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INVESTIGATION INTO THE DIFFERENCES BETWEEN MONTREAL AND VANCOUVER

BATTLE OF THE NEIGHBOURHOODS

RACHEL MUNRO



1 INTRODUCTION

1.1 BACKGROUND

Two of the most populated cities in Canada, apart from Toronto, are Montreal and Vancouver. Both cities are very multicultural, have hosted the Olympics, and are both homes to large universities, industry, and world-class attractions. However, located at opposite sides of this vast country they have drastically different cultural identities and local attractions. Montreal is Canada's oldest established city and was originally founded in 1642 and boasts a large francophone community. Vancouver, in contrast, was founded much later in 1867 and hosts a large population of immigrants from eastern Asia. This difference in ethnographic make-up can greatly influence available cuisines and other amenities within a city. Locations of resources within a city can be a huge factor for visitors when selecting which city to visit, and also for locals choosing where in the city to live.

1.2 PROBLEM

Given how culturally and historically different Montreal and Vancouver are, it would be interesting to look at the similarities and differences between these two cities based on popular amenities and rental prices. Foursquare data can be helpful in this regard, to look at trending locations within these cities and compare neighbourhoods within each city as well as between Montreal and Vancouver.

1.3 INTEREST

This study can potentially help people in determining which city to visit or live in based on their interests.

2 DATA ACQUISITION AND CLEANING

2.1 DATA SOURCES

Datasets were chosen to represent only the metropolitan boundaries as opposed to the greater Montreal area or the greater Vancouver area which comprise the surrounding cities and towns. The 2016 census was the last available source of population and cost of living values as the long-form national census is only performed every 5 years.

2.1.1 Montreal

Montreal is divided into 19 neighbourhoods and the dataset was found here: <https://en.wikipedia.org/wiki/Montreal>. This dataset included census data from 2016 which reported population, average monthly rent, and area of each neighbourhood. The geojson file for the metropolitan center of Montreal was found here: <https://github.com/blackmad/neighborhoods/blob/master/gn-montreal.geojson>. A complete set of census data for 2016 was found on Statistics Canada (<https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CMACA&Code1=462&Geo2=PR&Code2=01&Data=Count&SearchText=Montreal&SearchType=Begin&SearchPR=01&TABID=1&B1=All>). The data was downloaded as a .csv file and then imported into a pandas dataframe for cleaning.

2.1.2 Vancouver

The data was sourced from a combination of sources. Neighbourhood designations for the 22 districts in Vancouver were taken from: https://en.wikipedia.org/wiki/List_of_neighbourhoods_in_Vancouver. Other data including area, population and average monthly rent were taken from <https://vancouver.ca/news-calendar/areas-of-the-city.aspx>. Data was manually compiled from individual pdfs corresponding to 2016 census data in new table. The table was saved in .csv format and then converted into a pandas dataframe. The geojson file for the metropolitan center of Vancouver was found on the official Vancouver website: <https://opendata.vancouver.ca/explore/dataset/local-area-boundary/information/>. As was done for the Montreal census, a complete set of census data for 2016 was found on Statistics Canada (<https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=5915022&Geo2=PR&Code2=01&Data=Count&SearchText=5915022&SearchType=Begin&SearchPR=01&B1=All&Custom=&TABID=3>). The data was downloaded as a .csv file and then imported into a pandas dataframe for cleaning.

2.2 DATA CLEANING

2.2.1 Location data

Geojson files for Montreal and Vancouver were used to obtain Neighbourhood designations and coordinates for further analysis. The Foursquare API was then used to obtain the top nearby venues within a 1500 m radius of the center of each neighbourhood. Venues were then processed by one-hot encoding to quantify the number of venues within each neighbourhood which corresponded to venue categories

as supplied by Foursquare. The ten most common venues in each neighbourhood were aggregated. An unsupervised machine learning algorithm (k-means clustering) on these datasets, with the purpose of clustering neighbourhoods with similar characteristics.

2.2.2 Census Data

The census data for Montreal and Vancouver were inputted into pandas dataframes. Data related to age distribution, household income, and total immigration by country were transferred to separate dataframes and plotted by bar graphs.

3 RESULTS

3.1 LOCATION DATA

The neighbourhood boundary data for Montreal (Table 1) and Vancouver (Table 2) as derived from the geojson files were used to produce folium maps for both cities (Figure 1 and Figure 2). Populations for neighbourhoods were used to overlay a choropleth layer on both maps to look for highly populated areas within Montreal and Vancouver.

Table 1. Neighbourhoods in Montreal.

Neighbourhoods	Area (Square kilometer)	Population (2016)	Population Density	Average Monthly Rent
Ahuntsic-Cartierville	242	134245	5547.3	1167.0
Anjou	137	42796	3123.8	1151.0
Cote-des-Neiges--Notre-Dame-de-Grace	214	166520	7781.3	1300.0
Lachine	177	44489	2513.5	1078.0
LaSalle	163	76853	4714.9	1283.0
Plateau-Mont-Royal	81	104000	12839.5	1437.0
Sud-Ouest	157	78151	4977.8	1526.0
L'Ile-Bizard--Sainte-Genieve	236	18413	780.2	1639.0
Mercier-Hochelaga-Maisonneuve	254	136024	5355.3	1164.0
Montreal-Nord	111	84234	7588.6	1002.0
Outremont	39	23954	6142.1	1690.0
Pierrefonds--Roxboro	271	69297	2557.1	1303.0
Pointe-aux-Trembles-Rivieres-des-Prairies	423	106743	2523.5	1195.0
Rosemont--La-Petite-Patrie	159	139590	8779.2	1287.0
Saint-Laurent	428	98828	2309.1	1325.0
St-Leonard	135	78305	5800.0	1262.0
Verdun--Ile-des-Soeurs	97	69229	7137.0	1384.0
Ville-Marie	165	89170	5404.2	1613.0
Villeray-Saint-Michel-Parc-Extension	165	143853	8718.4	1197.0

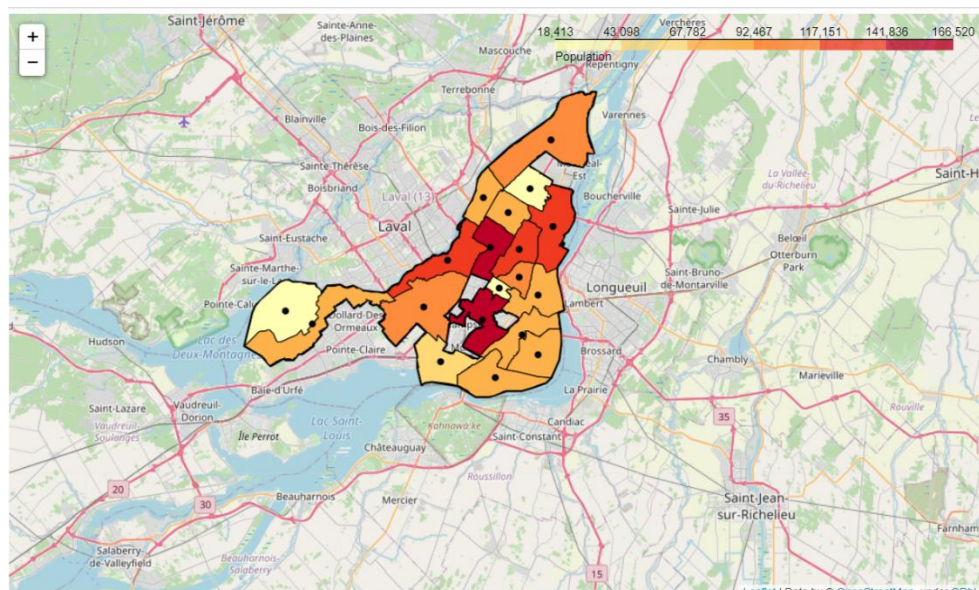


Figure 1. Neighbourhoods of Montreal coloured according to population in 2016.

Table 2. Neighbourhoods in Vancouver.

Neighbourhood	Area (Hectares)	Population	Average Monthly Rent
Arbutus Ridge	370	15910	1688
Downtown Vancouver	370	62030	1589
Dunbar-Southlands	856	21425	1824
Fairview	327	33620	1341
Grandview-Woodland	445	29175	1041
Hastings-Sunrise	793	34575	1103
Kensington-Cedar Cottage	724	49325	1163
Kerrisdale	631	13975	1504
Killarney	664	29325	1094
Kitsilano	546	43045	1472
Marpole	559	24460	1113
Mount Pleasant	366	32955	1291
Oakridge	401	13030	1494
Renfrew-Collingwood	805	51530	1107
Riley Park	491	22555	1361
Shaughnessy	446	8430	1789
South Cambie	217	7970	1500
Strathcona	388	12585	699
Sunset	626	36500	1112
Victoria-Fraserview	531	31065	1064
West End	198	47200	1308
West Point Grey	445	13065	1524

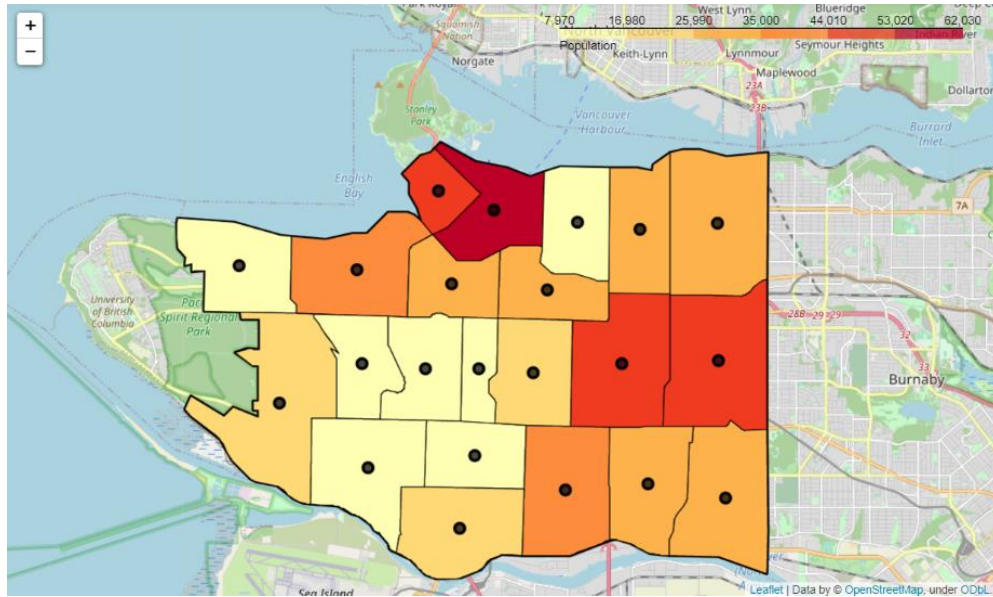
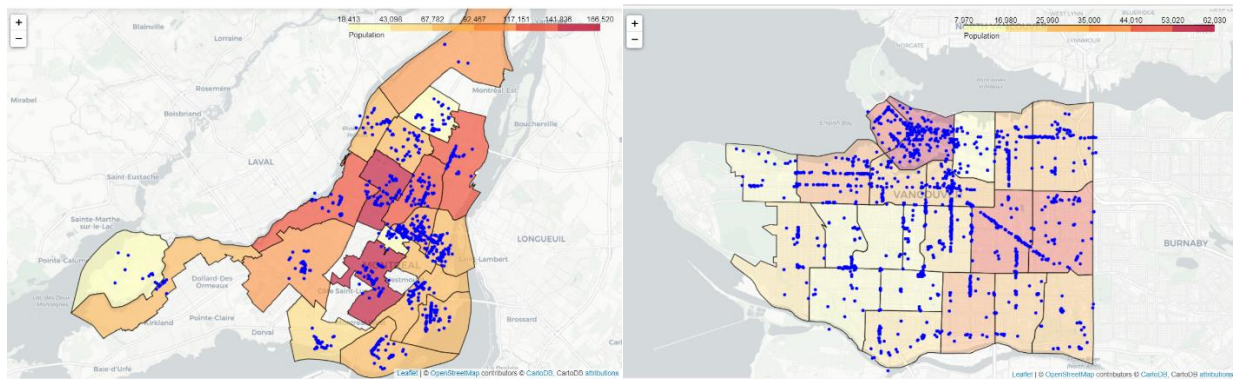


Figure 2. Neighbourhoods of Vancouver coloured according to population in 2016.

3.2 FOURSQUARE DATA

Foursquare API data was used to located the top 300 venues within 1500 m of the center of each neighbourhood. The venues were plotted in blue on top of the population density chloropath maps (Figure 3). For Montreal there were 197 unique venue categories with the most popular neighbourhoods being: Outremont, Plateau-Mont-Royal, Sud-Ouest, and Ville-Marie (Table 3). The majority of these venues are located within central region of Montreal. For Vancouver, 220 unique venue categories were returned with the most popular neighbourhoods being: Downtown, Fairview, Grandview-Woodland, Hastings, Sunrise, Kensington-Cedar Cottage, Kitsilano, Mount Pleasant, Riley Park, South Cambie, Strathcona, and West End (Table 4). The majority of these venues are located alone major routes across the city and in the downtown core at the north end of the city. In both cases the venue distribution seems to match the population distribution in each city.



(a)

(b)

Figure 3. Neighbourhoods of (a) Montreal and (b) Vancouver coloured according to population in 2016 overlaid with popular venues as derived from Foursquare API data.

Table 3. Neighbourhoods of Montreal with returned number of venues per neighbourhood via Foursquare API.

Neighbourhood	Neighbourhood Latitude	Neighbourhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
Ahuntsic-Cartierville	28	28	28	28	28	28
Anjou	48	48	48	48	48	48
Cote-des-Neiges--Notre-Dame-de-Grace	80	80	80	80	80	80
L'Île-Bizard--Sainte-Genevieve	4	4	4	4	4	4
LaSalle	58	58	58	58	58	58
Lachine	30	30	30	30	30	30
Mercier-Hochelaga-Maisonneuve	38	38	38	38	38	38
Montreal-Nord	30	30	30	30	30	30
Outremont	100	100	100	100	100	100
Pierrefonds--Roxboro	22	22	22	22	22	22
Plateau-Mont-Royal	100	100	100	100	100	100
Pointe-aux-Trembles-Rivieres-des-Prairies	4	4	4	4	4	4
Rosemont--La-Petite-Patrie	86	86	86	86	86	86
Saint-Laurent	42	42	42	42	42	42
St-Leonard	38	38	38	38	38	38
Sud-Ouest	100	100	100	100	100	100
Verdun--Île-des-Soeurs	62	62	62	62	62	62
Ville-Marie	100	100	100	100	100	100
Villeray-Saint-Michel-Parc-Extension	70	70	70	70	70	70

Table 4. Neighbourhoods of Vancouver with returned number of venues per neighbourhood via Foursquare API.

Neighbourhood	Neighbourhood Latitude	Neighbourhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
Arbutus-Ridge	63	63	63	63	63	63
Downtown	100	100	100	100	100	100
Dunbar-Southlands	39	39	39	39	39	39
Fairview	100	100	100	100	100	100
Grandview-Woodland	100	100	100	100	100	100
Hastings-Sunrise	100	100	100	100	100	100
Kensington-Cedar Cottage	100	100	100	100	100	100
Kerrisdale	54	54	54	54	54	54
Killarney	45	45	45	45	45	45
Kitsilano	100	100	100	100	100	100
Marpole	68	68	68	68	68	68
Mount Pleasant	100	100	100	100	100	100
Oakridge	45	45	45	45	45	45
Renfrew-Collingwood	90	90	90	90	90	90
Riley Park	100	100	100	100	100	100
Shaughnessy	41	41	41	41	41	41
South Cambie	100	100	100	100	100	100
Strathcona	100	100	100	100	100	100
Sunset	59	59	59	59	59	59
Victoria-Fraserview	44	44	44	44	44	44
West End	100	100	100	100	100	100
West Point Grey	52	52	52	52	52	52

3.3 CLUSTER ANALYSIS

The venues were sorted according to category and the first through tenth most common venue types for each neighbourhood were calculated. The k-means algorithm was then used to cluster neighbourhoods according to similar popular venues. The Silhouetter Score was used to select the number of clusters. For both Montreal and Vancouver, the maximum score was seen at 2 clusters. However, this isn't very helpful to differentiate between different locations within the city for any interesting conclusions. A similarly high score was seen for 3 clusters with a score of 0.487 for both Montreal and Vancouver. The resultant output for Montreal and Vancouver can be seen in Tables 5 and 6, respectively.

Table 5. Neighbourhoods, cluster designation and top 10 venues for Montreal.

Neighbourhoods	Average Monthly Rent	Cluster Labels	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
Pointe-aux-Trembles-Rivieres-des-Prairies	1195	0	Bakery	Convenience Store	Restaurant	Auto Dealership	English Restaurant	Flea Market	Fish Market	Fish & Chips Shop	Fast Food Restaurant	Farmers Market
Ahuntsic-Cartierville	1167	1	Park	Pharmacy	Grocery Store	Restaurant	Pizza Place	New American Restaurant	Farmers Market	Fast Food Restaurant	Seafood Restaurant	Breakfast Spot
Verdun--Ile-des-Soeurs	1384	1	Park	Pizza Place	Cafe	Bank	Sandwich Place	Mediterranean Restaurant	Indian Restaurant	Trail	BBQ Joint	Grocery Store
St-Leonard	1262	1	Pharmacy	Gas Station	Italian Restaurant	Sandwich Place	Drugstore	Fast Food Restaurant	Bank	Bakery	Sports Bar	Gastropub
Saint-Laurent	1325	1	Sporting Goods Shop	Hotel	Breakfast Spot	Bank	Restaurant	Sandwich Place	Fast Food Restaurant	Liquor Store	Shipping Store	Shoe Store
Rosemont--La-Petite-Patrie	1287	1	Park	Pharmacy	Bar	Breakfast Spot	Pizza Place	Bakery	Italian Restaurant	Grocery Store	Restaurant	Brewery
Pierrefonds--Roxboro	1303	1	Pizza Place	Restaurant	Convenience Store	Grocery Store	Park	Pharmacy	Skating Rink	Breakfast Spot	Food & Drink Shop	French Restaurant
Outremont	1690	1	Cafe	Bakery	Bar	Mediterranean Restaurant	Restaurant	French Restaurant	Bagel Shop	Supermarket	Breakfast Spot	Park
Ville-Marie	1613	1	Cafe	Hotel	Cocktail Bar	Plaza	Bar	Spa	Restaurant	Tea Room	Coffee Shop	Hostel
Montreal-Nord	1002	1	Pharmacy	Italian Restaurant	Grocery Store	Breakfast Spot	Restaurant	Supermarket	Gas Station	Fast Food Restaurant	Portuguese Restaurant	Video Game Store

<i>Sud-Ouest</i>	1526	1	Bakery	Cafe	Breakfast Spot	Restaurant	French Restaurant	Ice Cream Shop	Pizza Place	Brewery	Bar	Gastropub
<i>Plateau-Mont-Royal</i>	1437	1	Cafe	Bakery	Restaurant	Park	Vegetarian / Vegan Restaurant	Portuguese Restaurant	Yoga Studio	Coffee Shop	Deli / Bodega	Middle Eastern Restaurant
<i>LaSalle</i>	1283	1	Fast Food Restaurant	Breakfast Spot	Pizza Place	Pharmacy	Restaurant	Coffee Shop	Italian Restaurant	Gym / Fitness Center	Sandwich Place	Pet Store
<i>Lachine</i>	1078	1	Park	Italian Restaurant	Pharmacy	Fast Food Restaurant	Ice Cream Shop	Bank	Liquor Store	Lighthouse	Sandwich Place	Restaurant
<i>Cote-des-Neiges--Notre-Dame-de-Grace</i>	1300	1	Coffee Shop	Pharmacy	Bakery	Vietnamese Restaurant	Fast Food Restaurant	Restaurant	Bank	Liquor Store	Pizza Place	Grocery Store
<i>Anjou</i>	1151	1	Coffee Shop	Clothing Store	Restaurant	Fast Food Restaurant	Gas Station	Pharmacy	Pizza Place	Burger Joint	Convenience Store	Sandwich Place
<i>Mercier-Hochelaga-Maisonneuve</i>	1164	1	Coffee Shop	Restaurant	Breakfast Spot	Fast Food Restaurant	Pharmacy	Greek Restaurant	Liquor Store	Thai Restaurant	Italian Restaurant	Paintball Field
<i>Villeray-Saint-Michel-Parc-Extension</i>	1197	1	Grocery Store	Vietnamese Restaurant	Bakery	Fast Food Restaurant	Sandwich Place	Portuguese Restaurant	Pharmacy	Sushi Restaurant	Coffee Shop	Breakfast Spot
<i>L'Ile-Bizard--Sainte-Genieve</i>	1639	2	Golf Course	Construction & Landscaping	English Restaurant	Flea Market	Fish Market	Fish & Chips Shop	Fast Food Restaurant	Farmers Market	Falafel Restaurant	Fabric Shop

Table 6. Neighbourhoods, cluster designation and top 10 venues for Vancouver.

Neighbourhood	Average Monthly Rent	Cluster Labels	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
Strathcona	699	0	Brewery	Cafe	Park	Pizza Place	Ice Cream Shop	Gourmet Shop	Asian Restaurant	Coffee Shop	Italian Restaurant	Breakfast Spot
Grandview-Woodland	1041	0	Brewery	Coffee Shop	Cafe	Pizza Place	Sushi Restaurant	Ice Cream Shop	Italian Restaurant	Indian Restaurant	Bakery	Middle Eastern Restaurant
Mount Pleasant	1291	0	Coffee Shop	Brewery	Bakery	Vietnamese Restaurant	Sushi Restaurant	Yoga Studio	Chinese Restaurant	Pizza Place	Park	Outdoor Supply Store
Arbutus-Ridge	1688	1	Coffee Shop	Chinese Restaurant	Grocery Store	Park	Dessert Shop	Sandwich Place	Italian Restaurant	Bakery	Japanese Restaurant	Tea Room
Victoria-Fraserview	1064	1	Bus Stop	Convenience Store	Asian Restaurant	Chinese Restaurant	Sandwich Place	Coffee Shop	Electronics Store	Park	Japanese Restaurant	Gas Station
Sunset	1112	1	Chinese Restaurant	Sandwich Place	Coffee Shop	Indian Restaurant	Burger Joint	Gas Station	Vietnamese Restaurant	Restaurant	Asian Restaurant	Fast Food Restaurant
South Cambie	1500	1	Coffee Shop	Park	Chinese Restaurant	Japanese Restaurant	Bank	Sushi Restaurant	Garden	Bakery	Cafe	Vietnamese Restaurant
Shaughnessy	1789	1	Coffee Shop	Sandwich Place	Sushi Restaurant	Bubble Tea Shop	Bank	Burger Joint	Garden	Restaurant	Convenience Store	Gourmet Shop
Riley Park	1361	1	Cafe	Coffee Shop	Vietnamese Restaurant	Park	Japanese Restaurant	Chinese Restaurant	Pizza Place	Bakery	Furniture / Home Store	Arts & Crafts Store
Renfrew-Collingwood	1107	1	Chinese Restaurant	Park	Pizza Place	Coffee Shop	Bus Station	Asian Restaurant	Metro Station	Convenience Store	Grocery Store	Pet Store
Oakridge	1494	1	Coffee Shop	Sushi Restaurant	Bus Stop	Park	Tea Room	Restaurant	Fast Food Restaurant	Shopping Mall	Garden	Sporting Goods Shop

<i>Marpole</i>	1113	1	Bank	Vietnamese Restaurant	Pharmacy	Sushi Restaurant	Chinese Restaurant	Coffee Shop	Sandwich Place	Dessert Shop	Furniture / Home Store	Gas Station
<i>Kitsilano</i>	1472	1	Coffee Shop	Bakery	Sushi Restaurant	Cafe	Grocery Store	Restaurant	Thai Restaurant	Yoga Studio	Greek Restaurant	Sporting Goods Shop
<i>Killarney</i>	1094	1	Bus Stop	Coffee Shop	Shopping Mall	Gas Station	Park	Sushi Restaurant	Farmers Market	Burger Joint	Golf Course	Grocery Store
<i>Kerrisdale</i>	1504	1	Bus Stop	Coffee Shop	Chinese Restaurant	Pharmacy	Golf Course	Tea Room	Cafe	Park	Sushi Restaurant	Supermarket
<i>Kensington-Cedar Cottage</i>	1163	1	Vietnamese Restaurant	Chinese Restaurant	Vegetarian / Vegan Restaurant	Coffee Shop	Cafe	Japanese Restaurant	Gym / Fitness Center	Grocery Store	Bakery	Pizza Place
<i>Hastings-Sunrise</i>	1103	1	Vietnamese Restaurant	Coffee Shop	Park	Theme Park Ride / Attraction	Cafe	Sushi Restaurant	Chinese Restaurant	Bakery	Italian Restaurant	Event Space
<i>Dunbar-Southlands</i>	1824	1	Grocery Store	Golf Course	Liquor Store	Bakery	Coffee Shop	Sushi Restaurant	Bank	Park	Gym	Bus Stop
<i>West Point Grey</i>	1524	1	Park	Sushi Restaurant	Beach	Coffee Shop	Cafe	Japanese Restaurant	Bank	Vegetarian / Vegan Restaurant	Pub	Fast Food Restaurant
<i>Fairview</i>	1341	2	Park	Seafood Restaurant	Restaurant	Cafe	Japanese Restaurant	Indian Restaurant	Coffee Shop	Pizza Place	Bakery	Sushi Restaurant
<i>Downtown</i>	1589	2	Hotel	Restaurant	Seafood Restaurant	Japanese Restaurant	Dessert Shop	Sandwich Place	Coffee Shop	Concert Hall	Bakery	Yoga Studio
<i>West End</i>	1308	2	Hotel	Japanese Restaurant	Italian Restaurant	Dessert Shop	Coffee Shop	Sandwich Place	Park	Sculpture Garden	Bakery	Ramen Restaurant

The resultant cluster data for the neighbourhoods were mapped. The clusters were overlaid on a choropleth map showing the average rental cost in each neighbourhood (Figure 4). A bar graph showing the average rental cost per neighbourhood was plotted with respect to their cluster labels (Figure 5 and

Figure 6). This allows one to look at neighbourhoods with similar amenities and compare the cost of living in each neighbourhood. For example, if one lives in Outremont in Montreal, one can consider moving to the similar neighbourhood of Montreal-Nord, which is around \$600 per month cheaper to rent in.

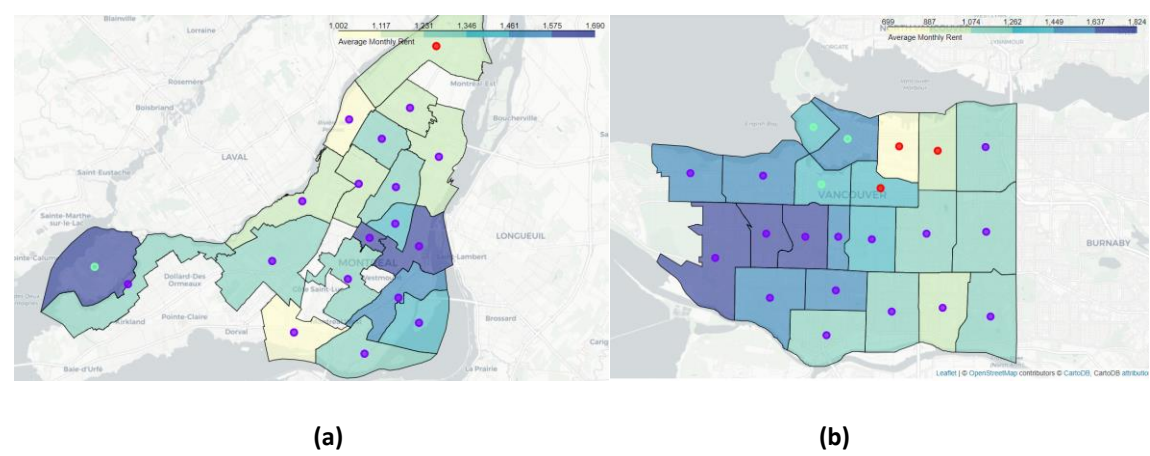


Figure 4. Neighbourhoods of (a) Montreal and (b) Vancouver coloured according to average monthly rental costs in 2016 overlaid with clusters as derived from Foursquare API data.

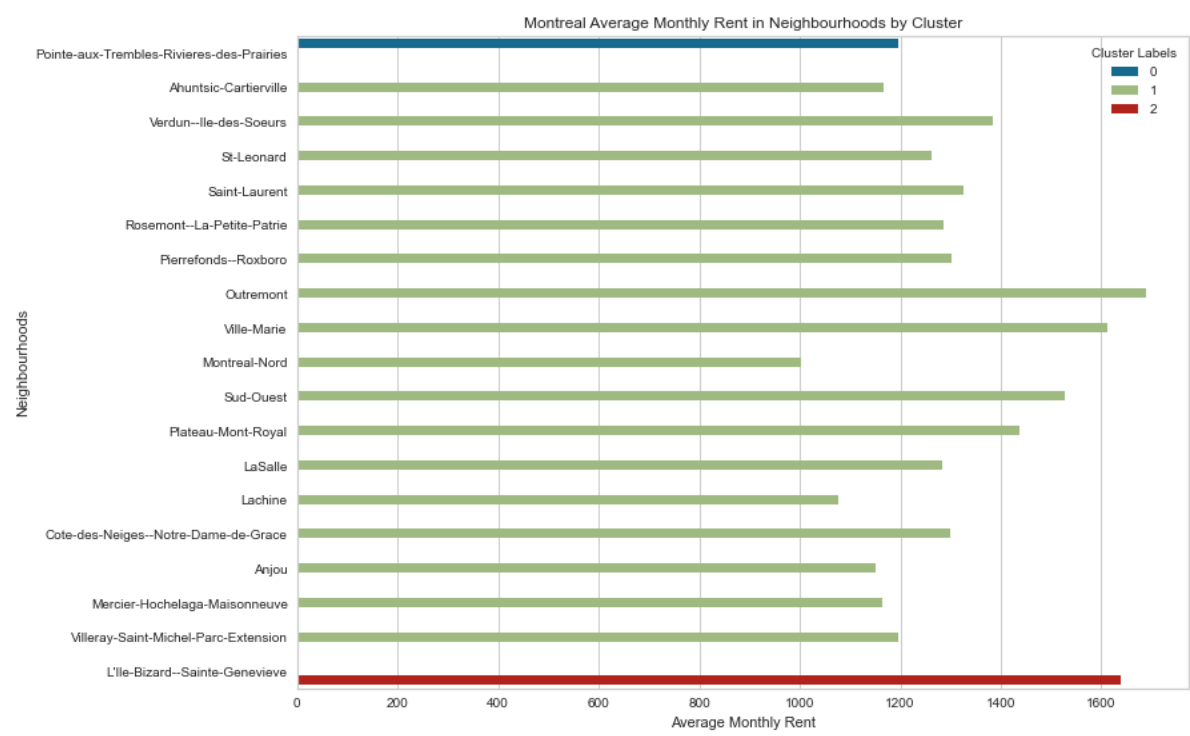


Figure 5. Average monthly rental cost in Montreal by cluster designation.

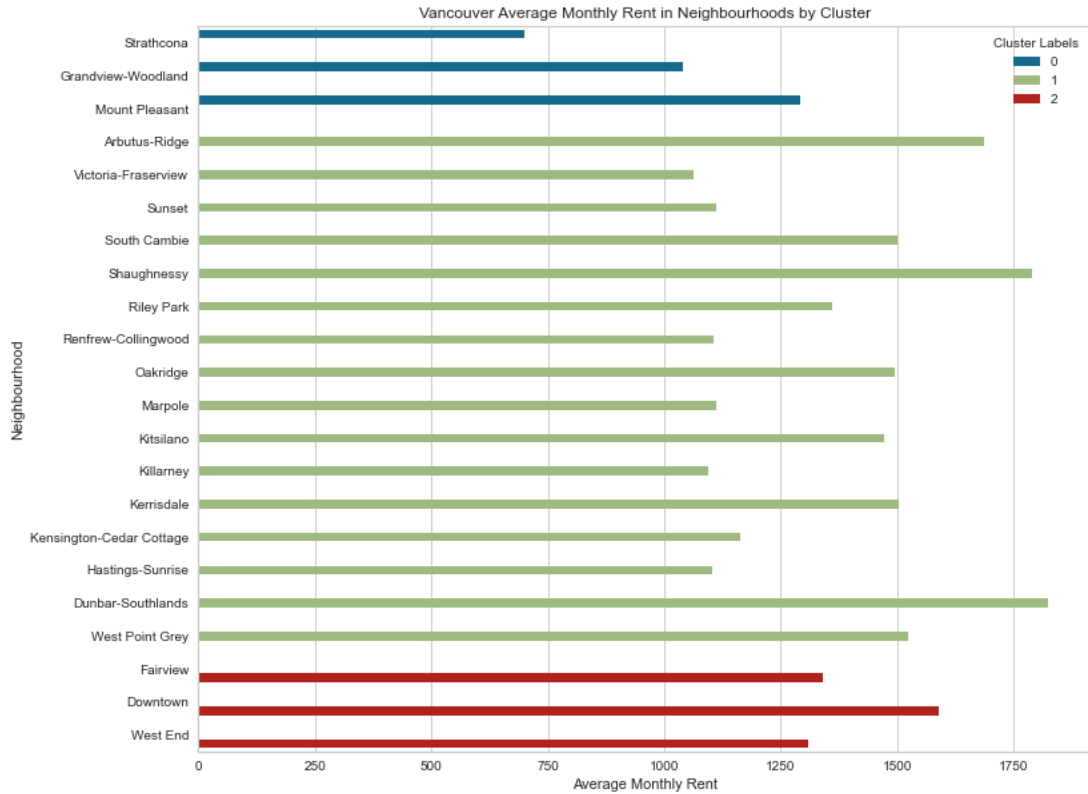


Figure 6. Average monthly rental cost in Vancouver by cluster designation.

3.3.1 Montreal Clusters

Table 7. Average monthly rental prices for Montreal clusters.

Average Monthly Rent	
Cluster Labels	
0	1195.000000
1	1304.058824
2	1639.000000

3.3.1.1 North-East Cluster (Cluster 0)

This cluster encompasses the Pointe-aux-Trembles-Rivieres-des-Prairies neighbourhood. This district seems to be more focused on shopping, with multiple bakeries and markets (Farmers market and Fish market). The rental price for this area is quite reasonable, likely given the distance from the downtown core.

3.3.1.2 South-West Cluster (Cluster 2)

This cluster includes L'Ile-Bizard--Sainte-Genevieve wherein the top venues are related to recreation (Golf course) and commerce (Construction). The average rental price is quite high in this area, as well.

3.3.1.3 Central Cluster (Cluster 1)

The remaining neighbourhoods in Montreal can be clustered in near the downtown core. This cluster includes shopping, European style dining, cafes, hotels, and recreational facilities like gyms and spas.

3.3.2 Vancouver Clusters

Table 8. Average monthly rental prices for Vancouver clusters.

Average Monthly Rent	
Cluster Labels	
0	1010.333333
1	1369.500000
2	1412.666667

3.3.2.1 Southern Cluster (Cluster 1)

This cluster comprises the majority of Vancouver, including a wide variety of shops, restaurants, and other amenities like banks, gyms and parks. Shaughnessy and Dunbar-Southlands are the most expensive neighbourhoods in Vancouver, but there are others within the cluster that are quite reasonable and have access to similar amenities.

3.3.2.2 Central Cluster (Cluster 0)

Consisting of 3 neighbourhoods (Strathcona, Grandview-Woodland, and Mount Pleasant), this cluster is the location of many breweries, parks, and small eateries. On average, this is the least expensive area in which to rent in Vancouver.

3.3.2.3 Downtown-Northern Cluster (Cluster 2)

This cluster encompasses the downtown core of Vancouver and its surrounding neighbourhoods. As such, this cluster included many hotels, attractions and a variety of restaurants. This cluster is also the most expensive in terms of rental prices on average.

3.4 OVERALL COMPARISONS BETWEEN MONTREAL AND VANCOUVER

3.4.1 Household income

The median household income in Vancouver is greater than that seen for Montreal as evidenced by the greater proportion of households which earn over \$100,000 a year (Figure 7). Household income is typically proportional to the cost needed to live and work in the city. The most expensive neighbourhood in Vancouver at \$1800 per month is almost \$200 more expensive than an equivalent residence in Montreal. This is something to be considered when moving or visiting a city, as costs for most goods and services will also reflect the higher cost of living.

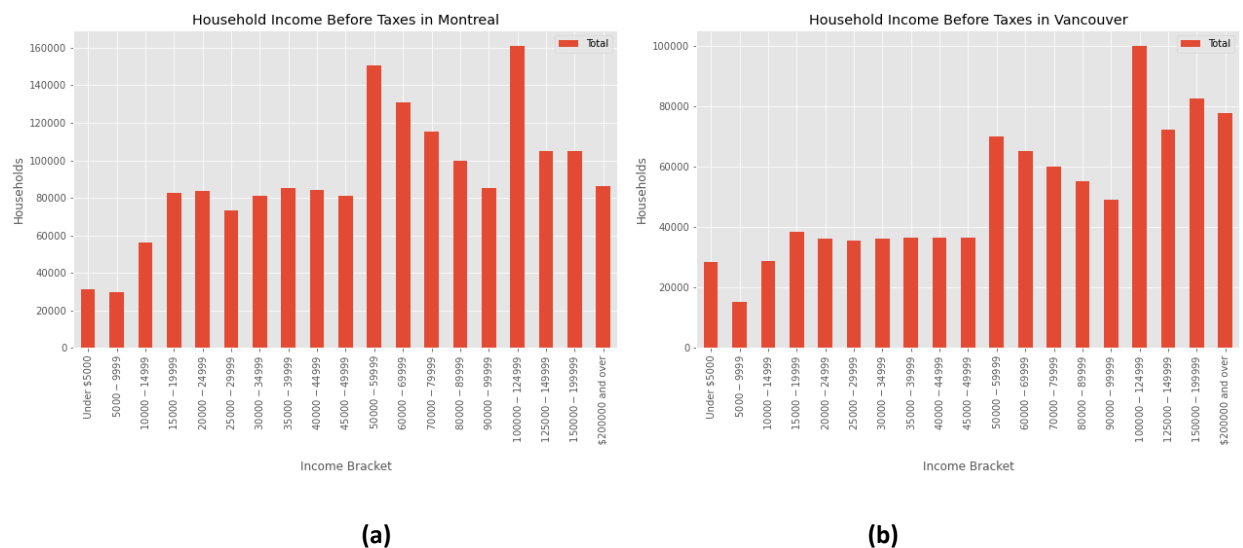


Figure 7. Household income before taxes in 2016 for (a) Montreal and (b) Vancouver.

3.4.2 Immigration

The top 15 countries which contributed to immigration to Montreal and Vancouver were plotted according to the number of immigrants (Figure 8). The highest contributors for Montreal immigration were Haiti, France, and Morocco. All of which are French speaking countries. In contrast, Vancouver has a high immigrant population from China, India, and other Asian countries. This cultural difference is reflected in the popular venues which were found via Foursquare. For example in Vancouver, especially in cluster 2, there is a large number of Chinese, Japanese, and Vietnamese restaurants. In contrast, in Montreal, there is a larger proportion of European-style restaurants, like French, Italian and Portuguese. This information is also relevant to those considering immigrating to Canada. Both Montreal and Vancouver are large urban centers of industry, providing ample opportunities for immigrants. The ability

to move into an established community which speaks the same language is invaluable for integrating into a new environment.

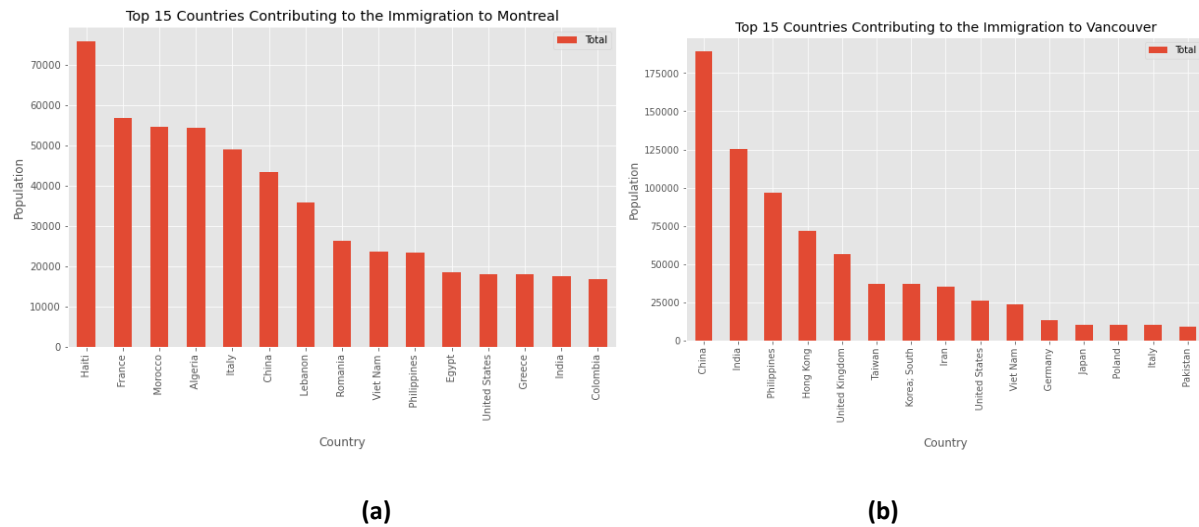


Figure 8. Top 15 countries which contributed immigration to (a) Montreal and (b) Vancouver.

3.4.3 Population Distribution

Montreal is a younger skewing city, with a greater proportion of young children compared to Vancouver (Figure 9). Given the higher cost associated with living in Vancouver, families with younger children are more able to afford accommodation in Montreal. Gender-wise there's a fairly uniform distribution for both sexes among the population.

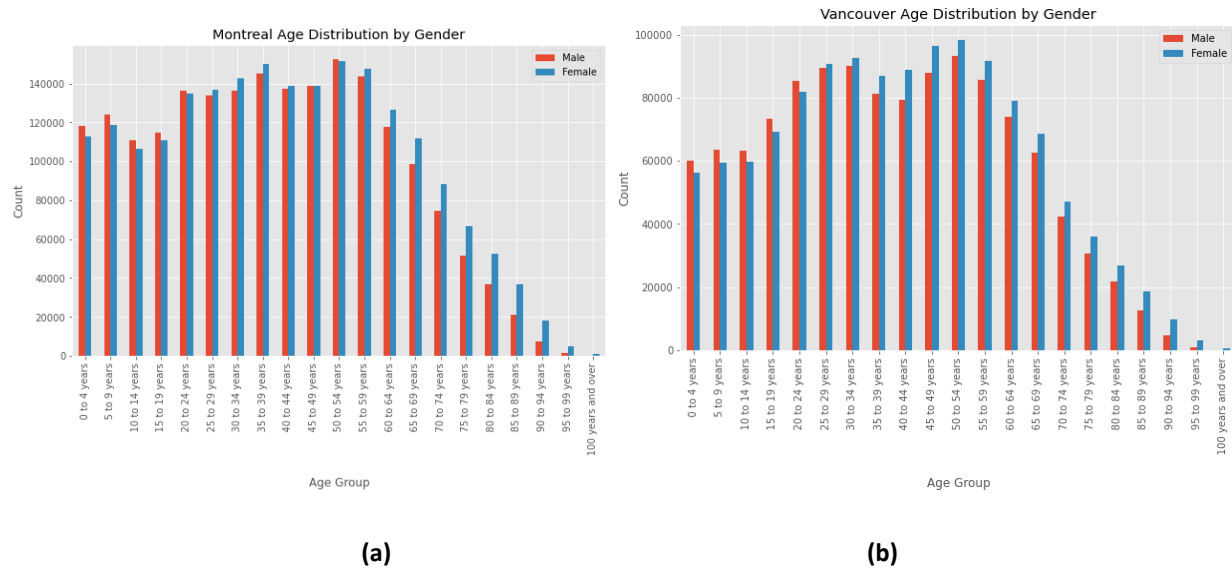


Figure 9. Age and gender distribution for (a) Montreal and (b) Vancouver.

4 DISCUSSION

This study sought to provide data to potential visitors to either Montreal or Vancouver to help: identify regions within the city which provide amenities which align with an individuals preferences, the cost associated with living within each city, and the ethnographic make-up of each city to provide immigrants with a built-in community. Both cities provide a large range of amenities throughout the majority of the municipalities, with the exception of small clusters. Thus, the main factor which can affect choosing between these cities is cost. Rental costs can depend on numerous factors like neighbourhood amenities (e.g. restaurants and attractions), access to public transportation, and views (e.g. waterfront, parks). Rental prices in both Montreal and Vancouver increase in the downtown core and for waterfront properties. In Vancouver there is a large Asian community which can help support new immigrants. Montreal has a large French population from European countries and Haiti. Larger proportion of young children (<15 years old) in Montreal implying more families with younger children live in the city. Montreal is likely more affordable and has more households in the <\$100,000 per year income bracket as compared to Vancouver.

5 CONCLUSIONS

Overall, the recommendation for individuals with moderate incomes and younger families the best choice is Montreal. In terms of tourism, there are several popular hotels in the downtown cores of both Montreal and Vancouver. Montreal has a variety of historical attractions, lower costs, and a variety of dining options such as Italian, Portuguese, and French restaurants and bakeries. Vancouver has a large variety of breweries, Asian-type dining options (e.g. Chinese, Japanese, and Vietnamese), and parks. It really is up to an individual's taste about which city they would like to visit.

6 FUTURE DIRECTIONS

In continuation of this study, it may be helpful to look at house prices in these areas. The Canadian housing market is currently in an upswing despite the global pandemic. While rental prices, as analysed above, provide helpful information for younger professionals, house prices are more applicable to those with established careers who are looking for a forever home. A further update to this study should be conducted once the 2021 census is completed, for more current conclusions pertaining to cost.