Smart Cities and Intelligent, Sustainable Transportation Systems: The Case of Seoul, South Korea

Case Study
Leaders in Urban Transport Planning (LUTP) Program

This case study is part of the Leaders in Urban Transport Planning (LUTP) program. It is intended to provide background information preceding a facilitated discussion. It does not purport to provide a complete description of the situation and should not be used as primary source material.

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"Smart cities—with their ability to harness data and technology to improve planning and the efficiency of service delivery, and their governance and effective urban management—are key to achieving a green, resilient, and sustainable future for all."[1] Recognizing that the greatest benefits from new urban mobility technologies and data is in their ability to provide evidence for planning, governance, and operations, Seoul adopted a holistic approach to intelligent transportation system (ITS) management. This case study explores how Seoul collects and analyzes urban mobility data to support evidence-based planning and city management.[2]

In the early 2000s, despite a previous decade of investments in urban freeways, Seoul's roads remained highly congested; supply of roads did not seem to be able to keep pace with growing demand for car travel. So, the Seoul Metropolitan Government (SMG) decided to take a new approach to managing traffic—one that focused less on supply of infrastructure and capacity expansion and more on reduction of car-based travel coupled with technology-enabled efficiency. ITS was an innovative approach that applied cutting-edge technology to manage travel demand and improve traffic flows at a much more affordable cost. ITS platforms provided the data and analytics necessary to underpin this new people-centered approach to urban transport planning—an approach that has shown measurable improvements in efficiency and environmentally sustainable.

As Seoul expanded their ITS functionalities to support a new people-centered urban transport planning approach, the SMG developed the Transport Operations and Information Services (TOPIS)—an integrated traffic center that plans, constructs, and operates Seoul's ITS. Restructured and streamlined in 2015, Seoul's TOPIS continues to collect a wide variety of traffic and infrastructure information across modes (private cars and public transport vehicles); provide real-time traffic information to travelers, operators, and incident responders; analyze traffic demand and causes of congestion; and inform transport project planning.[3] Over time, TOPIS continues to add new functionalities as additional sources of data and analytic needs are determined.

This case study provides background information for discussion on how TOPIS provides a useful source of evidence for decision-makers as they operate and improve Seoul's urban transportation system. Putting yourself in the shoes of the SMG decisionmakers, consider the following questions as you read through the material:

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[1] Wahba, Sameh. 2021. "Harnessing Smart Technology for Sustainable Development in Developing Countries," *The World Bank*, January 18. https://www.worldbank.org/en/news/feature/2021/01/18/harnessing-smart-technology-for-sustainable-development-in-developing-countries-tdlc

[2] "Korea Innovation 2020: Smart Urban Resilience," *WBx Talks.* https://olc.worldbank.org/content/korea-innovation-2020-smart-urban-resilience

[3] Lee, Shin. n.d. "ITS on Seoul's Urban Expressway," *SMG Policies that Work*. http://susa.or.kr/sites/default/files/resources/교통_8_ITS%20on%20Seoul's%20Urban%20Expressway.pdf

- What institutions, processes, and policies are needed to: (1) support the continued evolution of TOPIS and (2) make the best use of the data and information TOPIS produces?
- What additional data may need to be collected to support the SMG's goals for inclusive, resilient, green, and efficient mobility systems? In particular, what kind of data is needed to support and inform active mobility projects?
- What additional analytic functions might be added to TOPIS to further support evidence-driven planning and decision making?
- How have the outcomes of TOPIS allowed urban transport planners in the SMG to build political support to continue the sustainable mobility agenda outlined in the case study?

SEOUL, SOUTH KOREA

Seoul is the largest city in Korea with a population of approximately 10 million people (19% of the entire population of Korea) and an area of 605 km^2. With an average population density of 16,500 people/km^2, Seoul is also one of the densest cities in the world.[4]

Seoul is comprised of twenty-five districts with the Han River bisecting the northern and southern halves of the city. Seoul is a polycentric city—with the historical and political center of the city in the Jongno and Jung districts; the financial center in the Yeouido precinct of the Yeongdeungpo district; and the economic center in the Gangnam district (see Figure 1).

Figure 1. Map of Seoul's 25 districts and major activity centers[5]
Historical and political centers marked in gold, financial center marked in green, and economic center marked in blue.

[4] "Suzuki, Hiroaki, Robert Cervero, and Kanako Iuchi. 2013. *Transforming Cities with Transit: Transit and Land-Use Integration for Sustainable Urban Development.* Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/12233

[5] Adapted from Wikimedia Commons. https://en.wikipedia.org/wiki/File:Map_Seoul_districts_de.png

EVOLUTION OF SEOUL'S URBAN TRANSPORT SYSTEM: BUILDING UP AND TEARING DOWN HIGHWAYS

During the 1960s and 1970s, Seoul experienced significant urbanization. Development of transportation and other urban infrastructure failed to keep up with the rapidly growing population, resulting in serious traffic congestion, environmental pollution, unauthorized settlements, and housing shortages. The SMG concentrated on building road infrastructure and public housing, replacing infrastructure damaged in World War II and building new capacity to meet the massive inflows of people to the city. It was also during this time that the first subway line opened in Seoul.

During the 1980s and 1990s, the SMG implemented a series of urban improvement and beatification policies, developing and densifying new areas of Seoul. The SMG completed a large number of transportation infrastructure projects—including lines 2 through 8 of the subway system and the construction of major arterial roads and urban expressways—to connect the growing number of urban areas.

Increased income level of Seoul citizens led to a tenfold increase in the number of cars between the 1980s and 2015. In the early part of that period, the SMG responded by building additional road capacity to meet growing demand. But in the early 2000s, the SMG's approach changed, and they began adopting urban management goals focused on the achievement of a smart and sustainable city. The SMG began to implement a diverse set of policy measures to reduce the use of passenger cars and increase the use of public and active transport. It was during this period that the SMG restored streams, parks, and public spaces in the historic city center. The SMG also digitalized its administrative services and developed other information technologies to respond to the increasing citizen demand for improved quality of life.

A major flagship transport project during this time was the removal of the Cheonggye Freeway, a high-volume elevated expressway that covered up the historic waterfront of Cheonggye Creek. When the 30-year-old highway's condition failed to pass a safety inspection in 2001, the SMG had to consider whether to reconstruct the highway (at an estimated cost of 93 billion won) or demolish it. The restoration became a major topic during the mayoral election campaign that year. And Lee Myung-Bak was elected Mayor of Seoul due, in large part, to a platform that promised the removal of the freeway and restoration of the Creek, enhancing Seoul's appearance and creating a recreational area for pedestrians.[6]

Before the launching of the demolition project, the SMG simulated the effects of the highway's removal on the area's traffic flows by taking measures to alleviate anticipated problems. Measures included improvements in the accessibility of public transit, reduction of nearby parking lots and increasing of parking fee, and the provision of real-time traffic information to detour the traffic heading to the areas. The main consideration was to decrease the use of passenger cars in the affected area so that remaining traffic could continue to flow at street level. The SMG also demolished many of its pedestrian

[6] Congress for the New Urbanism (CNU). n.d. "Seoul | Cheonggye Freeway." https://www.cnu.org/highways-boulevards/model-cities/seoul
Seoul Solution. 2017. "Seoul Urban Regeneration: Cheonggyecheon Restoration and Downtown Revitalization," April 21. https://seoulsolution.kr/en/node/2374

overpasses and replaced them with crosswalks at the same places to enhance pedestrians' convenience.[7]

The success of the project was empirically demonstrated by collecting data on traffic flows and the environment both before and after the project. For instance, the Cheonggyecheon area reported a significant reduction in the concentration of local air pollutants, including fine dust (PM-10), NO_2, and volatile organic compound (VOC) shortly after the restoration project was completed. The heat island effect in the downtown also declined; the temperature of the Cheonggyecheon area before the restoration was 2.2℃ higher than the average of Seoul, but it declined to 1.3℃ after the restoration. And foot traffic in the area increased significantly, particularly on weekdays.[8]

TOPIS

Seoul's Transport Operations and Information Service (TOPIS) is an integrated, intelligent transport management system that manages operations and collects traffic information across modes operating in Seoul. TOPIS has evolved over time; additional functionality was built as new sources of data and analytic needs were determined. Starting from a regional traffic management system in 1998, TOPIS added capabilities over a 15-year period: [9]

- Institution of a regional traffic management system: 1998
- Institution and expansion of the urban highway traffic management system: 2000
- Inauguration of Seoul TOPIS (the situation control room) and introduction of traffic card system: 2004
- Introduction of the unmanned enforcement system: 2005
- Pilot installation and expansion of the bus information system (BIS): 2008
- Launched mobile traffic information service: 2009
- Traffic data open to the public: 2010
- Introduction of standards for variable message signs and a vehicle detection system
- Launched combined traffic, disaster, general affairs urban management situation control room: 2013
- Launched Seoul TOPIS platform (ITS Solution): 2015 to present

In 2015, the SMG launched the TOPIS platform that integrated and restructured all functionalities into new, streamlined platforms (described in more detail below):

1) Center platform or traffic information control room
2) Bus information system (BIS)
3) Unmanned enforcement platform
4) Urban expressway traffic management system (UETMS) and advanced traffic management system (ATMS)
5) Big data analysis system

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[7] Seoul Solution. 2017. "Transition from the vehicle-oriented city to the pedestrian-friendly city," September 26. https://seoulsolution.kr/en/content/6307

[8] Seoul Solution. 2017. "Seoul Urban Regeneration: Cheonggyecheon Restoration and Downtown Revitalization," April 21. https://seoulsolution.kr/en/node/2374

[9] Lee, Shin. n.d. "TOPIS: Seoul's Intelligent Traffic System (ITS)," *SMG Policies that Work.* http://susa.or.kr/sites/default/files/resources/교통_10_TOPIS.pdf
Ko, Joon Ho, and Shin Lee. 2018. "TOPIS: Seoul's Intelligent Traffic System," *Seoul Solution*, February 22. https://seoulsolution.kr/en/node/2595

1) Center Platform

The center platform collects, combines, and processes information from all other platforms in real time and then enables an immediate response by providing information to users, policymakers, and operators. The center uses data and technology to improve the resilience and disaster response of the urban mobility system. Monitoring incoming data, the center platform will detect abnormal situations or symptoms of disruptions. If detected, operators can then control on-site equipment such as traffic signals and electronic traffic information displays throughout Seoul to respond to the situation. Furthermore, the system is constructed to allow rapid contact and cooperation with relevant stakeholders, including law enforcement, first-responders and other emergency personnel, and citizens.

Eighty-five million points of data are generated from transit cards and 26 million points of data are generated from transport operations daily. This data is aggregated by the center platform and used to enable accurate and real time analysis for transportation planning, such as route rationalization, interval planning, forecasting, and simulation. In particular, data are used to provide historic baselines and calibrate analytics of the impact of new transportation projects and policies. All transportation projects in Seoul are required to undergo a traffic impact simulation and analysis using information provided by TOPIS. Critically, the multimodal coverage of TOPIS data collection and systems means that simulations are not restricted to analyses of vehicle traffic, but also consider impacts on the movement of public transport vehicles, and to a lesser extent, pedestrians, and cyclists.[10]

2) Bus Information System (BIS) and Bus Management System (BMS)

Operation of all buses in Seoul is collected in real time through the Seoul TOPIS Bus Information System (BIS). Each bus has an integrated bus terminal installed, which collects information on bus operations throughout and reads fare cards to process payments. Bus-related information collected includes real-time speed and location along the route, sudden accelerations or stops, and the number and location of passengers boarding and alighting. These data are analyzed for consumption by travelers and citizens, the SMG, and bus operators.

At bus stations along the 'open' bus rapid transit network of median bus exclusive lanes, terminals are installed that process and display BIS information, providing passengers with estimated arrival times. Via mobile phone application, travelers can also access information on the crowdedness of different buses (using aggregated information on the number of passengers collected from BIS) so that they can plan their trip and potentially wait for a less crowded bus for a more comfortable ride. All BIS information in Seoul TOPIS is 100% open, provided to the public via an application programming interface (API). This means that private developers of websites and smartphone applications can reprocess the information to best suit the needs of different types of consumers.

The SMG can use the data collected to improve network planning. Information on the number of passengers can help inform how demand patterns in Seoul are changing and where routes and service schedules could be modified to better serve demand. The SMG also uses the data to monitor performance of private bus operators—real-time speed and location information are important for enforcing service contracts and determining remuneration for services.

[10] Reliable and real-time data on pedestrians has been challenging to collect, with the best source of data being CCTV and other camera footage that can be computationally intensive to process.

Operators use the data collected to improve their service delivery, noting any operational issues that might cause harm to users. For example, sudden accelerations and sudden stops are important traffic safety indicators. The Bus Management System (BMS)—a center for real-time public transportation operation management—takes data from the BIS and uses it to enhance bus punctuality and improve operational orders and dispatching.

3) Unmanned Enforcement System

The advanced unmanned enforcement system uses cameras to detect and punish illegally parked or stopped vehicles on urban highways as well as vehicles driving in bus or, to a lesser extent, bicycle lanes. Fixed enforcement cameras are installed along freeways in all regions of Seoul, and many buses are equipped with cameras connected to the system. Following due process, violations detected through the system are fined. The objective is to induce good behavior among road users, so that revenue generation is not the objective of the enforcement system.

4) Urban Expressway Traffic Management System (UETMS) and Advanced Traffic Management System (ATMS)

The SMG installed the UETMS to centrally manage the traffic situation on the Seoul's expressways and to provide detailed, real-time traffic information to city officials and drivers. UETMS was developed in the mid-1990s, implemented in 1997, and expanded throughout the 2000s. In 2001, Seoul established the Urban Expressway Traffic Control Center and its operation plan.[11]

UETMS collects traffic information using loop detector—sensors installed under the roadway that count the number of vehicles passing over them—video vehicle detectors, closed-circuit television (CCTV) surveillance, and crowdsourced information from emergency phone calls and other reports from road users. Therefore, the system involves multiple hardware technologies including sensors on transport infrastructure and vehicles as well as communications and electricity systems. UETMS then processes that data for consumption.

The Advanced Traffic Management System (ATMS) merges data from UETMS with other sources, including taxi GPS data, weather conditions from the Meteorological Administration, and data from real time traffic signal operations. Like UETMS, ATMS processes and manages information—analyzing traffic congestion, planning real time operations of traffic signals, variable messaging signs, real time speed change monitoring of roads, traffic event detection, and traffic information services for citizens.

The information from UETMS and ATMS allows individual passengers to select the optimal route based on real-time traffic levels. It also helps SMG detect the cause of delays (including unexpected incidents), provide rapid response, and ultimately maximize the efficiency of the overall transportation system.

5) Big Data Analysis System

The big data analysis system analyzes a wide range of transport-related data, such as transaction data from the t-money transit card, real-time operations data from public buses and trains, road traffic data including vehicle speeds, and emergency information. The big

[11] Lee, Shin. n.d. "ITS on Seoul's Urban Expressway," *SMG Policies that Work*. http://susa.or.kr/sites/default/files/resources/교통_8_ITS%20on%20Seoul's%20Urban%20Expressway.pdf

data analysis system contributes to the traffic prediction system and traffic policy support system.[12]

One of the unique functions of the big data analysis system is that it receives data from outside the city's traffic management operations (i.e., data provided by private providers). For example, the SMG requires that private mobility operators of bike- and car-sharing services and ride sourcing platforms make their service data available for urban mobility planning and governance. To allay the private sector's concerns on data protection and the proprietary nature of certain information, the city government creates data sharing agreements that allow providers to remove all personal information tied to the provided data and provide the data either for single-use or continuously but with a time lag to allow for screening and processing. These restrictions mean that uses of private provider data are often limited to longer-term planning and governance rather than real-time operations.

One of the most successful examples of the use of private provider big data for transport planning, was in the determination of new bus routes and running intervals for late-night service. With Seoul's metro system closed from midnight to 5:00 am, the only option for many commuters was to take a taxi, which is expensive and unsustainable. Night taxis were also notoriously difficult to catch, putting many at risk on the road. Therefore, in 2013, the SMG launched an all-night bus service, which it dubbed the "Owl Service." Traditionally, the SMG relied on origin-to-destination data tracked through automated fare collection data to plan new bus routes. But, because there were no buses operating at night, traditional data sources were insufficient. Expanding the TOPIS big data analysis stream and using data provided by private telecommunications companies in the Seoul metropolitan area, the SMG was able to augment historical data with mobile call data that acts as a proxy for mobility patterns at night, overcoming data limitations and enhancing route planning accuracy.[13]

SEOUL'S TRANSPORT SYSTEM

Public Transit

In 2015, public transport served nearly 66% of average daily traffic in the city of Seoul (estimated at 32 million trips)—with 40% being served by the metro system and 25% being served by the bus system. Recognizing the importance of public transit systems for the resilience, health, and sustainability of the city, the SMG continues to improve the coverage and quality of the public transit network.

Bus System

In the Seoul metropolitan area, around 7,400 buses operate on 356 routes, serving approximately 4 million passengers per day.

[12] Lee, Shin. n.d. "TOPIS: Seoul's Intelligent Traffic System (ITS)," *SMG Policies that Work.* http://susa.or.kr/sites/default/files/resources/교통_10_TOPIS.pdf

[13] Sung, Nak Moon and Mauricio O. Rios. 2015. "How is big data transforming transport in South Korea? *World Economic Forum, Fourth Industrial Revolution*, April 30. https://www.weforum.org/agenda/2015/04/how-is-big-data-transforming-transport-in-south-korea/
Seoul Urban Solutions Agency (SUSA). 2019. "Using Big Data to Design Night Bus Routes," *Development Asia,* October 3. https://development.asia/case-study/using-big-data-design-night-bus-routes

In July 2004, the SMG embarked on a bus system reform that restructured its bus routes using a color-coded system of trunk (blue), feeder (green), inter-regional (red), and circular (yellow) lines:[14]

- Blue buses are trunk lines that run long-distance routes connecting among major urban centers of Seoul. 124 routes with 3,619 buses connect areas outside central Seoul to downtown Seoul. These buses focus on high-frequency and reliable service and increasingly run within median bus exclusive lanes.
- Green buses are feeder lines that operate on short distance routes and run at slower speeds than the trunk lines. These buses often provide first-/last-mile service for longer trips by trunk bus lines or metro. Therefore, they stop at most major subway stations and bus stations outside the center of Seoul.
- Red buses operate on nine express routes connecting Seoul and neighboring cities of Seoul with 229 buses.
- 27 yellow buses operate on four circular routes within downtown centers of Seoul. They have lower fares than green or blue buses and stop at railway stations, tourist sights, shopping and business areas, and blue bus stops which allow connections to areas outside downtown Seoul.

In addition to these regular services, the SMG also provides bus services on critical overnight routes. These routes reflect citizen demand and existing travel patterns late at night, determined by analyzing big data on taxi operations (600,000 pieces of GPS information) and cell phone use. As of July 2017, the overnight or "owl" bus system includes 70 buses on nine bus routes.[13]

As part of the bus system reform of 2004, the SMG adopted an open approach to Bus Rapid Transit (BRT) and began implementing an extensive network of median bus exclusive lanes on city corridors. As of 2020, there are 13 corridors with nearly 129 km of road with dedicated infrastructure. The open BRT system allows any bus to operate in the lanes for the portion of the route where dedicated infrastructure is available. The median bus exclusive lanes are primarily used by the blue trunk buses and red inter-regional buses. The open BRT system has boosted punctuality and speed, raising citizen satisfaction with the city's bus service.

Institutional arrangements for bus operations were also restructured. Since 2004, the municipal government retains responsibility for planning/defining routes, coordinating and setting performance targets for operations, evaluating performance, and financial support for the system. Under performance- and route-based contracts, private companies are then responsible for bus operations, vehicle management, and management of the 17,630 drivers employed within the bus system.[15]

[14] Seoul Metropolitan Government. 2015. *Seoul Public Transportation.* https://www.metropolis.org/sites/default/files/seoul_public_transportation_english.pdf

[15] Audouin, Maxime, Mohamad Razaghi, and Matthias Finger. 2015. "How Seoul used the T-Money smart transportation card to replan the public transportation system of the city; implications for governance of innovation in urban public transportation." Presentation at the *8th TransIST Symposium*, Istanbul Turkey, December. https://www.researchgate.net/publication/290574722

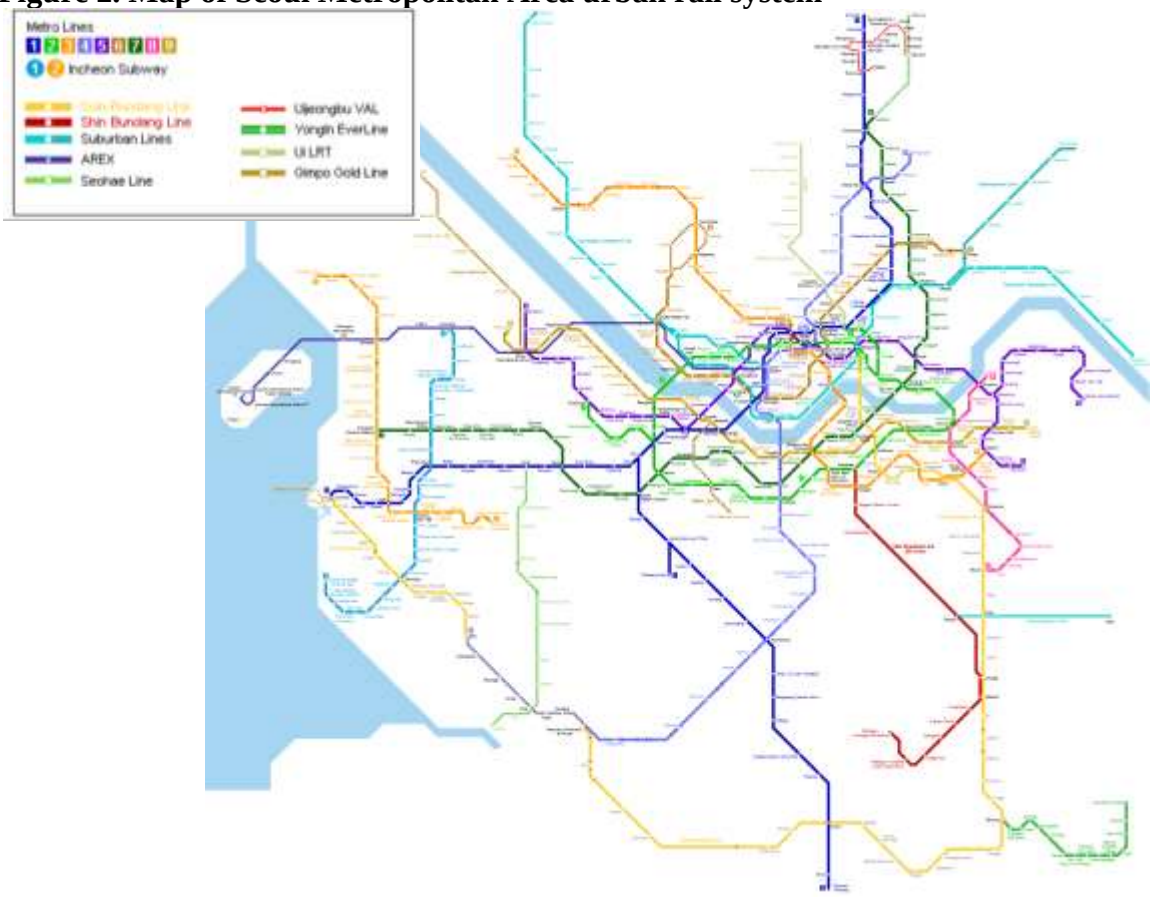
Seoul is also drastically expanding the introduction of electric buses into its fleet for a total of 460 by the end of 2020. Seoul has plans to increase the number of eco-friendly buses to 3,000 and green shuttle buses to 470 by 2025.[16]

Urban Rail System

The Seoul urban rail system comprises as many as 22 rail lines and 746 stations connecting the whole metropolitan area of Seoul with the surrounding Gyeonggi Province.

There are nine main subway lines and one LRT line operated by Seoul Metro—a public corporation owned by the SMG—that carry 5.2 million passengers a day. Seoul plans to extend the existing subway lines and expand the light rail network to build a compact urban rail network of 441km and make the subway available within 10 minutes of walking anywhere in the city. These subway lines connect with regional rail lines operated by Korail, the national railway operator (see Figure 2).

Figure 2. Map of Seoul Metropolitan Area urban rail system[17]



[16] Seoul Metropolitan Government. 2020. "Seoul Triples Number of Eco-friendly Electric Buses to Improve Air Quality," April 23. http://english.seoul.go.kr/seoul-triples-number-of-eco-friendly-electric-buses-to-improve-air-quality/?cp=3&cat=827

[17] R. Schwandl. 2021. Seoul Subway Map (including Incheon) via UrbanRail.net http://www.urbanrail.net/as/kr/seoul/seoul-map.htm

Transit Smart Card

The SMG introduced a transit smart card (called "T-money") in 2004 that can be used to pay for all bus, subway, and taxi fares as well as congestion and express way tolls. The smart card offers discounts on transfers between buses and subways and can be used to pay at convenience stores that also reload the fare card. T-money has high uptake, with the SMG reporting 100.00% of subway, 98.96% of bus, and 70.43% of taxi users paying by the smart card in 2018. In addition to paying for transport fares, T-money can also be used at many local markets like a credit card. To encourage shop owners to receive payments via the T-money card, SMG distributed card readers to shops in the market and subsidized 70% of commission fees for small payments.[18] With its high uptake and diverse use cases, T-money has helped boost citizens' convenient use of the city's public transit services and encouraged use of local, small businesses.

Car-Sharing

In 2013, the SMG launched a car-sharing program called "Nanum Car." In partnership with private car-sharing operators, the program provides for-rent gasoline-powered and electric vehicles to individuals for temporary use. The program was implemented with the goal of reducing the need for Seoul residents to own their own car, reducing traffic congestion, resolving parking issues, and mitigating pollution.

In its first phase (2013-2015), the program partnered with two operating companies to deploy 3,000 gasoline-powered vehicles, reaching 72,600 users. At the same time, SMG began preparing for electric car-sharing by building-out infrastructure for charging stations. By 2014, they had installed 850 outlets in public parking lots that supported a fleet of 1,916 cars.[19] In its second phase (2016-2018), the car-sharing system increased the number of total vehicles (both gasoline-powered and electric) to 4,700 and the user base nearly tripled to 210,000. And in its third phase, the SMG opened the system to two additional operating companies and plans to double the number of vehicles to 10,000 by 2022. SMG supports the program by dedicating spaces in municipal public parking lots for the car-sharing vehicles.[20]

In 2019, active transport—i.e., walking and cycling—accounted for 4.2% of door-to-door trips in the city of Seoul. In addition, active transport is a primary way for accessing public transit trips. Thus, mode shares not accounting for these important first-/last-mile journeys understate the importance of active transport in the city.

Bicycle Lanes

By 2020, the SMG had implemented 940 km of bicycle lanes, with plans to reach 1,330 km by 2030. The SMG aims to create "cycle rapid transport" supported by a network of main and branching bicycle lanes along which bicycles can move safely and quickly without danger of colliding with other means of transport.[21] This means creating bicycle

[18] Seoul Metropolitan Government. 2015. "Shop with T-money or credit card at Seoul traditional markets," January 14. http://english.seoul.go.kr/shop-t-money-credit-card-seoul-traditional-markets/

[19] Seoul Solution. 2017. "Shared Transport: Car Sharing in Seoul (Nanum-Car)," July 24. https://www.seoulsolution.kr/en/node/3462

[20] Seoul Metropolitan Government. 2019. "Seoul to launch the third phase of sharing car (Nanum Car) program, making it a semi-public transportation means by 2022," July 1. http://english.seoul.go.kr/seoul-to-launch-the-third-phase-of-sharing-car-nanum-car-program/

[21] Seoul Metropolitan Government. 2020. "Seoul Creates Commuting Lane for Bicycles by Repairing Existing Bicycle Lanes," September 7. http://english.seoul.go.kr/seoul-creates-commuting-lane-for-bicycles-by-repairing-existing-bicycle-lanes/?cp=3&cat=827

lanes that are totally separated from the roadway. Existing bicycle lanes that are right beside vehicle traffic lanes will be raised to be the same height as that of the sidewalk. The trees along the streets that block passing will be transplanted and the width of the road will be kept the same (see Figure 3).

Figure 3. Development of bicycle lanes[21]

Bicycle-Sharing

The Seoul public bicycle-sharing service, Ttareungi, is a docked (or station-based, unattended) public bicycle rental system available to anyone at any time. As of 2020, the system included 1,540 rental stations and as many as 37,500 bicycles.[22]

Sidewalks and the Pedestrian Environment

In 2013, the SMG revisited their approach to sidewalk provision and regulation to improve the travel experience of pedestrians. They found that, while 78% of all roads in downtown Seoul complied with the minimum 2-meter width required by regulations, pedestrians continued to experience considerable inconvenience from bollards, ventilation openings, roadside trees, and other obstacles in the sidewalk right-of-way. Furthermore, pedestrians often encountered illegally parked vehicles. Therefore, the city put out the goal to double the surface area of sidewalks in downtown areas from 10.13 km^2 to over 20.00 km^2.[23]

Since 2013, the SMG has made significant progress in meeting its goal to increase the surface area and quality of sidewalks in the city. Much of this has been achieved by renovating road space to pedestrian space. For example, in 2015, the SMG closed a 1 km

[22] Seoul Metropolitan Government. 2020. “Introducing New QR-type Ttareungi,” March 2. http://english.seoul.go.kr/introducing-new-qr-type-ttareungi/

[23] Seoul Metropolitan Government. n.d. “Seoul Transportation Vision 2030.” http://english.seoul.go.kr/policy/traffic/seoul-transportation-vision-2030/

highway overpass around Seoul Station because it no longer met infrastructure safety and resilience standards. Rather than demolish the roadway, the government decided to turn it into a park for pedestrians, which provides gardens and improves walking times around the city's central transit station. The project—called Seoullo 7017—created a walking tourism network with 17 pedestrian roads that opened in 2017.[24]

Another example is Sejong-daero—once a 12-lane road that catered only to vehicles. The project, which opened in 2021, reduced the number of lanes considerably. The recovered space was used to create pedestrian areas twice as large as Seoul Plaza along with bicycle lanes and green spaces filled with various trees and flowers. Branded as a "pedestrian forest path," the renovation of Sejong-daero is expected to become an example for further improvements in the city that embrace culture, history and landscaping, and link businesses, services, and people. The construction of the pedestrian forest path on Sejong-daero did not lead to traffic congestion; the speed of passing vehicles is the same as before the construction.[25]

New regulations are also supporting the quality of pedestrian environments by reducing obstacles and protecting pedestrians in their right-of-way and at intersections. Electric scooters, motorcycles, and bicycles are required to be driven off sidewalks in consideration of pedestrians. An amendment of the Enforcement Decree of the Road Traffic Act has been requested for the immediate towing of illegally parked personal mobility on sidewalks that hinder pedestrians without proactive fines.[26]

The SMG plans to enhance the safety of pedestrians by installing more than 30 additional crosswalks near zones with high traffic incidents involving pedestrians and safety warnings at hazard areas where the installation of a crosswalk is pending. Because of the large main block size in many urban centers of Seoul, highly visible mid-block pedestrian crossings that align with alleyways are an important intervention for improving walking conditions and safety. Diagonal crossings will also be installed at twenty-five locations to provide a safer and more convenient walking environment for pedestrians.[27]

Speed Limits

To implement safe speed limits and reduce road traffic fatalities and injuries in Seoul, Korea's Ministry of Land, Infrastructure and Transport piloted the "Safe Speed 5030" initiative in 2018. The initiative reduced speed limits to 50 km/hr on main roads in downtown areas and 30 km/hr on side streets nationwide.[28] In addition to the expanded implementation of the Safe Speed 5030 initiative, the SMG announced that it will lower

[24] Seoul Metropolitan Government. 2018. "Seoullo 7107 Overview" http://seoullo7017.co.kr/SSF/ENG/H/PRO/010/01010.do#

[25] Seoul Metropolitan Government. 2020. "Completion of Pedestrian Forest Path on Sejong-daero and Grand Opening in January 2021," December 30. http://english.seoul.go.kr/completion-of-pedestrian-forest-path-on-sejong-daero-and-grand-opening-in-january-2021/?cp=2&cat=827

[26] Seoul Metropolitan Government. 2021. "Seoul Makes Full-Scale Launch to Establish Pedestrian-Safe Culture in 2021," March 9. http://english.seoul.go.kr/seoul-makes-full-scale-launch-to-establish-pedestrian-safe-culture-in-2021/?cat=827

[27] Seoul Metropolitan Government. 2020. "Pedestrian-Friendly Diagonal Crossings at 25 Locations in Seoul," December 10. http://english.seoul.go.kr/pedestrian-friendly-diagonal-crossings-at-25-locations-in-seoul/?cp=2&cat=827

[28] Korea Bizwire. 2021. "Revamped Traffic Laws Expected to Reduce Traffic Accident Fatalities," March 26. http://koreabizwire.com/revamped-traffic-laws-expected-to-reduce-traffic-accident-fatalities/185771

the speed limit to 20 km/hr for priority zones (such as school zones) and in residential areas.[20] While these measures have already resulted in reductions in pedestrian deaths from vehicular crashes, pedestrians still represent a large share of traffic-related deaths, highlighting the importance of a safe systems approach to pedestrian and cyclist environments.

DISCUSSION QUESTIONS

As Seoul continues to operate and improve its urban transportation system, TOPIS provides a useful source of evidence for decision-makers. Key questions for the SMG decisionmakers to consider include:

- What institutions, processes, and policies are needed to: (1) support the continued evolution of TOPIS and (2) make the best use of the data and information TOPIS produces?
- What additional data may need to be collected to support the SMG's goals for inclusive, resilient, green, and efficient mobility systems? In particular, what kind of data is needed to support and inform active mobility projects?
- What additional analytic functions might be added to TOPIS to further support evidence-driven planning and decision making?
- How have the outcomes of TOPIS allowed urban transport planners in the SMG to build political support to continue the sustainable mobility agenda outlined in the case study?