Economic Evaluation of Seoul City's Bus-Only-Lane Project

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Following the suit of some other countries, the Seoul Metropolitan Government has ambitiously implemented the bus-only-lane (BOL) system as one of the new transportation reform plans. However, it does not seem that the project has achieved its primary goal of reducing the number of private vehicle drivers, and that the project is economically viable. This paper reports the results of an economic evaluation of Samil-Ro Bus-Only-Lane project, one of the representative BOLs in Seoul. It estimates travel demand both with and without project in order to examine the achievement of the project's goal of shifting private vehicle travelers to the reformed bus system. To test the project's economic viability, the paper also conducts a cost-benefit analysis by calculating the discounted net present value (NPV), internal rate of return (IRR), and benefit and cost ratio (B/C). Moreover, both the project's uncertainty and sustainability have been checked through the sensitivity and risk analysis and the environmental degradation effects test, respectively. In the conclusion, the paper also provides policy recommendations.

Keywords: Bus-Only-Lane, Seoul City, net-present-value (NPV), internal rate of return (IRR), uncertainty, sustainability, environmental impact

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1. INTRODUCTION

Over the last several decades, rapid population growth and urbanization led to a sharp increase in demand for urban transport facilities and services in many major cities around the world. However, factors such as inadequate development planning and inefficient government instruments prevented the timely and effective implementation of public transportation. Dissatisfaction with the level and quality of public transportation services led those people who can afford it to turn to private modes of transport. Consequently, many cities are facing serious problems, including significant levels of traffic congestion, air pollution, and high accident rates.

In a response to these problems, many cities and national governments began studying or implementing projects to increase the bus transport efficiency, the latter being the most flexible and widely used means of public transport for the foreseeable future.¹ They understand that by giving buses special lanes in the center of the road, buses can often move faster, which improve service for transit passengers and induce many people to give up private cars and shift to using buses. The followings are examples of major cities that implemented bus-only-lanes (BOL) system and motivated the Seoul Metropolitan Government to follow suit.

1. Curitiba, Brazil

The most commonly cited BOL example is found in Curitiba, Brazil, a city of 1.6 million people. Here, they established five bus-only-lanes on the city's predominant arteries, on which about 1,100 buses make 12,500 trips per day and serve 1.3 million passengers. Besides buses running on BOL, a simple and innovative device contributed to speeding up the bus: a glass-and-steel boarding station shaped like a tube, allowing fare purchases to take place at the vehicle door level, without the use of steps. Moreover, bus stops are built into the urban streetscape and offer distinctive, enhanced waiting amenities, passenger information, pre-boarding fare payment, wheelchair lifts, lighting at all bus doors, and raised platforms to facilitate rapid boarding. After the BOL project implementation, average bus speed increased up to 20km per hour and 70% of Curitiba's commuters use bus transport, 28% of the latter figure previously reported to be private car drivers (Lee and Kim 2004).

2. Bogota, Colombia

With a significant increase in private car ownership and the contraction of bus routes, the Bogota Metropolitan Government adopted the BOL system as part of its TransMilenio (Transport for the New Millennium) project. Bogota, a city of five million in Colombia, operates its 42-kilometer BOL system, where 235

buses make trips at an average speed of 26km per hour. After the operation, the system carries more than 800,000 passengers a day, which is 3.7 times higher than before its implementation (Lee and Kim 2004).

3. Pittsburgh, Pennsylvania

Pittsburg, a city of 1.4 million, is the first city to implement the BOL system in North America. The bus-only-lane was established on three routes totaling 29.4km, on which 240 buses make trips at an average speed of 40km per hour and serve 48,000 passengers (Lee and Kim 2004).

II. SEOUL CITY'S BUS-ONLY-LANE PROJECT

Traffic demand in Korea rapidly increased over the last several decades, causing problems such as road traffic congestion, traffic accidents, and noise and air pollution. In the case of Seoul, home to some 10.2 million people in 2004, traffic demand has increased rapidly while urban mobile efficiency level has significantly decreased. Moreover, with car ownership rising sharply in Korea, Seoul's vast bus system has been increasingly losing street space and average speed to private vehicles, and consequently mode-share and revenue. Recently, registered motor vehicles in metropolitan Seoul increased at an average annual rate of 3.9 %, reaching 2.8 million vehicles in 2004 (Seoul Metropolitan Transport Statistics).² But because of huge road construction costs, environmental damage concerns, and objections from citizen groups, road supply has reached its limits. While citizens complained about high gasoline prices, air pollution from traffic, car accidents, and inconvenience caused by traffic congestion, transportation problems in Seoul continued to worsen.

As a countermeasure against these problems, the Seoul Metropolitan Government launched a new transportation reform plan in July 2004. The most salient point of the plan was to introduce the bus-only-lane (BOL) project, which reserves the median lane exclusively for buses in major thoroughfares. Consequently, road surfaces for personal cars decreases. By 2004, Seoul installed four BOL routes totaling 36km, and in 2005, thirteen routes totaling 162.4km were created step by step (Chon 2004). Many people remarked that the project was too ambitious as it aimed at diverting passengers and vehicles to different modes of transportation by radically changing existing road surface usage and bus-routing systems. Similar bus reform projects implemented several times in the past were not successful.

The main objective of the recent bus reform plan is two-fold: 1) to enhance the speed and efficiency of the bus system; and 2) to mitigate traffic jams by attracting regular commuters away from personal cars and making them more dependent on public transportation (Seoul Metropolitan Government 2004). Seoul City expected that the BOL project would make personal car drivers switch to

the public bus system for two reasons. First, as a result of the exclusive bus-only-lane, a bus' driving speed would increase sufficiently to attract average citizens commuting in their own cars during rush hour to the bus system. Second, as personal cars would lose road surface relative to the past, driving speed would decrease to the point that there would be sufficient incentive to stop driving personal cars.

A year after the new bus system went into effect, it is questionable whether or not the Seoul Metropolitan Government's main objectives were achieved. After implementation, there were a series of accidents and technical glitches, including rush-hour engine breakdowns causing major disruptions in downtown Seoul. More importantly, people complain that the new system is very inconvenient and complicated while it makes traffic congestion worse.

In this paper, we will examine the effects of a new bus system in Seoul, focusing on the Samil-Ro Bus-Only-Lane. We chose the Samil-Ro BOL not only because it is one of the earliest and representative BOLs in Seoul, but it is also one of the busiest roads and will well represent the effects of the BOL project on the city's general traffic condition. The BOL project will be evaluated by using economic analysis tools to check its economic efficiency and viability. In other words, besides accounting for the project entity's financial costs and benefits in the usual way, we quantify the impact that the project has on the national economy, including costs and benefits of the major targeted beneficiaries and other stakeholders of the project. In this way, we can infer whether or not the project has been economically viable, and the investment fund has been put into a worthy project in comparison with other competing investment opportunities.

The analyzed project is Samil-Ro Bus-Only-Lane, which consists of five intersections (Jongro 2 ga, Cheoggye 2 ga, Euljiro 2 ga, Myungdong Church, and Taegero 2 ga). The total length of the road is 1.099km, having three platforms. The total reconstruction of Samil-Ro lasted from July 22, 2003 to July 20, 2004, but the bus-only-way system became operative from May 1, 2004. This evaluation is made after one full year of operation.

In the following section, we present forecasted travel demand for the Samil-Ro Bus-Only-Lane Project. The fourth section analyzes the project's economic viability by identifying, quantifying, valuating, and comparing costs and benefits. In the fifth section, we measure the uncertainty and sustainability of the project, including the environmental impact of the project. Lastly, the conclusion summarizes the project's main effects and provides policy recommendations.

III. TRAVEL DEMAND FORECASTING

Forecasting and evaluating travel demand is an important step in initiating the economic analysis of a transport project. This process requires the application of sophisticated mathematical techniques. By using data from the Construction Safety

Management Office of Seoul City, we calculated traffic volume and average driving speed of vehicles on Samil-Ro with and without the project and compared the differences. Both sets of data were calculated as averages of several observations at the same locations over time. The observation period of without-project was from April 26 to April 30, 2004 while a more accurate investigation for the with-project took a little more time, lasting from May 3 to May 14, 2004.

Table 1 shows observed traffic flows on Samil-Ro at three different times during the day, when the road gets most congested. On the one hand, with the project in the afternoon and evening, the number of both observed buses and personal vehicles declined compared to the without-the-project situation. Accordingly, driving speeds in the evening and afternoon increased significantly, by 80.9% and 87.2% for buses, and 7.2% and 14.8% for personal vehicles, respectively. These results prove that the project contributed to the enhancement of the bus system in terms of increasing bus driving speed and efficient road surface use for both buses and private vehicle drivers. However, it is difficult to say that the project transformed personal vehicle travelers to reformed bus riders, as the number of both buses and private vehicles decreased. This is contrary to the expectation that an increased number of buses would substitute for the number of private vehicles on the road.

TABLE 1. TRAFFIC FLOWS ON SAMIL-RO WITHOUT AND WITH PROJECT

(Unit: number of cars; %)

		Without Project		With Project		Rate of Change	
		P.V.*	BUS	P.V.*	BUS	P.V.*	BUS
Traffic Volume (car/hour)	Morning (8:00~9:00)	2,208	216	2,404	284	8.9	31.4
	Afternoon (13:00~14:00)	2,436	205	2,315	186	-5.0	-9.3
	Evening (18:00~19:00)	2,513	194	2,508	193	-0.2	-0.5
Average Driving Speed (km/hour)	Morning (8:00~9:00)	12	12.1	11.35	17.15	-5.4	41.7
	Afternoon (13:00~14:00)	8.1	9	9.3	16.85	14.8	87.2
	Evening (18:00~19:00)	8.3	9.45	8.9	17.1	7.2	80.9

NOTE: * P.V. stands for Private Vehicle

SOURCE: Construction Safety Management Office of Seoul City 2004

On the other hand, with the project, the number of buses observed in the morning increased by 31.4%, and their speed increased by 41.7%, while the number of personal cars increased somewhat by 8.9% percent, and their speed decreasing slightly to 5.4% percent. These results also enable us to infer that the project

contributed to the increase in bus driving speed. However, the project failed to encourage private vehicle travelers to ride buses. Contrary to expectations, private vehicle operators increased compared to the without project situation. In short, the project achieved one objective, i.e., increasing the driving speed of buses, but it has not succeeded in achieving the second objective, i.e., shifting private vehicle drivers to the reformed bus system.

Next, we analyze a set of data regarding delays on the road. Figures 1, 2, and 3 compare the rate of delay³ of general traffic, including both private vehicles and buses, at four intersections on Samil-Ro (without project to with project). Only Cheonggye 2 ga shows some improvement in all three different times a day, while areas like Euljiro 2 ga and Jongro 2 ga turn out to be much worse in the morning, and Jongro 2 ga, Myungdong, and Taegero 2 ga in the evening. In the morning, the rate of delay of general traffic at Euljiro 2 ga intersection increased from 74.3 sec/car to 131.2 sec/car, and in the evening, the rate of delay of general traffic at Taegero 2 ga intersection increased from 23.5 sec/car to 54.9 sec/car after the project.

FIGURE 1. RATE OF DELAY COMPARISON (MORNING)

FIGURE 2. RATE OF DELAY COMPARISON (AFTERNOON)

FIGURE 3. RATE OF DELAY COMPARISON (EVENING)

IV. COSTS AND BENEFITS ANALYSIS

In this section, we present the methodology employed and results obtained when evaluating the economic costs and benefits derived from the Samil-Ro BLO project. Such analysis requires making certain assumptions, which may have an important influence on the final result. Since this necessarily implies a certain degree of arbitrariness, they should be explicit at the outset. There also needs to be a sensitivity analysis, which will illustrate the degree with which they may influence the results.

At the outset, the quantification of the present value of the flows of costs and benefits generated by the project requires the determination of both its useful life and the discount rate, which is used to convert future values into present ones. We have considered a period of twenty years for the project's longevity and a discount rate of 7.5%. Both values are usually adopted in the economic evaluation of transport infrastructures in Korea (KDI 2001).

1. Identifying and Quantifying Costs and Benefits

(1) Costs

We can divide costs related to the Samil-Ro BOL project into two types: construction and maintenance costs. The construction period lasted two years prior to the project operation, and the total construction cost was estimated at KRW12,970 million. Table 2 shows that construction costs include costs for civil works, land reparation, and professional fees for supervision. Table 3 shows yearly estimated maintenance costs, calculated based on the practices of the Korean Development Institute (KDI) (see Table 3).⁴

TABLE 2. CONSTRUCTION COSTS

(Unit: KRW million)

	First Year (2003)	Second Year (2004)	Total
Civil Work	1,800	2,700	4,500
Land Reparation	2,490	5,810	8,300
Professional fees for Supervision	170	-	170
Sub-Total	4,460	8,510	12,970

SOURCE: Seoul City Office of Infrastructure Management 2004

TABLE 3. YEARLY MAINTENANCE COSTS

(Unit: KRW million)

Year	1	2	3	4	5	6	7	8	9	10
Cost	27	30	36	42	51	60	70	82	94	106

Year	11	12	13	14	15	16	17	18	19	20
Cost	121	133	152	170	188	207	228	249	271	295

SOURCE: Seoul City Office of Infrastructure Management 2004

(2) Benefits

Two types of benefits are taken into account in this analysis. The first is due to a reduction in vehicle's operating costs, and the other is due to travel time savings.

Reduction of Vehicle Operating Costs (VOC)

Savings in vehicle operating costs (VOC) are the most easily measurable benefit from transport projects. Vehicle operating costs (VOC) split into fuel costs, engine oil costs, tire costs, maintenance costs, and depreciation costs. Changes in those costs provoked by the existence of the Samil-Ro BOL can be calculated as a function of changes in number of kilometers traveled and also of traveling speed, as follows:

$$VOC = \sum (Dl_{kl} \times VT_k \times 365) \quad (1)$$

where the total length of road times the number of cars is Dl_{kl} , and the unit cost of vehicle operation per speed is VT_k .

Unit costs that depend on different traveling speeds are computed using the coefficients in Table 4. These values are also obtained from a KDI report (2001).

TABLE 4. COEFFICIENTS USED TO CONVERT TRAVELED SPEED INTO OPERATING COSTS

	Speed (km/h)	Fuel	Engine Oil	Tire Cost	Maintenance Cost	Depreciation Cost	Total (Won)
Private Vehicle	10	57.35	6.26	0.43	7.23	150.35	221.62
	20	34.58	5.21	0.79	8.54	128.14	177.26
	30	29.41	4.52	1.22	10.12	109.35	154.62
	40	26.56	3.82	1.77	10.51	92.26	134.92
	50	27.14	3.82	2.26	11.83	78.59	123.64
	60	28.17	3.82	2.87	12.49	70.90	118.25
	70	29.72	3.82	3.54	13.14	64.92	115.14
	80	30.46	3.48	4.27	14.46	58.09	110.76
	90	33.12	3.13	5.19	14.85	53.82	110.11
	100	35.71	3.82	6.17	15.77	50.06	111.53
	110	38.63	4.87	7.51	17.48	45.79	114.28
	120	43.31	7.30	8.92	19.06	40.49	119.08
Bus	10	62.11	6.36	0.33	7.26	171.08	247.14
	20	41.01	5.76	0.61	8.20	141.33	196.91
	30	32.01	5.15	0.99	9.03	116.04	163.22
	40	31.06	4.54	1.38	9.31	96.70	142.99
	50	26.07	4.54	1.77	10.24	83.31	125.93
	60	28.35	4.24	2.21	10.71	73.64	119.15
	70	29.97	3.94	2.76	11.18	66.20	114.05
	80	31.06	3.64	3.37	12.11	59.51	109.69
	90	34.06	3.33	4.09	13.32	54.60	109.40
	100	36.42	3.33	4.86	14.34	50.58	109.53
	110	41.01	3.64	5.91	15.55	46.12	112.23
	120	45.91	4.24	7.18	16.76	42.40	116.49

SOURCE: Korea Development Institute 2001.

Value of Time Savings (VOT_i)

Time savings are an important benefit of transport project, since time is a valuable resource. When converting absolute time values into monetary units, we need to choose a value for travel-time savings. Most literature considers that the value of time saved depends on the purpose of the trip. Working trips are valued at the value of output produced, while trips undertaken for pleasure are valued at

the individual's willingness to pay for leisure time, which is usually valued at one-third of the value of working trips (Belli et al. 2001). Since this can be a controversial calculation, we have decided to employ the values recommended by the Korea Development Institute (KDI). Through in-depth calculation and analysis, KDI came up with the result that the average time value per hour saved for a private vehicle is worth KRW9,697 while that for one bus amounts to KRW72,717. The value of time savings was calculated as follows:

$$VOT = \{ \sum (T_{kl} \times P_k \times Q_{kl}) \} \times 365 \quad (2)$$

where the total traveled time is T_{kl} , the average time value per different type of car is P_k , and the number of vehicles that pass the road is Q_{kl}

2. Valuating and Comparing Costs and Benefits

Table 3 shows the cost-benefit valuation results in the form of net present value (NPV), internal rate of return (IRR), and benefit and cost ratio (B/C), using a 7.5% discount rate. First, a negative value of KRW4,754 million is obtained for the NPV. Since the discounted value of economic net benefits should be greater than zero for a project to be economically viable, the conclusion is that the project is not economically viable.

Second, the internal rate of return (IRR) is also computed. The project's IRR is 1.77%, and this value can be interpreted as an indication that society would obtain an average return of KRW1.77 for each KRW100 invested in the project over a period of twenty years. Since the project's IRR is not equal or greater than the chosen discounted rate of 7.5%, the project is not economically viable.

Last but not least, the benefit and cost ratio is not greater than 1.0 and the project is also not acceptable based on the benefit and cost ratio criterion. As a reference, international development finance organizations like the World Bank and the Asian Development Bank use between 10 and 12% as a discount rate. If one follows such a practice, the NPV and IRR of the BOI project would be much lower, and the BOI project would be judged a poorer investment.

TABLE 5. TESTING THE ECONOMIC VIABILITY OF THE SAMIL-RO BOI PROJECT

	Cost (KRW million)			Benefit (KRW million)			Valuation		
	Capital Costs	Operating Cost	Total	VOT	VOC	Total	NPV (million)	IRR	B/C
Before Discounted	12,970	2,622	15,591	17,820	240	18,060	-4,754	1.77%	0.64
After Discounted	12,376	942	13,318	8,450	114	8,563			

V. UNCERTAINTY AND SUSTAINABILITY OF THE PROJECT

1. Sensitivity and Risk Analysis

The results obtained from a valuation of costs and benefits can be very sensitive to some of the assumptions employed in the monetary quantification of the benefits derived from the project. Because of this, a discussion of the changes that would take place if some assumptions are modified should complement the results of the analysis. More precisely, we evaluate the impact of the changes in the value of time savings. Table 6 summarizes the results of sensitivity and risk analysis when the value of time savings decreases by 5% percent. It shows the estimated value of a sensitivity indicator (SI) and a switching value (SV). A sensitivity indicator (SI) compares the percentage change in a variable and the percentage change in measure of project worth, while a switching value (SV) identifies the percentage change in a variable needed for the NPV to become zero, the IRR to fall to the cut-off rate, and the project decision to change (ADB 1997). The sensitivity indicator is 2.33, and the value of time savings would need to be 42.92% lower for the NPV to fall to zero. Thus, the project is relatively sensitive to changes in the value of time savings and has a relatively small margin for a negative decision on the investment. In other words, if the value of the time savings due to the BOL project declines by 5%, the IRR declines by 35%, and the NPV declines by 12%. Even if the NPV is positive, if the value of time savings declined by about 43%, the BOI project should have been rejected as it is an unviable project.

TABLE 6. SENSITIVITY AND RISK ANALYSIS RESULTS

(Unit: KRW million)

	If the Value of Time Saving changes by -5%
VOT in the base case	8,449
NPV in the base case	-4,754
IRR in the base case	1.77%
VOT in the sensitivity test	8,027
NPV in the sensitivity test	5,308
IRR in the Sensitivity test	1.15%
Sensitivity Indicator (SI)	2.33
Switching Value (SV)	42.92%

2. Environmental Sustainability Test

The value of environmental effects can be included in economic analyses of projects,

but it is often very difficult to place monetary value on all types of environmental effects (ADB 1997). In this section, we will check the environmental sustainability of this project by estimating the degree of environmental degradation resulting from the project and translating it into monetary value.

Here, we also use the basic data estimated in the KDI report regarding the emission rate of CO, HC, NO_x, and PM when a private vehicle and bus travel one kilometer. The report also estimates the monetary value of air pollution for each pollutant emission (Tables 7 and 8).

TABLE 7. POLLUTANT EMISSION RATES

(Unit: g/km)

	CO	HC	NO _x	PM
Private Vehicle	1.37	0.40	0.35	0.00
Bus	1.41	0.19	0.72	0.48

SOURCE: Korea Development Institute 2001

TABLE 8. AIR POLLUTION COSTS

(Unit: KRW/g)

	CO	HC	NO _x	PM
Private Vehicle	0.43	2.61	2.49	0.00
Bus	8.44	22.24	9.47	22.60

SOURCE: Korea Development Institute 2001

As seen in the previous section, the project itself triggered more buses to travel on Samil-Ro, but failed to shift private vehicle drivers into public bus riders. Consequently, numbers of both private vehicle and bus are projected to increase⁵, especially in the morning. When the number of buses observed increases, it may be due to the increase in speed as well as to the additional number of buses that may have been put into operation as part of the project. However, Seoul City confirmed that no additional number of buses was put into operation on the Samil-Ro as part of the project. Therefore, we can infer that the increase in the number of buses observed at the observation stations may be due entirely to the increased bus speed resulting from the project. From an environmental impact point of view, it does not matter whether the increases in the number of buses observed are due to the net addition of buses put into operation or due to the faster bus turnaround operating on Samil-Ro. They would both create the same amount of air pollution. Thus, for practical reasons, we assume that the increased number of buses operating on Samil-Ro with the project is due to additional buses put into operation.

Based on the information in Tables 7 and 8, we estimated the value of annual environmental degradation in Table 9.

TABLE 9. ESTIMATED INDIRECT NEGATIVE BENEFIT DUE TO AIR POLLUTION

(Unit: KRW million)

	CO		%	HC		%
	Without	With		Without	With	
Private Vehicle	10.1	10.2	0.98%	17.9	18.1	0.98%
Bus	17.6	18.9	7.80%	6.2	6.7	7.80%

	NOx		%	PM		%
	Without	With		Without	With	
Private Vehicle	14.1	14.2	0.98%	0	0	0.00%
Bus	10.1	10.8	7.80%	16.1	17.3	7.80%

Moreover, when we convert the future value of environmental degradation over next twenty years into present value at a discount rate of 7.5%, we get a negative benefit value of KRW45 million, which will further aggravate the NPV from KRW 4,754 million to KRW 4,799 million. If we take into account this negative benefit derived from the environmental degradation effect of the BOL system, the IRR and B/C will also become smaller than the values estimated without considering environmental effects, i.e., 1.77 and 0.63, respectively, forcing us to make a more negative judgment on the economic viability of the BOL project.

VI. CONCLUSIONS AND LESSONS LEARNED

In response to increased demand for better quality of public transportation as well as various problems that arose from a sharp increase in private car ownership, many major cities around the world began studying and implementing bus-only-lane systems. We examined several international cases in the beginning of this paper and focused on Samil-Ro Bus-Only-Lane, one of the representative BOLs in Seoul, to evaluate the project's economic viability.

First, we estimated travel demand on Samil-Ro was both without and with the project, and examined whether the project's goal of decreasing the number of private vehicles was achieved. The observed results are negative. It turns out that regular commuters who travel by private vehicles find the bus system less convenient and more time-consuming than before, while only bus travelers found the new system relatively faster and more convenient. The bus operates through an exclusive lane with no jams or bottlenecks. In other words, the project enabled the Project Entity (Seoul City) to use road surface more efficiently. However, it did not encourage private vehicle travelers to become the bus users.

Second, the cost-benefit analysis conducted showed that the project is not economically viable. The discounted net present value (NPV) is less than zero, and the

internal rate of return (IRR) is not equal to or greater than the chosen discounted rate, 7.5%. Moreover, the benefit and cost ratio (B/C) is not greater than 1.0, which means that this project is not economically acceptable. Lastly, the project also shows low performance in uncertainty and sustainability tests. The project is rather sensitive to the value of time savings and has a small margin for error or change in the estimated value of travel time savings. Moreover, the project's economic viability is expected to be aggravated when considering the future value of environmental degradation.

In short, of its two main objectives, the Samil-Ro Bus-Only Lane project seems to have achieved only one goal: enhancing the speed of the bus system. The other goal of mitigating traffic jams by decreasing the number of private vehicle commuters and increasing that of bus riders has not been realized; instead, private vehicle traffic jams have worsened.

To enhance the project's effects and achieve its articulated goals, the Seoul Metropolitan Government may want to make similar studies for BOLs in Seoul as well as in other cities of the world. It should make an in-depth study of the reasons for failed objectives and carefully compare them with experiences of other cities.

In the meantime, it would be worthwhile to improve the level of service on the bus system. Ever since the new bus system went into effect, there have been numerous accidents and technical errors that increase waiting time for buses and traffic jams, even in bus-only lanes. Before launching significant investment projects in the future, public authorities should conduct rigorous economic analyses of the project and test it on a pilot basis, comparing its viability with those of alternative investment opportunities. In turn, this will ensure the best use of public funds.

REFERENCES

- Asian Development Bank. 1997. *Guidelines for the Economic Analysis of Projects*. Manila.
- Belli, Pedro, Jock R. Anderson, Howard N. Barnum, John Dixon, and Jee-Peng Tan. 2001. *Economic Analysis of Investment Operations: Analytical Tools and Practical Applications*. Washington, D.C.: the World Bank.
- Chon, Kyung Soo. 2004. Toward a Sustainable Transportation System: New Transportation Policies in Seoul. Presented at the International Workshop on the Asian Approach toward Sustainable Urban Regeneration, September 4-7. Tokyo, Japan: Center for Sustainable Urban Regeneration, University of Tokyo.
- Lee, Hoon-Ki and Jong-Hak Kim. 2004. *Effects of Transport Environmental Improvement by Integrating BRT and Road Pricing Measures* (March). Seoul: Korea Research Institute for Human Settlements, Kuk-To-Yun (In Korean).
- Korea Development Institute (KDI). 2001. *Guidelines for Evaluating the Plausibility of Large-scale Construction Business*. Seoul: Regional Economic Development (In Korean).

- Seoul City Office of Infrastructure Management, 2004. *Final Auditing Reports on the Samil-Ro Remodeling Construction*. Seoul (In Korean).
- _____. 2004. *Monitoring Traffic Flows on Samil-Ro: Results of the Bus-Only Lane Construction*. Seoul (In Korean).
- Seoul Metropolitan Government Transport Statistic. Available: http://www.seoul.go.kr/seoul/summary/statistics/satistics_seoul/today/1214656_10585.html
- Seoul Metropolitan Government, 2004. *Understanding the Bus System Reform in Seoul*. Seoul: Transportation Bureau (In Korean).
- UNESCAP, 2003. Review of Developments in Transport in the ESCAP Region No. ST/EXCAP/2307. Bangkok.

ENDNOTES

- ¹ UN/ESCAP (2003) argues that bus transport will continue to provide the most flexible and widely used means of public transport for the foreseeable future despite the development of other public transportations.
- ² The average annual rate of increase is calculated with data from between 1995 and 2003.
- ³ The rate of delay represents a waiting time of vehicles (both private vehicles and buses) at the red lights before passing the intersection. The traffic signal system has not been changed with or without the project.
- ⁴ This practice is called "Standard Measures for Maintenance Costs." According to these measures, an average maintenance cost for a standard 4-lanes road during next twenty years after construction is estimated at KRW4.3 billion.
- ⁵ The number of private vehicles is projected to increase from 42,942 to 43,362 in one year while that of buses is projected to increase from 3,690 to 3,978 in the same period.