

IBM DATA SCIENCE PROFESSIONAL CERTIFICATE

IBM CAPSTONE PROJECT: APPLIED DATA SCIENCE CAPSTONE

COVID-19 Vaccine Distribution in Cape Town,
South Africa



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To everyone that has lost a loved one due to the Covid-19 pandemic

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1. Introduction

This project aims to determine the optimal location for a COVID-19 vaccine storage and distribution site in Cape Town, South Africa.

2. Business Problem

The COVID-19 pandemic of the early 2020s has severely changed the world.

Economies were shut down as countries went into lock down. As the infection rates increased and the number of people dying increased, the race to develop a vaccine was prioritized by governments and researchers.

South Africa, a country of approximately 60 million people, struggled to control the impact of the spreading of the virus and this affected lives and livelihoods. In June 2021, less than 1% of the population has been vaccinated and the procuring and distribution of the vaccine has been slow.

Cape Town is the legislative capital of South Africa, and as the virus has spread the city has been put in various degrees of lockdown. To ensure the safe reopening of the city, herd immunity needs to be reached with citizens getting vaccinated as soon as possible.

It is estimated that the City of Cape Town has a population of about 3 500 000 people and the larger provincial boundary the Western Cape has a population of about 7 000 000 people.

As the Government of South Africa purchases vaccines there needs to-be an optimal vaccination delivery plan that will enable quick and easy delivery of the vaccine to citizens of South Africa. As vaccination sites have been idenfitied, there maybe an

opportunity to use data and machine learning to critically analyze if there is a gap for a new vaccination site or storage centre.

A start-up company wants to investigate the optimal location for a vaccine distribution site, where the vaccines can be stored and then distributed to pharmacies that are with a close distance to the distribution site, furthermore, the company wants to investigate the optimal location to partner with local pharmacies, where theres isnt an existing vaccination site.

Therefore, there are two key business questions to-be answered;

- 1.) Which district in Cape Town is the optimal site to store vaccines?
- 2.) Which district in Cape Town has a shortage of vaccination sites but has pharmacies that could be used as a vaccination site?

3. Target Audience

The primary audience for this research is the said startup company, however, this research will also be of benefit to local and national health administrators, medical insurance companies, pharmacies, healthcare professionals, privately owned medical facilities and general citizens.

4. Data

The data required for the completion of this research is as follows;

1. A list of neighbourhoods in Cape Town, Western Cape, South Africa, this will be scrapped from the following web page:
https://en.wikipedia.org/wiki/List_of_Cape_Town_suburbs

2. A list of the currently approved vaccination sites in Cape Town, Western Cape, South Africa. This will be downloaded from the following web page:
<https://sacoronavirus.co.za/active-vaccination-sites/>
3. Determine the longitudes and latitudes of the neighbourhoods and vaccination site using the Geocoder package.
4. The location of pharmacies with the greater City of Cape Town will be identified using the Foursquare.com data repository.
5. Greater information about the different districts in the City of Cape Town will be identified using data sourced from the Foursquare.com data repository.

5. Methodology

The methodology will follow the methodology best practice which is to first understand the problem, develop ideas to solve the problem, source data, build a solution, review and iterate if necessary.

Data will be sourced that is freely and publicly available. Using Python techniques for web scraping the will be transformed into a pandas dataframe and then manipulated accordingly. We will use the Folium library to plot our data points on an interactive map of Cape Town, and use the SciKit learn package to develop the clustering.

For the purpose of this project, the review and iterations will be covered under sections 7 and 8 of the report namely, the limitations of this research and proposals for further research.

The results will then be analyzed and critiqued logically and any value obtained will be explained.

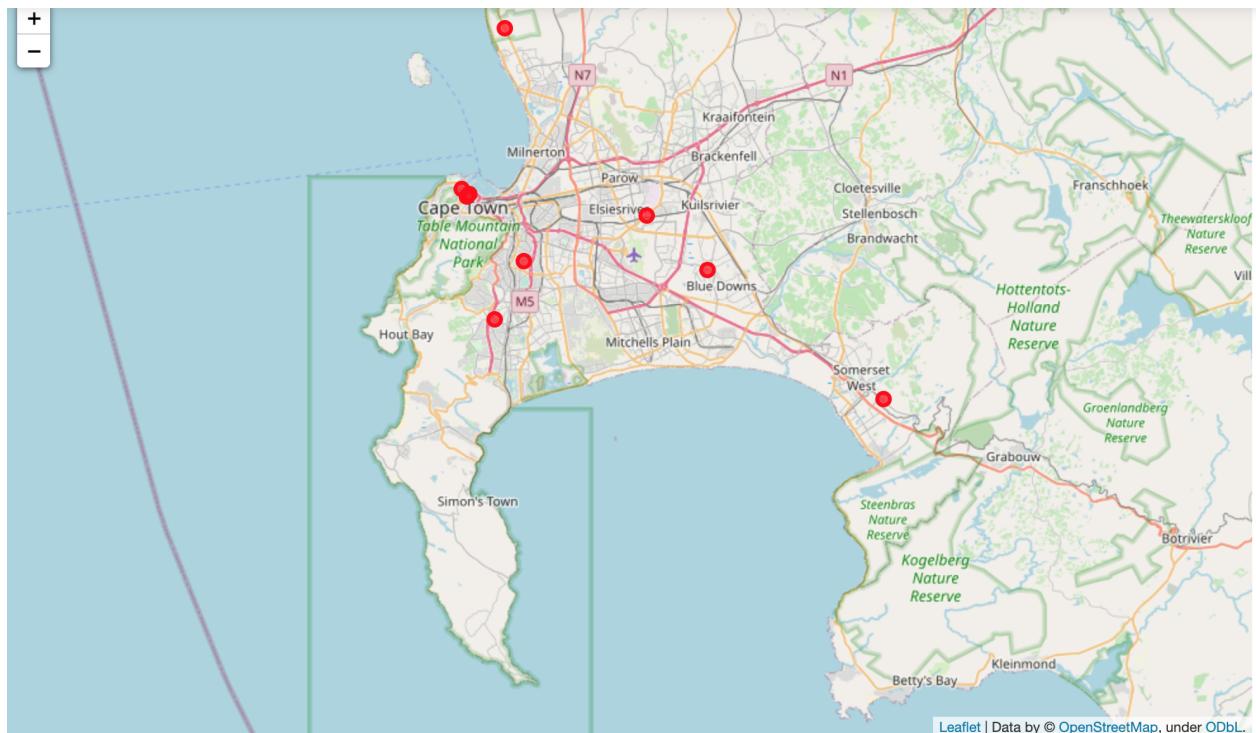
6. Results & Analysis

In this section we will discuss some of the results obtained from the research and the implications thereof.

The City of Cape Town is divided into 8 districts around the Southernmost tip of Africa. These districts are namely;

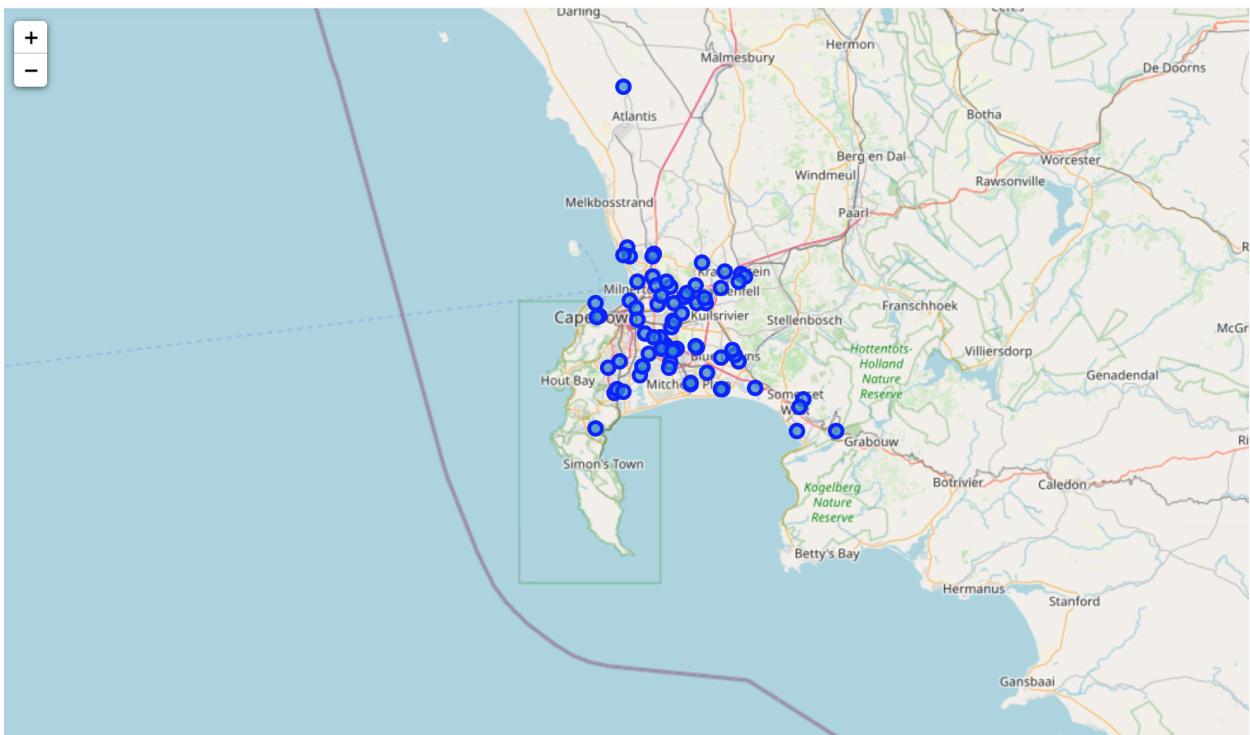
- Atlantic Seaboard
- Blaauwberg
- Southern Suburbs
- Northern Suburbs
- City Centre
- Cape Flats
- Helderberg
- South Peninsula

The central points of this districts can be visualized as follows:

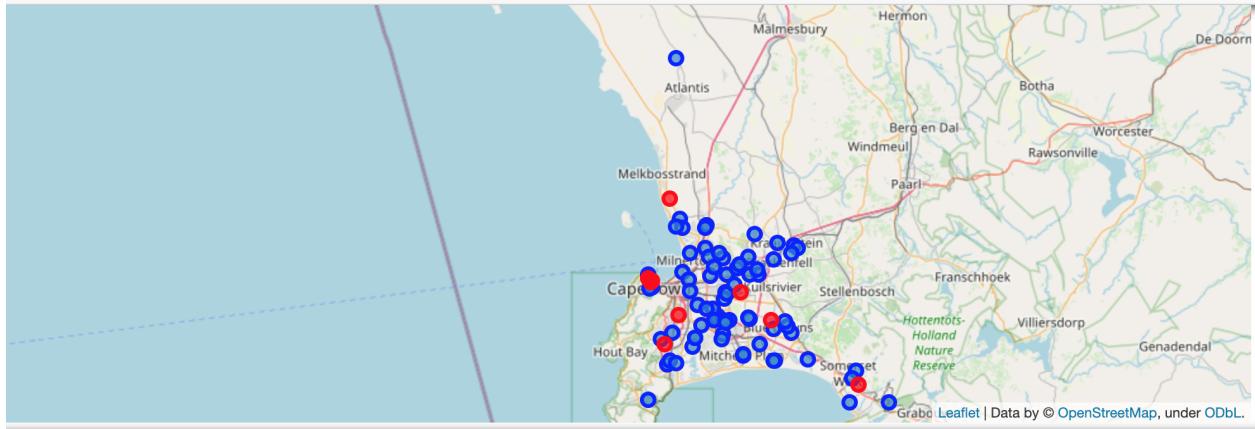


There are currently 74 vaccination sites across the City of Cape Town. These vaccination sites include both private and public vaccination sites. Given that the City of Cape Town has approximately 3 500 000 people, that would mean each vaccination site would need to administer 50 000 vaccinations. By introducing new vaccination sites and new storage and distribution centres, the speed of vaccination can be increased.

We can visualize the distribution of vaccination sites across the City of Cape Town as follows:

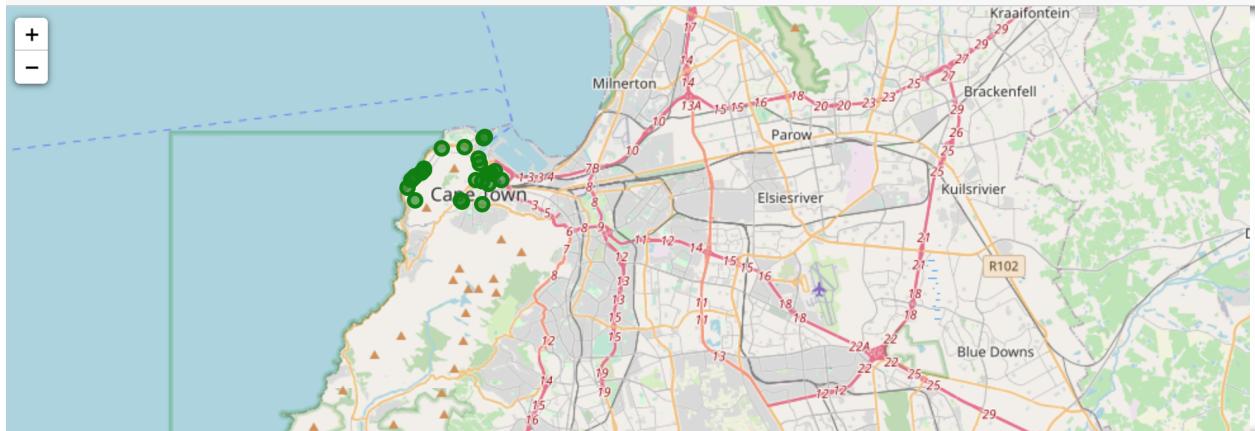


The next stage of analysis is to superimpose the vaccination sites onto the districts. This can be visualized as follows:



What this graphic demonstrates to us is that the vaccination sites are concentrated in the city centre, this means individuals on the outskirts of the city are further from accessing vaccination sites.

The next stage of our study is considering the existing pharmacy network in the City of Cape Town, and if they could potentially be partnered with to become a vaccine distribution site. Using the foursquare.com API, we are able to source the list of pharmacies in Cape Town closest to the City Centre. This is visualized as follows:



It is important to then repeat the process of sourcing pharmacies for the different districts, however the results yield the same results. Upon consulting the foursquare.com website directly and searching for the term “pharmacy” in Cape Town. It appears that the list of pharmacies in the City of Cape Town in the database on Foursquare is limited.

Therefore we need to assess whether or not there are alternatives to using a pharmacy as a partnering venue. To achieve this we will source the top 10 venues per district using the foursquare.com database of locations within a 5000m radius of the centre point of each district.

This will give us an idea of the popular venues in each district.

We normalize the results and obtain the following table.

| Neighborhood | 1st Most Common Venue | 2nd Most Common Venue | 3rd Most Common Venue | 4th Most Common Venue | 5th Most Common Venue | 6th Most Common Venue | 7th Most Common Venue | 8th Most Common Venue | 9th Most Common Venue | 10th Most Common Venue |
|--------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|
| 0 | Atlantic Seaboard | Hotel | Coffee Shop | Café | Park | Italian Restaurant | Theater | Steakhouse | African Restaurant | Gym |
| 1 | Blaauwberg | Café | Seafood Restaurant | Breakfast Spot | Restaurant | Grocery Store | Beach | Burger Joint | Pizza Place | Shopping Mall |
| 2 | Cape Flats | Fast Food Restaurant | Rental Car Location | Airport Lounge | Grocery Store | Breakfast Spot | Coffee Shop | Seafood Restaurant | Gift Shop | Hotel |
| 3 | City Centre | Hotel | Coffee Shop | Café | Steakhouse | Park | Theater | Seafood Restaurant | Brewery | Market |
| 4 | Helderberg | Coffee Shop | Fast Food Restaurant | Convenience Store | Steakhouse | Restaurant | Shopping Mall | Seafood Restaurant | Wine Shop | Italian Restaurant |
| 5 | Northern Suburbs | Convenience Store | Shopping Mall | Train | Steakhouse | Fried Chicken Joint | Arts & Crafts Store | Seafood Restaurant | Train Station | Winery |
| 6 | Seat: Cape Town | Hotel | Coffee Shop | Café | Seafood Restaurant | Park | Steakhouse | Theater | Tapas Restaurant | Hotel Bar |
| 7 | South Peninsula | Restaurant | Coffee Shop | Café | Steakhouse | Vineyard | Breakfast Spot | Fast Food Restaurant | Grocery Store | French Restaurant |
| 8 | Southern Suburbs | Café | Coffee Shop | Pizza Place | Thai Restaurant | Burger Joint | Sushi Restaurant | Bakery | Italian Restaurant | Bar |
| | | | | | | | | | | Athletics & Sports |

From this we can deduce that hotels are popular in the city centre and along the coastal districts. Given that the hospitality industry is suffering from the global impacts on the COVID-19 pandemic, this may be an optimal partner with which to partner as a vaccination site.

Lastly given the concentration of vaccination sites in the city centre, it would be advisable that vaccines are stored in this district as well, so that the cost and time of transportation is minimized.

7. Shortcomings of this research

Although this research maybe valuable as a first attempt to understand where there are potential partner sites for vaccination sites. The problem is far more complex as it also needs to include the national government accessing vaccines from pharmaceutical manufacturers. The

appropriate healthcare workers capable of administering the vaccine in a secure and safe environment. The trust of people in the vaccine and so on.

This research does not address any of these concerns and merely focuses on identifying a site.

8. Further research

Further research should include the cost of running a vaccine site, the appropriate skills and resources needed to run a vaccine site and the optimum amount of vaccines to-be administered daily per site.

9. Conclusion

This research was fairly novel in using applicable machine learning and artificial intelligence techniques to determine the best vaccination sites to open a new vaccine centre in the City of Cape Town. However, much more research is needed to determine if the optimally identified site is the best one for practical purposes.