Route Analysis of 52 Dundas

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Lay Abstract

Abstract

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Declaration of Authorship

I, Sadia Tasnim, declare that this thesis titled, *Route Analysis of 52 Dundas* and the work presented in it are my own. I confirm that:

Chapter 1

Route Alignment

1.1 1.1 Route Directness

Using Google Maps and Remix, the roundtrip distance, actual length of the route and the shortest path between the start-end stops were determined. In the northbound direction, the 52 Dundas route starts from Orchard at Pleasant and ends at Watson's Lane Loop. In the southbound direction, the 52 Dundas route starts from Watson's Lane Loop and ends at Orchard at Pleasant. The roundtrip distance for the 52 Dundas route from northbound to southbound is 10.49 km. The actual length of the route is 5.2 km in both directions (northbound and southbound). The shortest path between the start-end stops is 5.1 km in both directions (northbound and southbound). Generally known, the ratio indicates the route directness. The ratio between the shortest path and the actual route is 0.98 in both directions meaning the route is quite direct.

1.2 1.2 Service Coverage

According to the census data, and route characteristics from OpenStreetMaps, the population size served by the route is approximately 8245 in both directions. The service coverage area within 400 m of the local bus.

52 Dundas route characteristics:

	X	Inbound	Outbound
1	Roundtrip Distance	10.49 km	
2	Actual Route Length	5.2 km	5.2 km
3	Shortest Path	5.1 km	5.1 km
4	Ratio	0.98	
5	Population	8245	
6	Holistic Land Use	Residential	
7	Current Route Operation Cost	$144.9 k/year	

The information is also summarized below:

Characteristic	Value
Roundtrip Distance	10.49 km
Actual Route Length	5.2 km (inbound) and 5.2 km (outbound)
Shortest Path	5.1 km
Ratio	0.98
Population	8245
Holistic Land Use	Residential
Current Route Operation Cost	$144.9 k/year

1.3 1.3 Land Use

The northbound and southbound transit routes for 52 Dundas are both mainly comprised of residential land use considering it provides service to an area that is predominantly surrounded by housing infrastructure. Both directions also have few commercial and institutional land uses. This information was extracted with Remix. Alternatively, it can be extracted with census data for Hamilton.

Chapter 2

Some chapter

2.1 R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

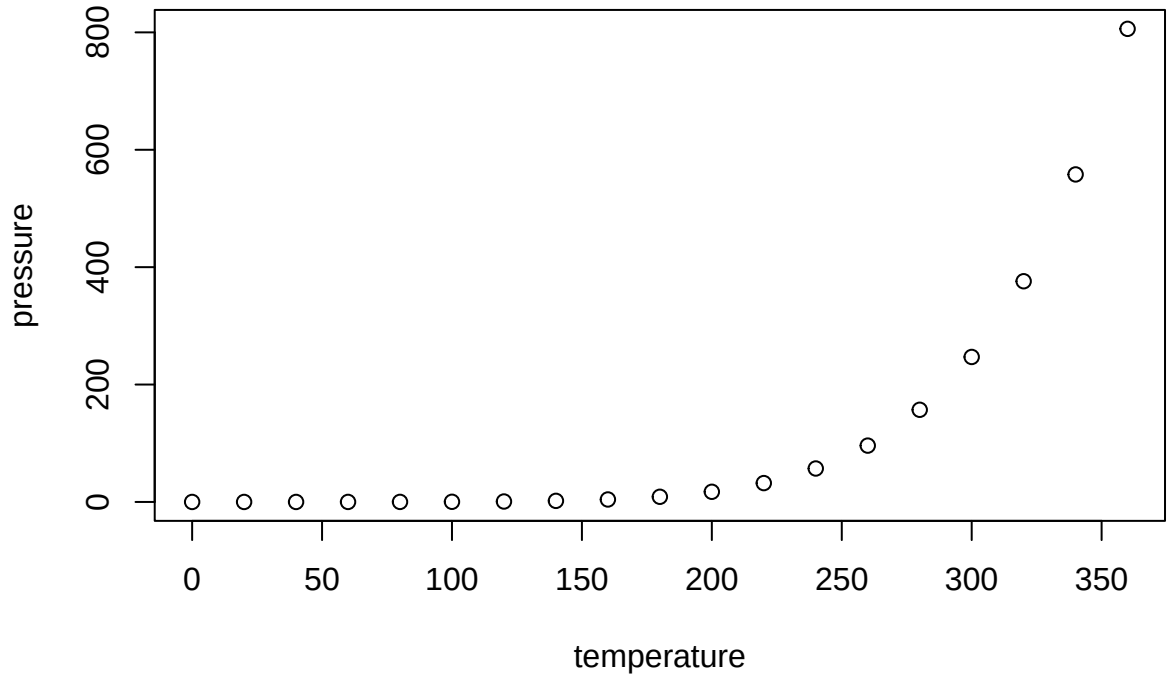
When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)
```

```
     speed           dist       
 Min.   : 4.0   Min.   :  2.00  
 1st Qu.:12.0   1st Qu.: 26.00  
 Median :15.0   Median : 36.00  
 Mean   :15.4   Mean   : 42.98  
 3rd Qu.:19.0   3rd Qu.: 56.00  
 Max.   :25.0   Max.   :120.00  
```

2.2 Including Plots

You can also embed plots, for example:



Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

Chapter 3

Service Frequency

The purpose of analyzing the service frequency of an existing transit system is to ensure that the level of service has adequate space to accommodate the maximum number of on-board passengers along the entire route over a given time period. Using Remix, both inbound and outbound timetable data were extracted to analyze both the weekday and weekend frequencies and fleet size.

To find the service frequency, divide the total operating hours by the number of trips made by the bus which will give you the average time between each buss arrival along the route or at the stop. Keep in mind, frequency and headway are both terms used to describe the time intervals between buses on a particular route or at a specific bus stop. However, they represent this information in slightly different ways. Frequency refers to the number of bus trips or arrivals at a stop within a specific period, often expressed as the number of buses per hour. For example, a bus service with a frequency of 15 minutes means that a bus arrives approximately every 15 minutes at that stop.

It will be calculated as 1/Time Interval. Headway represents the time interval between the departure or arrival of successive buses. It is the actual time that elapses between one bus leaving or arriving and the next bus following it at a particular stop or along a route.

Headway and frequency can be converted in that:

$$Frequency = 1/Headway$$

$$Headway = 1/Frequency$$

In other words, Frequency is simply just the inverse of the headway.

$$Frequency = Headway^{-1}$$

When referring to bus service, a higher frequency or shorter headway generally means better service, providing passengers with more options and shorter waiting times between buses.

3.1 3.1 Frequency Weekday

The frequency weekday was analyzed for both inbound and outbound directions by graphing the average frequency of the existing service for certain time intervals. Based on the frequency data patterns observed for both inbound and outbound, the level of frequency was consistent along the entire route over different time periods for all stops. This was the case for 52 Dundas considering there was not much change in the level of service along the route. To represent the frequency weekday for this route, the frequency of the inbound stop Orchard at Pleasant, and the outbound stop Watson's Lane Loop were used as a benchmark. The maximum frequency for both inbound and outbound is 1.67 buses/hr which occurs during both 06:30 – 09:30 AM and 15:00 – 18:00 PM peak hours.

3.2 3.2 Frequency Weekend

Currently, Route 52 Dundas is not scheduled to run during weekends, hence the frequency for the weekend is zero. It could be that there is not enough demand or ridership during the weekends for the 52 Dundas area. This could be something to reconsider when reconfiguring the route.

3.3 3.3 Fleet Size

The fleet size for Route 52 is 2 buses for both time periods during the Weekday. As Route 52 does not run-on weekends, there are no fleet sizes reported. The maximum fleet is 2 buses. The buses run every 30 minutes so for the first time period, there is one bus per hour and for the second time period, there is one bus every hour and a half.

```
                                                X52.Dundas.Lelouche
1                                https://platform.remix.com/map/81daf133
2
3                                                  PROJECT SETTINGS
4                                                        Costing by
5
6                                                     Calendar days
7                                                     Weekdays / yr
8                                                    Saturdays / yr
9                                                      Sundays / yr
10
11                                                    Layover rules
```

```
12                                                % of trip runtime
13                                     Minimum flat rate (minutes)
14 For each trip, Remix will use whichever of the above is greater
15
16                                                    SYSTEM STATS
17                                                   Yearly totals
18                                                           Lines
19                                                        Vehicles
20                                                          $ / yr
21                                                       Hours / yr
22                                                  Trip hours / yr
23                                                Layover hours / yr
24                                                   Kilometers / yr
25                                                           Stops
26                                                      Avg m apart
27
28                                                   Vehicle Types
29                                                             Bus
30
31                                                    Weekday totals
32                                                          $ / wkdy
33                                                       Hours / wkdy
34                                                  Trip hours / wkdy
35                                                Layover hours / wkdy
36                                                   Kilometers / wkdy
37
38                                                    Saturday totals
39                                                          $ / sat
40                                                       Hours / sat
41                                                  Trip hours / sat
42                                                Layover hours / sat
43                                                   Kilometers / sat
44
45                                                    Sunday totals
46                                                          $ / sun
47                                                       Hours / sun
48                                                  Trip hours / sun
49                                                Layover hours / sun
50                                                   Kilometers / sun
51
52                                                             Line
53                                                  52 Dundas Local
               X             X.1          X.2               X.3
1
```

```
2
3
4     Vehicle type
5
6
7               255
8                55
9                55
10
11
12              10%
13
14
15
16
17
18               1
19               2
20         145,860
21           1,459
22           1,326
23             133
24          31,508
25              35
26             296
27
28   Vehicle count            Lines       $ / hr $ / hr (Saturdays)
29               2                1       100.00                   0
30
31
32             572
33               6
34               5
35               1
36             124
37
38
39
40
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```

Inbound, A (km)	Outbound, A (km)	Vehicle type	Vehicle count	
5.3	5.2	Bus	2	
X.4	X.5	X.6	X.7	X.8

$ / hr (Sundays)	$ / km	$ / vehicle	Hours / yr	Kilometers / yr
0	0	0	1,459	31,508

```
36
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45
46
47
48
49
50
51
52       Hours / yr Kilometers / yr      $ / yr
53            1,459          31,508     145,860
             X.9
1
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```

```
26
27
28 Total $ / yr
29      145,860
30
31
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34
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```

Chapter 4

Service Demand and Evaluation

In this chapter, service demand and evaluation are explored!

4.0.1 Service Demand

Route 52 only runs during the periods of A.M. peak, midday and P.M. peak. Based on this we decided to allocate 34% to the A.M. peak, 32% to the midday period and the last 34% to the P.M. peak. In the data folder, the distribution of boardings at each stop along the route associated with each time period are detailed. From these results, load profile graphs can be generated. This is where the images of the figures should be displayed, however, it was unable to knit.

```
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```

The frequency we found doing the Load Profile Method was found to be the same freq

	Name	Distance.to.next.stop..m.	Boardings.weekdays
1	ORCHARD at PLEASANT	382	39.736
2	TURNBULL opposite KINGS GATE	197	0.845
3	TURNBULL opposite AUTUMN LEAF	296	5.474
4	TURNBULL at TERRACE	582	2.181
5	OLD ANCASTER opposite PLEASANT	443	1.976
6	OLD ANCASTER at DUNDANA	129	0.569
7	OGILVIE at OLD ANCASTER	342	5.525
8	OGILVIE at GOVERNORS	213	31.535
9	GOVERNOR'S at MAIN	445	9.705
10	YORK at COOTES	170	13.897
11	YORK at HUNTER	263	4.267
12	YORK at DONALD	322	0.990
13	YORK at CAMERON	503	1.029
14	YORK opposite MCKAY	162	2.924
15	YORK opposite WATSONS	251	1.355
16	YORK opposite FIELDGATE	383	2.904
17	YORK at OLYMPIC	203	0.176
18	WATSONS LANE LOOP		0.000
19	Total	5.288018069	
20			
21			
22	Desired Occupancy	35	
23	Capacity	75	
24			
25			
26	Northbound Direction	Aj/do*L)	Pm/C
27	A.M. Peak	0.070176	0.186666667
28	Mid-Day	0.066041	0.173333333
29	P.M. Peak	0.070176	0.186666667

```
30
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```

	A.M..Peak	Mid.Day	P.M..Peak	Aj.A.M..Peakl	Aj.Mid.Day	Aj.P.M..Peak	X	X.1
1	14	13	14	5.348	4.966	5.348	NA	NA
2	0	0	0	0.000	0.000	0.000	NA	NA
3	2	2	2	0.591	0.591	0.591	NA	NA
4	1	1	1	0.582	0.582	0.582	NA	NA
5	1	1	1	0.443	0.443	0.443	NA	NA
6	0	0	0	0.000	0.000	0.000	NA	NA
7	2	2	2	0.685	0.685	0.685	NA	NA
8	11	10	11	2.343	2.130	2.343	NA	NA
9	3	3	3	1.336	1.336	1.336	NA	NA
10	5	4	5	0.852	0.682	0.852	NA	NA
11	1	1	1	0.263	0.263	0.263	NA	NA
12	0	0	0	0.000	0.000	0.000	NA	NA
13	0	0	0	0.000	0.000	0.000	NA	NA
14	1	1	1	0.162	0.162	0.162	NA	NA
15	0	0	0	0.000	0.000	0.000	NA	NA
16	1	1	1	0.383	0.383	0.383	NA	NA
17	0	0	0	0.000	0.000	0.000	NA	NA
18	0	0	0	0.000	0.000	0.000	NA	NA
19				12.988	12.223	12.988	NA	NA
20				NA	NA	NA	NA	NA
21				NA	NA	NA	NA	NA
22				NA	NA	NA	NA	NA
23				NA	NA	NA	NA	NA
24				NA	NA	NA	NA	NA
25				NA	NA	NA	NA	NA
26	Fmin	Fj	Scale	NA	NA	NA	NA	NA
27	3	3	Appropriate	NA	NA	NA	NA	NA
28	5.5	5.5	Appropriate	NA	NA	NA	NA	NA
29	3	3	Appropriate	NA	NA	NA	NA	NA
30				NA	NA	NA	NA	NA
31				NA	NA	NA	NA	NA
32				NA	NA	NA	NA	NA
33				NA	NA	NA	NA	NA
34				NA	NA	NA	NA	NA

	X.2	X.3	X.4	X.5
1	NA			
2	NA			
3	NA			

```
4   NA
5   NA
6   NA
7   NA
8   NA Distribution of time periods Distribution Redistributed
9   NA  Early Morning (04:00-06:30)           3%
10  NA      A.M. Peak (06:30-09:30)          34%          0.34
11  NA        Mid-Day (09:30-15:00)          18%          0.32
12  NA      P.M. Peak (15:00-18:00)          29%          0.34
13  NA        Evening (18:00-22:00)          12%
14  NA     Late Night (22:00-04:00)           4%
15  NA                                      100%
16  NA
17  NA
18  NA
19  NA
20  NA
21  NA
22  NA
23  NA
24  NA
25  NA
26  NA
27  NA
28  NA
29  NA
30  NA
31  NA
32  NA
33  NA
34  NA
```

```
   ID
1   1
2   2
3   3
4   4
5   5
6   6
7   7
8   8
9   9
10 10
11 11
```

```
12 12
13 13
14 14
15 15
16 16
17 17
18 18
19 19
20 NA
21 NA
22 NA
23 NA
24 NA
25 NA
26 NA
27 NA
28 NA
29 NA
30 NA

1
2
3
4
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21
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```

25
26
27
28 The frequency we found doing the Load Profile Method was found to be the same freq
29
30

	Distance.to.next.stop..meters.	Boardings.Weekday	A.M..Peak
1	164	8.910	3
2	343	0.206	0
3	227	3.626	1
4	213	7.422	3
5	459	1.231	0
6	252	2.713	1
7	342	0.418	0
8	259	0.666	0
9	427	1.914	1
10	181	7.376	3
11	351	8.824	3
12	122	3.896	1
13	435	2.872	1
14	285	0.209	0
15	253	0.333	0
16	282	0.295	0
17	218	4.525	2
18	359	3.673	1
19		0.439	0
20	5.171		

21
22

Load Profile (Aj/(do*L)	Maximum Hourly (Pmj/C)	F minimum (Fmj)
0.027524	0.04	3
0.024146	0.04	5.5
0.027524	0.04	3

23
24
25
26
27
28
29
30

	Mid.Day	P.M..Peak	Aj.AM.Peak	Aj.Mid.Day.Peak	Aj.PM.Peak	X	X.1	X.2	X.3
1	3	3	0.491	0.491	0.491	NA	NA	NA	NA
2	0	0	0.000	0.000	0.000	NA	NA	NA	NA
3	1	1	0.227	0.227	0.227	NA	NA	NA	NA
4	2	3	0.639	0.426	0.639	NA	NA	NA	NA
5	0	0	0.000	0.000	0.000	NA	NA	NA	NA
6	1	1	0.252	0.252	0.252	NA	NA	NA	NA

7	0	0	0.000	0.000	0.000	NA	NA	NA	NA
8	0	0	0.000	0.000	0.000	NA	NA	NA	NA
9	1	1	0.427	0.427	0.427	NA	NA	NA	NA
10	2	3	0.542	0.361	0.542	NA	NA	NA	NA
11	3	3	1.052	1.052	1.052	NA	NA	NA	NA
12	1	1	0.122	0.122	0.122	NA	NA	NA	NA
13	1	1	0.435	0.435	0.435	NA	NA	NA	NA
14	0	0	0.000	0.000	0.000	NA	NA	NA	NA
15	0	0	0.000	0.000	0.000	NA	NA	NA	NA
16	0	0	0.000	0.000	0.000	NA	NA	NA	NA
17	1	2	0.436	0.218	0.436	NA	NA	NA	NA
18	1	1	0.359	0.359	0.359	NA	NA	NA	NA
19	0	0	0.000	0.000	0.000	NA	NA	NA	NA
20			4.982	4.370	4.982	NA	NA	NA	NA
21			NA			NA	NA	NA	NA
22	Fj	Scale	NA	Design Occupancy	35	NA	NA	NA	NA
23	3	Appropriate	NA	Capacity	75	NA	NA	NA	NA
24	5.5	Appropriate	NA	Min Freq	1 bus/hr	NA	NA	NA	NA
25	3	Appropriate	NA			NA	NA	NA	NA
26			NA			NA	NA	NA	NA
27			NA			NA	NA	NA	NA
28			NA			NA	NA	NA	NA
29			NA			NA	NA	NA	NA
30			NA			NA	NA	NA	NA

4.0.2 Service Evaluation

Use the data file labelled "Load Profile Analysis" to begin analyzing the how frequency changes throughout the time periods in a day. In order to evaluate the service utilization, the current frequency and the optimal frequency in each direction must be compared. Based on the steps, the results should be as follows.

For the AM/PM peaks, the current frequency is higher than optimal and therefore the allocated service is over-utilized. Ideally the frequency should be decreased to the minimum of 1 bus per hour to save costs and avoid running empty buses. For the mid-day time period the frequency was 0 as no buses were running at the time however by analyzing the data from task 4 and 5 we can see that the frequency can be brought up to the minimum of 1 bus per hour to accommodate the demand for mid-day service.

From the excel file, Load_Profile_Analysis, the desired occupancy of the buses operating on 52 Dundas have a desired occupancy of 35 and a capacity of 75 passengers. The total length route will be the summation of all the distances divided by 1000 to get the distance in kilometres.

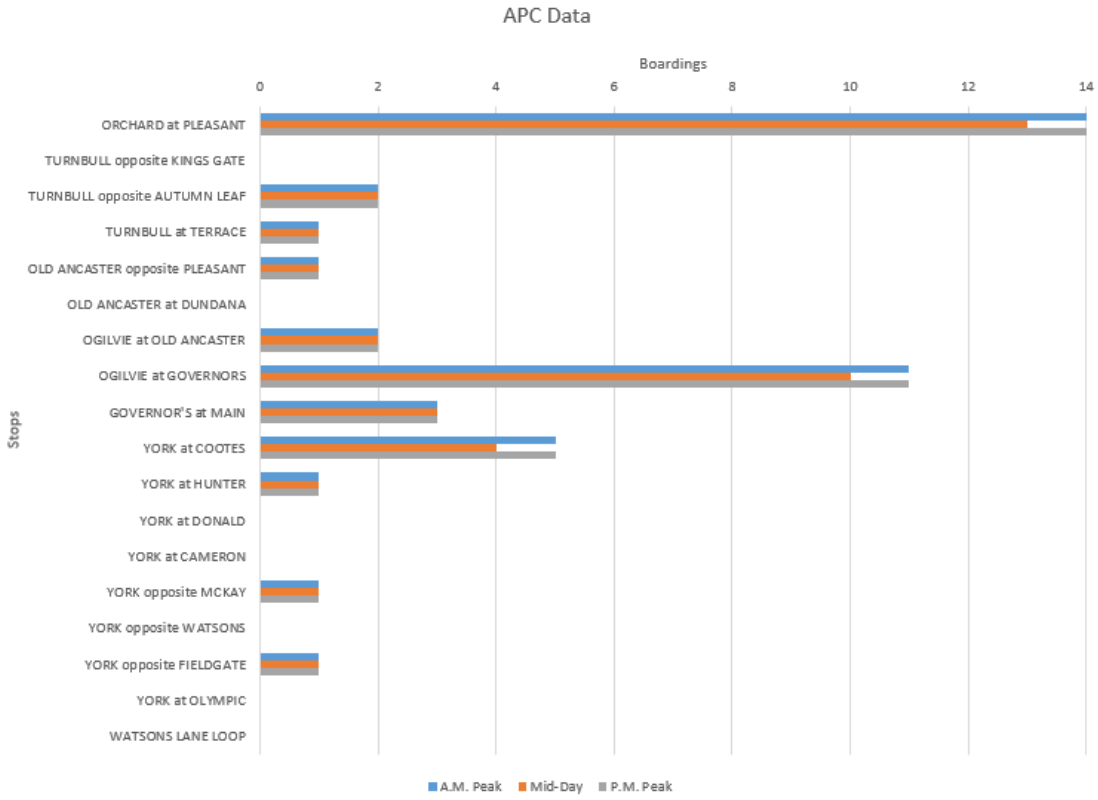
$$TotalDistance = \sum(DistanceToStop)/1000$$

When analyzing the load profiles, setting up the table as such will make it easier to calculate the Frequencies.

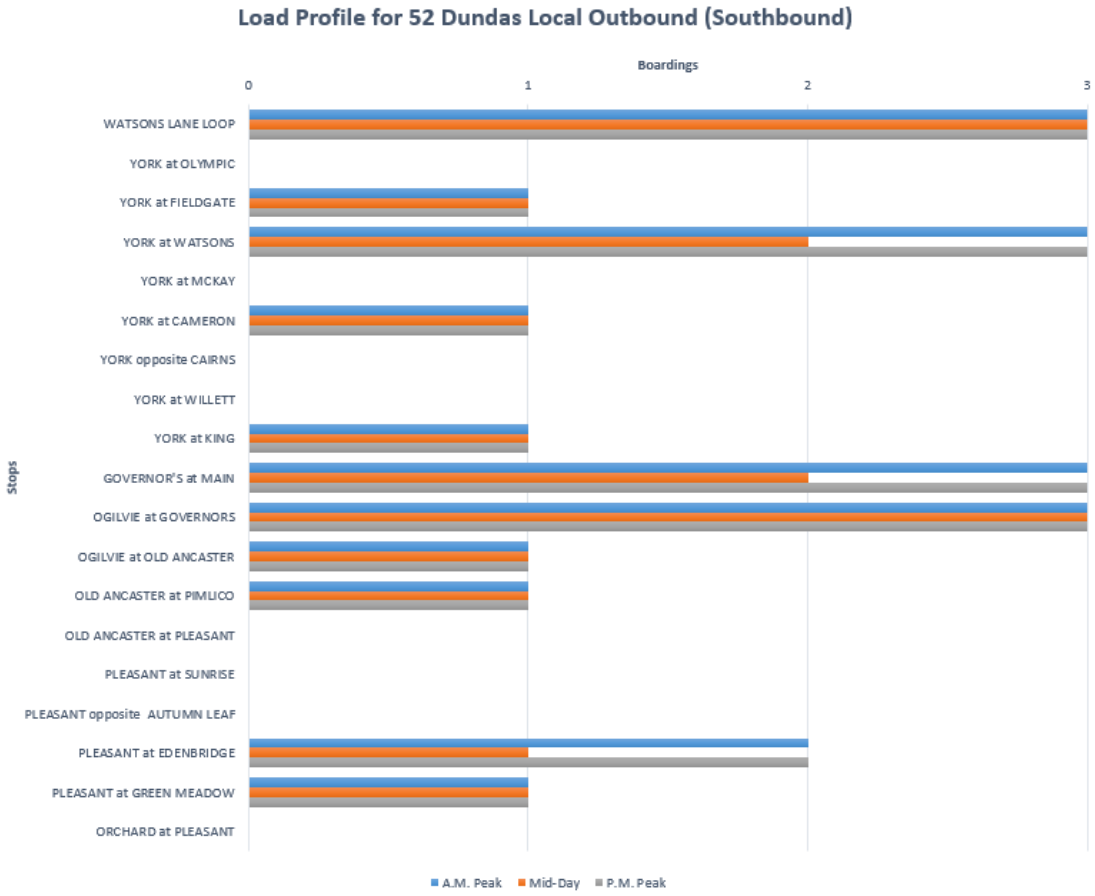
For the northbound direction, the frequency we found doing the Load Profile Method was found to be the same frequencies as calculated in Service Frequencies. The minimum frequency is 1 bus per hour for all time periods. With this reasoning, we determined that the service currently allocated within each time interval was appropriate. We assumed the desired occupancy of a 40 ft bus which requires 35 passengers and a capacity of 75 passengers.

For the southbound direction, the frequency we found doing the Load Profile Method was found to be the same frequencies as calculated in Service Frequencies. The minimum frequency is 1 bus per hour for all time periods. With this reasoning, we determined that the service currently allocated within each time interval was appropriate. We assumed the desired occupancy of a 40 ft bus which requires 35 passengers and a capacity of 75 passengers.

This is what the chart will look like for the **Northbound** direction.



This is what the chart will look like for the **Southbound** direction.


Load Profile for 52 Dundas Local Outbound (Southbound)
Boardings
0
1
2
3
Stops
WATSONS LANE LOOP
YORK at OLYMPIC
YORK at FIELDGATE
YORK at WATSONS
YORK at MCKAY
YORK at CAMERON
YORK opposite CAIRNS
YORK at WILLETT
YORK at KING
GOVERNOR'S at MAIN
OGILVIE at GOVERNORS
OGILVIE at OLD ANCASTER
OLD ANCASTER at PIMLICO
OLD ANCASTER at PLEASANT
PLEASANT at SUNRISE
PLEASANT opposite AUTUMN LEAF
PLEASANT at EDENBRIDGE
PLEASANT at GREEN MEADOW
ORCHARD at PLEASANT
A.M. Peak
Mid-Day
P.M. Peak

Chapter 5

Conclusion

A simple analysis was completed for 52 Dundas route in an effort to observe the existing system's infrastructure through changes in operational quality, service quality, and overall connectedness of the transportation grid. From these results, different reconfigurations could be made based on minimizing costs or improving the service within communities in close proximity to the 52 Dundas HSR route. However, it is important to note that there is no perfect, silver-bullet solution for this route or any route for that matter.

The data provided as well as the process of extracting these results have been outlined within this project. File naming, version control with Github, determining the appropriate tools (R Studio and Excel) to use, identifying the infrastructure and then creating a process flow were completed. This project can hopefully be reproduced and repeated with the data and the instructions provided.Ideally, the steps outlined in each of the chapters should allow a user to repeat the steps with the same data provided or alternatively, reproduce similar results with other APC data.

On a personal note, it has been a huge learning experience for me. I have been able to learn many new skills that I did not have at the start of this semester. I came into this course with null knowledge of R and Github and it is amazing what I can now do with the skills I have! Thank you so much Antonio!