Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
A Survey of Artificial Intelligence Solutions in Response to the COVID-19 Pandemic in Saudi Arabia

Jailan Aljizawi*, Dina Dalloul*, Layal Ghryani*, Shaymaa AlDabbagh*, Tayeb Brahimi**

*Computer Science Department, College of Engineering, Efiat University Jeddah, Saudi Arabia
**Energy and Technology Research Center, Natural Science, Mathematics and Technology Unit, College of Engineering, Efiat University Jeddah, Saudi Arabia

Keywords: Artificial Intelligence, COVID-19, Pandemic

Abstract

Artificial Intelligence (AI) has a significant impact on the course of the COVID-19 pandemic from various aspects. This paper aims to explore the trends of AI applications and how they help predict and prevent the progress of COVID-19 in Saudi Arabia. The method used in this study is based on a narrative review of recent literature on AI and COVID-19 and on a survey conducted on 211 participants. Results show that AI is a crucial element to overcoming COVID 19. The use of COVID-19 related Apps that helped reduce the pandemic spread was more common among the age group participants ranging from 15 - 30. The study concluded that COVID-19 made a positive impact on everyone, and by the use of technology, things got much more comfortable to help in enduring any long-term health consequences.

1. Introduction

COVID-19, also known as the coronavirus, is a highly contagious respiratory virus that infects the cell. Its symptoms may include a shortage of breath, chest pain, regular coughing, and a fever. According to World meter [1], by November 2020, the number of infected people exceeded 50 million worldwide. The first case of COVID-19 reported was in China, Wang, in December 2019; the numbers started to escalate by January 30, 2020. In Saudi Arabia, the first case of COVID-19 was in March 2020; since that date, the daily new cases increased to about 5000 cases by the end of May, then decreased to an average of 400 new cases by the end of October 2020, however total and daily cases have been decreasing over time, Figure 1. As reports of cases have been increasing rapidly worldwide, the World Health Organization (WHO) officially declared the virus's spread as a Public Health Emergency of International Concern [2]. An investigation has taken place to identify the virus and search for immediate solutions [3]. It has been found that the virus is zoonotic, a disease that's transmitted from animals (World Health Organization) [4]. The World Health Organization has instructed guidelines that order individuals across the world follow (World Health Organization) [4]. Preventive measures should be taken to stop the spread of the virus, for instance, social distancing,
wearing masks, and viewing temperatures in public places (local stores, malls, and restaurants) [5]. Countries worldwide are trying to manage the outbreak of the virus to avoid any harm to their citizens. Every country is taking precautions to learn and implement various methods in which to stop the spread. The technical advancements have made a substantial difference in handling a widespread virus by creating a system to properly screen, track, and predict the virus. Artificial Intelligence (AI) is a powerful and innovative tool that is an efficient and effective way to study disease progression [6]. Healthcare organizations integrate Artificial Intelligence into the work environment to reach their full potential and help patients surpass this virus healthily [6]. Moreover, this technology is essential in developing vaccines and cures to help patients [7]. Furthermore, AI is a very complex technology that is designed to work as a human can. The major applications that the AI can do are early detection, contact tracing of individuals, monitoring patients, developing vaccines, and reducing healthcare workers' service [7]. Saudi Arabia took unprecedented steps to contain the virus, including the suspension of Umrah (voluntary Muslim pilgrimage to Makkah), daily and Friday prayers in about 80,000 mosques, public transportation, the temporary closure of all schools and universities across the country, and shut down all workplaces except the essential ones and [8]. In parallel to that, in Saudi Arabia, health institutions have implemented different procedures to tackle the pandemic showing using AI technologies and showing due attention to their safety and welfare. The Ministry of Health ordered the citizens to download applications that are developed by the National Information Center such as Tatamna, Tawakklna, and Taboud) [9].

This work aims to explore AI applications' trends and how they help slow down or stop the pandemic's progress. The paper is divided as follows: section two explores how AI was integrated into the field and how it managed the virus's progression. In section three, the questionnaire is introduced, including understanding the credibility of the subject at hand by collecting qualitative analysis. The main focus of this study is based on the responses to the questionnaire. Furthermore, the usage of this collected information can enhance the study's credibility by gaining more insight into the respondents' various views. Then section four presents the results and discussion of the survey conducted in this study, the responses, and the graphs of the answers to depict how Saudi citizens view AI. Finally, section five presents a conclusion of the present study.

![Figure 1: COVID-19 total cases, daily cases, and recovered daily cases in Saudi Arabia.](image)

2. Literature Review

2.1 General Overview of COVID-19 and AI application

The world is embroiled in a global health emergency that imposes enormous medical and economic burdens on humanity [10]. This global health emergency, Covid 19, is an infectious disease caused by the most recently discovered coronavirus [11]; coronavirus is a virus type. There are several different types, and several of them cause illness. A newly identified coronavirus, SARS-CoV-2, caused a global respiratory illness pandemic called COVID-19 [12].
As of now, there is no specific treatment for the virus [12]; however, scientists have been trying to rush to find a coronavirus cure, but it's still not fast enough. They mobilize record speed to develop vaccines and effective treatments. The pandemic is moving even faster; however, more than 140 experimental drug and coronavirus vaccines are in development worldwide, most of them are in early stages, including 11 already in clinical trials, according to Informa Pharma Intelligence [13].

In this global health crisis, the medical industry is seeking better approaches to monitor and control the spread of the COVID-19 (Coronavirus) pandemic. AI is one such technology that can efficiently monitor the spread of this virus, recognize high-risk patients, and is useful in tracking this infection in real-time. Mortality risk can also be predicted by an adequate analysis of previous patient records.

AI will help us fight this virus through population monitoring, medical assistance, warning, and infection control recommendations [14].

Well before the world was aware of the threat posed by a coronavirus (COVID-19), artificial intelligence (AI) systems had detected an outbreak of an arbitrary precision of pneumonia in the People's Republic of China (hereafter "China").

As the epidemic has become a global pandemic, as seen in Figure 2, AI tools and technologies could be used to support the initiatives of policymakers, the medical community, and society to manage every stage of the crisis and its aftermath: identification, prevention, response, recovery and accelerate science.

Figure 2: Examples of AI applications at various stages of the COVID-19 crisis

Artificial intelligence helps collect and analyze the data to avoid the spread of the virus; it is an essential tool in other applications as well [14]. (1) Early detection: alerting the authorities as soon as an individual starts to acquire the virus's symptoms will lead to faster healing and less exposure to the surrounding people.Computed tomography (CT), Magnetic resonance imaging (MRI) are types of technologies useful in the medical field to diagnose the individual, resulting in immediate solutions. (2) Monitoring the infected people: studying how the patient is recovering and finding new treatment solutions. (3) Contact tracing of the individuals: the authorities are making its citizens follow preventative measures such as wearing a mask, sanitizing one's hands frequently when going outside the premises of their houses, and downloading on their portable devices the applications such as "Tawakklna" and "Tatman" to monitor one's movements. By doing so, it will help in predicting the future course of the pandemic. (4) Projection of cases: AI is monitoring all individuals, however, focusing on the vulnerable regions such as hospitalized people, nursing homes, etc., and taking measures strictly to maintain and reduce the number of cases. (5) Development of vaccines and drugs: standard testing usually consumes plenty of time and money. Integrating AI into the work field can analyze and develop a vaccine with a shorter time range, which will accelerate the process of finding a treatment with no dangerous side effects. (6) Reducing healthcare workers' service: since the pandemic was such a sudden change, the stress that medical professionals go through is very extreme, which might affect the service output
negatively at a time of need. However, the use of AI resulted in declining the intense pressures of the workload drastically and decreasing the potential challenges faced ahead. (7) Prevention of the virus: Since AI stores updated data daily, it can help find immediate preventive solutions for future pandemic diseases that might be widespread across the world. Because AI had the most influential role in the COVID-19, it can also identify and fight any pandemic or epidemic in the future [15].

Artificial Intelligence is an upcoming and valuable method to detect early coronavirus infections and help track infected patients' conditions. The quality of care and decision-making skills can be substantially approved by designing useful algorithms. AI is useful for the care of infected COVID-19 patients and the careful monitoring of their health. It can monitor the crisis of COVID-19 at various scales, such as medical, molecular, and epidemiological applications. It is also beneficial to promote research on this virus by analyzing the available data. AI will help establish effective treatment regimens, preventive methods, medications, and vaccine development [14].

2.2 Development of AI applications in Saudi Arabia

The first case of COVID-19 in Saudi Arabia was confirmed on March 3, 2020 [16]. Like many other countries around the world, Saudi Arabia has introduced a lockdown of both public and private services in response to the pandemic and has placed national limits on population movements. With the introduction of these stringent mitigation laws, innovations and digital solutions have made it possible to provide critical services [16].

The Kingdom of Saudi Arabia has launched new and updated software to solve the pandemic better. A collection of different applications and enhanced some of the current ones to provide various health services to its citizens. During the Riyadh Global Digital Health Summit, which took place earlier in August, Saudi Minister of Health Dr. Tawfiq Al-Rabiah said that pandemic preparedness and digital health were the main priorities for the Kingdom. That technology was the primary tool in the war against COVID-19. He said that Saudi Arabia "has capitalized on many of its existing digital applications that offer artificial intelligence components to address this pandemic," playing a key role in supporting emergency health management by improving existing response mechanisms.

At the start of the pandemic crisis, the Saudi Ministry of Health (MOH) introduced three new apps: Tetamman (Rest Assured), Tabaud (Social Distancing), and Tawakkalna, in addition to the latest edition of the Sehhaty app [17]. Tetamman electronic application was introduced in April 2020 to strengthen all individuals' commitment to isolation and follow-up. The app enables users to book a COVID-19 appointment, follow-up on outcomes, self-assess their health status, control their isolation time, access reliable educational materials, and more. It has helped promote mass testing plans, including drive-through test stations in 17 cities throughout the Kingdom, attracting more than 2.7 million beneficiaries to date [17].

Tawakkalna, an app created by the National Information Center and launched in April, offered a range of essential services during the enforced lockdown in the Kingdom, which was lifted on May 30, including a jogging permit, emergency medical exit permits, and temporary driving passes [17]. Other additional services were added to the app, including warning status, secure collection, and dependent treatment. This last function enables parents to monitor their children aged 15 or under and monitor them and their places.

The Saudi Authority for Data and Artificial Intelligence [17], in cooperation with the MOH, Tabaud has started to alert people in crowded areas of individuals who have contracted COVID-19 within the last 14 days. Notify users of infected individuals by sending encrypted data to smartphones running the app, use Bluetooth technology to identify nearby smartphones that also operate the app, calculate the distance, and notify users of the need to take precautions [17].

In Saudi Arabia, artificial intelligence could be further explored to combine various data sources during potential outbreaks. Decreasing the number of mobile apps and combining their roles will also increase and encourage their use [16]. As shown in Figure 3, Saudi Arabia's government and private sector developed and introduced approximately 19 applications and websites supporting public health roles and providing health services.

Given the extensive use of various technical platforms by Saudi Arabia during the current pandemic, this learning and sharing experience seems to be continuing. The community's transition to digital solutions will unravel more obstacles and benefits as we continue monitoring and mitigating the epidemic curve. The effect of these changes has yet to be known and examined.
3. Methodology

3.1 Method

Our research has been conducted using publications sourced from Google Scholar, Effat University's library, PubMed, and mainly Scopus, using the keyword of Artificial Intelligence or AI and Coronavirus COVID-19. Scopus was our primary source because of its unique feature of having subject areas, making it easier to access the information we needed depending on the subject we are researching. Figure 4 shows the number of publications from each database used in this study. Since Google scholar includes publications from various sources, including "PMC," "Scopus," "PubMed," "BioRix," "MedRix ArXiv," and many others, it has the highest number of publications (10,500 publications). As shown in Figure 5 Scopus database disturbed their publication on ten different subject areas. Johns Hopkins University Center for Systems Science and Engineering (JHU CCSE)'s database was also used to retrieve data about the total cases, total deaths, full recoveries, daily new cases, daily recovered points and cumulative cases in Saudi Arabia. A survey was also developed as part of this study. The survey was created using google forms and distributed among family members, students, and faculty members in Saudi Arabia via all social media platforms.
3.2 Participants

The survey was sent to 350 participants. However, only 221 participants responded to the survey.

3.3 Questions

The following sections provide the justification for each question on the survey.

**Question 1**
What is your gender?

- Female - أنثى
- Male - ذكر

*Justification: Identifying which sector is more informed about AI and how it helps predict the course of the pandemic.*

**Question 2**
How old are you?

- Under 18 years
- 18-24 years
- 25-34 years
- Above 35

*Justification: Identifying the average ages of those who are more informed about AI and how it helps predict the course of the pandemic.*

**Question 3**
Which Apps did you use during the global pandemic?

- Tawakkalna App
- Tabaud App
- Sehaty

*Justification: Identifying which Applications for various health sectors in Saudi Arabia.*

![Publication Distribution (AI in various aspects of COVID-19)](image-url)

*Figure 5: Distribution of publication on AI from various aspects of COVID-19 from Scopus's database.*
• Mawid
• tataman
• None
• Other

Justification: Seeing which apps have been used most during the pandemic

Question 4
• Were they Useful? Why? هل استفادت منهم ولماذا؟
  • yes, they helped reduce the spread of Covid in the country
  • yes, they helped the community be more organized
  • yes, they served my needs efficiently
  • yes, they served my needs within an appropriate time
  • no, I didn't see a difference
  • no, I didn't use them

Justification: Looking at how these apps helped during the pandemic and proving that people see a difference and that AI is helping fight this pandemic.

Question 5
Do you think that Artificial Intelligence has a significant impact on predicting the outcome of the pandemic? هل تعتقد أن إلكترونيات المعالجة إين ذات دور كبير في تحديد نتائج الأوبئة؟
  o Yes
  o No

Justification: Proving that AI has a significant impact on predicting the outcome of the pandemic.

Question 6
Does Artificial Intelligence make our life easier? هل آلكترونيات المعالجة يجعل حياتنا أسهل؟
  o Yes
  o No

Justification: Proving that AI is helpful every day, not just during the pandemic.

3.4 Ethical Considerations

Ethical considerations have been taken into account, where the participants were informed about the cause of the survey and exactly how the information is being used. The participants had the option of taking the survey. It was not forced upon them in any way possible, and the 221 participants voluntarily filled out the survey. They were also informed that the data would be anonymous and confidential.

4. Results

In the following sections of our study, we will discuss our results obtained through our survey.

4.1 Gender results

Figure 6 shows the number of responses received from the participants. One hundred fifty participants were females and the other 61 were males. According to our survey, there was a significant difference of 42% between the responses (71% were females and 29% were males).
4.2 Age groups of the participants

Figure 7 identifies the average ages of those who are more informed about AI and how it helps predict the pandemic. The most responses were from the age group ranging from 15 to 18, which were 211 responses, which makes up 57% of the answers. The second age group from which we got the most responses was 19 to 30 years old, who make up 36% of the participants. The other age groups make up the rest of the participants in the age groups of 31 to 45 (3% of the participants) and 45+ (4% of the participants).

4.3 Most used applications during the pandemic

Figure 8 shows the five applications that were made during the pandemic. Tawakkalna was the most used application among participants, where it was used by 33% of the participants. 20% used the application Sehhaty. Tabaud was used by 53 of the participants (14%). The other applications, Mawid and Tataman, combined were used by 19% of the participants, and 14% of the participants didn't use any of these applications.
4.4 Were these applications useful? How?

As shown in Figure 9, most of the participants agreed that these applications were helpful in many different ways, and only 18.9% of the participants thought that the apps were not helpful.

![Figure 9: Distribution of ways that these applications helped during the pandemic.](image)

4.5 Does AI help in predicting the course of the pandemic?

As shown in Figure 10, 167 participants agreed that AI has a significant impact on predicting the outcome of this pandemic, and this proves that people are aware of the importance of AI. Only 44 of the participants are not aware of the importance of AI during the pandemic.

![Figure 10: Distribution of whether AI is helping the pandemic.](image)
Figure 8: Distribution of most used apps among the participants during the pandemic.

4.4 Were these applications useful? How?

As shown in Figure 9, most of the participants agreed that these applications were helpful in many different ways, and only 18.9% of the participants thought that the apps were not helpful.

Figure 9: Distribution of ways that these applications helped during the pandemic.

4.5 Does AI help in predicting the course of the pandemic?

As shown in Figure 10, 167 participants agreed that AI has a significant impact on predicting the outcome of this pandemic, and this proves that people are aware of the importance of AI. Only 44 of the participants are not aware of the importance of AI during the pandemic.

Figure 10: Distribution of whether AI is helping the pandemic

4.6 Does AI help in predicting the course of the pandemic?

As shown in Figure 11, 190 participants agreed that AI makes their lives easier in many ways, which proves that people are aware of the importance of AI. Only 21 of the participants believe that AI doesn't make their life easier.

Figure 11: Distribution of whether AI is making our lives easier

5. Discussion

This research conducted a survey that was made to collect the people's opinions on Artificial Intelligence being an extensive service to COVID-19. The study's outcome had shown that Artificial intelligence was a huge success and helped back in the pandemic and still is. Our generation nowadays cannot abstain from "technology"; artificial intelligence made our life, as individuals, much more manageable. Back during the lockdown, technology was mainly used every day for governmental applications to get permission to leave their houses for an urgent case. It had to be approved. First, food applications such as "Hunger Station" was a significant hit, as it gained 137 Million riyals says the article "Megabytes", it made the citizen's life much easier to be at home and everything they wanted was delivered
to them by a click of a button, it claims to serve 3 million users through its network of 15,000 drivers, which also got them to partner up with most wanted restaurants and fast-food restaurants. Nevertheless, Numerous people agreed that Artificial intelligence was why COVID-19 cases were dropping by helping with the people's needs without them gathering around to get their own needs. As the survey shows, most people benefiting from it were Females and were mainly aged between 15-18 and mostly from 19-30 years old. 79.1% believe that it made a significant impact on the COVID-19 case back then, and still is in passing; as for the age, As a direct result, ages 15 to 18 and 19 to 30 were the highest rate of the age group who participated in the Survey, This shows that the Technology friendly generation mainly used those apps, As a generation of ambitious and expansive society, Apps like Hunger station and Tawaklina are primarily a target to those age groups as the elderly people would get everything done by the assistance of their sons or grandchildren. Along with the essential questions, 90% of the participants think that artificial intelligence makes our lives easier, which it does, we revolve around technology, and everything about our lives is about it. Overall, the survey shows a positive correlation between the questions asked and the outcome of the results.

6. Conclusion

This research, along with the survey, had shown a substantial positive impact on the Saudi Arabian Government and citizens; the economic rate of money has risen surprisingly good, and this is because of how everything turned technologically by ordering everything online, which proves the vision of Saudi 2030, which also shows the astonishing development that's happening and is showing that Artificial Intelligence truly changed the lives of countless people, The research is brief and proves to the readers and people interested that this is the generation of technology. Even COVID-19 could not make the people bored at home. Abnormally it got the families more connected and closer.

Acknowledgments

The authors gratefully acknowledge the College of Engineering's support at Effat University, Jeddah, KSA. Special thanks to all students who participated in the survey conducted during this study.

References

[1] Worldometer (2020). Coronavirus Tall Update: Cases & Deaths by Country Wuhan, COVID-19 - Worldmeter [online] Worldmeters.info. Available at: https://www.worldometers.info/coronavirus/
[2] WHO, The World Health Organization. (2020a, January 01). Novel Coronavirus (2019-nCoV) SITUATION REPORT - 1 Retrieved May 13, 2020, from World Health Organization
[3] Bragazzi ;Dai ;Damiani ;Behzadifar ;Martini ;Wu, N. (2020, May). How Big Data and Artificial Intelligence Can Help Better Manage the COVID-19 Pandemic. Retrieved November 17, 2020, from https://pubmed.ncbi.nlm.nih.gov/32370204/
[4] World Health Organization(WHO), .. (2020). COVID-19 Situation Report. Retrieved November 30, 2020, from https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200423-sitrep-94-covid-19.pdf?sfvrsn=b8304bf0_4
[5] WHO, The World Health Organization (2020b, May 18). Overview of public health and social measures in the context of COVID-19.WHO/2019-nCoV/PHSM_Overview/2020.1
[6] Mccall, B. (2020, April 1). COVID-19 and artificial intelligence: Protecting healthcare workers and curbing the spread. Retrieved November 30, 2020, from https://www.thelancet.com/journals/land/Article/PiIs2589-7500%2820%29300546/fulltext
[7] Vaishya, R., Javaid, M., Khan, I. H., & Haleem, A. (2020). Artificial Intelligence (AI) applications for COVID-19 pandemic. Clinical Research & Reviews, 14(4), 337-339. doi:10.1016/j.drrx.2020.04.012
[8] Alerts and Messages. (2019, January 29). Retrieved November 17, 2020, from https://sa.usembassy.gov/u-s-citizen-services/security-and-travel-information/
[9] Saudi Data and Artificial Intelligence Authority,. (2020). Tawakalna Application. Retrieved November 30, 2020, from https://tawakalna.sa/en/index
[10] Wiebers, D., & Feigin, V. (2020, June 04). What the COVID-19 Crisis Is Telling Humanity.
[11] Chen, N., DJ. Nokes, R., ME. Kruijshaar, J., K-H. Yu, A., O. Diekmann, H., R. Pastor-Satorras, A., . . . McCall, B. (1970, January 01). A review of mathematical modeling, artificial intelligence and datasets used in the study, prediction and management of COVID-19. Retrieved November 17, 2020, from https://link.springer.com/article/10.1007/s10489-020-01770-9
[12] Sauer, L. (n.d.). What Is Coronavirus? Retrieved November 17, 2020, from https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus
[13] Walker, J., Loftus, P., & Hopkins, J. (2020, April 06). Scientists Rush to Find Coronavirus Cure—but It Still Isn't Fast Enough. Retrieved November 17, 2020, from https://www.wsj.com/articles/inside-the-race-to-find-a-coronavirus-cure-11586189463
[14] Vaishya, R., Javaid, M., Khan, I., & Haleem, A. (2020, April 14). Artificial Intelligence (AI) applications for COVID-19 pandemic. Retrieved November 17, 2020, from https://www.sciencedirect.com/science/article/pii/S1871402120300771
Acknowledgments

This research, along with the survey, had shown a substantial positive impact on the Saudi Arabian Government. Using artificial intelligence to help combat COVID-19. (n.d.). Retrieved November 17, 2020, from https://www.oecd.org/coronavirus/policy-responses/using-artificial-intelligence-to-help-combat-covid-19-ae4e5c21/

15. Nguyen, T. (2020, April). Artificial Intelligence in the Battle against Coronavirus (COVID-19): A Survey and Future Research Directions. Retrieved November,2020, from https://www.researchgate.net/profile/Thanh_Nguyen372/publication/340487417_Artificial_Intelligence_in_the_Battle_against_Coronavirus_COVID-19_A_Survey_and_Future_Research_Directions/links/5f6e9e89299bf1b53ef4347/Artificial-Intelligence-in-the-Battle-against-Coronavirus-COVID-19-A-Survey-and-Future-Research-Directions.pdf

16. Hassounah, M., Raheel, H., & Alhefzi, M. (2020, September). Digital Response During the COVID-19 Pandemic in Saudi Arabia. Retrieved November 22, 2020, from https://www.researchgate.net/publication/344127616_Digital_Response_During_the_COVID-19_Pandemic_in_Saudi_Arabia

17. Obaid, R. (2020, September 23). The apps that helped keep Saudis safe from COVID-19. Retrieved November 17, 2020, from https://www.arabnews.com/node/1738016/media

18. Overview of Public Health and Social Measures in the context of COVID-19. (n.d.). Retrieved November 17, 2020, from https://www.who.int/publications/i/item/overview-of-public-health-and-social-measures-in-the-context-of-covid-19

19. Bathallath, J. Brahimi, T. (2020). Stress, Anxiety, and Depression Among Students and Employees During the Pandemic: a View from the KSA. Under Press, Routledge Education Book, Taylor & Francis Group, November 2020.

20. Coronavirus. (n.d.). Retrieved November 17, 2020, from https://www.who.int/health-topics/coronavirus

21. Novel Coronavirus (2019-nCoV) - WHO. (n.d.). Retrieved November 17, 2020, from https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019-ncov.pdf?sfvrsn

22. Ministry of Health, .. (2020). Tetamman Application. Retrieved November 30, 2020, from https://www.moh.gov.sa/en/eServices/Pages/Rest-assured.aspx

23. Mohamadou, Y., Halidou, A., & Kapen, P. T. (2020). A review of mathematical modeling, artificial intelligence and datasets used in the study, prediction and management of COVID-19. Applied Intelligence, 50(11), 3913-3925. doi:10.1007/s10489-020-01770-9

24. Using artificial intelligence to help combat COVID-19. (n.d.). Retrieved November 17, 2020, from https://www.oecd.org/coronavirus/policy-responses/using-artificial-intelligence-to-help-combat-covid-19-ae4e5c21/