# Computer Accessibility for Vulnerable Populations in Ottawa

A 4th year GIS course independent project (University of Victoria) submitted for the 2021 Esri Canada Higher Education Award

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## Background

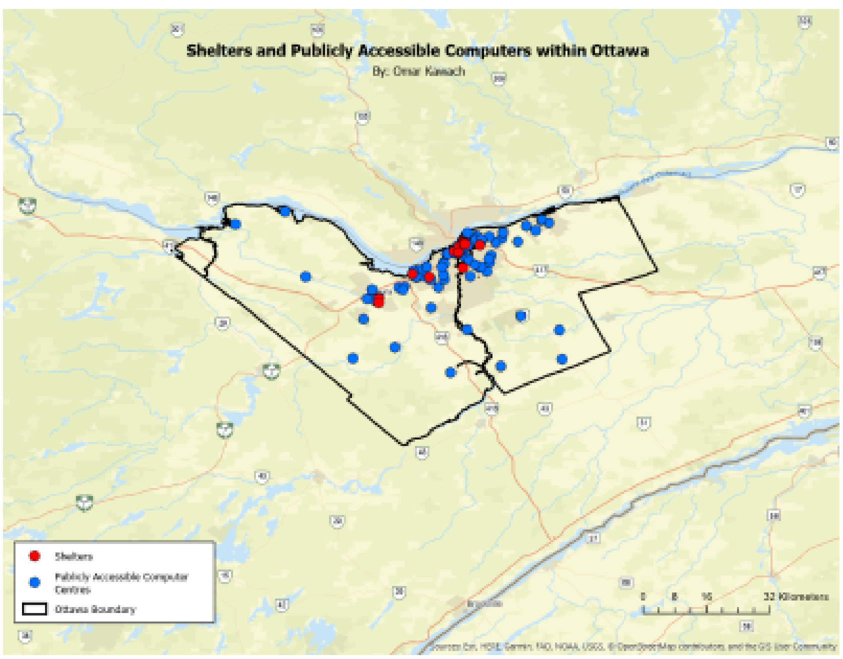
Ottawa has several shelters to support vulnerable populations such as disadvantaged low-income families, troubled youth, women facing abuse, the disabled, the homeless, etc. Vulnerable populations are more in risk of becoming homeless but are not always exclusively homeless, as evident in the different shelters in Ottawa. However, homelessness is a potential socio-economic consequence that vulnerable populations face as a part of their struggle.

Technology allows the vulnerable population to utilize social services, stay connected, and search for jobs and housing (Eyrich-Garg, 2011). One way to tackle the digital divide that impacts vulnerable populations is better access to technology. Given that supporting vulnerable populations is a socio-economic issue, unequal access to technologies may limit the feasibility of conducting a social service such as technology-based intervention (Rhoades, et al., 2017). Therefore, services that provide access to technologies should be conveniently accessible to vulnerable populations (Orrick, 2011).

The research may provide answers to questions concerning unequal access to technologies within a city. Questions regarding access to technologies in this case refers to how conveniently located publicly accessible computer (PAC) centres are from shelters, how much internet access is offered alongside computer access, and the number of publicly accessible computers that exist within the city. Also, the findings in the research conducted may supplement existing research by providing a unique GIS perspective; allowing Ottawa to discover how truly accessible their publicly accessible computers are.

## Research Question

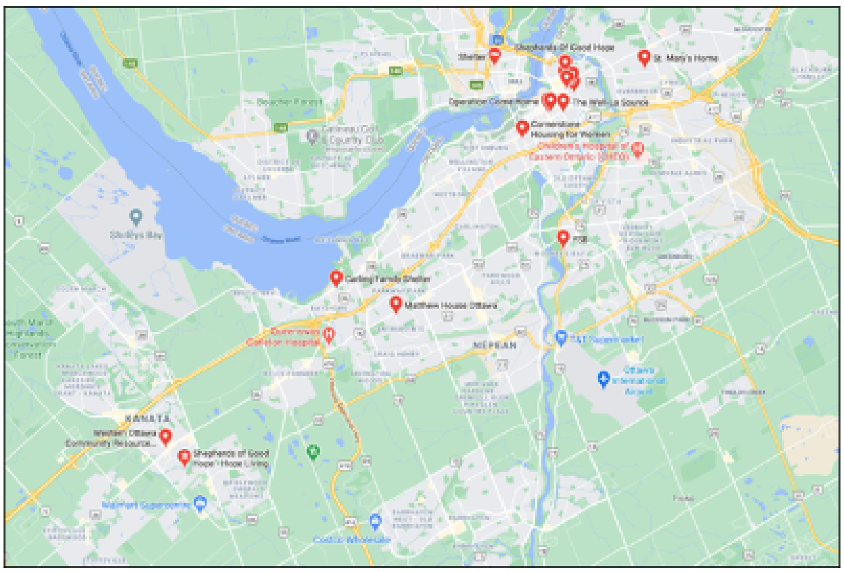
How accessible are publicly accessible computers for Ottawa's vulnerable population?




## Methodology

### Data Collection and Pre-Processing

As with any research, data collection and pre-processing is necessary. Since the research involves proximity-based analyses, point shapefiles (shelters and publicly accessible computers centres) and line shapefiles (roads and bus network) are required. For Euclidian-based analysis, only point shapefiles will be used whereas for network-based analysis, both locations and network datasets will be used. The two locations of interest are shelters and PAC centres. Ottawa shelter locations had to be manually collected from Google Maps since no such dataset publicly exists on the internet. The dataset, in CSV and Esri Shapefile format, would require information on shelter coordinates (latitude and longitude) and shelters used by vulnerable populations. The output from a simple search for shelters in Ottawa is seen below:




Google Maps Search Results for Shelters in Ottawa

Data pre-processing was necessary since a shelter outside the boundary of Ottawa was part of the search result and in some cases, animal shelters were returned in the search result. Also, shelters had to be verified by quick online investigation to ensure they serve vulnerable populations. In terms of the second location dataset, the PAC centres were already within the city boundary. The data was provided by Open Ottawa, and the PAC centre dataset offered information on location, hours, number of computers, Wi-Fi access, etc.

From Statistics Canada, the Road Network line shapefile was collected and fit to the boundary of Ottawa and the remaining Canada Road Network lines were ignored. Unfortunately, when it came time to the OC Transpo Bus Network from Carleton University, more pre-processing than usual was required. Each route in the OC Transpo Bus Network had it's own shapefile so the shapefile of each route had to be merged into one shapefile to be suitable for the conversion to Network Dataset format.

All collected and pre-processed datasets are seen below:

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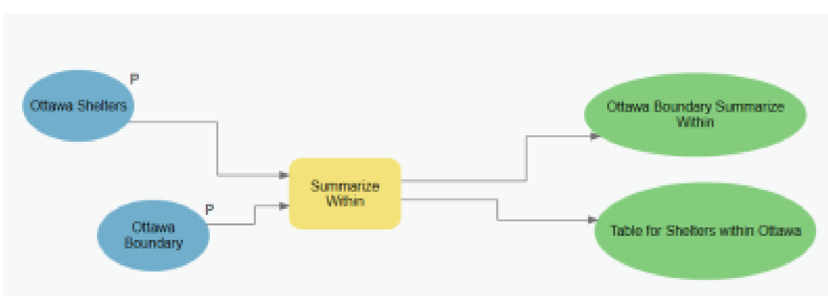
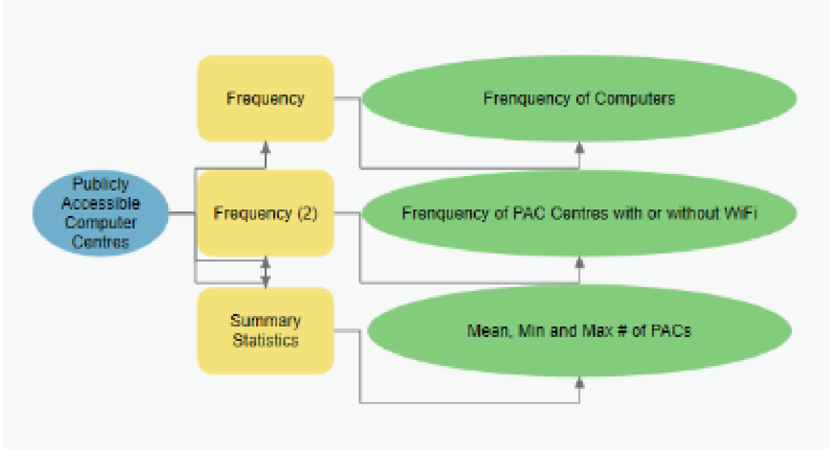
Data Collected

## Geoprocessing Workflows

Initially, for answering questions regarding the point datasets collected, Python scripting was done, but the effort was too time consuming and not beginner friendly. Instead, ArcGIS Pro's ModelBuilder was used to run these series of geo-processing operations. The use of visual programming made the results easier to follow and understand, and the outputs made more sense than simple print statement in a terminal. The first workflow below depicts the use of Summarize Within to solve for the count of Ottawa Shelters in Ottawa. The same workflow was used to solve for the count of PAC centres in Ottawa. The second workflow below depicts the use of Frequency and Summary Statistics to solve for the frequency of computers, frequency of PAC centres with Wi-Fi, and the mean, minimum, maximum number of publicly accessible computers.




Summarize Within to Solver for Count of Shelters in Ottawa




Summary Statistics to Solve Various Questions regarding PAC Centres

### Proximity-based Analyses

One approach to determine accessibility is to calculate the Euclidian distance between shelters and PAC centres. The spatial analysis techniques to be conducted follow the accessibility measures cited in a publication on access to urban health services (Apparicio et al., 2017). Therefore, the methodology of using Euclidian-based analysis is not unique, but the data and findings are. To implement this approach, a Python script was developed to solve for the closest PAC centre to a shelter using Euclidian distance (see source code in the Credits and Acknowledgements). However, moving in a straight line may not provide all the information required.

To gather more useful information in these proximity-based analyses, a transportation network-based measure of distance was was calculated using ArcGIS Pro's Network Analyst Extension. The first step was to build the gathered line shapefiles in ArcMap. The outcome was two network datasets: the OC Transpo Bus Network and the Ottawa Road Network. Then each network dataset was added in ArcGIS Pro. Once a network dataset was added as a source, Closest Facility analysis was conducted. The Facilities were the PAC centres, and the Incidences were the Shelters.

## Results

### ModelBuilder

From the ModelBuilder outputs using Summarize Within, Ottawa has 87 PAC centres and 15 shelters. 44 of the 87 PAC centres have Wi-Fi. The outputs using Summary Statistics found that there was 1 PAC centre with 82 computers (the maximum number of computers at a centre), and 11 PAC centres with 1 computer (the minimum number of computers at a centre). The highest occurrence of computers was 2 at 13 PAC centres, and finally the mean number of computers was 9.37.

## Euclidian-based Analysis

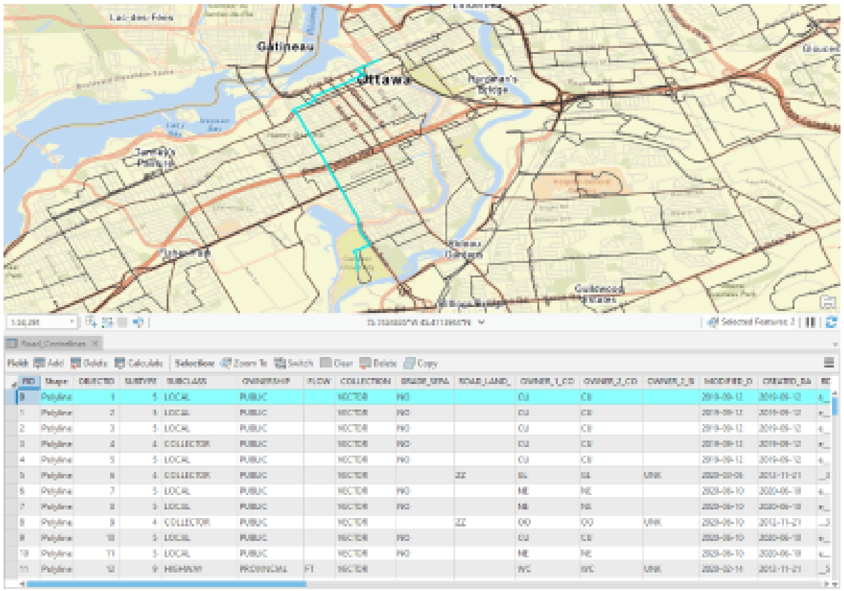
The outcome of this operation was that each shelter was assigned the closest PAC centre based on Euclidian distance. The output below was possible through the use of pandas.DataFrame.head() to show the first 5 rows.

| | Location | Lat | Lon | geometry | Closest_site | Closest_km |
|---|---|---|---|---|---|---|
| 0 | Matthew House Ottawa | 45.350385694079726 | -75.76826602678389 | POINT (-75.76827 45.35039) | Ben Franklin Place Client Service Centre | 1.03 |
| 1 | Western Ottawa Community Resource Centre | 45.301185773888354 | -75.87986632569025 | POINT (-75.87987 45.30119) | Community Employment Resource Centre | 0.35 |
| 2 | Shepherds of Good Hope - King Edward Ave | 45.431589435514905 | -75.68869370120741 | POINT (-75.68869 45.43160) | Bibliothèque Ottawa Library - Rideau | 0.65 |
| 3 | Shepherds of Good Hope - Castlefrank Rd | 45.291733482268984 | -75.88038506870554 | POINT (-75.88039 45.29173) | Bibliothèque Ottawa Library - Hazeldean | 0.88 |
| 4 | Caring Family Shelter | 45.35704549758195 | -75.80354111513182 | POINT (-75.80354 45.35705) | Michelle Heights Community House | 0.8 |

Top Five Rows of the Euclidian-based Analysis Outcome

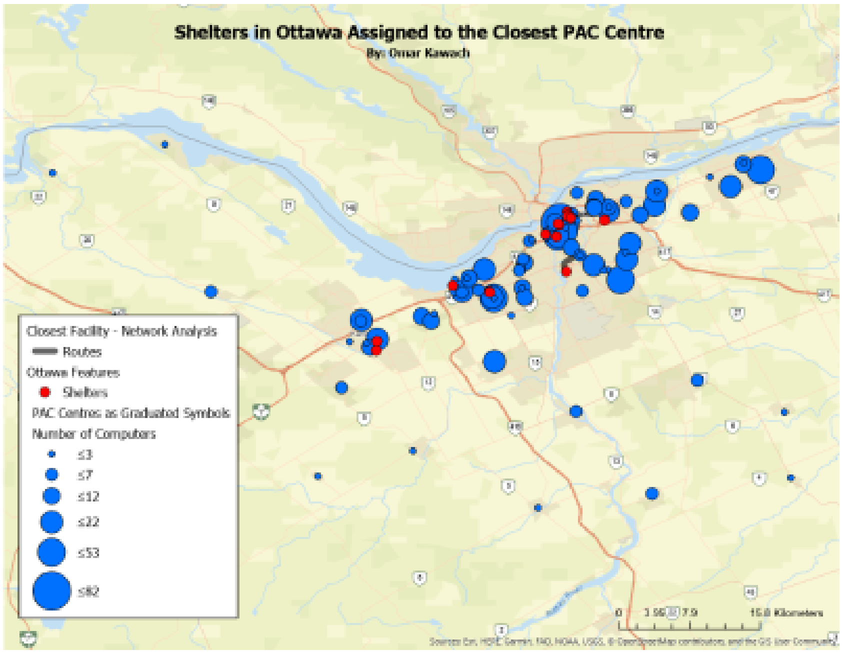
## Transportation Network-based Analysis

The transportation network-based analysis via the Ottawa Road Network had assigned shelters to a dedicated PAC centre and the same was done via the OC Transpo Bus network, but with less than favourable results. For instance, the image below depicts the bus route lacking bus stops so getting around downtown requires an unnecessary trip to Carleton University. The second image below depicts the path between shelters and their closest PAC centre and the third image below depicts the final outcome of the the network-based analysis using the Ottawa Road Network. Also, graduated symbols were used to emphasize the concentration of PAC centres in downtown Ottawa possessing a high number of computers.




OC Transpo Bus Network Analysis found to be Insufficient for Accessibility of PAC Centres to Shelters


Ottawa Road Network assigned Shelters to a Dedicated PAC Centre




## Limitations

The research conducted is beneficial, but is not without limitations. For one, Euclidian distance only measures the distance between two points using a straight, and this is unrealistic for accessibility in real world scenarios. In terms of the OC Transpo Bus Network, the dataset was time consuming to develop since each route had its own shapefile which needed to be merged into one shapefile. This may be a recurring issue for other cities if the research methodology is replicated. Another concern regarding the dataset was that each route in the OC Transpo Bus Network was considered one line so accessing nearby PAC centres from a shelter required an unnecessary trip around the city, i.e., the dataset didn't have stops. Thus, the OC Transpo Bus Network was found to be insufficient for the accessibility of PAC centres to shelters. Although the data provided by the use of the Ottawa Road Network was more favourable as it identified the closest PAC centre to a shelter, it failed to consider that it is unrealistic to expect all vulnerable populations to have access to a car since some may only afford to bus or walk. Therefore, it is limited in its results. Furthermore, even though the network-based analysis using ArcGIS Pro's Closest Facility solver provided useful information, it did not consider that one PAC centre can be close to shelters and not provide enough computers for those shelters.

## Future Work

Given what was previously noted in the *Limitations* section, shelters were assigned to dedicated PAC centres without the consideration of whether these PAC centres can provide an adequate supply of computers for vulnerable population coming from shelters. The research would benefit in the future if data was gathered regarding the service capacity of each shelter to conduct Location-Allocation analysis. Future work would also benefit from a more efficient bus network than the one currently available. One approach to getting a more efficient bus network would be to manually add bus stops to each route, or potentially reach out to the proper channels regarding the lack of sufficient data. Also, another measure of accessibility / convenience could include the consideration for hours of operation at PAC centres and shelters. Lastly, placing the results in a web viewer may be useful for vulnerable populations, city planners, and researchers.

## Conclusion

The use of Euclidian distance as a measure for accessibility was unrealistic since people travel along networks, not straight lines. Additionally, the OC Transpo Bus Network for network-based analysis was insufficient for the accessibility of PAC centres to shelters. Therefore, the Ottawa Road Network for network-based analysis was best able to answer the question of how accessible PAC centres are to Ottawa's vulnerable population. As expected, the shelters located in the downtown of Ottawa had the best accessibility to PAC centres while the PAC centres located outside of downtown are inaccessible and thus inconvenient for the shelters outside of the downtown core. Therefore, given the abundance of PAC centres near shelters, one may conclude that PAC centres are accessible to Ottawa's vulnerable population to an extent. And thus, Ottawa's accessibility centered in downtown means it fails to tackle the digital divide that impacts the homeless in the rest of the city, outside of downtown.

## Credits and Acknowledgements

Special thank you to the University of Victoria for the nomination and my Advanced Topics in Geographical Informational Sciences Course, where this project was originally conducted, and was instructed by Professor Jessica Fitterer

**Sources:**

Apparicio, P., Gelb, J., Dubé, A., Kingham, S., Gauvin, L., & Robitaille, É. (2017). The approaches to measuring the potential spatial access to urban health services revisited: distance types and aggregation-error issues. International Journal of Geographics, 16(1). https://doi.org/10.1186/s12942-017-0105-9

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Orrick, R. (2011). Envisioning an internet center for homeless individuals: One group's quest to reduce the digital divide. University of Minnesota Digital Conservancy. https://core.ac.uk/reader/211356988

Rhoades, H., Wenzel, S. L., Rice, E., Winetrobe, H., & Henwood, B. (2017). No digital divide? Technology use among homeless adults. Journal of Social Distress and the Homeless, 26(1), 73-77. http://dx.doi.org/10.1080/10530789.2017.1305140

**Source Code:** omarkawach/computer-access-for-homeless-in-ottawa: Computer Accessibility for the Homeless in Ottawa. An end of semester project for GEOG 428 at UVic. (github.com)