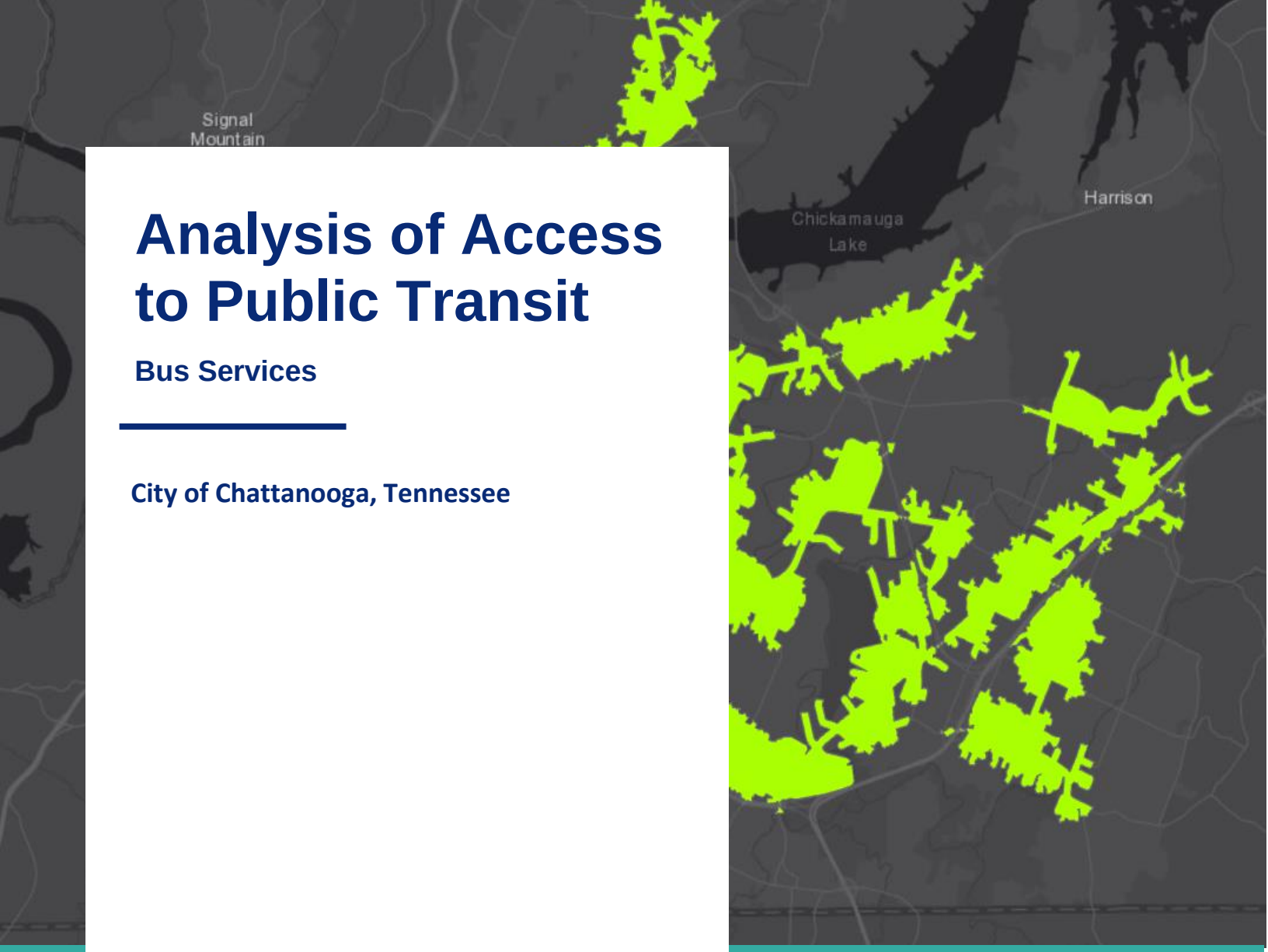

Analysis of Access to Public Transit

Bus Services

City of Chattanooga, Tennessee

NOVEMBER 5

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Project on Assessing Access to Public Transit

The material presented on this project is in the form of project deliverables—a proposal, a process log, and a report. The only deliverable not included is the GIS itself.

Proposal: The Problem and Approach to Solution

Spatial Planning is always connected with a country' development process. It aids to provide a good quality of life to the citizens, creating strategies to achieve more balanced and competitive territories. The mobility and accessibility are the main factors of cohesion, social integration and promotion of competitiveness and economic development.

This report intends to illustrate Geographic Information System tools (GIS) in the planning of public transportation and determine those areas in a city most in need of a new bus line. This article introduces a case-study: The City of Chattanooga, Tennessee in the United States, that is considering adding a new bus route, but they have not yet decided where it is most needed. The challenge is to understand how to map the area served by existing bus stops and compare it with demographic data to assess which part of the city is in greatest need of access to public transit.

Our approach will be to use GIS tool to map existing bus service by mapping service area polygons surrounding each bus stop and then assessing the map for future bus stops by enriching block groups with demographic data and compare to the existing bus service area.

Scope

To map existing bus service, we will be mapping the current bus stops in Chattanooga and the areas of the city that are within a 10-minute walk of these stops. To assess the map for future bus stops, we will map demographics in the city of Chattanooga to assess which areas would benefit the most from expanded bus service.

Sources of Data

Many cities provide their public transit data as a free download, and the most common format for this is General Transit Feed Specification (GTFS, https://developers.google.com/transit/gtfs/). GTFS datasets include information about a transit system's stops, routes, and schedules. Data for the City of Chattanooga can be found on the websites of Transitland and OpenMobilityData for finding GTFS data feeds on Chattanooga Area Regional Transportation Authority (CARTA).

Reference

Asmael, Noor. (2016). Analysis Local Public Transportation Using GIS (Baghdad Case Study). International Research Journal of Engineering and Technology (IRJET). 3.

Process Log:

This section has the list of major steps that we took to complete my project.

Map Existing Bus Service

Sourcing data and plotting current Bus stops is the city of Chattanooga

1. Create bus stop features from GTFS data and went to the Transitland Feed Registry site.
2. On the feed registry, search for Chattanooga and choose Chattanooga Area Regional Transportation Authority (CARTA).
3. On the next page, scroll down. Under Feed Detail, next to URLs, click www.gocarta.org/developers/GTFS.zip.
4. Locate and unzip the downloaded .zip file. The file contains nine text files with information about bus stops, routes, and schedules.
5. Download the Assess Access to Public Transit project package.
6. Locate the downloaded file on your computer. Double-click Assess Access to Public Transit.ppkx to open it in ArcGIS Pro.ArcGIS Pro opens to a map of Chattanooga, Tennessee, in the United States.Next, you'll convert the stops text file from the GTFS dataset into spatial features that you can view and analyze on your map.
7. On the ribbon, on the Analysis tab, in the Geoprocessing group, click Tools.
8. In the Geoprocessing pane, search for and open the GTFS Stops to Features tool.
9. For Input GTFS Stops File, browse to and choose stops.txt in your unzipped GTFS folder.
10. For Output Feature Class, type BusStops and Click Run. Press Ctrl+S to save your map.

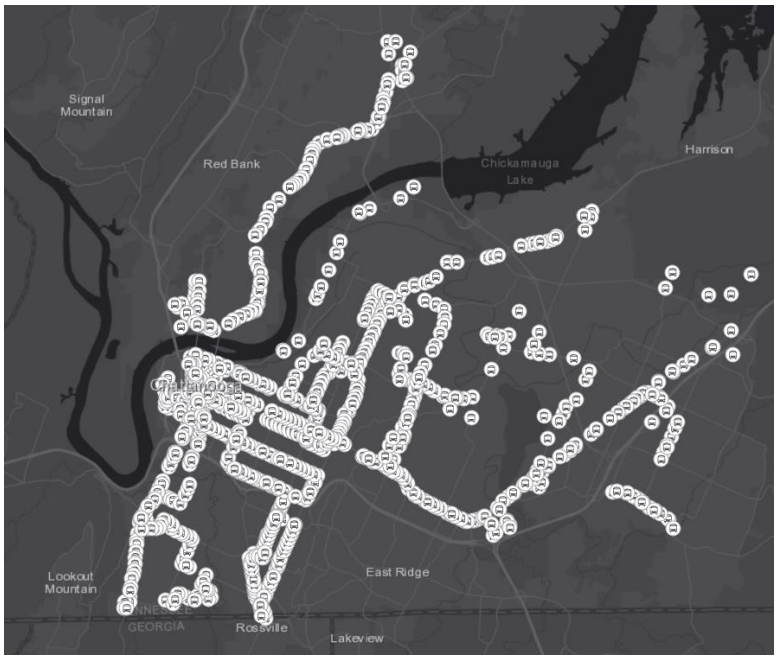

Figure 1: Bus Stops in the City Chattanooga, Tennessee

Generate Service Areas for Bus stops

1. In the Contents pane, turn on the Routing_ND layer. Routing_ND layer in the Contents pane and on the map. Routing_ND is a network dataset modelling the street network in Chattanooga. The features in a network dataset are aware of one another, providing the connectivity required to perform network analysis. You'll use Routing_ND to map service areas around bus stops.
2. Turn off the Routing_ND layer.
3. On the ribbon, on the Analysis tab, in the Tools group, click Network Analysis.
4. Confirm that the active Network Dataset is set to Routing_ND from assess_access_to_public_transit.gdb Routing.
5. On the Network Analysis menu, click Service Area. A new Service Area layer appears in the Contents pane, which contains six sublayers. Currently, all of these layers are empty. Next, you'll populate the Facilities layer with half of your bus stops.
6. In the Contents pane, confirm that Service Area is selected (highlighted in blue).
7. On the ribbon, click the Service Area tab.
8. In the Input Data group, click Import Facilities. The Add Locations tool appears in the Geoprocessing pane.
9. For Input Locations, choose BusStops.
10. Accept all other tool defaults and click Run. The points on the map are duplicated using the symbology of the Facilities layer. Next, you'll request a service area that represents a 10-minute walk time surrounding each of these stops.
11. On the ribbon, on the Service Area tab, change the following parameters in the Travel Settings group:
    i. Set Mode to Walking Time
    ii. Set Direction to Towards Facilities
    iii. Set Cutoffs to 10
12. In the Output Geometry group, change Standard Precision to High Precision. A high precision service area takes longer to generate but is more accurate and recommended for a walking time analysis.
13. Change Overlap to Dissolve. The Dissolve option creates polygons around each bus stop and merges them.
14. On the ribbon, in the Analysis group, click Run. A service area polygon now surrounds each facility (bus stop) point on the map.
15. In the Contents pane, right-click Polygons, point to Data, and choose Export Features. The Geoprocessing pane opens to the Feature Class to Feature Class tool. Input Features is set to Service Area\Polygons and Output Location to assess_access_to_public_transit.gdb.
16. For Output Feature Class, type BusServiceAreas. Feature Class to Feature Class tool with Output Feature Class set to BusServiceAreas
17. Click Run. A copy of the service area polygons is added to your map and to the project's geodatabase, separate from the Service Area data.
18. In the Contents pane, right-click Service Area and choose Remove.

19. Also remove the BusStops layer and the Routing_ND Network Dataset. Dissolved service areas on the map. The BusServiceAreas layer now has a polygon representing areas in the city that are within a 10-minute walk of at least one bus stop.
20. Save the project.

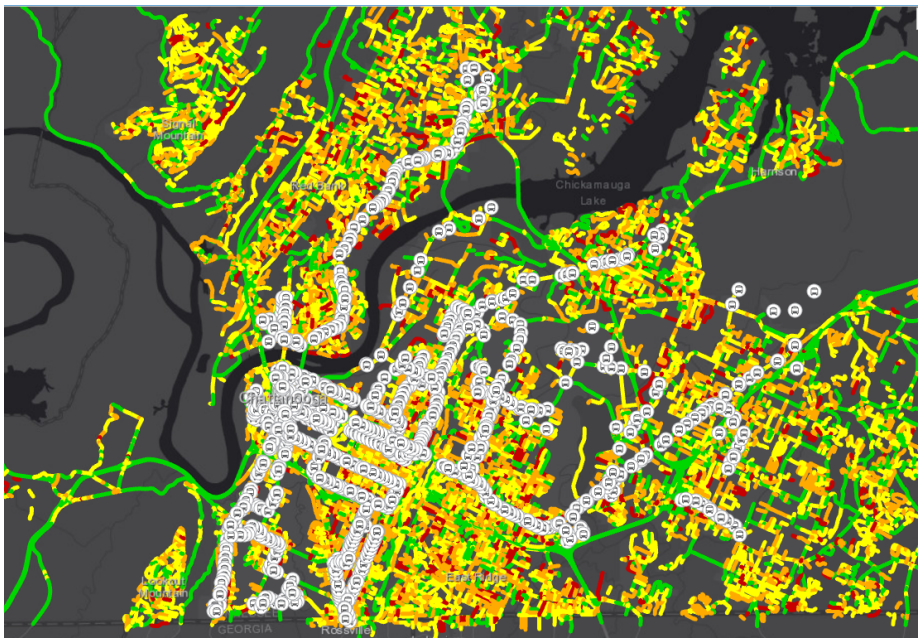

Figure 2: Street Network for the City of Chattanooga, Tennessee

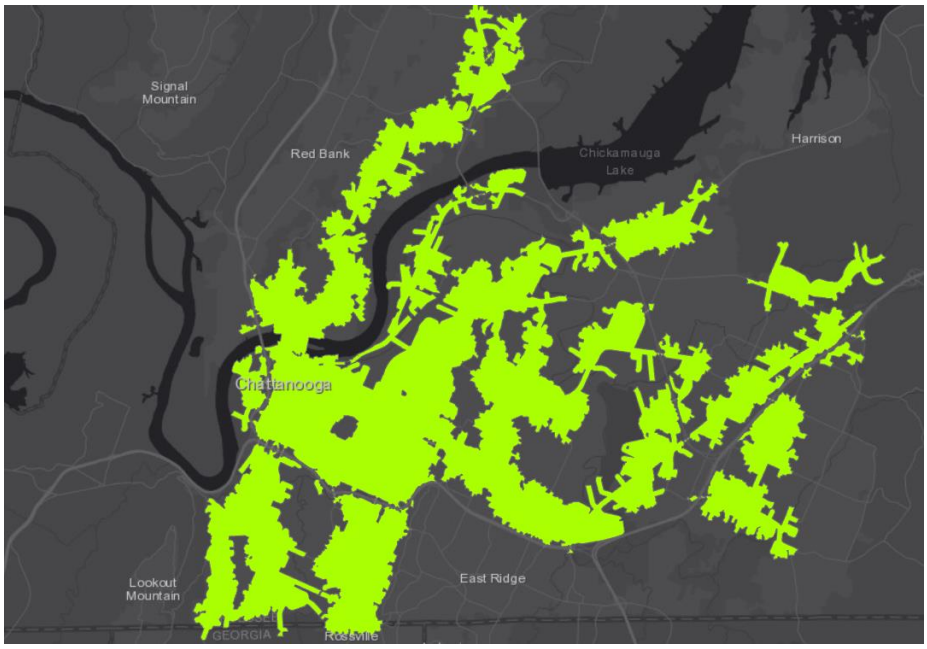

Figure 3: Areas that fall within 10 Mins walking distance of a Bus Station

Assess the Map for Future Bus Stops:

We'll start by adding data for block groups, the second smallest geographic unit used by the United States Census.

1. If necessary, open your project.
2. In the Catalog pane, click the Portal tab and click Living Atlas.
3. Search for USA Block Groups. Right-click the USA Block Groups layer and choose Add To Current Map. Add To Current Map on the context menu of the USA Block Groups web layer. This layer covers the entire United States, which is too large for your needs. You'll filter it to only cover Hamilton County, Tennessee.
4. Click any block group polygon to open its pop-up. The pop-up indicates that the code for Hamilton County is 47065.
5. Close the pop-up.
6. In the Contents pane, right-click USA Block Groups and choose Properties.
7. Click the Definition Query tab and click New definition query.
8. Use the drop-down menus to construct the clause Where County FIPS is equal to 47065.
9. Click Apply and click OK.
10. Zoom out until you can view the entire county. The block groups for Hamilton County appear on the map.

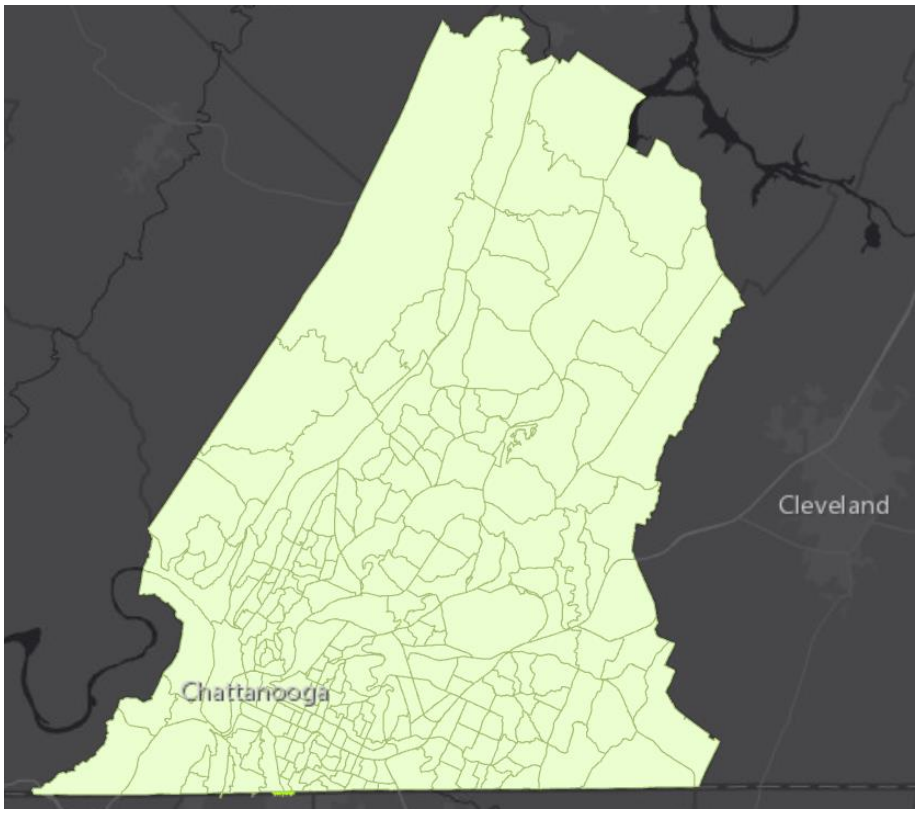

Figure 4: Blocks in the Hamilton County, City of Chattanooga, Tennessee

Adding Demographic Data over the Block Data

Part A

1. Enrich block groups with demographic data. To assess public transit needs, you'll map population density, poverty, and the percentage of people who do not own cars. In the Geoprocessing pane, search for and open the Enrich tool. The Enrich tool adds demographic and landscape information to your geographic data. It consumes 1 credit per 100 variables or features. In the following steps, you'll enrich 247 features with 3 variables each, which will cost 7.41 credits.
2. For Input Features, choose USA Block Groups.
3. Click the add variables button next to Variables.
4. If necessary, in the Add Variable window, under United States (Standard), click Categories.
5. Double-click Population and Common Population Variables.
6. Check 2019 Total Population.
   The number 1 appears under the search bar to indicate that you have 1 variable selected.
7. Click Categories. Double-click Poverty. Double-click Common Poverty Variables.
8. Check ACS HHs: Inc Below Poverty Level.
9. Click Categories and double-click At Risk.
10. Double-click the At-Risk folder.
11. Expand 2013-2017 Households by Vehicles Available (ACS) and check ACS Owner HHs by Vehicles Avail: 0.
12. Click OK. The three variables are added to the Enrich tool.
13. Click Run.
    A new layer, named USABlockGroups_Enrich, is added to your map. It contains attributes for the variables added by the Enrich tool.
14. Remove the original USA Block Groups layer.
15. Turn off the BusServiceAreas layer.

Part B

To visualize the demographic data that you've added, you'll make three layers, each depicting a different variable with a different transparent color.

1. In the Contents pane, click the USABlockGroups_Enrich symbol.
2. In the Symbology pane, if necessary, click Gallery. This project contains a custom style named Chattanooga.
3. Click Green no outline.
4. In the Symbology pane, click the Back button.
5. Click Vary Symbology by Attribute and expand Transparency.
   The Vary symbology by attribute tab is used to add a second visual variable to your layer, in addition to the one established on the Primary Symbology tab. While transparency can be used in your map in several ways, this method is the easiest way to derive transparency values from your data.

6. You'll symbolize the layer so all block groups are green, but they are more or less transparent based on the population density.
7. For Field, choose 2019 Total Population.
8. For Normalization, choose SQMI.
   Transparency will now represent the number of people divided by the number of square miles in each block group.
9. For High values, type 20%. For Low values, type 100%.
   Now you are better able to discern the population patterns on the map. The brighter polygons are more densely populated than the faint ones.
10. In the Contents pane, right-click USABlockGroups_Enrich and choose Copy.
11. Right-click Map and choose Paste.
12. Click the symbol for the new layer. From the symbol Gallery, choose Red no outline.
13. Click the Back button and click Vary Symbology by Attribute.
14. Expand Transparency and change Field to ACS HHs: Inc Below Poverty Level.
15. Copy the USABlockGroups_Enrich layer again and change the symbology to use the Yellow no outline symbol and the ACS Owner HHs by Vehicles Avail: 0 field.
16. In the Contents pane, rename each block group layer using the following table:

Symbol color	Layer name
Yellow	No Access to a Vehicle
Red	Poverty
Green	Population Density

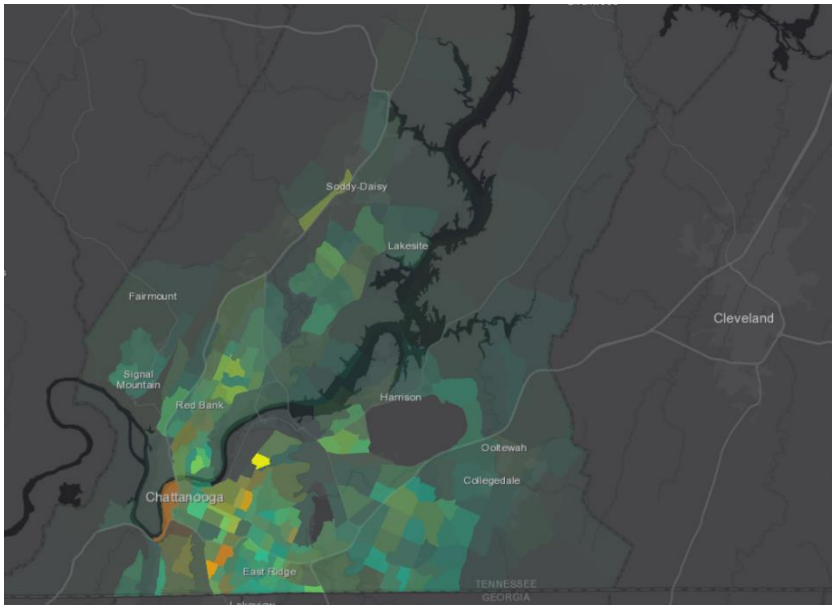

Figure 5: Different Colors Symbolize Different Demographic Indicators

Assess the Map for Future Expansion Sites:

It looks like downtown Chattanooga has the greatest need for bus stops, but you know from the BusServiceAreas layer that this neighbourhood is already well served by public transit. You can mask the map with the BusServiceAreas layer to better direct your attention to those places without bus stops.

1. In the Contents pane, press the Ctrl key while clicking Population Density, Poverty, and No Access to a Vehicle so all three layers are selected at once.
2. On the ribbon, click the Appearance tab.
3. In the Drawing group, click Masking and check BusServiceAreas.
   The block group layers are now masked by the bus stop service areas.
4. Zoom to the orange area in downtown Chattanooga.
   This area stands out on the map as an area that may require public transportation.
5. Change the basemap to Imagery.
   The unserviced area is part water, part industrial properties, and part uninhabited riverbank. Despite its bright color, it no longer seems like a high priority area to receive new bus stops.
6. Change the basemap back to Dark Gray Canvas and zoom out.
   From this map, the neighborhoods of East Ridge and Red Bank seem like the most likely candidates to receive a new bus route. Perhaps these areas have become more urbanized since the original public transit routes were created.
7. Save your project.

Figure 6: Area to South of River which probably Needs More Bus Service

Figure 7: After careful Analysis, we see Industries and Uninhabited Areas here so Bus Services Not Need

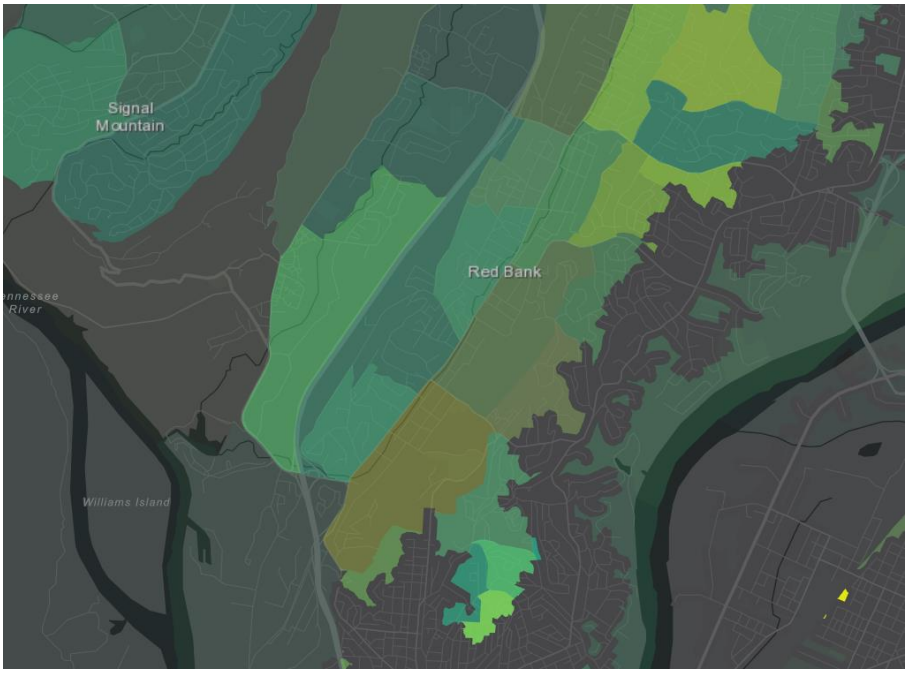

Figure 8: Red Bank Areas which is towards the North of the River requires Bus Services

Acknowledgements

The success and outcome of this project required a lot of guidance and assistance from many people and we are extremely privileged to have got this all along the completion of my project. All that we have done is only due to such supervision and assistance and we would not forget to thank them.

We respect and thank Prof. Saraswat for providing me an opportunity to do the project work and giving us all support and guidance, which made us complete the project duly. I am extremely thankful to him for providing such a nice support and guidance, although he had a busy schedule.

We would not forget to remember Bhaervi, Priyanka and Kartik for their encouragement and more over for their timely support and guidance till the completion of our project work.

Manan Arora and Aman Shah

Future Scope

In future, we wish to implement similar project for Gurgaon City, Haryana, India. We will be looking to collaborated with an external governmental agency for the same so that we can leverage their data and help development of public transit in different areas in Gurgaon. Currently, Gurgaon severely lacks public transit system which forces people to take up private transport that results in environmentally unhealthy practices.