Locating Potential Coronavirus Vaccination Sites

At Retail Pharmacies Near Public Transit Stations

in Morris County, New Jersey

Chase Kruppo

26 February 2021

The content of this project is hypothetical, and while it addresses a real issue, the premise is fictional and is a work of academic demonstration and not necessarily a real-world solution.

1. Introduction

1.1 Background

In February 2021, the global coronavirus pandemic is still causing major disruptions to daily life and continues to sicken and kill many people. To combat the virus, scientists around the world have been developing vaccines that will prevent new cases of infection.

At this time, there are 2 vaccines approved for use in the United States. They are being distributed by the federal government to the states, and administered by county governments, hospital networks, and more recently, retail pharmacy chains.

1.2 Business problem

Logistics for vaccine distribution have been stymied by miscommunication, slow rollout of each phase of eligible person to be vaccinated, and bringing the vaccine sites online in ways that are accessible to the people who need it most. For those that rely on public transit, just getting to a vaccination site can prove difficult or impossible.

A *hypothetical* request for proposals has been issued by the County of Morris in the State of New Jersey asking for bids to identify the most efficient choice of retail pharmacy locations to administer vaccine that are accessible by public transit.

For this exercise we will consider public transit options through the state agency, NJ Transit. This agency operates trains, light rail, buses, and a ADA paratransit program known as Access Link.

Access Link only picks up or drops off within 3/4 of a mile of a bus or light rail station, so for the purposes of this project, we will **LIMIT** our results to 3/4 miles away from any bus, train, or light rail station.

Train stations have fixed street addresses while bus stations may be roadside with no real street address. Train stations are also listed as physical places on mapping apps like Google Maps and Foursquare whereas bus stations do not have such profiles, often just a street sign or an overhead covering.

Because the array of bus stop data is much larger with greater variability in service, we will focus on rail station data only in this project proposal. If the proposal is accepted, we will expand to include bus stations in the report through geolocating or approximating the bus station data to a street address.

Our firm has been retained to explore the issue, to collect retail pharmacy location data from Foursquare's API, and to use train station data from Foursquare while also considering data from NJ Transit's own developer tools API. As needed, public information on train stations or pharmacies will be considered, with preference for live rather than static data.

For practical purposes, we will only consider the stand-alone locations for the Walgreen's, CVS, and Rite-Aid pharmacies, and disregard the in-store locations such as Walmart and Shoprite grocery stores.

1.3 Interest

In summary, the problem is to find appropriate pharmacies within an appropriate distance to public transit that will serve as vaccination sites.

The Foursquare API has location data for both pharmacies as well as train stations, though we will attempt to pull data from the NJ Transit API as well as sources like Wikipedia to verify or enhance data. One expanded use would be to match pharmacy operating hours with that of nearby public transit schedules, the granularity of bus schedules likely requiring use of the NJ Transit API.

The stakeholders are the county/state governments requesting the proposal, and ultimately the general public, who will be able to use the information to find a vaccination site near them that are accessible by public transit.

2. Data acquisition and cleaning

2.1 Data sources

1. **NJ Transit train stations**
    - **Data source: NJ Transit API - stops.txt - General Transit Feed Specification (GTFS)**
    - **Description:** A .txt list that can be converted into a pandas dataframe and used to identify train stations by name, location coordinates, and a unique train stop code that will be used to identify stations within the target county.

2. **Wikipedia List of Railway Stations in Morris County, NJ**
    - **Data source: Wikipedia**
    - **Description:** A list of railway station stops in Morris County, NJ. This source can be formatted to be compared to the complete list of station data.

3. **US Census County Data - FIPS codes**
    - **Data source: US Census website - State = 34 County = 027**
    - **Description:** A list of railway station stops in Morris County, NJ. This source can be formatted to be compared to the complete list of station data.

4. **Foursquare API**
    - **Data source: Developer Tools portal for Foursquare API**
    - **Description:** A series of venue search calls to the API to yield the specific pharmacies within the set radius of each of the stations (Walgreens, CVS, Rite-AID; 3/4mi (1200m) from each station).

2. 2 Data cleaning

Approach

The approach is to cluster the pharmacies around the train stations, using the specified radius of 1200 meters, roughly 3/4 of a mile, as described in the proposal.

The station data from Wikipedia had to be merged against the current station list from NJ Transit to reduce the list to Morris County stations only. Further, the Wikipedia data includes non-NJ Transit freight and historic non-passenger service station stops. So the data was scrubbed of those non-conforming station types.

Since there are fewer train stations than pharmacies, using the list of stations as a reference to find suitable venues should yield the desired result. i.e. Finding pharmacies near train stations instead of finding train stations near pharmacies.

Using the Census data to map the county, the Foursquare API to pull venue data, and NJ Transit data to map the clusters of pharmacies around the stations. In the future, the actual county map can be layered on top of the output map.

2.3 Feature selection

The goal of the project is to map pharmacy locations within ¾ mile of each train station in Morris County. The only features required location data for the train stations, and location data and venue names for the pharmacies.

Table 1. Simple feature selection during data cleaning.

Kept features	**Dropped features**	**Reason for dropping features**
Wiki: “title”	“pageid”, “ns”	Isolate title, rename to station
NJ Transit: “stop_code”, “stop_name”, “stop_lat”, “stop_lon”	'stop_id', 'stop_desc', 'zone_id'; str(‘LIGHT RAIL’)	Keep only location, name, and unique id code (for future use)
Foursquare: “dataframe_filtered.name”, “dataframe_filtered.lat”, “dataframe_filtered.lng”, “dataframe_filtered.name+" - "+dataframe_filtered.city+", "+dataframe_filtered.state”	Everything else.	Only mapping location, venue name, by category

3. Methodology

3.1 Calculation of target variable

There are 2 variables that we used a number of API calls to the different data sources to derive the desired results.

3.1.1 Train stations

The train stations are the independent variables that needed to be identified and plotted as static centroids by which the API calls would be based. The data is read into the notebook as dataframes and then merged to yield a short list of only train station data within Morris County, NJ.

3.1.1.a Wikipedia

The source of the train stations in Morris County come from the category page “Railway_stations_in_Morris_County,_New_Jersey” and is generated through Wikipedia’s API platform.

3.1.1.b NJ Transit

The source of the train station data comes from the NJ Transit API developer tools platform, not as a request, though as a downloadable .txt file that is updated regularly. It is stored on our github project folder and read into the notebook as a dataframe.

3.1.2 Pharmacies

The pharmacy venue data is generated through individual API calls to Foursquare, and then the output is assigned as dependent variables relative to each of the train station locations. Per the specs of the proposal, only pharmacies within ¾ mile or 1200 meters were considered.

The expansion to all “pharmacies” in the search query was made necessary after limiting the search only the 3 pharmacy chains yielded too few results to make accurate conclusions.

3.2 Relationship between Train Stations and Pharmacies

Because the scope of the business problem is limited to the presence of a pharmacy near an active train station, there were no qualities in the dependent variables that needed to be predicted, tested, or modelled. Either the existence of a pharmacy within ¾ mile of a given station was true, mapping the result, or false, adding no new content to the map.

If the question posed by the business problem sought to identify what qualities of the community around the train station increased or decreased the likelihood of there being a pharmacy near the station, then we could use demographic data to model the result. Further, we could make recommendations on where pharmacies should locate a new business based on lack of access in a given area. This exceeds the scope of the current proposal, though could be expanded in the future to provide the county with better insight as to why, where, and how to develop additional vaccination sites.

4. Results

4.1 Train Stations

The merge of county train station information from Wikipedia with the statewide station data from NJ Transit yielded 11 active NJ Transit train stations.

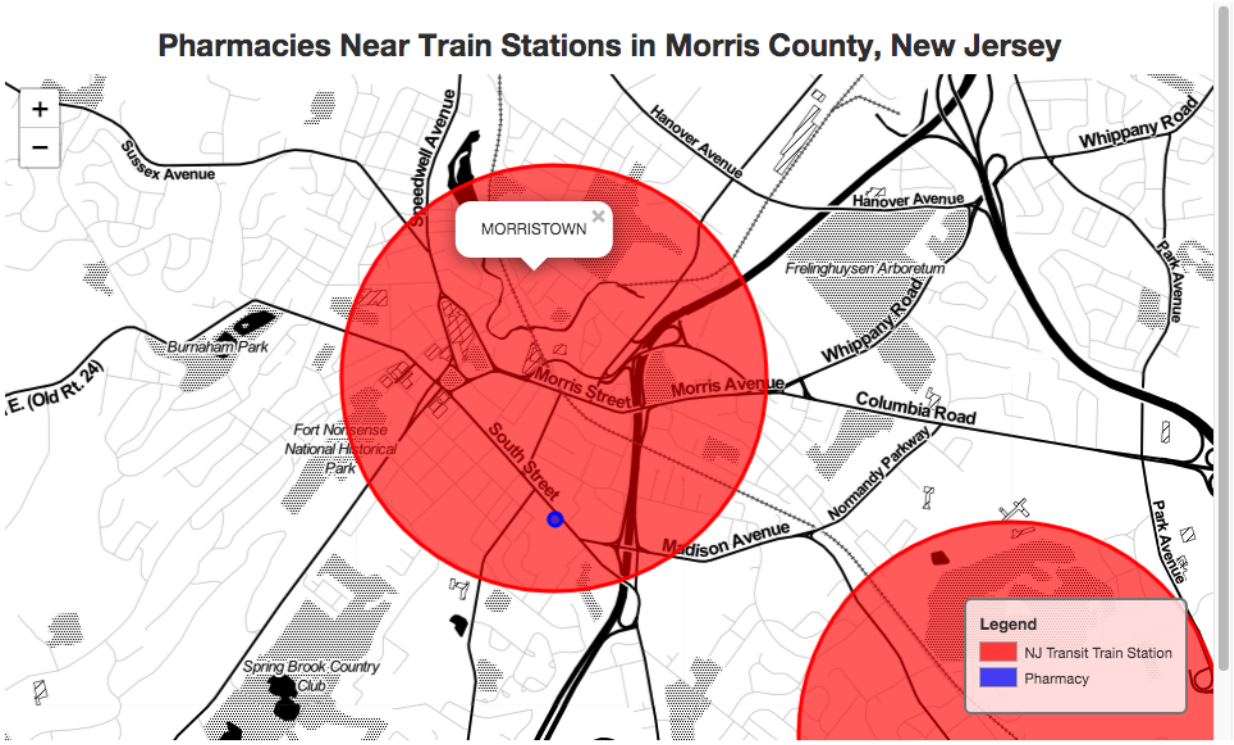

Figure 1. Train stations mapped in red circle with ¾ mi radius.

4.2 Pharmacies

The pharmacy location data was generated through multiple Foursquare API calls, and when plotted, yielded 11 pharmacies in 7 clusters.

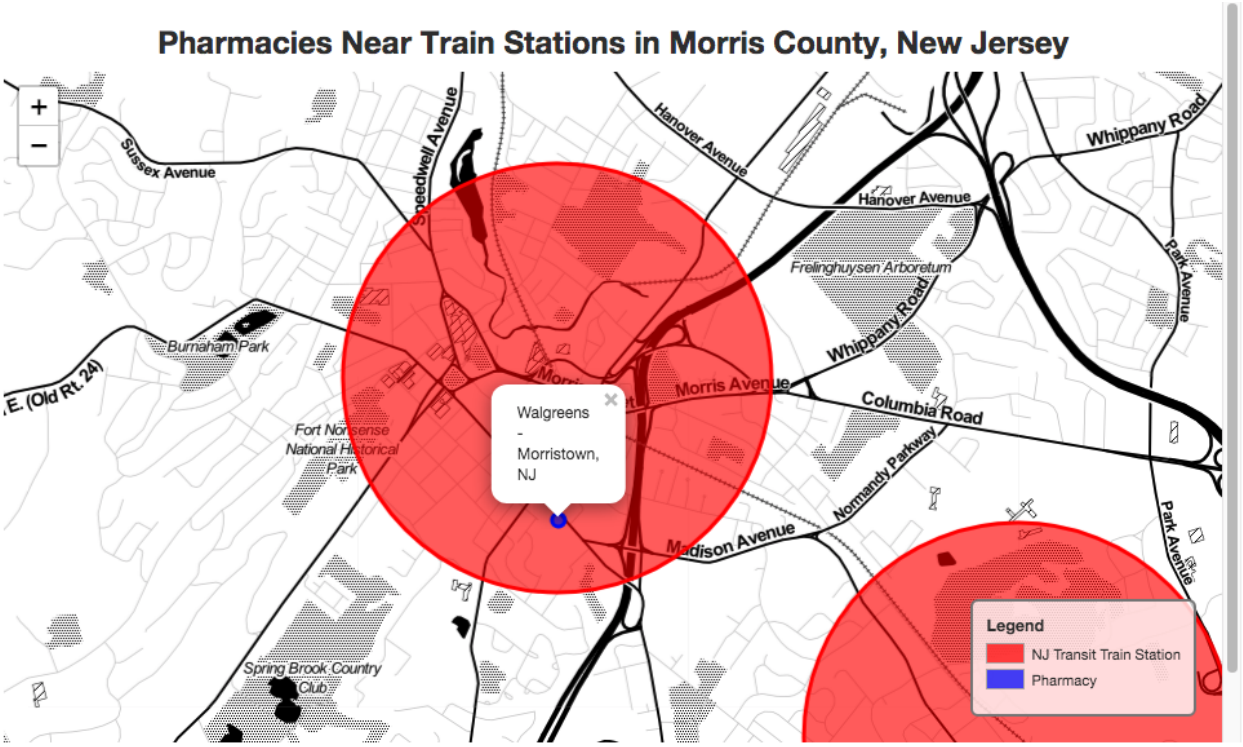

Figure 2. Pharmacy locations mapped in blue, within ¾ mile radius of a nearby train station.

4.3 Vacant clusters

In plotting the data, 3 clusters around the Lake Hopatcong, Millington, and Towaco train stations did not have any pharmacy within ¾ mile. None of these station stops were consecutive. This means that any NJ Transit train passenger in Morris County is at, or within 1 station stop of a pharmacy.

5. Discussion

In summary, our firm was able to produce 7 mapped clusters of 11 retail pharmacy locations within an ADA-compliant distance from 7 out of the 11 public train stations in Morris County, New Jersey, United States. This represents 63% of stations in Morris County.

The data and resulting visual representations show that there isn't sufficient access to coronavirus vaccine sites to individuals relying on ADA-compliant public train options at each of the county's train stations.

Further, in performing the Foursquare API calls, limiting the search to only the 3 indicated retail pharmacies (Walgreens, CVS, Rite Aid) yielded sparse results. Only by expanding the search query to include all pharmacies could a sufficient sample of possible vaccine sites be identified.

To concentrate the search only on the 3 retail pharmacy chains would eliminate potential future sites. It would require 3 API calls for each station. And this feature can be added to enhance discernment of the results. Instead, we highlight the pharmacies identified as suitable sites for future inclusion in vaccination efforts, not just the major chain stores.

The takeaway is that 36% (3) of train stations in Morris County are not within ¾ of a mile of any pharmacy, meaning that those seeking vaccines have to rely on private hire taxis or personal vehicles for transportation to these venues.

Encompassed in our future recommendations are expansion of the project to include other modes of public transit, which may provide additional access by increasing the number of stops.

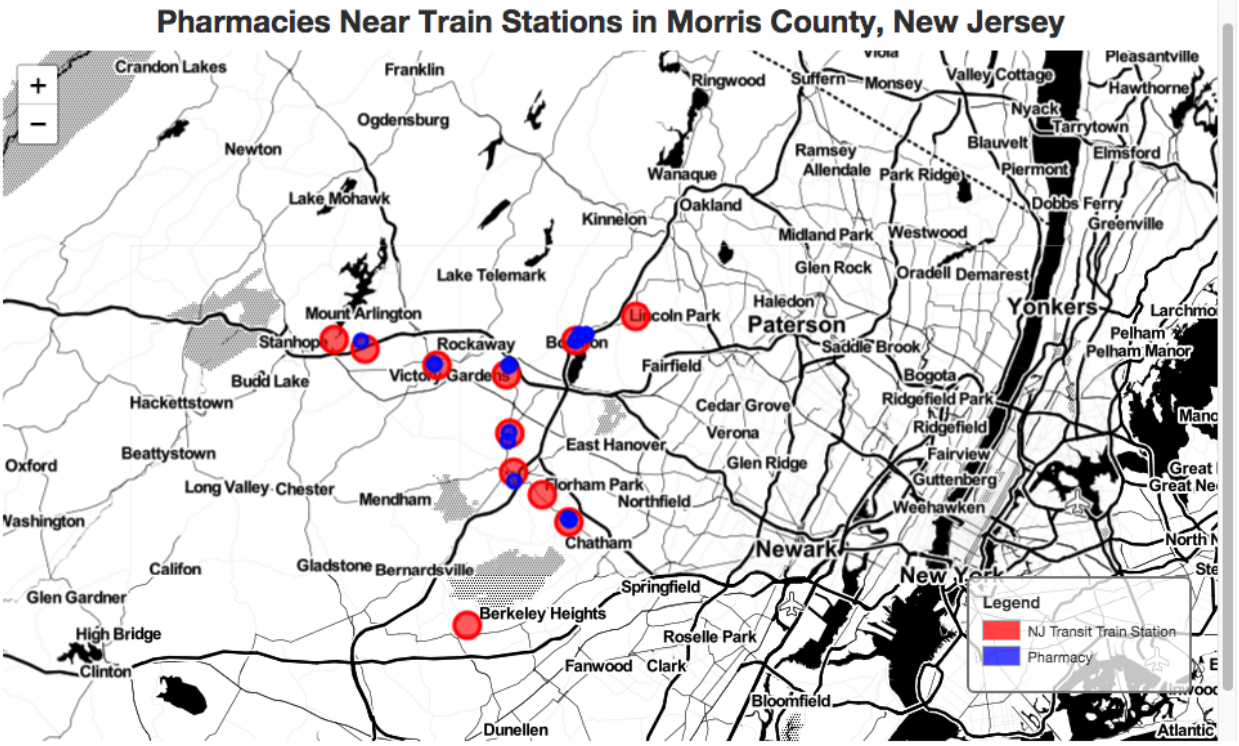

Figure 3. Map of pharmacies near train stations in Morris County, NJ.

6. Conclusions & Future Directions

The key findings are that most train stations are within ADA-compliant distance to a pharmacy that can be an ideal site for a coronavirus vaccination site. What that means is that anyone with access to the NJ Transit stations in Morris County is at or within 1 station stop of a pharmacy.

Based on our conclusions, we are recommending the following changes to improve access to vaccination sites by public transit and expand vaccination efforts to account for those who want a vaccine, though who cannot get to a site from where they live.

- Extending the limit of Access Link ride coverage from the existing 3/4 mile limit - OR -
- Waiving the 3/4 mile Access Link ride limit for the purpose of vaccination
- Waive train fare for the purpose of vaccination
- Coordinating with rideshare apps to waive fares to and from vaccination sites
- Offering in-home vaccination for homebound senior citizens by appointment
- Expanding vaccination sites to include other publically-accessible spaces such as libraries, schools, municipal offices
- Expanding vaccination sites to include population centers that do not have direct public transit access by train, light rail, or bus

Finally, if the proposal is approved, the same approach can be expanded to include bus stops, and further, to the entire state and the pharmacies within close proximity to all train, bus, or light rail station stops.