A COVID-19 Hub for Zimbabwe

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Key Words: Zimbabwe, Coronavirus (COVID-19), Data, Information, ArcGIS, Information Communication Technology (ICT)

SUMMARY

Like the rest of the world, Zimbabwe has been suffering from the effects and conditions associated with the Coronavirus (COVID-19) pandemic since March 2020. Throughout this period, citizens require information, knowledge, and understanding about the virus including the measures that have been implemented by the government in the fight against the pandemic. Decision-makers need data analytics to make informed decisions on policies and moreover, tech persons also require resources that can assist them in building solutions in the fight against the pandemic in this technology era.

The *COVID-19 Hub for Zimbabwe* house's location-based, informative, raw data and analytical resources that help the citizens, decision-makers, and persons in the technical fields to fight against this deadly virus which has claimed more lives over the past year. Citizens can also easily find resources using location intelligent applications contained within the hub (i.e., Vaccine Finders and COVID-19 Testing Centres). The solutions include dashboards, raw datasets, and visual informative tools for the republic of Zimbabwe. Moreover, through the ArcGIS API, we have managed to share external integration which leverages our data and resources into other innovative solutions by the Youth in Zimbabwe to promote and use Information Communication Technology (ICT) in the fight against COVID-19.

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MAIN

Like every other country in the world, Zimbabwe has not been spared from the global Coronavirus pandemic. As of 12 January 2022, the country has recorded a total of 224,433 confirmed cases of SARS-CoV-2, the virus that causes COVID-19 (*Coronavirus*, no date). In addition, a total of 3,207,302 citizens including foreign nationals had also been fully vaccinated against this deadly virus marking 21.09% of the population that is immune.

The government of Zimbabwe has also adhered to strict measures recommended by the World Health Organization (WHO) to curb the spread of COVID-19. Some of these recommendations include the compulsory wearing of face masks, social distancing, and minimizing travel among others (*Advice for the public on COVID-19 – World Health Organization*, no date). The coming of the vaccines has played a major role in the reopening of the economy allowing businesses to operate but still under strict protocols following the statutes that have been put into place.

To help the nation, move forward and plan, we need to rely on past and present data to make the best decisions for humanity. The COVID-19 Hub for Zimbabwe provides up-to-date data on the COVID-19 situation in Zimbabwe. Not only does the platform provide data for analysis, but it also provides a set of tools and applications that are being used by the public.

The data contained is constantly maintained and updated daily based on the official updates provided by the Ministry of Health and Child Care through their Twitter handle and other official communication channels (*Ministry of HealthZW (@MoHCCZim) / Twitter*, no date).

Multiple sources of data focusing on the COVID-19 pandemic exist over the internet, where dashboards are reporting the daily increase and progression including tracking and monitoring of the vaccine roll-out initiatives to achieve world herd immunity (Dong, Du and Gardner, 2020) (*A global database of COVID-19 vaccinations | Nature Human Behaviour*, no date). A more strategic approach that does not generalize the situation is however required to solve a nation's problem. In this case, Zimbabwe-specific data is available on the COVID-19 Hub for the Zimbabwe platform.

Our data has been tracking the progression and trends since the first case was recorded in the country on the 23 of March 2020 (*Coronavirus COVID-19 in Zimbabwe*, 2021). The platform also provided location-dependent applications and tools that help the public understand what is going on and where to find resources for their health and safety. As the need for reliable, authentic, and correct information is of importance throughout a pandemic, our platform also

caters to those needs by curating information from verified sources (Bernardino and Bacelar Nicolau, 2020).

Essential geolocation tools like the vaccine finder and COVID-19 testing center finder which resides within the platform have also contributed to assisting the public in easily finding, planning, and navigating to the closest health center for vaccination and PCR testing. In the early stages of the vaccine rollout program, only a limited number of facilities were provisioned to offer a dose of the vaccine hence providing challenges and doubts as to whether the vaccine would be available at their closest facility.

With the world finally realizing the important role of data in policymaking and development strategies, the COVID-19 Hub for Zimbabwe is also supporting scientists, analysts, and policymakers in the country in this process (*Data and Covid-19: Navigating Barriers to Data-based Policy-making*, no date). We have also provided developer documentation that helps promote innovation during these times. Technically skilled persons, especially the youth, are leveraging this data to develop solutions that combat COVID-19 at the lowest levels (community) taking a bottom-up approach until the whole nation is reached.

Our COVID-19 dataset is currently being used by journalists, media houses, policymakers, developers, and the public. Media houses like Pindula have included our infections dashboard on their COVID-19 updates page (https://news.pindula.co.zw/coronavirus/) to spread awareness and information on the status of the situation. The Ministry of Health and Child Care of Zimbabwe (MoHCC) also utilizes our digitized data for their coronavirus dashboard (http://pillars.mohcc.org.zw:2020/covid19-pillars/).

Local businesses in Zimbabwe are utilizing this data for business operations as they plan on managing their staff for effective business production during such a time. By knowing where the current surge is and is most likely to occur, businesses, individuals, and government institutions can plan.

The COVID-19 Hub for Zimbabwe also carries a set of applications that promote citizen participation and engagement in the making and management of policies in the country. One such application which is based on geographic data is the vaccine experience survey application. By asking the public a series of questions on the vaccination process in the country, policymakers and analysts can recommend the next course of action to improve outreach strategies towards achieving the required herd immunity of at least 70% (Iyaniwura *et al.*, 2021). This will also ensure the protection of the most vulnerable and non-eligible members of the community (‘Herd immunity’, no date).

The data dashboards that present a visual explanation of the pandemic have been the public’s main attraction and interest, as visually displayed information is critical in times of crisis to assist the public to better understand and make sense of the situation (Delicado and Rowland, 2021).

RESULTS

Provincial coverage of fully vaccinated people

All provinces in Zimbabwe have adopted the vaccination campaign and drive towards achieving herd immunity. As of 12 January 2022, Zimbabwe had a cumulative total of 4,183,395 people who have

received the first dose of the COVID-19 vaccines available in the country and at least 3,207,309 have received both doses. Additionally, 18,763 have received booster shots in protection against the emerging variants of the virus. This entails that 21.09% of the population have been fully vaccinated, while 27.51% have received a single dose. The booster shots have only covered 0.58% of the fully vaccinated population.

Fig.1 shows the percentage distribution of the fully vaccinated population in every province in Zimbabwe as of 12 January 2022.

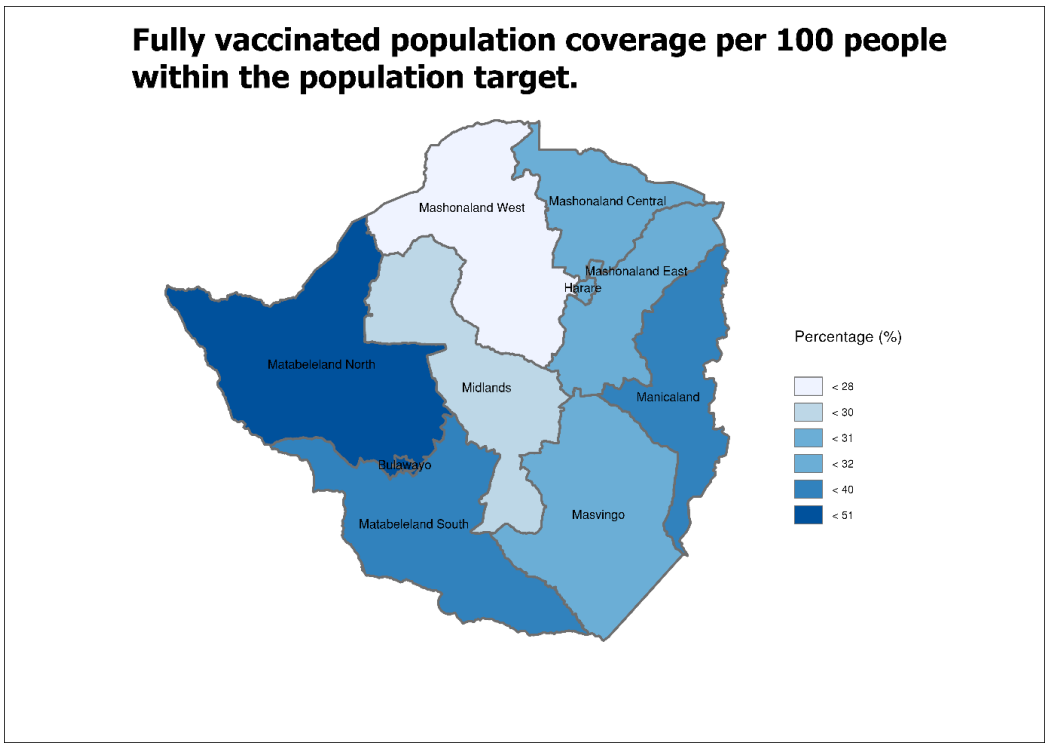

Figure 1

All provinces have coverage less than 51% that have been fully vaccinated whereas Matabeleland North province has the most coverage within the country. Mashonaland West province, however, has the lowest coverage of fully vaccinated people within the country. Masvingo, Harare, Mashonaland Central, and Mashonaland East have fairly and almost equal coverage of the fully vaccinated target population.

Trend variation over time

With the different surges and occurrences of different variants of COVID-19 in the world, Zimbabwe has also experienced peak times where there are more confirmed and reported cases than other days.

Fig. 2 shows the different peeks experienced in Zimbabwe to date.

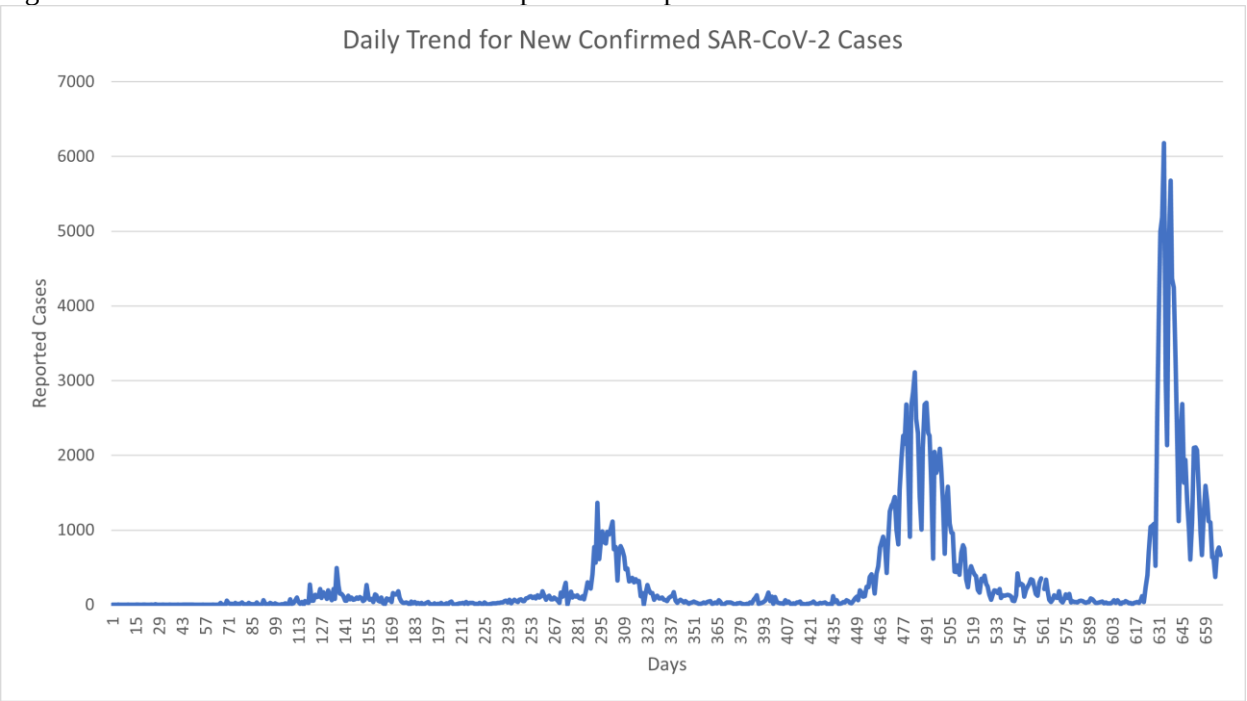

Figure 2

The peeks for the different COVID-19 variants Alpha, Beta, Delta, and Omicron are seen to begin their surge at days 99, 253, 435, and 617 respectively. With each coming of every variant, the total number of people infected daily increases. To date, the Omicron variant has the most reported daily cases in Zimbabwe.

Most of the vaccine dose is increased during peak times of the pandemic as can be shown in Fig.3.

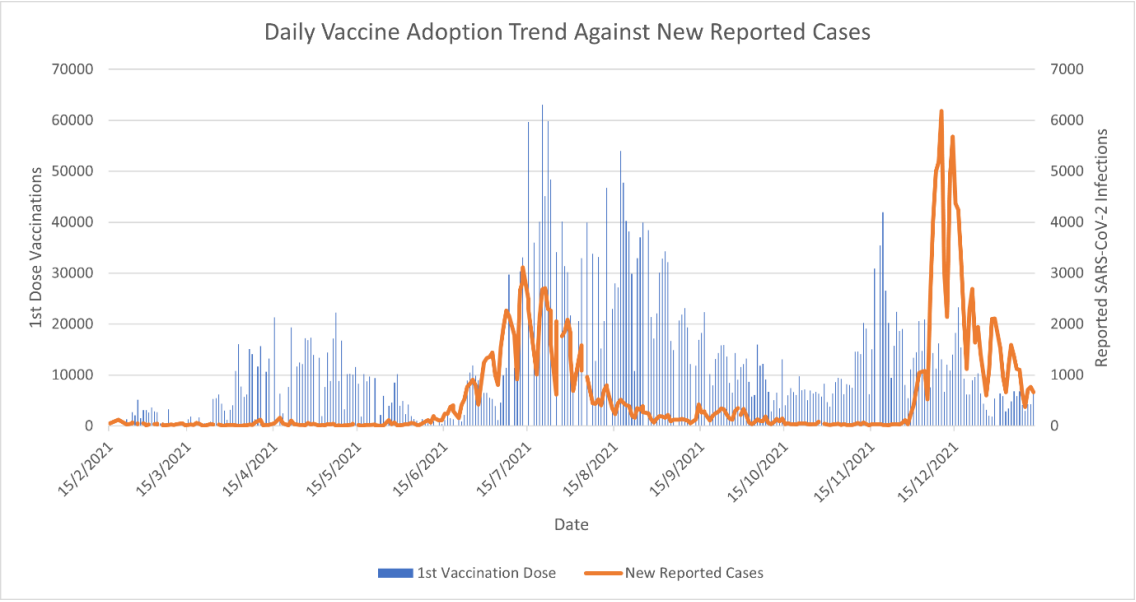

Figure 3

Fig.3. shows the daily increase in confirmed cases and the vaccine uptake since the first dose of the SARS-CoV-2 vaccine was administered in the country on the 18th of February 2021. This also shows a slow uptake during the early initiation days of the process in the country.

Public Participation

Through the My Vaccine Experience survey, a sample size of 118 responses was used to compare waiting times across the country based on the population that had been vaccinated. Fig. 4 shows that most people had to wait between forty minutes to an hour to receive a shot of the vaccine.

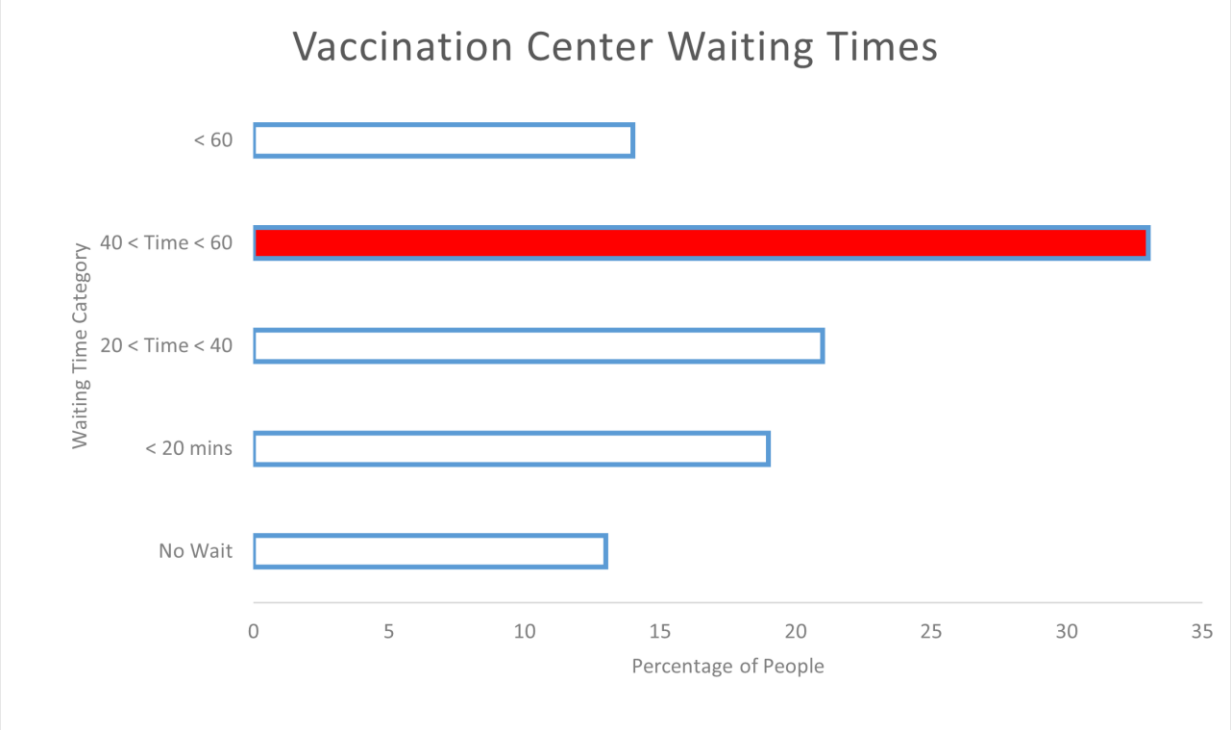

Figure 4

A small portion of people does not have to wait at all. The locations of the vaccination centers with the most waiting times can be observed in figure 5.

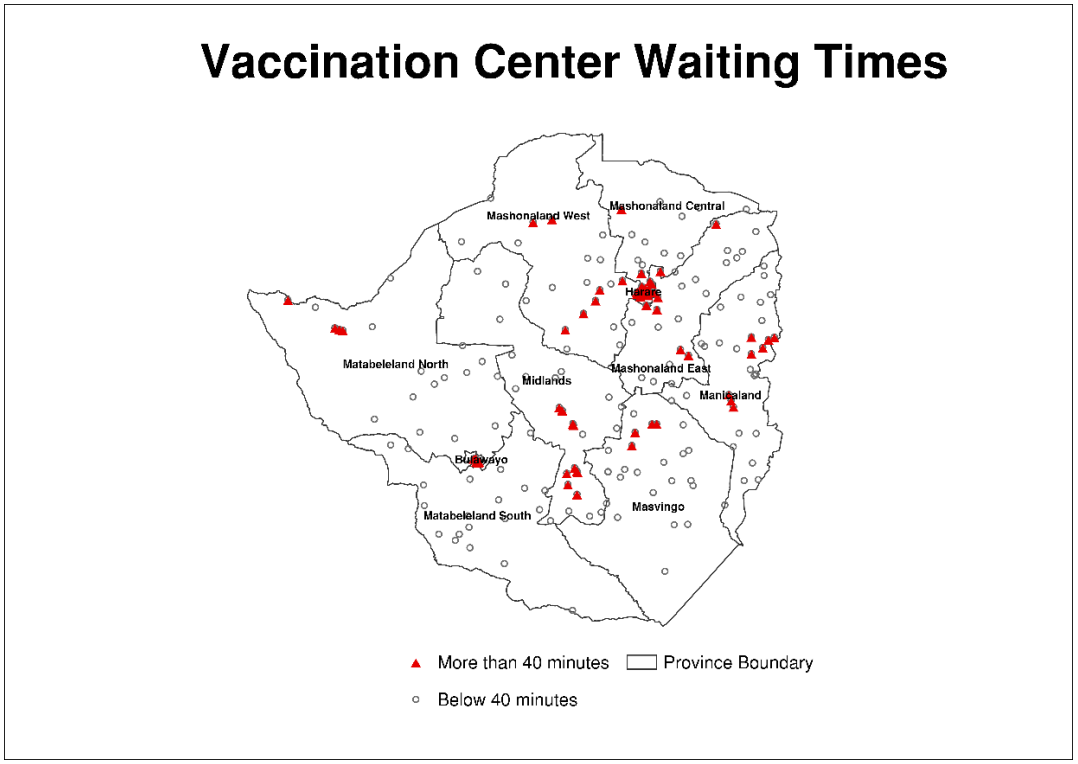

Figure 5

Harare Province, where the most population resides, has the longest duration of waiting times in the country followed by Bulawayo which also has a high population. Matabeleland South did not record any responses of people that have experienced any long duration of waiting times while Masvingo, Matabeleland North, and Mashonaland Central have a few facilities that have recorded waiting times exceeding forty minutes.

Geolocation and Navigation Apps

The public has been provided with navigation tools such as the vaccine and testing center finder which provide locations and directions to the nearest vaccination or testing centers based on the user's choosing. Fig. 6 displays a response rendered by a user looking for a vaccination center closest to them.

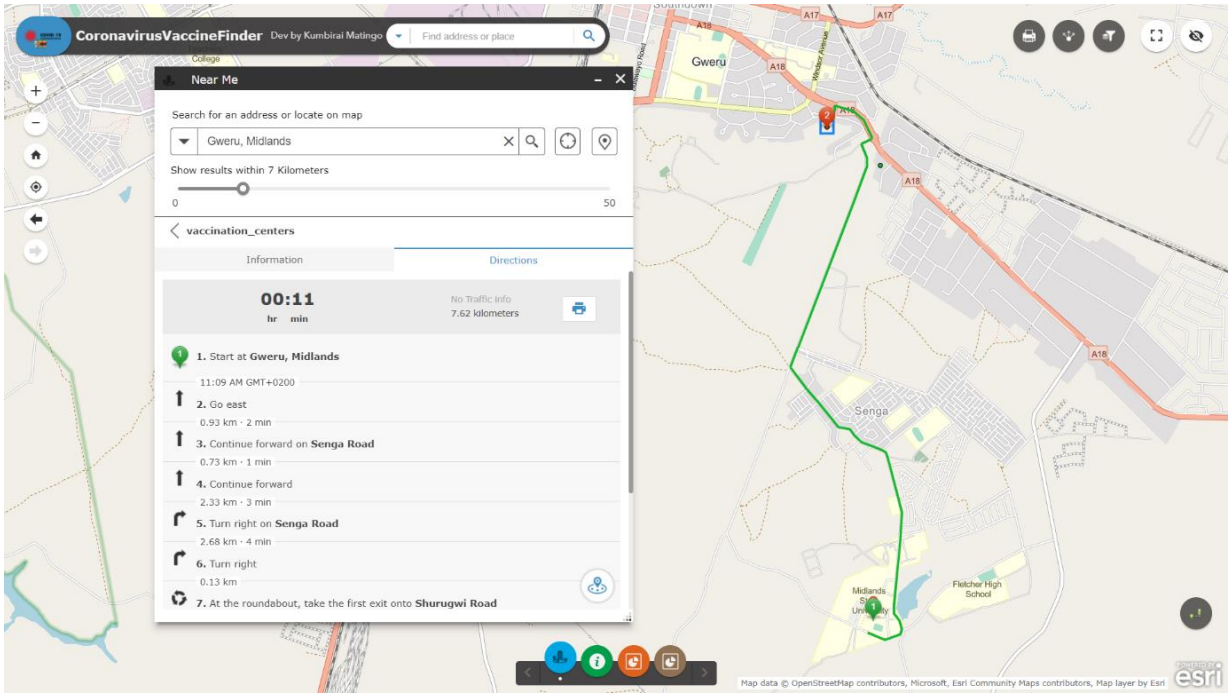

Figure 6

The application which is connected to the COVID-19 Hub for Zimbabwe provides the users with additional options to print their destination maps and search for centers in other different locations. The user can either choose to have their current location as the starting point or a different location within Zimbabwe thereby also specifying the amount of distance in kilometers as their search radius.

DISCUSSION

The COVID-19 pandemic came at a time when most developing countries like Zimbabwe and the rest of the world were not prepared. Roberts et al suggest that the virus emerged in China in early October and mid-November 2019 and developed into a global pandemic in the early days of 2020 (Roberts, Rossman and Jarić, 2021). Zimbabwe then later on recorded its first case of the Coronavirus on the 20th of March 2020 (*Zimbabwe records first coronavirus case | Africanews*, no date). By the time the first case was recorded, the nation was already in lockdown as a preventive measure to curb the potential spread.

The lockdown however did not stop SARS-CoV-2 from entering the country through returnees who were fleeing from different countries (Murewanhema *et al.*, 2020). As can be seen in fig.2 the first wave of the virus consisted of cases below the daily margin of 500. The induced lockdown which lasted for months worked in the nation's best interest. However, as new variants started coming in, this wasn't the case anymore as the daily cases begin to rise with each variant.

During these times of need and panic, our COVID-19 Hub which began operating a week after the first case was discovered provided data, information, and location support to the nation. The coronavirus was unforeseen and was a new disease while most citizens needed answers to understand the situation developing each day. Through the data dashboards located in the Hub, people could understand, track, and monitor the development of the situation at the same time have answers to their questions in a visual manner.

The rapid development of effective vaccines against SARS-CoV-2 was a huge achievement in 2020 for the medical industry (*A global database of COVID-19 vaccinations | Nature Human Behaviour*, no date). Zimbabwe was fortunate enough to receive doses of the vaccine in February 2021 setting the pace for the vaccination drive in the country which began on the 15 of February in the same month. The initial uptake of the vaccine was slow during the early stages and was later sped up by the increase in daily new cases as indicated in Fig. 3. The increase in the vaccine uptake during times when infections are on the increase also suggests increased efforts by relevant authorities to speed up the process to achieve herd immunity while the public responds positively to the call during such times.

To support these efforts, the COVID-19 Hub for Zimbabwe houses the Find A Vaccine location-based tool which helps anyone in Zimbabwe to easily find the quickest vaccination sites which are closest to them. Fig. 6. Displays the frontend interface to the tool. In addition to providing the location of centers, the Find a Vaccine application also provides the user with the best route to their intended destination while also providing an option for printing out the directions map for sharing or offline navigation.

While the vaccination efforts were increased through the application and different approaches by various organizations and institutes, the Hub provided a means for the users to provide their input as a way of public participation. This voluntarily acquired data is then shared with relevant authorities to conduct analysis and see how different approaches can be used to strengthen the efforts and increase vaccine uptake in line with the herd immunity targets set by the government of Zimbabwe. Fig. 4 suggests that from the sample taken, most people waited longer than 40 minutes for them to get a shot of the vaccine in Zimbabwe. Fig. 5 displays the locations of the centers in which most respondents who spent more than 40 minutes in the queue to get the shot were located. The question now remains to the relevant authorities as to what can be done to reduce the amount of time spent in line waiting for the vaccine. A study in the United States shows that most people preferred not to wait long enough to get inoculated (Eshun-Wilson *et al.*, 2021). Waiting too long inline also has its side effects which could lead to one getting infected with the virus during the process (*Can you get COVID-19 standing in line? How to lower risk*, no date).

Fig.1 displays the result of the vaccination efforts in Zimbabwe as of 12 January 2022. The targets that were set by the Ministry of Health and Child Care of Zimbabwe are dependent on the number of people living in the certain province who are eligible for the COVID-19 vaccine based on the available doses in the country (*Ministry of HealthZW (@MoHCCZim) / Twitter*, no date). Provinces like Matabeleland North have a high coverage per 100 people due to their low population in the province. Much of the population of the country resides in the capital city (Harare) which has an average coverage of fully vaccinated people. More efforts are however required in Mashonaland West to speed up the process and achieve the intended targets set by the Government through its health ministry.

Our dataset and the COVID-19 Hub for Zimbabwe help the nation including policymakers and decision-makers better understand the trends to make the right decision based on the occurring trends from real-time data.

LIMITATIONS

The lowest level contained in the dataset ends at the provincial level whereas the lowest administrative level in Zimbabwe is at the ward level. This leads to the generalization of the occurring trends in every part of the country. Moreover, trend occurrence and highly accurate hotspot analysis are more effective when the data is managed and collected at the household level giving a clearer vision of how the virus is spreading from place to place. The generalization at the provincial level can lead to some bias and inappropriate policies for some regions and divisions within the country.

Another limitation is the data that is received from the Ministry of Health and Child Care of Zimbabwe daily which comes as either PDF or in image format. This data is manually entered into the system daily which could lead to some minor errors thereby deviating from the actual values and statistics if data is left unrevised and unmonitored. Having this data in digital format would pave way for the development of data mining tools that automatically populate the database which feeds multiple systems within the COVID-19 Hub for Zimbabwe.

Lastly, no information is provided from vaccination sites that could help people seeking the vaccination shot to better understand and schedule their visits to the center. Most people get the vaccine in Zimbabwe on the assumption that the center could have fewer people seeking the same service on a particular day due to certain factors.

METHODS

The COVID-19 Hub for Zimbabwe consists of three segments which are the data, the location applications, and the data API. All these segments are delivered under the open-source initiative through the support of different service providers such ESRI and NivaCity (for additional hosting and cloud services).

Data

The data is collected from the daily sitreps provided by the Ministry of Health and Child Care of Zimbabwe and is entered using an ArcGIS Survey123 application. The application then directly feeds into the main database which in this case is a Feature Hosted layer in an ArcGIS Online Organizational account.

The data is then fed into different dashboards developed to display different kinds of information and visualization.

The main data used in the COVID-19 Hub for Zimbabwe consists of the following:

1. Daily Infections Trend

   This data contains the daily trends and statistics recorded for all confirmed infections, recoveries, deaths including hospitalizations within the country.

2. Daily Vaccinations Trend

   Like the infections daily series trend, this dataset contains information about vaccination information and statistical data daily.

3. Provincial Time Series

   This data breaks down all the nation's provinces to record a daily statistic of the number of PCR and Ag tests conducted including several confirmed and reported cases, recoveries, deaths, and the currently active cases.

4. Provincial Cases

   The dataset contains the static value of the situation in every province about the total number of cases, recoveries, deaths and provides the ratio of the population affected by the pandemic in each province.

In efforts to spread the use and discoverability of the data, we have also added it to the African Surveyors Connect GitHub repository (https://github.com/African-Surveyors-Connect/Zimbabwe-COVID-19-Data). The main format of the data is in CSV format.

Location Applications

The location applications rely on both crowdsourced data and available public datasets which also include health facilities in Zimbabwe.

The applications are built leveraging ESRI's ArcGIS Online technology for building web applications that are mobile responsive. All these applications are based on the data curated from official and public sources.

Algorithms such as the closest facility are embedded within the location applications such as the Vaccination Center Finder and COVID-19 Testing Center Finders. This helps the users easily find the shortest path with the minimum cost to travel to and from to get the vaccine shot and also for COVID-19 testing purposes (*Closest facility analysis—ArcMap | Documentation*, no date).

Geocoding is also an essential component that constitutes the location applications found within the COVID-19 Hub for Zimbabwe. These allow for the user's input data to be easily translated into a coordinate about a place and pave way for processes to follow such as the closest facility operations (Powell, no date).

The COVID-19 Hub for Zimbabwe has been hosted online and is freely available to the public (https://covid19.africansurveyors.net/).

Data API

To cater to the need to analyze and build innovative solutions during this period, we provided an access point for the data by leveraging the already existing ArcGIS Python API.

The data (feature layers hosted in ArcGIS Online) were made publicly available for access through the API. Our data varies and contains different metrics in each dataset provided for public usage. These metrics have been defined in our project documentation for developers and scientists (*Home - Zimbabwe COVID-19 Data*, no date). This documentation has been hosted on Read the Docs for easy accessibility to the community (https://zimbabwe-covid-19-data.readthedocs.io/en/latest/).

CODE AVAILABILITY

We have managed to make some of the scripts used in the process open-source. These can also be located in the GitHub repository (https://github.com/African-Surveyors-Connect/Zimbabwe-COVID-19-Data) and are mainly based and dependent on the Python programming language by leveraging the ArcGIS API for Python.

We intend to produce additional tutorials on how users can perform certain tasks and queries with the data.

DECLARATIONS

Acknowledgment

We would like to acknowledge the work being done by the Ministry of Health and Child Care (MoHCC) of Zimbabwe throughout the COVID-19 crisis by providing us with the much-needed data and support for implementing this solution for the nation. I would also to acknowledge my learning institution Midlands State University, for providing the support and guidance throughout the implementation phase and lastly, I would like to thank my parents Mr. and Mrs. Matingo, for their support, motivation, and assistance thus far. We would not have done this without them.

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Conflict of Interest
There is NO competing interest.

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BIOGRAPHY NOTES

A final year student at Midlands State University driven towards the goal to use Geospatial technology to achieve the Sustainable Development Goals by 2030. Kumbirai is a member of the Zimbabwe Institute of Geomatics and serves as the National Point of Contact for Zimbabwe with the Space Generation Advisory Council which is in support of United Nations programme of space applications.

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