Urban Rapid Rail Transit System Intermodality: Identifying Themes In Urban Public Transit within Canada and the United States

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Abstract

Urban Rapid Rail Transit System Intermodality: Identifying Themes In Urban Public Transit within Canada and the United States by Nathan Powell

High-quality public transportation improves the livability of neighborhoods, particularly in car-free or car-light urban environments. Public transportation is organized in a hierarchy, with different modes of transit serving different niches of travellers. Within this hierarchy, rapid rail provides the core service, operating vehicles with the highest capacity at the highest frequency. While ridership, fare provision, and other frequency-centric metrics have been at the forefront of public transit analysis, there is growing room for spatial metrics to describe connectivity within public transit. The Intermodality Index measures the average number of public transit connections at each rapid rail station within a given network. The full Intermodality Index is a composite of five intermodal paired indices that connect rapid rail to bikeshare, bus, ferry, rapid rail, and other rail services. By looking at intermodality through the lens of individual routes/services, this index approximates spatial intermodality since these routes/services serve unique geographies. Applying this index to the rapid rail networks of Canadian and American cities, we see that it favours networks that rely on intra-agency and supplemental rail and bus connections. Cities with minimal supplemental service providers and/or shallow intra-agency bus and rail service scored lower on this index. For bikeshare, overlapping service areas were highly conducive to higher intermodality. Ferry service was also notably dependent on physical geography to encourage intermodality.

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This study would not be possible without the support of my committee members Silvano de la Llata, Craig Townsend, and Kevin Gould. I also wish to thank Thomas Petluck, as well as the co-collaborators of the Red Line Podcast for facilitating numerous conversations about transit and inspiring the breadth of this study. A special thanks goes out to my family and friends for their steadfast emotional support throughout this process. To my father who passed before the completion of this study, we got it done. Lastly, I want to thank the entirety of the GPE department at Concordia for facilitating my undertaking of this research and supporting me throughout this process.

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List of Transit Data Sources and Abbreviations

Atlanta

Bus service:	Metropolitan Atlanta Rapid Transit Authority (MARTA), Georgia Regional Transportation Authority, Gwinnett County Transit, CobbLinc.
Rapid rail service:	MARTA – MARTA Rail
Other rail service:	Atlanta Department of Aviation – ATL SkyTrain, MARTA – Atlanta Streetcar
Additional Municipalities:	Decatur, Chamblee, Dunwoody, Brookhaven, Sandy Springs

Baltimore

Bus service:	Maryland Transit Administration (MTA) – CityLink, Baltimore City Department of Transportation
Rapid rail service:	MTA – Metro Subway
Other rail service:	MTA – Light RailLink
Additional Municipalities:	Lochearn, Owings Mill

Boston

Bikeshare service:	Bluebikes
Bus service:	Massachusetts Bay Transit Authority (MBTA), Charles River Transportation Management Association, Brockton Area Transit, Cape Cod Regional Transit Authority
Ferry service:	MBTA – MBTA Boat
Rapid rail service:	MBTA – the T[1]
Other rail service:	MBTA, Amtrak
Additional Municipalities:	Boston, Malden, Somerville, Braintree, Quincy, Cambridge, Quincy, Revere, Medford

Chicago

Bikeshare service:	Divvy
Bus service:	Chicago Transit Authority (CTA), Regional Transit Authority, River Valley Metro Mass Transit District
Rapid rail service:	CTA – Chicago L
Other rail service:	Navy Pier Trolley, Metra, Amtrak
Additional Municipalities:	Rosemont, Forest Park, Wilmette, Oak Park, Skokie, Evanston, Cicero

Cleveland

Bus service:	Greater Cleveland Regional Transit Authority (GCRTA), Stark Area Regional Transit Authority, Portage Area Regional Transportation Authority, Akron Metropolitan Regional Transit Authority, Laketran.
Rapid rail service:	GCRTA – RTA Rapid Transit[2]

[1] The Blue, Orange, and Red Line were included in this study as other lines service light rail.

[2] Only the Red Line meets the requirements for rapid rail within this system.

Other rail service:	GCRTA – RTA Rapid Transit

Los Angeles

Bikeshare service:	Metro Bike Share
Bus service:	Los Angeles County Metropolitan Transportation Authority (LACMTA) – Metro Bus, Burbank Bus, City of Santa Clarita Transit, Los Angeles Department of Transportation, Silver Streak, Torrance Transit, Big Blue Bus, City of Commerce Municipal Bus, Orange County Transportation Authority, Foothill Transit, Antelope Valley Transit Authority, Montebello Bus
Rapid rail service:	LACMTA – Metro Rail[3]
Other rail service:	LACMTA – Metro Rail, Amtrak – Metrolink

Miami

Bikeshare service:	Citi Bike Miami
Bus service:	Miami-Dade Transit, Broward County Transit
Rapid rail service:	Miami-Dade Transit – Metrorail
Other rail service:	South Florida Regional Transportation Authority (SFRTA) - Tri-Rail, Amtrak
Trolley/Streetcar service:	Miami-Dade Transit – Metromover, MIA Mover
Additional Municipalities:	South Miami, Opa-locka, Glenvar Heights, Golden Glades, Coral Gables, Kendall, Hialeah

Montreal

Bikeshare service:	Bixi
Bus service:	Société de Transport de Montréal (STM), Société de Transport de Laval (STL), Réseau de transport métropolitain (RTM) – Exo, Réseau de transport de Longueuil
Ferry service:	Autorité régionale de transport métropolitain (ARTM)
Rapid rail service:	STM
Other rail service:	RTM - Exo
Additional Municipalities:	Laval, Longueuil

New York City

Bikeshare service:	Citibike
Bus service:	New York City Transit Authority (NYCTA), Nassau Intercounty Express, Westchester Bee-Line, Roosevelt Island Operating Corporation (RIOC), Metropolitan Transportation Authority (MTA)
Ferry service:	New York City Economic Development Corporation (NYCEDC) – NYC Ferry, New York City Department of Transportation (NYCDOT) – Staten Island Ferry
Rapid rail service:	Staten Island Rapid Transit Operating Authority (SIRTOA) – Staten Island Railway, NYCTA[4] - New York City Subway, Port Authority

[3] Only the B and D Line meet the requirements for rapid rail.
[4] SIRTOA and NYCTA are subsidiaries of the MTA.

	of New York and New Jersey (PANYJ) - Port-Authority Trans Hudson (PATH)
Other rail service:	NJ Transit, Amtrak, MTA - Metro-North, Long Island Railroad, RIOC - Roosevelt Island Tramway, PANYNJ – JFK AirTrain
Additional Municipalities:	Harrison, Newark, Jersey City, Hoboken

Philadelphia

Bikeshare service:	Indego
Bus service:	Southeastern Pennsylvania Transportation Authority (SEPTA), NJ Transit
Rapid rail service:	SEPTA[5], Port Authority Transit Corporation – PATCO Speedline
Other rail service:	SEPTA, Amtrak, NJ Transit
Additional Municipalities:	Camden, Millbourne, Upper Darby, Collingswood, Haddon Township, Haddonfield, Cherry Hill, Vorhees Township, and Lindenwold.

San Francisco

Bikeshare service:	Lyft – Bay Wheels
Bus service:	San Francisco Bay Area Rapid Transit District (BART), Central Contra Costa Transit Authority – County Connection, City of Rio Vista – Rio Vista Delta Breeze, Tri Delta Transit, West Berkeley Shuttle, San Mateo County Transportation Authority, Valley Transit Authority, Golden Gate Transit, SamTrans, Livermore Amador Valley Transit Authority - Wheels, StanRTA, Commute.org, Fairfield and Suisun Transit (FAST), San Leandro LINKS, Dumbarton Express, Unity City Transit, SolTrans, San Joaquin Regional Transit District, WestCAT, SolTrans, Napa VINE, FAST, PresidioGO, Emery Go-Round, AC Transit
Ferry service:	Golden Gate Bridge, Highway and Transportation District – Golden Gate Ferry, San Francisco Bay Area Water Emergency Transportation Authority – San Francisco Bay Ferry, Treasure Island Development Authority – Treasure Island Ferry
Rapid rail service:	BART
Other rail service:	San Francisco Municipal Railway (Muni) – Muni[6] Metro, Amtrak, Caltrain
Additional Municipalities:	Colma, Orinda. Millbrae, Lafayette, El Cerrito, San Bruno, South San Francisco, Castro Valley, Walnut Creek, Union City, Dublin, Pittsburg, Pleasanton, Milpitas, San Leandro, Daly City, Antioch, Richmond, Berkeley, Concord, Hayward, Fremont, Oakland, San Jose

[5] The Broad Street, Broad-Ridge Spur, and Market-Frankford lines were considered for this study as they met the frequency for rapid rail.

[6] Cable car services owned by SFMTA, was counted as Other Rail for this study.

Toronto

Bikeshare service:	Bike Share Toronto
Bus service:	Toronto Transit Commission (TTC), Brampton Transit, Mississauga Transit, York Region Transit, Tok Transit, GO Transit
Rapid rail service:	TTC- Toronto Subway[7]
Other rail service:	TTC, Metrolinx, Amtrak, GO Transit
Additional Municipalities:	Vaughan

Vancouver

Bikeshare service:	Vancouver Bike Share, Inc. - Mobi
Bus service:	TransLink – RapidBus
Ferry service:	TransLink – SeaBus
Rapid rail service:	TransLink - SkyTrain[8]
Other rail service:	Amtrak, VIA Rail, TransLink – SkyTrain, West Coast Express
Additional Municipalities:	New Westminster, Burnaby, Surrey

Washington

Bikeshare service:	Capital Bikeshare
Bus service:	Washington Metropolitan Area Transit Authority (WMATA), Maryland Transit Administration (MTA), Alexandria Transit Company, Loudoun County Transit, District of Columbia Department of Transportation, OmniRide, Arlington Transit, Fairfax Connector, TheBus, Regional Transit Authority of Central Maryland, Montgomery County Department of Transportation.
Rapid rail service:	WMATA – Metro[9]
Other rail service:	WMATA – Metro, MTA, MARC, Amtrak, Virginia Railway Express
Additional Municipalities:	Temple Hills, Suitland, Hyattsville, College Park, Greenbelt, Arlington County, Alexandria, Huntington, Silver Spring, Forest Glen, Wheaton, Glenmont, Bethesda, North Bethesda, Rockville, Derwood

[7] Only Line 1, 2, and 4 of the Toronto Subway service rapid rail.
[8] The Expo Line meets the requirements of rapid rail although SkyTrain is considered a light metro system.
[9] The Red, Yellow, and Green Line meet the requirements for rapid rail.

Introduction

High-quality public transit connections make neighborhoods more livable. Over time, North American cities have grown to embrace different modes of transit leading up to the collective present need for increasing public transit. From the late 1880s to early 1930s, cities grew along privately owned rail corridors. The rise of the automobile in the 1930s not only caused majority of these privatized railways to be brought by public entities but changed the urban fabric of developing cities to favor automobile travel. This brings us to the present-day where given the population density of urban areas, it is not practical for everyone to rely solely on automobile travel due to space restrictions and the limited capacity of roads. Nonetheless, people in urban areas still need reliable means of travel to access their cities' amenities. Cities, in the present-day, tackle these needs by increasingly investing in public transit agencies, which provide subsidized public transit, in various modes and organizations, to those traveling to and within the city (Bruun, 2007).

These public transit networks can be seen as a system of systems with each individual transit mode acting as its own operational system. In this, broad metropolitan level transit networks can be better understood by examining different operators and services and seeing how they connect. Most cities, in this vein, have a primary transit agency connected to the municipal government that provides the foundation of services, often including rapid rail, with supplemental agencies and operators connecting their services to this foundational network. Through this, public transit networks grow to be expansive geographically, but also denser within their service areas. These two processes collaborate to increase the quality of service.

Since public transit agencies have the authority to organize their systems, public transit's effectiveness varies between cities. Several factors including fares, service provision, overall area coverage, and accessibility play into this (Nnaji, 2002). Transit intermodality is an under-looked facet in this regard. Transit intermodality, also referred to as transit interconnectivity or mode integration, refers to transportation by more than one type of transit mode during a single trip(Goetz, 2009). Intermodality looks at how different modes of transit interface, allowing users of each mode to transfer to other modes. Nonetheless, there needs to be more analysis looking at system-wide intermodality by mode to truly parse out how cities are served by intermodal transit options en masse. Intermodality is an important aspect of both public transportation use and organization. Intermodality is essential as a means of extending coverage, providing for different transit niches, and increasing the resiliency of public transit systems. Intermodality extends coverage by allowing the individual service areas to merge. Intermodality also allows modes of transit that operate on different scales to converge making public transit more attractive to different riders. An easy scalar example of this is the bus line that stops every other block that connects to the rapid rail line that stops around every mile. Allowing these services with different stop densities to intersect allows people to strategically utilize higher stop density services to mitigate obstacles to rapid rail, which has a relatively low stop density. Furthermore, intermodality provides more options to get to a destination, which in turn makes intermodal systems more resilient, making emergency service modifications more feasible as different unaffected modes of transit can supplement down service elsewhere.

Intermodality allows transit riders to approach, or ideally, obtain the luxury of door-to-door public transit service. The idealized 15-minute city model has been identified as a metric for livability, that transit plays an integral role in (Hosford et al., 2022). The inspiration for this model is the idea that people should be able to meet all their basic needs within 15 minutes of travel from their residence ideally through walking, biking or transit. A common inclusion within this model is access to a rail station or bus stop. However, cities with higher public transit intermodality often have multiple transit options within a 15-minute walkshed, which allows transit riders to experience the convenience of near door-to-door travel without a personal automobile (Logan et al., 2022).

This amounts to intermodality being beneficial to both planners and riders as a means of taking advantage of the margins between interconnecting services. However, intermodality is not equal across modes. For instance, while intermodality between a bikeshare dock and a bus line proves beneficial to riders within a 15-minute bikeshed of the bus line, this impact is rather marginal on the system level. Intermodality between rapid rail and other modes of transit proves to best take advantage of the benefits of intermodality. Rapid rail, synonymous with metro, subway, and heavy rail, forms the core backbone of urban public transit systems, offering high trip frequency with large capacity on an exclusive right-of-way. Because of this, rapid rail often provides the pinnacle of service within the public transit service hierarchy. In this regard, intermodality between rapid rail, specifically, and other modes of transit is important because it allows more people to be served by the most convenient and consistent mode of public transit. Furthermore, the other modes allow for more consistent first-mile/last-mile travel, which rapid rail alone struggles with due to infrastructural and operational burdens. (Bruun, 2007).

Rapid rail is a part of the public transit networks of these 14 cities in Canada and the United States.

- Atlanta
- Baltimore
- Boston
- Chicago
- Cleveland
- Los Angeles
- Miami
- Montreal
- New York City
- Philadelphia
- San Francisco
- Toronto
- Vancouver
- Washington

With these cities committing to providing consistent, high-quality public transit, it still begs the question of how these rapid transit cores interface with the rest of the public transit networks they belong to and how intermodality can categorize these public transit networks. These concerns coalesce into my overall research question: **What is the state of rapid rail intermodality, and how does it vary between different public transit networks within Canada and the United States?**

Literature Review

This literature review will primarily touch on the development and key tenets of urban systems theory to ground this system-centric analysis (Chadwick, 1978; Kuronen, n.d.; Pourmohammadi, 2022). From here, it goes over a contextualized history of rapid rail in Canada and the United States, focusing on the origins of these systems and the agencies in charge of their operation. This history extends to introducing the youngest rapid rail system in these two countries, Los Angeles, and any subsequent agency changes to the present day. These facets are significant in analyzing how rapid rail intermodality has developed. The urban fabric of these cities and rapid rail development increasingly affect each other the longer rapid rail continues to operate. Furthermore, the agencies operating these systems are important as they are ultimately in charge of ensuring intermodality is happening.

From here, this review will look at the existing literature around transit intermodality, primarily in general, and then explicitly tie each public transit mode to rapid rail(Bateman et al., 2021; Chan & Farber, 2019; Cheng et al., 2022; Cherry, 2011; Ganning, 2016; Ma et al., 2022; Nai et al., 2012; Qian et al., 2022; Z.-J. Wang et al., 2018; Zhou et al., 2021). There is significant variance in the amount of literature for each transit mode. Specifically, there needs to be more literature regarding ferry-rapid rail intermodality. Vancouver, Boston, New York City, Montreal, and San Francisco all offer service connections between ferry and rapid rail. Newer public transit networks built near large bodies of water, like that of Kochi, India which began rapid rail service in 2017, have been built with ferry integration in mind from conception (Singh, 2020). Nonetheless, this study will add to this area of analysis that has yet to see much attention. Although not formally apart of public transit networks in this study (excluding Los Angeles), the public-facing nature of bikeshare implicate these systems within this conversation of transit intermodality. This review will briefly explain the origins of bikeshare and how it works before discussing its integration with rapid rail. Discussions on rail integration will include rapid rail interlining, which is the coordination of two or more individual rapid rail routes to serve a common station, and the integration of rapid rail and other rail modes. Bus rapid transit (BRT) will also be discussed alongside bus-rapid rail integration in general. Depending on definitions, each of these cities have at least one BRT line.

Urban Systems

Urban systems theory became relevant to urban planning in 1960s as a response of the shrinking preponderance of rational planning. Rational planning includes movements like City Beautiful and Garden City, both stemming from the core tenets of reason and logic from the Enlightenment (Admin, 2020). At the core of rational planning is the rational decision-making model that imbues the process of understanding urban problems through creating planning criteria, evaluating data based on criteria, creating alternatives based off evaluation, implementing favored alternatives, and monitoring progress of these alternatives. In this, rational planning is highly concerned with technical expertise and logical resolutions (Iyoriobhe, 2019). The Garden City was an early rational planning movement devised by Ebenezer Howard that attempted to mediate the benefits of cities and rural areas through the deliberate rational decision-making model. Through this model, Howard created planned metropolitan areas devised of central cities surrounded in polycentric rings by smaller garden cities and agricultural land connected through a deliberate polycentric railway (Howard, 1965). The Garden city model was a pioneer in attempting to remedy urban plight through urban form. City Beautiful was a movement borne from interweaving this logical and deliberate decision-making model with the aim of extending public aesthetic properties along uniformity and precision (Hess, 2006). The argument towards City Beautiful is that the maintenance and beautification of public spaces increase the quality of life of residents and makes it more likely for citizens to feel invested in the places they live, which should, in turn, promote a more collaborative, harmonious social order.

The lack of nuance within the rational planning process and multiple major critiques and failures saw the rational planning movement gradually lose favor in the 1960s. While being able to identify and systematically solve problems in a well-designed manner facilitated urban growth and played a pivotal role in the development of most major North American cities, problems that existed outside of the realm of logic were not accounted for. Particularly, the lack of nuance within planning and the shrinking opportunities for chance encounters left people feeling disconnected to their communities. Jane Jacobs was a pivotal critic of rational planning, saying the garden city movement was 'essentially paternalistic, if not authoritarian' (Jacobs, 1961). The demolition of Pruitt-Igoe, a massive rational-planned housing project set to house impoverished people in St Louis that did not have resources to continue maintenance and fell into disarray within a year of opening in 1955, further intensified the drawbacks of rational planning opening the door for alternate theories to take hold. (Boyne et al., 2004)

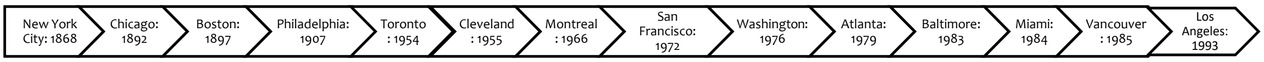
Urban systems theory conceptualizes cities as systems of systems and focuses on facets that allow individual systems to continue operating within themselves through scale. Systems theory, in this vein, relies on functionalism as its core inspiration, concerned with how systems function. At the lowest level, cities are made up of agents, as well as independent and interdependent parts of a given system (Kuronen, n.d.). In this, the role of planners is to understand how systems work through the relationship between its parts and the actions of agents. Agents within this context include markets, governments, and civil society, as described by Pourmohammadi (2022) in their study looking at system thinking and analysis in urban planning. This study breaks down the complexity of how urban subsystems facilitate each other and how actions by agents mediate the success of these systems. To understand any system within this broader logic, one must know how its agents and parts relate, and the effects of their relationship. Systems theory builds on the work of Patrick Geddes, who saw cities as organisms constantly in evolution, making Geddes a contributor to both rational and systems theory (Geddes, 1915). Looking at cities as organisms imbue the naturalistic tendency of functionality being affected by outside factors. In the natural world, organisms adapt to changes in their environments slowly over time through the promotion of favorable genetics. Similarly, cities adapt to various uncontrolled factors in a similar iterative manner where cities that adapt to their environment develop faster. (Chadwick, 1978)

Looking at public transit as a system, knowledge of the actors, e.g. transit operators, the government, and riders; and parts, e.g., stations, stops, vehicles, routes, and schedules, is vital to inform its functionality. For instance, whether transit operators are public or private has massive effects on how they provide service. Public operators have the duty to provide service, often through a mandate from a governing body. These mandates often entail minimum service levels and other requirements that both enable and limit service operation. These enablers often come in the form of land rights and the removal of other barriers to physical operation of a given transit service. However, governments also have variable amounts of decision-making power over where to place their limited number of resources dedicated to public transit, making public operators beholden to their requests over their own desires. Private providers often supplement transit service in the areas lacking a publicized transit connection (Gibson, 1969). Although not included in this study, private bus, rail, and ferry operators, as well as bike rental providers, fill in the holes of services within cities and connecting cities.

This study uses systems theory as a theoretical framework for analysis, focusing on the agents that make transit intermodality possible and the additive effects of overlapping intermodal services. In this, action is paid to the number of transit operators running service connected to rapid rail, as well as the histories of the agencies operating rapid rail themselves. This historical context is used to ground intermodality as a facet of the overall system. Systems theory is lauded for its inclusion of socioeconomic factors that were missing from rational planning, and this study ultimately brings these factors into conversation with intermodality.

History of Rapid Rail in Canada and the United States

Figure A: Cities by Introduction of Rapid Rail



(BART, 2022; Borzo, 2007; Cudahy, 1972; Farrow & Cox, 1985; Gilbert, 2016; Holle, 2012; Jackson, 1918; MARTA, 2022; NYC Subway, 1918; RTA, 2017; Schwandl, 2004, 2007; TTC, 2021; WMATA, 2022)

Figure A shows a graphic of rapid rail cities in chronological order of the introduction of rapid rail. Rapid rail introduction occurred during two 50-year periods: an early period from the 1860s to around 1910 and a second period from the 1950s to the mid-1990s. Advancements that allowed trains to operate within 15-minute headways bolstered this initial rapid rail development period. The pause in rapid rail development from the 1910s until the 1950s had two leading causes: the industrial focus on World War I and the automobile industry boom in North America (Flink, 2001; Post, 2007). The second period of rapid rail development started around the end of World War II, which saw a return to investment in domestic industry across Canada and the United States. Rapid rail systems developed in this period occurred in various up-and-coming cities on the continent. They marked a shift from the Midwest and Northeast industrial focus of the pre-1920s era. Nonetheless, new rapid rail development was curtailed in the mid-1990s as cities began opting for light rail and bus rapid transit systems over infrastructurally heavy rapid rail systems. (Post, 2007)
The first urban rapid rail line in North America was the West Side and Yonkers Patent Railway, which opened in 1868, five years after the opening of the first urban rapid rail line, the London Underground, in 1863. This cable-powered elevated railway originally operated from Dey Street to 29th Street on eight-minute headways. It initially cost five cents to board one of the 500-car Composites. The Composite was the original rolling stock of the subway but was riddled with congestion issues as its doors on each end design created bottlenecks. The Hedley Hi-V, a center-door fleet, replaced them in 1910 (NYC Subway, 2012). Chicago was next to introduce rapid rail to their urban fabric. The South Side Elevated Railroad began operation in 1892, with much of the original route now a part of the Chicago L Green Line (Cudahy, 1982). Chicago has since been an anomaly for continuously operating on predominately elevated or at-grade tracks.

Most early systems were elevated, as technology had yet to be advanced enough to make underground tunneling feasible. This began to change with the Tremont Street subway in Boston. The Tremont Street subway was North America's first underground urban rapid rail line, opening in 1897, and has since been incorporated into the MBTA Green Line[10] (Cudahy, 1972). Going

[10] Boston has rapid transit in the form of streetcars as early as 1889 (ETHW, 2017), but the Tremont Street subway was the first line that truly resembles modern-day rapid rail in the city.

underground proved popular, with New York City beginning to operate underground rapid rail service between Brooklyn, Manhattan, and the Bronx in 1904. The popularity of underground rail was strong in inner cities due partly to how it could link dense urban fabric without the restraints of above-ground urban construction. Early pioneers like Boston and New York City set the norm that at least downtown, rapid rail should be underground, with the elevation level increasing further from the urban core. Given that cities built after the 1900s have followed this logic for the most part, the preponderance of elevated tracks in Chicago, specifically the elevated downtown loop, makes rapid rail transit in Chicago a unique experience. (Cudahy, 1982)

Philadelphia was the last city of the first period to begin operation, with the Market Street line opening in 1907. The original line was underground between the City Hall and the Schuylkill River before transitioning to an elevated line from the Schuylkill to its terminus at 69th Street. The Market Street line was supposed to be complimented by the Frankford Elevated line, which began construction in 1915 but had slow progress because of World War I and the wartime effects on finances and labor. Nevertheless, the Frankford Elevated opened in 1922, and both lines have since been incorporated to form the present SEPTA Market-Frankford line (Jackson, 1918).

These systems started as private ventures and consolidated into public entities by the 1960s. Early New York rapid rail history was known for its multiple transit companies, many of which were incorporated into two companies by the early 1900s: the Interborough Rapid Transit Company (IRT) and the Brooklyn Rapid Transit Company (BRT). In practice, different transit companies within the same city, like the IRT and BRT, were competing companies offering the same good in a capitalist market economy. Within this vein of competition, railroad companies' best interest was to build as much rail as possible. By the 1930s, both companies continued to operate growing separate systems, and calls for consolidation were increasing. In response, the city-owned Independent Subway System (IND) opened in 1932, followed by the city buying both the BRT and IRT systems in 1940. Within this, the New York City Transit Authority (NYCTA) was created as a public authority in charge of rapid rail, bus, and then-streetcar operation in 1953, with the Metropolitan Transportation Authority (MTA) taking the reins in 1965. (Hood, 2004; MTA, 2015)

The Boston Elevated Railway (BERy), founded in 1884, operated the original Tremont Street Subway and became the primary transit operator in Boston after acquiring the West End Street Railway in 1897. BERy continued to grow its streetcar, underground rail and elevated rail system until the 1940s. The rise of the automobile and wartime efforts pushed the BERy system towards public ownership. This push led to the creation of the Metropolitan Transit Authority (MTA) in 1947, which continued to operate and expand the BERy system until the Massachusetts Bay Transportation Authority was formed in 1964. (Cudahy, 1972)

The Chicago Rapid Transit Company (CRT) was formed in 1924 as a consolidation of four railroad companies: the South Side Rapid Transit Railroad, Northwestern Elevated Railroad, Lake Street Elevated Railroad, and the Metropolitan West Side Elevated Railroad, becoming the leading railroad operator of the city, alongside the smaller Chicago Surface Lines (CSL) that primarily operated trolley services. These companies faced similar struggles as other railroad companies in the 1940s, leading to their consolidation into the Chicago Transit Authority (CTA) in 1947. (Chicago "L," n.d.; Cudahy, 1982)

The Philadelphia Rapid Transit Company (PRT) was incorporated in 1902 and was the original operator of the Market Street line. Although Philadelphia had several independent railroad companies then, the PRT grew to take up a large portion of the market. However, their early business practices made them unpopular with the public (Chomet, 2012). These business practices ultimately caused the PRT to be sold to the Philadelphia Transportation Company (PTC) in 1940.

Philadelphia was the last of these cities to turn rapid rail operations into a public entity. The Southeastern Pennsylvania Transportation Authority (SEPTA) was established in 1964, taking over the PTC system amidst the increasing unprofitability of privatized rail transit.

Although no new rapid rail systems were built from 1907 to 1954, the existing systems developed in distinct patterns. Chicago remained majority elevated, even as other systems became primarily underground. Chicago's first underground station opened in 1943; to this day, less than 15% of Chicago L stations are underground. Furthermore, the organizing logic of rapid rail in Chicago became apparent under the CRT: create a central loop in downtown Chicago and construct lines radiating out from the center into greater Chicagoland in a hub-and-spoke fashion. This logic contrasted that of the rapid rail system of New York City, which was primarily concerned with intracity connections between adjacent neighborhoods and boroughs. This focus on intracity connection was due to the competition between the BRT and IRT. With BRT focusing on developing rail within Brooklyn and to Manhattan, and the IRT focused on developing rail connecting Manhattan to Queens, Bronx, and even Brooklyn, the consolidation of these rail networks gave New York City a big heads up on intracity connectivity and set forth the transit culture that remains in place to this day. Philadelphia and Boston were similar because their early rapid rail systems concentrated on the downtown core. This has remained the same for the most part, with both systems relying on light rail, streetcar, and trolley service to service their greater regions, reserving rapid rail for within city limits and immediately adjacent municipalities. (Chomet, 2012; Cudahy, 1972, 1982)

The Toronto subway broke the almost 50-year lull of new rapid rail development with the Toronto Transit Commission (TTC) opening the first sections of Line 1 Yonge-University in 1954 from Union to Eglinton station (TTC, 2021). Cleveland followed closely behind with the RTA Red Line opening in 1955 from Windermere to Tower City station, although it was extended to West 117th-Madison station by the end of 1955 (RTA, 2017). Rapid rail was introduced to Montreal in 1966 with the original Green Line, from Atwater to Frontenac station, and the original Orange Line, from Crémazie to Place-d'Armes station, opening that year (Gilbert, 2016). San Francisco was the first West Coast city to introduce rapid rail with service on the Richmond-Fremont line between MacArthur and Fremont stations starting in 1972 (BART, 2022). Washington was next with WMATA opening five rapid rail stations from Rhode Island Avenue to Farragut North in 1976 (WMATA, 2022).

Atlanta followed suit with the original segments of the Blue Line, from Avondale to King Memorial station (interlined with the Green line from Edgewood/Candler Park to King Memorial station) opening in 1979. However, six stations were added by the end of the year, taking the Blue line to West Lake (interlined with the Green Line to Five Points and then again in Vine City) (MARTA, 2022). In 1983, Baltimore began rapid rail service with Metro SubwayLink opening from Charles Center to Reisterstown Plaza that year (Schwandl, 2007). The following year, Miami began rapid rail service operation, with the Green and Orange Line servicing ten stations from Dadeland South to Overtown (Holle, 2012). Skytrain brought rapid rail service to Vancouver next, with the Expo Line beginning service from Waterfront to New Westminster in 1985 (Farrow & Cox, 1985). Los Angeles was the last city in these two countries to introduce rapid rail. The initial Red and Purple lines sections between Westlake/MacArthur Park and Union station opened in 1993 (Schwandl, 2004).

A defining characteristic of cities in this second period is that public entities owned and operated their systems from inception. The Toronto Transit Commission (TTC) was formed in 1954 as the successor to the Toronto Transportation Commission, which was formed in 1921 and solely operated ferry, streetcar, and bus services. The amalgamation of several adjacent municipalities, including Old Toronto, East York, York, North York, Etobicoke, and Scarborough, into Metro Toronto in 1954 played a significant role in forming the TTC as the intracity service area of Toronto quadrupled. It became infeasible for this growing city to rely solely on streetcars and other non-rail transit options to serve the public, necessitating a rapid rail system (Bradburn, 2016). The Washington Metropolitan Area Transit Authority (WMATA) was formed in 1967 as an interstate compact between the District of Columbia, Maryland, and Virginia, in the face of the Urban Mass Transportation Act of 1964, which guaranteed 66% federal funding for urban mass transit projects. WMATA broke ground on the Washington Metro in 1969 and continues to operate the system. (Goldchain, 2017).

The Metropolitan Atlanta Rapid Transit Authority (MARTA) was formed in 1965 by an act passed by the Georgia General Assembly in 1965. This act sought the creation of a rapid transit agency for DeKalb, Fulton, Cobb, Gwinnett, and Clayton counties, although the succeeding referendum to increase sales tax to fund MARTA failed in Gwinnett and Clayton counties, with Clayton eventually reversing its decision, and Gwinnett country remaining outside MARTA's service area. MARTA began constructing its rapid rail system in 1975 and remains Atlanta's leading public transit agency (Toon, 2003). The Los Angeles County Metropolitan Transportation Authority (LACMTA), also known as Metro, was formed in 1993 as a merger of rival public transit agencies: the Southern California Rapid Transit District (SCRTD) and the Los Angeles County Transportation Commission (LACTC). Rapid rail was introduced to the existing light rail network of Los Angeles later that year, and Metro has continuously operated the Metro Rail B and D lines. The San Francisco Bay Area Rapid Transit District (BART) was created in 1957 by the California State Legislature to unify the suburban East Bay to the urban centers of San Francisco, Oakland, and Berkeley. This district originally consisted of Alameda, Contra Costa, Marin, San Francisco, and San Mateo counties. Construction of the BART rapid rail system began in 1964, with BART remaining the operator to this day. (California, 2016)

Nonetheless, public transit agencies in some cities have shifted within public ownership. This is the case in Cleveland. The Cleveland Transit System (CTS) was formed in 1942 from the public consolidation of the Cleveland Railway Company. Cleveland was an industrial powerhouse during the World War II effort but ran into issues of eroding ridership and revenue from the 1950s into the 60s. These struggles ultimately forced the CTS to regionalize, with the Greater Cleveland Regional Transit Authority (GCRTA, often shortened to RTA) forming in 1974 and continuing operation to the present day (Case Western Revere, 2022). Montreal has had four public transit agencies operate its rapid rail network. The original operator was the Commission de transport de Montreal (CTM), formed in 1950 with the public consolidation of various private transit agencies. The CTM transitioned to the Commission de transport de la communauté urbaine de Montreal (CTCUM) in 1970. This came alongside the creation of the Montreal Urban Community, an amalgamation of several municipalities on the Island of Montreal. The CTCUM transitioned then again to the Société de transport de la communauté urbaine de Montreal (STCUM) in 1985. The merger of the Montreal Urban Community into the city of Montreal in 2002 corresponded with the transition of the STCUM to the Société de transport de Montreal (STM) the same year, which remains the present-day operator. (Gilbert, 2016; STM, 2021)

In 1979, British Columbia produced the Livable Region Plan, which saw the Greater Vancouver Regional District, the Urban Transit Authority (UTA), and the Metro Transit Operating Company (MTOC) cooperate in providing rapid rail in Vancouver. During the construction phase, the UTA and MTOC were consolidated into BC Transit, which oversaw province-wide transit projects, in

1983. BC Transit oversaw the opening of SkyTrain until the Greater Vancouver Transportation Authority (GVTA), also known as TransLink, was formed in 1998 to concentrate on regional transit projects (BC Transit, 2019).

Several of the shifts in public transit agencies within these cities were administrative, with name changes due to government bureaucracy as opposed to changes in operators or service areas. Miami is an example of this, with the Metropolitan Transit Authority being formed in 1960 as part of an ordinance passed by the Dade County Commission. The Metropolitan Transit Authority underwent four name changes to Miami-Dade Transit (MDT), the present name of the agency (Nebhrajani, 2016). The Baltimore Metropolitan Transit Authority (BMTA) was formed as a public consolidation of the private Baltimore Transit Company in 1970. Planning for a rapid rail system in Baltimore was already taking place, with the Maryland General Assembly approving funding for Phase I in 1971. During this design phase, the BMTA was renamed to the Mass Transit Administration, which saw the opening of the Metro SubwayLink system. The Mass Transit Administration, renamed the Maryland Transit Administration (MTA) in 2001, remains the current operator (Maryland, 2022; Schwandl, 2007).

Intermodality

Per Eltis, a European Urban Mobility Observatory, intermodality "relates to improving the efficiency and attractiveness of a single trip made with more than one transport mode…, with the aim of offering travellers a seamless journey" (Eltis, 2019a). This single trip focus differs intermodality from multimodality, which "refers to the selection of alternative transport modes for different trips over a certain period of time" (Eltis, 2019b). Nonetheless, public transit intermodality operates on two fronts: the number of interconnecting transit services and their frequency. Framing intermodality around seamlessness, the frequency of services operates on the temporal plane, with higher frequency allowing seamless trips to occur during more hours of the day. Allowing mode transfers to occur during more hours of the day allows transit users with different needs to take advantage of intermodality. On the other end, the number of intermodal services, which is the focus of this study, operates on the spatial plane, with more services extending the physical areas where people can take advantage of intermodality. With different transit services serving unique routes/areas, having more intermodal transit services grows the catchment areas of transit systems, allowing people to travel to more areas. These fronts cooperate to make seamless, intermodal trips more accessible to the public.

Looking at intermodality system-wide is vital because public transit agencies should prioritize seamless transfers throughout their systems. Curtis et al. (2016) looked at system-wide intermodality, described as nodal connectivity, in their accessibility-centric sourcebook on public transit planning. They measure "how many times per hour a person can travel, in how many directions, on what size of vehicles from each node." (Curtis & Scheurer, 2016, p. 21) where nodes can be identified as public transit stops and stations. This nodal connectivity index thus provides a frequency-centric view of intermodality but needs more spatial context of possible destinations that comes with looking at which individual routes/services are available. However, this index does weigh the modes of transit differently, which allows for more accurate representations of capacity differences between modes.

Nevertheless, this index expresses the spatial attractiveness of land use development through access to quality public transit. Higher intermodality is associated with denser land use development, which is a benefit. Denser land use development around intermodal hubs also increases ridership by providing more service and facilitating those who rely on automobile travel to utilize public transit for immediate travel needs (He et al., 2019; Jonuschat et al., 2015).

Modes of Transit

Existing literature about modes of transit focuses heavily on enablers and inhibitors to increased ridership and integration. In this, integration between modes increases ridership and improves the service quality for existing riders. Ridership is often considered the most important metric in measuring the quality of public transit, but this comes with its caveats. In automobile-centric cities, it may be advisable to focus on providing services needed for those unable to use or afford an automobile, which may not directly overlap with the most significant ridership. Furthermore, public transit agencies are constantly balancing trying to increase ridership and ensuring they have the operational funds to move their rider base. Integrating different modes helps with this by allowing other agencies, e.g., bikeshare providers and supplemental bus/rail providers, to supplement coverage. In this, each mode of transit targets different groups of people and incorporates them into the comprehensive public transit system logic.

Bikeshare

Bikeshare service is a rapidly growing area of analysis within the area of transit planning, specifically within the realm of last-mile transit and micro-mobility (Bateman et al., 2021; Biehl et al., 2018; Marshall, 2018; Qian et al., 2022). Annual station-based bikeshare trips increased from 321,000 in 2010 to 47,000,000 in 2021 in the United States alone, with station-based bikeshare being a part of the micromobility trifecta alongside dockless bikeshare and scooter-share[11] (NACTO, 2022). The first community bikeshare pilot took place in Amsterdam under the direction of Luud Schimmelpennink. Coined the White Bicycle Plan, Schimmelpennink and the activist group, Provo, provided 50 bicycles that everyone in Amsterdam was free to use starting in 1965. This pilot was short-lived, as most bikes were stolen or otherwise unusable as the pilot continued. (Marshall, 2018)

Bikeshare development since then has been characterized by attempting to remedy theft and vandalism. Dockless bikeshare systems have been prone to both of these issues, with Chinese bikeshare start-up, Mobike, reporting 200,000 bikes lost to theft and vandalism in 2019 and other similar losses causing other bikeshare start-ups to pull out of entire markets (Reid, 2019). Station-based bikeshare systems offer some protection in these areas through the necessity to dock a bike to end a given trip, which allows for more accurate bike tracking at the cost of added infrastructural expenses for the construction and maintenance of stations. Station-based bikeshare systems, however, are prone to distribution problems, including shortages during AM peak hours in residential areas, at the foot of hills, and in central business districts in the evening. Box trucks that continuously circulate bikes mitigate these problems to ensure surpluses are distributed to shortage areas and unusable bikes are taken out of circulation (Freund, 2019). Stations distribution is also an important facet to bikeshare development. This distribution is often hierarchical with more stations around the central hub of a given service area with more sparse stationing around the outskirts.

Previous research has identified enablers and obstacles to adopting bikeshare systems in urban environments. Bateman et al. (2021) wrote a comprehensive study on factors that affect bikeshare adoption. They pointed to the lack of bike infrastructure, specifically bike lanes, as the leading

[11] Dockless bikeshare and scooter share systems were not included in this study due to the variable location and availability of vehicles.

obstacle and convenience of access as the leading enabler to bikeshare adoption. Furthermore, participants in this study identified "massive education outreach effort(s)" (Bateman et al., 2021, p. 6) alongside marketing and facilitating family riding as critical recommendations for new bikeshare start-ups. Biehl et al. (2018) build on this by comparing socioeconomic and environmental variables that affect bikeshare demand through coalescing previous case studies. In this, precipitation, being female, distance to the central business district, and household income had adverse effects on bikeshare demand across all relevant case studies. Conversely, network connectivity through bike lanes, temperature, population density, and university presence had positive effects across all relevant case studies. Qian et al. (2022) add that accessibility features also encourage bikeshare trips.

Integration between bikeshare services and rapid rail has also been the subject of numerous previous studies. Yang et al. (2016) looked at qualitatively integrating public bicycle systems with transit using surveys. They found a strong user demand for bikeshare integration with rapid rail systems; when available, this integration happens naturally across geographies. These findings are backed up by Ma et al. (2022) , who were able to quantitatively link rapid rail-bikeshare transfer trip chains using smartcard data in Nanjing. Looking at mode substitution, Yang et al. (2016) found that about 80% of bikeshare users would have walked, used other public transit, or used their bikes if bikeshare was unavailable. This reaches the key niche of bikeshare within last-mile transit as an option faster than walking and more flexible than bus or other public transit modes.

Bus

BRT and its implications on urban public transit have been a talking point among urban transit academics and professionals. Idealized as combining the frequency, and thus rivaling capacity, of rapid rail; with the flexibility already associated with busses, BRT systems have grown in popularity in recent decades, especially in metro areas that are newly embracing public transit (Kittelson & Associates. et al., 2007). These new markets embrace BRT because of the lack of upfront costs associated with rail transit. Nonetheless, BRT can be an enabler for further public transit development within the realm of bus transit and other modes (Ferbrache, 2019).

BRT is not without its drawbacks, however. Furthermore, North American BRT systems often fail to maintain 15-minute headways, the main qualifier to be deemed rapid transit and have yet to be effectively marketed and operated to compete with automobile travel (Dunstan et al., n.d.). Since BRT is seen as an alternative to rail, integration has been complicated, with BRT systems primarily operating in cities without rail transit or areas within cities without rail transit. The most common arrangement linking BRT to rapid rail is using a rapid rail station as the termini of a given BRT line, a strategy also used by conventional bus routes.

Coordination between bus and rapid rail services is a keen area for analysis, balancing the flexibility of bus services and the consistent reliability of rapid rail. Transit agencies have identified minimizing obstacles to transferring from bus to rapid rail as a key metric to retaining and attracting ridership (Cherry, 2011). Cherry (2011) did a comprehensive assessment of factors that affected user satisfaction with bus-rapid rail transfers in Bangkok and found that bus stop position and pedestrian environment significantly influenced overall satisfaction across all factors. Wang et al. (2018) build on this by identifying excessive detours, bus capacity limitations, and pedestrian flow conflicts as critical inhibitors to bus-rapid rail transfer within their Beijing GIS and Smart Card data-based study. Zhou et al. (2021) identified Passenger Flow Control (PFC) through Bus Route Adjustment to remedy capacity issues on both ends of these transfers. However, these issues are more prevalent in systems outside North America with higher public transit ridership shares. Nonetheless, transfers between bus and rapid rail are the most common transfers within North American public transit networks, with over one-third of rapid rail boardings in Los Angeles, for example, being from bus transfers (Ramos-Santiago, 2021), and simplifying them is a dependable way to improve overall service.

Rail

Rail transit incorporates various modes connected through running on tracks, granting vehicles complete or partial right-of-way. Rail transit can be loosely divided into two niches: intracity transit, which is scalable from trolley or streetcar systems for low-end capacity, light rail for medium capacity, and rapid rail for high capacity; and intercity transit, with commuter rail networks radiating out of a central hub and regional rail networks connecting multiple municipalities. Nonetheless, crossovers occur, most commonly with various rapid rail and light rail networks resembling small-scale regional rail networks. One or a few operators often operate rail services at the metropolitan level, which aids in integration.

Studies have examined rapid rail interchange, focusing on route choice, catchment areas, and walking facilities (Cheng et al., 2022; Nai et al., 2012; Z. Wang et al., 2016). Nai et al.(2012) focused on walking facilities within L-shaped rapid rail interchange stations to create models to determine the optimal number of escalators for given passenger flows. This is relevant to this study as modal intermodality ultimately increases ridership, and with this, passenger flow needs to be continuously examined. Cheng et al. (2022) examined how interchange stations affect route choice within rapid rail networks. In this, the idea of modeling perceived transfer time vs. actual transfer time is discussed, which is an important aspect of intermodality. For instance, the interlining structure of rail systems, like that of Washington DC, show how interlining can give a perception of faster headways than reality. Within this frame, passenger perception of transfer time influenced route choice greatly, alongside other environmental variables, e.g., out-of-station vs. cross-platform transfers. Wang et al. (2019) focused on rapid rail interchange through the lens of catchment areas. Intermodality increases rapid rail system catchment areas by introducing new first-mile/last-mile transit modes. Wang et al. speculate that analyzing access distance is the key metric for seamless interchanges. Within this, walking and cycling attract the most ridership over a relatively small catchment area. Taking the bus or driving/riding an automobile provide increasingly large catchment areas, but serve dwindling ridership, respectively.

The interchange between rapid rail and other rail transit, commonly commuter and regional rail, has been discussed and adds nuance to this conversation. Peng (2012) created a modal to aid operation coordination across regional rail, bus, and rapid rail. This triad of modes often interacts as stations where regional and rapid rail interchanges often serve several bus routes to accommodate the increased passenger flows inherent with more possible ride options. Specifically looking at commuter rail integration, literature has focused on the role of active transportation (Chan & Farber, 2019) and its role in transit deconcentration (Ganning, 2016). Chan & Farber (2019) focused on GO Transit within the Greater Toronto and Hamilton Areas as a case study for commuter rail, examining factors that influence people to use active transportation to travel to GO stations. In this, active transportation is a means to increase ridership as it infers reliable access to stations. They concluded population density and household income enable active transportation, while parking and lower street density dissuade active transportation. Although these factors were isolated to commuter rail, these findings still hold weight in generalizing transit behaviors. Ganning (2016) examined the intersection of regional economics and commuter rail by positing that the influence of commuter rail presence on rates of out-commuting impacts regional population deconcentration. These sources show the importance of context within rail analysis, the difference in niches, and, thus, the difference in enabling factors for regional/commuter rail and rapid rail.

Methodology

This comparative analysis of public transit within these Canadian and American cities is centered around an Intermodality Index. The Intermodality Index quantifies the connections to other modes of public transportation at every rapid rail station within each city's expanded rapid rail network. Analysis of this index, broken up into intermodal paired indices, takes up the bulk of the Results section of this study. Other quantitative variables and background research are brought in to fully dissect actualized intermodality and how these cities can be grouped together by the nature of their public transit networks.

Notes on Selected Quantitative Indices and Variables
Data tables, including transit connections and selected variables, are labeled, and included in the Results/Discussion and Appendix section.

Intermodality Index
The Intermodality Index is calculated by counting all public and selected quasi-public modes of transit that converge within each station and its immediate surroundings. Within this, a mode is identified by transit by different vehicles and/or capacity/frequency. Proximity-based information was originated sourced through buffer analysis and manually collated using information from public transit websites as of September 2022. The Intermodality Index is a composite of several indices that each look at the intermodality of rapid rail with an individual mode of transit. These separated indices are calculated at the station level by counting all possible public transit connections at each station, summing these counts, and then dividing this number by the total number of stations. Each index can be read as the average number of a given type of connection at each station within each rapid rail system. In terms of proximity, the station and connecting service must be a reasonable distance from each other. For most uses, this default area of proximity is a 2-block radius. However, there are exceptions for bikeshare services, intermodal rail hubs, and ferry stops outside this area that are considered official or de facto transfers. These intermodal paired indices include:

i. Bikeshare-Rapid Rail Intermodality Index: This index includes all the converging permanent or seasonal public bikeshare docks within each station's proximity. For this measure, stations with one or more bikeshare docks were counted as one since there is no consistently measurable change in service by having more than one bikeshare dock in the vicinity due to the ever-changing nature of bike availability at a given dock. Freestanding bikeshares like Limebike®, and bike lockers did not contribute to this measure.
ii. Bus-Rapid Rail Intermodality Index: This index includes all converging bus lines that have named stops within proximity of each station that service at least two buses to that stop on the average weekday. For this measure, most stations have designated bus stops with the station name or the street intersection. Busses with stops on both sides of the intersecting street were considered one connection. This measure prioritizes buses and shuttles run by public entities. Buses and shuttles run by private entities, predominantly corporate

campuses and hospital shuttles, were not included. Specialized night service buses were also counted as separate from their daytime counterparts as they offer a distinct service.

iii. Rapid Rail Intramodality Index: This index includes all the connections between rapid rail services that happen within direct interchanges, station complexes, or within proximity of each station. Each station count contains one less rapid rail line than the total number of lines present, as the index counts the number of transfers to rapid rail. This distinction was borrowed from the nodal connectivity index devised by Curtis and Scheurer (2016) .

iv. Other Rail-Rapid Rail Intermodality Index: This index includes all the connections to hybrid rail, light rail, trolley, streetcar, regional, and commuter rail lines within direct interchanges, station complexes, or in the proximity of each station. Hybrid/light rail lines may mimic rapid rail lines in organization or be part of shared networks with rapid rail lines but do not have consistent headways under 15 minutes or consistent trains of at least 6-car length. Trolley and streetcar service may mimic rapid rail service but with lower capacity/speed. Commuter and regional rail must service the station at least twice per weekday.

v. Ferry-Rapid Rail Intermodality Index: This index includes all converging ferry stops within the proximity of each station. For this measure, each distinct ferry line serviced at a stop was considered a distinct transfer. Privately run ferry services were not included in this study.

City Selection Criteria

The overall selection criterion for these cities is cities within Canada and the continental United States with rapid rail transit systems. Regarding individual rail lines, peak headways must be less than 15 minutes to be considered rapid rail. However, in this study, off-peak headways can exceed 15 minutes. To meet rapid rail capacity, the line must at least partially run 6-car length trains, if not solely ≥ 6-car length trains. Transit agencies and relevant service names organized by the principal city are listed below. Additional municipalities connected by rapid rail to the principal city are listed below. Information used for the Intermodality Indices and supplemental information, including service areas and hours, were provided by the official websites of respective transit services and are current as of September 2022.

Number of Lines/Stations/Transfers

The number of active lines, stations, and possible connections in each extended rapid rail network, as of September 2022 are included in this study. Specifically, all lines that meet the rapid rail qualifications and stations within those lines are included. The number of connections includes possible connections to rapid rail, bikeshare, bus, ferry, and other rail services from all rapid rail stations within each principal city's expanded network. These counts will be used to quantify the relative size of each rapid rail network for further analysis and comparison.

Public Transit Commute Share

This statistic looks at the share of the population who commute using public transit at the metropolitan area level for each principal city. This data is taken from 2016, 2019, and 2021 ACS 1-year estimates for cities within the United States and the 2016 and 2021 Canadian Census for cities within Canada. This data supports the qualitative analysis of how these cities are served by their public transit networks. The 2021 public transit commute shares are centered in this analysis, but previous years are included to portray the massive effects of COVID-19 on public transit ridership. Focusing on US cities in this study, public transit commute shares dropped on average by 4% from 2016 to 2019 and 54% from 2019 to 2021, primarily due to the pandemic. San Francisco had the most prominent individual drop, with a 74% reduction in public transit commute shares from 2019 to 2021. Miami had the lowest drop, with only a 31% reduction in public transit commute shares from 2019 to 2021. (Statistics Canada, 2017, 2021; US Census Bureau, 2016, 2019, 2021)

Service Population per Station

The service population per station in each extended rapid rail network is included in this study. Service population refers to the combined population of all municipalities each rapid rail network serves. This data is taken from the 2021 ACS 5-year estimates for municipalities within the United States and the 2021 Canadian Census for municipalities within Canada. This combined population is divided by the number of rapid rail stations. (Government of Canada, 2022; US Census Bureau, 2022). This data indicates population density within the vein of rapid rail development at the city level.

Results/Discussion

Intermodality

Bikeshare-Rapid Rail

Table A: Bikeshare-Rapid Rail Intermodality Index by Principal City

Principal City	Bikeshare Index
Atlanta	0
Baltimore	0
Boston	0.71
Chicago	0.81
Cleveland	0
Los Angeles	0.94
Miami	0.17
Montreal	1
New York City	0.64
Philadelphia	0.48
San Francisco	0.38
Toronto	0.66
Vancouver	0.25
Washington	0.83

Table A shows the proportion of rapid rail stations with adjacent bikeshare docks by principal city. Cities, like Montreal, Washington, Los Angeles and Chicago, with comparable bikeshare and rapid rail service areas have the most amount of bikeshare-rapid rail intermodality. Montreal's BIXI is the only bikeshare system connected to every rapid rail station in the city. BIXI's network is more than 700 stations and 9,600 bikes, of which over 2,000 are e-bikes (BIXI, 2022). From the introduction of BIXI in Montreal in 2009, over 50 million trips have been taken on their bikes, with 9 million trips taken in 2022 alone, a 55% jump in ridership from 2021 (La Presse Canadienne, 2022; Montréal, 2022). The marketing of BIXI to young adults centers around educating people on how bikeshare works and its benefits, which has been identified as a significant enabler of bikeshare development (Bateman et al., 2021). Alongside this, the comprehensive integration of BIXI with the STM and increased municipal focus on building new bike infrastructure has enabled popularity by allowing bikeshare to serve as a convenient last-mile transit provider in Montreal. Los Angeles' Metro Bike Share system also has a high level of intermodality with rapid rail. Made up of over 150 stations and 1,500 bikes, Metro Bike Share was introduced to Los Angeles in 2016 and is run by LACMTA, the same agency that operates Metro Rail (TAP, n.d.). Los Angeles' rapid rail system is also concentrated in the central business district of Los Angeles, which enables bikeshare demand (Biehl et al., 2018). The organizational integration allows Los Angeles' bikeshare and rapid rail system to grow in tandem.

Capital Bikeshare is the successor of SmartBike DC, the oldest bikesharing system in North America, starting in 2008. Capital Bikeshare was born out of a collaboration between the District of Columbia, Arlington, Alexandria, and Montgomery County to provide a comprehensive regional bikeshare system in 2010. The system has grown to over 5,000 bikes and 600 stations (Lyft, 2022). The service area is Capital Bikeshare is impressive, spanning several counties and municipalities in the DC metropolitan area, mirroring the regional layout of their rapid rail network. Divvy Bikes launched in 2013 with 75 stations and 750 bikes in downtown Chicago (Chicago, 2013). It has since grown to over 800 stations and 16,500 bikes, making it one of the largest bikeshare systems in North America (Greenfield, 2021). The large size of Chicago's rapid rail network makes achieving such a high Bikeshare Index impressive. Chicago stands alone taking on large public-facing infrastructural projects while remaining cost-competitive when it comes to transit and housing.

Cities with relatively moderate amounts of bikeshare-rapid rail intermodality often have bikeshare service areas that are growing to complement their rapid rail service areas. In Boston, Bluebikes offers 4,000 bikes and 400 stations across ten Greater Boston municipalities (Boston, 2016). Bluebikes has become popular in Boston, but several areas with the user base to support bikeshare still need to be introduced to Bluebikes. Citi Bike has a similar story in New York City. Citi Bike is the most extensive bikeshare system in North America, with over 24,500 bikes and 1,500 stations (Hurford, 2022), ; however, there are still concerns about coverage, specifically in the outer boroughs of the Bronx, Queens, and Brooklyn. Citi Bike has released plans to expand into these areas, but it still needs to match the coverage of its rapid rail network (Citi Bike NYC, 2019). Bike Share Toronto has 7,185 bikes and 630 stations. Although Bike Share Toronto operates over a 200-square-kilometer area of Toronto, it still needs to serve some areas with rapid rail service. (Toronto, 2022). Philadelphia is the first city to have bikeshare access at less than half of their rapid rail stations. Indego has over 1,000 bikes and 130 stations (Indego, 2015), with plans to expand to 3,500 bikes and 350 stations by 2026 (Philadelphia, 2021). A lack of investment is the largest inhibitor to increased integration between rapid rail and bikeshare in Philadelphia, but this is poised to change.

Cities with low intermodality between rapid rail and bikeshare service have considerable discrepancies between bikeshare and rapid rail service areas. Although Bay Wheels bikeshare system is relatively large, with over 7,000 bicycles and 550 stations (MTC, 2021), it punches below its weight due to a lack of integration at the regional level. Bay Wheels only serves San Francisco, Easy Bay, and San Jose. With rapid rail serving as the regional transit connector for the Bay Area, Bay Wheels must expand immensely to raise overall connectivity. Vancouver is unique in this regard in that its bikeshare service area is larger than its rapid rail service area. Nonetheless, bikeshare is only accessible at one in four rapid rail stations in Vancouver. Mobi has grown to 2,500 bikes and 250 stations (Mobi, 2022) , but integration with rapid rail has yet to be prioritized. It is concerning that Mobi is not utilizing integration to its most frequent transit corridor to its advantage. Miami has the lowest non-zero Bikeshare Index. Citi Bike Miami operates over 165 stations and 1,000 bikes. Citi Bike Miami is concentrated in the downtown core of Miami, although its rapid rail network extends into surrounding areas. This, alongside a lack of investment, points to its low score.

Atlanta, Baltimore, and Cleveland do not currently have station-based bikeshare systems. However, each city has embraced dockless bikeshare systems to varying degrees. Baltimore's urban fabric does lend itself to station-based bikeshare more so than the other cities, but there are inherent hesitations based on the performance of the prior system. Baltimore's former station-based bikeshare system was shut down in 2018, creating demand that various private dockless bikeshare start-ups supplied. Atlanta's former station-based bikeshare system was transitioned to a dockless system in 2020 (Atlanta, 2021a). Cleveland has several private dockless bikeshare start-ups, but the energy towards building station-based bikeshare in Cleveland is relatively low, given this city's lack of bike infrastructure.

Bus-Rapid Rail

Table B: Bus-Rapid Rail Intermodality Index by Principal City

Principal City	Bus Index
Atlanta	4.87
Baltimore	6.5
Boston	5.38
Chicago	3.34
Cleveland	3.72
Los Angeles	14.94
Miami	4.96
Montreal	9.18
New York City	5.49
Philadelphia	4.66
San Francisco	10.48
Toronto	6.2
Vancouver	6.71
Washington	11.78

Table B shows the average number of bus lines that stop within proximity of every rapid rail station by principal city. Reliance on intra-agency bus-rapid rail transfers is an indicator of actualized interconnectivity. Vancouver is the only city that solely provides intra-agency bus-rapid rail transfers between SkyTrain and RapidBus. There is a solid service baseline, with at least one bus line servicing every station, accented by four stations with over ten possible bus connections. A good portion of rapid rail interfacing bus service in Toronto is intra-agency, provided by the TTC, with supplemental bus service provided by operators in adjacent municipalities. Montreal also relies heavily on intra-agency bus-rapid rail transfers within the STM. In this, Canadian cities excel at providing an actualized sense of interconnectivity and transfer fluidity that is relatively unrivaled in North America.

Even so, some cities that rely on intra-agency bus transfers have shallow service levels. This is the case in Miami, Atlanta, Baltimore, and Philadelphia. Miami and Baltimore have at least one bus transfer at every station. In Miami, Miami-Dade Transit provides the most interfacing bus services, yet only one rapid rail station has over ten bus transfers. Baltimore has intra-agency connecting bus services through the MTA and supplemental service provided by the Baltimore City DOT. The central interchange station has over 20 bus transfers, yet most other stations offer less than five transfers. Atlanta and Philadelphia lack bus transfers within their networks at two rapid rail stations. On top of this, less than 10% of rapid rail stations have over ten transfers in both cities, and over 50% of stations in Philadelphia have less than five bus transfers.

Cities with regionalized rapid rail networks that utilize intra-agency bus transfers, supplemented by multiple other bus service operators, have high levels of intermodality. Washington has twelve primary bus operators connecting to the Washington Metro. Rapid rail in the DMV (Washington Metropolitan Area) is regionalized, allowing various adjacent municipalities to run service to and from the city. In this, there is a commuter focus, with bus service concentrated during am/pm peak hours and relatively sparse midday and weekend. BART is another system built on regionality with a high intermodality between bus and rapid rail. San Francisco has over 25 bus operators connecting to the BART system, the most of any of these cities. Similarly to Washington, these bus services are heavily-commuter based and target workers who live on the outskirts of the Bay Area and work within the urbanized transit core. Nonetheless, coordinating bus stop locations with various operators may prove more difficult than intra-agency coordination, which may inhibit actualized bus-rapid rail integration (Cherry, 2011).

Los Angeles is an anomaly in this case, with similar patterns in connecting bus operators and levels of bus-rapid rail intermodality as San Francisco and Washington, but without a regionalized rapid rail system—the B and D lines of the Metro Rail system solely service downtown Los Angeles and Hollywood. With the commuter area of Los Angeles stretching far into Southern California, twelve supplemental bus operators must run bus service to and from downtown Los Angeles to meet the public transit demands of Greater Los Angeles, with LACMTA being the second largest bus operator in North America running 2,911 buses alone. In this, three rapid rail stations in downtown Los Angeles have over 30 bus route transfers, with most stations in Hollywood having less than 10.

Gaps in bus service weakened rapid rail intermodality in several cities. New York has over twenty stations, predominately in the outer boroughs, without bus transfers. Nonetheless, some major interchange stations have over fifty possible bus transfers, with over 20% of stations having more than ten bus transfers. On top of this, MTA is the largest bus operator in North America, operating over 5,600 buses. Even so, bus service in New York City still trails behind rapid rail service. Boston also struggles with various stations lacking bus transfers; however, intermodality is slightly boosted by over 15% of stations with over ten possible bus transfers. Around 10% of rapid rail stations in Chicago lack bus transfers, and service is relatively shallow, with less than 5% of stations offering more than ten transfers. Among the three bus operators, there is a lack of investment in bus infrastructure in Chicago. This is partly due to the expansiveness of the Chicago L, which has the second highest number of stations in this study, and Chicago's rail-centric public transit culture (Garcia, 2017). Cleveland has the lowest amount of bus-rapid rail intermodality, with one station with over five transfers and over 10% of stations lacking transfers. This is surprising, considering five bus operators run services that connect to the RTA Red Line. These service gaps hurt the interconnectivity of these public transit systems by not providing a baseline of coverage to extend the catchment areas of rapid rail networks (Z. Wang et al., 2016).

Rapid Rail

Table C: Rapid Rail Intramodality Index by Principal City

Principal City	Rapid Rail Index
Atlanta	0.63
Baltimore	0
Boston	0.08
Chicago	0.52
Cleveland	0
Los Angeles	0.38
Miami	0.65
Montreal	0.07
New York City	1.45
Philadelphia	0.19
San Francisco	1.38
Toronto	0.06
Vancouver	0.04
Washington	0.33

Table C shows the average number of rapid rail connections that stop within proximity of every rapid rail station by principal city. Cities with high levels of rapid rail intramodality often have interlined trunks with branches. The interlining of the Green and Orange lines extends to over 65% of Metrorail stations in Miami, with one branch extending from the downtown trunk to the Miami International Airport and another branch that extends northwest from downtown Miami. In Atlanta, the Green and Blue lines interline in the east-west direction, and the Red and Orange lines interline in the north-south direction, with all four MARTA Rail lines meeting at Five Points. The Red, Orange, and Green lines each have a single branch in the north, northeast, and northwest direction from downtown Atlanta. The Blue line has two branches extending east and west from downtown.

Focusing rapid rail interlining on a downtown core is another common strategy within Canada and the United States. Interlining in Chicago is centered around the Loop, the eight-station loop of elevated rail that serves five lines in Downtown Chicago. Although most Chicago L stations are single-lined, interlined stations service more than three rapid rail lines on average. Washington has a similar logic, with its rapid rail interlining focused on a downtown core of three stations, with various other interlined stations throughout its rapid rail network[12].

New York City and San Francisco have the highest amount of rapid rail intramodality and combine these two strategies. On average, at least two rapid rail lines service each station in both cities. New York City has the most interlined rapid rail network in North America. The NYC Subway is known for its unique interlining structure that permits its extremely expansive local/express train schedules and extensive route choice for its transit users. Although de-interlining would improve reliability within the network, the unrivaled access to one-seat rides throughout New York City is a standout for interconnectivity (Levy, 2018). Both networks are similar in that interlined stations are spread throughout instead of focusing on a few stations. Around 30% of BART stations are single-lined, while around 40% are interlined between three or more lines. The interlining structure of BART excels at extending the single-trip rapid rail catchment area to a large portion of the Bay Area, which is rather impressive.

Cities with moderate to low levels of rapid rail intramodality are often aided by intra-agency rail lines that do not meet the requirements of rapid rail. Los Angeles has a rapid rail trunk section, but only 35% of stations are interlined. This interlined section is in downtown Los Angeles, with the B line extending to the northwest and the D line extending to the west. Nonetheless, Metro operates several supplemental rail lines that offer higher actualized connectivity. Philadelphia also has a modest amount of rapid rail interlining, with over 15% of stations servicing two or three rapid rail lines. Three stations service rapid lines operated by SEPTA and the PATCO Speedline, making Philadelphia, and New York City, the only cities in this study with rapid rail intramodality across multiple providers. Only 5% of rapid rail stations in Boston, Toronto, and Montreal service more than one rapid rail line. Boston has one station that services three lines, while Toronto maxes out at two lines. Montreal does not offer supplemental intra-agency rail transfers, making it an anomaly amongst these cities with low rapid rail intramodality. On top of this, the lack of interlining outside the four relatively isolated interchange stations hurt rail intermodality overall in Montreal.

[12] Washington also has various rail lines that operate on 20-minute headways that do not contribute to this index but greatly increase actualized interconnectivity.

Other Rail-Rapid Rail

Table D: Other Rail-Rapid Rail Intermodality Index by Principal City

Principal City	Other Rail Index
Atlanta	0.05
Baltimore	0.14
Boston	0.87
Chicago	0.43
Cleveland	0.72
Los Angeles	1.06
Miami	0.39
Montreal	0.12
New York City	0.65
Philadelphia	1.65
San Francisco	1.62
Toronto	0.81
Vancouver	1.5
Washington	0.81

Table D shows the average number of other rail lines that stop within proximity of every rapid rail station by principal city. A driving component of intermodality between rapid rail and other modes of rail is intra-agency transfers. However, cities relying solely on intra-agency transfers scored low on this index. The MTA Light RailLink system is the only rail system interfacing with MTA Metro SubwayLink in Baltimore, offering one transfer at Lexington Market. The majority of rail intermodality in Atlanta, which scored the lowest in this index, comes from the MARTA Atlanta Streetcar system, with one additional transfer to the ATL SkyTrain being available. Cleveland can attribute the entirety of its rail intermodality to the remainder of the RTA Rapid Transit system. Cleveland scored modestly on this index, given its low number of rapid rail stations and heavy interface with the light rail components of RTA Rapid Transit.

Cities that pair intra-agency transfers with transfers by supplemental rail providers, specifically Amtrak, scored comparatively high in this index. Rail intermodality in Philadelphia, the city with the highest average number of other rail transfers, is heavily built on the remainder of SEPTA's trolley and regional rail network, which heavily integrates with the Broad Street and Market-Frankford lines, as well as the out-of-system PATCO Speedline. On top of this, rail service is supplemented by NJ Transit and Amtrak rail lines. This coalesces to over 20% of rapid rail stations having available rail transfers in Philadelphia. Vancouver, the city with the second highest index, follows a similar logic with the light rail lines of SkyTrain and the West Coast Express interfacing the most with the Expo Line, with VIA Rail and Amtrak offering supplement coverage. Los Angeles offers, on average, at least one rail transfer at every B and D line station. This service comes from the light rail lines of the Metro Rail system and Amtrak, which operates the Metrolink system, as well as their national system. Boston, which also scored relatively high, can point to the remainder of the MBTA light rail and regional rail network for most of its rail intermodality, with supplemental service provided by Amtrak. Toronto also scored high due to interchange with the light rail sections of the TTC Subway, with supplemental rail service offered by GO Transit, Metrolinx, and Amtrak. All in all, over 25% of rapid rail stations in Toronto offer at least one supplemental rail transfer.

San Francisco is a relative anomaly, scoring high on this index but lacking intra-agency transfers. San Francisco and the broader Bay Area have a unique hierarchy of public transit agencies with several overlapping jurisdictions. Most agencies operate in one or two modes that interface with rapid rail. Over 25% of BART stations have at least one rail transfer, with 8% of stations having more than ten possible transfers. The majority of rail intermodality in San Francisco is provided by Muni, which runs Muni Metro and cable car service, as well as Amtrak and Caltrain. In this, BART operates rapid rail and bus service, and Muni operates interfacing light rail and cable car service.

New York City is also an anomaly within these cities for offering intra-system rail transfers and supplemental rail providers and scoring relatively low on this index. The New York City Subway interfaces with the MTA Metro-North and Long Island Railroad commuter rail system and the JFK AirTrain, Roosevelt Island Tramway, Amtrak, and NJ Transit rail lines. In this, its relatively low index is not an indicator of lack of service but an effect of the number of rapid rail stations in the New York City metropolitan area. Miami is another anomaly in this regard. Miami-Dade Transit runs two people-mover services, Metromover and MIA Mover, that interface with Metrorail in downtown Miami. On top of this, Amtrak and Tri-Rail provide supplemental interfacing rail service. Despite this, Miami scored low because of shallow interfacing, with these four services only offering nine rail transfers.

Cities that lack any intra-agency rail transfers scored lower on this index. This is the case in Montreal and Chicago. In Montreal, the rapid rail network only interfaces with Exo, a commuter rail service that connects the broader Montreal metropolitan area to the urban core. The interfacing is shallow, with Exo only interfacing with five Montreal Metro stations, less than 10% of all stations. Chicago also lacks intra-agency non-rapid rail transfers, with the Chicago L interfacing with Metra, Amtrak, and Navy Pier Trolley service. Chicago is unique in that two rapid rail stations offer over 20 possible rail transfers, with relatively sparse coverage elsewhere. Metra acts as Chicago's primary commuter rail network, with the Navy Pier Trolley interfacing with some downtown stations. With the backbone of other rail-rapid rail intermodality in these two cities being commuter rail networks that interface shallowly at few stations, these lower scores make sense.

Amtrak interfaces with the rapid rail networks of 11 out of 14 cities in this study. Amtrak's operation in the United States and Canada unifies these cities. The Northeast Corridor is where Amtrak does the best job of linking neighboring cities. The Acela and Northeast Regional lines link the rapid rail networks of Boston, New York City, Philadelphia, Baltimore, and Washington. Amtrak service continues from the Northeast corridor, spanning the East Coast to Miami. Chicago's strategic central location in the Midwest on the coast of Lake Michigan allows it to be a rail hub, specifically for Amtrak's cross-country routes. California has an interesting history with Amtrak, with Amtrak operating the Metrolink system of Southern California and previously operating Caltrain service from 1992 to 2012. These services were on top of Amtrak's national intercity routes, which created multiple interchange stations in San Francisco and Los Angeles. Amtrak also services routes that span the West Coast, connecting Vancouver to the American Pacific Northwest and California. Lastly, Amtrak runs the Empire Service, which spans the state of New York, connecting New York City to Toronto. (Britannica, 2022)

Of the three cities that lack rapid rail interchange with Amtrak, only Cleveland downright lacks Amtrak service. Atlanta has an active Amtrak service, the Crescent, that does not interface with MARTA rail, a clear missed opportunity to link intracity and regional travel in the Atlanta metropolitan area. Historically, Amtrak has operated the Adirondack service between Montreal and New York City, but the service was discontinued in 2020 and is expected to be continued in Spring 2023 (Riga, 2022). This makes Cleveland the only city with a rapid rail network in Canada and the United States without Amtrak service. (Britannica, 2022)

Ferry-Rapid Rail

Table E: Ferry-Rapid Rail Intermodality Index by Principal City

Principal City	Ferry Index
Atlanta	0
Baltimore	0
Boston	0.04
Chicago	0
Cleveland	0
Los Angeles	0
Miami	0
Montreal	0.01
New York City	0.06
Philadelphia	0
San Francisco	0.22
Toronto	0
Vancouver	0.04
Washington	0

Table E shows the average number of other ferry lines that stop within proximity of every rapid rail station by principal city Ferry service is highly dependent on enabling physical geography. Several common themes arise looking at the cities with rapid rail-interfacing ferry networks in Canada and the United States. One of these themes is estuarial geography, which influences the systems of New York City and Boston. Ferry service in New York City is concentrated within the New York – New Jersey Harbor Estuary. Boston Harbor, part of the more extensive estuary for the Charles River system, is where ferry service occurs in Boston. Island geography is another common theme. Ferry services in Montreal and New York City are influenced by island geography. Montreal and New York City differ in that the urban core of New York City is spread across multiple islands, including Manhattan and Long Island, while the urban core of Montreal is centered on the Island of Montreal. Peninsular geography is also a common theme, with Vancouver, San Francisco, and Boston being influenced by peninsular geography. San Francisco occupies the northern tip of the San Francisco Peninsula, with the Bay Area consisting of the entire peninsula and the coastal surroundings of San Francisco Bay. The Burrard Peninsula houses Vancouver and various adjacent municipalities, with Fraser River running through the urban core. Old Boston has occupied and grown the Shawmut Peninsula, with Boston's entire urban core now spreading across the Charles River.

New York City is an outlier regarding ferry-rapid rail intermodality, with over twenty stations having at least one ferry transfer. The Staten Island Ferry is the busiest ferry route in North America, traversing the Hudson River to connect Staten Island to Manhattan (Kahana, 2022). Within this, the Staten Island Ferry interfaces with the Staten Island Railway and the New York City Subway. The NYC Ferry supplements this service with seven ferry routes traversing the East River, Hudson River, New York Harbor, Jamaica Bay, and New York Bay. New York City's unique geography and transit culture facilitated the development of this relatively strong ferry network.

Intra-agency ferry transfers dominate ferry-rapid rail intermodality in Boston and Vancouver. MBTA Boat ferry service primarily traverses Boston Harbor and includes two ferry routes that interface with rapid rail at the same station. TransLink runs SeaBus service across Burrard Inlet in Vancouver, with one ferry route interfacing with Waterfront station. The fact that these cities lead

the pack in terms of ferry-rapid rail intermodality while only connecting to one rapid rail station speaks to the potential for the growth of these types of systems.
San Francisco and Montreal have ferry services provided by supplemental providers. San Francisco has the Golden Gate Ferry system, which covers the Golden Gate strait; the San Francisco Bay Ferry system, which connects the coastal areas of the interior of San Francisco Bay; and the Treasure Island Ferry, with one route connecting San Francisco and Treasure Island. Lines from all these systems stop at the San Francisco Ferry Building, which offers a transfer to Embarcadero station. This setup provides a relatively high level of ferry-rapid rail intermodality. The ARTM runs ferry services across the Saint Lawrence River, with a stop on Saint Helen's Island which offers a transfer to Jean-Drapeau station. This ferry service also has stops in Longueuil and Montreal but is far from rapid rail stations.

Full Intermodality/Discussion

Table F: Rapid Rail Intermodality Index by Principal City

Principal City	Intermodality Index
Atlanta	5.55
Baltimore	6.64
Boston	7.08
Chicago	5.1
Cleveland	4.44
Los Angeles	17.32
Miami	6.17
Montreal	10.38
New York City	8.29
Philadelphia	6.98
San Francisco	14.08
Toronto	7.73
Vancouver	8.54
Washington	13.76

Table F shows the average number of connections between the selected five transit modes that stop within proximity of every rapid rail station by principal city Bus service is the backbone of rapid rail intermodality across all cities, providing most transfers at all stations. All but two transfers with Metro SubwayLink in Baltimore are bus transfers. Bus transfers also provide over 85% of all transfers within Atlanta, Montreal, Los Angeles, and Washington. Over 80% of transfers are bus transfers in Cleveland, Miami, and Toronto. Vancouver, Boston, and San Francisco have bus transfers make up over 70% of all transfers. Chicago, New York City, and Philadelphia are the cities least reliant on bus service for their rapid rail intermodality. Nonetheless, bus transfers make up over 65% of all transfers in these cities. This level of connection makes sense as bus service provides local and feeder routes to supplement mass routes provided by rapid rail (Jian et al., 2012). On top of this, the dichotomy between the niches served by bus and rapid rail allows effective intermodality. Bus service is praised for its low-upfront costs and flexibility, which is not the case for rapid rail service. However, rapid rail provides consistency and capacity, where bus services struggle.
Cleveland and Atlanta have low public transit commute shares, low service population per station, and shallow rapid rail intermodality, which obstruct further rapid rail development. Cleveland, which has the lowest average number of public transit transfers at each station, relies on bus and supplemental rail service to provide rapid rail intermodality. On top of this, only 1.4% of people

in the Cleveland metropolitan area use public transit to commute, but its service population per station is relatively low at 20,826. These trends are partially attributed to regional changes that occurred when RTA Rapid Transit was built. The Red Line was officially opened in 1955, and by the 1960s, urban decline was spreading across the Rust Belt. This population and industrial output decline continued into the 2000s, with Cleveland losing about 45% of its pre-1970 population and 30% of its average household income by 2006 (Hartley, 2013). This left the RTA Rapid Transit system, which was built on the expectations of Cleveland maintaining its population, and even growing, without the expected ridership and thus lower-than-expected revenues. In this, lack of fit may be partially at fault for low rapid rail intermodality (RTA, 2020). Only 1% of people in the Atlanta metropolitan area use public transit to commute to work, the lowest of these cities. Atlanta's service population per station is relatively low at 20,285. Atlanta's low urban population density makes sense of this statistic and points to the limits of its rapid rail system. Alongside its low urban population density, Atlanta's auto-centric land use development patterns make it more challenging to operate rapid rail and, more broadly, public transit (Atlanta, 2021). This is reflected in its levels of intermodality.

Miami and Baltimore have similar public transit commuter shares and shallow rapid rail intermodality but have a moderate service population per station, pointing towards an underutilized market for rapid rail. Baltimore has slightly shallow levels of rapid rail intermodality at the service level, but a high service population of 46,741. This is accompanied by 2.6% of people commuting to work by public transit, compared with the national average of 2.5%. Baltimore has faced similar challenges as cities in the Rust Belt, including industrial and population decline. However, unlike Cleveland, Metro SubwayLink was built almost 20 years into Baltimore's population decline. Baltimore's pre-automobile urban fabric and population density, withstanding decline, made this possible. In this, Metro SubwayLink complements the Light RailLink system, with Metro SubwayLink providing frequent, high-capacity core service and Light RailLink serving broad, lower-capacity service across the city. Miami is a city growing in population that is starting to course correct for not embracing public transit. Miami-Dade Transit has only been operating its rapid rail system since the 1980s, one of the youngest systems in this study. Since then, 23 Metrorail stations have been opened, but the service population per station still stands at 37,910. In this case, the population growth of Miami has outpaced the development of its rapid rail network. Miami is also one of the lowest-scoring cities offering transfers in four of the five modes in this study. These facts indicate Miami's good service foundation and ridership base for further rapid rail development.

Rail Intermodality also had a significant presence in some of these cities. Rapid rail interlining becomes increasingly relevant the more individual rapid rail lines are in service. This is due to its positive implications on route choice and catchment areas, enablers for rail intermodality and ridership (Cheng et al., 2022; Z. Wang et al., 2016). Rapid rail interlining and integration with other modes of rail work together in these cities to offer a complete picture of rail intermodality. In this, the other can supplement cities that underperform in one aspect.

Chicago and New York City share expansive rapid rail networks, with rail service having a more prominent presence on rapid rail intermodality. These two cities operate arguably the two most recognizable rapid rail systems in this study: The New York City Subway and the Chicago L. Both systems are similar in that they have grown to be infrastructurally immense; taking advantage of their head start in the late 1800s, they would be nearly impossible to build today. Maintenance and other infrastructural costs are primary concerns regarding further development. Chicago has a relatively low service population per station of 21,491 and a public transit commute share of 4.8%, almost twice the national average. This statistic stands out as the Chicago L is organized to get people from the periphery of Chicagoland to the downtown core and is successful at that. Where Chicago needs to catch up is connectivity between adjacent outlying suburbs and its shallow integration between rapid rail and bus. The spoke-hub distribution model of the Chicago L and Metra, Chicago's commuter rail system, makes travel between Chicago suburbs difficult, often necessitating an intermediate stop downtown. This will continue to be an issue as trips, in the aggregate, become more diverse than simply commuting to work. Chicago has the least average number of bus transfers per station of all the cities in this study. With such an expansive backbone of rapid rail service, Chicago needs to continue to build up its bus network to complement its rail network.

New York City is in a league of its own regarding sheer levels of public transit intermodality. Of the over 9,000 transfers at all cities in this study, over 4,200 of them are within the New York City metropolitan area. Moreover, New York City has the lowest service population per station at 18,555 and the highest public transit commute share at 19%. New York City's unique transit culture was born out of its early adoption of rail and rapid economic and physical development before the rise of the automobile in the 1920s. Starting in the late 1800s, rapid rail development grew to the point where it remained the preferred mode of transit during and after the automobile age. New York City's public transit network has grown immensely since the 1920s. New York City has some of the busiest commuter rail systems, including the PATH system, Long Island Railroad, Metro-North, and NJ Transit rail lines to connect the downtown core to Long Island, New Jersey, Connecticut, and the Lower Hudson Valley. Intramodally, there are over 730 interlined rapid rail line stops, more than ten times more than San Francisco, the city with the second most rapid rail transfers. New York City has a world-class public transit system with the world's most extensive ferry system, competent bikeshare coverage, and reliable baseline bus service.

Philadelphia and Boston have small, regionalized rail systems with intra-agency rapid, hybrid, light, and regional rail interfaces. Philadelphia has a rapid rail network that spreads into New Jersey and a regional rail network that covers the entire Delaware Valley, including Southeastern Pennsylvania and parts of New Jersey and Delaware. Philadelphia and New York City are the only cities with more than one rapid rail operator. SEPTA provide the bulk of rail services in Philadelphia. This system includes the Broad Street and Market-Frankford lines, the Norristown High-Speed Line, and various trolley and regional rail lines. The PATCO Speedline supplements this coverage by interfacing with SEPTA downtown and providing rapid rail service into Camden. Also, similarly to New York City, rail service is supplemented by Amtrak and NJ Transit for commuter and long-distance travel. This regionalized system contributes to 4.7% of Greater Philadelphia commuting to work by public transit, which is relatively high by US standards. The MBTA has a unified rail service in the Boston metropolitan area[13], which covers most of Eastern Massachusetts and stretches into Rhode Island. Like Philadelphia, Boston has rapid, regional, and light rail interfacing elements under the same agency. MBTA operates four of the five transit modes looked at in the study. On top of this, Boston has a relatively low service population per station at 23,001, and 5,6% of people commute to work by public transit. Boston shines at embracing consolidation, which makes looking at the number of services an underestimate of its actualized interconnectivity, with incorporating frequency being a missing piece.

Nonetheless, consistent trends in Canadian cities indicate differences between American and Canadian public transit. Montreal, Vancouver, and Toronto all have high public transit commute shares of 15.3%, 14.9%, and 15.6%, respectively. With this, the service population per station

[13] Intercity Amtrak routes are the only rail service not operated by the MBTA.

tends to be higher in Canadian cities, alluding to these systems being in areas with enough people to validate their use. Similarly, relatively high intermodality indices allude to high levels of actualized interconnectivity. These trends point to development patterns in Canada that better encourage public transit. Nonetheless, there are some differences between these cities. Vancouver has the lowest level of bikeshare-rapid rail intermodality and the smallest rapid rail network of the three cities. Montreal's comprehensive overlap between STM and Bixi coverage area and dense bus coverage boost its Intermodality Index. Toronto plays the middle with moderate bus service and bikeshare service overlap with the TTC subway. Although bikeshare services have a minimal effect on the Intermodality Index, the Bikeshare Index is a good indicator of levels of commitment to public transit in these cities. Given the relative novelty of bikeshare, cities that have introduced station-based bikeshare systems that interface heavily with rapid rail have made substantial recent investments in their public transit network.

Cities that link expansive, regional rapid rail systems with dense service by other modes fare best when looking at intermodality. Washington and San Francisco position rapid rail as a regional connector and, in this, have high amounts of intermodality. Also, both cities have above-average public transit commute shares of more than 4%[14]. Commuting is a highly preferential public transit use case within these cities as their expanded networks serve dozens of municipalities each, mainly connecting them to various downtown cores. There are other variances between the two cities. Bikeshare service is more pervasive in Washington, but San Francisco has more prevalent rapid rail interlining and supplemental rail service. Nonetheless, these cities succeed under this method of looking at intermodality and provide realized interconnectivity. Los Angeles has similar average levels of intermodality as Washington and San Francisco but lacks an expansive rapid rail network. Los Angeles is mainly dominated by bus-rapid rail intermodality, with its Bus Index being higher than all other composite Intermodality Indices for other cities. While part of this is exaggerated due to the small size of the Metro Rail network, it also speaks to Los Angeles' attempts to course correct for years of investment into automobile-centric development. Even though Metro continues to provide public transit to downtown Los Angeles and surrounding areas, the preceding land development patterns of Greater Los Angeles make effective public transit development more difficult.

[14] Nevertheless, they vary greatly in service population per station, 28,847 for Washington and 81,990 for San Francisco.

Conclusions/Further Considerations

Looking at the state of rapid rail intermodality in Canada and the United States, we see bus-rapid rail intermodality has a large presence, making up more than 60% of all transfers in all cities. This makes sense because the sheer amount of individual bus routes when compared to other modes like ferry and rail. However, this is still surprisingly in its consistency across cities with both low and high intermodality. Rail connections, be it rapid rail interlining or connections between other types of rail and rapid rail, took up the next largest portion of intermodality. Rail intermodality was variable across these cities with some cities, particularly San Francisco, Philadelphia, New York City, Boston, and Chicago, relying more heavily on their rail infrastructure to serve public transit needs. Bikeshare service is most efficient when it interfaces heavily with the existing public transit networks and cities like Montreal, Los Angeles, Washington, and Chicago have best taken advantage of this benefit. Ferry service, where available, may have marginal effects looking at system level intermodality but remain impactful in connecting economic activity across maritime channels, and when connected to rapid rail, immensely expand respective service areas.

Nonetheless, several cities within Canada and the United States have room to improve rapid rail intermodality. Several mitigating socioeconomic factors have been identified to explain why cities like Atlanta, Baltimore, Cleveland, and Miami fail to truly embrace intermodality. Most of these factors are tied to either economic decline, particularly in older Rust Belt cities, or recent urban development that has yet to be packaged with public transit. Among these cities, we see extremely high reliance on bus-rapid rail intermodality, but within this shallow bus service. These cities are also less likely to have a station-based bikeshare system or public ferry service. There is some variation in the amounts of rail service, but for the most part rail service is often shallow within these cities, as well.

Cities that score towards the middle of the pack tend to have certain modes in which they thrive, but others that need attention. For instance, Chicago excels at bikeshare-rapid rail intermodality and aggregate rail intermodality but has yet to develop its bus network to match its rail network. The same can be said about New York City, with an immense amount of rail intermodality and respectable bikeshare-rapid rail intermodality, but lower levels of bus-rapid rail intermodality. Boston, Toronto, Vancouver, and Philadelphia scored in the middle of the pack for most categories, offering respectable amounts of intermodality across most, if not all modes of transit. Boston and Philadelphia have extremely similar public transit networks and their intermodality indices highlight this. Canadian cities also tended to score similarly with Montreal scoring slightly higher based on the density of its bus network and bikeshare systems. This density puts Montreal in the same league as the highest scoring cities – Washington, San Francisco, and Los Angeles – all of which combine heavy intra-agency connecting bus service with supplemental bus service across the entirety of their metropolitan areas. The sprawlic nature of urban form in these metropolitan areas make bus service an area of focus for public transit agencies. Specifically in Los Angeles, the city that scored the highest in this Index, the small size of its rapid rail network and the need to connect this small system to the entirety of the Inland Empire, sees several individual rapid rail stations offering connections to over 30 bus routes. San Francisco and Washington are similar in that their rapid rail networks are larger, but still connect to immense numbers of municipalities adjacent to the urban core.

Public transit intermodality is good practice. With public transit coalescing around bikeshare, bus, rail, and ferry services, allowing transit users to seamlessly transfer between these modes improves the overall flexibility and quality of their networks. Public transit agencies should pay more attention to intermodality as a means of meeting the needs of a larger portion of the public, thus increasing potential ridership, and creating a more faithful ridership through first-mile/last-mile travel consolidation. Several cities within this study fall short when it comes to investing in intermodality through the development of service in each mode. In this, agencies need to prioritize creating modal networks that interface, but also can stand on their own when it comes to service provision.

There should be a logic in how these cities tackle intermodality. Intermodality between bus and rapid rail services is the most significant sector of intermodality within this study. Public transit networks characterized by shallow bus service need to increase both frequency and number of bus services interfacing with rapid rail to offer a justifiable amount of intermodality to the public. Within these improvements, these agencies also must take heed to the journey from bus stop to rapid rail station, ensuring minimal impediments and distance. From here, rail intermodality should be the next focus. Rail services are often the costliest to make intermodal but offer unique benefits that truly improve public transit systems by increasing catchment areas at a larger scale than singular bus routes, offering unbridled priority through rights-of-way, and potentially providing the most seamless transfers with rapid rail. Rail investments, be it at the streetcar or trolley level, or the level of rapid rail, are worth the initial costs for the benefits it provides to cities. Ferry service's position in this logic is variable, with many cities not having a use-case for ferries. Cities with enabling physical geography should look to develop ferry service alongside connecting rail service to truly take advantage of its consistent connectivity. From here, bikeshare development should be seen as a means for topping off first-mile/last-mile transit and should be paired with investments in bike infrastructure, primarily bike lanes, on major throughfares throughout the city. Bikeshare thrives in cities that already have made major investments in public transit and should be developed after prerequisite rail and bus services has been heightened.

There are several key takeaways from this study on what intermodality can reveal about public transit operation. Primarily, integration with intra-agency service is a good indicator of a developed public transit network. Adding interface with supplemental transit providers is what continues to grow these networks and becomes crucial when operating regional public transit networks. In this, SEPTA, TransLink, and MBTA are the agencies that operate interfacing service across the most modes. TransLink and MBTA operating four of the five modes[15] of transit is impressive[16]. Geography also plays a role in public transit development. This is on two fronts. Physically, the geographies of different cities allow for certain modes of transit, most notably ferry service, which requires linked economic activity over navigable maritime channels. Historically, geographic trends have seen cities like Atlanta, Cleveland, and Los Angeles develop urban fabric that embraces the automobile, while inhibiting public transit. This is tied to the automobile age of the 1900s, with marked differences between cities that developed before and after. This makes it harder for cities newer to rapid rail to build a population base that rapid rail thrives in. Even within this, San Francisco stands to show that physical geography remains influential to public transit post-automobile age. Furthermore, the nuances of different service areas are also key to discussions about intermodality. This is most clear in the Bikeshare Index, which serves as a rough proxy for the proportion of rapid rail service area covered by bikeshare. This also is relevant looking at supplemental rail providers. In this regard, the different service areas of commuter, light, hybrid, and intercity rail add depth to what trips are possible.

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[15] Bikeshare service was predominately out-of-agency, except for Metro Bike Share.

[16] SEPTA technically operates 3 of the 5 modes of transit, but within this operates 3 levels of supplemental rail service.

All in all, the use of intermodality as a variable in discussions of public transit is valid. Taking the top-down view of rapid rail intermodality, is effective in illustrating hierarchies of public transit services. However, it should not be used as a standalone measure[17]. Nonetheless, in conversation with other relevant facets, rapid rail intermodality helps paints a fuller picture of the state of public transit networks within Canada and the United States.

Further Considerations

Incorporating frequencies and capacities into a study of this nature will allow for more nuanced analysis on actualized levels of intermodality. Looking at sheer number of services is a relevant approximator of service level but does not offer a complete snapshot of intermodality. From here, expanding this type of comparative analysis to other geographies can bring newer international systems with different patterns of intermodality into the fold. On the other end, station level data can be further analyzed. This could lend itself to area analysis and direct comparisons between downtown stations.

Limitations

There is a relatively weak positive correlation between public transit commute shares, which act as a proxy for ridership, and the composite Intermodality Index. However, removing bus indices improves this correlation.

Table G: Intermodality Indices and 2021 Public Transit Commute Shares by Principal City

Principal City	Intermodality Index	Bus-Isolated Intermodality Index	2021 Public Transit Commute Share
Atlanta	5.55	0.68	0.01
Baltimore	6.64	0.14	0.03
Boston	7.08	1.70	0.06
Chicago	5.10	1.76	0.05
Cleveland	4.44	0.72	0.01
Los Angeles	17.32	2.38	0.03
Miami	6.17	1.21	0.02
Montreal	10.38	1.20	0.15
New York City	8.29	2.80	0.19
Philadelphia	6.98	2.32	0.05
San Francisco	14.08	3.60	0.05
Toronto	7.73	1.53	0.16
Vancouver	8.54	1.83	0.15
Washington	13.76	1.98	0.04

[17] There are variances between different indices on this, with the Bikeshare and Rapid Rail Indices being more realistic indicators and Bus and Other Rail Indices being more prone to exaggerations.

This equation defines the Pearson correlation coefficient:

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

where r = correlation coefficient
x_i = Intermodality Index values
$\bar{x}$ = mean of the Intermodality Index values
y_1 = 2021 public transit commute share values
$\bar{y}$ = mean of the 2021 public transit commute share values

This produces an r-score of .0522 between full Intermodality Indices and 2021 public transit commute shares, a marginal positive correlation, and an r^2 value of .0027, signaling that the full Intermodality Indices explain less than 1% of the variability in public transit commute shares. Removing bus Indices from composite Intermodality Indices improves this correlation slightly, producing an r-score of .2779, a moderately weak positive correlation, and an r^2 value of .0772, signaling bus-isolated Intermodality Indices explain 7.7% of the variability in public transit commute shares. Nonetheless, actualized intermodality positively correlates to public transit ridership (Atlas, 2022; Miller et al., 2018; Reimer, n.d.). These indices would provide more accurate portrayals of actualized intermodality by incorporating frequencies; however, bus, rail, and ferry frequencies were not included to maintain consistency across other indices and feasibility concerns. Instances where a given index does not reflect actualized interconnectivity are brought up accordingly.

Furthermore, these indices favor smaller systems as the number of stations is the denominator for various calculations. For instance, there are only 16 rapid rail stations in Los Angeles, which causes an exaggerated perceived level of service when looking at the average number of services per station, as opposed to cities like New York and Chicago, with over 100 stations. Moreover, due to the design of these indices, no equivalent Walk-Rapid Rail Index is looking at populations within walking distance from each station. However, this type of intermodality is omnipresent within rapid rail stations and has been present in other studies looking at rapid rail interchange (Z. Wang et al., 2016).

These indices cannot measure actualized public transit service levels because frequency levels do not impact them. In this, these indices are used to approximate spatial intermodality and, overall, provide a standardized measure to compare systems. Looking at the average number of transfers per station is not an exact approximator for depth of interconnectivity as outliers heavily influence averages. These comparisons will address discrepancies in the perceived and actual level of service that come from these limitations.

Appendix

Table H: Rapid Rail Characteristics by Principal City

Principal City	Number of Rapid Rail Lines	Number of Rapid Rail Stations	Number of Connections	Service Population per Rapid Rail Station
Atlanta	4	38	211	20,285
Baltimore	1	14	93	46,741
Boston	3	51	349	23,001
Chicago	8	143	701	21,491
Cleveland	1	18	80	20,826
Los Angeles	2	16	250	243,903
Miami	2	23	142	37,910
Montreal	4	68	706	36,115
New York City[18]	16	507	4,201	18,555
Philadelphia	3	62	432	31,020
San Francisco	5	50	704	81,990
Toronto	3	70	541	44,535
Vancouver	1	24	205	64,942
Washington	3	54	743	28,847

Table I: Public Transit Commute Shares by Principal City Metropolitan Area

Principal City	2021 Public Transit Commute Share	2019 Public Transit Commute Share	2016 Public Transit Commute Share
Atlanta	0.01	0.028	0.031
Baltimore	0.026	0.059	0.061
Boston	0.056	0.134	0.131
Chicago	0.048	0.124	0.12
Cleveland	0.014	0.029	0.031
Los Angeles	0.028	0.048	0.051
Miami	0.02	0.029	0.038
Montreal	0.153	-	0.223
New York City	0.19	0.316	0.314
Philadelphia	0.047	0.094	0.093
San Francisco	0.049	0.189	0.172
Toronto	0.156	-	0.243
Vancouver	0.149	-	0.204
Washington	0.041	0.131	0.134
Canada[19]	0.077	-	0.124
United States[20]	0.025	0.05	0.051

(Statistics Canada, 2017, 2021; US Census Bureau, 2016, 2019, 2021)

[18] The MTA operates using trunk and branch lines with 11 trunk lines branching off to 36 branch lines. The Staten Island Railway runs a single line. The PATH systems runs 4 lines.
[19] Data at the national level for Canada is included for nationwide comparison.
[20] Data at the national level for the United States is included for nationwide comparison.

Table J: Intermodality Indices by Principal City

Principal City	Intermodality Index	Bikeshare Index	Bus Index	Rapid Rail Index	Other Rail Index	Ferry Index
Atlanta	5.55	0	4.87	0.63	0.05	0
Baltimore	6.64	0	6.5	0	0.14	0
Boston	7.08	0.71	5.38	0.08	0.87	0.04
Chicago	5.1	0.81	3.34	0.52	0.43	0
Cleveland	4.44	0	3.72	0	0.72	0
Los Angeles	17.32	0.94	14.94	0.38	1.06	0
Miami	6.17	0.17	4.96	0.65	0.39	0
Montreal	10.38	1	9.18	0.07	0.12	0.01
New York City	8.29	0.64	5.49	1.45	0.65	0.06
Philadelphia	6.98	0.48	4.66	0.19	1.65	0
San Francisco	14.08	0.38	10.48	1.38	1.62	0.22
Toronto	7.73	0.66	6.2	0.06	0.81	0
Vancouver	8.54	0.25	6.71	0.04	1.5	0.04
Washington	13.76	0.83	11.78	0.33	0.81	0

Table K: Service Population per Rapid Rail Station by Principal City

Principal City	Service Population per Station
Atlanta	20,285
Baltimore	46,741
Boston	23,001
Chicago	21,491
Cleveland	20,826
Los Angeles	243,903
Miami	37,910
Montreal	36,115
New York City	18,555
Philadelphia	31,020
San Francisco	81,990
Toronto	44,535
Vancouver	64,942
Washington	28,847

Table L: Transit Connections by Rapid Rail Station in Atlanta

Name	Rapid Rail	Bus	Other Rail	Total
North Springs	-	7	-	7
Sandy Springs	-	3	-	3
Dunwoody	-	5	-	5
Medical Center	-	3	-	3
Buckhead	-	2	-	2
Lindbergh Center	1	6	-	7
Arts Center	1	8	-	9
Midtown	1	6	-	7
North Avenue	1	8	-	9
Civic Center	1	3	-	4
Peachtree Center	1	4	1	6
Five Points	3	13	-	16
Garnett	1	-	-	1
West End	1	10	-	11
Oakland City	1	4	-	5
Lakewood/Fort McPherson	1	6	-	7
East Point	1	8	-	9
College Park	1	8	-	9
Airport	1	-	1	2
Doraville	-	7	-	7
Chamblee	-	6	-	6
Brookhaven/Oglethorpe	-	4	-	4
Lenox	-	2	-	2
Hamilton E. Holmes	-	15	-	15
West Lake	-	4	-	4
Ashby	1	2	-	3
Vine City	1	1	-	2
GWCC/CNN	1	1	-	2
Georgia State	1	3	-	4
King Memorial	1	3	-	4
Inman Park/Reynoldstown	1	4	-	5
Edgewood/Candler Park	1	2	-	3
East Lake	-	3	-	3
Decatur	-	5	-	5
Avondale	1	4	-	5
Kensington	-	8	-	8
Indian Creek	-	5	-	5
Bankhead	-	2	-	2
Total	24	185	2	211

Table M: Transit Connections by Rapid Rail Station in Baltimore

Station Name	Bus	Other Rail	Total
Owings Mills	3	-	3
Old Court	3	-	3
Milford Mill	2	-	2
Reisterstown Plaza	1	-	1
Rogers Avenue	7	-	7
West Cold Spring	2	-	2
Mondawmin	10	-	10
Penn-North	3	-	3
Upton-Avenue Market	1	-	1
State Center/Cultural Center	6	1	7
Lexington Market	9	1	10
Charles Center	24	-	24
Shot Tower	4	-	4
John Hopkins	16	-	16
Total	91	2	93

Table N: Transit Connections by Rapid Rail Station in Boston

Station Name	Bikeshare	Rapid Rail	Bus	Other Rail	Ferry	Total
Braintree	-	-	3	3	-	6
Quincy Adams	-	-	2	-	-	2
Quincy Center	-	-	15	3	-	18
Wollaston	-	-	4	-	-	4
North Quincy	-	-	3	-	-	3
Ashmont	1	-	-	1	-	2
Shawmut	1	-	-	-	-	1
Fields Corner	1	-	8	-	-	9
Savin Hill	1	-	-	-	-	1
JFK/Umass	1	-	3	3	-	7
Andrew	1	-	6	-	-	7
Broadway	-	-	3	-	-	3
South Station	1	-	7	8	-	16
Downtown Crossing	1	2	14	-	-	17
Park Street	1	-	5	4	-	10
Charles/MGH	1	-	-	-	-	1
Kendall/MIT	1	-	5	-	-	6
Central	1	-	6	-	-	7
Harvard	1	-	12	-	-	13
Porter	1	-	5	1	-	7
Davis	1	-	7	-	-	8
Alewife	1	-	8	-	-	9
Oak Grove	-	-	4	-	-	4
Malden Center	-	-	1	1	-	2
Wellington	1	-	9	-	-	10
Assembly	1	-	-	-	-	1
Sullivan Square	-	-	13	-	-	13
Community College	1	-	-	-	-	1
North Station	1	1	1	7	-	10
Haymarket	-	-	16	2	-	18
State	1	1	8	-	-	10
Chinatown	1	-	3	-	-	4
Tufts Medical Center	1	-	5	-	-	6
Back Bay	1	-	3	7	-	11
Massachusetts Avenue	1	-	1	-	-	2
Ruggles	1	-	13	3	-	17
Roxbury Crossing	1	-	8	-	-	9
Jackson Square	1	-	5	-	-	6
Stony Brook	1	-	-	-	-	1
Green Street	1	-	-	-	-	1
Forest Hills	1	-	17	2	-	20
Wonderland	-	-	11	-	-	11
Revere Beach	1	-	3	-	-	4
Beachmont	-	-	1	-	-	1
Suffolk Downs	-	-	-	-	-	0
Orient Heights	1	-	3	-	-	4
Wood Island	-	-	3	-	-	3
Airport	1	-	2	-	-	3
Maverick	1	-	5	-	-	6
Aquarium	1	-	1	-	2	4
Government Center	1	-	5	-	-	6
Bowdoin	-	-	4	-	-	4
Total	37	4	261	45	2	349

Table O: Transit Connections by Rapid Rail Station in Chicago

Station Name	Bikeshare	Rapid Rail	Bus	Other Rail	Total
18th	1	-	1	-	2
35th-Bronzeville-IIT	1	-	3	-	4
35th/Archer	1	-	4	-	5
43rd	1	-	1	-	2
47th (Green Line)	1	-	1	-	2
47th (Red Line)	1	-	5	-	6
51st	1	-	1	-	2
54th/Cermak	0	-	5	-	5
63rd	1	-	2	-	3
69th	1	-	6	-	7
79th	1	-	5	-	6
87th	1	-	2	-	3
95th/Dan Ryan	1	-	1	-	2
Adams/Wabash	1	4	5	-	10
Addison (Blue Line)	1	-	1	-	2
Addison (Brown Line)	1	-	1	-	2
Addison (Red Line)	-	-	4	-	4
Argyle	1	-	1	-	2
Armitage	1	1	1	-	3
Ashland (Green/Pink Line)	1	1	2	-	4
Ashland (Orange Line)	1	-	4	-	5
Ashland/63rd	1	-	3	-	4
Austin (Blue Line)	-	-	2	-	2
Austin (Green Line)	1	-	4	-	5
Belmont (Blue Line)	1	-	2	-	3
Belmont (Brown/Red/Purple Line)	1	2	2	-	5
Berwyn	1	-	1	-	2
Bryn Mawr	1	-	3	-	4
California (Blue Line)	1	-	3	-	4
California (Green Line)	1	-	1	-	2
California (Pink Line)	1	-	1	-	2
Central (Green Line)	1	-	1	-	2
Central (Purple Line)	1	-	1	-	2
Central Park	1	-	2	-	3
Cermak-Chinatown	1	-	3	-	4
Cermak-McCormick Place	1	-	2	-	3
Chicago/Franklin	1	1	2	-	4
Chicago/Milwaukee	1	-	2	-	3
Chicago/State	1	-	2	-	3
Cicero (Blue Line)	1	-	6	-	7
Cicero (Green Line)	1	-	2	-	3
Cicero (Pink Line)	-	-	6	-	6
Clark/Division	1	-	1	-	2
Clark/Lake	1	5	6	-	12
Clinton (Blue Line)	1	-	5	21	27
Clinton (Green/Pink Line)	1	1	3	3	8
Conservatory-Central Park Drive	1	-	-	-	1
Cottage Grove	1	-	3	-	4
Cumberland	-	-	5	-	5
Damen (Blue Line)	1	-	3	-	4
Damen (Brown Line)	1	-	1	1	3

Damen (Pink Line)	1	-	2	-	3
Davis	1	-	6	1	8
Dempster	-	-	2	-	2
Dempster-Skokie	-	-	5	-	5
Diversey	1	1	1	-	3
Division	1	-	4	-	5
Forest Park	-	-	7	-	7
Foster	-	-	-	-	0
Francisco	1	-	-	-	1
Fullerton	1	2	2	-	5
Garfield (Green Line)	1	-	1	-	2
Garfield (Red Line)	1	-	3	-	4
Grand	1	-	4	-	5
Grand/Milwaukee	1	-	3	-	4
Granville	1	-	1	-	2
Halsted	1	-	3	-	4
Halsted (Green Line)	1	-	2	-	3
Harlem	-	-	1	-	1
Harlem/Higgins	-	-	4	-	4
Harlem/Lake	-	-	5	1	6
Harrison	1	-	7	-	8
Howard	1	2	8	-	11
Illnois Medical District	1	-	4	-	5
Indiana	1	-	1	-	2
Irving Park (Brown Line)	1	-	1	-	2
Irving Park (Blue Line)	1	-	3	1	5
Jackson	1	5	12	-	18
Jackson/Dearborn	1	5	11	-	17
Jarvis	1	-	-	-	1
Jefferson Park Transit Center	-	-	14	1	15
Kedzie	1	-	-	-	1
Kedzie	1	-	1	-	2
Kedzie (Green Line)	1	-	1	1	3
Kedzie (Orange Line)	-	-	4	-	4
Kedzie-Homan	1	-	3	-	4
Kimball	1	-	3	-	4
King Drive	1	-	3	-	4
Kostner	-	-	-	-	0
Lake	1	6	7	-	14
Laramie	1	-	1	-	2
LaSalle	1	4	2	1	8
LaSalle/Van Buren	1	3	4	1	9
Lawrence	1	-	2	-	3
Library	1	1-	5	-	6
Linden	-	-	3	-	3
Logan Square	1	-	2	-	3
Loyola	1	-	2	-	3
Main	1	-	2	1	4
Merchandise Mart	1	1	2	-	4
Midway	-	-	19	-	19
Monroe	1	-	9	-	10
Monroe/Dearborn	1	1	6	-	8
Montrose (Blue Line)	1	-	1	1	3
Montrose (Brown Line)	1	-	1	-	2

Morgan	1	1	-	-	2
Morse	1	-	2	-	3
North/Clybourn	1	-	3	-	4
Noyes	-	-	-	-	0
O'Hare	-	-	2	2	4
Oak Park (Blue Line)	-	-	1	-	1
Oak Park (Green Line)	-	-	3	-	3
Oakton-Skokie	-	-	3	-	3
Paulina	1	-	-	-	1
Polk	1	-	3	-	4
Pulaski (Blue Line)	1	-	2	-	3
Pulaski (Green Line)	1	-	1	-	2
Pulaski (Orange Line)	-	-	2	-	2
Pulaski (Pink Line)	-	-	2	-	2
Quincy	1	3	1	21	26
Racine	1	-	4	-	5
Ridgeland	-	-	4	-	4
Rockwell	1	-	-	-	1
Roosevelt	1	2	7	-	10
Rosemont	-	-	13	-	13
Sedgwick	1	1	3	-	5
Sheridan	1	-	2	-	3
South Boulevard	-	-	2	-	2
Southport	1	-	-	-	1
Sox-35th	1	-	7	1	9
State/Lake	1	4	7	-	12
Thorndale	1	-	1	-	2
UIC-Halsted	1	-	4	-	5
Washington/Dearborn	1	-	12	-	13
Washington/Wabash	1	4	8	-	13
Washington/Wells	1	3	7	1	12
Wellington	1	1	-	-	2
Western (Blue Line Congress Branch)	1	-	3	-	4
Western (Blue Line O'Hare Branch)	1	-	4	-	5
Western (Brown Line)	1	-	4	-	5
Western (Orange Line)	1	-	4	-	5
Western (Pink Line)	1	-	2	1	4
Wilson	1	1	3	-	5
Total	116	65	459	61	701

Table P: Transit Connections by Rapid Rail Station in Cleveland

Station Name	Other Rail	Bus	Total	
Airport	-	-	-	
Brookpark	-	3	3	
Puritas-West 150th	-	1	1	
West Park	-	3	3	
Triskett	-	-	-	
West 117th-Madison	-	2	2	
West Boulevard-Cudell	-	3	3	
West 65th-Lorain	-	3	3	
West 25th-Ohio City	-	4	4	
Tower City	5	26	31	
Tri-C-Campus District	2	4	6	
East 55th	2	1	3	
East 79th	2	1	3	
East 105th-Quincy	-	3	3	
Cedar-University	-	3	3	
Little Italy-University Circle	-	1	1	
Superior	1	2	3	
Windermere	1	7	8	
Total	13	67	80	

Table Q: Transit Connections by Rapid Rail Station in Los Angeles

Station Name	Bikeshare	Rapid Rail	Bus	Other Rail	Total
Union Station	1	1	3	15	20
Civic Center/Grand Park	1	1	45	-	47
Pershing Square	1	1	37	-	39
7th Street/Metro Center	1	1	49	2	53
Westlake/MacArthur Park	1	1	7	-	9
Wilshire/Vermont	1	1	7	-	9
Wilshire/Normandie	1	-	4	-	5
Wilshire/Western	1	-	8	-	9
North Hollywood	1	-	14	-	15
Universal City/Studio City	-	-	6	-	6
Hollywood/Highland	1	-	5	-	6
Hollywood/Vine	1	-	7	-	8
Hollywood/Western	1	-	3	-	4
Vermont/Sunset	1	-	9	-	10
Vermont/Santa Monica	1	-	4	-	5
Vermont/Beverly	1	-	4	-	5
Total	15	6	212	17	250

Table R: Transit Connections by Rapid Rail Station in Miami

Station Name	Bikeshare	Rapid Rail	Bus	Other Rail	Total
Palmetto	-	-	2	1	3
Okeechobee	-	-	2	-	2
Hialeah	-	-	5	-	5
Tri-Rail	-	-	2	3	5
Northside	-	-	5	-	5
Dr.-Martin-Luther-King-Jr.-Plaza	-	-	3	-	3
Brownsville	-	-	4	-	4
Miami-International-Airport	-	-	9	1	10
Earlington-Heights	-	1	3	-	4
Allapattah	-	1	4	-	5
Santa-Clara	-	1	4	-	5
Civic-Center	-	1	5	-	6
Culmer	-	1	3	-	4
Historic-Overtown/Lyric-Theatre	1	1	5	-	7
Government-Center	1	1	19	3	24

Brickell	1	1	5	1	8
Vizcaya	1	1	4	-	6
Coconut-Grove	-	1	3	-	4
Douglas-Road	-	1	5	-	6
University	-	1	2	-	3
South-Miami	-	1	4	-	5
Dadeland-North	-	1	7	-	8
Dadeland-South	-	1	9	-	10
Total	4	15	114	9	142

Table S: Transit Connections by Rapid Rail Station in Montreal

Name	Bikeshare	Rapid Rail	Bus	Other Rail	Ferry	Total
Bonaventure	1	-	91	2	-	94
Longueuil–Université-de-Sherbrooke	1	-	65	-	-	66
Côte-Vertu	1	-	29	-	-	30
Montmorency	1	-	25	-	-	26
Radisson	1	-	24	-	-	25
Angrignon	1	-	23	-	-	24
Cartier	1	-	23	-	-	24
Henri-Bourassa	1	-	20	-	-	21
Atwater	1	-	19	-	-	20
Frontenac	1	-	14	-	-	15
Du-Collège	1	-	14	-	-	15
Honoré-Beaugrand	1	-	12	-	-	13
Lionel-Groulx	1	1	10	-	-	12
Papineau	1	-	10	-	-	11
Crémazie	1	-	10	-	-	11
Berri–UQAM	1	2	7	-	-	10
Namur	1	-	9	-	-	10
Guy–Concordia	1	-	8	-	-	9
Rosemont	1	-	8	-	-	9
Jean-Talon	1	1	7	-	-	9
Sauvé	1	-	8	-	-	9
Parc	1	-	7	1	-	9
Place-des-Arts	1	-	7	-	-	8
Vendôme	1	-	6	1	-	8
Laurier	1	-	7	-	-	8
Langelier	1	-	6	-	-	7
De-La-Savane	1	-	6	-	-	7
Place-Saint-Henri	1	-	6	-	-	7
Saint-Michel	1	-	6	-	-	7
Joliette	1	-	5	-	-	6
Plamondon	1	-	5	-	-	6
Snowdon	1	1	4	-	-	6
Beaubien	1	-	5	-	-	6
De-La-Concorde	1	-	4	1	-	6
Outremont	1	-	5	-	-	6
Jolicoeur	1	-	4	-	-	5
De-L'Église	1	-	4	-	-	5
LaSalle	1	-	4	-	-	5
Charlevoix	1	-	4	-	-	5
McGill	1	-	4	-	-	5
Préfontaine	1	-	4	-	-	5
Cadillac	1	-	4	-	-	5
Sherbrooke	1	-	4	-	-	5
Mont-Royal	1	-	4	-	-	5
Jean-Drapeau	1	-	3	-	1	5
Côte-des-Neiges	1	-	4	-	-	5
Fabre	1	-	4	-	-	5
Monk	1	-	3	-	-	4
Saint-Laurent	1	-	3	-	-	4
Pie-IX	1	-	3	-	-	4
Viau	1	-	3	-	-	4
Côte-Sainte-Catherine	1	-	3	-	-	4

Villa-Maria	1	-	3	-	-	4
Lucien-L'Allier	1	-	15	3	-	19
Square-Victoria–OACI	1	-	3	-	-	4
Jarry	1	-	3	-	-	4
Université-de-Montréal	1	-	3	-	-	4
Édouard-Montpetit	1	-	3	-	-	4
D'Iberville	1	-	3	-	-	4
Verdun	1	-	2	-	-	3
Peel	1	-	2	-	-	3
Beaudry	1	-	2	-	-	3
Assomption	1	-	2	-	-	3
Acadie	1	-	2	-	-	3
De-Castelnau	1	-	2	-	-	3
Place-d'Armes	1	-	1	-	-	2
Champ-de-Mars	1	-	1	-	-	2
Georges-Vanier	1	-	-	-	-	1
Total	68	5	624	8	1	706

Table T: Transit Connections by Rapid Rail Station in New York City

Station Name	Bikeshare	Rapid Rail	Bus	Other Rail	Ferry	Total
103rd St - 1 Line	1	-	1	-	-	2
103rd St - A B C Line	1	1	1	-	-	3
103rd St - 4 6 6 Express	1	1	3	-	-	5
103rd St - Corona Plaza	-	-	1	-	-	1
104th St	-	-	3	-	-	3
104th-102nd Sts	-	-	1	-	-	1
110th St - 4 6 6 Express	1	-	3	-	-	4
111th St - A S Line	-	-	2	-	-	2
111th St - 7 Line	-	-	1	-	-	1
111th St - J Line	-	-	2	-	-	2
116th St - 2 3 Line	1	-	3	-	-	4
116th St - A B C Line	1	1	3	-	-	5
116th St - 4 6 6 Express	1	1	5	-	-	7
116th St - Columbia University	1	-	3	-	-	4
121st St	-	-	4	-	-	4
125th St - 2 3 Line	1	1	5	-	-	7
125th St - 1 Line	1	1	3	-	-	5
125th St - A B C D Line	1	3	6	-	-	10
125th St - 4 6 6 Express	1	2	5	3	-	11
135th St - 2 3 Line	1	1	3	-	-	5
135th St - A B C Line	1	1	2	-	-	4
137th St - City College	1	-	2	-	-	3
138th St - Grand Concourse	1	1	2	-	-	4
145th St - 1 Line	1	-	3	-	-	4
145th St - 3 Line	1	1	4	-	-	6
145th St - A B C D Line	1	3	6	-	-	10
149th St - Grand Concourse - 4 Line	1	2	3	-	-	6
149th St - Grand Concourse - 2 5 Line	1	2	3	-	-	6
14th St - 1 2 3 Line	1	8	5	2	-	16
14th St - F M Line	1	8	5	2	-	16
14th St - A C E Line	1	3	4	-	-	8
155th St - B D Line	1	1	1	-	-	3
155th St - A C Line	1	-	5	-	-	6
157th St	1	-	7	-	-	8

15th St - Prospect Park	1	-	2	-	-	3
161st St - Yankee Stadium - 4 Line	1	-	3	1	-	5
161st St - Yankee Stadium - B D Line	1	-	3	1	-	5
163rd St - Amsterdam Av	1	-	3	-	-	4
167th St - B D Line	1	1	3	-	-	5
167th St - 4 Line	1	-	1	-	-	2
168th St - A C Line	1	2	6	-	-	9
168th St - 1 Line	1	2	6	-	-	9
169th St	-	1	17	-	-	18
170th St - B D Line	1	-	5	-	-	6
170th St - 4 Line	1	-	2	-	-	3
174th St	1	1	3	-	-	5
174th-175th Sts	1	1	3	-	-	5
175th St	1	-	17	-	-	18
176th St	1	-	1	-	-	2
181st St - 1 Line	1	-	6	-	-	7
181st St - A Line	1	-	17	-	-	18
182nd-183rd Sts	1	-	3	-	-	4
183rd St	1	-	1	-	-	2
18th Ave - F Line	-	-	1	-	-	1
18th Ave - N Line	-	2	1	-	-	3
18th Ave - D Line	-	-	2	-	-	2
18th St	1	1	2	-	-	4
190th St	1	-	2	-	-	3
191st St	1	-	2	-	-	3
1st Ave	1	-	3	-	-	4
207th St	1	-	3	-	-	4
20th Ave - N Line	-	2	2	-	-	4
20th Ave - D Line	-	-	1	-	-	1
215th St	1	-	3	-	-	4
219th St	-	1	2	-	-	3
21st St	1	-	4	3	-	8
21st St - Queensbridge	1	-	5	-	-	6
225th St	-	1	3	-	-	4
231st St	-	-	9	-	-	9
233rd St	-	1	4	1	-	6
238th St	-	-	2	-	-	2
23rd St - 4 6 6 Express	1	4	35	-	-	40
23rd St - 1 2 Line	1	2	3	-	-	6
23rd St - F M Line	1	3	3	-	-	7
23rd St - N R Q W Line	1	4	17	-	-	22
23rd St - A C E Line	1	2	3	-	-	6
25th Ave	-	-	3	-	-	3
25th St	1	2	2	-	-	5
28th St - N Q R W Line	1	3	-	-	-	4
28th St - 1 2 Line	1	-	2	-	-	3
28th St - 4 6 6 Express	1	1	37	-	-	39
30th Ave	1	1	2	-	-	4
33rd St - 4 6 6 Express	1	1	15	-	2	19
33rd St - 7 Line	1	-	3	-	-	4
34th St - Hudson Yards	1	-	2	-	-	3
34th St - Penn Station - 1 2 3 Line	1	7	7	40	-	55
34th St - Penn Station - A C E Line	1	5	5	40	-	51
36th Ave	1	-	2	-	-	3

36th St - E M R Line	1	1	1	-	-	3
36th St - D N R Line	1	4	4	-	-	9
39th Ave	1	1	1	-	-	3
3rd Ave	1	-	5	-	-	6
3rd Ave - 138th St	1	-	6	-	-	7
3rd Ave - 149th St	1	1	8	-	-	10
40th St	1	-	2	-	-	3
42nd St - Bryant Pk	1	16	30	-	-	47
42nd St - Port Authority Bus Term	1	16	86	-	-	103
45th St	1	3	2	-	-	6
46th St - E M R Line	1	1	1	-	-	3
46th St - 7 Line	1	-	4	-	-	5
47th-50th Sts - Rockefeller Ctr	1	3	3	-	-	7
49th St	1	2	4	-	-	7
4th Av - 9th St - F G Line	1	3	3	-	-	7
4th Av - 9th St - D N R Line	1	3	3	-	-	7
50th St - 1 2 Line	1	2	5	-	-	8
50th St - D Line	-	-	2	-	-	2
50th St - A C E Line	1	2	3	-	-	6
51st St	1	-	5	-	-	6
52nd St	1	-	1	-	-	2
53rd St	1	1	3	-	-	5
55th St	-	-	1	-	-	1
57th St - F Line	1	4	4	-	-	9
57th St - N Q R W Line	1	4	4	-	-	9
59th St	1	1	3	-	2	7
59th St - Columbus Circle - 1 2 Line	1	4	7	-	-	12
59th St - Columbus Circle - A B C D Line	1	4	7	-	-	12
5th Ave - 53rd St	1	-	7	-	-	8
5th Ave - 59th St	1	1	19	-	-	21
5th Ave - Bryant Pk	1	2	30	-	-	33
62nd St	-	1	1	-	-	2
63rd Dr - Rego Park	-	1	8	-	-	9
65th St	1	1	-	-	-	2
66th St - Lincoln Ctr	1	1	6	-	-	8
67th Ave	-	1	3	-	-	4
68th St - Hunter College	1	-	5	-	-	6
69th St	1	-	2	-	-	3
6th Ave	1	2	6	-	-	9
71st St	-	-	-	-	-	0
72nd St - A B C Line	1	1	3	-	-	5
72nd St - 1 2 3 Line	1	2	7	-	-	10
72nd St - Q Line	1	1	4	-	-	6
74th St - Broadway	-	4	5	-	-	9
75th Ave	-	1	3	-	-	4
75th St - Eldert Ln	-	-	1	-	-	1
77th St - 4 6 6 Express	1	1	4	-	-	6
77th St - R Line	-	-	3	-	-	3
79th St - 1 2 Line	1	-	2	-	-	3
79th St - D Line	-	-	-	-	-	0
7th Ave - F G Line	1	1	3	-	-	5
7th Ave - B Q Line	1	1	3	-	-	5
7th Ave - B D E Line	1	2	3	-	-	6
80th St	-	-	1	-	-	1

81st St	1	1	3	-	-	5
82nd St - Jackson Hts	-	-	3	-	-	3
85th St - Forest Pky	-	-	1	-	-	1
86th St - 1 2 Line	1	-	2	-	-	3
86th St - A B C Line	1	1	2	-	-	4
86th St - R Line	-	-	3	-	1	4
86th St - 4 6 6 Express	1	2	6	-	-	9
86th St - Q Line	1	-	3	-	1	5
88th St	-	-	-	-	-	0
8th Ave - N Line	-	2	2	-	-	4
8th Ave - L Line	1	3	4	-	-	8
8th St - NYU	1	3	7	-	-	11
90th St - Elmhurst Av	-	-	-	-	-	0
96th St - 4 6 6 Express	1	1	4	-	-	6
96th St - A B C Line	1	1	3	-	-	5
96th St - Q Line	1	-	3	-	1	5
96th St - 1 2 3 Line	1	2	3	-	-	6
9th Ave	1	-	1	-	-	2
Alabama Ave	-	1	6	-	-	7
Allerton Ave	-	1	4	-	-	5
Annadale	-	-	1	-	-	1
Aqueduct - North Conduit Av	-	-	1	-	-	1
Aqueduct Racetrack	-	-	3	-	-	3
Arthur Kill	-	-	1	-	-	1
Astor Pl	1	1	4	-	-	6
Astoria - Ditmars Blvd	1	1	2	-	-	4
Astoria Blvd	1	1	3	-	-	5
Atlantic Av - Barclay's Center - 2 3 4 5 Line	1	9	7	7	-	24
Atlantic Av - Barclay's Center - B Q Line	1	9	7	7	-	24
Atlantic Av - Barclay's Center - D N R Q Line	1	9	7	7	-	24
Atlantic Ave	-	-	1	1	-	2
Ave H	-	-	-	-	-	0
Ave I	-	-	1	-	-	1
Ave J	-	-	2	-	-	2
Ave M	-	-	1	-	-	1
Ave N	-	-	1	-	-	1
Ave P	-	-	-	-	-	0
Ave U - N Line	-	-	1	-	-	1
Ave U - F Line	-	-	1	-	-	1
Ave U - Q Line	-	-	1	-	-	1
Ave X	-	-	2	-	-	2
Bay 50th St	-	-	1	-	-	1
Bay Pky - D Line	-	-	4	-	-	4
Bay Pky - N Line	-	-	1	-	-	1
Bay Pky - F Line	-	-	1	-	-	1
Bay Ridge - 95th St	-	-	3	-	-	3
Bay Ridge Ave	1	-	4	-	-	5
Bay Terrace	-	-	-	-	-	0
Baychester Ave	-	-	-	-	-	0
Beach 105th St	-	-	3	-	1	4
Beach 25th St	-	-	-	-	-	0
Beach 36th St	-	-	2	-	-	2
Beach 44th St	-	-	1	-	-	1
Beach 60th St	-	-	2	-	-	2

Beach 67th St	-	-	3	-	-	3
Beach 90th St	-	-	3	-	-	3
Beach 98th St	-	-	3	-	-	3
Bedford - Nostrand Aves	1	-	3	-	-	4
Bedford Ave	1	-	1	-	1	3
Bedford Park Blvd	1	1	5	-	-	7
Bedford Park Blvd - Lehman College	1	1	7	-	-	9
Bergen St - 2 3 4 Line	1	1	7	-	-	9
Bergen St - F G Line	1	1	2	-	-	4
Beverly Rd - Q Line	-	-	-	-	-	0
Beverly Rd - 2 5 Line	-	1	1	-	-	2
Bleecker St	1	5	5	-	-	11
Borough Hall - 4 5 Line	1	6	9	-	-	16
Borough Hall - 2 3 Line	1	6	9	-	-	16
Botanic Garden	1	4	2	-	-	7
Bowery	1	1	1	-	-	3
Bowling Green	1	1	27	-	-	29
Briarwood - Van Wyck Blvd	-	1	8	-	1	10
Brighton Beach	-	1	2	-	-	3
Broad Channel	-	1	3	-	-	4
Broad St	1	-	23	-	1	25
Broadway - G Line	1	1	2	-	-	4
Broadway - N W Line	1	-	2	-	-	3
Broadway - Lafayette St	1	5	5	-	-	11
Broadway Junction - J Z Line	1	4	6	1	-	12
Broadway Junction - L Line	1	4	6	1	-	12
Broadway Junction - A C Line	1	4	6	1	-	12
Bronx Park East	-	1	2	-	-	3
Brook Ave	1	-	1	-	-	2
Brooklyn Bridge - City Hall	1	4	11	-	-	16
Brooklyn College - Flatbush Ave	-	1	8	-	-	9
Buhre Ave	-	-	3	-	-	3
Burke Ave	-	1	1	-	-	2
Burnside Ave	1	-	3	-	-	4
Bushwick - Aberdeen	1	-	-	-	-	1
Canal St - 4 6 6 Express	1	7	1	-	-	9
Canal St - 1 2 Line	1	3	1	-	-	5
Canal St - J Z Line	1	7	1	-	-	9
Canal St - R W Line	1	7	1	-	-	9
Canal St - N Q Line	1	7	1	-	-	9
Canal St - Holland Tunnel	1	2	3	-	-	6
Canarsie - Rockaway Pkwy	-	-	6	-	-	6
Carroll St	1	1	1	-	-	3
Castle Hill Ave	-	-	2	-	-	2
Cathedral Pkwy (110th St) - A B C Line	1	1	3	-	-	5
Cathedral Pkwy (110th St) - 1 Line	1	-	3	-	-	4
Central Ave	1	-	2	-	-	3
Central Park North (110th St)	1	1	3	-	-	5
Chambers St - A C Line	1	6	26	-	-	33
Chambers St - 1 2 3 Line	1	6	2	-	-	9
Chambers St - J Z Line	1	4	11	-	-	16
Chauncey St	1	1	2	-	-	4
Christopher St - Sheridan Sq	1	-	2	2	-	5
Church Ave - F G Line	1	1	4	-	-	6

Church Ave - B Q Line	1	1	2	-	-	4
Church Ave - 2 5 Line	-	1	3	-	-	4
City Hall	1	1	6	-	-	8
Clark St	1	1	13	-	2	17
Classon Ave	1	-	2	-	-	3
Cleveland St	-	-	1	-	-	1
Clifton	-	-	2	-	-	2
Clinton - Washington Aves - G Line	1	-	2	-	-	3
Clinton - Washington Aves - A C Line	1	-	3	-	-	4
Coney Island - Stillwell Av	-	3	5	-	-	8
Cortelyou Rd	-	-	5	-	-	5
Cortlandt St - 1 Line	1	8	26	2	-	37
Cortlandt St - N R W Line	1	8	26	2	-	37
Court Sq	1	3	5	-	-	9
Court Sq - 23rd St	1	3	5	-	-	9
Court St	1	6	9	-	-	16
Crescent St	-	-	1	-	-	1
Crown Hts - Utica Ave	-	1	5	-	-	6
Cypress Ave	1	-	2	-	-	3
Cypress Hills	-	-	2	-	-	2
DeKalb Ave - D B N Q R Line	1	3	5	-	-	9
DeKalb Ave - L Line	1	-	2	-	-	3
Delancey St - Essex St - F Line	1	3	3	-	-	7
Delancey St - Essex St - J M Z Line	1	3	3	-	-	7
Ditmas Ave	-	-	-	-	-	0
Dongan Hills	-	-	-	-	-	0
Dyckman St - 1 Line	1	-	2	-	-	3
Dyckman St - A Line	1	-	3	-	-	4
E 105th St	-	-	-	-	-	0
E 143rd St - St Mary's St	1	-	-	-	-	1
E 149th St	1	-	2	-	-	3
E 180th St	-	1	4	-	-	5
East Broadway	1	-	1	-	-	2
Eastchester - Dyre Ave	-	-	3	-	-	3
Eastern Pkwy - Bklyn Museum	1	-	2	-	-	3
Elder Ave	-	-	3	-	-	3
Elmhurst Ave	-	1	1	-	-	2
Eltingville	-	-	7	-	-	7
Euclid Ave	-	1	3	-	-	4
Far Rockaway - Mott Ave	-	-	7	-	-	7
Flushing - Main St	-	-	18	1	-	19
Flushing Ave - G Line	1	-	1	-	-	2
Flushing Ave - J M Line	1	1	5	-	-	7
Fordham Rd - B D Line	1	-	8	-	-	9
Fordham Rd - 4 Line	1	-	3	-	-	4
Forest Ave	1	-	4	-	-	5
Forest Hills - 71st Av	-	3	9	7	-	19
Franklin Ave - 2 3 4 5 Line	1	4	2	-	-	7
Franklin Ave - A C Line	1	1	2	-	-	4
Franklin Ave - Fulton St	1	1	3	-	-	5
Franklin St	1	1	2	-	-	4
Freeman St	1	1	1	-	-	3
Fresh Pond Rd	1	-	6	-	-	7
Ft Hamilton Pkwy - F G Line	1	1	6	-	-	8

Ft Hamilton Pkwy - N Line	-	2	1	-	-	3
Ft Hamilton Pkwy - D Line	-	-	-	-	-	0
Fulton St - G Line	1	-	4	-	-	5
Fulton St - A C Line	1	7	9	-	-	17
Fulton St - 2 3 Line	1	7	9	-	-	17
Fulton St - J Z Line	1	7	9	-	-	17
Fulton St - 4 5 Line	1	7	9	-	-	17
Gates Ave	1	-	2	-	-	3
Graham Ave	1	-	2	-	-	3
Grand Army Plaza	1	1	3	-	-	5
Grand Ave - Newtown	-	1	5	-	-	6
Grand Central - 42nd St	1	4	50	3	-	58
Grand Central - 42nd St	1	4	50	3	-	58
Grand Central - 42nd St	1	4	50	3	-	58
Grand St - L Line	1	-	2	-	-	3
Grand St - B D Line	1	1	1	-	-	3
Grant Ave	-	1	2	-	-	3
Grant City	-	-	1	-	-	1
Grasmere	-	-	1	-	-	1
Gravesend - 86th St	1	2	2	-	-	5
Great Kills	-	-	3	-	-	3
Greenpoint Ave	1	-	4	-	1	6
Gun Hill Rd - 2 5 Line	-	-	6	1	-	7
Gun Hill Rd - 5 Line	-	-	2	-	-	2
Halsey St - J Line	1	-	3	-	-	4
Halsey St - L Line	1	-	1	-	-	2
Harlem - 148 St	1	-	1	-	-	2
Herald Sq - 34th St - N R Q W Line	1	9	23	40	-	73
Herald Sq - 34th St - B D F M Line	1	9	23	40	-	73
Hewes St	1	1	1	-	-	3
High St	1	1	1	-	2	5
Houston St	1	-	2	-	-	3
Howard Beach - JFK Airport	-	-	1	-	-	1
Hoyt - Schermerhorn Sts	1	4	11	-	-	16
Hoyt St	1	4	10	-	-	15
Huguenot	-	-	3	-	-	3
Hunters Point Ave	1	-	2	3	-	6
Hunts Point Ave	1	-	4	-	-	5
Intervale Ave	1	1	3	-	-	5
Inwood - 207th St	1	-	5	-	-	6
Jackson Ave	1	1	1	-	-	3
Jackson Hts - Roosevelt Av	1	4	6	-	-	11
Jamaica - 179th St	-	-	17	-	-	17
Jamaica - Van Wyck	-	-	6	-	-	6
Jamaica Ctr - Parsons / Archer	-	1	27	-	-	28
Jay St - MetroTech - A C F Line	1	3	13	-	-	17
Jay St - MetroTech - N R Line	1	3	13	-	-	17
Jefferson Avenue	-	-	-	-	-	0
Jefferson St	1	-	1	-	-	2
Junction Blvd	-	-	1	-	-	1
Junius St	-	4	1	-	-	5
Kew Gardens - Union Tpke	-	1	9	7	-	17
Kings Hwy - F Line	-	-	2	-	-	2
Kings Hwy - B Q Line	-	1	6	-	-	7

Kings Hwy - N Line	-	-	2	-	-	2
Kingsbridge Rd - B D Line	1	-	6	-	-	7
Kingsbridge Rd - 4 Line	1	-	4	-	-	5
Kingston - Throop Aves	1	-	3	-	-	4
Kingston Ave	-	1	2	-	-	3
Knickerbocker Ave	1	-	1	-	-	2
Kosciuszko St	1	-	5	-	-	6
Lafayette Ave	1	-	3	-	-	4
Lexington Ave - 53rd St	1	2	5	-	-	8
Lexington Ave - 59th St - N R W Line	1	5	7	-	-	13
Lexington Ave - 59th St - 4 5 6 6 Express	1	5	7	-	-	13
Lexington Ave - 63rd St	1	1	4	-	-	6
Liberty Ave	-	-	2	-	-	2
Livonia Ave	-	4	-	-	-	4
Long Island City - Court Sq	1	-	3	-	3	7
Longwood Ave	1	-	2	-	-	3
Lorimer St - L Line	1	1	3	-	-	5
Lorimer St - J M Line	1	1	2	-	-	4
Lower East Side - 2nd Ave	1	-	3	-	-	4
Marble Hill - 225th St	1	-	3	1	-	5
Marcy Ave	1	1	11	-	1	14
Metropolitan Ave	1	-	3	-	-	4
Mets - Willets Point	-	-	1	1	-	2
Middle Village - Metropolitan Ave	-	-	3	-	-	3
Middletown Rd	-	-	2	-	-	2
Montrose Ave	1	-	1	-	-	2
Morgan Ave	1	-	1	-	-	2
Morris Park	-	-	-	-	-	0
Morrison Av - Soundview	-	-	3	-	1	4
Mosholu Pkwy	1	-	7	-	-	8
Mt Eden Ave	1	-	1	-	-	2
Myrtle - Wyckoff Aves - L Line	1	1	6	-	-	8
Myrtle - Wyckoff Aves - M Line	1	1	6	-	-	8
Myrtle Ave	1	2	4	-	-	7
Myrtle-Willoughby Aves	1	-	1	-	-	2
Nassau Ave	1	-	3	-	-	4
Neck Rd	-	-	-	-	-	0
Neptune Ave	-	-	1	-	-	1
Nereid Ave (238 St)	-	-	6	-	-	6
Nevins St	1	3	8	-	-	12
New Dorp	-	-	3	-	-	3
New Lots Ave - 3 4 Line	-	2	3	-	-	5
New Lots Ave - L Line	-	-	1	-	-	1
New Utrecht Ave	-	1	1	-	-	2
Newkirk Ave - B Q Line	-	1	1	-	-	2
Newkirk Ave - 2 5 Line	-	1	3	-	-	4
Northern Blvd	1	1	2	-	-	4
Norwood - 205th St	-	-	5	-	-	5
Norwood Ave	-	-	1	-	-	1
Nostrand Ave - A C Line	1	1	3	7	-	12
Nostrand Ave - 2 3 4 Line	1	2	2	-	-	5
Oakwood Heights	-	-	1	-	-	1
Ocean Pkwy	-	-	1	-	-	1
Old Town	-	-	-	-	-	0

Ozone Park - Lefferts Blvd	-	-	3	-	-	3
Park Pl - S Train	1	-	4	-	-	5
Park Pl - 2 3 Train	1	6	26	-	-	33
Parkchester	-	-	7	-	-	7
Parkside Ave	1	-	2	-	-	3
Parsons Blvd	-	1	10	-	-	11
Pelham Bay Park	-	-	9	-	-	9
Pelham Pkwy - 5 Line	-	-	3	-	-	3
Pelham Pkwy - 2 5 Line	-	-	9	-	-	9
Pennsylvania Ave	-	-	2	-	-	2
Pleasant Plains	-	-	2	-	-	2
President St	1	1	1	-	-	3
Prince St	1	1	3	-	-	5
Prince's Bay	-	-	3	-	-	3
Prospect Ave - 2 5 Line	1	1	3	-	-	5
Prospect Ave - D N R Line	1	1	2	-	-	4
Prospect Park	1	2	4	-	-	7
Queens Plz	1	5	9	-	-	15
Queensboro Plz	1	5	10	-	-	16
Ralph Ave	-	-	2	-	-	2
Rector St - N R W Line	1	2	7	-	-	10
Rector St - 1 Line	1	2	7	-	-	10
Richmond Valley	-	-	1	-	-	1
Rockaway Ave - A C Line	-	-	3	-	-	3
Rockaway Ave - 3 4 Line	-	-	1	-	-	1
Rockaway Blvd	-	-	8	-	-	8
Rockaway Park - Beach 116 St	-	-	4	-	1	5
Roosevelt Island - Main St	1	-	3	1	1	6
Saratoga Ave	-	-	1	-	-	1
Seneca Ave	1	-	3	-	-	4
Sheepshead Bay	-	1	3	-	-	4
Shepherd Ave	-	-	-	-	-	0
Simpson St	1	1	7	-	-	9
Smith - 9th Sts	1	1	2	-	-	4
South Ferry	1	3	15	-	1	20
Spring St - A C E Line	1	1	4	-	-	6
Spring St - 4 6 6 Express	1	1	-	-	-	2
St Lawrence Ave	-	-	2	-	-	2
St. George	-	-	22	-	1	23
Stapleton	-	-	8	-	-	8
Steinway St	1	1	3	-	-	5
Sterling St	1	1	3	-	-	5
Sutphin Blvd	-	-	6	-	-	6
Sutphin Blvd - Archer Av	-	1	18	11	-	30
Sutter Ave	-	-	1	-	-	1
Sutter Ave - Rutland Road	-	-	2	-	-	2
Times Sq - 42nd St - N R Q W Line	1	10	77	-	-	88
Times Sq - 42nd St - S Line	1	10	77	-	-	88
Times Sq - 42nd St - 1 2 3 Line	1	10	77	-	-	88
Times Sq - 42nd St - 7 7 Express	1	10	77	-	-	88
Tompkinsville	-	-	16	-	-	16
Tottenville	-	-	1	-	-	1
Tremont Ave	1	-	4	-	-	5
Union Sq - 14th St - 4 5 6 6 Express	1	7	9	-	-	17

Union Sq - 14th St - N Q R W Line	1	7	9	-	-	17
Union Sq - 14th St - L Line	1	7	9	-	-	17
Union St	1	2	2	-	-	5
Utica Ave	1	1	3	-	-	5
Van Cortlandt Park - 242nd St	-	-	5	-	-	5
Van Siclen Ave - J Z Line	-	-	1	-	-	1
Van Siclen Ave - A C Line	-	-	-	-	-	0
Van Siclen Ave - 3 4 Line	-	-	-	-	-	0
Vernon Blvd - Jackson Ave	1	-	4	3	3	11
W 4th St - Washington Sq (Lower)	1	8	4	-	-	13
W 4th St - Washington Sq (Upper)	1	8	4	-	-	13
W 8th St - NY Aquarium	-	-	2	-	-	2
Wakefield - 241st St	-	-	6	1	-	7
Wall St - 4 5 Line	1	3	10	-	-	14
Wall St - 2 3 Line	1	3	13	-	1	18
West Farms Sq - E Tremont Av	-	-	4	-	-	4
Westchester Sq - E Tremont Ave	-	-	8	-	-	8
Whitehall St	1	3	15	-	-	19
Whitlock Ave	1	-	3	-	-	4
Wilson Ave	1	-	-	-	-	1
Winthrop St	-	1	2	-	-	3
Woodhaven Blvd	-	1	6	-	-	7
Woodhaven Blvd - Queens Mall	-	-	13	-	-	13
Woodlawn	-	-	6	-	-	6
Woodside - 61st St	1	-	4	9	-	14
World Trade Center	1	6	26	-	-	33
York St	1	-	3	-	1	5
Zerega Ave	-	-	1	-	-	1
33rd Street - PATH	1	13	3	33	-	50
23rd Street - PATH	1	3	3	-	-	7
14th Street - PATH	1	7	3	-	-	11
9th Street - PATH	1	10	2	-	-	13
Christopher Street - PATH	1	3	2	-	-	6
World Trade Center - PATH	1	14	1	-	-	16
Hoboken Terminal	1	1	9	10	-	21
Newport	1	1	3	3	-	8
Exchange Place	1	1	4	3	-	9
Grove Street	1	1	4	-	-	6
Journal Square Transportation Center	1	1	14	-	-	16
Harrison	-	-	1	-	-	1
Newark Penn Station	-	-	29	16	-	45
Total	322	734	2784	331	30	4201

Table U: Transit Connections by Rapid Rail Station in Philadelphia

Station Name	Bikeshare	Rapid Rail	Bus	Other Rail	Total
11th Street	1	-	13	12	26
12-13th & Locust	1	1	2	-	4
13th Street	1	-	16	5	22
15-16th & Locust	1	2	2	13	18
15th Street	1	1	14	18	34
2nd Street	1	-	6	-	7
30th Street	1	-	19	29	49
34th Street	1	-	5	-	6
40th Street	1	-	4	5	10
46th Street	1	-	2	-	3

52nd Street	1	-	2	-	3
56th Street	-	-	2	-	2
5th Street/Independence Hall	1	-	5	-	6
60th Street	-	-	2	-	2
63rd Street	-	-	2	-	2
69th Street Transportation Center	-	-	18	3	21
8th Street	1	2	25	-	28
9-10th & Locust	1	-	2	-	3
Allegheny (Broad)	-	-	2	-	2
Allegheny (Market)	-	-	3	-	3
Arrott Transportation Center	-	-	7	-	7
Ashland	-	-	-	-	0
Berks	1	-	1	-	2
Broadway	-	1	8	2	11
Cecil B. Moore	1	-	3	-	4
Chinatown	1	-	14	-	15
Church	-	-	2	-	2
City Hall	-	-	2	-	2
Collingswood	-	-	1	-	1
Ellsworth-Federal	1	-	2	-	3
Erie	-	1	6	-	7
Erie-Torresdale	-	-	2	-	2
Fairmount	1	-	3	-	4
Fern Rock Transportation Center	-	1	4	4	9
Ferry Avenue	-	-	1	-	1
Frankford Transportation Center	-	-	17	1	18
Girard (Broad)	1	1	2	1	5
Girard (Market)	1	-	2	1	4
Haddonfield	-	-	3	-	3
Hunting Park	-	-	4	-	4
Huntingdon	-	-	3	-	3
Lindenwold	-	-	3	1	4
Logan	-	-	2	-	2
Lombard-South	1	-	4	-	5
Millibourne	-	-	-	-	0
North Philadelphia	-	1	3	6	10
NRG	1	-	2	-	3
Olney Transportation Center	-	1	9	-	10
Oregon	1	-	5	-	6
Race-Vine	-	-	11	-	11
Snyder	1	-	3	-	4
Somerset	-	-	2	-	2
Spring Garden (Broad)	1	-	3	-	4
Spring Garden (Market)	1	-	2	-	3
Susquehanna-Dauphin	1	-	3	-	4
Tasker-Morris	1	-	2	-	3
Tioga	-	-	2	-	2
Walnut-Locust	1	1	9	-	11
Westmount	-	-	2	-	2
Woodcrest	-	-	-	-	0
Wyoming	-	-	1	1	2
York-Dauphin	-	-	3	-	3
Total	30	12	289	102	433

Table V: Transit Connections by Rapid Rail Station in San Francisco

Station Name	Bikeshare	Rapid Rail	Bus	Other Rail	Ferry	Total
12th Street Oakland City Center	1	2	23	-	-	26
16th Street Mission	1	3	4	4	-	12
19th Street Oakland	1	2	16	-	-	19
24th Street Mission	1	3	7	1	-	12
Antioch	-	-	15	-	-	15
Ashby	1	1	6	-	-	8
Balboa Park	1	3	13	3	-	20
Bay Fair	-	2	8	-	-	10
Downtown Berkeley	1	1	13	-	-	15
Berryessa/North San José	-	1	5	-	-	6
Castro Valley	-	-	3	-	-	3
Civic Center/UN Plaza	1	3	19	11	-	34
Coliseum	-	3	10	1	-	14
Colma	-	1	8	-	-	9
Concord	1	-	18	-	-	19
Daly City	-	3	12	-	-	16
Dublin/Pleasanton	-	-	15	-	-	15
El Cerrito del Norte	-	1	17	-	-	18
El Cerrito Plaza	-	1	10	-	-	11
Embarcadero	1	3	32	16	11	63
Fremont	-	1	10	-	-	11
Fruitvale	1	2	15	-	-	18
Glen Park	1	3	6	1	-	11
Hayward	-	1	14	-	-	15
Lafayette	-	-	1	-	-	1
Lake Merritt	1	2	4	-	-	7
MacArthur	1	2	6	-	-	9
Millbrae	-	1	9	6	-	16
Milpitas	-	1	9	1	-	11
Montgomery Street	1	3	47	17	-	68
North Berekeley	1	1	8	-	-	10
North Concord/Martinez	-	-	4	-	-	4
Oakland International Airport	-	-	3	-	-	3
Orinda	-	-	2	-	-	2
Pittsburg/Bay Point	-	-	14	-	-	14
Pittsburg Center	-	-	1	-	-	1
Pleasant Hill/Contra Costa Centre	-	-	10	-	-	10
Powell Street	1	3	16	15	-	35
Richmond	-	1	7	3	-	11
Rockridge	1	-	6	-	-	7
San Bruno	-	1	5	-	-	6
San Francisco International Airport	-	5	5	1	-	11
San Leandro	-	2	8	-	-	10
South Hayward	-	1	5	-	-	6
South San Francisco	-	1	10	-	-	11
Union City	-	1	18	-	-	19
Walnut Creek	-	-	13	-	-	13
Warm Springs/South Fremont	-	1	3	-	-	4
West Dublin/Pleasanton	-	-	4	-	-	4
West Oakland	1	3	7	-	-	11
Total	19	69	524	81	11	704

Table W: Transit Connections by Rapid Rail Station in Toronto

Station Name	Bikeshare	Rapid Rail	Bus	Other Rail	Total
Finch	-	-	36	-	36
North York Centre	-	-	2	-	2
Sheppard-Yonge	-	1	14	-	15
York Mills	-	-	18	-	18
Lawrence	1	-	7	-	8
Eglinton	1	-	12	-	13

Davisville	1	-	5	-	6
St. Clair	1	-	4	2	7
Summerhill	1	-	2	-	3
Rosedale	1	-	3	-	4
Bloor-Yonge	1	1	3	-	5
Wellesley	1	-	3	-	4
College	1	-	2	2	5
Dundas	1	-	2	1	4
Queen	1	-	2	2	5
King	1	-	2	4	7
Union	1	-	17	21	39
St. Andrew	1	-	-	3	4
Osgoode	1	-	-	2	3
St. Patrick	1	-	-	1	2
Queen's Park	1	-	1	2	4
Museum	1	-	2	-	3
St. George	1	1	2	-	4
Spadina	1	1	2	2	6
Dupont	1	-	2	-	3
St. Clair West	1	-	6	1	8
Eglinton West	-	-	5	-	5
Glencairn	-	-	1	-	1
Lawrence West	-	-	6	-	6
Yorkdale	-	-	14	-	14
Wilson	-	-	12	-	12
Sheppard West	-	-	11	-	11
Downsview Park	-	-	7	-	7
Finch West	1	-	7	-	8
York University	1	-	4	-	5
Pioneer Village	-	-	16	-	16
Highway 407	-	-	13	-	13
Vaughan	-	-	7	-	7
Kipling	-	-	28	1	29
Islington	-	-	7	-	7
Royal York	-	-	5	-	5
Old Mill	-	-	2	-	2
Jane	1	-	6	-	7
Runnymede	1	-	4	-	5
High Park	1	-	3	-	4
Keele	1	-	8	-	9
Dundas West	1	-	4	5	10
Lansdowne	1	-	3	-	4
Dufferin	1	-	5	-	6
Ossington	1	-	5	-	6
Christie	1	-	2	-	3
Bathurst	1	-	3	-	5
Bay	1	-	2	-	3
Sherbourne	1	-	2	-	3
Castle Frank	1	-	4	-	5
Broadview	1	-	6	3	10
Chester	1	-	1	-	2
Pape	1	-	6	-	7
Donlands	1	-	3	-	4
Greenwood	1	-	2	-	3
Coxwell	1	-	5	-	6
Woodbine	1	-	4	-	5
Main Street	1	-	8	2	11
Victoria Park	1	-	6	-	7
Warden	-	-	10	-	10
Kennedy	-	-	17	2	19
Bayview	-	-	3	-	3
Bessarion	-	-	2	-	2
Leslie	-	-	3	-	3
Don Mills	-	-	13	-	13
Total	46	4	434	57	541

Table X: Transit Connections by Rapid Rail Station in Vancouver

Station Name	Bikeshare	Rapid Rail	Bus	Other Rail	Ferry	Total
Waterfront	1	-	3	11	1	16
Burrard	1	-	9	2	-	12
Granville	1	-	19	8	-	28
Stadium-Chinatown	1	-	8	3	-	12
Main Street-Science World	1	-	4	5	-	10
Commercial-Broadway	1	-	5	1	-	7
Nanaimo	-	-	1	1	-	2
29th Avenue	-	-	3	1	-	4
Joyce-Collingwood	-	-	4	1	-	5
Patterson	-	-	1	-	-	1
Metrotown	-	-	12	1	-	13
Royal Oak	-	-	1	-	-	1
Edmonds	-	-	7	-	-	7
22nd Street	-	-	9	-	-	9
New Westminster	-	-	8	-	-	8
Columbia	-	1	4	-	-	5
Scott Road	-	-	7	-	-	7
Gateway	-	-	3	-	-	3
Surrey Central	-	-	21	-	-	21
King George	-	-	9	-	-	9
Sapperton	-	-	1	-	-	1
Braid	-	-	7	-	-	7
Lougheed Town Centre	-	-	11	1	-	12
Production Way-University	-	-	4	1	-	5
Total	6	1	161	36	1	205

Table Y: Transit Connections by Rapid Rail Station in Washington

Station Name	Bikeshare	Rapid Rail	Bus	Other Rail	Total
Pentagon	-	-	60	1	61
Silver Spring	1	-	41	1	43
Farragut North	1	-	28	3	32
Union Station	1	-	14	16	31
Shady Grove	1	-	23	-	24
King Street - Old Town	1	-	12	9	22
Archives	1	1	20	-	22
Rockville	1	-	18	2	21
Metro Center	1	1	17	2	21
L'Enfant Plaza	1	2	14	4	21
Wheaton	1	-	19	-	20
Anacostia	1	-	17	-	18
Columbia Heights	1	1	15	-	17
Friendship Heights	1	-	15	-	16
Takoma	1	-	15	-	16
Southern Avenue	1	-	15	-	16
Greenbelt	1	1	12	1	15
Fort Totten	1	2	11	-	14
Pentagon City	1	-	12	1	14
Tenleytown-AU	1	-	12	-	13
Rhode Island Avenue-Brentwood	1	-	12	-	13
Glenmont	-	-	13	-	13
College Park - University of Maryland	-	1	11	1	13
Dupont Circle	1	-	11	-	12
Braddock Road	1	1	10	-	12
Prince's George's Plaza	1	1	10	-	12
Brookland-CUA	1	-	10	-	11
Huntington	-	-	11	-	11
Crystal City	1	-	8	2	11
Bethesda	1	-	9	-	10

Gallery Place	1	2	7	-	10
Naylor Road	-	-	10	-	10
North Bethesda	1	-	8	-	9
Medical Center	1	-	8	-	9
Georgia Avenue - Petworth	1	1	7	-	9
West Hyattsville	1	1	7	-	9
Congress Heights	1	-	8	-	9
Navy Yard - Ballpark	1	-	8	-	9
Waterfront	1	-	8	-	9
Twinbrook	1	-	7	-	8
Cleveland Park	1	-	7	-	8
Forest Glen	-	-	8	-	8
U Street	1	1	6	-	8
Suitland	-	-	7	-	7
Van Ness-UDC	1	-	5	-	6
Shaw- Howard University	1	1	4	-	6
Branch Avenue	-	-	6	-	6
Grosvenor-Strathmore	-	-	5	-	5
Woodley Park	1	-	4	-	5
Mount Vernon Square	1	1	3	-	5
NoMA-Gallaudet U	1	-	3	-	4
Eisenhower Avenue	1	-	3	-	4
Ronald Reagan Washington National Airport	1	-	1	1	3
Judiciary Square	1	-	1	-	2
Total	45	18	636	44	743

Table Z: Municipalities by 2021 Population

Municipality	Principal City	2021 Population
Decatur	Atlanta	24,334
Chamblee	Atlanta	29,894
Dunwoody	Atlanta	51,103
Brookhaven	Atlanta	54,902
Sandy Springs	Atlanta	108,080
Atlanta	Atlanta	492,204
Total	Atlanta	760,517
Lochearn	Baltimore	26,995
Owings Mill	Baltimore	35,170
Baltimore	Baltimore	592,211
Total	Baltimore	654,376
Braintree	Boston	38,172
Medford	Boston	60,708
Revere	Boston	60,720
Malden	Boston	65,602
Somerville	Boston	80,608
Quincy	Boston	100,544
Cambridge	Boston	116,892
Boston	Boston	672,814
Total	Boston	1,196,060
Rosemont	Chicago	4,027
Forest Park	Chicago	14,297
Wilmette	Chicago	27,895
Oak Park	Chicago	54,100
Skokie	Chicago	67,444
Evanston	Chicago	78,454
Cicero	Chicago	84,905
Chicago	Chicago	2,742,119
Total	Chicago	3,073,241
Cleveland	Cleveland	374,861
Total	Cleveland	374,861

Los Angeles	Los Angeles	3,902,440
Total	Los Angeles	3,902,440
South Miami	Miami	11,997
Opa-locka	Miami	16,310
Glenvar Heights	Miami	17,237
Golden Glades	Miami	33,930
Coral Gables	Miami	49,269
Kendall	Miami	78,007
Hialeah	Miami	224,362
Miami	Miami	440,807
Total	Miami	871,919
Longueuil	Montreal	254,483
Laval	Montreal	438,366
Montreal	Montreal	1,762,949
Total	Montreal	2,455,798
Harrison	New York City	18,824
Hoboken	New York City	59,369
Jersey City	New York City	287,146
Newark	New York City	306,247
New York City	New York City	8,736,047
Total	New York City	9,407,633
Millbourne	Philadelphia	1,154
Haddonfield	Philadelphia	12,383
Collingswood	Philadelphia	14,087
Haddon Township	Philadelphia	15,243
Lindenwold	Philadelphia	21,048
Voorhees Township	Philadelphia	30,864
Camden	Philadelphia	72,381
Cherry Hill	Philadelphia	74,203
Upper Darby	Philadelphia	84,986
Philadelphia	Philadelphia	1,596,865
Total	Philadelphia	1,923,214
Colma	San Francisco	1,353
Orinda	San Francisco	19,497
Millbrae	San Francisco	23,083
Lafayette	San Francisco	25,384
El Cerrito	San Francisco	25,898
San Bruno	San Francisco	43,775
South San Francisco	San Francisco	66,331
Castro Valley	San Francisco	66,324
Walnut Creek	San Francisco	69,876
Union City	San Francisco	70,828
Dublin	San Francisco	69,818
Pittsburg	San Francisco	75,701
Pleasanton	San Francisco	79,558
Milpitas	San Francisco	79,593
San Leandro	San Francisco	91,176
Daly City	San Francisco	104,914
Antioch	San Francisco	114,750
Richmond	San Francisco	115,677
Berkeley	San Francisco	119,607
Concord	San Francisco	125,769
Hayward	San Francisco	162,254
Fremont	San Francisco	231,502
Oakland	San Francisco	437,548
San Francisco	San Francisco	865,933
San Jose	San Francisco	1,013,337
Total	San Francisco	4,099,486
Vaughan	Toronto	323,103

Toronto	Toronto	2,794,356
Total	Toronto	3,117,459
New Westminister	Vancouver	78,916
Burnaby	Vancouver	249,125
Surrey	Vancouver	568,322
Vancouver	Vancouver	662,248
Total	Vancouver	1,558,611
Derwood	Washington	1,700
Forest Glen	Washington	6,942
Hillcrest Heights	Washington	17,090
Glenmont	Washington	15,795
Hyattsville	Washington	20,790
Huntington	Washington	13,979
Greenbelt	Washington	24,602
Suitland	Washington	26,375
College Park	Washington	34,961
North Bethesda	Washington	50,695
Wheaton	Washington	51,836
Rockville	Washington	67,095
Bethesda	Washington	66,294
Silver Spring	Washington	82,472
Alexandria	Washington	158,185
Arlington	Washington	235,764
Washington	Washington	683,154
Total	Washington	1,557,729

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