Consumer-Oriented Bus Information System

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1. Policy Implementation Period

- Commencement of bus information system construction: Year 2000
- Bus management system: Year 2003-2005
- Bus information system: Year 2006-2011 (pilot project in 2006-2008)

The construction of the bus information system was initiated with the establishment of Seoul city's intelligent transport system (ITS) in 2000. The contents of the public transportation sector from among a total of 5 ITS projects was to gather and analyze public transport information, allow bus operators to take advantage of the data for efficient transit operation and management to provide the users of public transit with the necessary information, and thus to enhance the transit service quality. Towards this end, the Bus Management System (BMS) for the operators and Bus Information System (BIS) for the users were pushed ahead separately: BMS was built up from 2003 to 2005 while BIS emerged as a fully-fledged system in 2009 after implementing its own pilot project from 2006 to 2008.

2. Background Information

Seoul City's Traffic

Seoul has experienced a great leap in population from 2 million people up to approximately 10 million for more than 30 years from the 1960s to the 1980s. In the midst of a wave of industrialization promoted in accordance with the state-initiated economic development plan, the population influx into Seoul as the heart of all economic activity was not beyond expectation. However, it was widely accepted that subway construction was necessary due to the mass transit

[1] Translation by ESL®

facility system suitable for the population expansion and transit requirements in Seoul resulting from the industrialization era. Despite this obvious need, however, it actually took about 30-40 years for the subway system, which obviously requires a very long period of planning and installation, to be large in scale enough to serve as the backbone of the Seoul transit system.

Looking at the trends of public transportation system in Seoul, the street car in the early 20th century was the main means of transportation in Seoul and its network went on to expand alongside the city's population growth. From the 1950s, however, automobile use increased significantly and freely moving buses began appearing on the streets and roads. This led to a natural course of decline in the use of the street cars –the decline took place as they were relatively difficult to install and extend and thus the last streetcar route was closed in 1968. Differing only in time, the trend is exactly in line with the transit history of big cities of many other major countries, including the United States.

At the time of the streetcar route's closure, the Seoul public transportation system was split fifty-fifty between both the streetcar and bus. With the start of full-blown growth of Seoul during this period, and by using buses as major means of transportation, metropolitan Seoul went on forming urban districts with the construction of the roads gradually taking place from near the center of the city. This differentiates Seoul from other western metropolises where metropolitanization came earlier during the railroad-centered era, and this then allowed the formation of the urban area to be centered on the railway station.

However, whilst experiencing an era of high speed growth, Seoul city experienced a rapid growth of road construction and road facilities for the increased bus services, which in turn caused an increase in vehicles on the streets and road shortages. This industrialization resulted in the continuing income growth of Seoul citizens and a corresponding increase in car utilization – this led to a repetitive vicious cycle involving road congestion, the resulting reduction of bus speeds, and an increased road capacity which was intended as a solution, but failed to deal with the increased demand for roads.

The use of automobiles continued to grow despite the ongoing subway construction and expansion which continued since the beginning of the early 1970s; at the beginning of the 2000s, passenger cars came to account for 72% of Seoul traffic, and, more specifically, drive-alone cars accounted for as much as 79%. This modal share rate signified an annual energy consumption amounting to 4.1 trillion won, and social costs due to traffic congestion amounted to approximately 5 trillion per year.

Seoul public transportation

In a situation where the use of automobiles soared and the overall role of public transport went downhill, the status of the subway surpassed that of the bus in the public transport market in the early 2000s. Although this phenomenon was not unrelated to the policy support aimed at making the subway system the backbone of all transportation in Seoul, it was also the outcome of a so-called vicious cycle centering on the bus industry; the excessive use of cars resulted in a drop in road service level, which in turn led to weakened competitiveness in bus services with a reliance on the roads, which again induced the outflow of transport users to other means of transportation.

In 1997, the bus companies reduced in number from 103 to 57; to make matters worse, the service quality kept on worsening with many problems including head-running, wild driving, passenger refusal against the slow-moving elderly or persons with disabilities, and traffic signal violations. These problems arose mainly due to excessive competition for profitable routes, the unilateral abolition of routes with low profitability, and a vulnerable business structure in which earning was determined primarily by the number of passengers. The fact was that a variety of qualitative degradations were occurring in addition to reductions in traffic speeds due to the worsening level of road services. As a result, the mode share of bus continued to decline from 30.7% in 1996 to 26.7% in 2002. This decline in the number of passengers then led to management aggravation, which caused fare increases. Ultimately, the combination of worsened service and increased fares served as sufficient reasons for citizens to use the buses less.

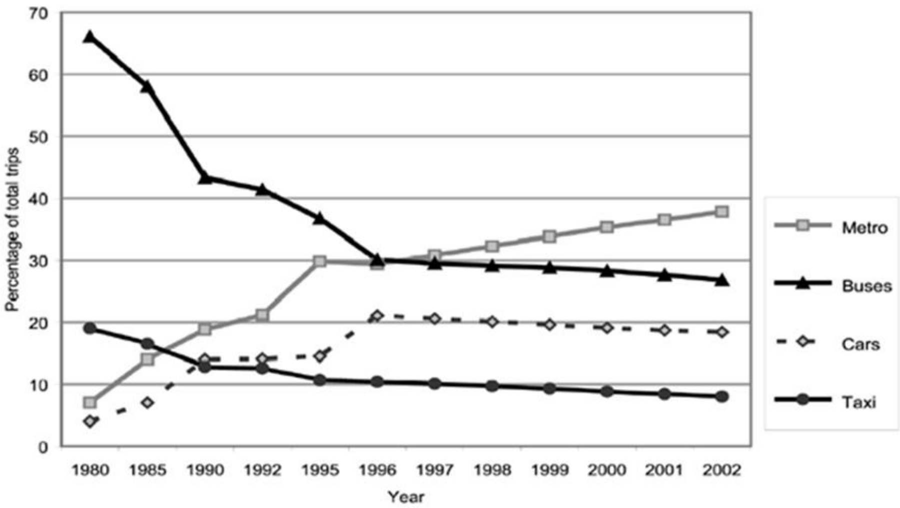

Figure 1: 1980-2002 Trends in mode shares of each transport mode

Source: Seoul Metropolitan Government 2004: The Seoul Institute 2003

Seoul public transportation reform

As with most of the cities in the 21st century, Seoul aims to achieve sustainable transportation in ways to enhance the mobility by relieving traffic congestion and to improve individual accessibility by making sure no group is marginalized either socially or geographically. Moreover, with the growth of civic consciousness along with household income in the 2000s, citizens' expectations toward the municipal administration and their demands for service quality continued to increase.

The city of Seoul has maintained and provided relatively better public transport services and mode shares on the whole in comparison with some overseas cities including North America which showed an overly high dependence on automobiles. In the 21st century buses secured the position as a means of eco-friendly and sustainable transport. However, the decline of the bus industry and traffic congestion owing to an increase in the number of cars emerged as challenges for Seoul to address. At the city level, on a few occasions, partial improvement measures in relation to bus operations were attempted but these failed to yield any noticeable outcomes. Meanwhile, when new mayor took office in 2002, the public transportation reform plan, a part of his election pledges, was pushed ahead with great force and enthusiasm.

Two main issues of this reform were:

1) To unify public transit services through the integration of the subway and bus systems in order to reinforce competitiveness against cars, and

2) To establish as so-called ‘semi-public bus management system’ in which the city would intervene in the operation management sectors judged essential for strategic objectives, such as the unification of public transportation system

In fact, BMS/BIS falls into a variety of initiatives taken to improve the public transit service quality separately or along with the reforming efforts to ensure competitiveness against cars as mentioned above. It is also seen as one of policies that played the most pivotal role in changing users’ awareness and perception of buses.

3. The Importance of the Policy

There are several limitations for public transit to overcome in order to ensure competitiveness against cars, among which is the notion that it would typically take more time to travel the same distance by using public transit instead of a car. In the field of traffic-behaviour related research, it is said that rather than the empirical travel time, the time felt or perceived by travellers has a more decisive effect on their individual preference for mode of transport.

In general, the time taken to travel via public transport has four phases - access, standby, run, and egress. The “access” time is the time taken to move from the departure point to the destination under the public transport system; the “standby” time is that spent waiting for a bus or train to arrive at the pick-up spot; the “run” time is that spent travelling via the bus or train; the “egress” time is that spent in moving from the pick-up spot under the public transport system to the final destination. In this process, the standby time is seen as most uncertain from the user's point of view. According to research findings people usually perceive unpredictable times as being longer than they actually are.

Taking into account the reasons why more time is spent in travelling via public transport, the complicated combinations of the following are likely to work together. First, it may be due to the low frequency of service. Secondly, it may happen when the waiting time becomes longer due to the delayed arrival of a bus. Thirdly, public transport is fundamentally different from a ‘door-to-door’ service so the steps of access and egress are usually carried out through low-speed means of transport such as walking on foot. Of course, in cases where transfers are required because the single use of public transport is not enough to arrive at the ultimate destination, the standby time as well as the access time may be extended.

The research findings suggest when passengers are provided with accurate information about travel time of public transport and thereby allowing the passengers to make an accurate prediction on the arrival time, the perceived time shorten. The perceived time shortens even without taking measures to increase the service frequency, to integrate the pick-up spots, or to ensure increased number of service routes. It can therefore be understood that there are many possibilities in which accurate information about public transport travel can contribute to the improvement of users' satisfaction. In fact, when provided with exact public transportation information, passengers can choose to make better use of and overall waiting time, thereby improving both personal and social benefits.

From a larger perspective, BMS/BIS for the buses in Seoul has contributed to making Seoul city's transit a more efficient and state-of-the-art system as a key element of the entire ITS. In particular, the construction, sustainable development, and management of BIS have been of great significance in the change of perspective from a provider-centered system to a consumer-oriented system. It suggests a new policy perspective from which humanistic elements - such as human perception, psychology and other factors - are taken into account, specifically those which have never previously been involved in transit policy. It also has its significance as a full-fledged beginning of the municipal administration taking care of individual welfare and as a transition toward other dimensional objectives for the realisation of traffic welfare beyond mere efficiency-centered policy goals.

4. Relevance with Other Policies

According to the general principles of transport integration, fare integration is one of the four elements of the public transport integration. During the course of reforming the public transport system of Seoul, the promotion was taken in the four following elements of the public transport integration.

- Service integration
- Fare integration
- Information integration
- Physical integration (transfer center)

The fare integration system has a very intimate relation to the remaining three integration-related policies. Among those mentioned, the service integration was conducted between bus and train, bus and bus, and one type of bus and other types of buses in terms of bus system, and it was the policy that primarily highlighted the technological and innovative aspects. In addition to dualizing the functionality of buses by separating the feeder lines covering short-distance traffic within a region from the trunk lines handling mid- and long-distance traffic between the regions, it was ultimately able to systemize the bus routes by dividing them into four different categories depending on their functionality: inter-regional line, trunk line, feeder line, and circular line. Moreover, the color of car bodies was differentiated in order to help users to identify the respective categories. The wide range line and trunk line were focused on improving their traffic efficiency by straightening, shortening, and reducing the duplicate routes while the branch line and circular line were improved with an emphasis on easiness of transfer and accessibility.

As far as the physical integration policy is concerned, transfer centers were installed at main locations such as Cheongnyangni transfer center to provide easier bus-bus and bus-train transfers. There are also representative policies of information integration, such as TOPIS (Transport Operation and Information Service), BMS (Bus Management System or Central Control Room), and BIS (Bus Information System). In a related move, the city of Seoul has established a real-time integrated information system for bus operators and bus users, and founded a traffic management center in charge of monitoring the traffic by pulling all transportation-related information together. Among those, the BIS policy is featured as a theme of this policy package under the title "Consumer-oriented Traffic Information."

The 'Bus Information System' (BIS) is most closely associated with the bus management system (BMS), and both are linked to TOPIS (Transportation Management Center). In addition, both systems are deeply involved in the ITS construction policy of Seoul city as s key elements of ITS.

One of the most important collateral effects of public transportation is fare integration - more precisely, the policy of digitalizing the entire payment system for payment, collection, and allocation - which enabled the collection of real-time bus operation data. Bus users are to touch the card reader once upon boarding and once again when getting off in order to make payments and calculate the applicable bus fare. Therefore, data including actual bus demand and usage patterns, which had not previously been utilised, have become recorded accurately and uniformly. Such detailed and accurate data about passengers' traffic pattern made it possible to figure out the actual demand based on specific routes, regions, and time, and to grasp temporal information about traffic flow. Therefore, bus companies have been able to make demand-driven scheduling in sensitive response to any demands and to operate routes more efficiently, which resulted in improved profitability. This data has already been digitalized, which enables data mining as well as revenue maximization modeling.

5. Policy Objectives

1) To improve bus punctuality.

2) To upgrade operation order.

3) To enhance bus competitiveness in ways to offer a variety of bus information and to draft reasonable public transport policies based on operation history.

6. Main Policy Contents

1) Bus Management System (BMS)

Seoul has made strenuous efforts to enhance the competitive edge of bus by establishing reasonable public transportation policies which improve bus punctuality, operation system, and provision of bus information. To that end, Seoul built BMS center to provide real-time operation and management of public transportation. The general situation room is at the heart of any bus service management strategy, and serves as a principal agent in implementing most strategies. The Bus management system (BMS) collects bus operation information by taking advantage of location tracking technology, process the collections of information into bus service policy data, and provide operators, bus companies and drivers with the processed data.

2) Bus Information System (BIS)

This system serves to gather bus location information, process the information into bus arrival information using algorithms, and utilize such processed information in order to provide users with information and link it with the relevant institutions. To this end, personal information services (such as internet homepage, ARS, mobile) have been promoted, and bus stop terminals (BIT: Bus Information Terminal) have been installed. In particular, the installation of bus information terminals (BIT) has been promoted step by step since 2006 by splitting the pilot project phase and the main project phase in consideration of the stabilization status of the BMS. The phased promotion strategy for Seoul bus information system is summarized in < Table 1 >.

Meanwhile, with the broadening phenomena of transport demand and increased inflow/outflow traffic volume, the importance of providing information about the inter-city buses has increased. Under the leadership of the Ministry of Land, Transportation and Maritime Affairs, a project focused on establishing the metropolitan inter-city bus information system (BIS) has recently been promoted in collaboration with Seoul city, Incheon city, Gyeonggi-do, Gyeonggi-do and 21 municipalities within Gyeonggi-do. The capital region metropolitan inter-regional bus information system (BIS) was designed to provide the public with easy access to all sort of bus information via electric boards installed at bus stops, internet, cellphone and ARS regardless of administrative districts;

The following figure shows a conceptual diagram of the metropolitan bus information system services.

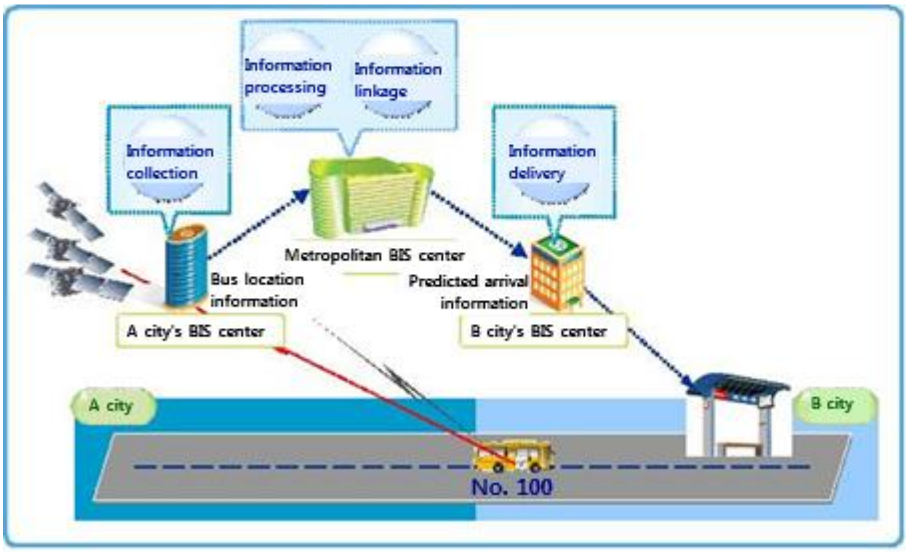

Figure 2: A conceptual diagram of the metropolitan bus information system services

Source: Seo, Byung-min, et al. (2012)

7. Technical Details

The bus management system (BMS) refers to a service system designed to secure the real-time management of bus service operations and thereby enhances service qualities for users and operators by taking advantage of bus location data and other related operation information. This can be collected through advanced bus location tracking devices such as GPS (Global Positioning System) or the Beacon system. In addition, bus information system (BIS) is a part of the public transport information system, which provides bus users with all sort of information on bus operation- - such as current bus locations, routes and dispatch time - via wired/wireless Internet, mobiles, and ARS.

Accordingly, BMS and BIS differ from each other in their purposes or components as shown in <Table 1>. Typically, bus information systems has been established in consideration of the securing reliable bus information, efficient operation following the establishment, and utilization; however, when taking a step-by-step expansion approach depending on the size of the city or the municipalities, more emphasis is put on BMS in the early stage, and later on BIS.

Table 1: Seoul bus information system promotion strategies: in comparison between BMS and BIS

System classification	Information utilization strategy			Major projects	Time-phased schedule
	Collection	Processing	Delivery		
Bus Management System (BMS)	Bus operation data	Bus operation policy data	Operators, bus companies, drivers	-Establishing central bus control center (BMS Center) - Installing terminals for operators, bus companies, Seoul city	2003-2005
Bus Information System (BIS)	Bus location information	Bus arrival prediction information	Users, related institutes.	-Installing but stop terminals -Creating internet homepage	Pilot phase: 2006-2007 Main project phase: 2008-2011

Source: Seo, Byung-min, et al. (2012)

The following figure shows a conceptual diagram of the metropolitan bus information system.

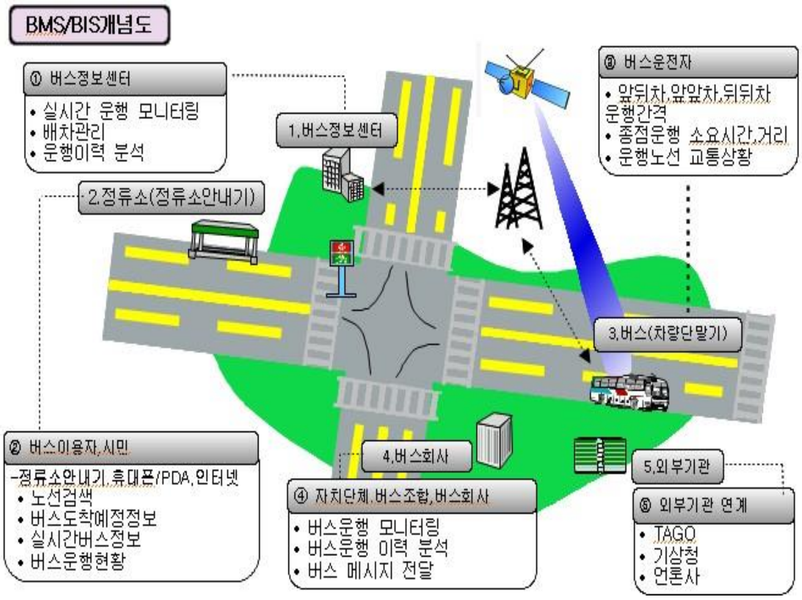

Figure 3: Conceptual drawing of the bus information system

English	Korean
Conceptual drawing of BMS/BIS	BMS/BIS 개념도
1. Bus information center Real-time service monitoring Dispatch management Service history analysis	1. 버스정보센터 실시간운행모니터링 배차관리 운행이력분석
2. Bus users, citizens Bus stop guide devices, cell phones/PDA, Internet Route search Bus arrival prediction information Real-time bus information Bus operation sites	2. 버스이용자,시민 정류소안내기, 휴대폰/PDA, 인터넷 노선검색 버스도착예정정보 실시간버스정보 버스운행현장
3. Bus drivers Service intervals of cars at the back and in front, the car two cars in front, the car two cars back. Time spent and distance between both ends of a route Service route traffic situations	3. 버스운전자 앞뒤차, 앞앞차,뒤뒤차운행간격 종점운행소용시간, 거리 운행노선교통상화
4. Municipalities, bus union, bus companies Bus service monitoring Bus operation history analysis Bus message delivery	4. 자치단체, 버스조합, 버스회사 버스운행모니터링 버스운행이력분석 버스메시지전달
5. Links to external agencies TAGO Meteorological agency Media	5. 외부기관연계 TAGO 기상청 언론사

8. Policy Effects

The most important policy effect is changes in public attitude and awareness on bus that new bus information has brought about. Three years after implementing the bus information system, the Seoul Transport Operation and Information Service (TOPIS) conducted an equivalent quota sampling survey targeted at Seoul citizens aged 19 or over who use buses twice a week or more and confirmed the following contents

1) Satisfaction index on using the bus information appeared to be overall high - 81.4% for bus stop guide terminals, 77% for mobile wireless Internet, 73% for website of Transport Operation and Information Service, and 72.8% for ARS services.

2) 85% of the respondents cited bus arrival time as the most useful information.

3) 91.9% of the experienced users answered that the bus arrival time information is "accurate."

4) 67.2% of the respondents answered that an average waiting time was 10 minutes while 10.1% said it was longer than 10 minutes, which indicates that the perceived waiting time is relatively short. Based on this, it can be inferred that the reliable information about waiting times helped reinforce positivity of the surrounding environment and the waiting experiences while waiting. That is, the results suggest human psychology will make the uncertainty surrounding the waiting perceived as longer.

5) 85.4% of the respondents answered that they are “satisfied” with bus information terminals (BIT), which is equivalent to 3.9 points out of 5. 96.5% of the respondents responded positively regarding the additional installation of the bus information terminal.

The following table outlines policy effects derived from the survey.

Table 2: Citizens' satisfaction index of the Seoul bus information system

Survey contents	Survey results	
Satisfaction index about the level of bus information	Bus stop information terminals (BIT)	81.4%
	Mobile wireless Internet	77.0%
	Traffic information center homepage	73.0%
	Phone (1577-0287)	72.8%
The most useful information of bus information system (BIS)	Bus arrival time.	85.4%
	Bus route change	6.8%
	Dispatch interval	5.4%
	Service hours of the first or last bus	1.6%
	Guides around bus stops	0.5%
	Bus passage information	0.3%
Accuracy of bus arrival time information	Positive	91.9%
	Moderate	7.0%
	Negative	0.8%
Difference between actual bus arrival time and information	2 min.	66.7%
	3 min.	33.3%
Average waiting time at bus stops	Less than 10 minutes	67.2%
	Less than 5 minutes	22.7%
	Less than 15 minutes	6.3%
	More than 20 minutes	2.9%
	Less than 20 minutes	0.9%

Source: Seo, Byung-min, et al. (2011)

Seoul may find it difficult to accurately ascertain how much the bus information system has contributed to the improvement of the overall bus service quality, other than user's awareness and satisfaction level. It took about 10 years for the overall information base to be built and developed into consumer-oriented information networks; during this period, many other changes took place in Seoul city's public transport system. The major changes include the bus service integration, cross-service integration between bus and subway, bus median line construction, public transportation fare integration and so on. For example, the bus service performance outcome in 2011, when user-centered information system was built in earnest, reflects not only the effects of the user-centered information system, but also the comprehensive policy effects of several elements that contributed to the improvement of Seoul's public transport system. Although it is hard to check the effect of each element, the direction of the effects could be identified through changes in the overall performance indicators as listed below (Park, 2010).

1) Improved bus punctuality: 18% increase

2) Improved bus regularity: 0.54 (2004.10)→ 0.49 (2004.12)→ 0.37 (2005.5)

Decrease in number of complaints about irregularities: 75%→ 25%

3) Number of traffic violations decreased by 80%: 4005 (2004.8.1)→ 815 (2005.6.27)

4) Bus traffic accidents decreased by 24%: 657 (2003.7-2004.5)→ 496 (2004.7-2005.5)

5) Increased bus passage speed via median bus lanes: maximally increased by 11km/hr

6) Increased profitability: operating costs reduced by 9% maximally, number of passengers increased by 20%.

7) Increased level of satisfaction

The followings are other empirical data related to the above indicators.

1) Increased bus speeds via median bus lanes

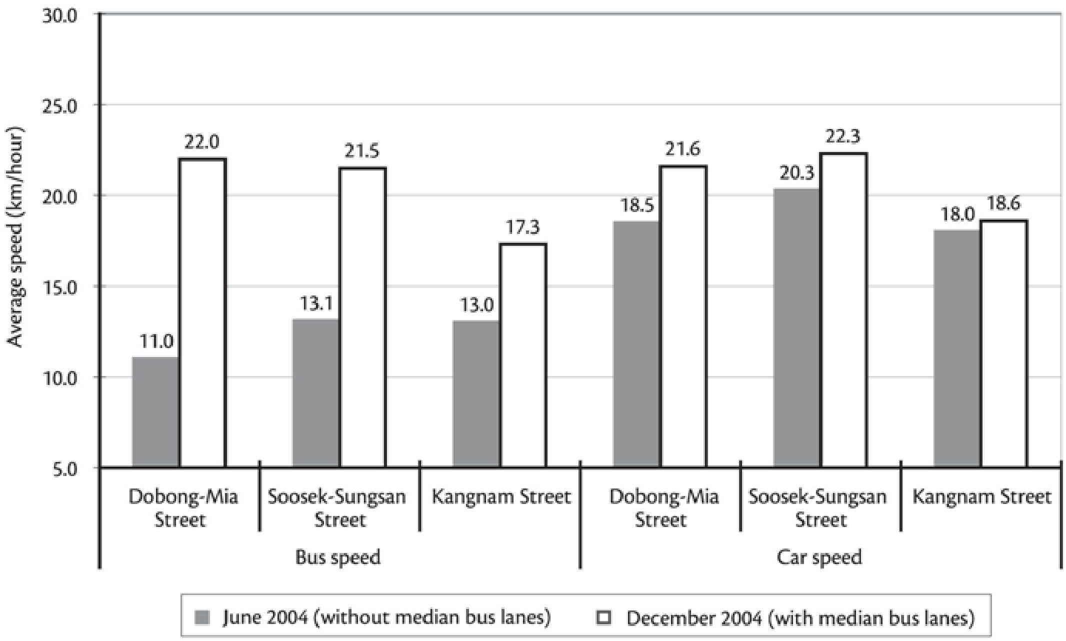

Figure 4: Increased bus speeds via median bus lanes (Average bus speeds before and after the implementation of Exclusive Median Bus Lanes)

Note: 7-9am,towards the city center.

Source: Seoul Metropolitan Government (2005)

2) Increased number of public transit users

Table 3: The increasing trend in the use of public transportation by year, 2004 – 2010

	2004	2005	2006	2007	2008	2009	2010
Subway	4,567	4,540	4,533	4,532	4,577	4,730	4,835
Bus	4,782	5,451	5,662	5,603	5,647	5,681	5,719
Total	9,349	9,991	10,195	10,135	10,224	10,411	10,554

(Unit: 1,000 persons / day)

Source: Seoul city 2011(quoted from Park 2010, Table 3. Increase in passenger ridership across the public transport system)

3) Reduction in Bus-related traffic accidents

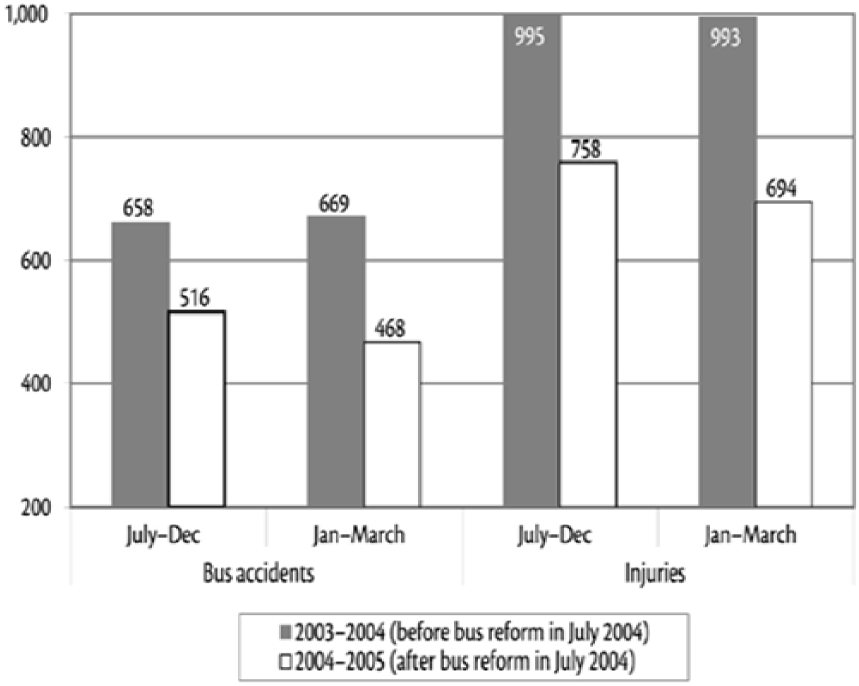

Figure 5: The decreasing trend in bus-related traffic accidents by month, 2003-2005

Source: Seoul Metropolitan Government 2004: The Seoul Institute 2003

9. Challenges and Solutions

While policy has been implemented, the overall understanding of and attention to the ITS has continually increased During the process of policy planning and implementation, there were no notable conflicts among stakeholder groups or technical obstacles since the city of Seoul, bus companies, drivers, and bus users were all direct beneficiaries of the process.

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