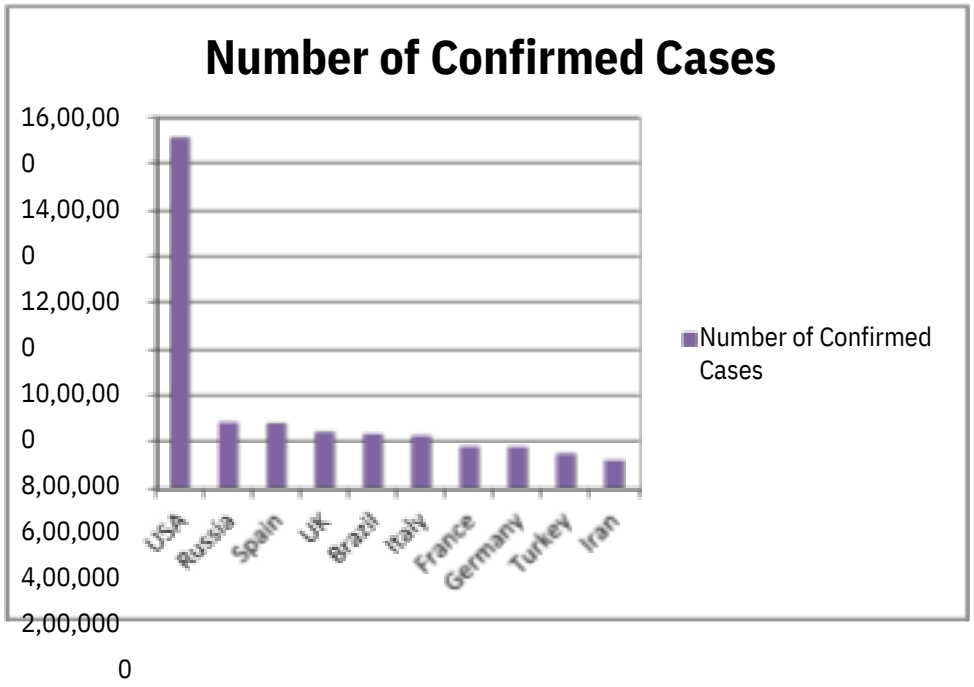

Fig. 4: Most affected countries showing number of confirmed COVID-19 cases.

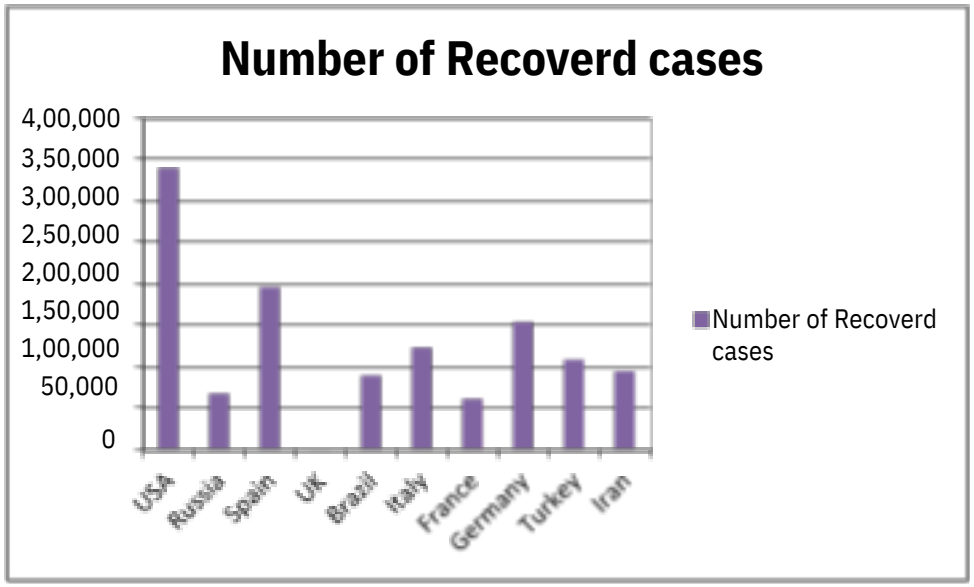

Fig. 5: Most affected countries showing number of recovered COVID-19 cases.

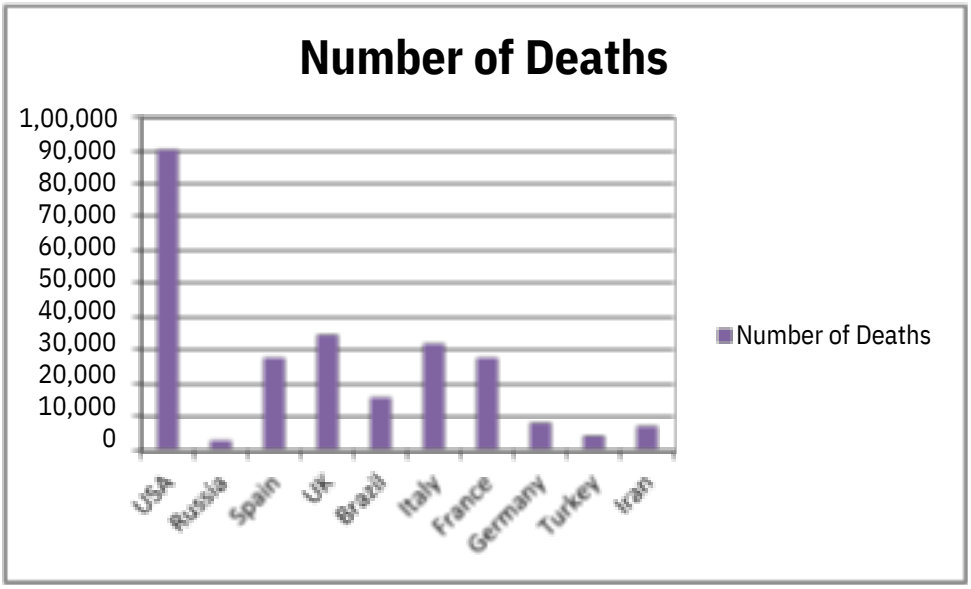

Fig. 6: Most affected countries showing number of recovered COVID-19 cases.

III. CONCLUSION

COVID-19 outbreak which took place in China was recorded and visualized through different online platforms. Data analysis was done through several methods. Exploratory Data Analysis was used to analyze data and visualize the dataset provided by different sources regarding the emergence of the disease. Visual Exploratory Data Analysis (EDA) was used as a method to analyze the rate at which COVID-19 was spreading throughout the globe. In this method, the data was analyzed through a map that helps an individual to understand the epidemiological nature of COVID-19. Susceptible-Exposed-Infectious-Recovered (SEIR) model was used to predict the time and the rate taken for the spreading up of disease throughout the globe. In this modeling method, real-time data was collected and visualized to forecast the rate of increasing cases for COVID-19 and was also used to forecast the analysis of infection. The results from the SEIR model were further used to analyze data for sentiment analysis among the community regarding the outbreak of COVID-19. The COVID-19 outbreak spreads not only through the country's policy but also through the social responsibility of each individual. The different online platform, updates the viewers with the situation of the disease including the number of confirmed cases, number of recoveries and number of deaths taking place throughout the world. Data analysis for COVID-19 is done to make aware humans against the infection caused by Corona.

ACKNOWLEDGEMENT

I would like to thanks Dr. Abhimanyu Kumar Jha for his continuous support throughout the research.

REFERENCES

1. Zhu N, Zhang D, Wang W, et al, “A novel coronavirus from patients with pneumonia in China”, *N Engl J Med*, https://doi.org/10.1056/NEJMoa2001017, 2019.

2. Centers for Disease Control and Prevention, “Novel Coronavirus (2019-nCoV), Wuhan, China”, https://www.cdc.gov/coronavirus/2019- nCoV/summary.html, 2019.

3. Chen Y, Liu Q, Guo D, “Emerging coronaviruses: genome structure, replication, and pathogenesis,” *J Med Virol*. https://doi.org/10.1002/jmv.25681, 2020.

4. Drosten C, Gunther S, Preiser W, et al, “Identification of a novel coronavirus associated with severe acute respiratory syndrome”, *N Engl J Med* 348:1967-1976, 2020.

5. Lu H, Stratton CW, Tang YW, “Outbreak of pneumonia of unknown etiology in Wuhan China: the mystery and the miracle”. *J Med Virol*. https://doi.org/10.1002/jmv.25678, 2020.

6. Chew C and Eysenbach G, “Pandemics in the Age of Twitter: Content Analysis of Tweets during the 2009 H1N1 Outbreak,” *PLoS ONE* 5: 11, 2010.

7. WHO. Novel coronavirus – China. Jan 12, 2020. http://www.who.int/csr/don/12-january-2020-novel-coronavirus-china/en/

8. Organization WH. WHO Statement Regarding Cluster of Pneumonia Cases in Wuhan, China; 2020. Available from: https://www.who.int/china/news/detail/09-01-2020-who-statement-regarding-cluster-ofpneumonia- cases-in-wuhan-china.

9. "Coronavirus Disease 2019 (COVID-19)," Centers for Disease Control and Prevention, 2020. https://www.cdc.gov/coronavirus/2019- ncov/about/symptoms.html.

10. Gorbalenya AE, Baker SC, Baric RS, et al, “Severe acute respiratory syndrome-related coronavirus: the species and its viruses —a statement of the Coronavirus Study Group”, *bioRxiv*. https://doi:10.1101/2020.02.07.937862, 2020.

11. Lin JL, McCloud R, Bigman C, et al, “Tuning in and catching on? Examining the relationship between pandemic communication and awareness and knowledge of MERS in the USA,” *Journal of Public Health* 4: 126-32, 2016.

12. Lauren G, “Coronavirus COVID-19 Global Cases by Johns Hopkins CSSE,” https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html, January 23, 2020.

13. Organization WH, “Novel coronavirus (2019-nCoV). Situation report 21. Geneva, Switzerland: World Health Organization,” https://www.who.int/docs/default-source/ coronaviruse/situation-reports/20200210-sitrep-21-ncov.pdf?sfvrsn=947679ef_2, 2020.

14. Lu R, Zhao X, Li J, Niu P, Yang B, Wu H, et al, “Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding,” *The Lancet*, https://doi.org/ 10.1016/S0140-6736(20)30251-8, 2020.

15.Corona Tracker Community, "Corona Tracker," Corona Tracker, (2020). https://www.coronatracker.com/.

16. Dong E, Du H, Gardner L, “An interactive web-based dashboard to track COVID-19 in real time,” *The Lancet Infectious Diseases*. https://doi.org/10.1016/S1473-3099(20)30120-1. PMID: 32087114, 2020.

17. Patel A, Jernigan D, “nCoV CDC Response Team. Initial Public Health Response and Interim Clinical Guidance for the 2019 Novel Coronavirus Outbreak—United States, December 31, 2019-February 4, 2020. MMWRMorb Mortal Wkly Rep,” https://doi.org/10.15585/mmwr.mm6905e1 *PLOS ONE* Forecasting of the COVID-19 outbreak PLOS ONE | https://doi.org/10.1371/journal.pone.0230405 March 31, 2020 20 / 21, 2020.

18. World Health Organization, "Coronavirus disease 2019 (COVID-19) Situation Report- 13," World Health Organization, 2020.

19. Battegay M, Kuehl R, Tschudin-Sutter S, Hirsch HH, et al, “Novel Coronavirus (2019-nCoV): estimating the case fatality rate —a word of caution. Swiss Medical Weekly,” 2020.

20. Hui D, et al, “The continuing 2019-nCoV epidemic threat of novel coronavirus to global health - The latest 2019 novel coronavirus outbreak in Wuhan, China,” *International Journal of Infectious Diseases* 91: 264-266, 2020.
21. Chen N, Zhou M, Dong X, et al, “Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study,” *The Lancet*. https://doi.org/10.1016/S0140-6736(20)30211-7, 2020.
22. Porter AT, “A path-specific approach to SEIR modeling," Ph. D Thesis University of Iowa, 2020.
23. The Institute for Disease Modelling, "SEIR and SEIRs models," Institute for DiseaseModelling,https://institutefordiseasemodeling.github.io/Documentation/general/model-seir.html, 2020.
24. Wu P, Hao X, Lau EHY, Wong JY, et al, “Real-time tentative assessment of the epidemiological characteristics of novel coronavirus infections in Wuhan, China,” *Eurosurveillance* 3: 25. https://doi.org/10.2807/1560-7917.ES.2020.25.3.2000044 PMID: 31992388, 2020.
25. Munikar M, Shakya S, Shrestha A, “Fine-grained Sentiment Classification using BERT,” *ArXiv,*2019.
26. Dong X, de Melo G, “A Helping Hand: Transfer Learning for Deep Sentiment Analysis, in Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics,” 2018.
27. Kim Y, Jeong Y, Kim K, et al, “Topic-based content and sentiment analysis of Ebola virus on Twitter and in the news,” Journal of Information Science, 42: 763-781, 2016.
28. Wang D, Hu B, Hu C, Zhu F, et al, “Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus–Infected Pneumonia in Wuhan, China,” JAMA. https://doi.org/10. 1001/jama.2020.1585, 2020.
29. Song M, “Text Mining Driven Content Analysis of Ebola on News Media and Scientific Publications,” *Journal of the Korean Society for Library and Information Science* 50: 289-307, 2020.
30. Rachah A, Torres DFM, “Analysis, simulation and optimal control of a SEIR model for Ebola virus with demographic effects,” *Commun. Fac. Sac. Univ*. Ank. Series 67:179-197, 2018.
31. Lee S, Han C, “The Effects of Social Media Use on Preventive Behaviors during Infectious Disease Outbreaks: The Mediating Role of Self- relevant Emotions and Public Risk Perception,” Health Communication 2: 1-10, 2020
32. World Health Organization, "Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19)," World Health Organization, 2020.

conclusion

The COVID-19 pandemic demonstrates that every country remains vulnerable to public health emergencies. The aspiration towards a healthier and safer society requires that countries develop and implement a coherent and context-specific national strategy, improve governance of public health emergencies, build the capacity of their (public) health systems, minimize fragmentation, and tackle upstream structural issues, including socio-economic inequities. This is possible through a primary health care approach, which ensures provision of universal and equitable promotive, preventive and curative services, through whole-of-government and whole-of-society approaches.

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