“Is There a Bus?”:

Ridership Changes from All-day, Every-day Transit Service in Toronto

By

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Abstract

This thesis explores the relationship between public transit ridership and service provision on bus routes in Toronto, Canada. The study examines how increasing the span-of-service, or the hours of operation for transit routes, affects ridership patterns. The research addresses a key question: "How does transit ridership change when additional hours of transit service are provided?" Additionally, the thesis analyzes the demographic characteristics of the neighborhoods where service enhancements occur, assessing the correlation between these characteristics and ridership changes.

This work is rooted in the broader context of public transit's role in urban mobility. Public transportation provides essential access to employment, education, and services while reducing dependence on private automobiles and contributing to environmental sustainability. The thesis highlights the importance of bus services within an integrated transit network, especially in a major city like Toronto, where buses serve diverse neighborhoods and play a crucial role in ensuring mobility for residents.

The study utilizes ridership data before and after two significant service increase initiatives in Toronto, in 2008 and 2015, to analyze changes in ridership across different routes. The research investigates the degree to which increased hours of operation lead to corresponding changes in ridership. The findings suggest that expanding the span-of-service can positively impact ridership, particularly in areas with specific demographic characteristics, such as neighborhoods with higher populations of low-income residents, recent immigrants, and renters.

Overall, this thesis contributes to the understanding of how public transit service improvements, particularly in bus operations, can enhance urban mobility and support equitable access to transportation in metropolitan areas like Toronto.

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This work had its beginnings more than 35 years ago, during my first incarnation as a master's student, and it has come to fruition now with the support of many people.

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Chapter 1 Introduction

"Is there a bus?". That is a question that is asked often, and in many different contexts. It could be an immediate temporal inquiry, meaning "Is there a bus coming here right now to pick me up?" It could be a spatial question, wondering "is there a bus that will get me there?" when considering a new job or a new place to live. At some point it is a fundamental question asked by most people who use public transit. "You can't ride the bus if it isn't there for you."

Public transit fulfils a crucial role in cities. Local urban public transit provides mobility to city residents, who can move about, access jobs, school, shopping and other locations, and do so without access to a personal automobile. Effective and accessible public transit unlocks development potential in cities, enables access to employment, education, housing, and services, reduces dependency on automobile travel, and can reduce road traffic congestion. Air quality is improved in cities where a significant percentage of travel is by public transit and other active transportation modes (Toronto Transit Commission, 2024b). Investment in the construction and operation of public transit generates economic benefits, contributing to the GDP, adding to economic activity, and providing jobs.

A recent study in Toronto, Canada estimated that every dollar invested in public transit generates more than seven dollars in economic, regional development, and quality-of-life benefits. The study also estimated that there is a further $5.78 in transit rider and motorist benefits, from reduced travel expenses, congestion, and personal vehicle ownership costs (Miller, DiFrancesco, Farber, & Hatzopoulou, 2023).

Public transit is also, at its heart, about people. The transit service exists to move people, and to do so effectively it must be available to customers when and where they need it. For many transit customers, having transit available to them can be a life-changing benefit. The availability of transit is constrained by the resources available to provide it; the ability of customers to pay a fare to ride it; and the support for transit provided by riders, residents, and funding stakeholders. Understanding how transit ridership changes when transit service levels are altered is important to ensuring that transit can be available and useful to customers.

This thesis examines a specific relationship between transit ridership and the provision of transit service, at the bus route level in Toronto. It asks the question "How does transit ridership change when additional hours of transit service are provided?", while also examining the characteristics of the neighbourhoods where the service changes are made, and how those characteristics are related to the degree of ridership change that results from the service improvements.

1.1 Public Transit Modes and Capacity

Public transport in major Canadian cities is provided by several modes of travel. The most common is the bus. Accommodating up to 80 people, driven by one operator, and powered by a diesel engine, electricity, or a hybrid combination of both, buses can effectively provide transit service to many different types of neighbourhoods. Buses can provide a local service in residential neighbourhoods, serving closely spaced stops, and can also provide a higher-capacity faster service on major roadways, including operating limited-stop express services, and on bus rapid transit rights-of-way (Transit Capacity and Quality of Service Manual, Third edition, 2013). Typically, bus routes provide service along minor or major streets, and in

neighbourhoods and commercial areas, serving local and shorter distance trips. Connections between bus routes are easily made at intersections along the way.

Farther up the hierarchy of urban transport modes are rail-based systems, such as streetcars, light rail, subways, and commuter railways. These provide higher passenger capacity per vehicle and per hour, requiring fewer operators per passenger, with more widely spaced stops, and offering a more visible and permanent transit service at their stops and stations (Transit Capacity and Quality of Service Manual, Third edition, 2013).

1.2 Transit Modes in Major Cities in Canada

Major transit agencies across Canada use several of these modes to operate a balanced transit system that matches the capacity of the mode to the ridership level, providing an integrated transit network that moves people in the most efficient way. Bus routes connect to light rail, subway, or commuter rail stations, where customers transfer for longer distance trips. In some transit systems, this modal integration is encouraged by the network design of the transit network, the fare structure, interchange facilities at stations, and the patterns of service operated on the routes and rapid transit lines. *Table 1-1 Public Transit Modes in Canada* shows the main public transit modes operated in Canada's ten largest metropolitan areas.

The three largest metropolitan areas, Toronto, Montreal, and Vancouver, have the greatest range of transit modes. All the regions operate bus services. Most regions have large fleets of buses of various capacities. Seven of the ten regions have more than just bus services, operating rail rapid transit in the form of subway/metro, light rail, or automated light metro. In all cases, the subway, light rail, and bus networks are operated in each region by a single operator, as part of an integrated local public transit network. Service, fares, and customer

service standards on these networks are harmonized. In Toronto and Montreal, the commuter rail services are operated by a separate agency, but with some degree of integrated fares.

Table 1-1 Public Transit Modes in Canada

Metropolitan area	Commuter Rail	Subway/ Metro/ Light Metro	Light Rail/ Streetcar	Bus
Toronto	Yes	Yes	Yes	Yes
Montreal	Yes	Yes	—	Yes
Vancouver	Yes	Yes	—	Yes
Ottawa-Gatineau	—	Yes	Yes	Yes
Calgary	—	—	Yes	Yes
Edmonton	—	—	Yes	Yes
Quebec City	—	—	—	Yes
Winnipeg	—	—	—	Yes
Hamilton	—	—	Planned	Yes
Waterloo Region	—	—	Yes	Yes
Sources: Metropolitan areas (Statistics Canada, 2022); **Transit modes (Canadian Urban Transit Association, 2020)**				

1.3 Transit Operations and Span-of-service

Simply having an expansive integrated transit network, with routes and lines and stations, is not in itself enough to ensure that the transit system serves its customers by providing them mobility or other benefits of a transit system. It is also necessary to provide service on the transit network, so that the buses and trains operate at times when customers want to travel. Two essential characteristics define the quality of service provided – the speed of the service, and the hours of operation of the service (Vuchic, 2005).

The first characteristic, the speed of the service, is important to transit customers, so that waiting time for a bus or train is minimized, so that sufficient capacity is provided to carry all the customers who want to travel, and customers get where they are going in a reasonable time. Customers may have other options for travelling and offering fast transit service. By

minimizing waiting time and operating a fast service free of delay, this helps to make transit competitive against other modes. The provision of frequent and fast service, and the effects on customer usage of the transit system, has been studied extensively (Litman, 2008; Berrebi, Joshi, & Watkins, 2021)

This thesis, however, is focussed on the second characteristic of providing service that is important to customers – the hours of operation of the service, also known as the span-of-service. The span-of-service is of vital importance to customers, as a transit system cannot serve people if it is not operating at the times when they want to travel from locations (bus stops) that are accessible to potential riders.

1.3.1 Span-of-service on rapid transit

The large capital investment in rail rapid transit lines is typically matched by lengthy hours of operation, throughout the day and evening. Rapid transit lines are the highest-order transit services, and attract the most attention from stakeholders, policymakers, and casual users of the system, and thus are provided with funding to operate at all times of the typical public transit day. Because of their higher fixed costs for infrastructure and station operation, the additional marginal cost of more hours of service is relatively lower, and thus more likely to be funded. *Table 1-2 Span-of-service for selected rail rapid transit lines in Canada, 2024* shows the span-of-service, as expressed by first and last train times, for selected rail rapid transit lines in the major metropolitan areas of Canada.

In almost all cases, these rail rapid transit lines operate from early in the morning to midnight, or beyond, providing service throughout the typical transit operating day. The span-

of-service on most of the lines is the same, or similar, for every day of the week. This consistent and full span-of-service is typical of the highest-order transit services in a transit system.

Table 1-2 Span-of-service for selected rail rapid transit lines in Canada, 2024

Metropolitan Area	Line	Monday-Friday		Saturday		Sunday	
		First train	Last train	First train	Last train	First train	Last train
Toronto	Line 1	05:53	01:42	06:02	01:40	08:14	01:40
Toronto	Line 2	05:54	01:51	06:00	01:52	08:08	01:52
Montreal	Green	05:45	00:57	05:45	01:27	05:45	00:57
Montreal	Orange	05:44	00:57	05:44	01:27	05:44	00:57
Montreal	REM	05:35	01:10	05:35	01:40	05:35	01:10
Vancouver	Expo	05:29	01:16	06:47	01:16	07:48	00:16
Vancouver	Canada	04:48	01:15	04:48	01:15	04:48	01:15
Ottawa	Line 1	05:05	01:09	06:01	02:09	08:03	23:10
Calgary	Red	03:57	01:38	04:09	01:38	04:09	01:38
Calgary	Blue	04:52	01:51	05:31	02:00	05:31	02:00
Edmonton	Capital	05:13	00:55	05:10	00:55	05:10	00:10
Edmonton	Valley	05:15	01:05	05:15	01:05	05:15	00:30
Waterloo	ION	05:10	00:23	05:25	00:23	06:40	00:23

Sources: Toronto (Toronto Transit Commission, 2024c); Montreal (Société de transport de Montréal, 2024); Vancouver (Translink, 2024); Ottawa (OC Transpo, 2024); Edmonton (Edmonton Transit, 2024); Calgary (Calgary Transit, 2024); Waterloo (Grand River Transit, 2024)

1.3.2 Span-of-service on bus routes

Bus services, however, may have shorter and less consistent spans of service. This is a result of the flexible nature of bus services, and the varied roles played by bus services, from low-volume local neighbourhood routes, typically with less service, to high-volume frequent routes on major streets, which often have longer hours of operation. *Table 1-3 Span-of-service for selected bus routes in Toronto, 2007* shows the span-of-service of selected bus route corridors in Toronto, as operated by the Toronto Transit Commission in 2007, before significant expansion to the span-of-service of bus routes was introduced. For six corridors in the city, two routes each have been selected that serve similar areas and are roughly parallel. The first and last bus times for each route are shown.

Considerable variation can be seen in the span-of-service. Each corridor has one route with full service, from before 06:00 to after midnight. Three of those major routes have 24-hour service, and so buses provide continuous service all-day, every-day. Other routes did not operate a full span-of-service, ending in the late evening, around 22:00, or earlier; and in some cases, did not operate on weekends. Variation like this in the span-of-service of bus routes is typical in the transit business in North America, with many systems having a significant number of bus routes that do not operate at all times.

Table 1-3 Span-of-service for selected bus routes in Toronto, 2007

		Monday-Friday		Saturday		Sunday	
Bus route	**Corridor location**	**First bus**	**Last bus**	**First bus**	**Last bus**	**First bus**	**Last bus**
5 Avenue Rd	Central	05:54	22:22	05:40	22:30	08:15	22:30
7 Bathurst		24-hour service		24-hour service		24-hour service	
9 Bellamy	East	05:00	22:00	06:30	20:00	09:30	19:00
17 Birchmount		05:14	00:50	05:18	00:50	07:00	23:30
45 Kipling	West	04:30	02:07	05:43	02:07	08:00	01:33
48 Rathburn		05:20	21:50	06:10	22:15	08:18	22:00
52 Lawrence West	West	24-hour service		24-hour service		24-hour service	
59 Maple Leaf		06:15	22:45	No service		No service	
78 St Andrews	North	05:55	19:00	No service		No service	
95 York Mills		24-hour service		24-hour service		24-hour service	
131 Nugget	East	05:20	00:38	06:30	01:00	08:00	00:38
134 Progress		05:15	22:30	05:34	22:34	08:36	19:07
Source: (Toronto Transit Commission, 2008)							

1.4 Importance of bus services in an integrated transit network

Even though bus routes often have less service than the more prominent rail rapid transit lines, the surface transit modes in an integrated system play a very important role in moving customers. This crucial role is not always understood or appreciated (Mis, 2024). *Table 1-4 Public transit ridership by mode, selected major Canadian metropolitan areas, 2019* shows the relative level of ridership on rail rapid transit and bus/surface networks for the five largest

integrated multi-modal transit agencies in Canada. The data shown is the annual unlinked boardings by mode. This counts customers each time they board a transit vehicle. As an example, for a customer making a connecting one-fare trip on an integrated transit system, the unlinked boardings count a rider who boards a bus as one boarding, and then counts the same person as a second boarding when they transfer to a subway train, even though they do not pay a second fare.

For three of the five transit agencies, in Toronto, Vancouver, and Edmonton, there are more annual boardings on the surface network than on the rapid transit network. For the other two cities, Montreal and Calgary, there are more boardings on the rapid transit network, but the proportion between the two is relatively close, with at least 40% of system boardings occurring on the bus routes.

Table 1-4 Public transit ridership by mode, selected major Canadian metropolitan areas, 2019

		Rail rapid transit/subway/ metro	Surface transit/bus	Total annual boardings (000's)
Toronto	Annual boardings (000's)	474,483	565,857	1,040,340
	Percent of total	46%	**54%**	
Montreal	Annual boardings (000's)	400,281	284,408	684,689
	Percent of total	59%	**42%**	
Vancouver	Annual boardings (000's)	165,062	277,044	277,044
	Percent of total	37%	**63%**	
Calgary	Annual boardings (000's)	91,605	72,848	164,453
	Percent of total	56%	**44%**	
Edmonton	Annual boardings (000's)	39,265	99,480	138,745
	Percent of total	28%	**72%**	
Source: (American Public Transportation Association, 2019)				

Far from being a minor part of a major multi-modal transit system, and even though a single bus provides less capacity than a rapid transit train, bus service provides a vital and

important part of moving people in major cities. Buses serve many trips by customers that are only made on a bus. Bus routes also feed riders to rapid transit lines, providing first or last mile connections in a longer multi-modal trip. Without buses supporting the network, ridership on rapid transit would be significantly lower (Mis, 2024).

1.5 Research Goals and Questions

It is important, therefore, to understand how bus service is operated, why customers ride it, and how ridership changes when service levels on bus routes are changed. This thesis examines a specific aspect of bus route ridership changes. More explicitly, the goals and research questions of this thesis are given below.

1.5.1 Goals

1. To identify the span-of-service changes made by the TTC on bus routes in 2008 and 2015;
2. To calculate the change in ridership on these routes, by time period and by day;
3. To determine if ridership changed on these routes at other times of the day and week, outside of when the span-of-service changes were made;
4. To calculate the elasticity of ridership change, in relation to the amount of service added; and
5. To understand the key demographic characteristics of the neighbourhoods served by the routes, and how those characteristics relate to the ridership change.

1.5.2 Research Questions

1. Did ridership increase on routes where span-of-service improvements were made?
2. Throughout the day on routes with span-of-service improvements, did ridership increase more that would be expected from just the service improvements?
3. What is the elasticity of ridership change, in relation to the amount of service added?
4. What demographic characteristics of the neighbourhoods served by the routes correlate with increased route ridership?

1.6 Organization of the Thesis

To accomplish the goals and address the research questions of this thesis, the remainder of the thesis is organized into five chapters. Chapter 2 reviews the processes by which the Toronto Transit Commission has planned its bus route services, and how the span-of-service of TTC bus routes has changed over time. Chapter 3 is a literature review, focussing on the study of public transit in transportation geography. Chapter 4 describes the data used in this thesis, including collection methods. Chapter 5 presents the analysis of the data. Chapter 6 is a concluding chapter that discusses the results of the analysis of the data and suggests future research.

1.7 Positionality

I served from 1990 to 2023 as a TTC employee, in the transit planning and customer experience areas. The first quarter century of my service was spent as a senior transit planner, developing, guiding, and implementing most of the service changes described in Chapter 5, and working to understand and improve the transit service provided to TTC customers. Changing

service standards, recommending improvements and reductions to service, developing strategic plans to improve service, and ensuring that the service best met the needs of customers was at the core of our team's work over the past three decades.

During my years as a transit planner, I was a primary user of the ridership data that forms the basis of this thesis. I used the data to plan service levels, hours of operation, and routings of bus, streetcar, and subway service. I helped to define what data should be collected, and worked with colleagues to ensure that the data was accurate and sound. I assisted with, and encouraged, efforts to modernize data collection.

In my later years at the TTC, I was Chief Strategy and Customer Officer, retiring from that role in 2023. I had overall responsibility for the departments that collected and used the data, and I supported staff as they made significant advances in data analytics.

Chapter 2 Urban Public Transit in Toronto

2.1 Transit in Toronto

Urban public transit has been operated in Toronto for more than a century by the Toronto Transit Commission (Toronto Transportation Commission, 1942)[1]. The TTC operates a large multi-modal urban public transit system, including subway lines, streetcar routes and bus routes. Close connections between all routes have long been the hallmark of the TTC system, with essentially every bus and streetcar route serving at least one subway station and offering multiple opportunities for customers to transfer to intersecting routes along the way (Levy, 2014). On average, a TTC customer makes more than one transfer between routes each time they make a trip (Soberman, 1997). Connectivity of the system is very important to customers, and the design of the network has evolved based on the concept of frequent routes that connect with other routes to allow customers to make multiple transfers (Toronto Transit Commission, 2019).

2.2 Planning TTC Service

In Toronto, the subway lines and streetcar routes for many years have operated throughout the normal transit service day, from approximately 06:00 to 01:00. Many bus routes also have operated for the entire normal service day (Soberman, 1997). These full-time bus routes typically have high ridership and serve major arterial roadways with many origins and destinations for transit riders (Mees, 2002). There were always some TTC bus routes that did

[1] Established in 1921 as the Toronto Transportation Commission, and always abbreviated as “TTC”, an organizational change in 1954 renamed the agency to the Toronto Transit Commission.

not operate all-day, every-day (Toronto Transit Commission, 2008). These limited-service routes typically operated during rush hours only (on routes that primarily served work destinations); or during the daytime on weekdays, with no evening service and limited or no weekend daytime service (on routes with relatively low ridership, often serving suburban residential neighbourhoods).

Decisions about service levels, including the hours of operation of routes, have been guided since the late 1970s by the TTC's Service Standards (Toronto Transit Commission, 2019). These standards provide direction on when service should be increased, reduced, or modified, based on objective criteria that include ridership levels, crowding levels, and the ridership and economic productivity of the service (Mis, 2024). TTC staff evaluate service changes based on these service standards. For relatively minor changes that meet the standards, such as an increase in the frequency of service on a route, the changes are implemented after an internal TTC staff approval process, and if sufficient vehicles, operators, and funding is available (Toronto Transit Commission, 1985b). For more significant changes, such as adding or removing a period of operation of service, the service standards require that the change, once recommended by staff as meeting the standards, must then be approved by the TTC Board before being implemented (Toronto Transit Commission, 2019). These changes are also subject to having sufficient budget and resources available. Since the TTC introduced the service standards, performance-based standards have become widely introduced throughout the transit industry (Wei, et al., 2017).

2.3 TTC Bus Route Span-of-Service

Table 2-1 TTC bus routes span-of-service, 1964-2004 shows the percentage of periods of operation on TTC bus routes, from the 1960s to the early 2000s, for selected dates. This period pre-dates a significant expansion of the span-of-service on TTC bus routes.

The 1964 data captures the hours of operation of the bus network immediately after a large expansion of bus services into newly developing suburbs in Metropolitan Toronto. In most cases, if a route operated on weekdays, it operated throughout the entire service day, with a full span-of-service. Some routes did not operate on weekends. By 1975, after most of the subway expansion over the previous two decades was complete and suburban bus routes continued to be added and improved, an even higher percentage of routes operated a full span-of-service. Many of the newer routes had been added to connect to the new subway expansions, and as a matter of policy were operated at all times of the day (English, 2021).

The service standards for deciding on service changes were first approved in 1977, and the data from 1985 and 1995 shows the effects of the gradual application of the service standards. While the number of routes increased, due to increasing ridership and fare changes, the percentage of routes with full service declined (English, 2021). New routes were added in a careful and considered fashion, starting with only the busiest periods of operation, as the projected ridership at quieter times, such as in the evenings and on weekends, did not meet the new service standards and so was not initially provided.

The final two years in the table, 1997 and 2004, show the effects of using the service standards to cut service, to meet reductions in subsidy for public transit from the Province of

Ontario and from the municipal government. These cuts were principally made in 1997. The number of routes was reduced, and many periods of service were cut, resulting in an all-time low percentage of routes with full service, at less than 60 per cent.

Table 2-1 TTC bus routes span-of-service, 1964-2004

Year	Number of TTC bus routes	Percent of route-periods operated				Percent of routes not operating full time	Notes
		Monday-Friday	Saturday	Sunday	Overall, entire week		
1964	63	97%	88%	83%	95%	83%	Suburban expansion of bus network
1975	108	97%	97%	95%	97%	95%	Bus network expansion after subway extensions
1985	122	94%	88%	86%	92%	86%	Service standards applied to bus routes
1995	140	91%	81%	79%	89%	76%	Continued application of service standards
1997	134	88%	72%	68%	84%	60%	After service cuts to overall network
2004	134	89%	74%	68%	86%	56%	Before service increases

Sources: 1964 (Toronto Transit Commission, 1964); **1975 (Toronto Transit Commission, 1975)**; **1985 (Toronto Transit Commission, 1985a)**; **1995 (Toronto Transit Commission, 1995)**; **1997 (Toronto Transit Commission, 1997)**; **2004 (Toronto Transit Commission, 2023b)**

2.4 Two Significant Service Increase Initiatives

In 2003, a newly appointed TTC Board took a more active role in improving TTC service. This was prompted by more than ten years of declining or stagnating TTC ridership, as a result of the economic recession of the early 1990s; the withdrawal of provincial subsidies for public transit operations in the mid-1990s; fare increases that were above the rate of inflation; and reductions in municipal funding for TTC operations (Bunting, 2004; English, 2021). The result of this new activist approach was a staff report, the *Ridership Growth Strategy*, which laid out

options for investing in more transit service to encourage increased transit ridership (Toronto Transit Commission, 2003).

Among the initiatives in the report was a recommendation that all bus routes should run all the time, so that the service was available to potential customers throughout the day and evening, seven days a week. The periods of service would be added as a matter of policy, without regard to the projected ridership, and thus would not be subject to the usual criteria in the service standards that governed the addition of periods of operation. Adding these periods of operation would end the practise of having limited-service routes, in favour of a policy-based approach of having all routes operate all the time. The improvements could be implemented relatively quickly, as the changes were at off-peak times, and so did not require any substantial capital investment in additional buses or other facilities, which are determined by the fleet size in the peak periods (Toronto Transit Commission, 2003).

These improvements were approved by the Board, sufficient additional funds and operators were secured, and the improvements were rolled out between 2004 and 2008, with most of the new periods of operation added in November, 2008 (Toronto Transit Commission, 2014). *Table 2-2 Number of additional periods of service added, 2008* lists all TTC bus routes, and identifies which routes and which operating periods were added as part of this initiative. Forty-three routes had 68 periods of operation added. Most of these periods are analysed in this thesis. These new periods from 2008 make up the first tranche of two, of the services that are evaluated in this thesis.

Table 2-2 Number of additional periods of service added, 2008

Monday-Friday					Saturday			Sunday		
06:00-09:00 AM peak	09:00-15:00 Midday	15:00-19:00 PM peak	19:00-22:00 Early Evening	22:00-01:00 Late Evening	06:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening	08:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening
3	16	3	28	61	29	48	74	39	56	82
139 total bus routes (Toronto Transit Commission, 2003)										

As with any policy-driven change, the political priorities behind the policy can change. This happened with transit service in Toronto. In 2010 a new mayor and city council were elected, and they chose to pursue a different path with regards to transit service and transit funding. The amount of subsidy provided to the TTC by the city was reduced, and the TTC was then required to reduce its budget. While some non-service-related cost reductions were implemented, the budget cut was significant enough that the amount of service operated had to be reduced (Toronto Transit Commission, 2011a). Among the resulting service cuts made in early 2011 were the elimination of 148 periods of operation on 41 routes (Toronto Transit Commission, 2011b). Ninety percent of these periods of operation had only been added in 2008; the remaining ten percent had been operated for some time. All periods that were cut were chosen because they fell below a newly-defined threshold of customer boardings per service hour (Toronto Transit Commission, 2011b). The policy of having all routes run all-day, every-day was thus eliminated.

A further reversal in policy occurred after the next municipal election. A new mayor and council were elected in 2014. One of their stated initiatives was to reverse funding cuts to the TTC, to improve service and attract more riders. A TTC staff report entitled *Opportunities to Improve Transit Service in Toronto* was presented to the TTC Board to respond to this initiative

(Toronto Transit Commission, 2014). Like the 2004 *Ridership Growth Strategy*, the *Opportunities* report recommended adding periods of operation to limited-service routes so that all routes operated all-day, every-day. This recommendation was approved by the TTC Board. The city provided the necessary additional funding, and in the fall of 2015 the additional periods of service were added. *Table 2-3 Number of additional periods of service added, 2015* lists all TTC bus routes, and identifies which routes and which operating periods were added as part of the 2015 initiative. Twenty-six routes had 41 periods of operation added. Many of these service increases restored periods of operation that had been added in 2008 and then cut in 2011 (Toronto Transit Commission, 2014). Most of these periods have been analysed in this thesis. These added periods from 2015 make up the second tranche, of two, of the services that are evaluated in this thesis.

Table 2-3 Number of additional periods of service added, 2015

Monday-Friday					**Saturday**			**Sunday**		
06:00-09:00 AM peak	09:00-15:00 Midday	15:00-19:00 PM peak	19:00-22:00 Early Evening	22:00-01:00 Late Evening	06:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening	08:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening
0	0	0	3	10	1	6	14	2	6	27
142 total bus routes (Toronto Transit Commission, 2014)										

Table 2-4 TTC bus routes span-of-service, 2007-2024, updates *Table 2-1,* and shows the percentage of TTC bus routes with full service before and after the significant increases in periods of operation. In 2007, just before the *Ridership Growth Strategy* increases, only 55% of TTC bus routes operated at all times. The introduction of the 2008 increases raised this to 91%. The only routes not operated at all times were a small number of rush-hour express routes, and routes that served employment areas and seasonal attractions.

The 2011 service cuts clawed back many of the 2008 new periods, and this is reflected in the reduction to 70% of routes with full service shown in the 2014 data. The cutbacks were not as drastic as those in 1997, which reduced the percentage to 55%. The 2015 *Opportunities* report added back most of these periods of operation and increased the percentage of routes with full service to 86%. Since then, continued application of the service standards has added more periods of operation; and the policy intent during the COVID-19 pandemic to provide full service for customers who may be essential health care or service workers raised the percentage to 90% in 2024 (Mis, 2024). Eight years of essentially full periods of operation on the bus network is the longest uninterrupted stretch of continuous all-day, every-day service.

Table 2-4 TTC bus routes span-of-service, 2007-2024

Year	Number of TTC bus routes	Percent of route-periods operated				Percent of routes not operating full time	Notes
		Monday-Friday	Saturday	Sunday	Overall, entire week		
2007	139	87%	74%	68%	84%	55%	Before full *Ridership Growth Strategy* service increases
2008	139	96%	93%	93%	95%	91%	Full *Ridership Growth Strategy* service increases
2014	142	92%	86%	82%	91%	70%	After service cuts, before *Opportunities* service increases
2015	142	94%	90%	89%	93%	86%	After *Opportunities* service increases
2024	135	97%	95%	93%	97%	90%	Present service

Sources: 2007 (Toronto Transit Commission, 2008); **2008 (Toronto Transit Commission, 2023b)**; **2014 (Toronto Transit Commission, 2023b)**; **2015 (Toronto Transit Commission, 2023b)**; **2024 (Toronto Transit Commission, 2024d)**

The 2008 and 2015 bus route span-of-service increases were highly significant improvements to the TTC service provided to customers (Mis, 2024). It is important to better understand how ridership changed because of the improvements, and what were the characteristics of the customers and the neighbourhoods served by those routes. It is these issues, in relation to these two tranches of service increases, that this thesis seeks to understand in the following chapters.

Chapter 3 Literature Review

This thesis draws on the literature of transportation geography, along with urban planning, and mobility studies to link the analysis that follows to the national and international scholarship on public transit

3.1 Public Transit and Transportation Geography

Public transit has been the subject of study in Geography for many years. Much of the earlier work that looked at public transit examined the basic utility of public transit, compared to other modes of urban transportation (Webber, 1976). Studies often focussed on the network effects of public transit, and how those networks related to urban development (Irwin, 1969); and the developing post-Second World War road and highway network and its effect on public transit (Tobin, 1976). Important works by Chorley and Haggett (1968) and Hanson (1986) typified the approach in this period, with an emphasis on technical issues and analytic examinations, such as network optimization and public transit ridership performance.

Another central theme of the literature of this period was the development of rapid transit, such as subways. The development and expansion of subway networks was studied in the context of providing transit service instead of, or in competition to, urban highway building (Viton, 1980; Baum-Snow, Kahn, & Voith, 2005). Other work looked at the modes that could provide rail rapid transit, comparing and evaluating subways verses light rail, or more advanced personal rapid transit or automated transit technologies (Vuchic & Stanger, 1973).

In the Toronto context, academic work followed these trends. Major regional planning efforts, particularly in the 1960s and early 1970s, generated papers that looked at the

organization and delivery of long-range transit planning in the Toronto region (English, 2021). Successive transit agency and political plans to develop the rail rapid transit and commuter rail networks followed at regular intervals throughout the 1980s and 1990s, and these attracted academic attention (Soberman, 1997). Much of the analysis of these schemes focused on the lack of progress in delivering increased rapid transit (Levy, 2014).

Also prominent in academic work around transit planning in the Toronto area were examinations of the organization of transport planning and delivery. The success of transit in Toronto from the mid-1960s to the 1980s was attributed to the metropolitan organization of municipal government and early regional transportation planning (Frisken, 1991; Addie, 2013); the fiscally-sound management of Toronto transit (Mees, 2000; English, 2023); a supportive provincial government (English, 2021); and Toronto's extensive reliance on bus connections to rapid transit, forming an integrated transit network (Frisken, 2001).

3.2 New Approaches to Transportation Geography

On a broader scale, by the early 2000s transportation geography was said to be "moribund" and stuck in the past in its analytical approaches, with an excessive focus on quantitative studies (Hanson, 2000). A review by Schwanen (2016) suggested that since that time, the field had been rejuvenated. Schwanen argues that a resurgence in transport studies has occurred because transport and movement is now being studied across broader themes such as economic flows, climate change, and public health. Public transit is being examined through the lens of politics and power dynamics. Instead of considering whether transit is better than highways, or whether money spent on transit is worthwhile, the newest transportation geography work on transit looks more broadly at issues such as social spatial

inequality and equity (Schwanen, 2016). Giuliano and Hanson (2017), in an update of Hanson (1986), show how the approach has changed. Hanson's collection (1986) mainly featured analytical approaches to transportation geography, while the updated edition (Giuliano & Hanson, 2017) focusses more on equity and accessibility.

The rise of mobilities studies has also changed transportation geography. Cresswell (2010) outlines the relationship between transportation geography and mobility studies. The paper notes how mobilities are more interdisciplinary than traditional transportation geography, and how the mobilities approach links science, social science, and the humanities. Movement at many scales is examined, from a human scale up through the technology of movement, and even including the flows of ideas, capital, and people across the world. Cresswell notes that "while transport geography's main concern might be summarized by the need to figure out how to efficiently get from A to B, the mobilities turn motto may well be 'it's about more than getting from A to B'." (Cresswell, 2010)

3.3 Recent Studies of Public Transit

The recent academic study of public transit has reflected the broadening of perspectives that is reflective of contemporary transportation geography and mobilities studies. Traditional studies, for example comparing rail and bus transit (Ben-Akiva & Morikawa, 2002), are now complemented by works that look at customer experience (Rodriguez-Valencia, Ortiz-Ramirez, Simancas, & Vallejo-Borda, 2022); the quality of transit facility designs (Litman, 2008); analysis of public transport systems from the perspective of spatial in-equalities and social exclusion (Keeling, 2009); and the usefulness of real-time transit information (Brakewood, Macfarlane, & Watkins, 2015).

The contemporary literature also looks at the continuing changes to public transit ridership levels, and the relevance of public transit in a world with changing urban forms and new modes of urban mobility. Many transit agencies were experiencing ridership declines, even before the pandemic. These declines have been analyzed as the result of urban demographic shifts, the changing nature of work, micromobility, active transportation, and the rise of transportation network companies (Shaheen & Cohen, 2018; Tian, Ewing, & Li, 2023). In the future, the development of integrated mobility-as-a-service providers could also challenge the traditional understanding of what constitutes urban transit, and how urban mobility is delivered and consumed (Agbe & Shiomi, 2021). New sources of information about transit riders travel habits have also been examined, including using mobile phone tracking

3.4 Focus on Equity

Consideration of equity issues has been a major topic of recent scholarship, and this is especially the case in the study of urban public transit. Understanding how transit benefits equitable access to jobs, housing and education is a major focus of work (Allen & Farber, 2020). Using assessments of equity in planning and classifying transit service have received considerable attention (Palm, Shalaby, & Farber, 2020). Understanding how new immigrants choose housing and jobs, and how that relates to transit access has been well-studied (Allen, et al., 2021). Other works consider, from an equity perspective, transit users who are “captive” to transit, with few other transport options (van Lierop & El-Geneidy, 2017). Transit “deserts”, where access to transit is poor, are also a subject of study (Jomehpour Chahar Aman & Smith-Colin, 2020). These works fall within the expanded understanding and scale of study that is a part of contemporary transportation geography scholarship.

The equity focus on transit is well populated by Toronto examples. Hulchanski (2010) described a Toronto that is segregated by income, and where access to transit both defines the segregation, and provides a path to reducing it. Detailed analysis of the access to transit in the inner versus the outer suburbs of the Toronto area has been carried out, and finds that the transit service in the suburban areas of the City of Toronto provides significantly improved access and equity, compared to the municipalities around Toronto (Yousefzadeh Barri, et al., 2021; Allen, Higgins, Silver, & Farber, 2023). Specific work on the TTC transit network finds that the bus network provides high levels of accessibility to jobs for the most socially disadvantaged neighbourhoods (Foth, Manaugh, & El-Geneidy, 2013). The focus of many of these studies tends to be on rapid transit accessibility, which can miss the importance and reach of the TTC's bus network (Barri, et al., 2021; Negm & El-Geneidy, 2024).

3.5 The Pandemic and Transit

Much recent work has looked at the impact of the COVID-19 pandemic on transit ridership, equity, and access. Negm and El-Geneidy (2024) look at the change in accessibility to transit post-pandemic in Canada's three largest cities. They examine the importance of accessibility to transit, both rail rapid transit and bus, and correlate the change in accessibility with they observed change in ridership levels and public transit mode split, particularly for low-income transit users, after the pandemic. They conclude that accessibility to transit for low-income users remains important, but somewhat less so than before the pandemic, because of the changes to employment and commuting patterns. They point to the importance in carefully targeted transit service changes to continue to effectively serve people, but do not specifically evaluate ridership changes at the bus route level.

Other post-pandemic studies include Palm, et al. (2024) which looked at changing attitudes towards using transit after the pandemic, how these attitudes changed amongst those who previously used transit frequently, and whether people would be attracted to using a private automobile, instead of transit. Their work found that customers who were more likely to use transit before the pandemic continued to use transit at high rates during the pandemic. They found that there was not a significant increase in people abandoning transit for automobile use, but that a significant number of "choice" riders are now not taking transit. One conclusion from the study was that transit agencies need to continue to improve the quality and the access to transit, to serve those who need it, and those who may choose to use it.

3.6 General Public Transit Ridership Change Studies

There have been relatively few detailed studies of how public transit ridership changes when service increases are implemented, particularly span-of-service increases on bus routes. There have been studies of transit ridership change, in general, and these works usually look at system-wide ridership change, not at the route level.

Taylor and Fink (2003) authored a review article that examined the literature around the factors that influence transit ridership. They noted the very numerous and complex factors that cause transit ridership change. They categorize transit ridership analyses as falling into two categories: descriptive and causal. The causal studies show that external factors, such as socio-economic factors, social factors, and transit funding, are more significant to ridership change than the internal changes made by transit agencies, such as pricing, and service quantity and quality. Of the internal changes, service quality is found to be more important to ridership increase than changes in fares. It is noted that many of the empirical studies of ridership change

at single transit agencies are often not easily generalizable to other transit systems, because of the unique service and external factors in each city. Taylor and Fink (2003) find a high degree of collinearity between the spatial and social-economic variables in each study, which limits the ability to fully understand which variables most affect transit ridership.

A paper by Hess, et al. (2002) presented the results of a survey of transit managers that asked about their perceptions of what factors led to ridership change. Consistent with Taylor and Fink's (2003) review, the Hess paper showed that senior employees of transit agencies felt that service improvements were the main internal factor that resulted in ridership increases. This was a qualitative, rather than a quantitative assessment, as it was based on interviews with transit managers.

Kain and Lui (1999) examined ridership change in Houston, Texas, and San Diego, California in the 1980s and 1990s. They examined the large ridership increases in the subject cities against representative data from a large sample of transit agencies throughout the US. They also tested whether the ridership increases were related to external factors, such as employment or population increases; or internal factors, such as changes in transit fares and service levels. Their econometric analysis concluded that the single largest contribution to transit ridership growth was a substantial increase in the amount of transit service provided. This was measured as service hours, at the system-wide level, and so it did not distinguish between increases in service frequency, improvements in geographic service coverage, or longer spans of service at the route level.

Currie and Wallis (2008) synthesised information from several studies and surveys to identify effective ways to increase ridership on urban public transit bus services. Drawing on the

literature and various research, they look at demand elasticities; “soft” variable evidence, such as transit cleanliness, security, and comfort; and mode-specific evidence, such as whether a bus runs in a dedicated transit right-of-way. Their conclusion was that fare changes, improvements to travel time, and improvements to service frequencies all have similar magnitudes of importance in increasing ridership. Of the three, improvement to service level frequencies is the most effective in generating additional riding. Their synthesis considered many different service aspects, such as travel time, waiting time, geographic coverage and reliability, but their study did not look at increasing span-of-service hours as a service characteristic.

There are many studies that have examined in detail the ridership changes from improvements in service frequency. Berrebi, Joshi & Watkins (2021) looked at ridership changes, at the aggregate level, in four U.S. cities. They used regression models to test whether ridership increased after frequency changes. They showed a positive elasticity of ridership to frequency, although with diminishing returns as more service is added. Greer and van Campen (2011) performed a regression analysis on census data for travellers in Aukland, New Zealand, and found that of the transit variables that affect public transit ridership, service frequency was the most significant.

An extensive analysis of ridership change at the bus route level in Montreal was conducted by Diab et al. (2021). Ridership was modelled using individual bus route data, and the relative impacts of different measures of service quality were investigated. The number of daily scheduled bus trips was used as a measure of service quantity, and other measures were examined that captured for average speed, express service, and nearby parallel routes. It was

found that changes in service frequency was the most significant variable in explaining ridership changes.

3.7 Studies Examining Changes in Span-of-service

All these preceding studies looked at ridership change. They all found that service improvements were significant in generating additional transit ridership. None of these studies, however, looked at changes in the span-of-service as a reason for ridership change. There have been a very limited number of studies that evaluate increased span-of-service. Five stand out as being similar to this thesis.

Currie and Loader (2009) looked at transit ridership on bus routes in Melbourne, Australia where higher-than-expected ridership occurred after new service was added to the routes, in evenings and on weekends. This is very similar to the Toronto service changes analyzed in this thesis. Currie and Loader (2009) note the paucity of similar span-of-service studies and review estimated elasticities related to ridership change and service increases. The paper describes the context of the service improvements in Melbourne, which were part of an overall program from 2006 to improve bus service. The programme included a detailed review of all bus services, new express bus services, new downtown bus services. The key part of the programme examined by Currie and Loader was the introduction of new minimum hours of service standards for bus routes, with more than 200 routes improved to operate at least hourly throughout the day and early evening, seven days a week. This was a policy decision, not based on projected ridership, but to provide a basic social safety net of bus route availability throughout the week. The concept and intent of this Melbourne plan was very similar to the TTC's 2003 *Ridership Growth Strategy*.

Currie and Loader (2009) looked at 22 routes with increases and compared ridership in the half year before and full year after the changes. The elasticities of ridership growth were calculated and were found to be overall positive. Weekend ridership growth was higher than weekdays. A hypothesis was developed that suggested that daytime ridership growth would be found in periods where service already operated, as the outward first trips from new ridership in new evening periods. An analysis of the data found that the ridership patterns throughout the day and evening were consistent with this hypothesis. The paper concluded that additional periods of service, particularly in the evening, were a valuable addition to transit service, and that the later evening service had positive implications for the effectiveness of the daytime service (Currie & Loader, 2009).

A paper by Loader and Stanley (2009) expanded on the Currie and Loader (2009) work by looking into the Melbourne bus service hours changes in more detail, particularly from a transit user perspective. The study examined a larger number of Melbourne bus changes. It confirmed the same ridership increases found by Currie and Loader, over a larger sample of routes. The paper also made use of a survey of bus users, which confirmed that many customers made use of the bus service even at hours of the day when it previously ran, because of the greater freedom and certainty that the bus would also be there in the evenings. Loader and Stanley noted that social exclusion was reduced, and that opportunities for greater social and employment activities were increased by the hours-of-service improvements.

A chapter in the *Traveler Response to Transportation System Changes Handbook*, "Transit Scheduling and Frequency", defined various types of transit service increases, including improvements to the span-of-service (National Academies of Sciences, Engineering, and

Medicine, 2004). Also included was a case study of service hours enhancements in a Los Angeles, U.S. suburb in the 1990s. The study looked at longer-term elasticities of weekday evening and weekend span-of-service increases, and found that the elasticities, over a five-year period, were well over 1.0. Ridership on the small system increased proportionally more when the service was increased.

A study of ridership changes on the Athens, Greece metro system was carried out by Veliou et al. (2010). Although somewhat less relevant to this thesis, as it was about a weekend extension of service hours on a metro line, the paper came to similar conclusions as did Currie and Loader in their study of Melbourne buses. The ridership in the new hours of the Athens metro late night service was matched by a substantial increase, of up to 45%, in riding earlier in the evening. The study also included an attitude survey of the late-night metro riders, and the survey recorded very high satisfaction with the new service.

Simmons and Haas (2016) have produced the most recent study of span-of-service hours expansion on a bus network Using detailed ridership by route, they analyzed 39 span-of-service changes on nine transit agencies in the western United States. The data included 24 span increases and 15 cases where the span-of-service was reduced. Ridership increased on the routes with service increases by up to 12%. The routes with decreases in service had ridership losses, but on average by less than 1%. As with the Currie and Loader (2009) paper, Simmons and Haas found that ridership during unaltered periods of service increased considerably when service was added later in the same day. The highest increases, throughout the day, were when the longest hours of new service were added later in the day. The lack of other research on this issue was specifically noted by the authors.

Given the importance of operating service for customers on bus routes in an integrated urban transit system, the lack of study of a fundamental aspect of that service provision – the span-of-service – is surprising. This could be ascribed to an over-focus on rapid transit as the more prominent mode of public transit, and a resulting discounting of the importance of bus services. The paucity of studies could also be a result of a lack of available data at the detailed level that is required to analyze additional periods of operation. In this regard, the TTC is somewhat unique because of its long history of collecting detailed ridership data. The under-appreciated importance of bus services could also be a reason why such a crucial aspect of moving customers has not been more frequently examined.

The study of transportation geography, and public transit in particular, has evolved over the decades. Analytical approaches, such as measuring the efficiency of transit service, have matured into more nuanced examinations of mobility and its effects on people. Discussions of the value of transit and the design of transit networks are now accompanied by evaluations of access to transit, and whether that access is equitable, and for whom. Unusually, although it is inherent to a discussion of equity, the span-of-service of bus services is an issue that has not been extensively explored. Against this backdrop, the remaining chapters focus on bus routes in Toronto, their changes in span-of-service, and how that has affected transit customers.

Chapter 4 Data

This chapter describes the data used for analysis in this thesis. The data includes transit ridership data for Toronto, as collected by the Toronto Transit Commission on an annual or semi-annual basis. Other data used in this thesis is also outlined. Also described is the organization of the transit service, by time of day and by day of the week.

4.1 Ridership data

Ridership data has been collected by the Toronto Transit Commission since 1921, when the company began operations. The ridership data has been continuously used by the TTC to plan and modify service levels, to track trends in ridership change, and to project future ridership levels on existing and proposed services (Toronto Transit Commission, 1985b).

4.1.1 Types of ridership data

Several types of ridership data have been collected by various means. For this analysis, bus route ridership data is used. Bus route ridership data is collected by counting every passenger boarding and alighting the bus, on every bus on the route. The time, location, and specific bus trip identification of each boarding and alighting event is recorded. This forms a complete picture of ridership on the route, by each trip, down to the detail of the passenger activity at each bus stop on the route (Toronto Transit Commission, 1985b). This data is available in detailed form and can also be aggregated to the route level by periods of the day, or for the entire day. The fundamental information provided by these counts is how many customers rode on the route, and this is what is used for this analysis. Specifically, the number of boardings is used for this analysis, as it reflects the total usage of the route. Alightings are not used, as every

customer who boards eventually alights from the bus, and use of alightings would double count the customers.

The data is anonymous; no characteristics of the passengers are recorded, other than the fact that they boarded or alighted the bus at specific locations. The data provides information about the origin and destination of passenger trips on the specific route, but it does not link boardings or alightings to each other, and so does not provide full origin-destination information for individual passenger journeys. The data is route-specific, and so it does not identify which customers transferred to or from other routes at the many transfer points and subway stations (Shen, 2024). The data is used to calculate the accumulation, or "crowding" levels on each trip, and can identify by trip, and by time period, the relative density of ridership along the entire route, but this additional information is not used in this research.

4.1.2 Methods of collecting ridership data

The data has been collected by manual and automatic means over the years. Until approximately 2010, all data was collected manually by traffic checkers, who were employed and trained by the TTC for this task (Shen, 2024). The traffic checkers rode every trip on a route and recorded the boardings, alightings, time, location, and trip number. For many routes, this activity would take place over several days, as there were more buses and trips on the route than available traffic checkers. While each count is nominally dated to one day, the data may have been collected over several days or weeks, until all trips on the route have been covered. Data from any trips that were disrupted, by severe road delays, diversions, etc. were discarded and the trip would be counted again on another day. The data was checked for reasonableness and accuracy. The TTC considers it to be accurate to better than 90% (Toronto Transit

Commission, 1985b). The data was only finalized and published for TTC use once it was fully representative of a typical day on the route.

Until the mid-1990s the detailed on-off counts as described above were conducted once per year per route on weekdays, usually in the same month; and approximately once every five years per route on Saturdays and on Sundays. From the mid-1990s, due to budget cutbacks, the number of traffic checker positions was reduced, and the detailed on-off counts were taken less frequently, especially on major routes with many buses. Starting in 1998 the TTC began testing automatic passenger counters (APCs), a commercial off-the-shelf system for counting bus ridership (Shen, 2024). The APC system uses infrared sensors mounted on each bus over each door. These counters are installed on every bus, and record boardings and alightings, as well as time, location, and bus trip. The data is downloaded wirelessly every night. The APC system fully replicates the work done manually by traffic checkers and permits the collection of much more data, including, for the first time, full Saturday and Sunday data.

By 2012 the results of the APC counts were available in an interim format, and by 2019 APC counts had fully replaced manual counts by traffic checkers (Shen, 2024). Because of the large amount of daily data from APCs, where almost every bus trip is fully counted, the APC counts are generally averaged and reported on over six-week periods. The data is monitored, checked, and confirmed by TTC staff before it is published for TTC use. Count data from severe service disruption days is discarded, and not included. Once completed, the counts are considered fully representative of a typical day on the route, and accurate to better than 93% (Shen, 2024). These accuracy results are consistent with those observed in other studies of

automatic passenger counting in the transit industry (Kimpel, Strathman, Griffin, Callas, & Gerhart, 2003; Berrebi, Sanskruti, & Watkins, 2022).

4.2 Other ridership data

Other types of bus ridership data are collected by the TTC but are not used in this analysis. Specific ridership counts taken at single locations, known as “standing counts”, were used to supplement the detailed on-off counts. These standing counts record the number of people on the bus as it departs the bus stop. These are typically done at the busiest point on the route, and so provide peak point crowding information (Toronto Transit Commission, 1985b). Because they are taken at only one location, they do not provide a full picture of total ridership on the route. Standing counts have now been replaced by APC data (Shen, 2024).

Data from fares paid by passengers is also available (Toronto Transit Commission, 2024b). Since 2017 most fares on the TTC have been paid using a stored-value smart card system. To pay a fare when boarding a bus, customers can tap a smart card on a reader. These taps record whether a fare was successfully paid, the fare category, time, location, route, and bus number. At approximately half of the TTC’s 75 subway station bus terminals, customers are not, however, required to tap when boarding the bus, as the bus is inside the fare-paid area of the station. At these locations, customers have already paid their fare upon entry into the station, or earlier in their trip. All doors are opened on the bus, and entry to the bus does not require a fare transaction or tap, and so no data is collected. Furthermore, customers are not required to tap when they leave the bus. There are also instances where customers board a bus but do not pay a fare when they are required to do so. As a result, fare taps do not record all boardings, or any

alightings, and the use of on-off counts is the only accurate way to count total passenger-trips on the service (Shen, 2024).

4.3 Operating periods

Transit systems in general, and the TTC in particular, organize and deliver their service by operating days, and within those days, operating periods. These are discrete but variable periods of time where the scheduled service is broadly similar and is planned to meet the demonstrated passenger demand. The time periods can be varied as necessary to meet demand. Defining the service by these periods allows the service quantity, operational reliability, and ridership to be consistently delivered and analyzed (Toronto Transit Commission, 1985b).

At the TTC, there are four types of days for transit scheduling purposes, each of which is subdivided into three or five operating periods. The schedule days are Weekdays, Saturday, Sunday, and Holidays. Weekdays are from Monday to Friday, except for statutory holidays[2]; the schedules and the service are identical on each of these weekdays. Saturday schedules are used on Saturdays, except if a Saturday is a statutory holiday. Sundays and holidays have separate schedules, but for analysis purposes are generally combined, as they have the same service levels, with the only difference being a slightly earlier start to the service on statutory holidays (Toronto Transit Commission, 1985b).

[2] In Toronto, there are ten statutory holidays each year. New Year's Day in January; Family Day in February; Good Friday in March or April; Victoria Day in May; Canada Day in July; Civic Holiday in August; Labour Day in September; Thanksgiving Monday in October; and Christmas Day and Boxing Day in December. Family Day, Victoria Day, Civic Holiday, and Labour Day are always observed on a Monday. Good Friday is always observed on a Friday.

Within the days, there are defined operating periods. For weekdays, these are the morning peak period, midday, afternoon peak period, early evening, and late evening. On Saturdays and Sundays/holidays these periods are daytime, early evening, and late evening. *Table 4-1 TTC Schedule Days and Operating Periods* show the operating days, the operating periods, and the approximate time boundaries of the operating periods (Toronto Transit Commission, 2019).

Table 4-1 TTC Schedule Days and Operating Periods

Schedule day:	**Weekday**	**Saturday**	**Sunday/Holiday**
Applies to:	Monday-Friday, except on statutory holidays	Saturdays, except on statutory holidays	Sundays and statutory holidays
Periods of service, with approximate time boundaries:	Morning peak period 06:00 to 09:00	Daytime 06:00 to 19:00	Daytime 08:00 to 19:00
	Midday 09:00 to 15:00		
	Afternoon peak period 15:00 to 19:00		
	Early evening 19:00 to 22:00	Early evening 19:00 to 22:00	Early evening 19:00 to 22:00
	Late evening 22:00 to 01:00	Late evening 22:00 to 01:00	Late evening 22:00 to 01:00

Operating periods are the basic building blocks for defining when a route operates and describe the time boundaries of the service (Mis, 2024). The vast majority of TTC bus routes operate either for an entire operating period; or not at all in that period. The TTC has service standards that define when a service is warranted, and these standards are based on the operating periods. When service was added in 2008 and 2015, it was added in discrete operating periods. When a service is cut, usually for budget reasons, a service is reduced by eliminating periods of operation. Cuts of this nature occurred in 2011 and included some of the periods of service that were added in 2008 (Toronto Transit Commission, 2014).

4.4 Demographic information

In addition to TTC bus route ridership data, demographic data is used in the analysis in Chapter 5. The demographic information came from the Statistics Canada Census of Canada assembled by the City of Toronto at the city ward level. For the 2008 service changes, data from the 2011 Census was used (City of Toronto, 2011). For the 2015 service increases, data from the 2016 Census was used (City of Toronto, 2016). For each route, the city ward that best covers the area served by the TTC route was identified. Several key measures from the Census were selected to be used as independent variables to be compared to the route ridership performance indicators.

The nine variables, all at the ward level, selected were:

1. Whether or not the route substantially serves an area that has been designated by the City of Toronto as a Neighbourhood Improvement Area[3].
2. The percentage of population change in the preceding five years (2006-2010 for the 2011 Census, 2011-2015 for the 2016 Census).
3. The percentage of residents, aged 18-64, classified as living in a household with low income.
4. The percentage of residents who make their primary trips by public transit.
5. The percentage of residents who immigrated to Canada within the preceding five years (2006-2010 for the 2011 Census, 2011-2015 for the 2016 Census).
6. The percentage of residents who rent their primary residence.
7. The unemployment rate in the ward, as a percentage.
8. The percentage of residents who are youth, aged 15 to 24.
9. The percentage of residents who are seniors, aged 65 or higher.

The variables were selected based on demographic attributes that are relevant to transit usage. They have been identified by the TTC in its Service Standards as factors that are important to understand in the context of planning and delivering transit service that is

[3] As defined by the City of Toronto, Neighbourhood Improvement Areas are "neighbourhoods that face significant inequities in Economic Opportunities, Social Development, Participation in Decision-Making, Healthy Lives and Physical Surroundings and are recommended for targeted support." (City of Toronto, 2014)

equitable for a broad range of residents of Toronto (Toronto Transit Commission, 2019). In recent years these attributes have been used for equity-based route planning by the TTC (Toronto Transit Commission, 2024a), (Mis, 2024). These attributes have also been used in other studies of transit service equity on the TTC network (Palm, Shalaby, & Farber, 2020), (Allen, et al., 2021).

In summary, bus route ridership data provide a unique and robust set of data to analyse whether service improvements result in improvements for specific areas of the city and what this means for spatial equity when the characteristics of those areas are considered. Census data is also used for this analysis. In the concluding chapter, the limitations of the data and the analysis are considered in the context of directions for future research.

Chapter 5 Ridership Change Data Analysis

This chapter provides an analysis of the change in customer ridership on TTC bus routes when service was increased by improvements to the span-of-service. The first part of the analysis looks at ridership change by route and by time of day, compared to the ridership levels before the change. The second part examines the service elasticity of the changes. The third part of the analysis considers select demographic characteristics pertaining to the areas served by the routes, and tests them to determine how the demographic characteristics of areas in Toronto correlate with service increases.

5.1 Service changes analyzed

New periods of operation were added in 2008 and 2015. All service increases analyzed were the introduction of new service over the entire route during the specified operating period; in other words, no part of the route operated in that period before the service change was made.

As an example, on the 14 GLENCAIRN bus route up to mid-2008 the service operated from 06:00 to 22:00 from Monday to Friday only. There was no service in the late evening from Monday to Friday, from 22:00 to the end of the usual TTC service day at approximately 01:00. The service that was added in late 2008 was the introduction of new weekday late evening service. As a result, after the service change the route then operated from 06:00 to 01:00. Three hours of new late evening service added, from 22:00 to 01:00. Thus, the analysis looks at the new ridership on the new late evening service, as well as the ridership change during the existing periods of service during the rest of the weekday, prior to 22:00.

Some of the service increases do not have sufficient data available for analysis. This is particularly true for new services added on weekends in 2008; there are no preceding weekend counts, because service did not operate (Shen, 2024). In other cases, where there are preceding counts at other times of the day, the counts were taken more than ten years before the service change; or were taken before the route was substantially changed by a rerouting, a new subway connection, or other significant route change. These service increases are not analyzed as part of this study because of the lack of usable baseline data.

Some of the service increases in 2008 and 2015 were the introduction of new periods of service on only part of a route. That is, a route may have already operated full service (06:00 to 01:00) over its entire length, and the new additional service that was added was on a separate part or "branch" of the route that previously only operated part time.

As an example, the 76 ROYAL YORK SOUTH bus route operated all-day, every-day from the Bloor subway in the north to Lake Shore Boulevard in the south. This service was provided by the main branch on the route, the 76A service. A second, part-time branch, the 76B, also operated. It paralleled the main part of the route about halfway to the southern terminus, and then branched off to serve a different residential community a short distance to the east of the main route. The 76B branch only operated in the morning and afternoon peak periods. With the service changes in late 2008, the 76B branch had new service added during the midday and evenings from Monday to Friday, and all-day on Saturdays and Sundays, so that it became an all-day everyday service, in addition to the existing 76A service.

These partial service increases have not been analyzed as part of this study. The partial route service increases require more detailed evaluation of the data, including separating out

the ridership on the parallel main branch. This adds to the complexity of analysis, and in some cases the detailed before data is not readily available. There are sufficient entire route periods available to provide a suitable study sample without taking on the complexity of the partial route service increases.

In some cases, new service was added in both the early and late evenings on a single day. These have been analyzed as one combined “Evening” period, instead of as two separate “Early Evening” and “Late Evening” periods. They cannot be evaluated separately, as it is not possible to determine how ridership would have been different if just the early evening service was added, without the late evening service.

A similar combination of periods was used for the six instances where new weekday midday and evening service was added to a route that previously operated in the peak period only.

5.2 Ridership change analysis

Overall, 109 periods of service were analyzed, 68 from the 2008 service increases, and 41 from the 2015 service increases. These service increases were made on 49 of the approximately 140 TTC daytime bus routes. By day of the week, 42 of the periods of service that were added were on weekdays, 26 were on Saturdays, and 41 were on Sundays. *Figure 5-1 Routes analyzed from 2008 service increases* (Parry, 2024) is a map of the 2008 routes that had periods of service that were analyzed, and *Figure 5-2 Routes analyzed from 2015 service increases* (Parry, 2024) is a map of the analyzed 2015 routes. In both figures, the City of Toronto is shown in grey, TTC bus routes are shown in white, with the bus routes that were analyzed

shown in green (for the 2008 map) and red (for the 2015 map). The route numbers are labelled on each route.

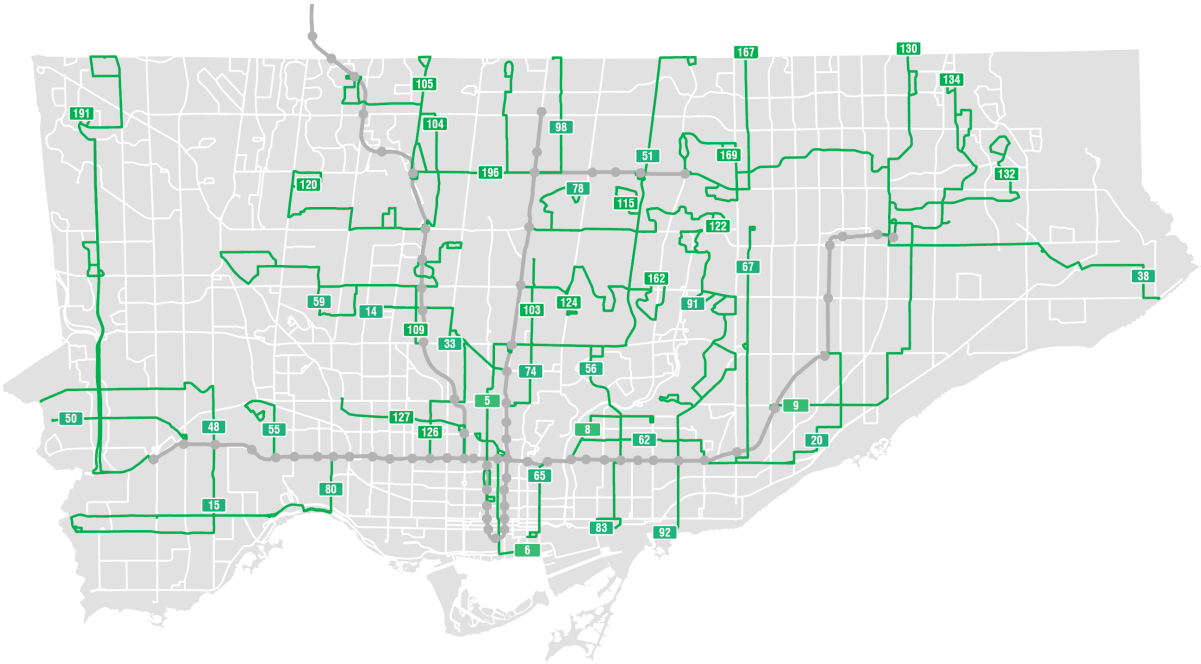

Figure 5-1 Routes analyzed from 2008 service increases

(Parry, 2024)

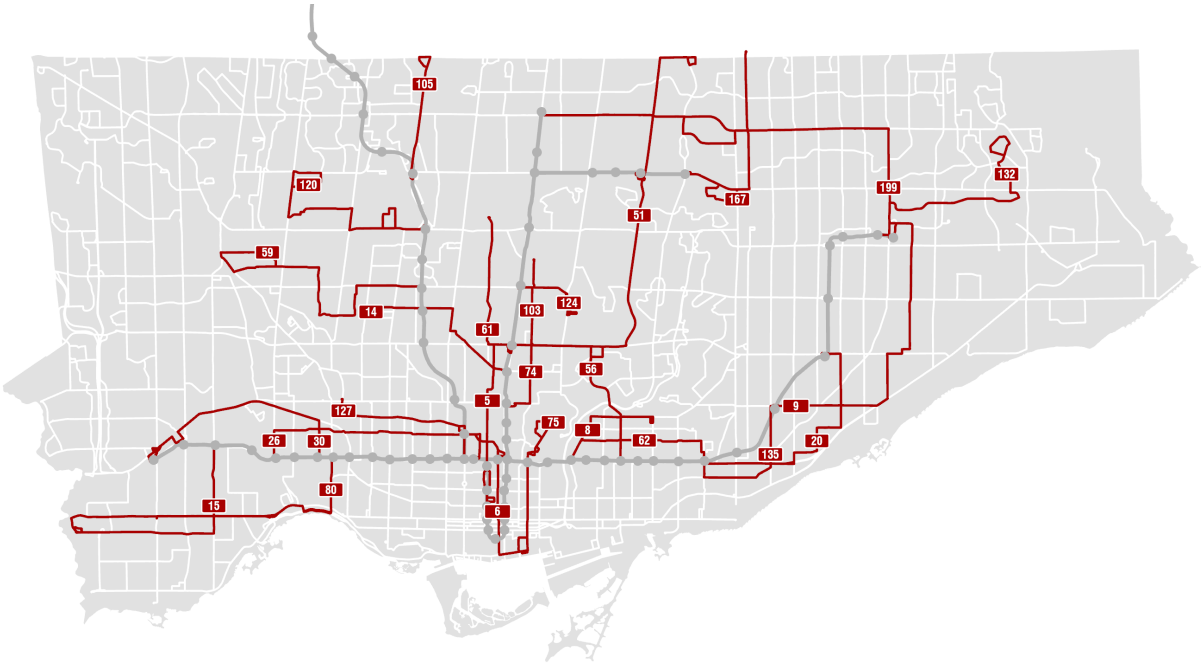

Figure 5-2 Routes analyzed from 2015 service increases

(Parry, 2024)

Detailed ridership on each route is available from the TTC. This records the number of boardings on each route on each trip at each stop and can be aggregated to the standard operating periods defined by the TTC. For some of the 2008 service improvements, there were only one or two ridership counts undertaken after the service improvement, and before the service was then removed as part of the 2011 service cuts. For the 2015 service increases, there are generally more ridership counts available after the service increase, as the counts were being automated at this time, thus providing more data (Shen, 2024).

In both the 2008 and 2015 cases, ridership increased on the routes that had new periods of service added. The 2008 service increases that were analyzed show that that number of annual customer-trips on the routes and days with service improvements increased by 6.09

million (21%) from 28.90 million to 34.98 million. The new periods of service contributed 2.56 million (9%) of the additional customer-trips. Therefore, while the new periods of service contribute an increase in ridership of 9% on the improved routes, overall ridership on the same routes increased more, by 21%. *Table 5-1 Ridership change on 2008 routes* shows these results.

Table 5-1 Ridership change on 2008 routes

Number of periods of service analyzed	**Annual ridership on subject routes before service increases (000's)**	**Annual ridership on subject routes after service increases (000's)**	**Ridership change**	**New periods of service**	
				Annual ridership on new periods of service (000's)	Ridership change on new periods, as percent of total ridership
68	28,900	34,980	21%	2,560	9%
Source: (Toronto Transit Commission, 2023b)					

For the 2015 service increases, the equivalent values are a total increase in annual customer-trips of 1.91 million (16%) from 12.20 million to 14.11 million. The new periods of service contributed 701,000 (6%) of the additional customer-trips. *Table 5-2 Ridership change on 2015 routes* shows these results.

Table 5-2 Ridership change on 2015 routes

Number of periods of service analyzed	**Annual ridership on subject routes before service increases (000's)**	**Annual ridership on subject routes after service increases (000's)**	**Ridership change**	**New periods of service**	
				Annual ridership on new periods of service (000's)	Ridership change on new periods, as percent of total ridership
41	12,200	14,110	16%	701	6%
Source: (Toronto Transit Commission, 2023b)					

A full list of routes, showing the additional periods added in 2008 and 2015, is in *Appendix A – Summary of Additional Periods Added*. A list of route-by-route ridership change, for all the additional periods that were analyzed, is in *Appendix B – Route Ridership Data.*

Adding new service clearly attracts additional customers to the route; this is seen by the ridership in the new periods of operation, essentially all of which was new to the route as service did not previously operate at those times. On the routes where the services were added, ridership in the new periods alone provides an increase in all-day route ridership of between 6% and 9%, compared to the daily ridership on the route before the change.

Since the vast majority of urban public transit trips are round-trips, it is to be expected that a customer who rides a new period of service at one time of the day would make at least one additional trip on the route on the same day, and likely during a different time period; this would the first leg or the return leg of the trip during the new period (Currie & Loader, 2009). Based on this, it is hypothesized that ridership in the new periods should be at least matched by an equivalent number of additional trips at other times of the day on the same route.

The resulting ridership change supports this hypothesis. The average increase in route ridership, for both the 2008 and 2015 service increases, is greater than the simple doubling of the new period ridership. In 2008 the new periods added nine percent to the average route ridership, while overall ridership on these routes increased by 21%. This is three percentage points higher than a simple doubling of the new period ridership. The 2015 new periods added six percent to the average route ridership, while overall route ridership on the improved routes increased by an average of 16%, four percentage points higher than a doubling of the new

period ridership. Similar results have been noted in studies of additional periods of transit service in Australia (Currie & Loader, 2009) and the United States (Simmons & Haas, 2016).

Other factors can result in route-specific ridership increases, by making service more attractive to customers. Changes in the frequency of service on the existing route can generate more ridership, as customer waiting time is reduced, which attracts additional riding (Vuchic, 2005). Improvements in service on connecting routes can result in ridership increases on connecting routes, given the prevalence of customer transfers in the TTC's integrate network. Increased residential development, new employment or educational opportunities, along with changes to routes to serve new sources of demand, can increase ridership from new trips made by new customers. Fare changes or the relative cost of competing transport modes can affect transit ridership, by reducing the relative cost of using public transit (Vuchic, 2005).

As much as possible, this analysis has attempted to isolate these factors. Any routes with substantial service level changes or routing changes have been excluded from this work. Most routes that had new periods of service added are relatively short and infrequent routes, and so had no significant increase in service during other periods of operation. Most analysed routes serve established neighbourhoods and so have had relatively little new residential development, which has been concentrated, by City of Toronto planning policy, on major arterial roads and near existing rapid transit stations. There were no significant TTC fare changes immediately after the 2008 or 2015 service changes. While external factors cannot be completely excluded as sources of ridership increase, the route-specific analysis carried out in this thesis has limited, as much as is possible, these external factors as significant drivers in the observed ridership changes.

It is important to recognize the significant improvement in service to transit customers that is provided by these service improvements. Without the additional periods of operation, customers who use the service would have instead used a different TTC route and walked longer, transferred more, or traveled on a longer, slower route to reach their destination. In some cases, they would not travel at all or would not choose public transit for their travel. In such a closely integrated network, the new services provide additional connection opportunities for customers, and so thus generate more riding on other routes, as customers transfer to or from the existing network and the new services. The new evening services improve the perception of safety for transit customers, as they provide closer access to destinations, shorter walks for customers, and "more eyes on the street." Having a transit route operate all-day, every-day provides a consistency of service that is similar to the availably of the road network for customers who travel by car, thus improving equity for those who use transit, and increasing the likelihood of people carrying out everyday activities without owning or using a car.

New services come at a cost. There is a net increase in operating cost to provide the new periods of operation, as additional ridership in the periods did not generate sufficient additional new fare revenue to offset the increased operating costs. The fact that the new ridership revenue did not offset the costs was not unique to the new services.

The TTC as a network has not covered its operating costs from fare revenue on an annual basis since 1970 (Toronto Transit Commission, 1973). In the decade preceding the COVID-19 pandemic, the TTC's system-wide revenue-cost ratio, or the percentage of operating costs covered by fares and other revenues, was in the 65% to 75% range (Toronto Transit Commission, 2020). The remainder of the revenue was made up of an operating subsidy provided by the City

of Toronto. Based on the data analyzed for this thesis, the new periods of operation added in 2008 and 2015 had a lower revenue-cost ratio than the TTC network, ranging from 3% to 43%.

The additional periods of operation become accepted and ingrained as a core part of the TTC network (Mis, 2024). The initial all-day every-day service, introduced in 2008, only lasted less than four years, until changed political priorities brought the service cuts of 2011 that ended the all-day every-day policy. The 2015 restoration of all-day every-day service, however, continues to the present day, surviving even the significant ridership drops of the 2020 COVID-19 pandemic and the resulting worsening of the TTC's budget situation and revenue-cost ratio since the pandemic. A key feature of the TTC's pandemic response service plan was to not eliminate any periods of operation, so that the vital importance of providing transit service access for essential workers was continued (Toronto Transit Commission, 2023a). The pandemic plan emphasized the importance of operating a full-service route network, and how this policy was broadly and formally accepted (Mis, 2024).

5.3 Service Elasticity

The elasticity of ridership change was calculated for most of the subject routes, to gauge the relative performance of the service changes in attracting ridership, in comparison to the quantity of additional service added. Of the 109 service periods examined, 103 periods were subjected to the elasticity analysis. The six periods that were not included could not be analyzed because the pre-existing quantity of service data was not available.

For the analysis, the elasticity ratios were calculated as short-term values using a shrinkage ratio approach. The formula used was:

$$R = (Q_{t0}/Q_{t1})/(P_{t0}/P_{t1})$$

Where R is the shrinkage ratio; Q_{t0} is service hours scheduled on a route before the change in service hours on a subject day; Q_{t1} is service hours scheduled on a route after the change in service hours on a subject day; P_{t0} is the ridership each day before the change in service hours on a subject day; P_{t1} is the ridership each day after the change in service hours on a subject day.

Table 5-3 Average service elasticity of analyzed span-of-service changes shows a summary of the calculated elasticity values. On average, the elasticity of increased ridership demand is 1.96. The 2008 service changes are higher, at an average elasticity of 2.27, while the 2015 changes have an average of 1.48. New periods of service added on weekdays have an elasticity of 2.09, while Saturday service changes are 2.22 and Sunday changes are 1.65.

Table 5-3 Average service elasticity of analyzed span-of-service changes

	Year	**Service Elasticity**
All service changes	2008 and 2015	1.96
All service changes	2008	2.27
All service changes	2015	1.48
Weekday service changes	2008 and 2015	2.09
Saturday service changes	2008 and 2015	2.22
Sunday service changes	2008 and 2015	1.65
Total changes measured = 103 **Source: (Toronto Transit Commission, 2023b)**		

These figures are higher than typical values cited for transit service improvements in other studies. In most cases the other studies looked at frequency improvements or travel time improvements, not specifically at additional periods of operation or span-of-service changes.

The limited research into span-of-service improvement elasticities suggests that the elasticity for these changes is higher than for frequency and travel time improvements (Currie & Loader, 2009).

As with the ridership change analysis in *Section 5.2*, care has been taken to exclude any routes and periods where significant other service change or route changes took place at the same time as the new periods of operation were added. This ensures, as much as possible, that the calculated elasticity values represent the ridership change that results from the addition of the new periods of operation.

5.4 Demographic analysis

To further understand the reasons behind the ridership changes on the routes with new periods of service, an analysis of the demographic characteristics of the routes was carried out.

To carry out this analysis, a combination of the route and ridership data was required. Whereas in the ridership analysis and elasticity calculations described in *Sections 5.2* and *5.3* looked at ridership change on each route during each operating period, for the purposes of the demographic analysis it was necessary to compare route ridership and ridership change to the demographic attributes of the route at the route level. This is to take into account that demographic data is area based and does not vary by time of the week and applies to the entire route.

As a result, the route-periods for each route were combined into a single combined route data point. In some cases (40 of 109 route-periods) there was only one period of service for a route, and so no combination was required. For routes with multiple periods, they were

combined to produce one data set for each route. The before and after ridership and ridership change, and the change in costs and revenues, all annualized, were combined for each route with multiple periods. This aggregation process reduced the data to be analysed at this step from a total of 109 operating periods to 69 routes with data from 2008 and 2015. The routes and their key ridership statistics are shown in *Appendix A – Summary of Additional Periods Added* and *Appendix B – Route Ridership Data*.

The demographic information for this analysis came from the Statistics Canada Census of Canada assembled by the City of Toronto at the city ward level (See Chapter 4 for more details).

The nine variables, all at the ward level, included for analysis as independent variables were:

1. Whether or not the route substantially serves an area that has been designated by the City of Toronto as a Neighbourhood Improvement Area[4].
2. The percentage of population change in the preceding five years (2006-2010 for the 2011 Census, 2011-2015 for the 2016 Census).
3. The percentage of residents, aged 18-64, classified as living in a household with low income.
4. The percentage of residents who make their primary trips by public transit.
5. The percentage of residents who immigrated to Canada within the preceding five years (2006-2010 for the 2011 Census, 2011-2015 for the 2016 Census).
6. The percentage of residents who rent their primary residence.
7. The unemployment rate in the ward, as a percentage.
8. The percentage of residents who are youth, aged 15 to 24.
9. The percentage of residents who are seniors, aged 65 or higher.

Several different measures of ridership change and ridership performance were evaluated for use as a dependent variable that represents route ridership performance in the demographic analysis.

[4] As defined by the City of Toronto, Neighbourhood Improvement Areas are "neighbourhoods that face significant inequities in Economic Opportunities, Social Development, Participation in Decision-Making, Healthy Lives and Physical Surroundings and are recommended for targeted support." (City of Toronto, 2014)

The first measure examined was the percentage of annual ridership change on each of the subject routes, comparing the ridership before and after the new periods of operation were added. This measure identifies the ridership increases on each route. Because not all routes operated the same periods of operation before the service improvements, the percentage increase, in relation to the “before” ridership, varies greatly and cannot be compared between routes. For this reason, this measure was not evaluated further.

The second measure considered was the revenue-cost ratio of the new periods of operation on the subject routes. The new riders on the route were assigned an average fare revenue per boarding, based on the TTC’s 2019 ridership and revenue statistics (Toronto Transit Commission, 2020). This was then divided by the cost of the new service. This provides a high-level measure of the relative cost of operation per passenger on the new periods of service on the subject routes. In a transit system with a high number of transfers between routes a system-wide average fare per boarding does not accurately allocate revenue to trips made on a specific route, because these trips are also made on other routes. It is a complex task with an imprecise outcome to attempt to allocate revenue to only part of a linked multi-transfer trip (Soberman, 1997). This is made even more difficult by the varying lengths of trips on the subject route, as a percentage of the overall trip, and this overall fare paid. For these reasons, this measure was not evaluated further.

The third measure considered was the boardings per hour of service for the new periods of operation on the subject routes. This measure compares the number of new boardings on the routes, compared to the service hours required to provide the new service. This measure is the basis of the TTC’s Service Standards for evaluating new routes and new periods of

operation. There are several advantages of this measure, compared to total ridership change or to revenue/cost measures. Boardings per service hour look at the contribution of the new riding on a route level, not at the system level, and so avoid having to determine what portion of a trip on an interlinked system is attributable to riding on the specific subject route. The boarding per hour measure normalizes comparisons between routes that have longer or shorter periods of new operation by comparing it to the number of service hours required to add the service. No matter if three hours of late evening service is added on a one-bus route (three hours of new service a day) or six hours of midday service is added on a three-bus route (18 hours of new service a day), the measure consistently compares ridership to the quantity of service provided. Effectively, the density of riding on the new service is captured by this measure, no matter how much service was added, or how much service was operated in the past (Mis, 2024). For these reasons, boardings per service hour was selected as the dependent variable for the route ridership demographic analysis.

5.4.1 Results – Neighbourhood Improvement Area

A first comparison was made between route ridership performance and serving a Neighbourhood Improvement Area. The NIA measure is binary, as either the route serves a NIA or it does not. To match this, the route performance measure (boardings per service hour), were sorted into two categories, high and low, to also create a binary measure. A table was created to test the association between route ridership performance and whether the route served a NIA. This is a simplified test to determine if there is a statistical relationship between the two.

The result of the Chi-square test for Neighbourhood Improvement Areas shows that the distribution of route ridership performance and serving a NIA is statistically significantly 4.305 ($0.038 < p$, $df = 1$) different from the expected distribution if there was no association. This suggests that there is an association between higher route ridership performance and routes that operate through Neighbourhood Improvement Areas.

5.4.2 Results – Individual regression analysis of eight independent variables

The second method of analysis looked at the remaining eight variables, noted above in Section 5.4. These were individually regressed against the measure of route ridership performance, the boardings per service hour for each route. The boardings per service hour were calculated at the route level, not by the individual periods of the day, as the data for service hours is more readily available by whole day. This test focussed on the r values, to determine if there is a correlation between better route ridership performance (higher boardings per service for the new services) and the variable being examined. The results are shown in *Table 5-4 Regression analysis for individual independent variables*.

Table 5-4 Regression analysis for individual independent variables

Variable	r value	Standard error	Degrees of freedom	Statistical significance
Percent population change in the preceding five years	.207	19.16	1	.088
Percent of residents in households with low income	.432**	17.66	1	<.001
Percent of residents who are primarily public transit users	.206	19.16	1	.090
Percent of residents who immigrated to Canada in the preceding five years	.389**	18.04	1	<.001
Percent of residents who rent their primary dwelling	.164	19.32	1	.179
Percent of residents who are unemployed	.411**	17.85	1	<.001
Percent of residents who are youths	.209	19.15	1	.085
Percent or residents who are seniors	.395**	17.99	1	<.001
**** Correlation is significant at the 0.01 level (2-tailed)**				

The results of the individual regression analysis show that route ridership performance is statistically significantly correlated with the percentage of residents with low income, recently immigrated, unemployed, and seniors. Appendix C shows the full results of the individual regression analysis for all eight of the independent variables, in Tables C-1 through C-8.

From an equity perspective, the individual results can be interpreted to suggest that the improvements to routes benefited people living in NIAs, areas with higher percentages of

households with low incomes, areas with higher percentages of people who had immigrated to Canada recently, areas with higher unemployment rates, and areas with higher percentages of older people.

5.4.3 Results – Multiple regression analysis of independent variables

As a last step, two multiple regression models were run. These models used the same dependent variable (boardings per service hour) and the same eight independent variables as were used in *Section 5.4.2 Results – Individual regression analysis of eight independent variables.* The first model run added the NIA status as a ninth variable. The results are shown in *Table 5-5 Multiple regression analysis, including NIA status.*

Table 5-5 Multiple regression analysis, including NIA status

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	**(Constant)**	40.862	23.120		1.767	.082
	NIA	5.454	5.656	.130	.964	.339
	Population Change	-.635	.383	-.226	-1.660	.102
	Low Income	.636	.564	.253	1.129	.264
	Public Transit	.056	.344	.024	.163	.871
	Recent Immigrants	.569	.474	.184	1.201	.234
	Renters	-.066	.159	-.053	-.413	.681
	Unemployed	-.376	1.298	-.049	-.290	.773
	Youths	-.317	1.012	-.050	-.313	.755
	Seniors	-1.505	.606	-.302	-2.485	.016

a. Dependent Variable: Boardings per Service Hour

The results of the first multivariate model run, including the NIA variable, show that 30% of the variance is explained (R2=.361), and that the model is statistically significant overall at F=.082. In this model run, the only variable that is statistically significant to the route

performance is the percentage of seniors living on the route. Contrary to expectations, the value for seniors is negative, suggesting that route performance would be better on routes with fewer senior residents.

A second multivariate model run was done, without the NIA variable. This was excluded because it is a binary (Yes/No) variable, and as a composite of the other independent variables it likely introduces collinearity into the data. The results are shown in *Table 5-6 Multiple regression analysis, not including NIA status*.

Table 5-6 Multiple regression analysis, not including NIA status

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
2	**(Constant)**	40.059	23.092		1.735	.088
	Population Change	-.735	.368	-.262	-1.996	.051
	Low Income	.823	.529	.327	1.556	.125
	Public Transit	.013	.340	.006	.039	.969
	Recent Immigrants	.484	.465	.156	1.040	.302
	Renters	-.082	.158	-.067	-.521	.604
	Unemployed	.007	1.235	.001	.006	.995
	Youths	-.398	1.008	-.062	-.395	.695
	Seniors	-1.477	.605	-.297	-2.443	.018

a. Dependent Variable: Boardings per Service Hour

The model fit is marginally lower, at (R2 = .351), and the model is statistically significant overall at F=.088. In this model two variables, the percentage of seniors on the route, and the percentage of population change in the last five years, are statistically significant. As with the first model run, the direction of the coefficients is negative, and are thus counter to expectations, that both variables would predict better route performance in areas with higher

percentage of seniors and greater recent population increase. Appendix C shows the full results of the multivariate regression analysis, in Tables C-9 through C-10.

Given the analysis in sections 5.4.1 and 5.4.2, the improvement in route performance generally has been positive, has made transit access better for equity-seeking residents, and has improved equity in the system. The analysis in Section 5.4.3, however, shows some that more investigation is required to understand why in the multivariate framework, there are counterintuitive results and only about 35 percent of the variance is explained regardless of whether the NIA variable is included.

Chapter 6 Conclusions

Public transit is vitally important to many people in many urban areas. The service, whether provided by bus or train, must be available for it to be useful. In Toronto, buses are a key part of the integrated public transit system and contribute greatly to the personal mobility that is provided by the Toronto Transit Commission.

6.1 Summary of Findings

Significant improvements in the span-of-service on many bus routes were made in Toronto, in 2008 and again in 2015. These changes added new midday, evening, and weekend service to a third of the bus routes in the system. As a result, most bus routes in the TTC network now operate all-day, every-day. After these service improvements were implemented, ridership on these routes increased, and the increase in ridership was greater than would be expected from just the new periods of operation. The new service generated additional rides at other times of the days and weeks, at a higher rate than would be expected from the new periods of operation alone.

There was a positive elasticity from the service changes, when comparing the ridership with the percentage increase in service quantity. On the subject routes overall, ridership has increased in a greater proportion than the quantity of service was increased. This shows, within the limitations of the data, that the increase in service has generated additional riding on the routes. The results are consistent with similar studies of transit service elasticity (Currie & Loader, 2009).

An examination of key demographic variables from neighbourhoods served by the routes shows a positive correlation of ridership increase with the percentage of persons with low income, recent immigrants, persons who are unemployed, and seniors, when these variables are examined individually.

The service improvements that introduced full all-day, every-day service to bus routes had a positive impact on spatial equity in Toronto, and benefited equity-seeking residents.

The service improvements did increase operating costs for transit, because of the additional hours of service that were added. The increased ridership generated new fare revenue, but the operation of the new services continues to require subsidy, as the fare revenue does not cover the additional cost. This is typical of public transit, on all modes, at all times (Vuchic, 2005). Given that the changes generated additional transit riding, improved personal mobility, and had a positive impact on spatial equity, the additional service provides worthwhile benefits that should be viewed more broadly than from a simple revenue-cost perspective.

There were limitations in the data and the analysis carried out in this thesis. The dispersed nature of transit ridership in a dense, interconnected network means that counts on specific routes may capture on one day a rider who uses that route, while on another day when another count is taken that rider uses a different route. These variations are not fully reflected in the data. The demographic data reflects the characteristics in a geographic area served by the subject routes, but other routes in the network also serve those areas and may be used by customers at some or all times, instead of the subject route. As such, the demographic data provides a reasonable but imperfect representation of the ridership on the subject routes.

While the route ridership data is abundant, there are routes where the before data was limited to only one ridership count. Some of the counts used were taken a year or more before or after the service change. Ridership counts only up to 2019 were used, and so the analysis does not capture the effects on transit ridership of the COVID-19 pandemic. While anomalous counts and counts on routes with significant other service changes were excluded from the analysis, ridership changes may have occurred because of factors unrelated to the span-of-service improvements.

The regression analysis of individual variables produced results that were expected and explainable. Two multivariate regression analyses of the same variables, however, returned results that were not consistent with the individual variable analysis. These multivariate results also were counterintuitive to the hypothesis of this study, which is that service improvements result in increased ridership. A further examination of this analysis is warranted, ideally using more recent census, ridership, and service quantity information.

6.2 Policy Implications and Further Research

This work helps confirm that adding transit service results in increased ridership, on bus routes in Toronto. This conclusion is doubly confirmed by the fact that twice, in 2008 and in 2015, service was added and ridership increased. These actions were the result of specific policies enacted by the TTC that were intended to improve service for transit customers by adding service, in ways which were known to stimulate more transit ridership.

Is the policy of adding service to increase ridership transferable to other transit systems? The Toronto experience suggests that this is true. While the TTC is different than many other

Canadian transit agencies by virtue of its multiple modes, wide geographic reach, and high service levels, the routes analyzed in this thesis are mostly short, low-frequency, local bus routes. Services such as these are commonly found in many other Canadian transit agencies (Bunting, 2004). Most of the analyzed routes also serve post-Second World War suburban neighbourhoods, similar in built form and demographics to many other Canadian cities. It can be reasonably assumed that span-of-service increases in other transit agencies would produce similar ridership and equity improvements. The costs of the service increases can be relatively modest, and should be achievable within the budgets of smaller transit agencies. If the improvements do not work out, they can be easily reversed. It is simply a matter of policy to implement these proven investments.

The work in this thesis points to further research that could be done to understand other service changes, and the effects they have on transit customers. As noted in Section 6.1, above, further evaluation of the multivariate analysis would better understand the counter-intuitive results. This work could include determining how many of the variables used in the analysis duplicate each other, by counting the same people more than once.

More research could be done on how service frequency increases affect ridership, complementing this work on span-of-service increases. A service frequency study would have many more potential routes and service increases to analyze, both in Toronto and elsewhere. There is more relevant scholarship on frequency increases, compared to span-of-service increases, to help guide and compare a frequency study.

The inverse of this work – service reductions, instead of service increases – could also be studied. The limited examples of service reduction analysis suggest that ridership goes down

with service cuts less than it goes up with service increases, but this needs to be tested in detail, where data is available (Berrebi, Joshi, & Watkins, 2021). A valuable path of research would also be to study how long ridership takes to respond to service changes, and how long ridership increases – or decreases – are sustained after the service changes.

In all cases, the availability of relevant data could determine the feasibility of additional research into ridership and service changes.

6.3 Final Thoughts

The span-of-service of a local transit operation is vitally important to transit customers, in providing mobility and ensuring spatial equity. This study shows that the improvements made by the Toronto Transit Commission to the span-of-service on bus routes has, within reasonable study limitations, produced positive results for transit riders.

Thinking back to the question posed at the beginning of this work – “Is there a bus?” – the answer, in Toronto, is unequivocally “Yes!”.

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Appendix A – Summary of Additional Periods Added

TTC bus routes with new periods of service added, 2008														
		Monday-Friday					Saturday			Sunday				
		06:00-09:00 Morning peak	09:00-15:00 Midday	15:00-19:00 Afternoon peak	19:00-22:00 Early Evening	22:00-01:00 Late Evening	06:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening	06:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening		
	New	New service was added to the entire route in this period, and it has been analyzed as part of this research.												
	New (D)	New service was added in this period. Insufficient ridership data exists and it has not been analyzed as part of this research.												
	New (P)	New service was added to part of this route in this period. Insufficient ridership data exists and it has not been analyzed as part of this research.												
	Existing	Service was already operated on this route in this period before the service increases.												
	No service	Service was not operated on this route in this period.												
5	Avenue Rd	Existing	Existing	Existing	Existing	**New**	Existing	Existing	New (D)	Existing	Existing	New (D)		
6	Bay	Existing	Existing	Existing	Existing	**New**	Existing	**New**	**New**	Existing	**New**	**New**		
7	Bathurst	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing		
8	Broadview	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**		
9	Bellamy	Existing	Existing	Existing	Existing	**New**	Existing	Existing	New (D)	Existing	New (D)	New (D)		
10	Van Horne	Existing	New (D)	Existing	No service	No service	No service	No service	No service	No service	No service	No service		
11	Bayview	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)		
12	Kingston Rd	Existing	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)		
14	Glencairn	Existing	Existing	Existing	Existing	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)		
15	Evans	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (D)	Existing	**New**	**New**		
16	McCowan	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing		
17	Birchmount	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)	Existing	New (P)	New (P)		
20	Cliffside	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**	Existing	Existing	**New**		
21	Brimley	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (D)		
22	Coxwell	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing		
23	Dawes	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (D)		
24	Victoria Park	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing		
25	Don Mills	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing		
26	Dupont	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (D)		
28	Davisville	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service		
29	Dufferin	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing		
30	Lambton	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**		
31	Greenwood	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)	Existing	Existing	New (P)		
32	Eglinton West	Existing	Existing	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)		
33	Forest Hill	Existing	Existing	Existing	**New**	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)		

TTC bus routes with new periods of service added, 2008

		Monday-Friday					Saturday			Sunday		
		06:00-09:00 Morning peak	09:00-15:00 Midday	15:00-19:00 Afternoon peak	19:00-22:00 Early Evening	22:00-01:00 Late Evening	06:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening	06:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening
34	Eglinton East	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
35	Jane	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
36	Finch West	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
37	Islington	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
38	Highland Creek	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
39	Finch East	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
40	Junction	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
41	Keele	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
42	Cummer	Existing	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
43	Kennedy	Existing	Existing	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
44	Kipling South	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
45	Kipling	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
46	Martin Grove	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
47	Lansdowne	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
48	Rathburn	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**	Existing	Existing	**New**
49	Bloor West	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)	Existing	Existing	New (P)
50	Burnhamthorpe	Existing	Existing	Existing	Existing	**New**	Existing	Existing	New (D)	Existing	Existing	**New**
51	Leslie	Existing	Existing	Existing	Existing	**New**	Existing	**New**	**New**	New (D)	New (D)	New (D)
52	Lawrence West	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
53	Steeles East	Existing	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
54	Lawrence East	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
55	Warren Park	Existing	**New**	Existing	**New**	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)
56	Leaside	Existing	Existing	Existing	Existing	**New**	Existing	New (D)	New (D)	Existing	**New**	**New**
57	Midland	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
58	Malton	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
59	Maple Leaf	Existing	Existing	Existing	**New**	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)
60	Steeles West	Existing	Existing	Existing	Existing	Existing	Existing	New (P)	New (P)	Existing	New (P)	New (P)
61	Avenue Rd North	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
62	Mortimer	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**
63	Ossington	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
64	Main	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
65	Parliament	Existing	Existing	Existing	Existing	**New**	Existing	**New**	**New**	Existing	**New**	**New**

TTC bus routes with new periods of service added, 2008

		Monday-Friday					Saturday			Sunday		
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66	Prince Edward	Existing	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
67	Pharmacy	Existing	Existing	Existing	New (P)	New (D)	Existing	New (P)	**New**	Existing	New (P)	**New**
68	Warden	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
69	Warden South	Existing	Existing	Existing	Existing	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)
70	O'Connor	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
71	Runnymede	Existing	Existing	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
72	Pape	Existing	Existing	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
73	Royal York	Existing	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
74	Mt Pleasant	Existing	Existing	Existing	**New**	**New**	Existing	New (D)	New (D)	New (D)	New (D)	New (D)
75	Sherbourne	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
76	Royal York South	Existing	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
77	Swansea	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
78	St Andrews	Existing	Existing	Existing	Existing	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)
79	Scarlett Rd	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
80	Queensway	Existing	Existing	Existing	Existing	**New**	Existing	Existing	New (D)	Existing	**New**	**New**
81	Thorncliffe Park	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
82	Rosedale	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
83	Jones	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**	New (D)	New (D)	New (D)
84	Sheppard West	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
85	Sheppard East	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)
86	Scarborough	Existing	Existing	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
87	Cosburn	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
88	South Leaside	Existing	Existing	Existing	New (P)	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)
89	Weston	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
90	Vaughan	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
91	Woodbine	Existing	Existing	Existing	Existing	**New**	New (P)	New (P)	**New**	New (P)	New (P)	New (D)
92	Woodbine South	Existing	Existing	Existing	Existing	**New**	Existing	Existing	New (P)	Existing	Existing	New (P)
94	Wellesley	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
95	York Mills	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
96	Wilson	Existing	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
97	Yonge	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)	Existing	Existing	New (P)
98	Willowdale-Senlac	Existing	Existing	Existing	Existing	**New**	Existing	New (D)	New (D)	Existing	New (D)	New (D)

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99	Arrow Rd	No service	Existing	No service	Existing	No service	Existing	Existing	No service	Existing	Existing	No service
100	Flemingdon Park	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
101	Parc Downsview Park	New (D)	New (D)	New (D)	New (D)	No service	New (D)	New (D)	No service	New (D)	New (D)	No service
102	Markham Rd	Existing	Existing	Existing	Existing	Existing	Existing	New (P)	New (P)	Existing	New (P)	New (P)
103	Mt Pleasant North	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**	Existing	**New**	**New**
104	Faywood	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
105	Dufferin North	Existing	Existing	Existing	Existing	**New**	Existing	Existing	New (D)	Existing	Existing	New (D)
106	York University	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
107	Keele North	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
108	Downsview	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)	Existing	Existing	New (P)
109	Ranee	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)	Existing	Existing	**New**
110	Islington South	Existing	Existing	Existing	Existing	Existing	Existing	New (P)	New (P)	New (P)	New (P)	New (P)
111	East Mall	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
112	West Mall	Existing	Existing	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
113	Danforth	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
115	Silver Hills	Existing	**New**	Existing	**New**	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)
116	Morningside	Existing	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)	New (P)
117	Alness	Existing	Existing	Existing	No service	No service	No service	No service	No service	No service	No service	No service
120	Calvington	Existing	**New**	Existing	**New**	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)
122	Graydon Hall	Existing	Existing	Existing	**New**	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)
123	Shorncliffe	New (P)	Existing	New (P)	Existing	New (P)	Existing	New (P)	New (P)	Existing	New (P)	New (P)
124	Sunnybrook	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
125	Drewry	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (D)	Existing	Existing	New (D)
126	Christie	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**	**New**
127	Davenport	Existing	Existing	Existing	Existing	**New**	Existing	**New**	**New**	New (D)	New (D)	New (D)
129	McCowan North	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
130	Middlefield	Existing	Existing	Existing	Existing	**New**	New (D)	New (D)	New (D)	New (P)	New (D)	New (D)
131	Nugget	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
132	Milner	Existing	**New**	Existing	Existing	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)
133	Neilson	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (P)	Existing	New (P)	New (P)
134	Progress	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**	Existing	**New**	**New**
135	Gerrard	Existing	Existing	Existing	Existing	Existing	Existing	New (D)	New (D)	New (D)	New (D)	New (D)

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139	Finch-Don Mills	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
141	Downtown/Mt Pleasant Express	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
142	Downtown/Avenue Rd Express	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
143	Downtown/Beach Express	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
144	Downtown/Don Valley Express	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
160	Bathurst North	Existing	Existing	Existing	Existing	No service	Existing	Existing	No service	Existing	Existing	No service
161	Rogers Rd	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)	Existing	Existing	New (P)
162	Lawrence-Donway	Existing	Existing	Existing	**New**	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)
165	Weston Rd North	Existing	Existing	Existing	Existing	Existing	Existing	New (P)	New (P)	Existing	Existing	New (P)
167	Pharmacy North	Existing	Existing	Existing	New (D)	New (D)	Existing	**New**	**New**	New (D)	New (D)	New (D)
168	Symington	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)	Existing	Existing	New (P)
169	Huntingwood	Existing	**New**	Existing	**New**	**New**	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)
171	Mt Dennis	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)	New (D)
190	Scarborough Centre Rocket	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (D)	Existing	Existing	New (D)
191	Highway 27 Rocket	Existing	Existing	Existing	Existing	**New**	Existing	**New**	**New**	Existing	**New**	**New**
192	Airport Rocket	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
196	York University Rocket	Existing	Existing	Existing	Existing	**New**	Existing	**New**	**New**	New (D)	New (D)	New (D)
224	Victoria Park North	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service

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	New	New service was added to the entire route in this period, and it has been analyzed as part of this research.										
	New (D)	New service was added in this period. Insufficient ridership data exists and it has not been analyzed as part of this research.										
	New (P)	New service was added to part of this route in this period. Insufficient ridership data exists and it has not been analyzed as part of this research.										
	Existing	Service was already operated on this route in this period before the service increases.										
	No service	Service was not operated on this route in this period.										
5	Avenue Rd	Existing	Existing	Existing	Existing	**New**	Existing	New (D)	New (D)	Existing	New (D)	New (D)
6	Bay	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
7	Bathurst	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
8	Broadview	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**
9	Bellamy	Existing	Existing	Existing	Existing	**New**	Existing	Existing	New (D)	Existing	New (D)	**New**
10	Van Horne	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
11	Bayview	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
12	Kingston Rd	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
14	Glencairn	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**	Existing	Existing	**New**
15	Evans	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
16	McCowan	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
17	Birchmount	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
20	Cliffside	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**
21	Brimley	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
22	Coxwell	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
23	Dawes	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
24	Victoria Park	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
25	Don Mills	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
26	Dupont	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**	Existing	Existing	**New**
28	Bayview South	No service	No service	No service	No service	No service	Existing	No service	No service	Existing	No service	No service
29	Dufferin	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
30	Lambton	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
31	Greenwood	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
32	Eglinton West	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
33	Forest Hill	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing

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34	Eglinton East	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
35	Jane	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
36	Finch West	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
37	Islington	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (P)
38	Highland Creek	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
39	Finch East	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
40	Junction	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
41	Keele	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
42	Cummer	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
43	Kennedy	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
44	Kipling South	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
45	Kipling	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
46	Martin Grove	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
47	Lansdowne	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
48	Rathburn	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
49	Bloor West	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
50	Burnhamthorpe	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
51	Leslie	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
52	Lawrence West	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
53	Steeles East	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
54	Lawrence East	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
55	Warren Park	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
56	Leaside	Existing	Existing	Existing	Existing	**New**	Existing	**New**	**New**	Existing	**New**	**New**
57	Midland	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
59	Maple Leaf	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
60	Steeles West	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
61	Avenue Rd North	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
62	Mortimer	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**
63	Ossington	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
64	Main	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
65	Parliament	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
66	Prince Edward	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing

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67	Pharmacy	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
68	Warden	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
69	Warden South	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
70	O'Connor	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
71	Runnymede	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
72	Pape	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
73	Royal York	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
74	Mt Pleasant	Existing	Existing	Existing	**New**	**New**	Existing	**New**	**New**	Existing	New (D)	New (D)
75	Sherbourne	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
76	Royal York South	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
77	Swansea	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
78	St Andrews	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
79	Scarlett Rd	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
80	Queensway	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**
81	Thorncliffe Park	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
82	Rosedale	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
83	Jones	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
84	Sheppard West	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
85	Sheppard East	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
86	Scarborough	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
87	Cosburn	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
88	South Leaside	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
89	Weston	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
90	Vaughan	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
91	Woodbine	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
92	Woodbine South	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
94	Wellesley	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (P)
95	York Mills	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
96	Wilson	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
97	Yonge	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
98	Willowdale-Senlac	Existing	Existing	Existing	Existing	Existing	Existing	Existing	New (P)	Existing	Existing	New (P)
99	Arrow Rd	No service	Existing	No service	Existing	No service	Existing	Existing	No service	Existing	Existing	No service

TTC bus routes with new periods of service added, 2015

		Monday-Friday					Saturday			Sunday		
		06:00-09:00 Morning peak	09:00-15:00 Midday	15:00-19:00 Afternoon peak	19:00-22:00 Early Evening	22:00-01:00 Late Evening	06:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening	06:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening
100	Flemingdon Park	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
101	Downsview Park	No service	No service	No service	No service	No service	Existing	Existing	No service	Existing	Existing	No service
102	Markham Rd	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
103	Mt Pleasant North	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
104	Faywood	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
105	Dufferin North	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
106	York University	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
107	Keele North	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
108	Downsview	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
109	Ranee	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
110	Islington South	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
111	East Mall	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
112	West Mall	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
113	Danforth	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
115	Silver Hills	Existing	Existing	Existing	Existing	No service	Existing	Existing	No service	Existing	Existing	No service
116	Morningside	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
117	Alness	Existing	Existing	Existing	No service	No service	No service	No service	No service	No service	No service	No service
120	Calvington	Existing	Existing	Existing	Existing	**New**	Existing	Existing	**New**	Existing	Existing	**New**
122	Graydon Hall	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
123	Shorncliffe	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
124	Sunnybrook	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
125	Drewry	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
126	Christie	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
127	Davenport	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
129	McCowan North	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
130	Middlefield	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
131	Nugget	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
132	Milner	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**
133	Neilson	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
134	Progress	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
135	Gerrard	Existing	Existing	Existing	Existing	Existing	Existing	Existing	**New**	Existing	**New**	**New**
139	Finch-Don Mills	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service

TTC bus routes with new periods of service added, 2015

		Monday-Friday					Saturday			Sunday		
		06:00-09:00 Morning peak	09:00-15:00 Midday	15:00-19:00 Afternoon peak	19:00-22:00 Early Evening	22:00-01:00 Late Evening	06:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening	06:00-19:00 Daytime	19:00-22:00 Early Evening	22:00-01:00 Late Evening
141	Downtown/Mt Pleasant Express	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
142	Downtown/Avenue Rd Express	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
143	Downtown/Beach Express	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
144	Downtown/Don Valley Express	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
145	Downtown/Humber Bay Express	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service
160	Bathurst North	Existing	Existing	Existing	Existing	No service	Existing	No service	No service	Existing	No service	No service
161	Rogers Rd	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
162	Lawrence-Donway	Existing	Existing	Existing	New (D)	No service	New (D)	New (D)	No service	New (D)	No service	No service
165	Weston Rd North	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
167	Pharmacy North	Existing	Existing	Existing	**New**	**New**	Existing	New (D)	No service	No service	No service	No service
168	Symington	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
169	Huntingwood	Existing	Existing	Existing	Existing	New (P)	Existing	New (P)	New (P)	New (P)	New (P)	New (P)
171	Mt Dennis	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	No service
190	Scarborough Centre Rocket	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
191	Highway 27 Rocket	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
192	Airport Rocket	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
195	Jane Rocket	Existing	Existing	Existing	Existing	No service	Existing	No service	No service	Existing	No service	No service
196	York University Rocket	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing	Existing
198	U of T Scarborough Rocket	Existing	Existing	Existing	Existing	No service	No service	No service	No service	No service	No service	No service
199	Finch Rocket	Existing	Existing	Existing	Existing	**New**	Existing	Existing	No service	Existing	Existing	No service
224	Victoria Park North	Existing	No service	Existing	No service	No service	No service	No service	No service	No service	No service	No service

Appendix B – Route Ridership Data

Route		Year service added	Day of week	New period	Total daily ridership, before	Total daily ridership, after	New period ridership, daily	Total daily ridership change	New period per cent increase	Total ridership per cent increase
5	Avenue Rd	2008	Mo-Fr	22-01 Late eve	1825	1803	30	-22	2%	-1%
6	Bay	2008	Mo-Fr	22-01 Late eve	7967	7944	116	-23	1%	0%
6	Bay	2008	Sat	19-01 Evening	1376	2561	452	1185	33%	86%
6	Bay	2008	Sun	19-01 Evening	795	1141	165	346	21%	44%
8	Broadview	2008	Sat	22-01 Late eve	570	774	111	204	19%	36%
8	Broadview	2008	Sun	22-01 Late eve	489	543	58	54	12%	11%
9	Bellamy	2008	Mo-Fr	22-01 Late eve	3724	4103	139	379	4%	10%
14	Glencairn	2008	Mo-Fr	22-01 Late eve	1764	1815	51	51	3%	3%
15	Evans	2008	Sun	19-01 Evening	456	683	124	227	27%	50%
20	Cliffside	2008	Mo-Fr	22-01 Late eve	5300	5759	244	459	5%	9%
20	Cliffside	2008	Sat	22-01 Late eve	3379	3777	227	398	7%	12%
20	Cliffside	2008	Sun	22-01 Late eve	2155	2663	142	508	7%	24%
33	Forest Hill	2008	Mo-Fr	19-01 Evening	540	615	47	75	9%	14%
38	Highland Creek	2008	Sun	22-01 Late eve	1818	2890	269	1072	15%	59%
48	Rathburn	2008	Mo-Fr	22-01 Late eve	2553	2266	93	-287	4%	-11%
48	Rathburn	2008	Sat	22-01 Late eve	945	835	64	-110	7%	-12%
48	Rathburn	2008	Sun	22-01 Late eve	447	658	43	211	10%	47%
50	Burnhamthorpe	2008	Mo-Fr	22-01 Late eve	3124	3121	89	-3	3%	0%
50	Burnhamthorpe	2008	Sun	22-01 Late eve	765	839	53	74	7%	10%
51	Leslie	2008	Mo-Fr	22-01 Late eve	3363	4076	124	713	4%	21%
51	Leslie	2008	Sat	19-01 Evening	1266	1622	343	356	27%	28%
55	Warren Park	2008	Mo-Fr	09-15 19-01 Daytime off peak	640	1234	525	594	82%	93%

Route		Year service added	Day of week	New period	Total daily ridership, before	Total daily ridership, after	New period ridership, daily	Total daily ridership change	New period per cent increase	Total ridership per cent increase
56	Leaside	2008	Mo-Fr	22-01 Late eve	3527	3327	112	-200	3%	-6%
56	Leaside	2008	Sun	19-01 Evening	684	1072	213	388	31%	57%
59	Maple Leaf	2008	Mo-Fr	19-01 Evening	2495	2780	436	285	17%	11%
62	Mortimer	2008	Sat	22-01 Late eve	1554	1411	28	-143	2%	-9%
62	Mortimer	2008	Sun	22-01 Late eve	1248	1156	49	-92	4%	-7%
65	Parliament	2008	Mo-Fr	22-01 Late eve	3118	4098	139	981	4%	31%
65	Parliament	2008	Sat	19-01 Evening	2005	2802	608	797	30%	40%
65	Parliament	2008	Sun	19-01 Evening	681	1208	240	527	35%	77%
67	Pharmacy	2008	Sat	22-01 Late eve	1763	3046	185	1283	10%	73%
67	Pharmacy	2008	Sun	22-01 Late eve	1013	2049	169	1036	17%	102%
74	Mt Pleasant	2008	Mo-Fr	19-01 Evening	866	1070	103	204	12%	24%
78	St Andrews	2008	Mo-Fr	22-01 Late eve	1564	1671	72	107	5%	7%
80	Queensway	2008	Mo-Fr	22-01 Late eve	1784	1930	63	146	4%	8%
80	Queensway	2008	Sun	19-01 Evening	814	1236	202	422	25%	52%
83	Jones	2008	Mo-Fr	22-01 Late eve	2083	2297	120	214	6%	10%
83	Jones	2008	Sat	22-01 Late eve	886	1225	171	339	19%	38%
91	Woodbine	2008	Mo-Fr	22-01 Late eve	4949	5379	231	430	5%	9%
91	Woodbine	2008	Sat	22-01 Late eve	1784	2672	233	888	13%	50%
92	Woodbine South	2008	Mo-Fr	22-01 Late eve	3148	3378	168	230	5%	7%
98	Willowdale-Senlac	2008	Mo-Fr	22-01 Late eve	1939	2295	114	356	6%	18%
103	Mt Pleasant North	2008	Mo-Fr	22-01 Late eve	1381	1423	35	42	2%	3%
103	Mt Pleasant North	2008	Sat	22-01 Late eve	469	744	47	275	10%	59%
103	Mt Pleasant North	2008	Sun	19-01 Evening	449	487	89	38	20%	8%
104	Faywood	2008	Sun	22-01 Late eve	827	1404	92	577	11%	70%
105	Dufferin North	2008	Mo-Fr	22-01 Late eve	3456	3831	149	375	4%	11%
109	Ranee	2008	Sun	22-01 Late eve	1520	2567	169	1047	11%	69%

Route		Year service added	Day of week	New period	Total daily ridership, before	Total daily ridership, after	New period ridership, daily	Total daily ridership change	New period per cent increase	Total ridership per cent increase
115	Silver Hills	2008	Mo-Fr	09-15 19-01 Daytime off peak	645	1101	402	456	62%	71%
120	Calvington	2008	Mo-Fr	09-15 19-01 Daytime off peak	367	1135	424	768	116%	209%
122	Graydon Hall	2008	Mo-Fr	19-01 Evening	3722	4121	592	399	16%	11%
124	Sunnybrook	2008	Sun	22-01 Late eve	541	543	40	2	7%	0%
126	Christie	2008	Sun	19-01 Evening	999	1199	311	200	31%	20%
127	Davenport	2008	Mo-Fr	22-01 Late eve	903	1553	91	650	10%	72%
127	Davenport	2008	Sat	19-01 Evening	737	1117	278	380	38%	52%
130	Middlefield	2008	Mo-Fr	22-01 Late eve	1645	2118	59	473	4%	29%
132	Milner	2008	Mo-Fr	09-15 19-01 Daytime off peak	2096	2591	935	495	45%	24%
134	Progress	2008	Mo-Fr	22-01 Late eve	8079	9388	210	1309	3%	16%
134	Progress	2008	Sat	22-01 Late eve	2488	2697	156	209	6%	8%
134	Progress	2008	Sun	19-01 Evening	1138	1255	261	118	23%	10%
162	Lawrence-Donway	2008	Mo-Fr	19-01 Evening	313	634	103	321	33%	103%
167	Pharmacy North	2008	Sat	19-01 Evening	494	471	88	-23	18%	-5%
169	Huntingwood	2008	Mo-Fr	09-15 19-01 Daytime off peak	909	1625	714	716	79%	79%
191	Highway 27 Express	2008	Mo-Fr	22-01 Late eve	7530	14144	603	6614	8%	88%
191	Highway 27 Express	2008	Sat	19-01 Evening	2229	6377	1498	4148	67%	186%
191	Highway 27 Express	2008	Sun	19-01 Evening	1187	2536	581	1349	49%	114%
196	York University Express	2008	Mo-Fr	22-01 Late eve	18528	21046	975	2518	5%	14%
196	York University Express	2008	Sat	19-01 Evening	1346	2859	825	1513	61%	112%
5	Avenue Rd	2015	Mo-Fr	22-01 Late eve	1983	1964	45	-19	2%	-1%
6	Bay	2015	Sun	22-01 Late eve	2376	2328	90	-49	4%	-2%
8	Broadview	2015	Sat	22-01 Late eve	594	702	67	108	11%	18%
8	Broadview	2015	Sun	22-01 Late eve	584	481	38	-103	7%	-18%
9	Bellamy	2015	Mo-Fr	22-01 Late eve	4220	4888	184	668	4%	16%

Route		Year service added	Day of week	New period	Total daily ridership, before	Total daily ridership, after	New period ridership, daily	Total daily ridership change	New period per cent increase	Total ridership per cent increase
9	Bellamy	2015	Sun	19-01 Evening	1348	2232	487	884	36%	66%
14	Glencairn	2015	Mo-Fr	22-01 Late eve	2659	3255	138	596	5%	22%
14	Glencairn	2015	Sat	22-01 Late eve	1405	1938	154	533	11%	38%
14	Glencairn	2015	Sun	22-01 Late eve	1175	1396	97	222	8%	19%
15	Evans	2015	Sun	22-01 Late eve	738	759	52	21	7%	3%
20	Cliffside	2015	Sat	22-01 Late eve	3738	4000	242	262	6%	7%
20	Cliffside	2015	Sun	22-01 Late eve	2299	2794	199	495	9%	22%
26	Dupont	2015	Mo-Fr	22-01 Late eve	3657	3763	109	106	3%	3%
26	Dupont	2015	Sat	22-01 Late eve	1423	1998	172	574	12%	40%
26	Dupont	2015	Sun	22-01 Late eve	1233	1643	89	410	7%	33%
30	Lambton	2015	Sun	22-01 Late eve	1120	1373	129	253	12%	23%
51	Leslie	2015	Sun	22-01 Late eve	1216	1371	59	155	5%	13%
56	Leaside	2015	Mo-Fr	22-01 Late eve	3576	4028	110	452	3%	13%
56	Leaside	2015	Sat	19-01 Evening	1637	2378	457	741	28%	45%
56	Leaside	2015	Sun	19-01 Evening	1129	1561	255	432	23%	38%
59	Maple Leaf	2015	Sun	22-01 Late eve	691	1068	87	377	13%	55%
61	Avenue Rd North	2015	Sun	22-01 Late eve	1155	1221	75	66	6%	6%
62	Mortimer	2015	Sat	22-01 Late eve	1517	1479	92	-38	6%	-3%
62	Mortimer	2015	Sun	22-01 Late eve	1322	1254	71	-69	5%	-5%
74	Mt Pleasant	2015	Mo-Fr	19-01 Evening	1112	1169	98	57	9%	5%
74	Mt Pleasant	2015	Sat	19-01 Evening	423	531	96	107	23%	25%
75	Sherbourne	2015	Sun	19-01 Evening	321	360	216	39	67%	12%
80	Queensway	2015	Sat	22-01 Late eve	1811	1801	102	-10	6%	-1%
80	Queensway	2015	Sun	22-01 Late eve	891	1217	46	326	5%	37%
103	Mt Pleasant North	2015	Sun	22-01 Late eve	497	546	32	49	6%	10%
105	Dufferin North	2015	Sun	22-01 Late eve	1455	1547	72	93	5%	6%

Route		Year service added	Day of week	New period	Total daily ridership, before	Total daily ridership, after	New period ridership, daily	Total daily ridership change	New period per cent increase	Total ridership per cent increase
120	Calvington	2015	Mo-Fr	22-01 Late eve	1366	1708	80	342	6%	25%
120	Calvington	2015	Sat	22-01 Late eve	831	960	78	130	9%	16%
120	Calvington	2015	Sun	22-01 Late eve	699	777	61	78	9%	11%
124	Sunnybrook	2015	Sun	22-01 Late eve	706	851	73	145	10%	21%
127	Davenport	2015	Sun	22-01 Late eve	816	1047	100	231	12%	28%
132	Milner	2015	Sun	22-01 Late eve	583	986	82	403	14%	69%
135	Gerrard	2015	Sat	22-01 Late eve	1523	1710	113	187	7%	12%
135	Gerrard	2015	Sun	19-01 Evening	651	899	219	247	34%	38%
167	Pharmacy North	2015	Mo-Fr	19-01 Evening	1248	1546	159	298	13%	24%
199	Finch Express	2015	Mo-Fr	22-01 Late eve	20034	23442	896	3408	4%	17%

Appendix C – Summary of Regression Analysis

Table C-1 Summary output for regression of population change and route ridership performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.207[a]	.043	.028	19.15688	.043	2.994	1	67	.088

a. Predictors: (Constant), PopChange

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1098.710	1	1098.710	2.994	.088[b]
	Residual	24588.066	67	366.986		
	Total	25686.776	68			

a. Dependent Variable: Boardings per Service Hour
b. Predictors: (Constant), PopChange

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	30.339	2.758		11.002	<.001	24.835	35.844			
	PopChange	-.580	.335	-.207	-1.730	.088	-1.250	.089	-.207	-.207	-.207

a. Dependent Variable: Boardings per Service Hour

Table C-2 Summary output for regression of persons with low income and route ridership performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.432[a]	.187	.174	17.66015	.187	15.361	1	67	<.001

a. Predictors: (Constant), LowIncome

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4790.763	1	4790.763	15.361	<.001[b]
	Residual	20896.013	67	311.881		
	Total	25686.776	68			

a. Dependent Variable: Boardings per Service Hour
b. Predictors: (Constant), LowIncome

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	7.468	5.588		1.336	.186	-3.687	18.622			
	LowIncome	1.086	.277	.432	3.919	<.001	.533	1.640	.432	.432	.432

a. Dependent Variable: Boardings per Service Hour

Table C-3 Summary output for regression of public transit users and route ridership performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.206[a]	.042	.028	19.16153	.042	2.960	1	67	.090

a. Predictors: (Constant), PubTransit

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1086.783	1	1086.783	2.960	.090[b]
	Residual	24599.993	67	367.164		
	Total	25686.776	68			

a. Dependent Variable: Boardings per Service Hour
b. Predictors: (Constant), PubTransit

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	10.155	10.469		.970	.336	-10.741	31.051			
	PubTransit	.490	.285	.206	1.720	.090	-.078	1.058	.206	.206	.206

a. Dependent Variable: Boardings per Service Hour

Table C-4 Summary output for regression of recent immigrants and route ridership performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.389[a]	.151	.139	18.03793	.151	11.947	1	67	<.001

a. Predictors: (Constant), Immigrants

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3887.202	1	3887.202	11.947	<.001[b]
	Residual	21799.574	67	325.367		
	Total	25686.776	68			

a. Dependent Variable: Boardings per Service Hour
b. Predictors: (Constant), Immigrants

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	11.190	5.253		2.130	.037	.704	21.675			
	Immigrants	1.206	.349	.389	3.456	<.001	.509	1.902	.389	.389	.389

a. Dependent Variable: Boardings per Service Hour

Table C-5 Summary output for regression of renters and route ridership performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.164[a]	.027	.012	19.31594	.027	1.846	1	67	.179

a. Predictors: (Constant), Renters

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	688.699	1	688.699	1.846	.179[b]
	Residual	24998.077	67	373.106		
	Total	25686.776	68			

a. Dependent Variable: Boardings per Service Hour
b. Predictors: (Constant), Renters

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	18.901	6.897		2.740	.008	5.134	32.669			
	Renters	.202	.149	.164	1.359	.179	-.095	.498	.164	.164	.164

a. Dependent Variable: Boardings per Service Hour

Table C-6 Summary output for regression of unemployed persons and route ridership performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.411[a]	.169	.156	17.85437	.169	13.579	1	67	<.001

a. Predictors: (Constant), Unemployed

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4328.616	1	4328.616	13.579	<.001[b]
	Residual	21358.160	67	318.779		
	Total	25686.776	68			

a. Dependent Variable: Boardings per Service Hour
b. Predictors: (Constant), Unemployed

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	-.740	8.018		-.092	.927	-16.743	15.264			
	Unemployed	3.149	.855	.411	3.685	<.001	1.443	4.855	.411	.411	.411

a. Dependent Variable: Boardings per Service Hour

Table C-7 Summary output for regression of youth and route ridership performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.209[a]	.044	.029	19.14923	.044	3.050	1	67	.085

a. Predictors: (Constant), Youths

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1118.352	1	1118.352	3.050	.085[b]
	Residual	24568.425	67	366.693		
	Total	25686.776	68			

a. Dependent Variable: Boardings per Service Hour
b. Predictors: (Constant), Youths

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	10.622	10.060		1.056	.295	-9.458	30.702			
	Youths	1.331	.762	.209	1.746	.085	-.190	2.852	.209	.209	.209

a. Dependent Variable: Boardings per Service Hour

Table C-8 Summary output for regression of seniors and route ridership performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.395[a]	.156	.143	17.98801	.156	12.386	1	67	<.001

a. Predictors: (Constant), Seniors

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4007.686	1	4007.686	12.386	<.001[b]
	Residual	21679.090	67	323.569		
	Total	25686.776	68			

a. Dependent Variable: Boardings per Service Hour
b. Predictors: (Constant), Seniors

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	58.142	8.910		6.525	<.001	40.357	75.927			
	Seniors	-1.966	.559	-.395	-3.519	<.001	-3.081	-.851	-.395	-.395	-.395

a. Dependent Variable: Boardings per Service Hour

Table C-9 Summary output for multivariate regression to route ridership performance, with NIAs

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.601[a]	.361	.264	16.67738

a. Predictors: (Constant), PopChange, Immigrants, Renters, Seniors, PubTransit, NIA, Youths, Unemployed, LowIncome

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9276.820	9	1030.758	3.706	<.001[b]
	Residual	16409.956	59	278.135		
	Total	25686.776	68			

a. Dependent Variable: Boardings per service hour

b. Predictors: (Constant), PopChange, Immigrants, Renters, Seniors, PubTransit, NIA, Youths, Unemployed, LowIncome

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	40.862	23.120		1.767	.082
	NIA	5.454	5.656	.130	.964	.339
	PopChange	-.635	.383	-.226	-1.660	.102
	LowIncome	.636	.564	.253	1.129	.264
	PubTransit	.056	.344	.024	.163	.871
	Immigrants	.569	.474	.184	1.201	.234
	Renters	-.066	.159	-.053	-.413	.681
	Unemployed	-.376	1.298	-.049	-.290	.773
	Youths	-.317	1.012	-.050	-.313	.755
	Seniors	-1.505	.606	-.302	-2.485	.016

a. Dependent Variable: Boardings per service hour

Table C-10 Summary output for multivariate regression to route ridership performance, without NIAs

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.593[a]	.351	.265	16.66762

a. Predictors: (Constant), PopChange, Immigrants, Renters, Seniors, PubTransit, Youths, Unemployed, LowIncome

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9018.202	8	1127.275	4.058	<.001[b]
	Residual	16668.574	60	277.810		
	Total	25686.776	68			

a. Dependent Variable: Boardings per service hour

b. Predictors: (Constant), PopChange, Immigrants, Renters, Seniors, PubTransit, Youths, Unemployed, LowIncome

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	40.059	23.092		1.735	.088
	PopChange	-.735	.368	-.262	-1.996	.051
	LowIncome	.823	.529	.327	1.556	.125
	PubTransit	.013	.340	.006	.039	.969
	Immigrants	.484	.465	.156	1.040	.302
	Renters	-.082	.158	-.067	-.521	.604
	Unemployed	.007	1.235	.001	.006	.995
	Youths	-.398	1.008	-.062	-.395	.695
	Seniors	-1.477	.605	-.297	-2.443	.018

a. Dependent Variable: Boardings per service hour