A CRITICAL REVIEW OF TRANSPORT INVESTMENT APPRAISAL PRACTICES IN KOREA

Seungbum AHN
Research Associate
The Korea Transport Inst.
Seoul, Korea
Fax:+82-2-538-1459

Jaehak OH
Senior Researcher
The Korea Transport Inst.
Seoul, Korea
Fax:+82-2-538-3511

abstract: Despite its importance, the effort to improve the transport investment appraisal methodology in Korea has rarely been given. Since the first version of the Transport Investment Appraisal Manual was published in 1982, it has not been updated to reflect changes in the transport investment environment. This paper describes theoretical and practical problems of transport investment appraisal practices in Korea and reviews foreign experiences. An improved framework of the transport investment appraisal method is suggested and required data, information, and studies are recommended.

1. INTRODUCTION

As traffic growth becomes much greater than expected, many roads can't accommodate traffic growth. Traffic congestion becomes widespread all over the network of the country. A large amount of infrastructure investments in the transport sector are required to deal with traffic congestion and to reduce the economic loss due to transportation cost increases and traffic accident damages. However, the financial resources available for transport investments are limited, and thus, the efforts to utilize such limited financial resources in a more economical way appears to be an important task in the appraisal of transport investment projects. The rational decision-making in transport planning and investment programming should be based on the sophisticated method of transport investment appraisal.

The present method of transport investment appraisal in Korea originates from the Transport Investment Appraisal Manual provided by the government in 1982. The manual documents the general concept and method of traffic forecasting and cost-benefit analysis for highway and railway investment projects. The manual has widely been used as the textbook for planning and evaluating transport investment projects in Korea.

Since its release, substantial changes in the socio-economic requirements of Korea's transport sector has been made. Accordingly, the present manual is too outdated to accommodate the rapidly changing socio-economic environment in the transport sector. Some of apparent changes include: 1) the external effects such as traffic accidents and environment pollution become an important factor in the process of investment appraisal, 2) the analysis of impacts to the regional development and national economic development is required more rigorously, 3) the intermodality

among transport modes becomes a big stake as the network become more complicated, 4) the utilization of new technologies such as high-speed railway system, advanced urban rail system and intelligent transport system (ITS) increases. In particular, the present manual is criticized for its failure to adequately deal with the issue of prioritization of investment projects.

The main purpose of this paper is to review the present practices of the transport investment appraisal method in Korea and to propose suggestions for its improvement. For this purpose, the state of art of the transport investment appraisal method, i.e., cost-benefit evaluation, is reviewed broadly. In addition, foreign practices of transport investment appraisal in U.K., USA and Germany are reviewed for lessons.

2. OVERVIEW OF TRANSPORT INVESTMENT APPRAISAL PROCESS

The appraisal of transport investment projects involves the estimation of benefits of travel time changes or traffic accident reduction as a consequence of improved transport conditions. These, with the more straightforward items such as investment and operating costs, can be used for the evaluation of investment projects. These projects are compared with other competing projects which claim limited public resources depending on relative net values. Thereby, a more rational allocation of public funds to transport investment is made possible.

The purpose of this section is to review the general contents involved in the transport investment appraisal process. The major elements of transport investment appraisal process consist of: 1) forecasting transport demand, 2) estimation of economic costs, 3) estimation of economic benefits, 4) comparing costs and benefits.

2.1 Forecasting Transport Demand

Measuring the benefits of transport investment projects requires the estimation of its future use, i.e., the transport demand during its useful life. Estimating future demand is an imprecise - but unavoidable - element in the transport investment appraisal. Since many transport investments have potentially long lives, the decision to make such investments is based inherently on long-term forecasts of demand.

In general, the conventional approach to estimate traffic volume on the network involves four stages: trip generation, trip distribution, modal split and trip assignment. Although this approach is used widely, it is often criticized by many practitioners. Their common criticism includes that conventional forecasting methods are inaccurate, inflexible, too complicated, costly, policy-insensitive and etc. Furthermore, the interaction between land use change and transport development is ignored in the modelling process.

In the appraisal of highway investments, especially under congested network condition, the generation of traffic, suppressed or induced traffic, becomes an

important issue. The generation of traffic is due to either the form of traffic which doesn't use a facility because of congestion or extra traffic which results from new investment. The economic benefits derived from highway schemes are very sensitive to the amount of newly generated traffic if the system is, or will operate under congested conditions.

2.2 Estimation of Economic Costs

Measuring the economic costs of a project involves adjustment of actual expenditures on inputs where the prices paid don't properly reflect the real scarcity value of inputs. Such adjustments of distorted market prices involve the calculation of shadow prices which reflect actual prices. Distorted market prices are apparent in developing countries where rapid inflation, strict government regulation and imperfect market conditions are common. The estimation of shadow prices requires large quantities of data and forecasts that are difficult to make. In large, shadow pricing is accomplished through corrections using foreign exchange, taxes, wages and interest rates.

2.3 Estimation of Economic Benefits

Measuring the economic benefits of transport investment projects involves more complex conceptual and practical problems than measuring economic costs. There are a number of reasons for this. First, some benefits such as increased comfort and convenience when a project is invested are difficult to express in monetary terms since there are usually no market prices to indicate to what extent users are willing to pay for them. Second, benefits in the form of reduced transport costs accrue to a wide range and a great number of people over a long period of time. This makes it difficult to forecast their impacts. Third, many benefits from transport improvement are indirect such as the stimulation of the economy.

The major important benefits from transport investment projects include any or all of the followings:

- Reduced operating costs, initially for the users of the new or improved facility and sometimes also for those who continue to use the existing facilities, which may become less congested.

- Stimulation of economic development

- Savings in travel time for both passengers and freights

- Fewer accidents and reduced property damage

- Increased comfort and convenience in travelling

At the present state of the art of investment evaluation, the reduction in operating expenses can be measured in monetary terms more readily than benefits. The

measurement of greater comfort and convenience appears to be related to the social value, the willingness to pay for improved transport services.

The most direct benefits from transport investment projects is the reduction of transportation costs. The reduction of transportation costs is the one most readily measurable in monetary terms. The types of reduction in transport costs vary widely. The improvement of one transport mode frequently affects the costs of other modes. For traffic which is diverted to a new or improved facilities from other modes of transport or from other routes, the benefits are measured by the difference between transport costs.

It is frequently assumed that transport investments stimulate economic development. In many situations, however, the transport investment is not the only new investment needed to achieve economic development. This raises the problem of allocating the benefits among transport and other public investments.

Many transport investments reduce travel time and increase the reliability of transport services. Studies on the value of time (VOT) generally distinguish between travel for business and working purposes and for non-working purposes. Also, it is appropriate that factors such as travel purpose, mode of travel, travel length, whether time is saved in vehicle or in waiting, and so on are to be considered in the estimation of the VOT.

Finally, many transport investments help to reduce traffic accidents. This clearly produces an economic benefit. However, there might exist some transport investments that don't reduce traffic accidents. That is, transport investments may increase traffic accident by generating more traffics and increasing vehicle travel speed. In general, measuring the economic benefits of traffic accident reduction involves two steps: estimation of the probable reduction in accidents and estimation of the economic benefits of the accident reduction.

2.4 Comparing Costs and Benefits

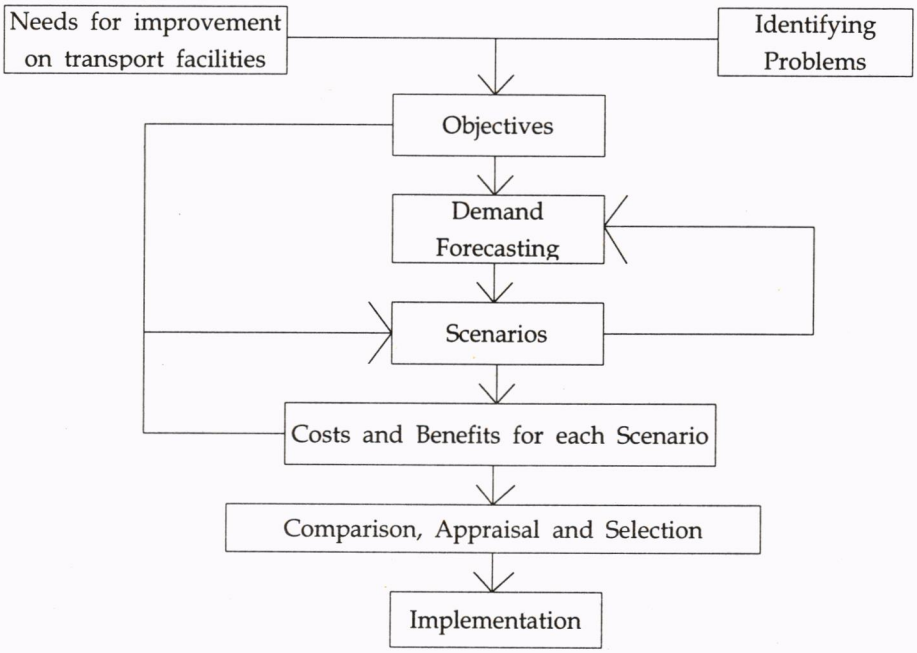
Once the costs and benefits have been measured for each year of the useful life of the investment project, it becomes necessary to bring two flows of costs and benefits to a common figure of the present values by discounting. The process of discounting involves the use of discounting rate. The choice of discounting rate is important. However, in general, there is no clear agreement on which rate of discount to use. The rate of discount varies with not only the combination of financial resources used in the investment projects but also the value of time.

In general, there are four common methods of comparing costs and benefits. The comparison can measure the net worth of a investment project, that is, the net difference between its discounted costs and benefits, the internal rate of return (IRR); the rate at which discounted costs and benefits are equal, the ratio between costs and benefits or the payback period - the number of years needed for annual net benefits to equal investment costs.

3. REVIEW OF TRANSPORT INVESTMENT APPRAISAL PRACTICES IN KOREA

The Transport Investment Appraisal Manual was published by the government in 1982 to support feasibility studies of transport investment projects. Since its publication, feasibility studies on roads and railway projects have been done on the basis of the Manual, which includes the concept and methods of transport planning and economic analysis for comparison of scenarios and prioritization of investment projects.

Rapid growth of the Korean economy evoked several issues relating to transport investment appraisal. In this section, transport investment appraisal practices and shortcomings identified in the transport investment appraisal practice in Korea are reviewed, focusing on forecasting travel demands, estimating costs and benefits, and economic analysis. Figure 1 shows the process of transport investment appraisal currently applied in Korea.



<Figure 1> The Process of Transport Appraisal in Korea

3.1 Forecasting Travel Demand

Forecasting travel demand provides a basis for transport improvements. Overestimation of demands forecasted will cause waste of resources and underestimation will cause traffic congestion and miss the proper timing of investment.

In the stage of trip generation, traffic demand is usually forecasted based on various input data: population of the design year, land use plans, GNP, traffic generation rate as well as socio-economic data of the base year and current traffic condition.

The demand forecasting methods used in Korea are in large divided into two approaches depending on the scope of study area: Systems-analysis and Corridor-analysis. In the Corridor-analysis approach, demand forecasting is conducted along the corridor. In the other hand, the Systems-analysis approach usually goes through four stages to cover much wider study area: trip generation, trip distribution, mode choice and traffic assignment. Although the analysis is systematic, the process is rather complicated and it requires a large amount of input data. Major problems identified in the traffic demand forecasting process in Korea are:

1) Use of simple forecasting population methods

Local and national investment decisions for transport facilities are based on the projected number of people in the designated area. Population forecasting in Korea is done through extrapolation methods. The cohort analysis is believed to be the most reliable one, based on fertility rate and fertile cohorts in female population. In addition, migration rates can be identified by urbanization, economic activities, development plans, available laborforce, etc.

2) Lack of intermodal relationships in traffic forecasting

Because of the use of simple extrapolation methods in traffic demand forecasting, the traffic demand of highways tends to be overestimated. Extrapolation methods are simple to use. But, it fails to model the intermodal functions between competing or complimentary modes and facilities.

3) Ignoring the effects of induced traffics

Ignoring induced traffics or extra traffics generated after transport improvements may lead to overestimation of the benefits. One of the major difficulties for estimating the amount of induced traffic is the lack of standard data and method for each type of roads and railways.

3.2. Costs

The present Manual considers construction costs and maintenance costs as the major costs for economic evaluation. Construction costs are based on unit costs and size

of the investment project, land and property acquisition cost, length of the roads or rails, etc. Maintenance costs vary depending upon traffic volumes on the facility. The Manual offers values for construction and maintenance costs. However, those values are too outdated to reflect actual costs. The followings are major problems in the Manual concerning costs.

1) Proportion of land and property acquisition costs

Delayed compromise in land acquisition sometimes makes the proposition of land and property acquisition costs exceed 90 percent of total project costs.

2) Uncertainty in costs

Feasibility studies include sensitivity analysis for uncertainty. However, the present sensitivity analysis relies upon a fixed change to original costs, regardless of the types of investment project.

3) Treatment of vehicle or train purchasing costs.

In railway projects, train purchasing costs are included in the project investment costs, while in highway projects the vehicles purchased privately are not included in the project cost. Railway investment projects are likely to be more costly than highway ones. As a result, railway projects appear to be less competitive in terms of net values.

4) Environment costs

After environmental assessment studies, mitigation for reduction of environmental effects should be followed. Costs for mitigation measures such as reservoir, pollution abatement and anti-noise facilities are to be contained in the economic appraisal.

3.3 Benefits

Benefits from transport investment projects are in large divided into two categories, user and non-user benefits. Benefits in the economic analysis tend to be aggregated. The aggregation of benefits causes equity issues among income groups, users and non-users, and regions. Currently, only the reduction of vehicle operating costs and travel times is considered as benefits in Korea. However, some items of benefits such as accident reduction, increase and improvement in comfort and convenience, regional development, tourism, environmental improvements are not properly assessed in the estimation of benefits.

Vehicle operating costs are composed of fixed costs and variable costs. The present method of estimating is based on the ΔL method, which takes into account of various highway physical conditions. At present, six categories for vehicle types and speeds under ideal conditions are given to estimate operating costs, shown in the Table 1.

<Table 1> Operating costs per vehicle-kilometer by vehicle type and speed level under ideal road conditions in Korea

unit: won/veh-km

Speeds (km/hr)	Passenger Car	Bus(small)	Bus(large)	Truck(small)	Truck(medium)	Truck(large)
8	195.74	279.92	588.31	463.77	513.94	615.51
16	143.84	175.84	403.13	308.74	347.39	431.75
24	122.21	136.05	303.51	247.96	284.46	361.05
32	110.20	114.70	250.02	215.01	250.43	323.40
40	102.20	101.90	217.23	194.22	230.32	301.75
48	96.94	93.36	195.19	180.41	217.15	288.69
56	93.13	87.57	179.68	170.67	208.80	281.99
64	90.37	83.63	168.75	163.76	204.13	279.89
72	88.51	80.84	160.70	159.05	202.12	278.34
80	87.12	79.32	155.19	155.86	202.01	284.71
88	86.37	78.71	152.08	154.12	203.87	290.17
96	86.22	78.68	150.24	153.49	207.74	301.03

Source: The Korea Highway Corporation, 1992.

To find out savings due to reduction of travel times, two items are necessary: the value of time and estimation of travel times. The value of time is estimated based on 'willingness to pay' or level of average wages. Values of travel time for working trips are estimated for different type of vehicles. Values of travel time for non-working trips becomes approximately 25% to 30% of those of working time. Table 2 shows the values of travel time for working trips by vehicle type. However, as shown in Table 2, the values of travel time in transport investment appraisal are various from project to project. This diversity in values of travel time makes it difficult to compare competing projects in a consistent way.

<Table 2> Values of Travel Time applied in Korea

Source	Criteria	Unit	Value time	Comments
Policy Analysis for Reduction of Passenger Vehicles (KOTI, 1990)	willingness to pay	won/person-hr	in-vehicle: 6,900 out-of-vehicle: 9,870	-
A Feasibility Study of Seoul-Pusan High speed Railway Project (KOTI, 1990)	wage	won/person-hr	passenger car: 2,062 bus: 1,883 railway: 2,102	Based on working hours and non-working hours
A Feasibility Study of Chunan-Honam Region Expressway Project (KHC, 1992)	wage	won/veh-hr	passenger-car: 3,045 bus: 14,099	Average persons per passenger car: 2.1 bus: 14.5
A Study on the Estimation of Transport Congestion Costs (KOTI, 1992)	wage	won/veh-hr	passenger-car: 8,817 bus: 5,964	Based on working hours

Note: KOTI; The Korea Transport Institute
KHC; The Korea Highway Cooperation
** 1 dollar was about 850 to 900 won.

The estimation of travel time under congested network condition is based on BPR curve, which was initially provided by the Bureau of Public Road of the U.S. The exact BPR curve currently used is in Korea:

$$T = T_o(1 + 0.15(\frac{V}{C})^4) \quad (1)$$

where T: travel times
T_0: free flow travel time
V: volume
C: capacity

An investigation of the composition of benefits in transport investment appraisal in Korea shows that the proportion of benefits due to travel time reduction is less than that due to a reduction in operating costs. This result is quite contrasted to the composition of benefits in other countries such as U.K., where benefits from travel time saving account for approximately 95 percent of total benefits in transport investment appraisal.

3.4. Cases

Although the Transport Investment Appraisal Manual has not been updated, most transport investment reports and feasibility studies followed the format of the Manual. Table 3 shows items considered in the several recent feasibility studies.

<Table 3> Economic Analysis in Feasibility Studies in Korea

Costs	Benefits	Financial Analysis	External Effects	Comments
1. Feasibility Study for Chunan-Kongju and Kongju-Buyeo Expressway (1991)				
-Construction Costs -Maintenance Costs	-Reduction of Operating Costs -Time Savings	Not Considered	Regional Development Effects	-Discount Rate: 11%, 14%
2. Feasibility Study for Seoul-Taejon Expressway(1985)				
-Construction Costs -Maintenance Costs	-Reduction of Operating Costs -Time Savings	Not Considered	Not Considered	-Discount Rate: 13%, 15%, 18%
3. Feasibility Study for Temple Naejang-Temple Baekyang Highway(1982)				
-Construction Costs -Maintenance Costs	-Reduction of Operating Costs -Time Savings	Not Considered	Tourism effects are considered in cost-benefit analysis	-Considered induced traffic for calculating benefits
4. Feasibility Study for Seoul Beltway(1991)				
-Construction Costs -Maintenance Costs	-Reduction of Operating Costs -Time Savings **User and nonuser benefits in the Seoul city network	Not Considered	Not Considered	-Discount Rate: 10% -Without Beltway and With Beltway
5. Feasibility Study for Kyungbu High Speed Rail(1991)				
-Construction Costs -Maintenance Costs -Train Acquisition Costs	-Reduction of Operating Costs -Time Savings **Considered both roads and railways	Considered	Considered -Accidents -Pollution -Regional Development -etc.	-Discount Rate: 10% -Do Minimum
6. Feasibility Study for East-West High Speed Rail(1990)				
-Construction Costs -Salvage Costs	-Consumer Surplus: Time Saving, Operating Costs -Producer Surplus: Fares, Reduction of Operating Costs -Reduction of Road Construction	Considered	Not Considered	-Do Minimum (Road construction) -Discount Rate: 12%, 14%, 16%, 18%

*** Benefit/Cost Ratio, Internal Rate of Return (IRR), and Net Present Value (NPV) are used for Economic Analysis in all the feasibility studies.

*** Items for sensitivity analysis are change of construction costs, traffics, discount rates, operating costs, etc.

4. EXPERIENCES AND PRACTICES IN FOREIGN COUNTRIES

This section reviews practices of transport investment appraisal in the following foreign countries: U.S., U.K., and Germany. Some lessons from their experiences are drawn.

4.1. United States

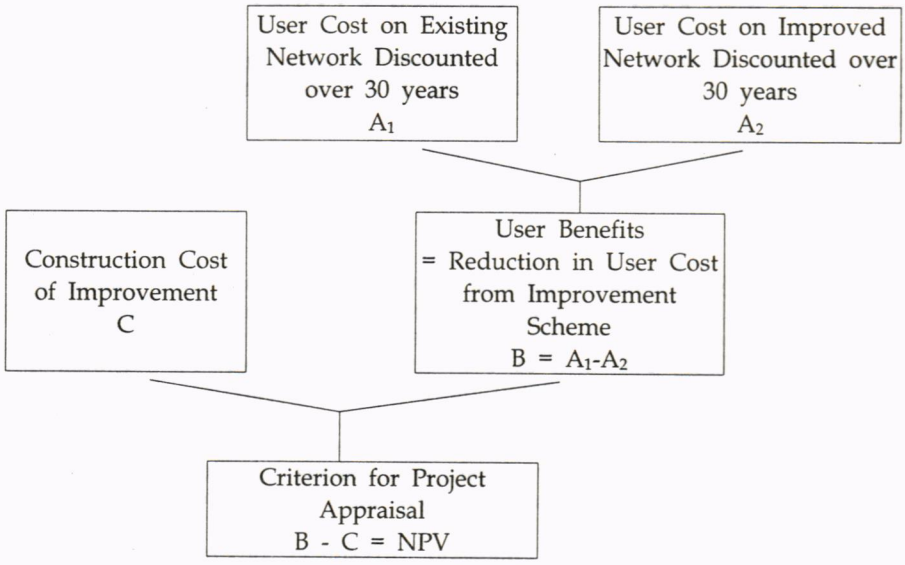
The process of highway investment appraisal in the United States is regulated by two major guidelines: the manual provided by the AASHTO(American Association of State Highway and Transportation Officials) and the Highway Economic Requirements System(HERS) published by FHWA(Federal Highway Administration). In principle, these two manuals are based on cost-benefit analysis. Furthermore, the federal government requires socio-economic analysis, environmental assessment and public consultation for feasibility studies of large scaled investment projects. An important fact is that the state or local governments should satisfy these requirements for allocation of financial subsidy from the federal government.

In 1991, as a new initiative in the transport investment program, the federal government announced the ISTEA91(Intermodal Surface Transportation Efficiency Act 1991, Public Law 102-24). The ISTEA91 includes not only the future national transport policies but also a detailed transport investment plan. Some of important features contained in the ISTEA91 are: 1) Pursuing environmental-friendly and energy efficient transport system, 2) Encouraging intermodal transport system, 3) Reduction of traffic congestion and traffic accidents, 4) Development of new advanced technologies such as ITS, high-speed railway and etc., in transport sector.

4.2 United Kingdom

The British practice of transport investment appraisal is guided by the Cost-Benefit Analysis(COBA9) manual, provided by the Department of Transport(1980). The COBA9 is mainly responsible for the economic analysis of highway investment projects and is available in the form of the computer software program. As shown in Figure 2, COBA9 includes benefits in traffic accident reduction along with reduction in operating costs and travel time savings. Congestion costs which occur during construction and maintenance are also accounted for.

In the U.K., the appraisal of railway investments is based on the cost-revenue analysis rather than social cost-benefit analysis. The British approach in railway investment appraisal is quite distinctive in this sense and it is argued that this led to underinvestment in the British railway sector. The cross-comparison between road and railway investments is not easy.



<Figure 2> COBA Evaluation System (COBA9 Manual, 1992)

4.3 Germany

The German evaluation for transport investment appraisal is guided by Macroeconomic Evaluation of Transport Infrastructure Investment, provided by the Federal Ministry of Transport in 1992. The Manual covers the concept and methodology of estimating a wide range of costs and benefits. It attempts to quantify most of the costs and benefits in monetary terms. As shown in Table 3, the manual requires a wide range of assessing cost and benefit items in monetary terms. This manual was applied to prepare the Federal Transport Investment Plan 1992(FTIP92).

The German approach emphasizes coordinated traffic forecasting to encourage the intermodal transport system in transport planning. Also, it shows a typical example for assessment of external impacts such as traffic accidents or environmental impacts from investment projects.

<Table 4> Evaluation Items and Criteria applied for FTIP92

Evaluation Criteria	Monetary Value	
1) Reduction of Transportation Costs(NB)	Possible	Impossible
· NB_1 Reduction of vehicle standing costs	*	
· NB_2 Reduction of vehicle operating costs	*	
· NB_3 Avoidance of modal shifts	*	
2) Maintenance of traffic infrastructure(NW)		
· NW_1 Renewal of traffic infrastructure	*	
· NW_2 Maintenance of traffic infrastructure	*	
· NS Improvement of traffic safety	*	
· NE Improvement of accessibility	*	
3) Spatial advantages(NR)		
· NR_1 Employment effects during construction of traffic routes	*	*
· NR_2 Employment effects during operation of traffic routes	*	*
· NR_3 Advantages of spatial structure		*
· NR_4 Promotion of international exchanges on information and efficiency		*
4) Environmental Benefits (NU)		
· NU_1 Reduction of noise	*	
· NU_2 Reduction of exhaust fumes	*	
· NU_3 Reduction of separation effects	*	
· NU_4 Reduction of impairment on living quality and communication	*	
· NF Benefits from other than traffic-related effects	*	

5. SUGGESTIONS FOR IMPROVEMENT OF TRANSPORT INVESTMENT APPRAISAL IN KOREA

Despite its importance, the effort to improve the transport investment appraisal methodology in Korea has rarely been given. Since the first version of the Transport Investment Appraisal Manual was published in 1982, it has not been updated to reflect changes in the transport investment environment. Based on the findings identified in the previous section, this section proposes some suggestions for improvement of the transport investment appraisal practices in Korea.

As transport networks become complicated, the intermodality of transport networks should be considered in the process of transport planning and investment appraisal. The transport project under planning is affected by the presence of other projects. Also, under the limited financial investment resources available, the comparison of competing or complementary projects is required to form a more efficient transport network system. For this purpose, forecasting of transport demand for investment projects should be conducted in a more comprehensive way. For example, the traffic forecast of highway projects should be made by coordinating with railway project in the whole transport network.

As concerns for transport safety and environmental pollution grows, the appraisal of transport investment projects treats external effects due to transport projects as an important factor. The current practice of transport investment appraisal ignores the external effects. As a result, highway investment projects appear to be more advantageous than railway projects which produce less external effects.

The following summarizes some aspects to be included in the improved version of the transport investment appraisal manual in Korea:

- A standard method of evaluating transport investment projects should be provided at the national level. The standard method includes the method and values necessary in transport investment appraisal. It might be more useful if the manual is provided in the form of computer software like COBA9.

- National traffic forecasts should be given a guideline for traffic growth in transport investment appraisal. Also, the coordination efforts in traffic forecasting should be emphasized. The coordinated traffic forecasting makes it possible to compare the project with other competing alternative projects in an entire network.

- One of the most important factors in the estimation of benefits is the value of time (VOT). As discussed in the previous section, the value of time should be given in a more disaggregate form such as by trip purpose, by income group, by transport mode etc. For this purpose, a wide range of survey for identifying the values of time should be conducted regularly.

- Various indices such as construction costs, maintenance costs, accident and environmental costs, fuel consumption rate, speed-flow relationship curves, vehicle operating costs and so on should be updated regularly and provided at the national level. The consistent use of values should strongly be required in feasibility studies of all transport investment projects. This makes possible coordinated planning and prioritization of investment projects.

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