A COMPARATIVE ANALYSIS OF SUBWAY SYSTEMS AND COMMUTER RAILS IN THREE MAJOR WORLD CITIES: PARIS, NEW YORK AND SEOUL

By

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Table of Contents

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Glossary of Acronyms

ADA: Americans with Disabilities Act
BMT: Brooklyn-Manhattan Transit Corporation
BRT: Brooklyn Rapid Transit Company
CCTV: Closed Circuit Television
CMP: Compagnie du Chemin de Fer Metropolitain de Paris
CPTED: Crime Prevention Through Environmental Design
GPSR: Groupement de Protection et de Securite des Reseaux
IND: Independent Rapid Transit Railroad
IRT: Interborough Rapid Transit Company
KORAIL: Korea Railroad Corporation
KPI: Key Performance Indicators
KSCC: Korea Smart Card Company
LIRR: Long Island Rail Road
LCD: Liquid Crystal Display
LED: Light Emitting Diode
MDBF: Mean Distance Between Failure
METEOR: Metro Est-Ouest Rapide
MMTOA: Metropolitan Mass Transportation Operating Assistance Tax
MTA: Metropolitan Transit Authority
MTAPD: Metropolitan Transit Authority Police Department
NFC: Near Field Communication
NYPD: New York Police Department
NYCTP: New York City Transit Police
OTP: On-Time Performance
PSD: Platform Screen Door
RATP: Régie Autonome des Transports Parisiens
RER: Réseau Express Regional
SDRPT: Sous-direction Regionale de la Police des Transports
SMG: Seoul Metropolitan Government
SMRT: Seoul Metropolitan Rapid Transit
SNCF: Société Nationale des Chemins de Fer Français
STIF: Syndicat des transports d'Île-de-France
USCTC: l'Unité de Coordination de la Sécurité dans les Transports en Commun
VT: Versement Transport (Metropolitan Transport Tax)
WA: Wait Assessment

Introduction

Cities are dynamic and interconnected entities where public transportation has, over the past century, become an indispensable factor for their functioning and organization. The various modes of public transport – which include buses, light rails, rapid transits, commuter rails, and ferries – facilitate urban mobility for both city dwellers and for working populations that commute from outer towns or suburbs.

The Case Studies

This study focuses on the subway systems and commuter rails of three major world cities: Paris, New York, and Seoul. Each of the cities is located on a different continent and pertains to a distinctive era of urban development. These settings are colloquially referred to as the Old Continent, the New World and the Tiger Economies. The Paris Metro, opened in 1900, is the oldest; it was closely followed by the inauguration of the New York City Subway in 1904, which became by far the United States' largest underground system. The Seoul *Jihachul* (□□□), on the other hand, was constructed seventy years later and began its service in 1974. Each system is also characterized by a unique ridership culture and is part of the world's top ten busiest subway systems (metrobits.org). As noted by their high percentages of annual ridership and rider dependency, these systems are essential for commuters. Because of the particular cultural, geographic and historical settings from which the systems arose, Paris, New York and Seoul act as a representative sample of public transport in the developed world.

Emerging Challenges for Public Transportation

In recent years, urban transit systems have been met with a new set of requirements. The environmental dangers of climate change have become a major source of global concern. Developing the sustainability of urban transport systems and decreasing the reliance on automobiles have therefore gained a more prevalent part in planning agendas. Developing efficient and sustainable public transportation, however, requires substantial investments in infrastructure, and modes and operations which depend on high ridership to guarantee a return on investment. Public transportation relies on economies of scale (i.e. the revenue from increased ridership will reduce operational costs) in order to break even. The main obstacle to reaching these economies of scale lies with public transit's main competitor: the automobile.

To this day, the automobile continues to be the transport mode of choice in both developed and developing cities. Automobiles are responsible for traffic congestion and parking difficulties, as well as contributing to gas emissions within cities. In 2001, 89% of urban movements in the USA were made by automobile; additionally, in 2006, the International Energy Agency found that approximately 30% of the country's greenhouse gas emissions stemmed from the transport sector (IEA, 2006). Therefore, fossil fuel-burning vehicles have been responsible for a large amount of the USA's CO_2 emissions (Buehler, 2011). In France, 67% of employed Parisian residents and 61% of regional working commuters living in the greater Paris region – known as Ile-de-France – were recorded as using public transportation to get to work in 2011 (Calvier and Jacquesson, 2015). However, the 2014 yearly TomTom study still recorded as much as 65% congestion in the capital during peak hours and 35% congestion during off peak hours (Tomtom, 2014). Thus, while public transportation is a popular option in Paris, many commuters still greatly depend on automobiles for their movements. In addition while car use may represent only 12.5% of trips in the core area of the capital, 90% of trips in the peripheral areas are still made with the automobile (Stantec, 2011). "In Ile-de-France, nearly 80% of suburb-to-suburb journeys are currently made by car, due to the lack of any satisfactory alternatives. When travelling by RER or metro, passengers often find they have to go via Paris. Over 8.5 million Ile-de France residents have to deal with this" (Société du Grand Paris). Congestion issues in the intramural part of the city are mainly caused by incoming suburbanites.

Aside from walking and bicycling, public transportation is the most energy efficient form of urban mobility; its increased use would help reduce overall greenhouse gas emissions as well as develop a city's sustainability. However, frequent automobile users are not likely to abandon the comfort and convenience of their vehicles. The preference for and predominance of automobiles in developed and newly developed cities are associated with social, cultural and economic values. Although most New Yorkers and Parisians take public transportation for home-work commutes, its use for other activities is much lower. While a great cultural dependency on the automobile exists in France, it is much more pronounced in the USA, where the car culture became predominant immediately after World War II (Veitch, 1994). Although declining slightly with the millennial generation (Rosenthal, 2013), automobiles have, since then, been socially ingrained as a sign of personal freedom (Morgan, 1959); in most US states a provisional license can be acquired as early as 16 years of age.

South Korea experienced the emergence of its middle-class decades after France and the US. Following the Western experience, the ownership of private cars automatically became a universal sign of affluence. As a result,

> By the 1990s, the automobile had gone from being a luxury scarcely obtainable by the upper middle class to a household necessity for the entire middle class. [...] the combination of overcapacity and falling sales of automobiles abroad caused the automobile manufacturers – Hyundai, Kia and Daewoo – to market their cars at home. There, a tremendous latent demand coupled with enough disposable income created an explosion of automobile… (Robinson, 2007)

As per-capita incomes rose from $311 in 1970 to $12,531 in 2002, an increase of 4,000% in just 30 years, vehicle ownership became more affordable (Pucher et al., 2005). In the 1990s, this evolution led to a significant rise in private transportation which continued in the early 2000s with vehicle ownership rising annually by 5% in ten consecutive years (Stantec, 2011). As car ownership increased so did congestion and air pollution. Today, 20% of the country's total population resides in the capital, making Seoul's density twice that of New York City. The trend fuelled in the 1990s is even more relevant today as 67% of the Korean population is middle-class; this number represents 7.65 million out of the 11.4 million households in the country (Cho, 2015). Vehicle ownership and usage in the capital is therefore high and has led the Seoul Metropolitan Government to implement more or less successful policies towards reducing congestion, such as congestion pricing schemes through the use of tolls (Hwang and Son, 1997).

Barter applied the concept known as path dependency to urban transport development (Barter, 2004); his theory demonstrated that cities develop by following a determined path on which they set themselves. A city's past decisions in urban development lock it on a specific path of development from which it is very difficult to stray. Changing paths would only be possible if a city, or society, exerts strong political, economic or public will. All cities that emerged before the industrial revolution begin as walking cities. The chosen paths lead to three possible outcomes: automobile-dependent, transit-oriented or hybrid cities. To various degrees, all three of the cities studied in this project can be defined as hybrid cities as road development has occurred more rapidly than urban transit development. The cities are saturated with automobiles and buses yet still rely on public transport. These cities may diverge either to greater automobile dependency or, through a reduction in vehicle ownership and use, to greater transit reliance (Barter, 2004 and Rodrigue, 2013). Automobile dependency remains a constraint that restricts a city's ability to change paths and develop more efficient transport systems. However possibilities for change exist; for example, the recent fluctuations in gas prices, especially in the US, have generated uncertainties in regards to the automobile's future. By finding ways of diverging towards the transit-oriented path, cities could "limit the adverse effects of urban sprawl, automobile congestion, [and] energy use…" (Gershon, 2005).

To increase ridership and efficiency, a city's public transport must meet another requirement; that is, the needs of today's evolving urban populations. Since the 2008 financial crisis, the middle classes as an income group in developed countries have been under stress and even on a relative decline (Erickson, 2014). This middle class is regarded as the "swing-users" of public transport, using both cars and public transport to travel. They are not part of the "captive market" (Rodrigue, 2006) such as the lower or poor classes who rely solely on public transit for their movements, or part of the upper classes who can afford the constant use of private vehicles. Paradoxically, the decline of the middle classes calls for more affordable, efficient and user-friendly transportation for the general public, which would increase ridership and, in turn, increase revenue and profitability.

The Approach

The few comparative studies in the current literature highlight improvements and innovative characteristics in each city they study, but rarely analyze the same factors across multiple cities. Furthermore, according to Gershon, (2005) poorly managed systems are inaccessible, unreliable, unsafe, and expensive. This study will therefore provide a multi-city assessment of the four main factors that are crucial to efficient public transport: reliability, safety, accessibility, and affordability (Gershon, 2005). Focusing on subway and commuter rails, affordability comprises the quality of services compared to the cost of ridership. It analyzes the source of funding as well as the type of fare collection and fare policy for each system. Safety is the analysis of passengers' sense of fear and security while using the transit system (e.g. waiting on platforms and within train compartments). The feeling of safety will vary according to the system's overall maintenance and cleanliness as well as to the passenger's gender. Accessibility refers to the ease of access to, and availability of, stations particularly for the elderly and for people with disabilities. It also analyzes the information provided to passengers and the ease of transfers with other means of public transportation (e.g. bus system, tramway, etc.) Finally, reliability encompasses train punctuality, the recurrence of delays and disruptions, and the impact these may have on commuter itineraries.

The main question is to what extent does the user's perspective, as well as the system's performance, vary between the major transit systems of Paris, New York, and Seoul, particularly in terms of affordability, safety, accessibility, and reliability? Analyzing these factors will enable a more thorough comparison of the subway and commuter rails of these major metropolitan areas. Assessing the systems side by side will help better understand each one's various strengths and shortcomings as well as highlight areas for possible improvement. This study will try to determine how the four studied interdependent factors act as the new global standards for efficient mass transit. Determining how to improve the ridership experience might be a step towards inciting populations to reduce automobile use and help achieve greater sustainability in cities. This outcome is desirable and has been part of the sustainability discourse for decades; however, aspects such as social preferences and irrational policy-making have contributed to locking cities in their paths of development. A substantial shift will be necessary in order to achieve a more ideal level of urban transport.

Methodology

To gather information on, and get a better understanding of, rider expectations and experiences, a survey was conducted in each city. It evaluated riders' opinions and assessment of their systems. The survey was translated from English into both French and Korean (all three may be found in the Appendices). In New York, surveys were administered on-site, to passengers in subway cars and train stations. Due to travel constraints, the Seoul and Paris surveys were administered online through my personal social networks. The sampling demographic for Paris and Seoul was therefore biased towards students and young adults in the workforce within the lower income range. Still, these constitute some of the main users of public transport (Neff and Pham, 2007). In the case of New York City, the sampling was more random.

Each surveyed rider ranked the cleanliness, affordability, punctuality, accessibility and safety of his or her subway system and commuter rail on a scale of 1 to 5, 5 being the best.

The surveys, as a whole, provided data on how the passengers experience their own city's system as well as aspects that they believe to be lacking. The survey results are used as a means of comparison. A few issues should be noted. First, the Seoul survey is shorter than those of Paris and New York because the *Jihachul* services both the inner and outer city as part of the same system. In Paris and New York, however, there is a distinction between the subway system and the commuter, or suburban, rails. Secondly, it should also be noted that the results may vary from one population to the next for cultural reasons; the population's expectations and opinions of government financed public facilities may vary. All survey results have been compiled in Appendix 1.

Part1: History of the Transit Systems of Paris, New York and Seoul

Paris

During the Second French Empire (1852-1870), it became evident that Paris required an organized transit system to accommodate the city's developments. Following London's model, the state and various private companies vouched, as early as 1845, for rail lines that would interconnect with existing provincial stations. The city, however, was against such plans. Although over a dozen proposals were made between 1856 and 1890, none were put into effect. By the end of the 19th century, Paris had become one of the world's largest cities with over 80,000 people per square kilometer (Big, Bigger, Biggest, NatGeoChannel, 2011), making the project a dire necessity. It was only in 1895, with the 1900 Universal Exposition imminent, that Paris won a legal fight against the state allowing the city to build a municipal, intramural rail system that would serve the local interests of its population. Because there was no space above ground, the population's urban movements would be eased through a metro system with a station on almost every block.

In 1899, the Compagnie du Chemin de Fer Metropolitain de Paris (CMP) was created to design and construct the system. At the head of the planning process was engineer Fulgence Bienvenue to whom the city owed innovative strategies. Paris lies at the bottom of a valley through which the river Seine flows. The river extends underground and is surrounded by soil made of viscous mud. This, along with Paris' underground limestone quarries and catacombs, was a real challenge to the system's construction. Two massive underground stations, St. Michel and Cité, were built on the banks of the Seine. If the workers dug the treacherous soil, it would automatically collapse on itself; so, Bienvenue used the soil's sliminess as an advantage rather than an obstacle. A huge steel skeleton, sealed on the sides so as to be waterproof, was set up in the middle of St. Michel square. Workers, in a sealed chamber at the bottom of the steel structure, dug out the soil and sunk the station into the ground before anchoring it down with concrete and installing the tracks and platforms (Big, Bigger, Biggest, NatGeoChannel, 2011). In only 20 months, the Paris Metropolitain's first line was built between Porte Maillot and Porte de Vincennes. It discretely opened for business on July 19, 1900. Ten trains consisting of three cars each ran every 10 minutes during peak hours. While most Parisians were unaware of the system's opening, within a few days, traffic increased so much that trains had to run more frequently.

The Metro was an electrically powered system with 2.40 meter cars that did not allow outside trains to use its tracks. The aim was to guarantee the Metro's control by the city and its independence from private ownership. While trains began to run on the first line, construction was simultaneously being done on the second and third lines which opened in December 1900 and 1904, respectively. These three lines became the base of the metro's network. Between 1904 and 1910, lines were constructed, extended, and opened so that the network had a total of six lines (amtuir.org).

During the same time, a company created in 1902, la Compagnie du Chemin de Fer Electrique Souterrain Nord-Sud de Paris, began constructing three new rail lines, line A, B, and C. As opposed to the city-owned CMP, the Nord-Sud was a private corporation that wished to develop deeper-entrenched subway routes like those of the London Underground. This proved to be impossible because of the nature of Paris's soil; instead, the three lines created by the Nord-Sud, distinguished themselves from their CMP rival through esthetic and artfully built stations. The power supply on these rails also differed from the CMP's third rail system with both an aerial arrival line and a third rail power exit. Line A opened in 1910 while line B began servicing in 1913 (line C was never officially put in operation). Connections between the CMP and the Nord-Sud lines were free for riders but the Nord-Sub owed the city a 1 to 2 cent royalty on each ticket sold (amtuir.org).

Viewing the Nord-Sud as a threat, the CMP opened lines 7 and 8 before WWI began. During the war period, the Metropolitain sustained damage, but planning and construction was only momentarily suspended. Soon after service was completely restored, the first of many labor strikes took place. In January 1919, workers demanded higher wages. After negotiations were made, the Metro saw its first fare hike. The following decade was marked by the opening of lines 9 and 10.

In the early 1930s, the city's internal population was stagnant while the suburban population had more than tripled in the previous three decades, increasing from 956,000 in 1901 to 2,062,000 in 1931. It became necessary to extend the Metro to the capital's outlying neighborhoods, which were slowly becoming Parisian districts. Preexisting lines were extended but, on December 31 1931, the construction costs for lines A and B became too much to bear for the Nord-Sud. The company was taken over by the CMP which integrated the former's lines to its own – lines A and B, became lines 12 and 13 respectively. The CMP completed construction of line C shortly after, which ultimately became an extension of line 13.

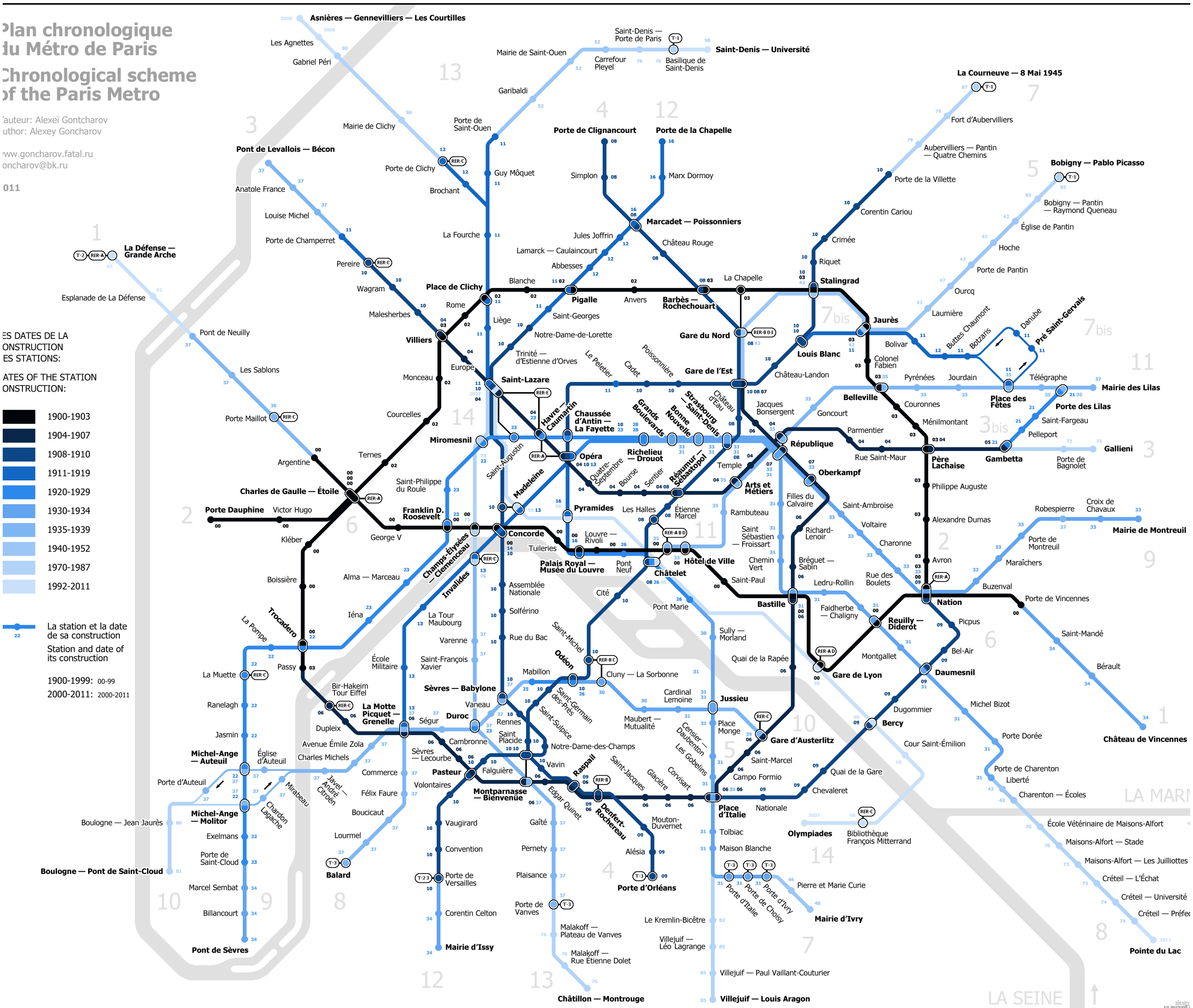
Most lines were extended at the extremities during the next decade, further expanding the network. By 1940, World War II and the occupation weakened the Metropolitain. Coal was hard to come by, making electrical power scarce; to reduce consumption, a number of stations were closed, lighting was reduced and escalators were put out of use. The underground stations and tunnels were frequently used as shelters from air raids. However, aerial shellings often caused much damage to both. It was not until after the war, in March 1945, that the system began running fully again. The first year after the Liberation was one of the busiest for the Metro, accommodating over 1.598 million riders (amtuir.org).

On January 1st 1949, the CMP and the city's bus system were combined under the state-owned Régie Autonome des Transports Parisiens (RATP) which oversaw operations for both. The future of public transportation was looking grim; as automobile usage began to grow, many believed that public transportation would become obsolete. The Metro's network stayed at the level it had been since 1952 and no additions were made until the 1970s. However, during that period, stations were renovated and pneumatic, rubber-tired trains were developed, improving adhesion and lessening noise pollution (Simanaitis, 1994). Four lines have been fitted with pneumatic trains since their invention – these mainly include elevated lines passing near homes (amtuir.org).

As the use of the automobile resulted in high congestion levels in the early 1970s, the metro was pulled out of its slump and ridership increased. The next decade was marked by many line extensions and the appearance of the long awaited Réseau Express Regional (RER). New patterns of traffic that could not be alleviated by the metro appeared as the city limits spread to include its former suburbs. The RATP and the Société Nationale des Chemins de Fer Français (SNCF), France's public rail company that managed passenger and freight transport across the country, began constructing the RER lines A and B as regional commuter lines. Started in 1962, construction would last over 30 years and result in the creation of five commuter lines; however, sections were first opened in 1969.

In the late 1990s, the RER A reached overcapacity. In order to alleviate congestion, the RATP and the SNCF quarreled over the construction of either a new metro or a new RER line. The city decided to adopt both plans. The RER E, "Eole," opened between 1999 and 2003, while the RATP's project, "METEOR" (Metro Est-Ouest Rapide), which became the Metro's fourteenth line, opened in 1998 and was finalized in 2007. Applying innovative concepts, it was the first entirely automatic line which was also designed with glass barriers on the platforms.

Figure 1.1: Chronological Development of the Paris Metropolitain



Source: Alexey Goncharov, 2011

Today, the Metropolitain has moved from serving local redidents to providing services at a larger regional level, i.e. Ile-de-France (Gleyze, 2007). It boasts one of the most accessible systems; a Parisian is said to never be more than 500 meters from a metro stop (Simanaitis, 1994). With its 300 standard and transfer stations, the system's 16 independent lines (14 main and 2 alternative lines) spread across 217 kilometers, and serviced 1,527 million riders in 2013 (OMNIL, 2013). With its 242 stations and 5 independent lines covering 605 km, the RER services 1,205 million passengers to and from the capital each year (OMNIL, 2013). According to Barter's theory of path dependency, Paris's development points to a hybrid city. Initially, high density levels in Paris geared the city towards promoting public mobility through transit. The arrival of automobiles created a conundrum that divided Paris into two path dependencies: a central transit area supported by the Metro, and an outer Ile-de-France area utilizing the RER but mostly dominated by car use. The RER was built to connect outer towns to the capital, providing a source of transportation which then spurred greater urban development around its lines. Therefore, while still facing high automobile congestion, Parisians' extensive use of public transportation sets the capital apart as a truly hybrid city. Higher efficiency, reliability and affordability could help shift the capital towards a transit-oriented path.

New York City

New York City's first subway car was conceived using a drastically different mechanism than that known today. While the elevated railways began servicing the city in 1868 to relieve high road congestion (Ascher, 2005), inventor Alfred E. Beach thought of a way to move people under the city's streets without using steam engines, based on the idea of the London Underground. He drilled a tunnel under Broadway that extended from Warren Street to Murray Street, the distance of one block, and engineered a 12 passenger stagecoach that moved using fan driven pneumatic pressure (mta.info, Asher, 2005, nycsubway.org). However, due to a lack of political support and funding, the demonstration tunnel operated only between 1870 and 1873 before being shut down. The city's elevated lines became overcrowded as the immigrant population kept pouring into the city. In 1894, New Yorkers voted to use public funds to construct a city-owned, but privately built and operated, subway system.

It was engineer William B. Parsons who, after visiting Europe, finally designed the premise of the New York City subway system. He favored an electrically powered system over the coal-fired engines of the elevated lines. Massive coal-fired power plants distributed electrical power to the trains through a third-rail system (Malcolm, 2006). Funded by financier August Belmont, the Rapid Transit Construction Company built a 20.5 mile system mostly using the cut-and-cover method which consisted in digging trenches along the sFtreets deep enough for stations and tracks. Once in place, they were covered up. In a display of public-private partnership, the Interborough Rapid Transit Company (IRT) opened its doors on October 27 1904, providing transportation for 150,000 people. The rail line traveled 9.1 miles from City Hall to 145th Street and stopped at 26 stations. This line is the basis of today's 4, 5, and 6 interconnected lines. The IRT extended to the Bronx in 1905 through the Harlem River Tunnel, to Atlantic Ave. in Brooklyn in 1908 and to Queens in 1915 through the Steinway tunnel (mta.info, nycsubway.org).

To speed up construction, the city adopted the “Dual Contracts” agreement, which split the network’s expansion between the IRT and the Brooklyn Rapid Transit Company (BRT), another private company that owned Brooklyn’s elevated lines. By 1915, the BRT provided services between Brooklyn and Manhattan and reached new areas in Queens. On the other hand, the IRT developed lines that connected to its original network in order to maintain a monopoly in Manhattan. Some lines, however, were serviced by both companies such as the Astoria line. Working simultaneously allowed for the development of a more widespread network (New York Transit museum). After declaring bankruptcy in 1918, the BRT became the Brooklyn-Manhattan Transit Corporation (BMT) (New York Transit museum).

In 1932, with a push by NYC mayor, John Hylan, who believed transit should not be dominated by private firms, the Independent Rapid Transit Railroad (IND) became the first city-run subway service. It opened with a new Eighth Avenue line; its subsequent ones were named following a letter code. The fast and efficient IND ran many elevated trains out of business in Manhattan, Brooklyn, and the Bronx. For eight years, New York City’s subway system was owned and managed by three different companies. Since its opening, the system’s fares had not increased even though operating costs exceeded passenger fares during the 1930s. It was politically difficult to hike fares in fear of public outcry, and it became impossible after the impact of the Great Depression. The IRT and BMT were running at a loss (New York Transit museum).

In 1940, “with the private lines on the verge of bankruptcy, the city purchased both the IRT and BMT and became the sole operator of all subway and elevated lines within city limits” (Ascher, 2005). The city, however, was also in great debt and could not sustain its subway system for long; therefore, in 1953, New York stepped in by creating the New York City Transit Authority “as a separate public corporation to manage and operate all city-owned bus, trolleys, and subway routes” (mta.info). For the next fifteen years, the NYC Transit Authority still operated in deficit while public funds were used for developing easier automobile access to the city. In 1968, New York Governor, Nelson Rockefeller, pushed for the combination of the Triborough Bridge and Tunnel Authority with the NYC Transit Authority. Their merging allowed for tolls to subsidize the subway’s operational and capital costs. Although opposition was high within the suburban commuting population, it was largely believed that private car use and its urban cost “should help pay for the comparatively clean public transit systems” (New York Transit museum). Under the newly created Metropolitan Transit Authority (MTA), bridges, tunnels, commuter rails and city transits all pooled from the same funds (New York Transit museum). In 1979, the subway lines were color coded as they are today so as to unify the system and tie together trains that run along the same lines (Ascher, 2005).

Figure 1.2: NYC Subway Map

Source: MTA, 2015

Today, the New York City Subway counts 6,325 subway cars that carry 5.5 million people daily across 660 miles of track running along 21 interconnected lines (some local and others express) and stopping at 460 stations, the most among the world's subway systems. 1.708 billion passengers are serviced annually (mta.info). Most significantly, the NYC Subway is one of the few systems in the world to provide services 24/7.

Figure 1.3: Long Island Rail Road Map

Source: MTA, 2015

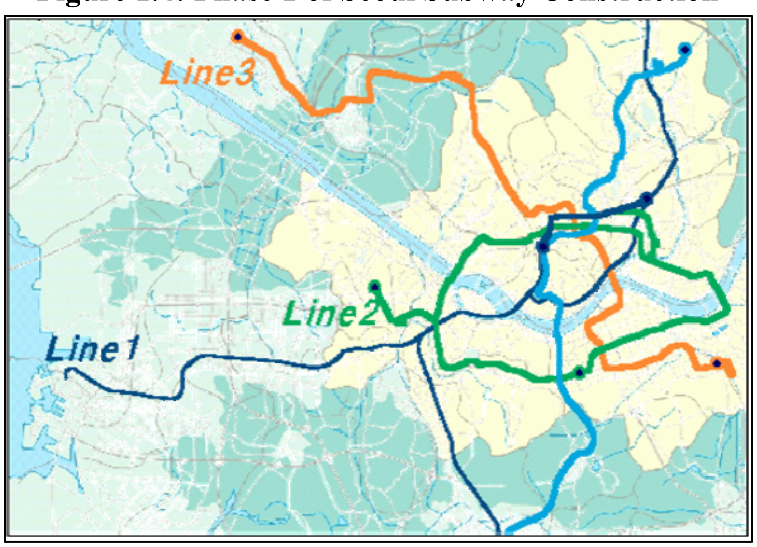
Although New York counts multiple commuter rails – the Long Island Railroad (LIRR), the New Jersey Transit, and Metro North – this project will focus on the LIRR as it is the busiest railroad in North America. Opened in 1834, it is the oldest railroad to operate under its original name. A subsidiary of the MTA, the LIRR provides service across Long Island through 700 miles of track divided among 11 branches that cross 124 stations located in Manhattan, Queens, Brooklyn, Nassau and Suffolk. Each week day, it transports an average of 282,400 riders, approximately 81 million passengers a year. Two thirds of all trains either originate or terminate at Penn Station, and all but one branch passes through Jamaica Station, the transfer hub. Seven lines are powered by an electrical third rail, while four are diesel powered. The LIRR operates 24/7; train availabilities vary according to time and destination (mta.info).

High density areas, as seen in the core region of Paris, tend to become more hybrid. According to Barter's theory, Manhattan shares many of the characteristics of the Parisian core, making it a more transit-oriented area. As the distance grows from the city center however, the suburban area shows greater signs of automobile dependency. Indeed, while the LIRR had first prompted the development of the Long Island suburbs around its lines, the transit-oriented development model came to a standstill in the 1950s. The greater urban sprawl on the Island was caused by the arrival of, and dependence on, the automobile. This combination makes New York a hybrid city.

Seoul

In the 1960s South Korea's central government was pushing for industrialization and modernization. As the country began experiencing economic growth, the rural population migrated in waves towards the capital searching for employment and economic opportunities. The surge in population density prompted the need for an organized means of public transport in the capital. In 1970, President Park ChungHee pressed for the establishment of a subway system to relieve the city's growing congestion. With support from a Japanese loan, the Seoul municipality initiated construction of the first subway line in 1971. Line 1 opened in 1974 followed by line 2, a loop line, in 1984 and lines 3 and 4 in 1985(Kim, 2014). This first set of lines, functioning with overhead current, was operated by the Seoul Metropolitan Subway Corporation, a public corporation owned by the city – it was re-named Seoul Metro in 2005. By the late 1980s the rail system had already become the major mode of public transport, and ridership rates had reached the system's capacity (Kim, 2014). As in Paris, suburbanization caused population growth to stagnate in central Seoul and increase in the outer metropolitan area (Kim and Rim, 2000). In 1996-1997, the capital counted 22.9% (10.3 million) of the national population and, on average, 2.3 million vehicles a day on the streets.

Figure 1.4: Phase 1 of Seoul Subway Construction

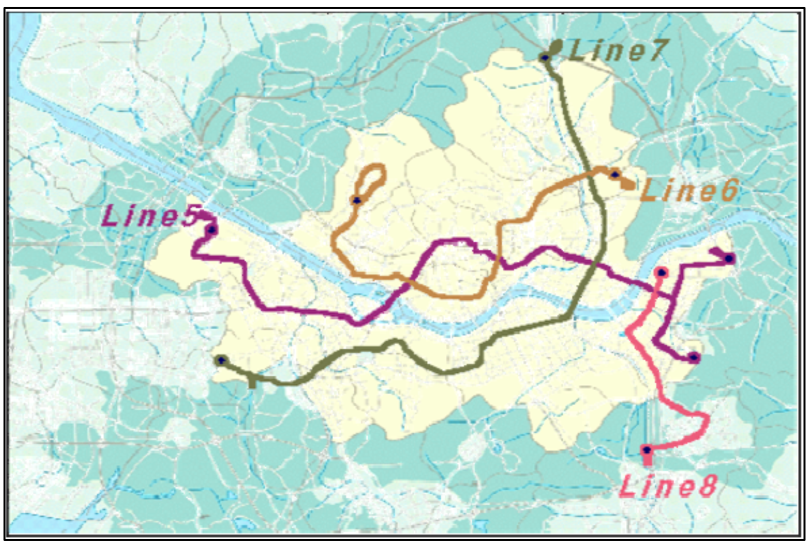


Source: Experiences in Seoul Subway Development, In-Keun Lee 2004

In an effort to reduce vehicle congestion, the Seoul Metropolitan Government expanded roads and facilities and constructed new expressways. This proved to be in vain as "the 10-fold increase in cars […] overwhelmed the progress" (Kim and Rim, 2000). Between, 1980 and 1990 the average vehicle speed decreased from 30km/h to 16.4km/h (Kim and Rim, 2000). The SMG introduced policies to promote public transport and decrease private vehicle use. While the SMG made plans to construct additional lines, the huge financial deficit caused by the construction of the first phase slowed further extensions.

In order to develop a second phase in the subway's network, the city secured the central government's support (Kim and Rim, 2014). Four additional lines were built; construction on lines 5, 7, and 8 began in 1990. Line 5 was the first to pass under the Han River – previous lines had used bridges. The construction of line 6 began four years later. That same year, it was announced that a new public corporation, separate from the Seoul Metro, would operate the second phase of the network. The Seoul Metropolitan Rapid Transit (SMRT) was officially established on March 15 1994. The East-West line 5 opened fully in 1996. By that year, subway usage accounted for 35% of the city's urban modal split (Kim and Rim, 2000). In 1999 line 8 opened, followed by lines 7 and 6 in 2000 (smrt.co.kr).

Figure 1.5: Phase 2 of Seoul Subway Construction



Source: Experiences in Seoul Subway Development, In-Keun Lee 2004

Since 2000, the private sector has become involved in what was once an exclusively government operated system. A ninth line, the first to be privately run in Korea, opened in 2009 and was operated by Seoul Metro Line9 Corporation. KORAIL (Korea Railroad Corporation) also runs five routes (Bundang, Suin, Gyeongchun, Gyeongui–Jungang and AREX, the Airport Railroad) within the metropolitan area, thus incorporating suburban rail networks in Greater Seoul, as well as connecting the capital with its 27 satellite cities. Other lines operated by private companies include the Everline, the ULine, Shinbundang line and Incheon line 1. While most of these lines, like the RER in Paris, service both the inner and outer city by connecting Seoul to many of its satellite cities, they differ greatly in one way: the SMG has succeeded in integrating all lines, except for AREX, to its system, even though the regional lines consist of many different investors and operators. It is done in such a way that a rider will not see any apparent difference between the city's metro system and the privately operated lines aside from basic aesthetics and the difference between underground and surface rails (Baker, 2012). Line extensions are in the process of development for the next five years so as to construct a wider rail network in the city's metropolitan and surrounding area. These lines are under government concession. Private companies build, operate and manage the projects; upon completion, ownership is transferred to the government but the private operator is given the right to manage and maintain the lines as well as receive between 60 and 90% of estimated revenues (Stantec, 2011).

The Seoul Subway system is composed of nine lines that carry seven million passengers on a daily basis across 327km of railway and services 260 stations (metrobits.org). As opposed to Paris and New York, Seoul started out as an automobile dependent city. The sharp increase in density and road saturation called for the development of public transit services. Therefore, according to Barter's theory of path dependency, the development of both allowed Seoul to become a hybrid city. The quality of the capital's existing system shows promises towards shifting paths to a transit-oriented city.

Figure 1.6: Evolution of Path Dependencies for Paris, New York and Seoul

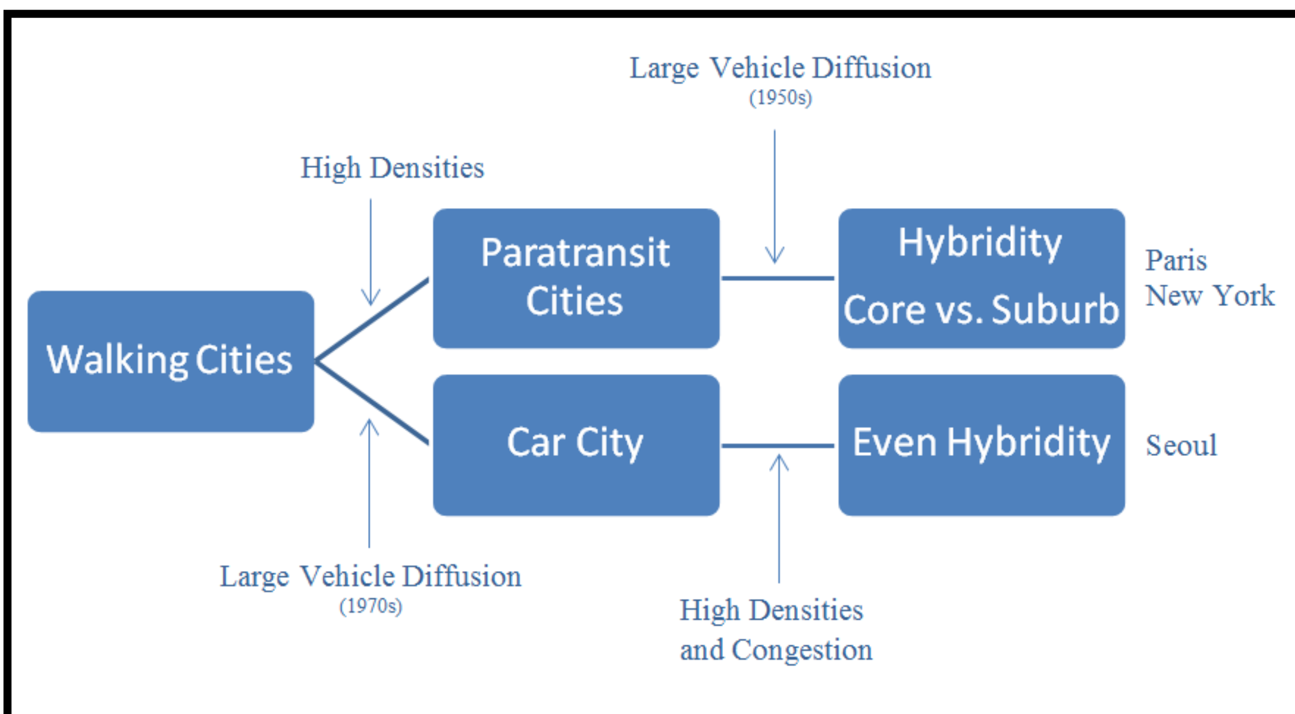


Figure 1.7: Paris, New York, and Seoul - Comparative Data

	Paris		New York		Seoul
	Le Metro	Le RER	The Subway	The LIRR	Jihachul
Rail Length	217 km	605 km	660 miles	700 miles	327 km
Number of Lines	16	5	21	11	9
Line Type	Independent	Independent	Partially Interconnected	Branch	Independent
Number of Stations	300	242	460	124	260
Daily Passengers	4.18 million	3.3 million	5.5 million	282,400	8.4 million
Annual Passengers	1.527 billion	1.205 billion	1.708 billion	81 million	3 billion
Hours of operation	5:30am-1:14am (weekdays) 5:30am-2:15 (weekends)	Varies per line but between 4:50am-1:20am	24/7	24/7	5:30am-1am
Service Type	Scheduled	Scheduled	Scheduled	Scheduled	Scheduled

Source: metrobits.org/Pucher et al., 2005/Oh,2013

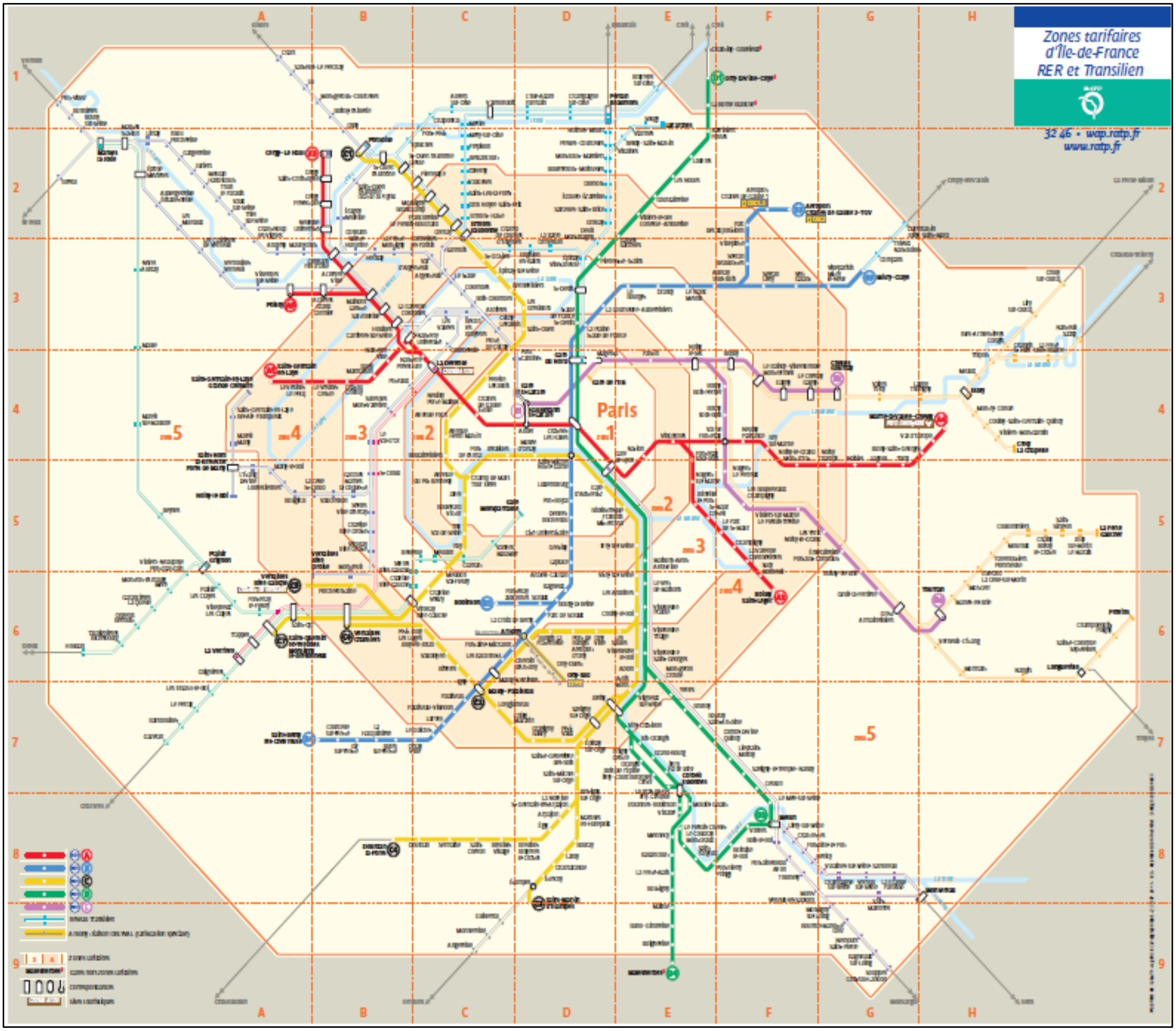
Part 2: Fare Systems

Ridership on rail systems, be they subways or commuter rails, is affected by cost. Historically, ridership usually declines when fares increase. For example, subway ridership dropped 5.2% in New York City after the 1975 fare hike (Gershon, 2005). To be attractive, a transit system must be affordable or financially accessible to the public; most of all, the population must feel that it is receiving its money's worth, i.e. a positive price-quality ratio. The concept of affordable public transportation does not solely rely on fare recovery measured against the GDP per capita, it also requires stable and sustainable funding policies. However, since most transit systems are publicly owned, it is not rare for them to become financial burdens to the city or the state. Cost recovery from fare income has been falling especially in regards to North American and European metro systems. After the economic crisis of the past decade, stable and dependable funding, which is required for long-term planning for investment, has become harder to obtain (Anderson et al., 2011). The growing concerns over budgetary deficits have led transport authorities to approach the issue through various policies which may or may not affect the affordability of transportation as a public service. The issue of cost is all the more relevant because "as income inequality grows in urban areas, fare affordability is becoming a more relevant and more complex metric" (Perrotta, 2013). This chapter analyzes each city's type of fare collection and policy as well as other sources of funding, and will assess the impact on its commuters.

Paris

Paris's fare system is divided into five zones. Zone 1 encompasses all metros as well as RER stops that are within the city center. Zones 2 to 5 are shaped as concentric rings around the inner part of the capital and are located within the Ile-de-France area. The system relies on a variety of different payment methods which can often appear confusing. The first is the *Ticket t+* which has, since January 1 2015, a flat price of $1.95 (1.80€). A block of 10 tickets is set at $15.47 (14.10€). This ticket only allows transfers between metros and RERs inside of Paris (i.e. zone 1). In order to travel on the RER lines outside of zone 1, passengers must buy the second ticket. The *Ticket Origine/Destination*, is used if the trip originates or terminates in one of the outer zones (2 through 5). These fares are distance and zone-based. There exists no easy access to any information that would explain the methods of fare measurement for these tickets. The lowest possible fare – between two neighboring RER stations – is $2.07 (1.90€) while the highest can exceed $12.34 (11.35€).

Figure 2.1: Paris Fare Zones



Source: RATP, 2015

Paris's system uses not only tickets for fare collection but also a variety of smart cards. The number of pass cards is extensive and is used to subsidize the mobility of various groups of people, from students and seniors to welfare recipients. For example, a 50% discounts is offered to children between the ages of 4 and 10, to families with many children, to seniors citizens over 60 years old, to certain cases of welfare recipients, and to people with a recognized disability (STIF Guide Tarifaire, 2015). The RATP fare structure is thus reflective of an extensive welfare policy.

The Navigo Card, however, launched in 2001 is accessible to all daily riders. In 2014, it was equipped with a micro-processing chip that allows passengers to use all Metro and RER lines within the purchased zones. During the weekend, cards are dezoned, allowing riders to travel for free on any mode of transportation regardless of the distance. The new improvements allow the card to charge the user for any trips made outside of the card's specified zones during the week. These cards are organized as weekly, monthly or yearly plans that allow the passenger to ride as often as he or she wants within the selected zones (STIF Guide Tarifaire, 2015).

Figure 2.2: Plans according to zones for the Navigo Card

Zones	Weekly (€)	Monthly (€)	Yearly (€)
1-2	21.25	70.00	731.50
1-3	27.15	89.20	927.30
1-4	32.95	107.80	1,125.30
1-5	35.40	116.50	1,204.50
2-3	19.80	65.10	676.50
2-4	25.10	82.50	856.90
2-5	29.00	95.50	993.30
3-4	19.00	62.80	654.50
3-5	23.15	76.40	795.30
4-5	18.45	60.70	634.70

Source: STIF Guide Tarifaire des Tranports Ile de-France, 2015

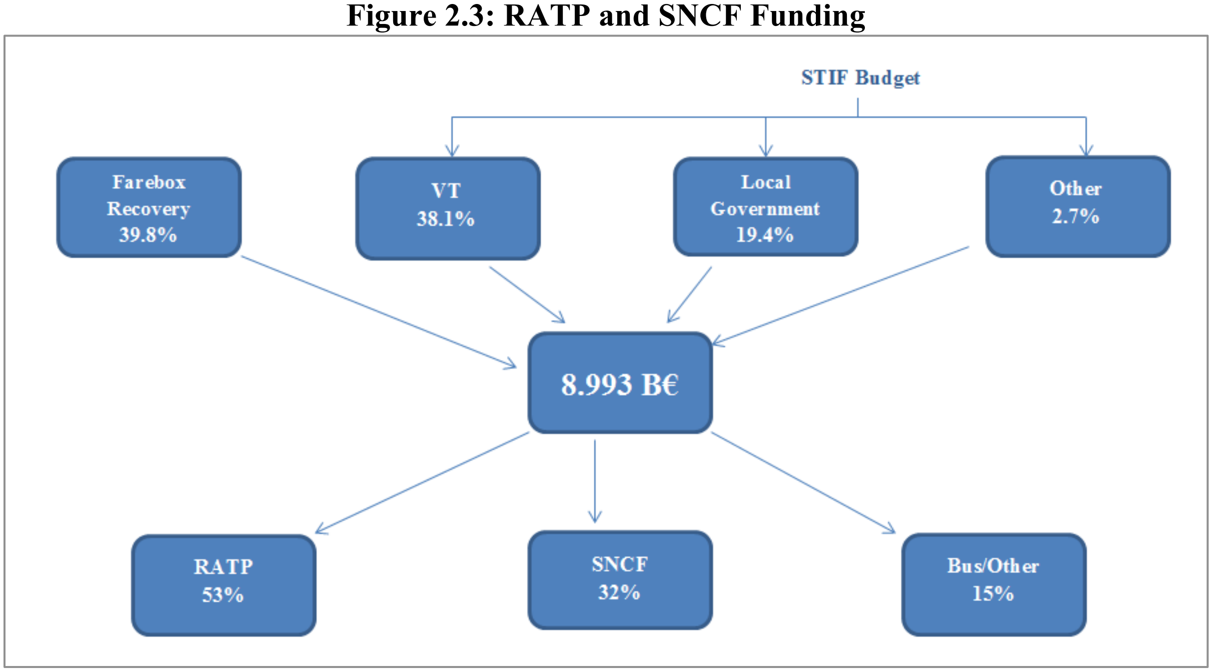
If a person lives in zone 5 but works in zone 1, he or she will have to pay a minimum of \$1,309.72 (1,204.50€) a year to use public transportation; this represents more than one month of minimum wage income which was set at \$1,235.22 (1,135.99€) on January 1st 2015. Still, according to French Labor laws, companies of 10 or more employees are required to subsidize 50% of their employee's transportation costs (Code du Travail, 2009), making transit costs part of the social charge a corporation must assume.

In the survey conducted for this project and compiled in Appendix 1, Parisians graded their metro's affordability at 2.49 out of 5, while the RER was given a 2.01. Users complained that the service-to-price ratio is highly imbalanced. The price to travel between zones 1 and 5 is exorbitant and the supplementary charge for out-of-zone trips with a card incites people to commit fare fraud instead of paying. A surveyee said: “I pay a zone 4-5 plan but am still charged an additional 7.50€ to go into Paris? This is absurd!” Although given only half a grade higher, the metro was commented as being far more affordable.

Fares are set by the Syndicat des transports d'Île-de-France (STIF), the transport authority which coordinates activities from different transport companies that operate in Île-de-France, namely the RATP and the SNCF. The STIF “is responsible for managing public transit budgets and finances, which include co-financing improvement with the region” (Stantec, 2011). The RATP owns the rails while the STIF owns the cars and maintenance facilities. The STIF finances all of the development costs and splits maintenance costs on existing lines with the RATP. The STIF funds the RATP according to a 4-year plan but both share commercial risks (RATP Rapport d’Activité, 2013).

In 2013, the system’s budget (which is illustrated in Figure 2.3) amounted to a total of $9.778 billion (8.993 billion €). The farebox recovery for the entire system was 39.8% ($2.971billion /2.733 billion €) that year. The STIF’s budget, which does not receive fare income, is funded by the metropolitan transport tax (VT). This tax, also known as the Employer’s tax, is paid by companies of nine or more employees, and is based on “a yearly aggregate of their salaries” (National Strategies on Public Transit Policy Framework, 2011). The VT represents over a third (38.1%) of total revenue and is fundamental because the national government plays a very limited role in operating funding. Another 19.4% of the revenue encompasses the local government budget; and the final 2.7% stems from advertising, fines and various other sales (STIF Rapport d’Activité, 2013). The RATP receives 53% of the STIF’s budget and the SNCF, which owns two thirds of the RER lines, receives 32% of the budget.

Figure 2.3: RATP and SNCF Funding



Source: STIF Rapport d’Activité, 2013

The RATP is, like almost every public transit system operator in the world, highly indebted. Its debt comes from investment rates exceeding its farebox revenue and subsidies. This imbalance started as early as 1980 with the development of the RER lines; at the time, the debt slightly exceeded 1 billion € then. In 1990, the creation of line 14 in the Metropolitain added another billion euros to the deficit. Since 1998, this deficit has been slowly rising. In 2009, revenue reached $967 million (890 million €) through farebox recovery and subsidies but investments hit $1.354 billion (1.246 billion €). It is estimated that if the RATP's spending pattern does not shift, it will be facing a deficit of $8.698 billion (8 billion €) by 2020. The transit operator has had a history of disregarding profitability in its investment decisions as shortcomings are usually covered by the government; fiscal discipline is not upheld. Moreover, this deficit did not originate from the inability to cover operational costs but by the desire to increase supply and improve the existing system (Cours des Comptes, 2009).

This deficit is all the more important as Paris begun a new project: La Société du Grand Paris. The Grand Paris is a development project designed to improve residents' quality of life, and address regional inequalities by extending services to the Greater Paris region (JLL, 2014). Between 2019 and 2030, it plans to spend $13 billion (12 billion €) on the modernization of the RER lines and various other extensions. Another $24.5 billion (22.6 billion €) will be spent on the Grand Paris Express which will develop 205km of automatic metro line by extending lines 11 and 14 and by constructing four new lines (from 15 to 18) that would cater to more suburban areas of Paris. These developments would relieve the existing RER lines and help mitigate congestion and urban sprawl. Funding for this project will come from four different sources. Tax revenues will contribute to the largest share of the project's budget. The tax on office premises, the special facilities tax and the tax on network businesses are providing $543 million (500 million €) to the project every year. If needed, the state will allocate a maximum of 1 billion euros as of 2015. Local governments will provide $244 million (225 million €). Finally the Societe du Grand Paris will rely on loans that it expects to repay through farebox revenue and other taxes (JLL, 2014).

The funding system put in place for Paris' transit is reflective of the political and cultural state of French society. The applied fare system is close to a social experiment as mobility is subsidized according to a social contract.

New York

Since its opening in 1904, the New York City subway has operated under a flat fare system. In 1904, a paper ticket for a ride cost 5 cents. This price was maintained up until 1948 as the risk of financial solvency was preferred over public outcry. However, maintaining and operating the subway was a financial burden that necessitated a first fare hike in 1948; it was doubled to 10 cents. In 1953, the dime was replaced by the first token. The Y token paid for a 15 cent ride since turnstiles could not accept both a dime and a nickel. Through the years, new tokens were introduced for every fare hike. These hikes are compiled on Figure 2.4.

Figure 2.4: History of fare hikes in New York City

Year	Fare (Inflation Adjusted Fare)	Fare Collection System
1904-1948	5 cents ($1.19)	Paper Ticket
1948	10 cents ($0.98)	1st fare hike
1953	15 cents ($1.33)	Y Token
1966	20 cents ($1.46)	Aqueduct Token
1970	30 cents ($1.83)	Quarter-Sized-Cut-Out Token
1972	35 cents ($1.98)	
1976	50 cents ($2.07)	1979-1980 Diamond Jubilee Token
1981	75 cents ($1.95)	Quarter-Sized Solid Token
1984	90 cents ($ 2.05)	
1986	$1.00 ($2.15)	Bull's-Eye Token
1990	$1.15 ($2.08)	1988 Archer Avenue Token
1992	$1.25 ($2.10)	
1995	$1.50 ($2.32)	Last Token
1997	$1.50 ($2.21)	Metrocard system wide
2003	$2.00 ($2.57)	
2009	$2.25 ($2.89)	
2010	$2.50 ($2.71)	
2013	$2.50 base fare ($2.53)	$2.75 single ride metro card ticket ($2.79)
2015	$2.75	$3.00 single ride metro card ticket

Source: New York Transit Museum. Note: The price in parenthesis is inflation adjusted in 2015 dollars

In 1997, the Metrocard, an electronic fare card, was introduced to the entire system. The magnetic strip in the card is encoded and subtracts the cost of a ride from the remaining value on the card. The introduction of the card allowed for free bus-to-subway transfers (mta.info). As of March 2015, the base fare for the NYC subway system is $2.75. A single ride ticket was raised to $3.00; this ticket must be used within the next 2 hours and does not allow transfers between transport modes. Purchasing a new Metrocard costs $1.00 and gives riders the incentive to refill their card rather than get a new one for every ride. Once the card expires, a rider can exchange his or her card at a vendor for no fee. "MTA produces nearly 160 million MetroCards each year at an annual cost of $10 million. Many of these cards are used once and then discarded, often ending up as litter in the system. By refilling and reusing your current MetroCard, you avoid the new $1.00 "new card fee," reduce MTA expenses and help the environment" (mta.info). The card fee also acts a new means of extracting revenue from riders.

The MTA suggests that passengers that ride less than 13 times a week use the Pay-per-Ride option, which allows riders to save 11%. The 7-day unlimited Metrocard is worth $31.00

and the monthly, or 30-Day unlimited Metrocard, is worth $116.50. Both can reduce the price of a ride to $1.55 if used at least 20 times in the week. The EasyPay Xpress allows a Metrocard to be automatically refilled through a debit or credit card. A rider's account can be viewed online and no money is lost if the card is lost or stolen.

The LIRR fare system, similar to that of Ile-de France, works according to zones. There are eight zones which start from Manhattan and extend out to Eastern Long Island. Fares increase based on the distance of travel and number of zones crossed. Fares are also differentiated between Peak and Off-Peak hours. Peak hours are between 6 and 10am for westbound trains and 4 to 8pm for eastbound trains, as commuters flow towards the city and back from work. If tickets are purchased on board rather than at vending machines in the station, an additional $5.75 to $6.50 fee is added. Off peak tickets offer 27% savings while weekly tickets save a rider on average 30% and monthly tickets save approximately 50%. This having been said, a commuter traveling only through three zones will pay over $250 for a monthly ticket, and a passenger that crosses all eight zones pays $485 a month which represents an average of $5,820 per year (mta.info).

According to the survey (which was administered prior to the Spring 2015 fare hike), New Yorkers found the subway somewhat affordable with an overall grade of 3.07 out of 5. On the other hand, the LIRR received an average of 1.92 in affordability (the worst grade attributed in this survey). Indeed, using the LIRR for commutes represents a notable expense in a family's budget. This expense, however, is compensated by higher rents in more central areas, as opposed to those in the suburbs of Long Island. The LIRR is therefore part of a cost trade-off.

The farebox revenue comprises 41% of the MTA's total revenue; the rest is divided between toll revenue (12%), dedicated taxes such as the Metropolitan Mass Transportation Operating Assistance Tax (MMTOA), the gasoline tax, and the real estate tax revenue (36%), state and local subsidies (7%), and other revenue – which come from advertising sales, retail and telecommunication (4%) (MTA Financial Plan, 2014).

The numerous fare hikes that New Yorkers have witnessed are understandable from a financial perspective. Budgetary deficits in New York became more pronounced after the 2008 economic crisis because subsidies were linked to real estate or sales tax (Anderson et al., 2011). While the MTA's expenditures rose rapidly between 2003 and 2008 because of increasing debt services and higher fringe benefits, they decreased the two subsequent years due to frozen wages and budget costs. The MTA's budget has since been able to recover from the recession. In order to finance its previous capital improvements, the MTA has depended on issuing additional debt. With the advent of the 2015-2019 capital program, "the amount of MTA debt outstanding is expected to exceed $39 billion by 2018, more than twice the 2003 level" (Bleiwas, 2014). This proposed capital program amounts to $32.1 billion. Among other projects, $23.5 billion will be used to maintain and modernize the existing subway, bus and commuter rails, $2.8 billion will be allocated for the creation of the East Side Access, which will be the first LIRR line to terminate at Grand Central station. Finally, $1.5 billion with be put towards Phase 2 of the Second Avenue Subway.

The New York Capital Program Review Board rejected the capital program, resulting in a $15.2 billion funding gap. New York City is anticipated to contribute an increased 25% funding while New York State will not participate at all. Therefore, “the MTA will have to work closely with its funding partners to ensure that its capital needs are adequately funded without putting the financial burden on riders” (Bleiwas, 2014). The funding gap will be filled through cost reduction programs and additional loans. However, each $1 billion borrowed would translate in a 1% fare and toll increase even though past cost-reduction programs have allowed the 2015 and 2017 planned fare hikes to be lowered from 7.5% to 4 %. These numbers align with Anderson, Findlay and Graham’s study (2011) in which they affirm that older metros spend approximately 35% of operating costs on renewals and enhancements.

The NYC subway’s reliance on flat fare is questionable; a flat fare system can dissuade users from taking the subway for short trips and encourages long movements which are less profitable per user (Rodrigue, 2006). Fares can end up being cheaper for long journeys or during peak hours or expensive for off-peak hours. The Anderson, Findlay, and Graham study also found that flat fares “reduced a metro’s revenue potential and can increase the need to invest in additional capacity” (2011).

Seoul

Before 2004, Seoul’s transport system underwent a funding crisis. Complex train transfers led to an increase in automobile usage creating bottlenecks and congestion which, in turn, led to decreased bus ridership due to constant lateness. Government subsidies were being used to cover the financial loss this incurred (Oh, 2013). These were added to the already cumulated construction debt which had reached $6 billion in 2003, representing a grand total of 80% of the city’s entire debt. Farebox revenue accounted for 75% of operating costs while the remaining 25% came from city government subsidies. “Financing both construction costs and operating deficits […] put an enormous financial burden on the city” (Pucher et al., 2005). This financial pressure and the necessity to find cost-effective alternatives to metro expansion led to the 2004 Public Transport Reforms.

The Public Transport Reforms included an update in fare structure and ticketing systems (Pucher et al., 2005). The newly applied policy was a quasi-public unified fare system, applied to the entire network and across all modes of public transport, which uses smarts cards, i.e. the T-Money card. Unlike the independent fare structures before it, the present unified system, operating on a distance-time-mode based fare structure, allows easy transfers between buses and rails. Since the 2012 hike, a passenger with a T-Money card will pay a base fare of $0.97 (1,050₩) for a ride up to and including 10km, and an additional $0.09 (100₩) for every 5 km travelled between 10 and 40km. Beyond a 40km trip, every 10km is an additional $0.09 (100₩). Buying a T-Money card costs $2.78 (3,000₩); however, savings are high because single ride tickets are 1,150₩ per ride up to 10km.When purchasing a single ride ticket, riders must pay a $0.46 (500₩) deposit fee which they retrieve at the end of their trip by returning the card to an automatic machine which allows the cards to be reused and increases savings. A 20% discount is available for youths aged from 13 to 19 years old, and a 50% discount is offered to children aged from 6 to 12 years old. Fares are collected upon boarding and alighting. The initial read upon boarding charges the basic fare while any extra charge for additional distance is calculated and charged on the final read upon alighting. The extra distance traveled, for passengers transferring from a subway to a bus, is automatically recorded and added to the alighting-fare charge. In order for this to work, every passenger must get their card read when boarding and alighting a mode of transport; if they fail to do so, they lose transfer privileges and are charged for an extra full ride (metro9.co.kr). On average, a Seoulite spent $97.24 (104,670 ₩) a month on public transportation in 2007 (Rust, 2007), which is but a fraction of what a New Yorker or a Parisian must provide for his or her commute.

The smart cards' ability to calculate distance and penalties resides in a very innovative system. All T-Money cards are tracked by time and location through a GPS system upon boarding. The data collection system then sends the information to a Fare Settlement Center that computes over 22 million records each day. The center not only calculates each passenger's fare, it also collects valuable data from its processed numbers. For example, it gathers the number of passengers present at each station at any particular time of day and can therefore help meet real time demands. The system can optimize the number of vehicles needed on each line, as well as the train schedules and allocation of manpower (Park, 2007). By analyzing demand patterns, the system can better align its supply to increase reliability and reduce futile costs.

The transit operators pay service fees to the card issuers who, in turn, pay commissions to the infrastructure operator, the KSCC (Korea Smart Card Company). The KSCC was established as a joint venture between LG CNS and the SMG in 2003. Backed by strong leadership in the Seoul City Government, it serves all mass transportation in the capital and is widely popular among the public. The T-Money card has many uses; it is accepted in taxis, tunnel tolls or even in convenience stores to purchase goods (Oh, 2013). So, the transit card has expanded to become an instrument for transactions.

Today, smart cards are becoming mainstream internationally. These newer technologies have much lower life cycle costs than ticketing systems. While magnetic stripped cards require a physical swipe, smart card technology are "microprocessor-embedded devices issued by the transit agency that communicate a very short range so that they do not have to touch the readers, i.e. they are contactless" (Perrotta, 2013). Not only does Seoul use the smart card system, it also utilizes Open Payment System which allows riders to use third party smart cards on the readers and Near Field Communication which allows enabled-mobile-phones to be used as payment methods. This increases passenger convenience as cards can be automatically refilled from bank accounts or may even be directly linked to an account. Employee or student identification cards can also be used for entry. "NFC-enabled phones can also purchase fares directly from any NFC-enabled poster or sign" (Perrotta, 2013). Smart cards are not only the size and consistency of an average credit card; they can take various forms such as phone charms, bracelets, phone cases… etc. They are more convenient because passengers are not required to go digging for their card in their wallet. The smart cards also decrease the number of "payment media" that is carried around. Smart Card systems allow transit agencies to charge different fares according to the time of day, mode and route taken by a passenger.

Figure 2.5: T-money Payment Methods

Source: hanintel.com

The use of new fare technologies ensures cost reduction; while capital costs may be higher for smart cards than for magnetic stripe cards, life-cycle costs are much lower. Investments might be required but returns will come through the reduction of collection costs. A smart card's cycle can be up to 500 times that of a magnetic ticket. These advantages, among many others, have become necessary in order to meet the demands of today's passengers. This explains New York City's recent experiments with Open Payment and NFC.

Even after the 2004 Public Transport Reforms, Seoul is still undergoing financial difficulties. Even though the farebox recovery ratio is over 80% today, it seems that the local government, suffering from fiscal rigidity, is struggling to subsidize the extra 20% of the budget. In 2009, the Seoul Metropolitan area spent $380 million (409.1 billion₩) on subway operations, heightening the struggle to repay the principle and interest of subway debt. Researchers have been advocating for independent funding measures such as the metropolitan transport tax in

France as well as public transport financing through local consumption taxes such as New York's MMTOA (Mo, 2010).

In terms of affordability, Seoulites graded their system with a 3.73 out of 5. While this is higher than both Paris and New York, it is the category which received the lowest grade among all others in the Korean survey. The SMG's ability to maintain low fares seems to be under great pressure; new means of gaining revenue must be found in order to keep the system afloat. This will probably translate in a new fare hike some time down the road.

Conclusion

According to the surveys, Parisians were mostly dissatisfied with the cost of ridership for both the Metro and the RER even though there are many opportunities to receive subsidized transportation. New Yorkers were split between an overall affordable subway and an overpriced LIRR. Unlike in France, there are less instances of subsidized fare for passengers or employees in New York, making the commuter rail less financially accessible. Seoulites were the most pleased even though they paradoxically graded affordability as the worst factor in their system. This might imply that Seoul users expect ameliorations in terms of affordability, even though their system already has the lowest fares.

All three transit networks utilize different fare collection systems. Both New York and Paris use flat fares for their subway and zone-based fares for their commuter rails. Paris however, has been able to implement an integrated fare system so as to ease transfers, resulting in a rather complex mesh of fares. Seoul, on the other hand, has fully integrated its entire network through a distance-based fare system. On the whole, Seoul's integrated smart card system and distance-based fare appear as the most profitable and most reliable in the long term. It has many benefits; riders do not need to change their means of payment like in New York, and the charged price is clear unlike in Paris. The distance-based system is preferable to flat fares as riders are charged according to their trip thus not supporting a ridership bias that subsidizes long-distance trips at the expense of short-distance trips.

Additionally, all three systems are facing a financial deficit. This is not surprising, since by providing a public service, transit authorities "often [run] a recurring deficit as services are becoming more expensive to provide" (Rodrigue, 2006). The Seoul Metropolitan Government, even with its system's large farebox revenue, knows that it must find alternative means of funding and has already shown an interest in developing a subsidizing tax system similar to that found in both New York and Paris. Although these systems are under financial stress, they continue to plan developments and engage in expansions that will further their deficits. All three are stuck in a path dependency that requires the continuous development and modernization of their transit system even though it does not guarantee a shift in path.

Part 3: User Issues

Safety and Comfort

> Lighting can be dim, surroundings dirty, and unpleasant smells may fill the air. In addition, paths may be circuitous, signs unclear, and security or station personnel scarce. Overall many subway systems are uninviting and unappealing.
> (Myhre, 1996)

In 1982, an article titled "Broken Windows" was published in *The Atlantic Monthly* in which writers James Q. Wilson and George L. Kelling developed the "broken window theory." Based on previous studies and observations, they concluded that, if left unrepaired, a building's broken window becomes a sign of neglect. This one shattered window leads to many others as well as to break-ins, loitering and squatting. The same can be said for litter on the streets. If left unattended, it accumulates and people "start drinking in front of the grocery; in time, an inebriate slumps to the sidewalk and is allowed to sleep it off. Pedestrians are approached by panhandlers. At this point, it is not inevitable that serious crime will flourish" (Kelling and Wilson, 1982). While some of these conclusions may appear exaggerated at first, they are underlined with truth; if an area is run down or appears abandoned, people will tend to steer clear of it, reducing the amount of natural surveillance and allowing for the proliferation of delinquent activities. Whether crime is actually high or not, people will have a greater sense of fear, in general, and fear of crime, in particular, in areas that are not well maintained.

Cities are responsible for the maintenance of their public spaces. Some cities, such as Seoul, have been leaders in developing and applying the concept of Crime Prevention Through Environmental Design (CPTED). "The goal of CPTED is to reduce opportunities for crime that may be inherent in the design of structures or in the design of neighborhoods" (Crowe, 2000). For example, CPTED favors large lit spaces over tight dark corners; it also limits the amount of physical barriers that may reduce opportunities for natural surveillance. CPTED applies to public spaces such as subway or train stations as well as train compartments. Cities can only benefit in the development of safe, comfortable and pleasing environments that will satisfy the needs of their communities. Paris has been demonstrating movement towards CPTED design and structure in its rail system; on the other hand, New York has shown almost none.

This part of the chapter will focus on the environment within the subway and commuter networks of the three cities as well as determine how it may influence the overall sense of safety for passengers. To do so, multiple factors such as cleanliness, maintenance and material structures, CCTVs, lighting, platform doors and overall comfort will be studied.

Crime Distribution in Subways and Commuter Lines

The Numbers

Seoul

With an 18.17% crime rate in 2015, as measured per the *numbeo crime index*, Seoul represents the safest of the three studied cities (numbeo.com). Despite such low crimes, subway criminality has been on the rise in the last few years. Between 2011 and 2013, the number of offenders increased 11.7%, with a total of 348,788 offenders recorded in SMRT stations and trains in that last year alone. "There are various kinds of 'subway outlaws' […]. Some are drunk, and some try to force their wares on passengers. And then there are others who are secretly taking photographs of women" (Jang, 2014). Offenders are fined by "sheriffs" in the amount of $23.25 (25,000 ₩) – penalties double with every repeated offense. Some stations renowned for higher crime-related activities; for example, Seoul Station, which connects lines 1 and 4, has the "most instances of peddling, begging, smoking and sexual crimes […] About two to three voyeurs are caught each day" (Jang, 2014). Danggogae Station, on line 4, is also infamous; reports tally 20,000 annual loitering drunks that employees must frequently wake from drunken stupor (Jang, 2014). The most prevalent crime in the capital's rail system, however, is sexual harassment. "Secret photographing or filming accounted for more than half of the sexual crimes" in 2013 (Lee, 2014). "Many people do not recognize that secret filming is a crime. More public education should be carried out to teach them that it is serious" (Lee, 2014). Crime rates in public transportation have been on the rise in Seoul because the city has tightened its security. "'We have enhanced the crackdown since last year, exposing more crime,' a Seoul Subway Police official said" (Lee, 2014).

New York

New York City's crime index reached 47.15% in 2015; while much higher than that of Seoul, it remains lower than that in Paris (numbeo.com). In the 1970s, the New York City subway was the world's most dangerous system. Since then, strides have been made to increase safety. Today, 1.6 crimes occur per 100,000 trips, which translates to approximately 33 crimes committed each day. While ridership increased 4.7% between 2009 and 2012, the number of crimes decreased by more than 16%. Nevertheless, is still widespread in the subway system; between, 2008 and 2013, over 48,000 felonies were recorded. This five year period was marked most with 13,000 cases of larceny, over 5,000 cases of weapons possession, 4,000 instances of assault and almost 4,000 cases of robbery. Physical force was used in 70% of these robberies while 12.5% of them involved weapon use. Of the 3,000 misdemeanor sex crimes reported during that same period, 40% happened during rush hours. In 2013, 62% of crimes took place in train cars and 38% occurred in stations. Although rates have decreased in the past few years, these numbers show that the New York City Subway still hosts a variety of crimes (Ryley and Donohue, 2014). The LIRR is not exempt from crime or fatalities. For example, in 2013, 35 people were struck by LIRR trains leading to 28 deaths as a consequence of suicide, accident, or train pushers (web.mta.info).

Paris

Paris, with a 54.9% crime rate, positions itself as the most dangerous of the three studied cities (numbeo.com). Crimes and cases of violence that occur within the capital's public transit system are considered private data. However, the limited information made public acknowledged that between 2005 and 2012, 233 people died on the RATP network (the metro and RERs A and B) and over 60,000 were injured (Bonjean, 2014). Violence towards passengers doubled between 2007 and 2010 reaching 11,665 cases of violent theft, but decreased from 2.91 cases per million users in 2011 to 2.73 cases in 2013 (Le Parisien, 2013). On average, 29 deaths occur each year on the RATP rails. Injuries have decreased 27.5% since 2005 and amounted to 6,269 cases in 2012. In 2010, 461 cases of sexual harassment, rape and groping were recorded; that year represented one of the worst for the RAPT as the Transit Police arrested about 15 suspects each day (Cornevin, 2011).

Police Response

Seoul

In 1987, the Seoul Metropolitan Police Agency launched a Subway Criminal Investigation Team to operate on the four existing lines. In 2005, this special subway unit expanded and became the Subway Police Force (Han and Lee, 2014). The unit, which works with 19 local police stations, is dispatched accordingly to the 19 major transfer stations. The officers "patrol stations and conduct ambush duty" (Lee, 2014). In 2011, the Seoul Metro (lines 1- 4) put into effect a subway sheriff program; three years later, the number of sheriffs patrolling stations and subway cars was doubled in light of increasing disruptive behaviors (Jang, 2014). Approximately 140 of these subway sheriffs assist the Subway Police Force every day; by 2018, this number should reach 350 (10 magazine, 2015). Undercover officers are also common and often patrol stations and subway cars in order to avert any preventable crimes.

At the beginning of this year, the SMG developed an app "in hopes that it will curb the prevalence of sexual assault cases" (10 Magazine, 2015). The *Seoul Metro Safety Keeper* app allows victims to notify the Seoul Metro Police directly rather than having to call-in an assault. For now, the app is only available on lines 1 to 4, where cases of sexual assault are highest; if it is successful, the app will be applied to the entire system.

It should be noted that the Seoul Subway stations are also equipped with emergency flashlights, gas masks, fire extinguishers, oxygen tanks, and communication and water facilities, and are designed to be used as shelters in the event of a North Korean air raid. The subway is the safest place to find refuge in the capital and can shelter 2.7 times the city's population for up to 10 hours (Cho and Choi, 2010).

Paris

Following multiple accidents on the RER D in both 2009 and 2010 causing multiple deaths and hours of interrupted service, a national public transport security plan was enacted in April 2010. One month later, l'Unité de Coordination de la Sécurité dans les Transports en Commun (USCTC) was created, combining the police force and the gendarmerie (a military force which performs police duties among civilian populations). The USCTC performs as an overseeing organization which aims to create a synergy of forces among the many actors involved in the security of the capital's public transit system. These actors are the national and local police force, the gendarmerie, the transit operators' internal security services and more (interieur.gouv.fr).

The RATP's internal security service, the Groupement de Protection et de Securite des Reseaux (GPSR), counts 1,100 security agents that provide 95 units patrolling the metro and RER lines each day. Their aim is to maintain a safe environment for passengers by preventing crime and dissuading delinquent behaviors thus increasing the sense of security. They carry firearms that are only allowed to be used in self-defense (interieur.gouv.fr). The Sous-direction Regionale de la Police des Transports (SDRPT) acts alongside the GPSR. Its missions are to fight criminality on the transit network in Paris and Ile-de-France, to secure metro and RER lines as well as stations and to conduct undercover anti-criminal operations. It is organized between a unit which secures public transportation and a "rail squad" which is itself divided into three services: the department of general security, the police department of Parisian stations and the department of judicial investigations (police-nationale.net, 2012).

New York

Responsibility for the safety of New York City's system is divided between the NYC Transit Police (part of the NYPD), which services the Subway, and the MTA Police Department, which services the commuter rails. In 2013, the MTAPD counted over 780 uniformed and civilian officers. They are armed and "fully empowered under the New York State Public Authorities Law" (Turton, 2013). The MTAPD ensures passenger and employee safety and keeps MTA property secure. Officers "patrol trains, road crossings, train stations, and MTA rights-of-way as well as its rail yards and maintenance facilities"; they also "investigate many reported incidents, including crime" and assist during disruptions of train service (Turton, 2013). After the events of September 11, the MTAPD's role in countering terrorism increased greatly with added patrols and inspections. Three new units were created: an Intelligence Unit, an Emergency Services Unit, which deals with heavy weapons and hazardous materials, and a Canine Unit made up of 50 dogs trained to detect explosives and track individuals (Turton, 2013). As subway crimes had increased, the NYCTP started tightening its security measures. Patrols began "walking through late-night trains with conductors announcing their presence" (Donohue, 2013). Some lines now have an officer placed on each train running from late night to early morning on weekends; and multiple undercover operations were conducted to deter iPhone theft (Donohue, 2013).

At the end of 2014, New York State Governor Andrew Cuomo pushed for enhanced security. As an anti-terrorist measure, National Guard troops and additional police officers were placed at major mass transit points in the city. Penn Station has already witnessed higher security with more police officers and canine patrols (CBS News, 2014).

The MTA also utilizes many safety campaigns. In 2003, after the events of 9/11, the transit company launched its "See Something, Say Something" slogan which has become an integral part of NYC Transit. Over the years, it has been "the ideal outlet for all New Yorkers to get involved" by asking riders to "Be alert to unattended packages," "Report exposed wiring or other irregularities," "Report anyone tampering with surveillance cameras or entering unauthorized areas," and "Learn the basics of safe train evacuation" among other things. Passengers are asked to alert a police officer or MTA employee if anything arises. The campaign has been criticized for its inefficiency as it has not helped prevent any terrorist attacks; on the contrary, it has encouraged "New Yorkers to call in leads that are likely to amount to nothing [and which] can cause subway workers to ignore credible threats" (Gunn, 2012).

Security Systems, Structure and Maintenance

Video Surveillance and Intercom Buttons

Seoul

Following a subway fire that occurred in Daegu in 2003, the SMRT began investing in "real-time wireless video surveillance systems to helps protect their subway riders and transit workers against potential fires, accidents, thefts and other harmful incidents" (Firetide, 2011). The first "high-bandwidth mobile wireless video surveillance subway system in the world" began operating in 2012. Images are sent both to train conductors so they may assess whether or not there is potential danger on the tracks before entering a station, and to the subway control center which can stop a train in the case of an emergency (Na, 2012). While CCTVs had previously been installed only on platforms and in stations, new cameras allowed activity to be monitored within train cars; all cars running on line 7 were so fitted as well as 350 of them on line 2. These cameras help to" respond to theft and sexual harassment more quickly and more effectively" (Na, 2012). Cameras are expected to spread to other lines in the next few years. Platforms and Stations are also equipped with emergency alarm bells in case passengers feel in danger. Language services are also available if riders call 112 and feel exposed to possible crimes (Lee, 2014). The presence of cameras can reduce crimes and accidents but cannot eliminate them completely. Indeed, on May 2 2014, two subway trains collided in

Sangwangsmni Station (line 2) derailing two cars and injuring 170 people, 32 of whom sustained injuries requiring hospitalization. No fatalities occurred.

Paris

When the Meteor line was developed, it was automatically built with CCTVs located at each extremity of station platforms (Myhre, 1996). In 2013, already 8,950 cameras were set up across the metro and RER lines – including 5,760 directed towards the rails and platforms; numbers should reach 18,000 by 2016; According to the RATP's 2013 report, a command center called PC Sécurité receives a call and automatically visualizes footage through the CCTV system. In 85% of cases, the call is answered under the 10 minute goal by either the national or local police or GPSR agents (STIF Rapport d'Activité, 2013). These calls can be made by emergency intercoms or call buttons dispersed across the system's stations.

New York

In 2010, the MTA installed over 3,700 security cameras that became part of the Integrated Electronic Security System and the NYPD's Midtown Manhattan Security Initiative (mta.info). There is a variety of CCTV networks located within the city's transit system. Recently, cameras camouflaged as metal pipes were even discovered near Metrocard vending machines, turnstiles and in high crime areas. These cameras are said to have aided the police in many criminal investigations (Evans, 2015). Within the next four years, the MTA is planning to install 1,000 cameras in new and preexisting subway cars to help fight the high number of sex crimes such as groping and flashing (Donohue, 2014). Plans to install similar cameras in LIRR train cars are currently being discussed (Castillo, 2014). Furthermore, CCTVs are not placed at every LIRR station; the question of full camera surveillance was raised only after recurrent acts of anti-Semitic vandalism took place in Cedarhurst Long Island Railroad station (Bessen, 2015). Finally, in 2014, high-tech intercoms named "Help Points" were placed in 102 NYC subway stations allowing passengers "to get basic travel information or summon help in an emergency with the push of a button" (Donohue, 2012). The MTA is expected to install the devices in all 468 stations.

Design and Lighting

Paris

When developing plans for the METEOR line, RATP officials took into account many CPTED principles as seen in Figure 3.1. For example, "open design for the Meteor station entrances [allows] natural light to enter the platforms and the spacious lobby areas;" furthermore, the architecture is based on "innovative and extensive use of open spaces, clear lines of vision throughout the station and their use of natural and reflective lighting." "Meteor's architects and planners strategically chose specific designs and reflective materials to increase surveillance potential, decrease the fear of crime, and enhance the comfort of their subway line" (Myhre, 1996). Meteor distinguishes itself from the rest of the metro lines which have many dark stations, multiple entrances and exits, and long winding passageways. Because of the success of line 14 in bringing a sense of security to users, it can be trusted that similar efforts will be made in the development of future lines; the modernization of pre-existing stations, however, remains difficult and expensive.

Figure 3.1: Station on METEOR Line

Source: linternaute.com

New York

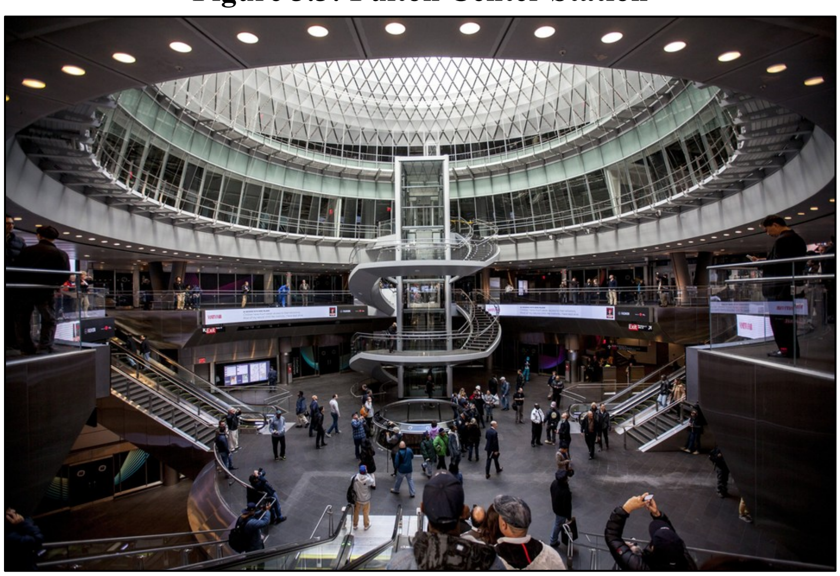
The NYC subway is in a very similar situation. In some cases, its dated architecture and design leave much to be desired, especially in respect to maintenance. A report from the Office of State Controller, based on a 2012 survey done by the NYC transit, found that almost 90% of all subway stations in the city presented structural defects. These include "worn platform edges, cosmetic flaws such as peeling paint," broken tiles, and defective lights (Donohue, 2014). Some 30% of ceilings were also in need of new paint; and "25% of tiles, paint and lighting components needed repairs" in some 83 stations (Donohue, 2014). These shortcomings give riders a low opinion of their transit system and also feed into the broken window theory. A degraded environment does not make people feel safe. The dark industrial appearance of the city's subway stations, as seen in Figure 3.2, along with the many long hallways reflects the system's history and time of construction; alterations and modernizing plans for today's travelers are necessary. The MTA had already projected the need to address the various defects in its 2010-2014 Capital Program, allowing it to fix many of the "most deteriorated structural components" in 150 stations (Donohue, 2014).

Figure 3.2: NYC Subway Sation

Source: nycsubway.org

The 2015-2019 Capital Program has allotted $1.075 billion of its budget to station repairs system-wide (regarding stairs, platforms, lighting, and signage) as well as to the reconfiguration of two major stations (Grand Central and Times Square) to improve passenger circulation (MTA Board, 2014). The opening of Fulton Center, "a transit mega-hub that replaces the subway station destroyed on September 11" (Campbell-Dollaghan, 2014), in October of 2014 gave NYC passengers access to a modern "jaw-dropping" station that was reorganized to better coordinate the eight different lines that run through it. The architectural design uses "over 1,000 aluminum panels to reflect sunlight down into the station" (Campbell-Dollaghan, 2014) allowing for natural light to access its "brushed aluminum corridors."

Figure 3.3: Fulton Center Station



Source: Keyssar, 2014

Seoul

Architects seem to have taken CPTED principles into account in the design of Seoul's subway stations. Most stations are spacious and airy, especially those of lines 5 – 8 (Mazlan, 2014). They are extremely well lit and large spaces and corridors allow for natural surveillance. The SMRT views its stations not only as a space for transit but also as "a public arena for culture and arts, enriching the quality of life of citizens" (SMG, 2014). Quite a few of the larger stations offer performance and exhibition spaces, meeting plazas, areas for reading or working and even in some cases, small museums or cinemas.

Figure 3.4: Seoul Subway Station

Source: Chen, 2014

Platform Screen Doors

Platform Screen doors have become one of the benchmarks for safe public rail transport. These "screen doors separate platforms from tracks and interlock with train doors to open and close" (metro9.co.kr). PSDs are slower to operate than common doors; in case of an emergency, they can be manually opened on either side. The benefits of PSDs are numerous. First, they prevent people from falling, jumping or being pushed onto the tracks. Platforms are quieter, cleaner and draught and air pressure caused by trains is greatly reduced. Stations can also be temperature controlled at lower costs during hot and cold seasons. Finally, PSDs stop users from throwing trash on the tracks which reduces the risk of debris coming in contact with the third rail and starting rail fires (metrobits.org).

Seoul

The Seoul Metro, the Seoul Metropolitan Transit Corporation and Seoul Metro Line9 have installed PSDs on all nine of Seoul's subway lines; some commuter rails have not yet been fully fitted, but many already have at least half barriers on their platforms. Hyundai Elevator Co,. LTD fitted numerous stations across South Korea including some on the SinBundang commuter line as well as 24 stations on Metro Line9 and 61 on the Seoul Metro (Hyundai Elevator Co., LTD, 2011). A second Company, TIS, Inc, installed "289 screens in Seoul in little more than two years" (Rowan, 2014). The company used a financial model based on advertising. TIS manufactured and installed "the screens at their own costs, and [made] their money back from advertising on digital monitors affixed on the screens" (Rowan, 2015). Between 2008 and 2009, 56 suicide attempts were recorded in the subway system; by 2010, with the installation of PSDs, the number dropped to two (Cho et al., 2013) proving the system's efficiency.

Paris

In 1998, with the opening of the METEOR line, the Metro pioneered the use of PSDs on its network. The aim was to reduce suicide attempts and opportunities for "subway pushers" as well as to prevent the deposit of narcotics on the tracks for later resale (Myhre, 1996). Unlike in Seoul where almost all PSDs in the underground subway extend from the floor to the ceiling, METEOR's glass barrier arches over the tracks and extends to both platforms so as not to disrupt the view from each side (Myrhe, 1996). In 2006, a couple of stations on line 13 were used to test PSDs on existing rail lines – by 2010, half of the line was suited. Between 2009 and 2011, PSDs were extended to line 1 – similar to those of line 13, they are only half barriers that do not extend completely to the ceiling – which was turned into an automatic, driverless subway line. As line 4 is being prepared to transition to an automatic line in the next few years, plans to install PSDs are also being made (Collet, 2013); however, there has been no further talk, for now, of expanding them to the entire system. Suicides and suicide attempts have long disrupted the Paris transit system; and, while they have decreased from 185 in 2005 to about 60 in 2012, the numbers are still too high (Le Parisien, 2013), perhaps calling for an extension of PSDs as safety measures for the entire network.

New York

Seoul has them and Paris has been installing them, yet New York has none. In 2012 alone, 141 cases of human to train collision resulted in 55 deaths. Although in July 2014, MTA Chairman and CEO Thomas F. Prendergast claimed that "[s]afety is the top priority for all of the MTA's daily operations" (mta.info), the MTA has turned down the use of platform screens. The doors could prevent tragedies such as those of Sunando Sen and Ki Suk Han who were pushed to their deaths in December of 2012 (Rubinstein, 2013). The director of transportation programs for the Regional Plan Association supported plans for the installation of doors that would prevent future passenger falls or crimes on the tracks; the crowds on platforms during peak hours continually augment, increasing the need to find safe solutions. The current platform ADA strips may warn of danger, but do not prevent it.

Furthermore, the NYC Subway has extremely filthy tracks and still counted 900 cases of track fires in 2013 (NYCT Safety Program and Culture, Feb 2014). Platform screen doors can "'prevent garbage and other debris from falling on the tracks,' averting the possibility of fires. (Rubinstein, 2012). Not only does trash on the rails encourage more littering, it also attracts pests such as rats. The Subway system appears dirty and abandoned which increases the sense of fear and unease. The installation of PSDs would keep trash off the tracks and therefore, would not only improve the system's environment but also "reduce the costs of sending workers out every day to clear debris" (Rubinstein, 2012).

Even though many advantages have been highlighted throughout the years, the challenge that installing PSDs would represent is far too great, not to mention too expensive for the MTA; the age of the platforms as well as the adjustments that would be required – the NYC Subway uses different sized trains with different door locations – have been pointed out on various occasions as arguments against PSD installations (Stieber, 2013). Although these challenges can be acknowledged, the MTA has made no effort to put into effect the L line's pilot project which has been discussed for years. Instead, it has resorted to Public Awareness Campaigns; the most widespread is the 2012 "Don't Become a Statistic Campaign" which encourages passengers to stay away from platform edges (mta.info). This campaign is used for both the subway and the commuter rails.

Figure 3.5: MTA Safety Campaign

Source: MTA, 2012

Cleanliness and Overall Comfort

Cleanliness is a major factor that influences people's sense of safety and comfort. As explained previously, if a transit system appears dirty, it relays a feeling of abandonment and carelessness which can translate into a fear of crime.

Paris

In the survey conducted for this project, Parisians voiced great dissatisfaction in regards to their system's cleanliness. They attributed a 2.19 out of 5 to the Metro and a 2.15 out of 5 to the RER. Indeed, the Paris rail system is known for its repugnant odors; these stem from various sources such as the rubber tires, sewers, rails, fungi from moisture, the friction from brakes on the rails or even the age of the cars and various materials (Bounoua, 2010). A common smell in the RATP's system is that of urine. Restrooms were never part of the system's original design plans because trips were short in the early years of operation; bladder issues were not a concern back then. Today, however, long commutes call for relief stations, the presence of which is non-existent. In August 2011, only eleven public restrooms were counted on the entire RATP underground system. Four of these were in stations on the metro lines and seven were in stations on the RER lines (Lussac and Marx, 2013). The lack of public restrooms also reflects a greater social issue; public toilets are seen as a way of promoting loitering (especially homeless loitering) within the confines of the Metro and RER. The lack of public facilities may or may not be a way of dissuading loitering; however, it may well be the cause of some of the Metro and RER's repulsive odors. In another attempt to dissuade such behavior, stations on the METEOR line (unlike the rest of the system) were designed with separated and sparse seating so as to "discourage loitering or sleeping off a drunken stupor on the platforms" (Myhre, 1996).

While all of the RATP's metro trains are temperature controlled, only the RER A trains and the new cars of the RER B are heated in the winter and cooled in the summer. Both metro and RER stations within zones 1 of Paris are not temperature controlled; hot air is sometimes blown in some areas. RER stations in Ile-de-France are all outer, surface stations. Wi-Fi and phone service will be available on line 1 of the metro and on the RER A by the end of this year but will only be extended to the entire system in 2017 (Renouard, 2015).

New York

In New York, the population graded the Subway with a 2.5 out of 5, and the LIRR received a 3.43 out of 5. In 2013, the Straphangers Campaign's annual survey found that users considered only 42% of subway cars as meeting an acceptable standard of cleanliness (Sanders, 2014). This, added to the continuous filth on subway tracks, results in an overall necessity to increase cleaning efforts. The NYC Subway is not exempt from urine coated platforms either. The situation became so dire in March 2015 that the MTA had to put up signs in areas "notorious for public urination" asking people to restrain themselves. "Night-life patrons, homeless people and others all seem drawn to relieve themselves" (Newman, 2015) in certain areas of the subway.

This might, once again, be due to the fact that "the total number of toilet-equipped stations in New York City currently stands at 77 out of 468 stations, with the number of toilets down to 129 from 1,676 in 1940" (Marshall, 2015). In 2013, 1,800 people found refuge in the subways (Kern-Jedrychowska, 2014); indeed, Penn Station is even known as "homeless central." The station provides access to a 24 hour public restroom and gives homeless people a feeling of safety (NBCNews, 2014). However, their presence in the public transit system disturbs users; while conducting the survey for this project, many passengers complained of homeless loiterers and expressed feeling threatened by them and other panhandlers on many occasions.

Like in Paris, NYC's Subway and LIRR trains are temperature controlled while the stations are not – this does not include big transfer stations such as Penn Station. (It should also be noted that all LIRR stations, like those of the RER in the Greater Paris region, are exterior stations. Some provide indoor waiting areas that are open during specific times in the day.) In NYC, 76 subway stations now receive Wi-Fi and cell service. Passengers have access to these services when subway trains arrive in stations but lose them between stops. The remaining stations are expected to be connected by 2017 as well (Mocker, 2014).

Seoul

Seoulites graded the capital's rail lines with a 4.31 out 5 in cleanliness. Compared to other metros, Seoul's system fares very well in this regard. The platform screen doors keep trash and debris off the tracks as well as improve indoor air quality in the stations. Passengers are able to breathe in clean air rather than the particles that emanate from the tracks (Son et al., 2014). The use of PSDs allows stations as well as the train cars to be heated in the winter and air-conditioned in the summer. Seats on the subway trains are climate controlled and automatically heat up in the winter. Furthermore, commuter stations in the Greater Seoul area are similar to those in Paris and New York as they are exterior stations; however in most cases, they do provide shelter from the weather. In general, the Seoul Subway system is noted for its cleanliness and has been recognized as one of the best transit systems in regards to comfort (Sood, 2013).

Still, the Euljiro il-ga station on line 2 counted over 7,000 cases of homeless loitering in 2013. Along with Seoul Station, Euljiro il-ga has the highest number of homeless cases as it is one of the few stations open twenty-four hours (Jang, 2014). Since 2013, transit employees have been evicting the homeless from the station, forcing them to move to other locations across the city (Kim and Jo, 2013). Therefore, while homeless loitering is much less noticeable, it is still present. However, the urine stench present in Paris and New York is non-existent in Seoul. Restrooms are located in all of the capital's "622 stations, many of them accessible even before you've passed the turnstile" (Marshall, 2015). Most of these restrooms are equipped with powder rooms, children's chairs and diaper changing boards (Metro9). Finally, the subway also has mobile phone reception and wireless internet throughout the system both in stations and in train cars (Sood, 2013).

Gender and Cultural Differences

A Case for Women

In October 2014, the Thomson Reuters Foundation conducted a survey in 16 of the world's largest capitals (New York was chosen to represent the United States). They surveyed hundreds of women of different age and socio-economic background in each city in order to determine their sense of safety while using public transportation. On a ranking of 1 to 16, the 1st city is found to be the most dangerous and the 16th, the safest. Here is a tally of the ranking for the three studied cities in the survey according to the various questions:

Figure 3.6: Thomson and Reuters Foundation Survey Results*

	PARIS	NEW YORK	SEOUL
How safe, do you feel travelling alone at night in the city where you live?	10	15	12
Have you been verbally harassed by men when using public transport?	7	9	15
Have you been groped or experienced any other form of physical harassment when using public transport?	16	15	11
How confident are you that other people would come to your assistance if you were being abused, either physically or verbally, on public transport?	4	16	1
How confident are you that authorities (e.g. police) would investigate it if you were to report that you had been sexually harassed or attacked whilst using public transport in the city where you live?	13	16	9
To what extent do you agree or disagree with the following statement? 'Safe public transport is available in the city where I live.'	10	16	12
Overall Ranking	**11**	**16**	**12**

Source: Thomson and Reuters Foundation, 2014. *the scores are a ranking with the lowest numbers representing lowest conditions (the scale is of 1 to 16)

These results are quite interesting and reflect much about each city's culture, in general, and ridership culture, in particular. In Paris and New York, women appear to be a lot more verbally than physically harassed while the opposite is true in Seoul. In New York, women might be overly confident in their fellow passengers and their local authorities while in Seoul and Paris, there is almost no confidence whatsoever in fellow passengers. Indeed, 85% of surveyed women in Paris and a total of 90% of the women in Seoul claimed not to expect any type of assistance if they were in a dangerous situation. These numbers may affected by respective cultural tendencies; Americans are more outgoing and Koreans are more introverted. Although all three cities are ranked high, women feel the safest in New York and the least safe in Paris. Seoul, while placed between the two, is much closer to Paris. The results from the Thomson and Reuters Foundation closely match those of the survey administered for this project. Indeed, Parisians gave their system the worst grades in terms of safety with 2.53 for the Metro and 2.21 for the RER. New Yorkers gave higher grades of 3.48 for the Subway and 4.71 for the LIRR. Finally, Seoulites placed themselves in the middle by giving their system a 4.12 out of 5.

Cultural Differences

France has long had a reputation of turning rudeness into an art form; public transportation is not exempt from this behavior. In 2012, the pollster IPSOS found that the French were tired of their own aggressive behavior and bad manners in public transportation. RATP officials had been alerted by staff of the overwhelming cases of rudeness in the past few years (The Associated Press, 2012). In Ile-de-France, 95% of passengers claimed to have been targets for incivilities while taking the train on the RATP lines (RATP, 2015). According to the operator's data, in 2015, each frequent passenger will on average experience 75 instances of rude behavior while using public transportation – this is five cases less than in 2012. In the last three years, the RATP has launched three seasons of its "Restons Civils sur Toute la Ligne" ("Staying civil right down the line") awareness campaign. The publicity campaign uses humor to promote better behavior on board trains and on platforms.

Figure 3.7: Restons Civils sur Toute la Ligne Campaign

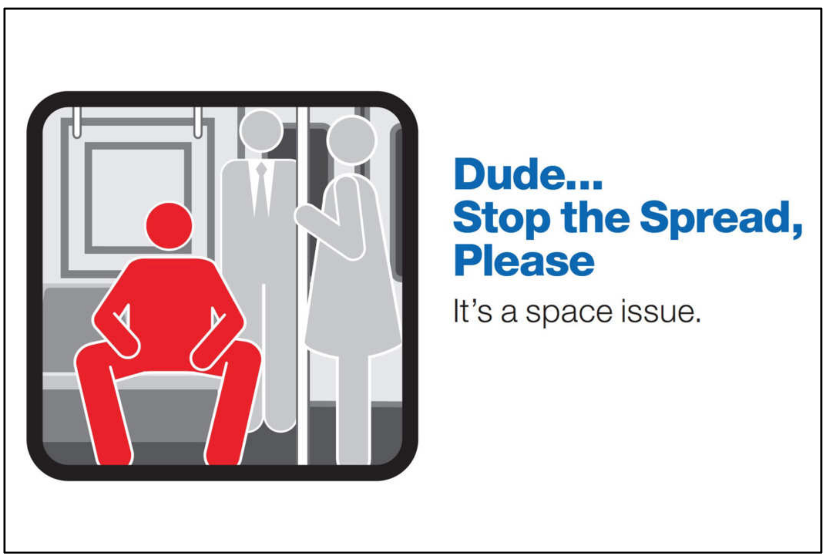
Source: RATP, 2015

While the frequency of observed incivilities has decreased overall by 6% in the last three years, some negative passenger practices, such as talking loudly on the phone and eating on board, have increased; others, such as standing on the left of escalators, have stayed constant.

The campaign uses displays in metros and RERs as well as floor to ceiling posters in certain stations. Although having received positive feedback, the campaign still has many issues to address; 63% of the French population still finds the level of civility in today's public transit unacceptable (RATP, 2015).

The NYC Subway, much like Paris, is notorious for its passengers' boorish behavior. Following passenger complaints, the MTA developed its "Courtesy Counts, Manners Make a Better Ride" campaign in late 2014. The campaign uses a series of placards displayed inside subway cars to emphasize 'dos,' such as "Step Aside to Let Others Off First," "Offer Your Seat to an Elderly, Disabled, or Pregnant Person," or "Keep the Sound Down," and the 'don'ts,' which include "Clipping? Primping?," "It's a Subway Car Not a Dining Car," and "Dude…..Stop the Spread, Please" (The Associated Press, 2015).

Figure 3.8: Courtesy Counts, Manners Make a Better Ride Campaign



Source: Kirby, 2014

Some of the most disturbing behavior includes fingernail cutting, smelly food consumption, *manspreading* – men monopolizing seating space because of their spread legs – and not letting other passengers off before boarding the train. This last act of rudeness is the cause of delays on many lines, especially during rush hours (Harshbarger, 2015). To curb these vile behaviors, the courtesy campaign reminds "riders of the most rudimentary etiquette in a tone that's part shaming, part scolding" (The Associated Press, 2015); many riders thought the campaign to be long overdue.

While Paris and New York have a history of rude behaviors on public transportation, Seoul's etiquette crisis has been developing a lot more recently and is but a fraction of that in the other two cities. Seoulites still strongly abide by the rules of their ridership culture. For example, for all of the wireless coverage in the subway, it is uncommon to hear passengers talk loudly on their phones; being loud and unruly is looked down upon. In addition, sitting on one of the six seats located at each end of every train car is taboo. These seats are dedicated to the elderly, the disabled or injured, pregnant women and women with small children. Even during rush hour, with the trains overcrowded, passengers will stand rather than use those seats at the risk of getting scolded by the next elder who steps onto the train. Furthermore, all stations have arrows on the platforms which position passengers on the outer sides of train doors as they open; this custom is still maintained. Recently however, complaints about bad behavior on trains have multiplied. These incivilities also concern *manspreading* and primping; however the most disturbance involves the "backpack tribe" (Yang, 2015). Passengers would rather keep their backpacks on than hold them or put them on the shelf space that is available along every train car. Backpacks, as well as bulky hiking gear, often block the way for other passengers or accidentally hit them, sometimes leading to injuries or fights. This can instill a sense of fear in passengers. In order to promote backpack etiquette, the SMRT created a video clip, which plays on the TV screens located in the trains – along with many other safety ads (Yang, 2015).

Fare Evasion

Fraud and fare evasion are low level crimes that can be extremely costly for transit systems. Following the broken window theory, the MTA in NYC began enforcing laws against fare evasion in the 1980s in the hopes that stopping low crimes would prevent the occurrence of more violent crimes. Between 2008 and 2013, arrests for fare evasion increased 69%, and in 2014, 3,084 arrests for fare evasion translated into jail time. On average, the MTA, all services included, loses $100 million annually from fare evasion (Paddock and Riley, 2014). In both 2013 and 2014, fare beaters have cost the LIRR up to $1 million dollars; the MTA police carried out 83 arrests in 2012 – a 63% increase from the previous year (Donohue, 2014).

In 2014, fare evasion was estimated to affect 5% of total rides in Paris, representing a $98 million (110 million €) loss for the RATP. Every day, 1,000 controllers roam the entire system verbalizing 4,000 fare beaters (Molinie, 2014). Turnstile jumping has become an underground culture in Paris; for example, "la mutuelle des fraudeurs de metro" works as an insurance company for its members. Each turnstile jumper who is a registered member contributes 5 to 7 € a month (a much smaller sum then the cost of the Navigo pass); if he or she is stopped by controllers, the *mutuelle* takes on the penalty fee (Macherez, 2014).

On the other hand, fare evasion is much less a part of Korean culture than it is part of the French one. That being said, in 2011, all three subway operators in Seoul caught 17,331 fare beaters and collected 484 million ₩ in fines (Rahn, 2012), representing still only a fraction of the frauds which occur in Paris and New York.

Conclusion

The sense of safety and comfort, which depends on a system's environment, security and ridership culture, is crucial to maintaining high passenger rates. If the fear of crime is high, less people will be willing to use public transportation; if less people use it, the sense of fear increases. It is a vicious cycle. Paris, New York and Seoul have all three more or less successfully considered safety and security issues in their design and development plans and actively promote safety projects. While sharing many safety features such as CCTVs, intercom buttons, and safety campaigns, a few differences and shortcomings are noticeable.

The age of both Paris and New York's systems works as a disadvantage; the outdated design can feel unwelcoming and maintenance is constantly required; restrooms are also not available to passengers and cleanliness standards are not met. Seoul will not be exempt from some of these problems; its system, which is now 40 years old, will need to modernize its rails and stations in the near future. However, its design, its cleanliness and the services it offers already meet user standards.

One of the biggest issues for New York City is its lack, and apparently unfeasible installation, of platform screen doors. While Seoul has installed PSDs on every line and Paris is gradually fitting its own system, New York still struggles with suicides, passenger attacks, trash, track fires, and rats. Logistical issues, related once more to the system's age, keep it from developing the security system which has become a global standard in public transit.

The feeling of safety on all three systems is paradoxical. Overall, even though the New York system has high crime rates that require constant police presence, passengers feel safe using the Subway and even more so the LIRR. In Paris, on the other hand, even with a large police presence to counter high crime rates, users do not feel safe. While in Seoul, users are confronted with much lower crime rates and are still wary at times for their safety.

This paradox might be linked not to the physical environment but to each city's ridership culture. In Seoul, following subway etiquette is still the custom; smaller incidents may therefore instigate greater fear especially with the recent rise of incivilities. In the New York City Subway, safety has been an issue for many decades; New Yorkers are therefore accustomed to an environment that poses some risks and perhaps tend to minimize it. For Paris however, the sense of fear is exacerbated by individualistic or defying behavior such as fare evasion or rudeness.

Accessibility

"Several reasons are given to explain low ridership, with the most common being the lack of convenience, that is, does not reach destinations close enough to where people need to go, […]

or is not easily accessible – this latter in an important barrier to individuals with disabilities" (Gershon, 2005). For a transit system to attract users and increase its ridership, it must be accessible; this implies user-friendly structures and access to all so as not to discriminate against passengers with ambulatory disabilities. For major world cities, such as the ones studied in this project, transit systems should also be tourist-friendly and offer assistance in various languages.

System Layout and Accessibility through Other Means of Transport

According to metrobits.org, the average distance between stations in Seoul is 1,114m (0.69mi); in New York it is 834m (0.52mi), and in Paris it is 599m (0.37mi). For the RER, stops are between 1.7 and 3.3 km apart. For all three cities, the further away from the city core, the longer the distance becomes between stops. This reflects declining density levels, and implies a necessity to use either other means of public transport or to rely on the use of private vehicles. While the Parisian center is easily accessible, the rest of Ile-de-France still requires a greater network and service. This also applies to NYC, where the five boroughs are mostly well serviced, especially Manhattan; but areas serviced by the regional commuter lines show a greater reliance on automobile use and bus networks. This is a main reason for high vehicle use within cities; private cars from suburban areas pervade the inner core for commuting purposes.

Figure 3.9: Station Accessibility in Paris, New York and Seoul

	Paris	New York	Seoul
Land Area (km^2)	105	790	605
# stations	300	460	260
distance between stations (km)	0.599	0.834	1.114

Source: metrobits.org/britannica.com

According to Figure 3.9, central Paris is the most easily accessible with the shortest distance between stations and a stations-per-area ratio of 2.8 stations per square kilometer. New York comes in second with a ratio of 0.58 stations per square kilometer. Finally, Seoul places third with a ratio of 0.42 stations per square kilometer and the highest average distance between subway stations. On the question of accessibility, French users assigned the Metro a 3.66 out of 5, the highest grade received by the system. New Yorkers and Seoulites expressed satisfaction by both attributing a 4.4 to their subways. For commuter rails, the RER was adequately graded with a 2.86; many New Yorkers surveyed said to live close to an LIRR station therefore satisfactorily grading it with a 4.2.

Access through other means of transportation is facilitated with a unified fare system. In Seoul, connections between the subway and the bus are eased through unified fare. In Paris, only the Navigo card users can enjoy free transfers between transport modes; while in NYC, transfer privileges are provided within two hours of a first Metrocard swipe.

In early 2014, Paris began applying an innovative concept to improve the accessibility between its public transportation modes; the RATP started installing 3,000 screens at the entrance of RER and metro stations. By the end 2015, these screens will allow passengers to check wait times between connecting buses and tramways (Marguerite, 2014).

Train and Station Accessibility for Disabled Passengers

Paris

In 2005, the *loi d'accessibilité* (accessibility law) was passed in France, dictating that all areas of public transportation would have to be fully accessible to handicapped citizens by 2015 (legifrance.gouv.fr). Paris's Metropolitan was exempt from meeting the law's requirements on the basis of its age and underground configuration; the *Association des Paralyses de France* (The French Paralyzed Organization) deems it "a subtle way of revealing that accessibility is impossible to achieve in the Metro. On the older lines, construction is not feasible." Therefore, only the METEOR line is fully equipped with elevators and enlarged passageways at each station to ensure the mobility of disabled users; that is, when elevators are not out of order, as is often the case at the Olympiades station (de Fortanier, 2014). Aside from line 14, only a dozen stations on the entire network are equipped with elevators (RATP, 2013). Platforms are not adapted for easy wheelchair access, and only the intercom phones located in stations provide a means for passengers to get in contact with RATP agents if they are in need of assistance. To compensate for the inaccessibility of its metro system, Paris has developed its bus network so that in 2014, 91% of all buses in the capital were equipped to provide transportation for passengers in wheelchairs (de Fortanier, 2014).

In 2009, 90% of RER stations on lines A and B (those operated by the RATP) were deemed accessible (ratp.fr). By the end 2015, all stations will meet the requirements of the accessibility law. Elevators, enlarged passageways, adapted turnstiles, and easy access to platforms were added to most stations. The use of the term "accessibility" also implies training personnel to assist disabled users. Indeed, because the gap between platforms and RER trains is too wide, passage from one to the other is provided to passengers in wheelchairs on demand. RATP agents put in place a mobile walkway allowing passengers to board the train by the door located behind the conductor. Agents from the departing stations then warn those at the arrival station so as to assist the passenger as he or she gets off the train. Although such a system facilitates the mobility of disabled passengers, it still requires the use of human assistance which not only lowers the level of passengers' independence but also incurs major service disruptions (RATP, 2013). For people with a recognized disability of 80% or more, FlexCite, a subsidiary of the RATP, offers on demand door-to-door transportation services (RATP, 2013).

For all of its current shortcomings, the RATP as made accessibility a main concern in the designs for upcoming Metro rail extensions and new line developments. According to the organization, all new stations will be equipped with elevators and, as often as possible, with escalators.

Seoul

Almost every station in Seoul is equipped with elevators and platform gap modifications to reduce gaps between trains and platforms. The few small and older stations that could not be retrofitted with elevators have wheelchair lifts that can accommodate disabled passengers. Most stations have two sets of elevators: one that connects the street level to the ticketing level and another which connects the ticketing level to the platform. Furthermore, stations that still have turnstiles instead of the new entry gates are equipped with wheelchair access gates. In order to board the train, disabled users can search for the arrows in front of every screen door. Those marked with the appropriate sign give direct access to each end of the subway car where reserved seating is provided as well as show where the gap between the platform and train is reduced. Wheelchair users can cross the gap without assistance (wheelchairtravel.org, 2015).

New York

Twenty-five years after the Americans with Disabilities Act (1990) was passed, still only a fraction of the NYC Subway is capable of providing services to those who live with ambulatory disabilities in the city. Although some enhancements were made to accommodate wheelchair users, the visually impaired and those with walking aids, progress has been slow. Only 89 of the subway's 460 stations are fully ADA-accessible. These stations are equipped with "AutoGates" which can be used instead of turnstiles allowing easy access the platform. In order to board the train, passengers are asked to place themselves by the boarding area sign where platforms are modified to facilitate wheelchair access to the train (Rivoli, 2014). These areas are purposely located near the middle of the train so that the conductor may hold the door for the passenger. The MTA advises users that arrive at non-accessible stations to "transfer on the same platform for a train that later stops at an accessible station" (mta.info), which can bring a passenger much farther from his or her desired stop. Many trains also do not align with platforms resulting in wheelchairs getting stuck in the gap. (Rivoli, 2014). And, while elevator availability has risen to 97.7% in 2012, over 75% of users are dissatisfied with the services because of recurrent maintenance issues (Williams, 2013). The MTA has planned on converting 19 more key stations to ADA standards by 2020 (Williams, 2013).

Like Paris's FlexCite, the MTA offers paratransit services. Customers may "reserve a trip in advance to a destination within the service area covered by public buses and subways" (mta.info). This service, called "Access-A-Ride," is also a door-to-door service that operates 24/7. Passengers that require such services are charged the same fare as public transit users. This means that for each trip, the passenger will pay $2.75 but the trip will cost the MTA over $66. "Facing a steep rise in cost ridership, the MTA in recent years has made eligibility stricter" for the service (Rivoli, 2014). "Access-A-Ride" has also been critiqued as being unreliable as it is often late. Most users also resent it as they would rather be independent than have to rely on an alternate transport service. As a means of information, Dustin Jones, a board member of *Disabled in Action*, co-created the *Wheely NYC* app which "devises routes through accessible stations and keeps track of problems with elevators" (Rivoli, 2014).

Information Displays

Clocks and time displays on platforms are "a convenience long enjoyed by [many] users of mass transit." These displays soothe "the usual anxieties that come with waiting for a bus or train that might never arrive" (Grynbaum, 2010).

Paris

All RER lines in Paris have displays in each station and/or platform which indicate upcoming train schedules as well as the stations serviced by these trains. In the trains, overhead LED lit linear maps tell passengers at which stop they are located and which ones are coming up. Some of the new trains on the A line now have TVs in each car that display the upcoming stations.

Every metro platform is also equipped with a visual overhead display which indicates the wait time for the next two upcoming trains (Figure 3.10). Inside the metro trains, overhead illuminated linear maps similar to those in the RERs (or sometimes simple maps) inform passengers of the various stops on the line (ratp.fr).

Figure 3.10: Wait Time Display Metropolitain

Source:datadisplayfrance.com

Both metros and RERs usually have voice announcements in French. However, these can also be heard in other languages on the most tourist-used lines such as line 1 or the RER A which terminates at Euro Disney theme park. When translated, the announcements are played in English, German, Italian or Japanese.

Seoul

Every platform in Seoul is equipped with LCD screens which display real-time subway arrival times. They even display the location of upcoming subway trains. The *Jihachul* also uses a smartphone application which provides real-time train arrivals, measures efficient trip routes according to departure and destination locations, calculates fare for said trip, and gives information about each station such as restrooms, elevator, exits and so forth.

"All directional signs in the system are written in Korean and English. Station signs and some maps also display Hanja. In the trains, the pre-recorded voice announcement that states the upcoming station, any possible transfer, and the exiting side are all in Korean followed by English. In some cases, this is also followed by an announcement in Japanese and Mandarin" (World Heritage Encyclopedia, 2015). All of this information can also be found on the screens that are located within each subway car.

New York

The NYC subway's numbered lines have been equipped with time displays on their platforms for many years. However, no such service is available on the lettered lines. Because lettered lines are much older, larger, and apparently more complex, pilot real-time display programs have thus far failed. Similarly, the subway real time app only services lines 1, 2, 3, 4, 5, 6 and the S 42nd shuttle providing estimated arrival times for 153 stations (mta.info).

Displays in the subway cars depend on the age of the trains. Older subway cars have simple linear maps that show all stops, both local and express, along the line. Newer trains have digital displays showing upcoming stops as well as "a mechanical voice that announces the current and next station" (mta.info). According to the New York Public Interest Research Group Straphangers Campaign's Summer 2014 Subway Report Card, "accurate and understandable subway car announcements" reached 92% across NY's 21 lines. Lines 2, 5, 6, E and Q had perfect, accurate and audible announcements; however, line C was recorded as the worst, with "missing or garbling announcements 23% of the time" (straphangers campaign, 2014). Furthermore, announcements in New York are solely made in English.

All LIRR stations have displays of the scheduled trains and their stops and destination. Announcements are made regularly in the station to let passengers know if the train is on time, delayed or approaching the station. Inside the trains, displays along with announcements instruct passengers on the upcoming stops.

Conclusion

Accessibility is a factor that exacerbates the difference between older and newer systems. Regarding travel distance between stations, the older systems of Paris and New York appear more accessible. They have a higher number of stations per city area and a shorter distance between stations. As the newest transit system, the *Jihachul* still has to construct lines in order to better accommodate certain parts of the city. However, it should also be noted that unlike Paris and New York's predominantly flat topography, Seoul is famous for its mountainous landscape. A total of 18 mountains are registered in the city's area (Han and Yoon, 2014). These spaces, which are not inhabited and do not require transit service, slightly skew the station distribution. Passengers in all of the systems, aside from RER, were satisfied with the accessibility and layout of their system.

The other side of accessibility also emphasizes the transit systems' age. Ambulatory disabled passengers cannot be fully accommodated because they were not taken into account in the original Metro and the Subway designs. Also, because of the age and the underground foundation of both cities, structural modifications are difficult and extremely expensive. While the NYC Subway has been making gradual progress in offering accessibility services, Paris has compensated for its shortcomings by developing its bus system. The *Jihachul*, as a much newer system, was able to address the special needs of disabled passengers in its early stages of construction. Finally, New York and Paris lack consistency across their systems in regards to voice announcements. Paris should provide Multilanguage information on all of its trains not only a select few. New York should not only provide Multilanguage announcements, it should be able to provide basic English announcements consistently on all of its lines like on the LIRR. The MTA must also remediate the issue with providing real-time information on its lettered lines.

Part 4: Operations

"Service reliability is a key success factor for mass transit systems and is often identified by passengers as the most important aspect determining service quality" (Barron et al., 2013). Every transit operator must deal with incidents, such as equipment and power failures, suicides, or natural hazards that create delays and impact customer satisfaction. "Furthermore, major delays are the subject of media attention in most countries, and delays can impact both an operator's public perception and its relationship with the government, potentially affecting decisions on funding" (Barron et al., 2013). While all transit systems experience such disturbances, some encounter more than others. The ability to deal with disruptive incidents also varies from one system to the next.

Multiple Key Performance Indicators (KPI), that measure service quality, must be met so as to offer reliable services to users. Wait Assessment (WA) is an indicator that measures the amount of time a passenger is required to wait for the next train. The permissible wait period is the headway time plus 25% of that time; as such, with a 10 minute headway, a wait time that exceeds 12:30 minutes does not meet the standards. Terminal On-Time Performance (OTP) is another KPI that measures the percentage of trains arriving at their terminal location within 5 minutes of their scheduled arrival time. The Mean Distance Between Failure (MDBF) assesses the distance traveled by a train car before it breaks down, or requires maintenance (Ferrer, 2015). This chapter will compare the service reliability provided by the systems of Paris, New York and Seoul. While not all three systems use the same indicators to measure their reliability, those provided for each allow for a rough comparison in service-quality assessment.

Paris

The Metropolitain has been stable and reliable in its service supply for the past few years. Figure 4.1 tabulates peak hour performances and WA during off peak hours for each line in 2014:

Figure 4.1: On-Time-Performance and Wait Assessment Metropolitain

Line	**OTP Peak Hours (%)**	**WA during Off Peak hours (%)**
1	100.1	99.4
2	99	98
3	99.2	97.2
4	96.8	98.5
5	98.3	97.8
6	96.4	96.3
7	98.4	96.9
8	99.8	97.4
9	99.6	96.3
10	99.2	97.7
11	98.4	98.6
12	98	98.5
13	96.2	98.7
14	101	99.8
Total System Average	**98.6**	**97.9**

Source: STIF Bulletin de Ponctualité, 2015

All lines, except for line 13, met the contractual requirements of 96.5% performance during peak hours. Lines 1 and 14 have even exceeded perfect performance – lines 8 and 9 are close to supplying similar service quality. On the other hand, even with a remarkable average of 97.9%, only half of the lines meet the contractual agreement of 96.5% WA during off peak hours. On average, Parisians graded their metro's service with a 3.29 out of 5. User feedback adequately matched performance rates, since Parisians complained about line 13 but were otherwise quite satisfied with the Metro's service supply.

After experiencing a particularly dark year in 2013 in terms of commuter rail punctuality and reliability, the RATP and SNCF saw a slight improvement in their performances. However, small improvements did not save the RER from receiving the worst grade in punctuality, a 2.26, out of all of the other systems.

Figure 4.2 below, although showing data for lines A and B, reflects the scheduled headways across all five RER lines. The core of Paris (or zone 1) is well serviced while the branches that extended across Ile-de-France to service regional commuters are much sparser. This is especially visible after 9:30pm, which can be considered early to begin reducing train traffic. A delay is therefore a lot more costly for regional commuters than for Parisian inhabitants.

Figure 4.2: Headway times for RERs A and B

RER	Location	During Peak Hours	During Off Peak Hours	During Night Hours (+9:30pm)
A	Intramural/Core/Zone1	2 min	3:20 min	7:30min
	Ile-de-France branches	3:20/5/10 min	6:40/10/20 min	15/30min
B	Intramural/Core/Zone1	3min	5min	6min
	Ile-de-France branches	6min	15min	15min

Source: STIF Schema Directeur du RER A, May 2012 /STIF Schema Directeur du RER B Sud, April 2013.

The main reason for passenger dissatisfaction can be seen in Figure 4.3. In 2014, the RER's OTPs were well below the contracted goals. With only 84.8% of its trains running on time, the RER A was the worst performer.

Figure 4.3: RER OTP

RER Line	A	B	C	D	E	Total Average
OTP (%)	84.8	88.1	89.6	86.5	94.3	88.6
Contracted Goal (%)	94	94	93	92.5	95	93.7

Source: STIF Bulletin de Ponctualité, 2015

The RER A is the busiest regional commuter line in Ile-de-France and the most used transit line in Europe. It services over 25% of all RER passengers, e.g. 1.2 million commuters (STIF et al., May 2012). It has been performing below expectations for years, heightening user frustration until early 2015, when passenger advocacy groups threatened to take judicial action against the RATP, the SNCF, and the STIF. RER A riders are tired of the daily disruptions which include delays, canceled trains, and traffic interruptions. While riders may be guilty of causing delays such as the 2:30 hour service disruption after a suicide (Le HuffPost, 2012) or the necessary police intervention occasioned by abandoned items, most issues are fully attributable to the operating rail company.

In the past few years some users, to reduce their daily commutes, were forced to move into the Paris core from their suburban homes. Before moving, these users spent twice the necessary amount of time commuting and arrived to work late every day (Ricard and Bolo, 2015). This growing trend defies the fundamental purpose of a commuter rail. The latter is supposed to connect suburban or outer areas to the city center in order to decrease the inner city's density and congestion. Through its unreliable service, the RER A has been encouraging the opposite dynamics.

In response to the recent user accusations, Pierre Seme, the Vice-President of the STIF, claimed that "if the line was not efficient, 1.2 million people wouldn't be using it." He also added that 85% of the trains are less than 5 minutes late and dysfunctionalities causing over 15 minute delays remain rare" (Gril and Bourdin, 2015). He went on to reassure the public that by 2017 all trains on the 40-year-old line would be renewed, and that an automatic speed piloting system would be introduced with the hopes of easing trains in and out of stations faster (Gril and Bourdin, 2015).

Another major issue causing train service disruptions in the capital is the French's notorious inclination towards organizing mass strike events. Statistics have shown that transportation is the sector most affected by the consequences of national strikes. In the past twelve years, 110 strike notices were provided to the SNCF alone (Baruch, 2014). That is an average of nine strike periods per year. In 2003, 380,000 strike days were cumulated between 180,000 railroad employees; this translates to two strike days per employee. In 2013, these numbers were reduced by half to 170,000 strike days (Brunon and Berthelot, 2014). While still high, numbers have gone down for various reasons; the first is that companies no longer compensate their employees for strike days. The second is that unions, closer to the Socialist Party currently in place, do not want to exert too much pressure on the government (Andolfatto, 2012). Finally, while the right to strike is often used to express discontent over maters of importance such as social dumping, the suppression of the "ecotaxe" or retirement funds, it can also be taken advantage of. On January 29th 2015, RER A train conductors decided to go on a spontaneous strike at 6am after one of their colleagues was assaulted. The disruptions caused on the line were consequential both on a human – with over a million people left without transportation – and an economic level. Many passengers were furious and felt disrespected, "it is simply disgraceful and irresponsible. An assault on a conductor of the RATP, no matter how unjust it was, does not legitimize the lightning raid action of his colleagues" (de Valicourt, 2015).

New York

With the recent fare hikes in NYC (March 2015), passengers have been expecting better service, less delays and shorter wait times. However, instead of rising, service reliability has been decreasing across the city's subway system. Delays and service cancellations, while extremely heterogeneous and varying from line to line, have been happening more regularly, affecting passenger itineraries and causing frustrations (Ballaban, 2015).

In the survey conducted for this project, New Yorkers graded the punctuality of their subway system with a 3.25 out 5; while expressing a positive assessment of the Subway's service, this number does not reflect the great performance disparities among the lines. For example, differences are seen in rush hour headway times; some trains can run as quickly as 2:30 min apart (lines 6 and 7) while others have a headway of 7:30-8:15 minutes (lines R and B). During off-peak hours, however, most trains are scheduled 8 minutes apart while all trains are set to run every 20 minutes overnight, an uncommon privilege for subway riders around the world (straphangers campaign, 2014).

Service quality decreased as a whole in 2014; wait assessment standards were met only 78.8% of the time during weekday schedules. There were 8.8% of minor gaps (wait time exceeds headway by over 25% to 50%), 6.1% of medium gaps (wait time exceeds by 50% to 100%), and 6.4% of major gaps (wait time is more than doubled) as shown in Figure 4.4.

Figure 4.4: Wait Assessment NYC Subway

	Met Standards	Minor Gap	Medium Gap	Major Gap
Weekday (%)	78.8	8.8	6.1	6.4
Weekend (%)	85.2	7.6	3.9	3.3

Source: Ferrer et. al "Transit & Bus Committee Meeting." (January 2015).

Low service quality is also reflected in the Subway's terminal OTP performances. In 2014, only 74% of weekday trains arrived either early or within the 5 minute limit. This is a 7.9% decrease from 2013. Figure 4.5 further emphasizes the system's disparities between numbered and lettered lines. The latter are overall less reliable.

Figure 4.5: Terminal On-Time-Performance NYC Subway

	Met Standards System wide	Met Standards Numbered Lines	Met Standards Lettered Lines
Weekday (%)	74	69	78.1
Weekend (%)	81.2	78.9	82.7

Source: Ferrer et. al "Transit & Bus Committee Meeting." (January 2015).

In addition, the MDBF decreased 7.9% in 2014, moving from 153,382 miles between failures in 2013 to 141,202 miles in 2014, implying an increase in material failures and incidents (Ferrer, 2015). The Straphangers Campaign found that car breakdown rates increased 11.2% between 2011 and 2013 especially affecting thirteen of the system's lines. MDBF is also very unequal across the 21 lines; in 2013, the E line counted a mechanical failure for every 546,744 miles while the C line trains broke down an average of once every 58,859 miles (straphangers campaign, 2014).

These performances are a major source of concern for passengers. Over 56,000 causes for delays across the system's 21 lines were recorded each month in 2014. The MTA has blamed many of these on overcrowding which doubled the cases of service disruption since 2013 (Ballaban, 2015); indeed, according to the MTA, 30% of delays are caused by riders trying to cram onto trains" (Donohue, 2015). While ridership has increased in the past years, the numbers do not adequately correlate with the high increase in delays. The MTA also defends its performance assessment with the argument that "subway signals in some areas are 70 years old and prone to fail" (Donohue, 2015), causing many right-of-way delays (produced by malfunctions in switches, signals, and rails). Finally, the subway system is still said to be suffering from the aftermath of hurricane Sandy.

The commuter rail was attributed a slightly better grade of 3.51 out 5 in the survey, even though commuters complained of low train frequency. Indeed, the LIRR has relatively long headway times that vary for each station according to the number of daily users. The times are compiled in Figure 4.6 (these times are not applicable to the midnight to 6am schedule):

Figure 4.6: Headway LIRR

Level of Service in Station	Weekday Peak	Off-Peak	Weekend
Level 1 (+6,000 riders/day)	20 minutes	60 minutes	60 minutes
Level 2 (2,000-6,000 riders/day)	30 minutes	60 minutes	60 minutes
Level 3 (1,000-1,999 riders/day)	45 minutes	90 minutes	90 minutes
Level 4 (-1,000 riders/day	60 minutes	120 minutes	120 minutes

Source: MTA Supplementary Information, 2011-2015

Like the Subway, the LIRR's performance decreased in 2014 with evening peak hours experiencing the biggest delays: only 86.5% of trains were punctual across the system's eleven branches. The average LIRR delay was of 12:10 minutes (Castillo, 2015). The Port Jefferson branch performed the worst with only 88% of trains running on time. "The Montauk, Ronkonkoma, Huntington and Port Jefferson branches historically have the lowest OTP because they are the branches with the most operational challenges" (MTA Press Releases, 2015). Overall, the system ran 92.15% of its trains within the required standards, a number that places the LIRR's reliability far higher than that of the Subway. Until 2015, the LIRR had the same OTP goal of 95.1% set for all eleven of its branches; only two of these – the Hempstead Branch and the Far Rockaway Branch – ever met the standards. This year, however, independent goals based on past performances were set for each branch.

Figure 4.7: On-Time-Performance and New Goals LIRR

Branch	**OTP 2014 (%)**	**New Goals for 2015 (%)**
Babylon	91.4	93.9
Montauk	89.9	90.8
Ronkonkoma	90.3	91.6
Hunt/Hicks	89.6	92.5
Port Jefferson	88	90.9
Port Washington	93	95.3
Hempstead	95.1	96.5
Long Beach	93.7	95.9
Far Rockaway	95.6	96.6
Oyster Bay	92.8	94.1
West Hempstead	94.3	95.8
System Average/Overall Goal	**92.15**	**94**

Source: MTA Press Releases, 2015

In regards to MDBF, the LIRR has been exceeding its goal for the past five years. Older electric trains with a 55,000 mile MDBF goal have reached on average 97,000 miles before breaking down, while newer trains exceeded their 355,000 mile MDBF goal by running for 485,000 miles. Faced with such positive numbers, the MTA has raised the 2015 targets to 75,000 miles for older cars and 400,000 miles for newer fleets (MTA Press Releases, 2015).

Even though the LIRR performs better than the subway, users complained in the survey of delays, equipment issues, and lengthy wait-times reflective of long headways. A main concern for riders was the maintenance issues and delays caused by weather conditions, especially considering the system shutdowns that are caused by bad weather.

Seoul

Seoul's subway system stands out as extremely reliable against that of Paris and New York. Even though trains run slower on lines 1-4 than on lines 5-9 because of the age difference, they are still overall extremely performant. This is visible through the headway times compiled in Figure 4.8.

Figure 4.8: Headway *Jihachul*

Line	1	2	3	4	5	6	7	8
Peak (min)	3	2:30	3	2:30	2:30-3	4-5	2:30-4	4:30-6
Off-Peak (min)	4	6	6:30	5:30	5	6	5	6

Source: Rail Safety Information system, 2008. Note: Line 9 does not differentiate between peak and off-peak hours but between local, with a 5 minute headway, and express, with a 10 minute headway.

Compared to the other two cities, the difference between peak and off peak headway in Seoul is much slimmer. Services are more or less provided continuously and more evenly throughout the day.

Figure 4.9: On-Time-Performance *Jihachul*

Operating Company	MTR (1-4)	SMRT (5-8)	Seoul Metro Line9 (9)
OTP (%)	99.9	98.5	99.9

Source: SMG, 2014

From the data provided by the operating companies, the system's punctuality, as shown in Figure 4.9, appears close to perfect. Users agreed by grading the *Jihachul* accordingly with a 4.26 out of 5 on punctuality.

To decrease the potential for right-of-way incidents and technical failures that cause delays, Seoul uses state-of-the-art rolling stock supervision, control and monitoring that "establishes diverse signaling systems for safe and comfortable train operation" (SMRT, 2012). Platform screen Doors also provide the means to meet punctuality standards, by reducing the potential for human error; PSDs "enhance train drivers' concentration on train operations" (SMRT, 2012) so that conductors are not distracted by what might be occurring on the platform. Furthermore, PSDs reduce headway and wait time by allowing trains to approach the stations at a much faster speed since passenger safety is not a concern. This is especially useful during rush hours; trains can "circulate faster and more efficiently" (Rowan, 2014). This is also reflected in the Paris Metro where lines 1 and 14, fully equipped with PSDs, operate successfully over 100% of the time. Finally, in 2013, the SMRT launched an application to aid staff file report failures, incidents or damaged equipment more efficiently. This resulted in a 40% reduction in material-related incidents and "has significantly reduced the fault response time" which in turn has helped decrease delays on the lines (Edwards, 2013). All of these factors contribute to the system's low level of accidents:

Figure 4.10: Accident Frequency *Jihachul*

Operating Company	MTR (1-4)	SMRT (5-8)	Seoul Metro Line9 (9)
#Accidents per year	3	3	1

Source: SMG, 2014

The scarcity of accidents on Seoul's subway lines does mean however, that when they do occur, accidents tend to stand out in the system's history. The rear-end collision mentioned in the previous chapter especially stood. It was partly caused by frequency disruptions resulting from the incompatibility between the line's older and newer safety systems. In response, the SMRT has already placed an order to substitute all old trains with newer that are integrated with the updated security system; this will hopefully minimize risks of future incidents and service disruptions (Park, 2014). As the busiest line in the system, the SMRT's 2nd line experiences the most issues, even though these may be infrequent. For example, on a day in May 2014 service was delayed during rush hours because of the "crowd and [the necessity] to secure and maintain a safe distance between trains" (Suh, 2014). Most cases of rail incidents or disruptions in Seoul appear isolated. This implies better quality service on the part of the Korean system but obviously demonstrates that perfection in terms of reliability and punctuality is not feasible.

Conclusion

From the data provided by each system's operators, as well as the users' feedback related through the media and the survey, a comparison may be drawn between the three transit systems in regards to reliability and service quality. Seoul's system, through its mostly even distribution of short headways and its remarkable on-time performances, outshines the other two cities' systems. Seoulites recognize their transit system as being reliable and offering quality service. From these observations, it can be assumed that the safety features of Seoul's transit system greatly help in providing reliable transportation for the public.

On the other hand, New York and Paris have much less reliable systems. Performances between Paris's Metro and RER systems could not be more opposite. Although Parisian users remained somewhat critical (as the French often are), the Metro provides efficient and punctual services that have been aided by intergrading new safety systems like those found in Seoul. Riding the RER, however, is seen as a daily hellish experience by passengers. Headways discriminate between inner and outer rings of the metropolitan area and delays have become so frequent that they are expected. Furthermore, the high number of users that take the line does not justify the operator's inability to provide the best possible services to its public: the *Jihachul* service 5million people more than the RER on a daily basis.

In New York City, the opposite can be observed. Users are more satisfied with the performances of their commuter rail than their subway. Even though LIRR trains could run more frequently, be less susceptible to weather conditions, and reduce delays, they still perform better than the Parisian commuter rail. The Subway, however, is very heterogeneous in its service; some lines perform much better than others. Still, the overall train punctuality has been decreasing and delays have become more recurrent to the dissatisfaction of New Yorkers.

Conclusion

This study has provided a multi-city assessment of subway and commuters rails according to four main factors: affordability, safety, accessibility, and reliability. Analyzing Paris, New York, and Seoul's systems from a comparative perspective allows an overview of successful or failing policies, possible shortcomings and obstacles, and possible improvements. Each system's strengths and weaknesses, whether within the operator's control or not, are more easily discernible. While user perspectives have been proven to be culturally relative through the administered survey and do not always reflect the system's actual performance, they do reveal the expectations of each individual population. In order to meet these expectations and increase ridership to provide more efficient and sustainable public transportation, systems must meet all of the standards. Indeed, the four factors in this study are interdependent. Failing to meet the standards in one aspect greatly hinders the ability to meet the others.

The era of development in which each rail system originated is the primary influence on their current state and performance. Paris and New York's transit systems, although located on two different continents, share many similarities because they were developed around the same time period; they are now faced with many of the same challenges.

As systems have been accumulating past debts and facing greater financial instability, the concept of public transit affordability has taken on new meaning in the last few years. Setting fares and relying on outside sources of funding have become even more complex and delicate to balance. In terms of affordability, Korean passengers are the most privileged. Unlike Parisians and New Yorkers, who have been experiencing accelerated fare hikes in the last few years, Seoulites, even though they are responsible for 80% of their system's budget, are only starting to feel the weight of their transit's financial burden. In Paris, users are dissatisfied with the cost of their public transportation services even though most of these are subsidized. New Yorkers, on the other hand, are divided between an affordable subway and an expensive LIRR. In general, affordability is the factor that received the worst grades, no matter the system. While consumers would always prefer their services to be cheaper, the costs of operation and developments to provide better services incur costs that cannot always be government or tax subsidized. This is especially apparent in Seoul, where the current funding structure cannot sustain expansion for much longer, forcing the SMRT, MTR, and Seoul Metro to find new sources of revenue. They have already turned to the American and French system for ideas on how to overcome this barrier. While funding is an issue for Seoul, fare structure and collection is not. Paris and New York fall short in this aspect. New York is still stuck using magnetic striped tickets and a base fare in its subway, and uses a completely different fare collection system for its commuter rails. Paris, on the other hand, offers an array of partially or fully subsidized pass cards that easily confuse users, and has tried to unify both its Metro and RER lines under the same fare structure resulting in a complex cost measurement for suburban commuters.

Safety and comfort are interconnected with affordability; the higher the fares, the higher the passengers' expectations. In this respect, Seoul, with its more modern system, meets the current standards. Stations are designed with safety in mind; the use of platform screen doors affords greater security and has the additional advantage of keeping tracks clean, thereby reducing fire hazards. Stations are clean and provide the basic comforts, and passengers are kept informed of train arrivals at all times. Although characterized by a strong ridership etiquette and an overall low crime rate, the Seoul system must make progress in increasing women's feeling of safety. Once more, Paris and New York face many similar issues in terms of safety and comfort. Both systems have higher crime rates that require the presence of security personnel and a police force. They are also both failing in terms of design and cleanliness. Improving on the former has obvious obstacles that would require substantial modernization; whereas the latter is very much achievable. While Paris has been gradually equipping its system with PSDs, their absence in New York City is an important shortcoming that places the system at a disadvantage in terms of both cleanliness and safety. Both cities must also work to reduce the amount of incivilities on its transit systems.

Accessibility has become a new standard in public transit as rail systems are expected to cater to all passengers and not only the majority. They must provide services for both disabled passengers and those living in more remote areas. Subway users in all three cities were satisfied with the accessibility of stations in terms of location. For commuter rails, opinions were much less positive. Especially in Paris, efforts must be made to improve services in Ile-de-France so as to reduce the dependence on automobiles. Accessibility for disabled minorities is not as even across the systems. Seoul once more outshines the other two cities by providing stations that adapt to standards. On the other hand, Paris and New York, because of the systems' age cannot provide such high quality services. Paris has found alternatives such as an adapted bus system; while New York still struggles to fit its Subway to its passengers' needs.

Finally, reliability is probably the most reflective factor of a system's quality. Although experiencing a few accidents in the last few years, Seoul is a very reliable system; trains are punctual and incidents contained. New York, however, has been experiencing an increase in delays on its subway system caused by overcrowding and maintenance issues. The biggest shortcoming is seen on Paris's RER lines. The Metro's remarkable reliability is overshadowed by the RER's continuous delays and disruptions and the impact these have on commutes.

Overall, Paris and New York must modernize their systems in order to provide better services and performance. This, however, is unlikely given the current state of both cities' funding structure. Because thoroughly updating their current systems to meet the standards that Seoul has achieved in many areas is implausible, both systems must continue developing alternative strategies that will help meet standards. Innovations and successes applied in Seoul's system should, however, be taken into account for the systems' expansion.

All three cities have evolved to become hybrid cities; the capital development programs set for the next few years maintain cities on this path. Although they increase transit availability, developments probably will not substantially impact automobile use. Unless a major social, economic or political shift occurs, these cities will continue down this path dependency until full saturation. The transfer from a hybrid city to a transit-oriented one will require the appearance of a new set of challenges or requirements that will force the city or society to switch path dependency. In the meantime, improving public transport services that meet user expectations to increase ridership can alleviate congestion issues, decrease gas emissions and overall better a population's quality of life.

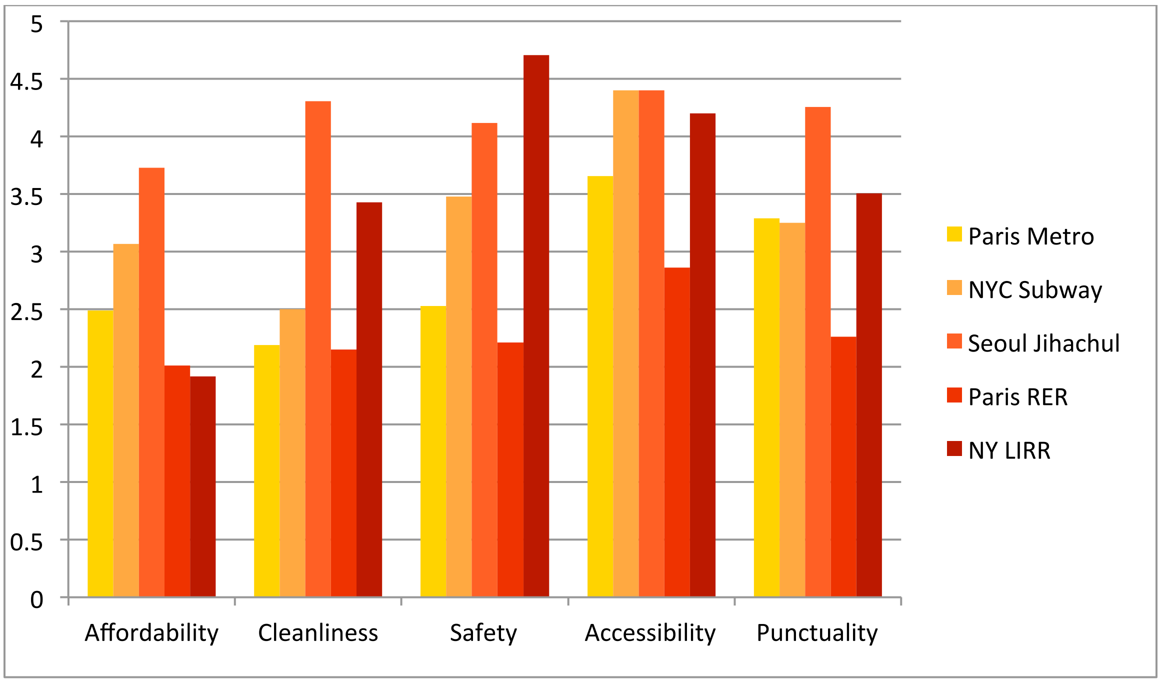
Appendix 1: Compiled Survey Results

The survey was conducted in January 2015 and administered to 100 users in each city. The gender and age distribution for each are as follows:

Paris	
Men	44%
Women	56%
18 & under	2%
18 to 24	82%
24 & up	16%

New York	
Men	55%
Women	45%
18 & under	0%
18 to 24	20%
24 & up	80%

Seoul	
Men	36%
Women	64%
18 & under	0%
18 to 24	51%
24 & up	49%



	Paris		New York		Seoul
	Metro	RER	Subway	LIRR	Jihachul
Affordability	2.49	2.01	3.07	1.92	3.73
Cleanliness	2.19	2.15	2.5	3.43	4.31
Safety	2.53	2.21	3.48	4.71	4.12
Accessibility	3.66	2.86	4.4	4.2	4.4
Punctuality	3.29	2.26	3.25	3.51	4.26

Appendix 2: SURVEY

Gender: □ Female
□ Male

Age: □ Under 18
□ 18 to 24
□ 24 & Up

■ Please grade on a scale of 1 to 5 (with 1 being the most displeased with and 5 the most pleased with) the following aspects in regards to the **New York City Subway.**
Please add any comments or factors which may influence your grading.

	1	2	3	4	5	Comments
Cleanliness (1=very dirty 5=clean)						
Affordability (1=very expensive 5=very cheap)						
Punctuality (1=always late 5=always on time)						
Accessibility* (1= difficult to access 5=easily accessible)						
Safety (1=feel very unsafe 5=feel very safe)						

■ Please grade on a scale of 1 to 5 (with 1 being the most displeased with and 5 the most pleased with) the following aspects in regards to the **LIRR/Metro North/NJ Transit.**
Please add any comments or factors which may influence your grading.

	1	2	3	4	5	Comments
Cleanliness (1=very dirty 5=clean)						
Affordability (1=very expensive 5=very cheap)						
Punctuality (1=always late 5=always on time)						
Accessibility* (1= difficult to access 5=easily accessible)						
Safety (1=feel very unsafe 5=feel very safe)						

*Accessibility here refers to the location of the stations, i.e. closeness to the place of residence or ease of access through other means of public transport

Appendix 3: SONDAGE

Sexe: □ Femme
□ Homme

Age: □ Moins de 18 ans
□ Entre18 et 24 ans
□ Plus de 24 ans

■ Sur une échelle de 1 à 5 (avec 1 représentant le moins satisfaisant et 5 le plus satisfaisant) veuillez noter le **Metro Parisien** par rapport aux critères suivant**.**
Veuillez ajouter tout commentaire ou facteur influant votre note.

	1	2	3	4	5	Commentaires
Propreté (1=très sale 5=très propre)						
Prix (1=trop cher 5=très abordable)						
Ponctualité (1=toujours retardé 5=toujours à l'heure)						
Accessibilité* (1=difficile d'accès 5=facile d'accès)						
Sécurité (1=très sécurise 5=aucune sécurité)						

■ Sur une échelle de 1 à 5 (avec 1 représentant le moins satisfaisant et 5 le plus satisfaisant) veuillez noter le **RER** par rapport aux critères suivant**.**
Veuillez ajouter tout commentaire ou facteur influant votre note.

	1	2	3	4	5	Commentaires
Propreté (1=très sale 5=très propre)						
Prix (1=trop cher 5=très abordable)						
Ponctualité (1=toujours retardé 5=toujours à l'heure)						
Accessibilité* (1= difficile d'accès 5=facile d'accès)						
Sécurité (1=très sécurise 5=aucune sécurité)						

*Accessibilité fait référence au placement des gares, c'est-à-dire la distance par rapport au lieu de résidence et la facilite d'accès par d'autres moyens de transports publics

Appendix 4: □□□□

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Bibliography

"About Us - History." *SMRT*. Seoul Metropolitan Rapid Transit Corp. Web.<http://www.smrt.co.kr/main/publish/view.jsp?menuID=002005004>.

"Afficheurs électroniques / Panneaux Lumineux - Data Display." *Afficheurs électroniques / Panneaux Lumineux - Data Display*. Web. <http://www.datadisplayfrance.com/>.

Anderson, R.J., Findlay, N.S. and Graham D.J. "Improving Fares and Funding Policies to Support Sustainable Metros." *Transportation Research Record* (2011).

Andolfatto, Dominique. "La France est-elle vraiment la championne du monde des grèves ? La réponse rn chiffres." Atlantico.fr. 27 Oct. 2012. Web. <http://www.atlantico.fr/decryptage/france-est-elle-vraiment-championne-monde-greves-reponse-en-chiffres-dominique-andolfatto-526723.html/page/0/1>.

"Articles L.3261-2 et R.3261-1 à R.3261-5." Code du travail. Lettre-circulaire Acoss n°2009-24.16 Feb, 2009.

Ascher, Kate, and Wendy Marech. *The Works: Anatomy of a City*. New York: Penguin, 2005. Print.

Baker, Brian. "Seoul Subway: One of the World's Most Advanced Transport System." *City Mayors: World Metros 20*. 31 Mar. 2012. Web. <http://www.citymayors.com/transport/seoul-subway.html>.

Ballaban, Michael. "You Are Not Insane, The New York City Subway Is Getting Worse." Jalopnik. 3 May 2015. Web. <http://jalopnik.com/you-are-not-insane-the-new-york-city-subway-is-getting-1687817007>.

Barron, Alexander, Patricia Melo, Judith Cohen, and Richard Anderson. "Passenger-Focused Management Approach to Measurement of Train Delay Impacts." *Transportation Research Record: Journal of The Tranportation Research Board* 2351 (2013): 46-53. Web.

Barter, Paul A. "A Broad Perspective on Policy Integration for Low Emission Urban Transport in Developing Asian Cities." (Jan 2004). *Policy Integration towards Sustainable Energy Use for Asian Cities: Integrating Local Air Pollution and Greenhouse Gas Emissions Concerns,* Global Environment Strategies, Kanagawa, Japan. Web.

Baruch, Jeremie. "En douze ans, 110 préavis de grève à la SNCF." Le Monde. 24 June 2014. Web. <http://www.lemonde.fr/les-decodeurs/visuel/2014/06/24/en-douze-ans-110-preavis-de-greve-a-la-sncf_4444359_4355770.html>.

Bessen, Jeff. "Cedarhurst LIRR Station to Get Security Cameras." *Five Towns Heralds*. 17 Feb. 2015. Web. <http://liherald.com/fivetowns/stories/Cedarhurst-LIRR-station-to-get-security-cameras,63962>.

Big, Bigger Biggest - Le Metro De Paris. National Geographics Channel, 12 Jul 2011. Web. <http://www.natgeotv.com/fr/big-bigger-biggest/videos/metro-paris>.

Bonjean, Fanny. "RATP: Une trentaine de personnes meurent chaque année dans le métro ou le RER Parisien." *RTL.fr*. 1 May 2014. Web.<http://www.rtl.fr/actu/societe-faits- divers/ratp-une-trentaine-de-personnes-meurent-chaque-annee-dans-le-metro-ou-le-rer-parisien-7771613657>.

Bleiwas, Kenneth B., and Thomas P. DiNapoli. *Financial Outlook for the Metropolitan Transportation Authority*. New York, NY: Office of the State Comptroller, New York City Public Information Office, 2014. Oct. 2014. Web.

Bounoua, Melissa. "Mais pourquoi ça pue autant dans le Métro Parisien ?" Rue89. 25 Feb. 2010. Web. <http://rue89.nouvelobs.com/2010/02/25/mais-pourquoi-ca-pue-autant-dans-le-metro-parisien-140401>.

Brunon, Damien, and Pascal Berthelot. "Pourquoi la SNCF fait de moins en moins grève." Europe 1. 20 Mar. 2014. Web. <http://www.europe1.fr/economie/pourquoi-la-sncf-fait-de-moins-en-moins-greve-1918821>.

Buehler, Ralph. "Determinants of Transport Mode Choice: A Comparison of Germany and the USA." *Journal of Transport Geography* 19.4 (2011): 644-57. Web. https://ralphbu.files.wordpress.com/2011/09/buehler_germany_usa_jtg.pdf

Campbell-Dollagan, Kelsey. "Inside NYC's Dazzling New $1.4 Billion Subway Station." Gizmodo. 10 Nov. 2014. Web. <http://gizmodo.com/inside-nycs-dazzling-new-1-4-billion-subway-station-1656793731>.

Calvier, Celine, and Francoise Jacquesson. "En Ile-de-France, l'usage de la voiture pour aller travailler diminue." *www.insee.fr*. Data.gouv.fr, Jan. 2015. Web. http://www.insee.fr/fr/themes/document.asp?reg_id=20&ref_id=22046

"Caractéristiques Du Réseau, Accessibilité Et Intermodalité." *OMNIL*. 2013. Web. <http://www.omnil.fr/spip.php?article117>.

Castillo, Alfonso A. "New LIRR Report Blames Public for 2014 Rise in Train Lateness." *Styrk*. Newsday, 18 Jan. 2015. Web. <http://www.styrk.com/posts/new-lirr-report-blames-public-for-2014-rise-in-train-lateness>.

Castillo, Alfonso A. "LIRR Passenger Cars Would Get Security Cameras Under MTA Proposal - Newsday." *Newsday*. 30 Aug. 2014. Web. <http://www.newsday.com/long-island/lirr-passenger-cars-would-get-security-cameras-under-mta-proposal-1.9189585>.

Chen, Anna. "A Better Blue Line: Taking a Look at Some Station Improvements." *Metros The Source*. 16 Dec. 2014. Web. <http://thesource.metro.net/2014/12/16/a-better-blue-line-taking-a-look-at-some-station-improvements/>.

Cho, Kang-Su, and Joon-Ho Choi. "What to Do When the Shells Hit Seoul." *Korea JoongAng Daily*. 10 Dec. 2010. Web. <http://koreajoongangdaily.joins.com/news/article/article.aspx?aid=2929444>.

Cho, KyeWan. "South Korea's Middle Cass is Shrinking, According to Recent Report." *Business News: The Hankyoreh*. 13 Feb. 2015. Web.

Collet, Valerie. "La RATP prepare l'automatisation de la ligne 4 du Metro Parisien." Le Figaro. 3 Apr. 2013. Web. <http://www.lefigaro.fr/societes/2013/04/02/20005-20130402ARTFIG00282-la-ratp-prepare-l-automatisation-de-la-ligne-4-du-metro-parisien.php>.

Cornevin, Christophe. "Train Et Metro: Les lignes les plus dangereuses à Paris." *Le Figaro*. 25 Sept. 2011. Web. <http://www.lefigaro.fr/actualite-france/2011/09/25/01016-20110925ARTFIG00235-train-et-metro-les-lignes-et-stations-les-plus-dangereuses.php>.

La Cours Des Comptes. "La soutenabilité de la dette de la RATP." *Communication à la Commission Des Finances De L'Assemblée Nationale* (2009). Web.

"Crime Index by City 2015." *Numbeo*. Web. <http://www.numbeo.com/crime/rankings.jsp>.

Crowe, Timothy. "Crime Prevention Through Environmental Design: Applications of Architectural Design and Space Management Concepts," 2nd Edition. Oxford: Butterworth-Heinemann. 2000.

"Cuomo: Police, National Guard Patrols Stepped Up In NYC Area Amid Heightened Terror Threat." CBS New York. 19 Sept. 2014. Web. <http://newyork.cbslocal.com/2014/09/19/cuomo-police-national-guard-patrols-stepped- up-in-nyc-area-amid-heightened-terror-threat/>.

De Fortanier, Diane. "Accessibilité : Le Métro Parisien À La Traine." Le Figaro. 16 July 2014. Web. <http://www.lefigaro.fr/actualite-france/2014/07/16/01016-20140716ARTFIG00330-accessibilite-le-metro-parisien-a-la-traine.php>.

De Valicourt, Benoit. "Grève du RER A : Mais que penseraient les salariés RATP-SNCF si les usagers les prenaient en otage la prochaine fois qu'un voyageur se fera agresser ?" Atlantico.fr. 30 Jan. 2015. Web. <http://www.atlantico.fr/decryptage/greve-rer-mais-que-penseraient-salaries-ratp-sncf-usagers-prenaient-en-otage-prochaine-fois-qu-voyageur-se-fera-agresser-benoit-1980810.html/page/0/1>.

Donohue, Pete. "Subway Fares Are Up — and So Are Train Delays: MTA Data." *NY Daily News*. 24 Mar. 2015. Web. <http://www.nydailynews.com/new-york/subway-delays-increased-mta-data-article-1.2159473>.

Donohue, Pete. "MTA to Put Cameras in Hundreds of Subway Cars." NY Daily News. 2 Oct. 2014. Web. <http://www.nydailynews.com/new-york/mta-put-cameras-1-000-new-subway-cars-5-years-article-1.1959217>.

Donohue, Pete. "90% of Subway Stations Have Structural Damage: Thomas DiNapoli." NY Daily News. 2 Oct. 2014. Web. <http://www.nydailynews.com/new-york/90-subway-stations-structural-damage-thomas-dinapoli-article-1.1960809>.

Donohue, Pete. "Help Point High-tech Intercoms on N.Y.C. Subways." NY Daily News. 24 Sept. 2012. Web. <http://www.nydailynews.com/new-york/point-high-tech-intercoms-installed-new-york-city-subways-article-1.1166323>.

Donohue, Pete. "Safer Subways upon Us, Believe It or Not." NY Daily News. 10 Mar. 2013. Web. <http://www.nydailynews.com/new-york/donohue-don-fooled-safer-subways-article-1.1284648>.

"Don't Shortcut Your Life." *Web.mta.info*. 2013. Web. <http://web.mta.info/lirr/safety/images/LIRRdontshortcutyourlife.pdf>.

Edwards, Simon. "South Korea's Urban Transport Innovations." Metro Americas. 22 Sept. 2013. Web. <http://metroamericas.com/2013/09/22/south-koreas-urban-transport-innovations/>.

Encyclopedia Britannica Online. Encyclopedia Britannica, Web. <http://www.britannica.com/>.

Erickson, Jennifer. "The Middle-Class Squeeze." *Center For American Progress*, 24 Sept. 2014. Web.

Evans, Sophie J. "Revealed: The Hidden Surveillance Cameras in New York Subway Stations That Are Disguised as Metal Pipes." Daily Mail Online. Associated Newspapers, 18 Jan. 2015. Web. <http://www.dailymail.co.uk/news/article-2915923/The-hidden-surveillance-cameras-New-York-subway-stations-disguised-metal-PIPES.html>.

"Fares & Tolls." *Mta.info*. Web. <http://web.mta.info/fares/>.

"Fares & Ticket Information." *MTA LIRR*. Web. <http://web.mta.info/lirr/about/TicketInfo/>.

"Fare Guide." *Metro Line 9*. Web. <https://www.metro9.co.kr/eng/guide/gu_charge01.jsp>.
Ferrer, F., J. Banks, J. Ballan, and A. Cappelli. "Transit & Bus Committee Meeting." (January 2015). Web. <http://web.mta.info/mta/news/books/pdf/150120_1030_transit-bus.pdf>.

Firetide. "Seoul Korea's Subway System." *Wireless Video Surveillance* (2011). Web. <http://www.firetide.com/files/8114/0122/6068/4.2.1-Case-Study-SeoulKoreaSubway-10_13.pdf>.

Gershon, Robyn R. M. "Public Transportation: Advantages and Challenges." *Oxford University Press-Journal of Urban Health: Bulletin of the New York Academy of Medicine* 82.1 (2005).

Gleyze, Jean-Francois. "La desserte de Paris par le réseau de Metro et de RER." *HAL Sciences de l'Homme et de la Société.* June 2007.

Goncharov, Alex. Chronological Scheme of the Paris Metro. 2011. Wikipedia. Web. <http://commons.wikimedia.org/wiki/File:Goncharov.fatal.ru_paris_metro_chronological_2011.png>.

Grand Paris Express. *Societe Du Grand Paris*. Youtube.com, 26 Nov. 2014. Web. <http://www.societedugrandparis.fr/english>.

Gril, Philippe, and Jean-Jacques Bourdin. "RER A - Les réponses du Stif à la colère des usagers." BFMTV. RMC Info, 4 Mar. 2015. Web. <http://rmc.bfmtv.com/emission/rer-a- les-reponses-du-stif-a-la-colere-des-usagers-il-faut-relativiser-867062.html>.

Grynbaum, Michael M. "Experimental Clocks Tell Straphangers If the Wait May Soon Be Over." The New York Times. The New York Times, 07 Mar. 2010. Web. <http://www.nytimes.com/2010/03/08/nyregion/08clocks.html?_r=0>.

Gunn, Dwyer. "Does “See Something, Say Something” Do Nothing?" New York Magazine.21 Sept. 2012. Web. <http%3A%2F%2Fnymag.com%2Fnews%2Fintelligencer%2Fmta-anti-terrorism-2012-10%2F>.

Han, Jean, and Seung-Ah Lee. "Seoul Metro Turns 40 in Safety and Security." *Korea.Net: The Official Website of the Republic of Korea*. N.p., 11 Sept. 2014. Web. <http://www.korea.net/NewsFocus/Society/view?articleId=121622>.

Han, Jeon, and Sojung Yoon. "Bukhansan Mountain Reveals Seoul's Hidden Beauty." Korea.net : The Official Website of the Republic of Korea. 5 Aug. 2014. Web. <http://www.korea.net/NewsFocus/Travel/view?articleId=120910>.

"How to Use the T-Money Card." *Hanintel*. 05 Aug. 2013. Web. <http://travelkorea.hanintel.com/2013/08/05/korea-t-money-card/>.

Harshbarger, Rebecca. "Subway Delays Skyrocket Because Riders Lack Basic Manners." New York Post. 24 Feb. 2015. Web. <http://nypost.com/2015/02/24/overcrowding-on-subways-leads-to-massive-spike-in-delays/>.

Hwang, KeeYeon, and Bongsoo Son. "The Effectiveness of Congestion Pricing in Seoul - The Case of Namasan 1&3 Tunnels in CBD." *Journal of the Eastern Asia Society for Transportation Studies* 2.6 (Autumn 1997): 2099-115. Print.

Hyundai Elevator Co.,LTD. PSD Hyundai Platform Screen Doors. Rep. 4th ed. Vol. 3. 2011. Print.

IEA, 2006. Co2 Emissions from Fuel Combustion: 1971–2004. International EnergyAgency, Paris, France.

Jang, Hyeok-Jin. "Subway Station Crimes Rise, But Few Penalized." *Korea JoongAng Daily*. 30 June 2014. Web. <http://koreajoongangdaily.joins.com/news/article/Article.aspx?aid=2991302>.

JLL, "Le Projet Du Grand Paris."*jll.fr*. 2014. Web. <http://www.grand-paris.jll.fr/le-projet-dugrand-paris/presentation-generale/id/48>.

Kelling, George L., and James Q. Wilson. "Broken Windows." *The Atlantic Monthly*. Atlantic Media Company, 01 Mar. 1982. Web. <http://www.theatlantic.com/magazine/archive/1982/03/broken-windows/304465/>.

Keyssar, Natalie. "Photos: Fulton Center Subway Station." *Wall Street Journal*. N.p., 10 Nov. 2014. Web. <http://www.wsj.com/articles/photos-fulton-center-subway-station-1415638339>.

Kim, Kyu-Nam, and Ae-Jin Jo. "Homeless Seoulites Seek Refuge From the Cold in Public Washrooms." The Hankyoreh. 17 Jan. 2013. Web. <http://www.hani.co.kr/arti/english_edition/e_national/570131.html>.

Kim, Gyengchul and Rim, Jeewook. "Seoul's Urban Transportation Policy and Rail Transit Plan – Present and Future." *Japan Railway & Transport Review* 25 (2000).

Kim, Seungjun. "A Driving Force for Sustainable Development and Remarkable Change, Seoul Metropolitan Subway." *Seoul Solution*. 26 May 2014. Web. <https://seoulsolution.kr/content/driving-force-sustainable-development-and-remarkable-change-seoul-metropolitan-subway?language=en>.

Kirby, Jen. "Here Are the New MTA Ads Targeting Manspreaders, Subway Eaters, and More." *Daily Intelligencer*. 22 Dec. 2014. Web. <http://nymag.com/daily/intelligencer/2014/12/mta-is-not-messing-around-with-new-psas.html>.

Kern-Jedrychowska, Ewa. "NYPD to Begin Kicking Out Homeless Seeking Shelter in Subways." The Huffington Post. 21 Feb. 2014. Web. <http://www.huffingtonpost.com/2014/02/21/nypd-homeless_n_4830978.html>.

Lee, Hyun-Jeong. "Subway Crime Rate Increases Sharply." *The Korea Herald.* 1 July 2014. Web. <http://m.koreaherald.com/view.php?ud=20140107000792&ntn=0>.

Lee, In-Keun. "Experience in Seoul Subway Development." *Seoul Metropolitan Government* (2004). Web.

Légifrance. "Le service public de l'accès au droit." Web. <http://www.legifrance.gouv.fr/>.

Le HuffPost. "Pourquoi les trains ont 2h30 de retard après un suicide." Le Huffington Post. Le Monde, 9 Dec. 2012. Web. <http://www.huffingtonpost.fr/2012/12/09/pourquoi-les-trains-ont-2h30-de-retard-apres-suicide_n_2267548.html>.

"La Ligne 14 Du Métro Parisien." *Le Tour Du Monde Des Métros En Images*. 15 Jan. 2010. Web. <http://www.linternaute.com/savoir/magazine/photo/le-tour-du-monde-des-metros-en-images/la-ligne-14-du-metro-parisien.shtml>.

Lussac, Claude, and Nathalie Marx. "Vessies Sous Tension: mais pourquoi n'y a-t-il pas de toilettes dans le métro parisien?" Atlantico.fr. 15 Jan. 2013. Web. <http://www.atlantico.fr/decryptage/vessies-tension-mais-pourquoi-t-pas-toilettes-dans-metro-parisien-claude-lussac-et-nathalie-marx-606440.html>.

Macherez, Felix. "Des sans-tickets Parisiens ont trouvé la solution pour ne plus jamais payer le métro | VICE | France." VICE. 11 July 2014. Web. <http://www.vice.com/fr/read/la-mutuelle-des-fraudeurs-du-metro-paris>.

Malcolm, Tom. "The Renaissance Man of New York's Subways." TR News 242 (January-February 2006): 8-13. Print.

Marguerite, Bruno. "De nouveaux écrans d'information pour les voyageurs." Portail Su STIF. 22 Jan. 2014. Web.

Marshall, Colin. "Subway Station Toilets: A Surprisingly Accurate Indicator of Urban Civilisation." The Guardian. 10 Apr. 2015. Web. <http%3A%2F%2Fwww.theguardian.com%2Fcities%2F2015%2Fapr%2F10%2Fsubway-station-toilets-indicator-urban-civilisation>.

Mazlan. "Seoul Subway & Taipei MRT (Metro), Two of the Top 4 Subways or MRT Systems in Asia." HubPages. HubPages, 29 Apr. 2014. Web. <http://hubpages.com/hub/Top-4-Subways-or-MRT-Systems-in-Asia-Part-2-Seoul-Metro-Taipei-MTR>.

"Metrobits.org - Metro, Subway, MRT, U-Bahn, Metrorail - Arts, Architecture, Lists, Fact Sheets, Guides, Photos." *RSS*. Web. 03 Apr. 2015.

Metro9. "FAQ." *Customer Services*. Web. <https%3A%2F%2Fwww.metro9.co.kr%2Feng%2Fcs%2Fcs_faq.jsp>.

Mo, Changhwan, and Suna Cho. "A Public Transport Funding Crisis in the Seoul Metropolitan Area and Possible Solutions." *KOTI World-Brief* 2.11 (March 2010). Web. <http://www.koti.re.kr/mail/pdf2/world10-11/focus.pdf>.

Mocker, Greg. "Wi-fi and Cell Service Arrive at 40 More NYC Subway Stations." New York's PIX11 WPIXTV. 16 Oct. 2014. Web. <http://pix11.com/2014/10/16/wi-fi-and-cell-service-arrive-at-40-more-nyc-subway-stations/>.

Molinie, William. "Transports en commun: la fraude en cinq chiffres." 20 Minutes Actualité. 11 July 2014. Web. <http://www.20minutes.fr/societe/1417139-20140711-transports-commun-fraude-cinq-chiffres>.

Morgan, T.B. "What a Car Means to a Boy." *Look* 23 (January 20, 1959): 84-90.

MTA. "July Financial Plan 2015-2018." *MTA 2015 Preliminary Budget* 1 (July 2014). Web.

MTA Board. "MTA Capital Program 2015-2019." New York: 2014. 24 Sept. 2014. Web. <http://web.mta.info/capital/pdf/Board_2015-2019_Capital_Program.pdf>.

MTA. "Supplementary Information for 1269(d) 2011-2015." Performance Goals by Agency. 2015. Web.

MTA. "Introducing MTA Subway Time® App." Mta.info. Web. <http://web.mta.info/apps/subwaytimeapp.html>.

"MTA Guide to Accessible Transit." Mta.info. Web. <http://web.mta.info/accessibility/stations.htm>.

"MTA Press Releases." MTA. 20 Jan. 2015. Web. <http://www.mta.info/press-release/lirr/mta-long-island-rail-road-sets-new-goals-boost-time-performance-improve-fleet>.

"Musée Des Transports Urbains, Interurbains Et Ruraux (AMTUIR) - Site Officiel." *Musée Des Transports Urbains, Interurbains Et Ruraux (AMTUIR) - Site Officiel*. 20 Aug. 2011. Web. <http://www.amtuir.org/>.

Myhre, Marina L., and Fabien Rosso. "Designing for Security in Meteor: A Projected New Metro Line in Paris." *Preventing Mass Transit Crime*. Monsey, NY: Criminal Justice, 1996. 199-213. Print.

Na, Jeong-Ju. "Cameras to Watch Subway Passengers." The Korean Times. 17 May 2012. Web. <http://www.koreatimes.co.kr/www/news/nation/2012/06/116_113238.html>.

Neff, J., and Larry H. Pham. *A Profile of Public Transportation Passenger Demographics and Travel Characteristics Reported in On-board Surveys*. Washington, DC: American Public Transportation Association, 2007. Web.

Newman, Andy. "New Subway Etiquette Campaign: 'Please Don't Urinate in This Area'" The New York Times. 02 Mar. 2015. Web. <http://cityroom.blogs.nytimes.com/2015/03/02/words-on-a-subway-wall-please-do-not-urinate-in-this-area/?_r=0>.

"New York City Winter Turns Homeless Invisible." NBC News. 26 Feb. 2014. Web. <http://www.nbcnews.com/news/photo/new-york-city-winter-turns-homeless-invisible-n33186>.

"New York City Transit - History and Chronology." *Mta.info*. Web. <http://web.mta.info/nyct/facts/ffhist.htm>.

NYC Transit Museum. General Exhibit. Brooklyn, New York City.

Oh, Jungsu. "A Revolution in Mass Transportation from Seoul to Bogota." *LG CNS*, 19 June 2013. Web. <http%3A%2F%2Fwww.lgcnsblog.com%2Flatest-news%2Fa-revolution-in- mass-transportation-from-seoul-to-bogota%2F>.

Paddock, Barry, and Sarah Ryley. "Fare Evasion Arrests Surge in Recent Years, Making It Among City's Top Offenses Leading to Jail." NY Daily News. 18 Aug. 2014. Web. <http://www.nydailynews.com/new-york/nyc-crime/fare-evasion-arrests-surge-years-article-1.1906667>.

Le Parisien. "Violences et suicides en baisse sur le réseau RATP." *Leparisien.fr*. 16 Oct. 2013. Web. <http://www.leparisien.fr/espace-premium/paris-75/violences-et-suicides-en-baisse-sur-le-reseau-ratp-16-10-2013-3228421.php#xtref=https%3A%2F%2Fwww.google.fr%2F>.

Park, Eun-Jee. "City Gov't Unveils Plans to Overhaul Seoul Metro." *Korea JoongAng Daily*. 10 May 2014. Web. <http://koreajoongangdaily.joins.com/news/article/Article.aspx?aid=2988943>.

Park, Young-Wook. “Evolution of Fare Collection System: Seoul Transport Reform and Integrated Ticketing System.” *Seoul Metropolitan Government* (2007).

Perotta, Alexis. “Fare Collection and Fare Policy.” *Transit Leadership Summit* Singapore (2013).

"Police Régionale Des Transports." *La Police Nationale Municipale et la Gendarmerie RSS*. Police-Nationale.net, 04 July 2012. Web. <http://www.police-nationale.net/sdrpt/>.

Pucher, John, HyungYong Park, MookHan Kim, and Jumin Song. "Public Transport Reforms in Seoul: Innovations Motivated by Funding Crisis." *Journal of Public Transportation* 8.5 (2005): 41-62. Print.

RATP. "Accessibilité des réseaux - Le Guide." Département des Espaces et du Patrimoine, 2013. Web. <http://www.ratp.fr/fr/upload/docs/application/pdf/2010-12/guideacc.pdf>.

RATP. "Rapport d'activité 2013." 2014. Web. <http://www.ratp.fr/en/upload/docs/application/pdf/2014-05/rapport_dactivite_2013.pdf>.

RATP. "The Public Awareness Campaign: "Staying Civil Right down the Line"" *Ratp.fr*. 2015. Web. <http://www.ratp.fr/en/ratp/r_111226/the-public-awareness-campaign-staying-civil-right-down-the-line/>.

RATP. "Le Réseau Ferré." Web. <http://www.ratp.fr/fr/ratp/c_23489/le-reseau-ferre/>.

Renouard, Laure. "RATP : La couverture en 3G et 4G des métro et RER, ce sera finalement pour 2017." FrAndroid. 28 Jan. 2015. Web. <http://www.frandroid.com/0android/operateurs/264990_4g-metro-rer-2017>.

Ricard, Maxime, and Barthelemy Bolo. "La colère des usagers du RER A." BFMTV. RMC Info, 4 Mar. 2015. Web. <http://rmc.bfmtv.com/emission/la-colere-des-usagers-du-rer-a-a-cause-des-retards-je-vais-devoir-demenager-867079.html>.

Rivoli, Dan. "Disability Access Improvements to NYC Subway Stations and Taxis Sought - Am New York." AM New York. 12 Oct. 2014. Web. <http://www.amny.com/transit/disability-access-improvements-to-nyc-subway-stations-and-taxis-sought-1.9495992>.

Robinson, Michael Edson. *Korea's Twentieth-century Odyssey*. Honolulu: U of Hawai'i, 2007. Print.

Rodrigue, Jean-Paul. *The Geography of Transport Systems*. Third ed. New York: Routledge, 2013. *Urban Transport Development Paths*. Web.

Rodrigue, Jean-Paul, Claude Comtois, and Brian Slack. *The Geography of Transport Systems*. London: Routledge, 2006. Print.

Rosenthal, Elisabeth. "The End of Car Culture." *The New York Times*, 29 June 2013. Web. <http://www.nytimes.com/2013/06/30/sunday-review/the-end-of-car-culture.html?_r=0>.

Rowan, Tommy. "SEPTA Could Get Platform Screen Doors." Metro. 21 Oct. 2014. Web. <http://www.metro.us/local/septa-could-get-platform-screen-doors/tmWnjt---96rnKmnLNg6E/>.

Rubinstein, Dana. "Council Demands an End to the M.T.A.'s Subway-Safety 'Exploratory' Phase | Capital New York." Capital8 Feb. 2013. Web. <http://www.capitalnewyork.com/article/politics/2013/02/7614308/council-demands-end-mtas-subway-safety-exploratory-phase>.

Rubinstein, Dana. "No Seoul-style Platform Doors for New York Subways, Even in New Stations | Capital New York." Capital. 7 Dec. 2012. Web. <http://www.capitalnewyork.com/article/politics/2012/12/6785265/no-seoul-style-platform-doors-new-york-subways-even-new-stations>.

Rust, Jayna. "Seoul Improves Smart Cards, Allows A Negative Balance." *Metro Magazine*. 13 Aug. 2007. Web. <http://www.metro-magazine.com/management-operations/article/211081/seoul-improves-smart-cards-allows-a-negative-balance>.

Ryley, Sarah, and Pete Donohue. "Safest and Riskiest Areas of New York's Subway System Revealed in Daily News Investigation." *NY Daily News*. 22 June 2014. Web. <http://www.nydailynews.com/new-york/nyc-crime/daily-news-analysis-reveals-crimerankings-city-subway-system-article-1.1836918>.

Sanders, Anna. "New York City Subway Cleanliness Declined from 2011 to 2013: Survey Says Yes." Metro. 20 Mar. 2014. Web. <http://www.metro.us/local/new-york-city-subway-cleanliness-declined-from-2011-to-2013-survey/tmWnct---d73cTGuViSxAs/>.

"Sécurité dans les transports en commun." *Interieur.gouv.fr*. Ministère De L'Interieur. Web. <http://www.interieur.gouv.fr/Actualites/Dossiers/Securite-dans-les-transports-en-commun>.

Simanaitis, Dennis. “Three Great Subterranean Transportation Systems.” *Road and Track* 45.8 pp98-106. Apr94. Print.

SMG. *Seoul, Ready to Share with the World! Seoul Metropolitan Rapid Transit*. Rep. Seoul. 2014. Print.

SMRT. Seoul Metropolitan Rapid Transit to the World. Rep. Seoul: Seoul Metropolitan Infrastructure Headquarters, December 2012. Print.

Son, Youn-Suk, Jae-Sik Jeon, Hyung-Joo Lee, In-Cheol Ryu, and Jo-Chun Kim. "Nstallation of Platform Screen Doors and Their Impact on Indoor Air Quality: Seoul Subway Trains." *Journal of the Air & Waste Management Association* 64.9 (2014): 1054-061. *TaylorFrancis Online*. Web.

Sood, Suemedha. "Subway Systems by the Numbers." BBC Travel. 15 Mar. 2013. Web. <http://www.bbc.com/travel/story/20130314-subway-systems-by-the-numbers>.

Stantec Consulting Ltd., and Victoria Transport Policy Institute. *National Strategies on Public Transit Policy Framework.*: Stantec, May 2011. Print.

"State of the Subways Report Card - NYPIRG Straphangers Campaign." NYPIRG, Summer 2014. Web. <http://www.straphangers.org/statesub14/>.

Stieber, Zachary. "NYC Subway Deaths Spur Officials to Call for Action." The Epoch Times. 24 Jan. 2013. Web. <http://www.theepochtimes.com/n2/united-states/nyc-subway-deaths-spur-officials-to-call-for-action-339576.html>.

STIF L'autorité organisatrice des transports en commun en Ile-de-France. "Rapport d'activité 2013." *Stif.info*. 2014. Web. <http://publications.stif.org/rapport-annuel-2014#p=0>.

STIF. "Guide tarifaire transports Ile-de-France 2015." OPTILE, RATP, SNCF, 2015. Web. <http://www.stif.org/IMG/pdf/guide-tarifaire-2015.pdf>.

STIF. "La qualité de service en chiffres Janvier-Decembre 2014." *Bulletin de Ponctualité* 21 (February 2015)Web.

STIF, SNCF, RATP, and Réseau Ferre de France. Schema directeur du RER B Sud. April 2013. Print.

STIF, SNCF, RATP, and Réseau Ferre de France. Schema directeur Du RER A. May 2012. Print.

"Subway Infrastructures." Rail Safety Information System. Regional Metropolitan Subway Dept., Ministry of Land, Transport & Maritime Affairs, 2008. Web. <http://www.railsafety.or.kr/web/por/eng_rail/kotsa15.html>.

Suh, Ye-Seul. "Subway Hold-Up Delays Commuters." The Korea Herald. 26 June 2014. Web. <http://www.koreaherald.com/view.php?ud=20140526001540>.

The Associated Press. "NYC Subway Sign Campaign Takes Aim At Rudeness." CBS New York. 4 Mar. 2015. Web. <http://newyork.cbslocal.com/2015/03/04/nyc-subway-sign-campaign-takes-aim-at-rudeness/>.

The Associated Press. "Rude Awakening: French Sick of Their Own Incivility, New Study Shows ." NY Daily News. 27 July 2012. Web. <http://www.nydailynews.com/news/world/rude-awakening-french-sick-incivility-new-study-shows-article-1.1123280>.

Thomson Reuters Foundation. "Most Dangerous Transport Systems For Women," 31 Oct. 2014. Web. <http://www.trust.org/spotlight/most-dangerous-transport-systems-for-women/>.

"TomTom Traffic Index." *TomTom Traffic Index*. TomTom International BV., 2014. Web.http://www.tomtom.com/news/category.php?ID=4&NID=1541&Year=2014&Lang uage=2

Turton, Micheal. "Patrolling the Rails: A Profile of the MTA Police Department." *Philipston.info*. 19 Feb. 2013. Web. <http://philipstown.info/2013/02/19/patrolling-the-rails-a-profile-of-the-mta-police-department/>.

Veitch, Jonathan. "Angels of the Assembly Line: The Dream Machines of the Fifties." Southwest Review 79, no. 4 (Autumn 1994): 650.

WheelchairTravel.org. "Seoul, South Korea Wheelchair Accessible Travel Guide." Complete Destination Accessibility Report. 7 Mar. 2015. Web. <http://wheelchairtravel.org/seoul-south-korea/>.

Williams, Keith. "The MTA's Key Station Plan for Subway Accessibility." The Weekly Nabe. 13 June 2013. Web. <http://theweeklynabe.com/2013/06/13/mta-key-station-plan-subway-accessibility/>.

World Heritage Encyclopedia. "Seoul Metropolitan Subway." Project Gutenberg Self-Publishing Press. 2015. Web. <http://self.gutenberg.org/articles/seoul_metropolitan_subway>.

"www.nycsubway.org." *www.nycsubway.org*. Web. <http://www.nycsubway.org/wiki/Main_Page>.

Yang, Hyeji. "Crisis of Etiquette on Seoul Subways, Backpack Edition." Koreabang. 20 Mar. 2015. Web. <http://www.koreabang.com/2015/stories/bulky-backpack-wearers-the-rudest-of-seoul-subway.html>.

10 Magazine Staff. "Seoul Launces App to Prevent Sexual Abuse on the SUbway." *10 Magazine*. 2 Jan. 2015. Web. <http://www.10mag.com/seoul-launches-app-to-prevent-sexual-abuse- on-the-subway/>.