General Guidelines for Preliminary Feasibility Studies

(fifth edition)

December 2008

Public and Private Infrastructure Investment Management Center

(PIMAC)

< Research Team >

General Guidelines for
Preliminary Feasibility Studies (Fifth Edition)

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Korea Development Institute

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CHAPTER 1

Outline

Ⅰ. Background and Purpose of Revising the General Guidelines

1. Role of the General Guidelines

The "General Guidelines for Preliminary Feasibility Studies" (hereinafter "General Guidelines") has served as a basic manual for conducting all preliminary feasibility studies. The General Guidelines include the methods and standards for conducting preliminary feasibility studies. They comprehensively suggest theoretical and practical ground rules concerning evaluation of public investment projects. They also serve as a basic manual for standard guidelines in studies on different subjects such as roads, railroads, ports, culture and tourism, and water resources.

2. Background and Purpose of Revising the General Guidelines

The General Guidelines were first published in 1999 and revised three times with the Second Edition in 2000, Third Edition in 2001, and Fourth Edition in 2004. The on-going revision of the General Guidelines is intended to reflect the cumulative findings of studies; to supplement contents regarding theoretical and methodological issues; and to renew statistical data and parameter values as needed.

The results of preliminary feasibility studies conducted so far are indicated in

Table 1-1. Based on the reports published until 2008, a total of 382 preliminary feasibility studies were completed. Of these reports, 165 were on roads and 74 were on railroads, accounting for the majority.

▌Table 1-1▌ Preliminary Feasibility Studies by Project Type

(Unit: Case)

Year	Road	Railroad	Port	Culture & Tourism	Water Resources	Others	Total
1999	11	2	1	3	1	1	19
2000	11	7	5	2	1	4	30
2001	20	14	1	5	0	1	41
2002	9	8	2	2	5	4	30
2003	11	7	3	5	5	2	33
2004	24	13	1	2	3	12	55
2005	11	6	2	1	3	7	30
2006	27	11	3	6	1	4	52
2007	30	4	1	1	1	8	45
2008	11	2	4	3	2	15	37
Total	165	74	23	30	22	58	372

Note: Based on the preliminary feasibility study reports published through August 2008.

Looking at the numbers of preliminary feasibility studies by project type, the numbers of non-transport projects where project-specific characteristics are of relatively greater importance, such as those for culture and sports facilities, hospitals, industrial complexes, and the like, are gradually increasing. This is, in turn, gradually increasing the need for a more comprehensive manual to cover the various types of public investment projects while maintaining the consistency of guidelines used for each type. There is also an increasing need to renew and revise various indices and parameters for transport projects, where the study methodology is relatively standardized.

In this light, this report intends to revise and supplement the General Guidelines as follows:

First, there are various revisions and additions to the guidelines that need to be made regarding an economic feasibility analysis and financial feasibility analysis. Namely, the guidelines for an analysis of economic feasibility should be worked out including the basic methodology of a cost-benefit analysis (e.g. setting of an appropriate social discount rate) as well as demand estimation, benefit calculation,

and cost calculation; the guidelines for analysis of financial feasibility need to be devised; and the possibilities to induce private investment need to be studied. Changes in the circumstance, the Sectoral Guidelines of each type of project, and such should be considered, and more credible, current data should be referenced.

Second, primarily with respect to the transport projects, some of the indices used in the process of demand estimation, benefit calculation, and cost calculation should be renewed, and the precision in the values of parameters should be reviewed. The details of this work can be found in the study to revise the Sectoral Guidelines for Road and Railroad Projects.

Third, there is the need to supplement policy analysis that constitutes the basic analysis framework of preliminary feasibility studies along with economic feasibility analysis, and to supplement the Analytic Hierarchy Process (AHP) analysis that comprehensively evaluates both analyses. Data on relative development by region needs to be updated for policy analysis. Ways need to be considered to supplement the basic analysis framework for policy analysis and AHP analysis such as adding special evaluation items and reorganizing the system of evaluation items.

Due to the aforementioned needs and background to revise the General Guidelines, this revision report mainly intends to develop a range of analysis methodologies to be uniformly applied to all types of projects and to work out more detailed principles and standards for application. Particularly, it includes the contents from the soon-to-be revised “Study to Revise and Supplement the Sectoral Guidelines for Preliminary Feasibility Studies for Road and Railroad Projects (fifth edition)” as well as the “Study to Estimate the Values of Cultural and Scientific Facilities,” “Study on the Methodologies of Preliminary Feasibility Studies for Health and Welfare Projects,” and “Study on the Sectoral Guidelines for Preliminary Feasibility Studies for ICT Projects” currently underway regarding the guidelines for non-transport projects, in order to increase the scope covered by the General Guidelines.

Ⅱ. Guiding Directions and Major Contents

1. Composition and Directions of the General Guidelines

The existing “General Guidelines (fourth edition)” are largely divided into two

parts: ‘Part 1: general guidelines for preliminary feasibility studies’ serves as a formal manual by suggesting the basic contents and methodologies of study that should be observed when conducting an actual feasibility study. ‘Part 2: study on methodologies to establish general guidelines’ contains a theoretical review and a methodological study that serve as the background of Part 1. In other words, the basic structure of the existing general guidelines places contents directly related to execution of preliminary feasibility studies in Part 1 in keeping with the flow of the report, and matters that require more in-depth theoretical study and definition of issues in relation to methodologies and parameter estimation in Part 2.

The General Guidelines (fifth edition) are intended as a revised and supplemented version of the Fourth Edition. As in the Fourth Edition, the Fifth Edition has study guidelines in Part 1 and methodology study and parameter estimation in Part 2. This report includes the core contents of this revision study, e.g. setting an appropriate social discount rate; ways to attract private investment; financial feasibility analysis; implementation guidelines for application of Contingent Valuation Method (a method to calculate benefits for atypical projects); standards to reflect future development plans; and estimation of the population and Gross Regional Product of each administrative district, as well as various issues related to study methodologies. Moreover, sufficient reasons and grounds are presented about contents that are difficult to codify into guidelines or apply to an actual study.

2. Major Contents and Methodologies

The “General Guidelines (fifth edition)” reviews and revises the existing reports as necessary and focuses on economic feasibility analysis, financial feasibility analysis, policy analysis, and comprehensive evaluation, the core contents of general guidelines. Under these directions of revision, the Guidelines focus on the following areas:

A. Analysis of Economic Feasibility

a. Setting the Social Discount Rate

The need to set the social discount rate, a major index used in economic feasibility analysis, is especially important in light of the recently low interest rates

that have been maintained since 2000 and the expectations for low economic growth due to the decline in the per-capita GDP growth rate and the rate of savings occasioned by low fertility and population aging. This report intends to comprehensively consider the needs, issues, etc. of such adjustment and suggest an appropriate discount rate. To ascertain whether it is necessary to adjust the current real social discount rate, 5.5%, it reviews changes in the capital market such as the downward trend in the interest rate, and recent application of discount rates in developed countries.

Regarding the differentiation of evaluation methods for different types of projects, it reviews the practicality as well as pros and cons of applying different social discount rates for such projects as those for roads, railroads, ports, water resources, and cultural and sports facilities.[1]

b. Reflection and Inclusion of other Guidelines

As the General Guidelines serve as comprehensive guidelines for different types of projects, this revision report intends to build a general system by including the revisions and additions of standard manuals of preliminary feasibility studies. Nevertheless, this report only carries the outline of analysis and leaves out specific analysis methods, parameters, etc. to be carried by the manuals and reports of each type of project.

It includes the contents from the "Study to Revise and Supplement the Sectoral Guidelines for Preliminary Feasibility Studies for Road and Railroad Projects (fifth edition)" (hereinafter "Sectoral Guidelines for Road and Railroad Projects") currently underway. It is also more closely connected and consistent with the "Handbook of Investment Evaluation of Roads and Railroads" published by the competent authority for each project. Since preliminary feasibility studies became institutionalized, the government agencies that carry out such studies, like the Ministry of Land, Transport and Maritime Affairs, have developed and used handbooks of investment evaluation, similar to the General Guidelines for preliminary feasibility studies and the sectoral guidelines of each type of project. Though they bear some difference in terms of the execution steps, scope, and specific study methods, preliminary feasibility studies and regular feasibility studies apply the same basic evaluation methods. As there is a need to maintain consistency

1 Current water resource projects (dams) have a longer economic life cycle (50 years) than other SOC projects and thus benefits occur over a long period. For this reason, the social discount rate for such projects is 6.5% in the first 30 years of operation and 5.0% in the remaining 20 years.

in the evaluation of public investment projects, these handbooks were reviewed to ensure maximum consistency and expertise in the evaluation methodology. The contents necessary to revise the Sectoral Guidelines for Road and Railroad Projects are reflected, and the main contents are included in these Guidelines.

For greater consistency in the guidelines for non-transport projects, which account for an increasingly greater share, the "Study to Revise and Supplement the Sectoral Guidelines for Preliminary Feasibility Studies for Water Resource Projects (fourth edition)," the "Study on the Sectoral Guidelines for Preliminary Feasibility Studies for Research and Development Projects," and others are currently in the making. The General Guidelines intend to include, if only briefly, basic study methods and theoretical matters to review these types of projects.

B. Study on Ways to Attract Private Investment

The "General Guidelines (fifth edition)" report intends to review projects where the cost-benefit ratio exceeds 0.9 for their potential to attract private investment and suggest appropriate procedures.

Originally, preliminary feasibility studies entailed financial feasibility analysis to provide basic information that helps decide whether to conduct a project as a public-private partnership (PPP) project by roughly suggesting the potential for profitability and the minimum rate of government financial support. Nevertheless, the financial feasibility analysis in preliminary feasibility studies fails to comprehensively consider qualitative elements such as better quality of service, ease of management, risk distribution, and ripple effects other than profitability when setting the minimum rate of government financial support to determine whether or not to conduct a project as a PPP project. It, therefore, has limits in making a final decision on whether or not to pursue a PPP project.

From the perspective of the government or nation, a project is financed by the taxpayer regardless of whether it is a public investment project that is 100 percent government-financed or a PPP project partially funded by the government. Therefore, there should be principles to systematically select projects in place in advance without regard to whether it is a government-financed project or PPP project.

The 'Basic Plan for PPP Projects' (Ministry of Strategy & Finance, January 2008) stipulates that government-financed projects that can be carried out as PPP projects in consideration of financing conditions, urgency, profitability, and such and that need to secure profitability with appropriate financial assistance shall indeed be converted into PPP projects. It also stipulates that the decision as to whether a project shall be funded by public finances or private investment be made

when conducting a preliminary feasibility study. To implement this regulation, there should be a way to determine whether to pursue a project with public finances or with private investment *ex ante* at the step of preliminary feasibility study.

C. Supplementation of the Guidelines for Financial Feasibility Analysis

To facilitate attraction of private investment, the Ministry of Strategy & Finance is currently improving the overall private investment system in such ways as expanding the scope of PPP projects to include infrastructure projects and conducting Value for Money (VfM) tests for large-scale unsolicited projects. The importance of private investment involvement to public investment projects is ever increasing. This highlights the rising need to supplement the guidelines for financial feasibility analysis to provide more meaningful data for judgment of the possibility to attract private investment in course of the preliminary feasibility study, the first step of a public investment project.

Based on the guidelines for financial feasibility analysis presented in the "General Guidelines (fourth edition)," the "General Guidelines (fifth edition)" suggest revised and supplemented guidelines in detail for analysis such as appropriate financial discount rates and forms of financial statements. In the case of the financial discount rates, the Guidelines review the existing methodology to estimate a discount rate and re-derives the rate that reflects changes in the financial market and the market's risk premiums. It also defines specific items for the financial statement of each type of project to devise a prototype of financial feasibility analysis and provides guidance on the writing method.

D. Policy Analysis and Comprehensive Evaluation

Supplementation of the guidelines for policy analysis and comprehensive evaluation in preliminary feasibility studies focuses on updating the index of regional backwardness and supplementing the AHP analysis system.

First, to update the index of regional backwardness, each indicator of the index must be updated as of 2005, and because North Jeju County and South Jeju County in Jeju Island were integrated into Jeju City and Seogwipo City, respectively, the number of cities and counties shall decrease from 170 to 168.

Second, to supplement the AHP analysis method, this report adds some evaluation items; reorganizes the system of AHP evaluation items; and examines ways to suggest, along with AHP results, the sensitivity of evaluation results toward

the weights on economic feasibility analysis and policy analysis and that of evaluation results toward the weights on basic and special evaluations. It also intends to delve into the best way to respond when the evaluators come up with different decisions and ways to expand the scope of evaluators.

E. Prospects for the Population and GRP in each Administrative District

The results of population and GRP estimation by local government organization in Part 2 of the General Guidelines (fourth edition) are inputted as raw data into origin/destination (O/D) data, the basic data to estimate the demand when evaluating transport projects. At present, it is not only out-of-date but is not reported by small sublevel administrative districts, which renders it less useful.

This revision report intends to revise and supplement the long-term prospects for the GRP in each small administrative district made in 2004. The revision will be used to correct O/D data and validate population prospects and plans in target districts when conducting a preliminary feasibility study.

Part I

General Guidelines for Preliminary Feasibility Studies

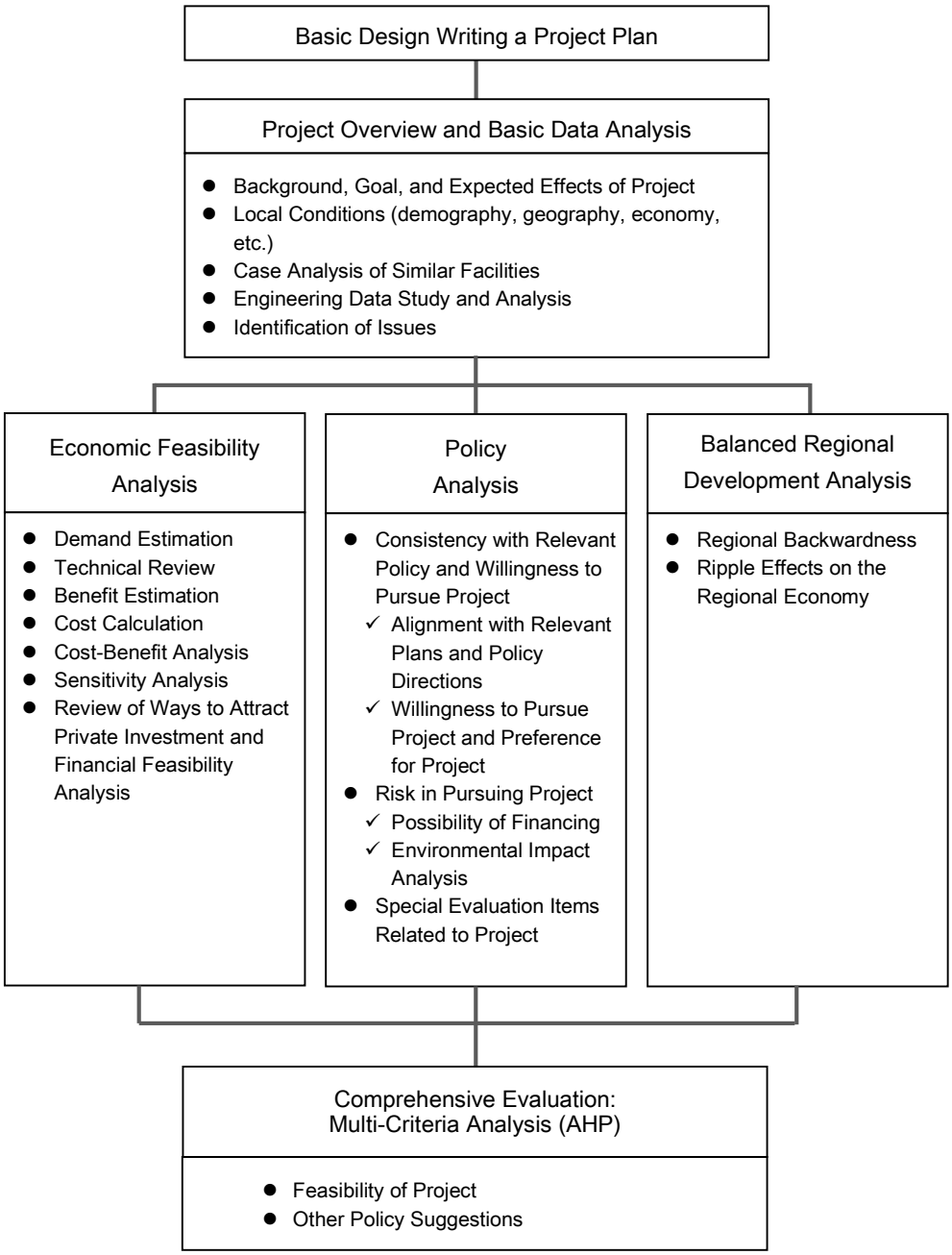
As in the "General Guidelines (fourth edition)," the basic methodology to conduct preliminary feasibility studies is to be established as follows: First, the overview of a project and basic data are reviewed and analyzed to identify issues; second, economic feasibility analysis is conducted through demand, benefit, and cost estimation; third, the importance of a project to the national economy is ascertained based on policy analysis (e.g. consistency with relevant policies, willingness to pursue the project, risks in pursuing the project, special evaluation items, etc.) and analysis of balanced regional development (analysis of factors that affect regional development including job creation, ripple effects on the regional economy, and regional backwardness in order to prevent even greater imbalance and to increase equity among regions); and lastly, comprehensive evaluation is conducted on the results of economic feasibility analysis and policy analysis using multi-criteria analysis.

Against this background, to establish general guidelines for preliminary feasibility studies, details should be stipulated including which basic data should be used in each of the aforementioned four steps and which models or parameters should be used and how they should be used. Part 1 will stipulate them in order.

It is important to bear in mind that Part 1 focuses on presenting general guidelines. It, therefore, does not list and compare all possible 'theoretical' alternatives and finally look for the best alternatives. Instead, it presents general guidelines for analyzing 'real' issues which can face those conducting preliminary feasibility studies as well as researchers in this field, and briefly demonstrates the grounds for selection of analysis methods. Part 2 should be referred to for more in-depth methodology for each issue.

Part 1 proceeds as follows: It talks about the project overview and basic data analysis in Chapter 2; economic feasibility analysis in Chapter 3; policy analysis in Chapter 4; and the AHP method in Chapter 5.

Figure 1-1 Basic System of Preliminary Feasibility Studies



CHAPTER 2

Project Overview and Basic Data Analysis

Ⅰ. Project Overview

A Preliminary Feasibility Study is based on a project plan submitted to the budget authority by the competent authority requesting execution of such study. The level of detail of a project plan depends on its nature. For standardized projects like a national highway network project, only basic information is included like the origin and destination, route length, and number of lanes. For some projects, the competent authority has a completed preliminary project plan as detailed as a feasibility study.

For projects with a concrete project plan, the study team, which conducts the preliminary feasibility study, can reduce time and costs at the step of preliminary feasibility study. It is, therefore, best for the competent authority to submit a preliminary project plan that is as detailed as possible when asking for a preliminary feasibility study. Nevertheless, if a preliminary feasibility study is urgent, projects may be selected for preliminary feasibility studies even when they have not been concretely planned.

For projects for which a preliminary feasibility study is requested without a concrete plan, the study team should have its competent authority submit a plan that is as concrete as possible and as soon as possible to comprehend the outline for a preliminary feasibility study. The contents that should be included in the overview of a preliminary feasibility study are as follows:

1. Background and Purpose of a Project

Projects targeted for preliminary feasibility studies have different backgrounds and purposes. For example, in the case of road or railroad construction projects, the need can be raised in accordance with the Master Plan for Nationwide Transport Network or with the purpose of ensuring balanced regional development, balanced development between the nation's eastern and western parts, or facilitating South-North Korean exchange. The need for a project can be raised by a civil petition to improve local transportation or based on a region's natural, industrial, or cultural background.

The purpose of a project is similar to its need in some respects, but it can still be defined as an objective. The purpose of a project should be explicitly defined in its plan. In the case of a project to build a highway, national highway network, or local road, the transportation problem to be solved by the project, its ripple effects, the spatial scope of the effects, etc. shall be roughly indicated.

The study team considers all the information from a project plan submitted by the competent authority, relevant literature, and field visits; identifies the background and purpose of the project; and states them in a report.

2. Project Selection Process and Implementation Agency

Even when a project subject to a preliminary feasibility study has a background and a purpose, the process by which the project has been chosen as the subject of a study should be clarified. Investigating the process of a project selected as the subject of a preliminary feasibility study and the party or agency that played a leading role in requesting a budget can hint at issues that should be dealt with in the analysis of the project.

Interests can differ between projects led by the central government and those by local government organizations. Though it is not always the case, projects by the central government often have ripple effects that spread to varying degrees throughout different regions, not only in a specific region. Projects by local government organizations tend to have ripple effects that do not spread much beyond their jurisdictions, if at all. There can also be a political consideration: a legislator may pursue a project for his/her electorate, or a project may be initiated after persistent civil petitioning by local residents. It may be difficult to concretize the details of politically-motivated projects in advance compared to those directly

pursued by the central government or local government organizations. This is because the National Assembly or local residents are not the party that carries out the projects at any stage.

What is more, the central government does not uniformly pursue all of its projects with the same zeal. Ministries like the Ministry of Knowledge Economy, Ministry of Land, Transport and Maritime Affairs, Ministry of Culture, Sports and Tourism, Ministry for Food, Agriculture, Forestry and Fisheries, and Ministry of Environment may have conflicting opinions over them.

Also, while it is important to know the process of selecting a project, it is also important to know which party will actually carry it out. For example, the Korea Expressway Corporation will carry out an expressway project, while the Korea Railroad Corporation will lay a double track railroad.

In some cases, which engineering companies are likely to participate in the project needs to be checked. It should be borne in mind that a party that conducts a project or is highly likely to do so tends to have subjective opinions about the project.

This points to the need for the preliminary feasibility study team to be fully aware of interests according to the aforementioned selection process and the different involved parties and to ensure that the most objective study can be done.

3. Contents of a Project

Among the details that go into a project plan to be written by the competent authority, the most important is contents of the project other than its background and purpose, selection process, and the implementation agency. Knowing in advance the location of a project, its construction scale, and costs are important clues in roughly determining its economic feasibility. A project plan needs to state the spatial location, construction details, and total project costs based on data and past experience.

Although the spatial location of a project is the element first considered when considering whether to pursue it, it requires extensive investigation to determine a specific location and detailed routes. Also, a bit of preliminary investigation is required to estimate construction details and total project costs. Arguably, a preliminary investigation should be conducted to select a specific location and route, and to estimate construction details and total project costs. Nevertheless, there should be no request for a preliminary feasibility study without an estimated spatial

location, rough route, or total project costs. To this end, it should be mandatory to include a rough spatial location, construction details, and total project costs in a project plan submitted to the budget authorities.[2]

4. Guidelines for Writing Project Plans for Candidate Projects

Based on the above discussion, the competent authorities of projects should write a project plan about candidate projects applying for preliminary feasibility studies as follows and submit it to the budget authorities:

First, the project plan (draft) of a candidate project should explicitly mention its background and purpose. A vague description of the background or purpose like 'promotion of regional development' or 'resolution of regional transportation problems' is inadequate and unacceptable. The industry or sector that stands to benefit from the project, the specific transportation problem, the region(s) affected, and the way in which the problem will be solved should all be clearly stated.

Second, the project plan (draft) should state the specific location of the project, namely the region where it will be conducted or the route it will cover to the possible maximum extent. Merely mentioning the jurisdiction names of the origin and destination or listing candidate cities is inappropriate. For a building construction project, a site where the building will be built should be properly selected in the plan.

Third, the implementation agency should be specified. Even for a project where it will likely be determined automatically according to standard procedures, the plan should explicitly state the implementation agency. In this regard, well-defined role sharing between the central government and local government organizations should be clarified as well.

Fourth, the contents of a project should be rendered explicitly and the total project costs should be estimated and offered. As the project costs depend on the details of a project, only when the project plan can settle which facilities or structures will be included can total project costs be properly estimated. Estimation of total project costs can only be derived at first from the cost data of similar projects, but such estimation is critical to determining the need for investigation into the project.

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[2] If a preliminary feasibility study is launched without concrete project details, the competent authority should be requested to submit a project plan (draft) of specific details as soon as possible.

Fifth, the plan should also stipulate the expected effects of a project. Such effects as increased production, employment, added value, and the like once it is completed may not be definitely known at this step, but other expected effects need to be roughly presented like, in the case of a transport project, how much travel time can be reduced, how many commuters or travelers can be accommodated, and how much congestion costs can be reduced.

Ⅱ. Basic Data Analysis

The first thing to do when pursuing a public investment project or evaluating feasibility is to fully analyze basic data about the region subject to the project. For a preliminary feasibility study, therefore, the study team starts by visiting the target region and gathering basic data about it. The basic data of a region can be largely divided into data on the natural environment and that on the social and economic environment.

Data on the natural environment refers to that about climate, geological features, altitudes, slopes, etc. A more full-blown investigation like a geological survey and local due diligence is for regular feasibility studies rather than for preliminary feasibility studies. Preliminary feasibility studies entail basic investigation through existing literature like the statistics and higher-level plans about the region in question. Data on the social and economic environment includes demographics, each industry's employment structure, gross regional domestic product (GRDP), land use, and so on. In the case of transport projects, particularly, the status of main roads in the target region should be delineated. For access roads into industrial complexes, and roads or railroads into ports, the status of traffic-generating facilities like industrial complexes, ports, and such in relation to the target project should be analyzed intensively.

Rather than simply enumerating standardized data about the target region, basic data analysis should state the conditions of the region in relation to the project subject to a preliminary feasibility study. Analysis of the transportation situation should be done to ascertain what the project can do for the transportation system of the target region so that the need for the project can be determined before transportation analysis is conducted in full swing.

1. Analysis of the Natural and Living Environments

Depending on their characteristics, some projects are more strongly impacted by the natural environments than others. Projects to build expressways or railroads can be very different in nature and vary greatly in cost depending on topography. On the other hand, projects to build industrial complexes are influenced more by the social and economic environment than the natural one. Their success or failure depends on the population, industrial structure, regional income level, and such.

It is also important to look into living environment conditions like water and/or soil pollution, sanitation, and construction noise that have direct impact on daily life. Preliminary feasibility studies should conduct a rough investigation in any form about daily life pollution, etc. that can happen when the concerned project goes ahead. For example, for water resource development and other such projects that greatly impact the environment, the environmental impact should be checked when the decision is made as to whether to push ahead with the projects. A multipurpose dam project in Yeongwol and a comprehensive water management plan for the Nakdong River were stymied by stiff opposition by local residents or concerns about environmental destruction. If a water resource development project proceeded without looking into environmental impact, much difficulty would be expected in executing the project. Daily life pollution like soil pollution, sanitation, noise, and air pollution can become daunting problems, which means that all forms of daily life pollution should be checked as necessary depending on the types of projects.

2. Analysis of the Social and Economic Environments

Already pointed out was the need to check the population demographics and industrial structure, GRDP, use of land, transportation conditions, etc., namely the socio-economic environment of the target region. The most basic data is that on demographics, industrial structure, and GRDP. This is true regardless of the type of project at issue, and these are important determinants of the project's ripple effects. Demand is higher in densely populated regions, so the project is likely to be more economically feasible. The industrial structure serves as a definite clue as to whether the project is appropriate for the region. GRDP data are important in determining economic feasibility and balanced regional development.

Provincial and metropolitan city government organizations can easily acquire basic data on demographics, industrial structure and GRDP, but this is difficult for

lower-level local government organizations such as those of cities, counties, and *gu* districts. This is particularly true for forecasts. A local project should secure such data at the level of at least city, county, and *gu*-district government organizations or even at a lower level. Also, several strong assumptions should be made for assessing prospects.

To conduct more refined preliminary feasibility studies, the aforementioned data and prospects should be developed in a way that they are readily accessible and usable by both provincial and metropolitan city government, and lower-level local government organizations.

In the case of transport projects like those for roads and railroads, the most important part of basic investigations for preliminary feasibility studies is to know the transportation conditions of the target region. For example, the number of roads of different types, their lengths, traffic volume, etc. in the target region are to be presented. Detailed description of transportation facilities closely related to the concerned project can shed light on its importance and/or necessity for the region.

Preliminary feasibility studies on access roads into industrial complexes, access roads and railroads into ports, and such should include details on the facilities of industrial complexes and ports to ascertain not only the status of transportation facilities but also that of industrial complex and port facilities and generated traffic volume so that the importance of the concerned project can be understood.

It is also important to review upper-level and relevant plans of the concerned project as a sort of socio-economic environment analysis. Few SOC projects are handled by a single implementation agency alone. Instead, a project is more likely to impact other plans by the central or local government, in turn involving more than one party. Review of higher-level plans can indicate whether the concerned project has been well coordinated and check the order of priority for investment determined in higher-level plans.

Each type of project has higher-level sectoral plans that have to be first checked, and there are various relevant plans that need to be reviewed depending on the nature of the concerned project. Under Korea's planning system, national land plans, plans under individual laws, plans by local governments, and such are often intertwined in a morass of complexity. Therefore, whether higher-level and relevant plans have actual impact on the concerned project and the project is in alignment with the overall direction of national development, etc. should be determined.

Ⅲ. Identification of Issues

Once the outline and basic data on the natural, living, and social and economic environments of a project are analyzed in detail, the main issues to be dealt with in its preliminary feasibility study are identified. Such issues depend not only on the nature and background of the project but also on the natural and socio-economic environments of the concerned region.

The most important issue in any preliminary feasibility study is the review of alternatives. Looking into alternatives is as important as estimating the costs and benefits of a suggested project plan. In the case of highway construction projects, the question of whether alternatives like expanding other national and/or local roads or building a railroad instead of building the planned highway are more desirable should be addressed. There is one restriction in reviewing alternatives: considerable time and effort are required to compare alternatives at a level playing field as doing so entails at the very least roughly calculating the costs and benefits of as many alternatives as possible. Consequently, a detailed and accurate cost-benefit analysis should be conducted for a project plan while the costs and benefits of alternatives are estimated using the existing data and such.

One point to bear in mind is that ‘doing something’ is not the only alternative: ‘doing nothing’ is also in many cases an entirely legitimate alternative and should, therefore, be carefully considered. For example, in addition to considering expansion of a national highway network or laying a railroad instead of laying an expressway, ‘doing nothing’ should be seriously considered as well. The opportunity costs should be considered in all cases to determine a project’s feasibility, and doing nothing may be found to be in fact the best alternative.

Moreover, preliminary feasibility studies can identify other issues like technical feasibility, possibility of financing, inter-regional conflicts, national defense consideration, and possibility of attracting private investment.

Whatever they are, the final report of a preliminary feasibility study must highlight important issues in analysis and suggest their solutions.

CHAPTER 3

Economic Analysis

The primary scope of analysis of preliminary feasibility studies can be largely divided into two parts: analysis of economic feasibility of the concerned projects and what could be termed "policy analysis." Economic analysis helps understand the economic value of a project to better understand it. Furthermore, information on a project's economic feasibility is used as the most basic and indispensible data in policy analysis. As such, economic analysis is the most essential part of preliminary feasibility studies.

The details of economic analysis in preliminary feasibility studies differ depending on the types of projects. The benefits of a highway construction project can be estimated by travel time savings, vehicle operating cost savings like cuts in fuel expenses, accident cost savings, etc. The benefits of a cultural facility construction project can be estimated by non-use value like the value of its existence and use value.

Economic analysis starts from the estimation of demand for a project. Demand estimation requires various statistical methods. Estimated demand should be validated with past experience and similar domestic and foreign projects. It is also used to estimate benefits. To estimate total project costs, it should be possible to estimate initial investment costs like construction and land acquisition costs as well as Operating and Maintenance costs (O&M costs).

Economic analysis is a process of ascertaining a project's economic and financial feasibility through calculation of the Benefit-Cost Ratio (BCR), Net Present Value (NPV), Internal Return Rate (IRR), etc. When necessary to address the errors of various estimates used in economic analysis, sensitivity analysis is conducted with respect to changes in primary variables like demand, unit price, and the discount rate to determine their impact on economic feasibility.

The following describes the specific methods of economic analysis in the order of demand estimation, benefit estimation, cost estimation, economic feasibility evaluation, and ways to attract private investment.

Ⅰ. Demand Estimation

1. Transportation Projects[3]

A. Process to Estimate Transportation Demand

The feasibility of a project that invests in transportation facilities can be analyzed by comparing the associated costs and resulting benefits. Transportation demand is one of the elements that have the greatest impact on the estimation of costs and benefits in feasibility evaluation. The decision on whether to go ahead with the concerned project, priority for investment, etc. is evaluated through the estimation of transportation demand, and such estimation is used to derive an appropriate size of transportation facilities to provide and analyze the impact on the surrounding areas of such facilities. In the case of a PPP project, the estimated transportation demand serves as important background data to determine the project's feasibility as well as usage fees and construction subsidies.

Demand for transportation can be estimated by various methods. A model based on the data of individual travelers or households or a model based on the data of each zone subject to analysis can be used. In Korea, a four-step model is most commonly used to estimate transportation demand not only in large cities but also between regions. It is not so much that the model is appropriate for any case but that the consistent steps to estimate transportation demand used by the model are easy to understand, even for laymen.

To estimate transportation demand, each of the four steps of trip generation, trip distribution, mode choice, and traffic assignment is successively applied based on Traffic Analysis Zones (TAZ). Each step has different techniques and models to apply as follows:

First, trip generation estimates trips that are either produced by a TAZ or attracted to a TAZ and uses the rate of change model, trip rate model, cross-classification, regression analysis, etc. This step discovers the generated and attracted traffic volume of passengers and cargo in each TAZ.

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[3] In fact, demand estimation methods used only in road, railroad, or bridge construction projects, out of all transportation projects, can be used as they are, and slightly different methods should be used for projects to build ports or airports. For demand estimation methods for transportation projects of each type, refer to the "Study to Revise and Supplement the Sectoral Guidelines for Preliminary Feasibility Studies for Road and Railroad Projects (fifth edition)" (KDI, 2008), "Study on the Sectoral Guidelines for Preliminary Feasibility Studies for Port Projects" (KDI, 2000), and "Study on the Sectoral Guidelines for Preliminary Feasibility Studies for Airport Projects" (KDI, 2000), respectively.

Second, trip distribution allocates the generated and attracted traffic volume estimated above among TAZ and often uses models like those for growth factor, gravity, entropy maximization, and intervening opportunity. This step generates passenger O/D (Origin/Destination)[4] and cargo O/D data among TAZ.

Third, mode choice divides the O/D data among traffic zones from the previous step into the modes of transportation available for choice by users and often uses trip end models, trip interchange models, disaggregate behavioral models, etc. This step produces O/D data for different passenger modes like passenger cars, buses, and railroads and O/D data for cargo like truck and railroad cargo.

Lastly, traffic assignment assigns the O/D data of each transportation mode to the transportation network in the TAZ, and often uses static assignment techniques like all-or-nothing assignment, capacity restraint assignment, stochastic assignment, and equilibrium assignment.[5]

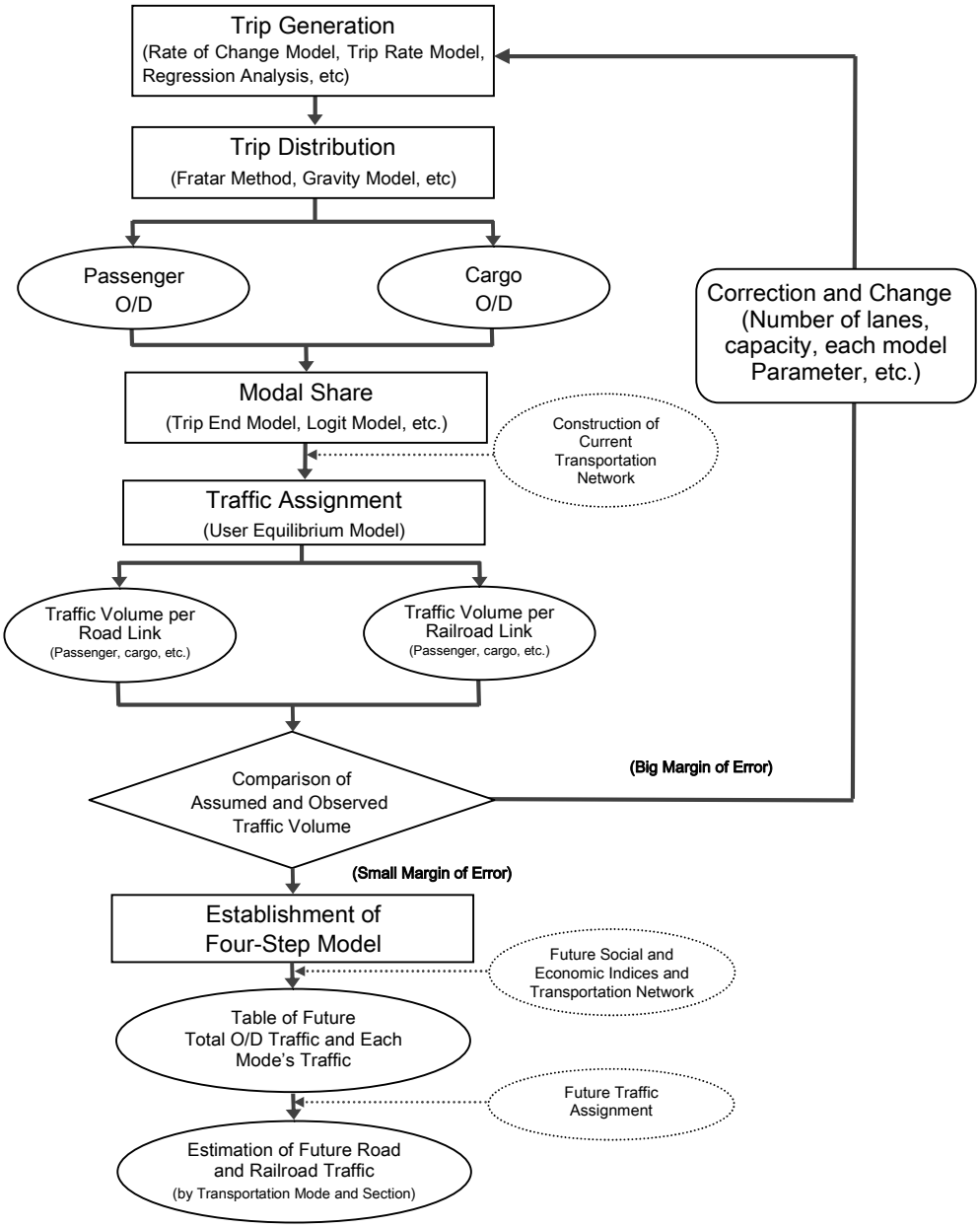
Figure 3-1 shows the process of transportation demand estimation under the conventional four-step model. In the preliminary feasibility studies of most road projects, transportation demand at the origin and destination of each future mode of transportation estimated by the government's transportation database center is used so that the three steps out of four—trip generation, trip distribution, and mode choice—are omitted. The first thing to do in the process of estimating transportation demand in a road project is calibration of data from the base year based on given O/D and network data. This work refers to building a model of current transportation patterns within the margin of error, and the calibration is considered well done if the deviation is small between the results of network traffic assignment within the TAZ and the actual observed traffic volume. Once data calibration of the base year is completed, future transportation patterns are forecast in accordance with O/D and network changes based on the assumption that the traffic assignment pattern of the base year continues. This forecast is compared with the transportation patterns of a year when the project is implemented to predict any change in transportation patterns resulting from project implementation such as changes in traffic volume and speed. Preliminary feasibility studies use commercial transportation planning software to analyze transportation demand. Recently widely used are EMME/2, TransCAD, and others developed overseas as well as Korea's

[4] In Korea, institutions that have public confidence distribute passenger O/D data, and estimation of transportation demand often uses relevant O/D data. Some foreign cases use P/A (Production-Attraction) data for urban transportation analysis.

[5] Recently, there has been substantial research based on real-time dynamic traffic assignment techniques using ITSs (intelligent transportation systems) to estimate the traffic volume of cars and passengers for each section of roads and railroads.

Satongpaldal. Preliminary feasibility studies do not force use of specific software, but there is a need to use software to ensure analysis at a level required for studies.

| Figure 3-1 | Transportation Demand Estimation Process under the Conventional Four-Step Model



Unlike road projects that use the already-established O/D data of each transportation mode, the mode choice step is very important in railroad projects. Accordingly, in addition to transportation demand estimation for roads, calibration in relation to mode choice and transportation demand estimation for each future transportation mode should be conducted. The calibration is considered well done if the deviation is small between the demand estimated for each transportation mode in the base year within the TAZ and the actual demand observed.

B. Use of Data that have Public Confidence

To estimate transportation demand for projects in the Seoul metropolitan area, preliminary feasibility studies in principle use as raw data present and future O/D and network data of the Seoul Development Institute, Gyeonggi Research Institute, and Incheon Development Institute at the request of the Metropolitan Transportation Authority. For projects in other regions and to build transportation facilities connecting regions across the country, they are to use the Korea Transport Database (KTDB) of the Korea Transport Institute (KOTI). The Korea Transport Database Center provides present and future O/D and network data about transportation between regions and about transportation in regional zones across the nation.

In principle, major parameters used to estimate transportation demand use data corresponding to adopted O/D and network data, and if such data is not available, data from institutions that have strong public confidence should be used.

C. Constancy of Total Traffic Volume

The total traffic volume of the TAZ of a transportation facility project does not change without a reason. This is based on the assumption that future O/D data used as raw data already reflects the impact brought about by changes in social and economic indices like population, number of cars, and income level. As such, the total traffic volume is generally in principle unchanged before and after project implementation.

If the future development plan of some of the areas in the TAZ that can cause change to the O/D data of each analysis zone is omitted from the existing database, the plan can be added to change the O/D data of each analysis zone, but the total traffic volume must remain constant. In other words, while additional traffic occurs in an analysis zone due to the development plan, the traffic in other analysis zones declines. However, in case of projects that can cause marked change in total traffic

volume like those to build bridges between islands and between islands and the mainland, the total traffic volume can change to reflect the induced traffic.[6]

This condition of constant total traffic volume applies only within the zone system indicated in provided data. If the zone system changes through segmentation, aggregation, etc., the total traffic volume before and after the change is naturally different. Under the assumption of constant total traffic volume, the O/D data of traffic volume by modes can change. In a railroad project, the modal share rate increases as a result, and the O/D traffic pattern of another transportation mode (i.e. roads) changes, inevitably leading to change in the O/D data of traffic volume by modes for both roads and railroads.

D. Omission of the Mode Choice Step for Road Projects

As preliminary feasibility studies provide the already-built O/D data of present and future modes, there is not always a need to conduct the four-step analysis for all projects. As the traffic volume converted from railroads is insignificant in almost any road project, the feasibility of such a project is mostly affected by changed routes at the traffic assignment step. In this case, it is important to calculate shifts in traffic volume to other routes due to change in traffic costs, so the mode choice-step analysis can be omitted. Analysis mainly uses network properties, volume delay function, and traffic assignment.

In the case of large-scale expressway projects, etc., the impact on demand for railroad transportation can be substantial, so mode choice analysis can be included when necessary.

2. Water Resources Projects

Water resources projects including those for multipurpose dams have significant impact on the public and the nation's economy and create a financial burden if they overestimate or underestimate the future demand for water in the impact areas. Water supply and demand analysis in preliminary feasibility studies is essential to ascertaining the feasibility of projects and deciding on their optimal scale. Therefore,

[6] The "Preliminary Feasibility Study on Projects to Build Three Bridges between Islands and between Islands and the Mainland in Sinan County" (KDI, 2003) used the assumption that the construction of island-connecting bridges causes additional traffic.

more rational and objective methods should be used for such analysis, and much focus should be placed on it at the step of preliminary feasibility study to ensure precise estimation.

A. Scope and Procedures of Analysis

Details that should go into the analysis of water supply and demand are as indicated in Table 3-1: ① estimation of water demand[7] that considers future uncertainties; ② estimation of water supply that considers the conditions of water resource supply; and ③ analysis of water supply and demand that considers all these mentioned above.

Table 3-1 Contents of Analysis of Water Supply and Demand

Analysis Items	Description
Water Demand Estimation	■ Estimate demand for water for residential purposes considering population, penetration rate, and per-unit water supply (including water for other purposes) ■ Estimate demand for industrial water in national, regional, and agricultural industrial complexes in the impact area ■ Estimate demand for irrigation water ■ Estimate demand for water to preserve rivers and improve the environment
Water Supply Estimation	■ Investigate supply facilities and plans to expand them in the impact area and estimate possible future supply volume
Analysis of Water Supply and Demand	■ Predict future water supply and demand and compare excess or deficiency before and after development

The demand estimation step in preliminary feasibility studies should refer to the population plans, penetration rates, various units, and other such prospects suggested in several higher-level plans. Nevertheless, these higher-level plans make some of the forecasts only every five years, and these need to be interpolated for analysis items in annual units. Considering that all sorts of water resource plans abide by the highest-level plan, the 'Long-Term Comprehensive Plan on Water Resources (Water Vision 2020),' preliminary feasibility studies should use the same base period to propose forecasts as that used in the long-term plan. If the time of the concerned project completed does not coincide with the base year, the supply and demand status at the time of completion should additionally be suggested.

[7] Demand for water consists of water for residential purposes, industrial water, agricultural water, water to preserve rivers, and water to improve the environment.

If the estimated demand for water exceeds the actual demand, and the newly developed water resources and supply facilities are not efficient, the economic feasibility of the concerned project drops. Similarly, if the estimation falls short of the actual demand, a new water resource should be developed and its supply facilities should be planned in the near future, also resulting in lower economic feasibility. Extorted estimation of future water supply capacity can have similar results. Preliminary feasibility studies should accurately estimate actual future supply and demand to determine a point of time when supply exceeds demand as that of the concerned project completed. Supply and demand should coincide in the planned year, and the scale of development should be set to ensure smooth reconciliation of supply and demand. Nevertheless, some degree of flexibility should be exercised to determine the volume of supply and time of development as there are many uncertainties in demand estimation.

B. Water Demand Estimation

Demand for water changes over time with economic development, environmental change, and other such factors. To properly distribute limited water resources, the present and future demand for water for different purposes should be precisely calculated. The water demand in the previous preliminary feasibility studies as well as general water resources projects is for residence, industry, agriculture, and minimum instream flow requirements, and the wholly-amended 'River Act' proclaimed in April 2007 added a new purpose: improvement of the environment. These Guidelines use these five purposes of demand estimation as shown in Table 3-2.

The methods to estimate demand for different purposes are as follows:

First, the residential demand for water can be estimated by an econometric technique using functional formulas for water demand[8] and extrapolation using units. Preliminary feasibility studies employ in principle extrapolation using units that can easily reflect the characteristics of individual local governments, and bottom-up estimation based on *eup* and *myeon* district units. The residential demand for water targets the population that receives water supply and is calculated by estimating future population; penetration rate of water supply; per-capita, daily average water consumption (ℓpcd); and demand for water for other purposes

[8] The "Long-Term Comprehensive Plan on Water Resources (Water Vision 2020)" (Ministry of Land, Transport and Maritime Affairs, 2006) estimated water demand for residence by an econometric technique.

(tourism, port maintenance, military, airports, etc.) in the impact area.

| Table 3-2 | Water Demand for Different Purposes

Purposes	Description
Residential	■ Water for household uses, commercial uses (including small-volume industrial uses), bathhouse uses, specific industrial uses, public uses, temporary uses, and other uses (tourism, port maintenance, military, etc.)
Industrial	■ Water for industrial uses for raw materials, product processing, boilers, and other purposes
Agricultural	■ Water for rice paddies, dry fields, stockbreeding, and other such uses
Preservation of rivers	■ Water to discharge to maintain the three functions of rivers: irrigation, water control, and environmental function.
Improvement of the environment	■ Water needed for some sections of rivers to improve the living environment. The water is provided when requested by a beneficiary group.

Second, the actual demand for water for industrial purposes is divided into that from industrial complexes in planned locations[9] and that from freely-located plants[10]. Preliminary feasibility studies only investigate the demand from industrial complexes in planned locations by extrapolation and unit load methods. Extrapolation entails regression analysis of fluctuations in the past use of water to estimate future demand, and therefore, the past data of each complex needs to be fully studied. It is impossible to apply this method in Korea because the available data is inadequate. The unit load method is used to estimate the demand from industrial complexes. The unit load method applies units, derived from elements closely related to the amount of industrial water used, to these elements in order to ascertain the amount of industrial water used. To use this method, the most appropriate unit should be selected for each industry type, and these units include the area of a plant site, number of employees, production volume, etc. The per-unit method is used as the unit for the existing industry complexes. Its applicability was reviewed in the 2006 Long-Term Comprehensive Plan on Water Resources. The area of a plant site is used for new complexes as such data is easy to acquire.

Third, water for agricultural purposes is divided into water for rice paddies (well-irrigated paddies/partially-irrigated paddies), dry fields (irrigated fields/non-irrigated fields), and stockbreeding (livestock/processing). Preliminary feasibility

[9] Industrial complexes in planned locations are national, regional, and agricultural industrial complexes that are planned for specific locations and accommodate a large number of plants.

[10] Freely-located plants are small individual plants scattered across the nation.

studies only consider rice paddies (well-irrigated paddies/partially-irrigated paddies) and dry fields (irrigated fields) for demand estimation. The demand for water for agricultural purposes can be estimated by various methods. In previous estimates, it was practically impossible to add up actually-measured amounts used or employ the per-unit water demand of a sample zone due to a lack of observational data. Instead, the demand was calculated and amount used summed up through established theories. In consideration of the characteristics of preliminary feasibility studies and the limited data, the amount of evapotranspiration is estimated using established theories and formulas, but the per-unit water demand suggested in the upper level plans of the impact area is multiplied by the forecast irrigation area of each of three different types of farmland.

Fourth, the water volume to preserve rivers is an important component of the required water volume to manage rivers along with irrigation water. It is set by river management to preserve natural functions in sections or representative points of rivers. The 'River Act' (amended on March 21, 2008) defines water volume to preserve rivers as the "minimum flow requirement to maintain rivers' normal functions and status in consideration of uses of river water for daily living, industrial, agricultural, environment improvement, electric power generation, maritime transportation, and other purposes." It is believed to be difficult to directly calculate the flux to preserve rivers at the step of preliminary feasibility study. It is to be estimated using the flux to preserve rivers announced by the Ministry of Land, Transport and Maritime Affairs (MLTM).

Lastly, water to improve the environment is the water quantity required by some river sections or regions to improve the daily life environment, which involves water fronts, water activities, tourism, recreation, cultural events held by rivers, and improvement of the water quality of unprocessed natural water. It is generated at the request of beneficiary groups (local governments, specific institutions, or individuals). Unlike the flux to preserve rivers calculated by the government, the amount of water to improve the environment should be calculated by beneficiaries themselves, and the calculated amount should be permitted by river management (government). Preliminary feasibility studies should look into data used by beneficiaries to calculate demand for water for this purpose.

C. Water Supply Estimation

The procedures to estimate water supply capacity are ① ascertaining the supply capacity of existing water resource facilities; ② ascertaining how much supply will change as a result of development plans of water supply and industrial water supply and adjustment of regional distribution worked out until the project is planned; and ③

calculating the supply capacity of a new dam to secure additional water resources.

To ascertain the water supply volume for residential purposes at the water supply facilities of each administrative district, the data of the Korea Water Resources Corporation and local governments is to be referred to, and distinction should be made among regional waterworks, special-purpose waterworks, and such. To ascertain the volume of water supply facilities for industrial purposes, data should be gathered on regional and industrial water supply as well as water supply facilities exclusively for industrial purposes allowed by regional MLTM offices and local governments to supply water. Underground water facilities used by industrial complexes and freely-located plants are excluded. The capacity of regional and industrial water supply facilities for industrial purposes should be calculated excluding volume used for residential demand under the 'Water Service Statistics'. Irrigation facilities of agricultural water include reservoirs, pumping and drainage stations, dammed pools for irrigation, collecting conduits, tube wells, etc. Data kept by local governments and farmland improvement associations is to be used.

To ascertain the supply capacity of existing water resource supply facilities, that of water service facilities like distributing reservoirs and clean water reservoirs is to be calculated by dividing the facility capacity of each district (city, county, and gu) in the 'Water Service Statistics' by the peak load factor (1.2%~1.35%). The capacity of water resource facilities like multi-purpose dams to secure unprocessed water is to be calculated using their facility capacity as reported.

D. Analysis of Water Supply and Demand

Water budget analysis until the project is planned is necessary for water resources to be developed, but the potential scale of water resource development is to be identified by referencing the results of existing plans without water budget analysis. The supply capacity of new dams to secure additional water resources is the total water supply derived through engineering analysis minus the supplies of agricultural water and water to preserve rivers. In this case, not total demand for agricultural water of the impact area, but the required amount to be supplied by a new dam with guaranteed water rights is considered for agricultural water. At the time of completion, supply should exceed estimated demand to ensure reliable supply, and at the time of planning, supply and demand capacity estimates should strike a balance.

3. Other Projects

Projects to build industrial, cultural, tourism, sports, and science complexes generate effects that are direct but not so great. They mostly have indirect effects.[11] As such, demand arising from indirect effects must be higher than direct demand for projects. If the main purpose of a project to form an industrial complex is to raise the competitiveness of the appropriate industry, the most important is to accurately estimate the demand to be created by the project in the industry. As demand estimation can be extremely difficult in some cases, it is recommendable to estimate demand for both the best-case and worst-case scenarios.

4. Standards to Reflect Development Plans

Development plans go through several steps of review by the central government or local governments from project conception to implementation. Projects can be cancelled midway, or even when implemented, and the scale and other aspects can be altered as necessary. Their implementation depends on how systematically the execution agency executes them. Development plans are an important factor in the analysis of projects' feasibility and should be included in project plans (drafts).

Preliminary feasibility studies have mostly targeted national plans or concrete development plans that will certainly be implemented, even when they are large-scale plans pursued by local governments. Development plans of which implementation is certain are those for which implementation plans are established, and preliminary feasibility studies do not reflect those of which implementation is uncertain, where the year of implementation is not determined, or the implementation plan is so unclear that calculating demand is difficult. If development plans are not concrete and thereby not proper for preliminary feasibility studies but are highly likely to be pursued and can greatly influence feasibility, preliminary feasibility studies analyze their effects through scenario analysis.

[11] Of course, indirect effects mentioned here are not entirely the same as those in the next chapter: policy analysis. Indirect effects here refer to direct and indirect effects of a project, but not 'economic' ripple effects directly given to its principal agent. They are also not very general indirect effects like ripple effects to the local economy to be dealt with in policy analysis.

Details on how to reflect development plans will be dealt with in the guidelines for different types of projects. In the case of transportation projects, for instance, they can include how much more traffic should be additionally reflected and how increased traffic should be distributed. To increase consistency in all studies, these General Guidelines intend to define clear standards for the step at which development plans should be reflected in preliminary feasibility studies and suggest their basis.

In general, the standards to reflect development plans are largely divided into those of cities and provinces and of the central government. Development plans include those for housing site development, industrial complex development, and tourist resort and resort complex development. As the reflection of development plans can greatly influence the feasibility of projects, the reflection standards should be carefully approached.

Preliminary feasibility studies have so far reflected development plans when their detailed implementation plans are approved in order to exclude uncertain plans from analysis, ensure precise demand estimation, and prevent excessive and overlapping investment.

To suggest clearer standards about when to reflect development plans, these General Guidelines studied the rate of project implementation, mainly for the development plans of housing sites and industrial complexes, according to the development plan procedures suggested in the "Evaluation Guidelines for Transportation Infrastructure by MLTM" (2007), "Land Business Handbook" (2007), and "Housing Business Handbook" (2008) of the Ministry of Land, Transport and Maritime Affairs that are used as the standards in feasibility studies. As a result, the times of reflection are indicated in Table 3-3 as follows:

| Table 3-3 | Comparison of Standards to Reflect Development Plans

Classification	Current Guidelines (fourth edition)	Changed Guidelines
Housing site development plan	Projects which are certain to be implemented	Detailed implementation plan approved
Industrial complex development plan		Development and detailed implementation plans approved
Tourist resort and resort complex development project		Formation plan approved
Other development plans		Step corresponding to the detailed implementation plan being approved

Note: The standard for reflecting any type of development plan is when the development plan is approved in the case of water resources projects.

Not many housing site and industrial complex projects in the past were cancelled after sites were designated. Nevertheless, as the O/D data distributed by the Korea Transport Institute's Korea Transport Database Center already reflect most development plans, reflecting those plans of which detailed implementation plans are approved would improve the accuracy of analysis.

Plans for multi-functional administrative cities, innovation cities, transfers of provincial governments, and such led by the central government, which are more likely to be implemented than other development plans, need to be reflected before approval of detailed implementation plans. When development plans have a great influence on project feasibility, scenario analysis can also be carried out, and clear description needs to be made in reports. However, any reflection of development plans should be carefully done taking into account actual conditions. These General Guidelines focused on development plans for housing sites and industrial complexes, but it would be appropriate to reflect plans of other kinds like those for tourist resorts and resort complexes at a step corresponding to approval of detailed implementation plans.

Ⅱ. Benefit Estimation

Benefit estimation starts with the identification of benefit items. Benefit items vary greatly according to the characteristics and contents of projects, and they need to be subdivided according to project plans submitted by the competent ministry. Once they are identified, opportunity cost or value per unit is calculated by item to estimate benefits. For instance, the estimated benefit B_{it} is expressed as follows:

$$B_{it} = P_i \times D_{it},$$
$$B_t = \sum B_{it},$$

where value per unit of benefit item i is P_i and estimated demand is D_{it} at the point of time t.

The following is divided into transportation, water resource, and other projects. As in Section 1, demand estimation, the individual guidelines should be referred to for more specific estimation methods, and these General Guidelines only deal with

overall estimation.

1. Transportation Projects

Investment projects of transportation facilities generate direct benefits for transportation and indirect social benefits. The benefit items of road and railroad projects are indicated in Table 3-4 and Table 3-5.

Direct benefits generated by transportation projects for users of transportation facilities include savings in vehicle operating costs, travel time, and accident costs as well as increased pleasure, improvements in punctuality, greater safety, and such. It is relatively easy to put a monetary value on the first three items, but it is difficult to do so for the others as their value can vary according to individuals' subjective levels of satisfaction. For railroad projects, the benefits resulting from shifts in demand from aviation and shipping and benefits from reductions in accidents and delays thanks to improved crosswalks need to be reflected, but quantifying these benefits is difficult.

The indirect benefits are ripple effects for all people regardless of their use of transportation facilities and include pollution cost savings and noise cost savings, regional development, expansion of markets, and improvement in industrial structures. For railroad projects, also considered are savings in expressway O&M costs thanks to shifts in demand, lower opportunity costs of parking spaces thanks to lower demand for parking, and negative benefits in the form of increased congestion and reduced road space during construction.

▎Table 3-4 ▎Benefits of Road Projects

Classification	Benefits
Direct Benefits	■ Vehicle operating cost savings ■ Travel time savings ■ Accident cost savings ■ Increased pleasure, improvements in punctuality, greater safety, etc.*
Indirect Benefits	■ Pollution Cost Savings and Noise Cost Savings ■ Regional development ■ Expansion of markets* ■ Improvement in regional industrial structures*

Note: * refers to items not quantified and reflected in benefit calculation.

| Table 3-5 | Benefits of Railroad Projects

Classification		Benefits
Direct Benefits (User Benefits)	Railroad User Benefits	■ Reduced travel time for people and cargo using railroads (both existing and new) ■ Increased pleasure, improvements in punctuality, and greater safety, etc.*
	Benefits for Users of Other Modes	■ Vehicle operating cost savings ■ Travel time savings due to shift in demand from roads to railroads ■ Shift in demand from aviation and shipping* ■ Accident cost savings ■ Reductions in accidents and delays due to improved crosswalks
Indirect Benefits (Non-User Benefits)		■ Pollution Cost Savings and Noise Cost Savings ■ Regional development* ■ Expansion of markets* ■ Improved regional industrial structures* ■ Lower expressway maintenance costs* ■ Lower opportunity costs of parking spaces due to lower demand for parking ■ Negative benefit of increased congestion during construction ■ Negative benefit of reduced road space during railroad projects

Note: * refers to items not quantified and reflected in benefit calculation.

Studies have been conducted to quantify pollution cost savings and noise cost savings, and they can now be reflected in cost-benefit analysis. However, to realize the benefits of regional development, expansion of markets, and reorganization of industrial structures, investment should be made in other areas in tandem with transportation facilities, which means difficulty in quantification. There is also controversy regarding directly classifying them as benefits in cost-benefit analysis due to crowding-out effects, etc. As such, they are not included as benefits. Savings in expressway O&M costs need to be reflected, but they are still not easy to quantify.

Putting together the above discussion, these General Guidelines divide the scope of benefit calculation into common benefits and benefits specific to projects as follows. Common benefits are common to both road and railroad projects, and benefits specific to projects are those to be calculated only for evaluation of specific projects.

▎Table 3-6 ▎Benefits of Road and Railroad Projects

Classification	Benefits
Common Benefits	■ Vehicle operating cost savings ■ Travel time savings ■ Fewer traffic accidents ■ Pollution cost savings and noise cost savings
Benefits Specific to Projects	■ Parking cost savings ■ Negative benefit of increased congestion during construction ■ Negative benefit of reduced road space due to railroad projects

2. Water Resources Projects

It is not easy to classify the benefits of water resources projects as direct or indirect or as tangible or intangible and to suggest calculation methods for each project. The benefits of water resources projects are identified to represent irrigation, water control, and the environment, and the benefits of major water resources projects are indicated in Table 3-7. The classification in Table 3-7 only considers general things, and actual feasibility analysis should consider the nature of individual projects and make careful choices. Items marked △ in the table can be included or not in such analysis depending on the development purpose and direction of the concerned project.

▎Table 3-7 ▎Benefits of Different Water Resources Projects

Project / Type / Benefits	Dam (reservoir)	Water-works	Under-ground water	Agri-cultural water supply	Canal	Drain	River resto-ration	River park	River repair	Retention ponds for flood control	Under-ground water retention facility	Small hydro-power plants
Residential water	△	○	○									
Industrial water	△	○	○									
Agricultural water	△		○	○						△		
Reduced flood damage	△				△	○			○	○	○	

Table 3-7 Continued

Project Type / Benefits	Dam (reservoir)	Water-works	Under-ground water	Agri-cultural water supply	Canal	Drain	River resto-ration	River park	River repair	Retention ponds for flood control	Under-ground water retention facility	Small hydro-power plants
Electric power production	△											○
Environmental cost savings	△				○		○					○
Improved quality of unprocessed water	△						○					
Improved natural resources	△						○			△		
Recreation	○				○	△	○	○		△		△
Emergency water	△		○							△	△	
Inland transportation by ship	△				○				△			
Asset advancement	△				△	○	○	○	○	○	○	
Land formation					○			○		△	△	
Transportation facilitation/damage prevention	△				△	○			○	○	○	
Improved public health	△	○			△	○			○	○	○	

3. Other Projects

As in demand estimation, the benefit estimation method differs slightly for different projects of building industrial, cultural, tourism, sports and science complexes as they are each of somewhat different character.

The benefits of industrial complexes can be derived from the revenue of additional added value or industrial production that will occur as a result of their formation. When calculating expected added value, simple transfer income, namely, revenue expected to be transferred from other regions or projects should be excluded.

The benefits of cultural and tourism facilities are divided into their admission and sales from their supplementary facilities. The admission revenue includes admission fees, usage fees arising inside the facilities, and viewing fees, and also items closely related to their establishment goals. The sales from their amenities include those of shops (food and beverages, souvenirs, etc.), and sales and extra income of lodgings (hotels, youth hostels, condominiums, etc.). Admission revenue or sales should be determined thoroughly based on users' willingness to pay, not just on prices.

The main benefits of sports facilities are profits from various programs offered within the facilities like training, screening, and competitions; extra income derived from them; usage fees of facilities, etc. Training revenue should be divided according to the characteristics of programs and target groups to make estimation easier. Extra income should be estimated in the same way, and it includes income from lodgings, sales of food and beverages, sales of souvenirs, and the like. If the main purpose of a project is to provide sports facilities and tools, facility usage fees like venue rental fees will be the main benefit.

The next step in benefit estimation is estimating the per-unit prices of specific benefits. Unit prices are amounts assigned to a unit of services provided at facilities. Examples are per-capita admissions to theme parks, lodging charges per capita and room at lodgings, and per-capita training fees of training programs. Unit prices should be estimated as necessary depending on the benefits and such estimation should consider the following:

First, the characteristics and purposes of facilities should be considered. Minimum unit prices necessary for facility operation should be applied if the facilities are more like public properties or established for policy purposes like the restoration and preservation of traditional culture and improvement in public health. Examples are museums, restored historic sites, and public sports facilities. If they are less like public properties and likely to be operated by a private party, unit prices are in principle set at levels that maximize profit in reference to the size and unit prices of similar facilities at home and abroad.

Second, when referencing the unit prices of similar facilities at home and abroad, the data of facilities similar to those targeted for preliminary feasibility studies in terms of the purpose, size, and characteristics should be chosen.

Third, the locational conditions of facilities should also be considered, which include the natural environment, tourism resources, and transportation from inland cities.

It should also be noted that there are limitations to the value estimation of cultural and science facilities, as follows:

First, admission fees reflected as a benefit are not determined based on market prices but by law, which means that the amounts users willingly pay, the result of true value judgment by users, are not properly reflected.

Second, reference to overseas data due to the absence of similar domestic facilities can be problematic as the value of benefits varies with differences in nations' income levels, the public's preferences, and cultural and social conditions.

Third, preliminary feasibility studies define benefits from an economic viewpoint as the highest amounts users willingly pay by reducing spending on other goods. Benefit calculation based on unit prices does not properly reflect this, and its theoretical basis is weak.

Fourth, including user spending at cultural and science facilities as part of benefits does not reflect value judgments by people who do not use the concerned facilities but still grants significant value to them. It disregards value held by non-users. This is very problematic in that the true value of cultural and science facilities for public interest should be estimated.

Fifth, there is always a possibility of underestimation when calculating admission revenue, extra income, etc. as benefits. Time and travel expenses and the like to come and go between home and cultural and science facilities are willingly paid to receive value from the facilities, so they should be included as part of benefits.

In this light, to overcome the limits of unit price-based value estimation, preliminary feasibility studies have since 2004 used the contingent valuation method (CVM) and the conjoint analysis method (CAM) to estimate the value of non-market goods.[12] Preliminary feasibility studies of cultural and science facilities should, therefore, use unit price estimation or CVM and CAM that is appropriate for the concerned projects.

Ⅲ. Cost Estimation

Cost estimation also differs depending on the nature and specifics of projects. Project costs can be largely divided into construction costs, land acquisition costs,

[12] For more details, refer to Park, Hyeon, Gyeongjun Yu, and Seungjun Gwak, "Study on the Value Estimation of Cultural Facilities" (2004).

Operating and Maintenance costs (O&M costs), etc. Construction costs refer to the entirety of project costs minus lot purchase costs and additional facility costs, and, land acquisition costs are the costs of buying lots in the project area and compensation costs. O&M costs include not only initial investment costs but also ordinary operating costs that even consider life cycle costs to maintain the functions of fixed assets like land, buildings, and facilities.

The following reviews and suggests cost estimation methods for transportation, water resources, and other projects:

1. Transportation Projects

Cost analysis should be done differently for different transportation projects to build expressways, roads, bridges, railroads, ports, and airports.

Demand and benefit analysis for railroad and bridge construction has a similar analysis framework to that of road construction, but they require different criteria for cost analysis. Also, not only demand and benefit analysis but also cost analysis for port and airport construction differ from that of road construction.[13]

A. Road Projects

The costs of road projects should be clearly stated in the process of reviewing project feasibility. When calculating project costs, both the number or scale of structures in concerned projects and average construction costs should be considered. Though figures that are as realistic as possible should be suggested, routes are not yet finalized at the stage of preliminary feasibility study, so cost items, quantities, unit prices, and other figures will need to be adjusted at the actual step of project implementation.

The following are some basic assumptions for cost estimation in road projects defined in the "Sectoral Guidelines for Road and Railroad Projects":

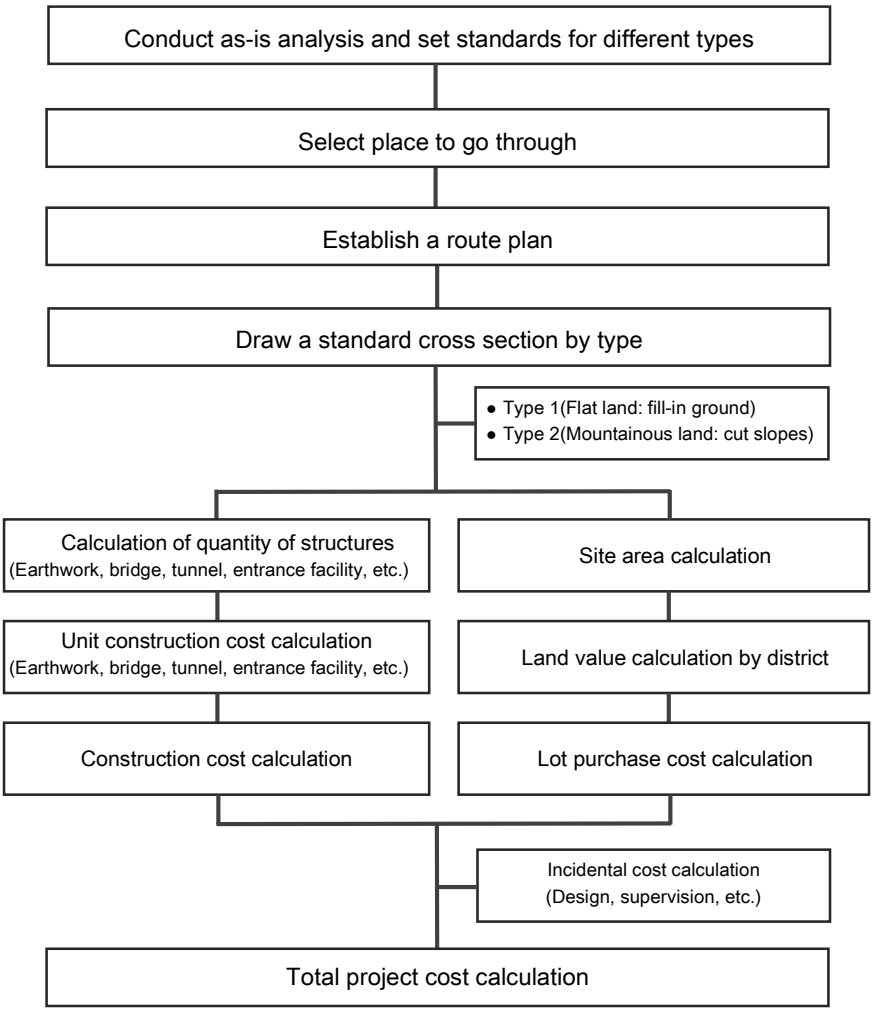
[13] As in demand and benefit estimation, these General Guidelines only deal with the basic assumptions and directions about cost estimation in the 'Sectoral Guidelines for Road and Railroad Projects.' Refer to the appropriate guidelines for specific analysis methods and relevant parameters like unit prices to apply.

- The past data of the Korea Expressway Corporation about expressways was used to determine estimation methods and to estimate important figures such as cost items and average unit prices in road projects. Though the same data can be applied to national highway networks and the like in proportion of road width, the data of the "Road Business Handbook" from the Ministry of Land, Transport and Maritime Affairs (MLTM) and other recent official data should be used. A separate review can be made for sub-national highway networks, local roads, and other roads of which design work is very slow.
- Suggested values are averages, but if there are reasons and grounds, appropriate unit prices can be calculated that reflect the characteristics of project area.
- Construction cost items, specific figures for construction costs, application methods, etc. not indicated in this study can be determined for different projects based on rational grounds.
- For road design standards, the 'Rule on Road Facilities and Standards' and 'Road Design Handbook' of the MLTM and 'Road Design Guidelines' of the Korea Expressway Corporation, and other latest standards should in principle be applied.

Construction costs and lot purchase costs account for the vast bulk of road project costs. Construction costs are divided into main route earthwork, bridges and tunnels, and affiliated facilities like access facilities (interchanges & junctions), tollgates (including buildings), and rest areas.

Road project costs are calculated as indicated in the following Figure 3-2.

Figure 3-2 Flow to Calculate Total Project Costs for Road Construction



The 'Sectoral Guidelines for Road and Railroad Projects (fifth edition)' stipulate that cost estimation results by type of construction or work be suggested in certain forms. The following form shown in Table 3-8 is to be used to indicate the details of the Total Project Costs (TPC) of road projects.

Table 3-8 Details of Total Project Costs (Road Projects)

- Total length: ___km (existing: __km, extension: __km, newly laid: __km)
- IC __ea, JC __ea, tollgates at main route ea
- Structures: Bridge __ea (__m), tunnel ea (__m)
- Others: ____

Construction type	Standard		Unit	Quantity	Unit price (1 million won)	Amount (100 million won)
A. Construction costs						
A-1. Earthwork						
A-2. Bridge	Slab	RC	m			
		PC	m			
	PSC-Beam		m			
	PC-Box	ILM	m			
		FCM	m			
		MSS	m			
		FSM	m			
	ST.Box		m			
	ST.Plate		m			
	RC Rahmen		m			
A-3. Tunnel	Two lanes		m			
	Three lanes		m			
A-4. Entrance facility	IC		ea			
	JC		ea			
A-5. Tollgate	Main route		ea			
	IC		ea			
A-6. Rest area			ea			
A-7. VAT						
B. Incidental costs						
B-1. Basic design	(A1~A6)×rate(%)		formula			
B-2. Detailed design	(A1~A6)×rate(%)		formula			
B-3. Supervision	(A1~A6)×rate(%)		formula			
B-4. Research & survey	(A1~A6)×rate(%)		formula			
B-5. VAT	(B-1~B-4)×10%		formula			
C. Lot purchase costs						
C-1. Main route			formula			
C-2. IC, JC			formula			
C-3. Rest area			formula			
D. Contingencies	(A+B+C)×10%		formula			
E. Total project costs	(A+B+C+D)					

B. Railroad Projects

There are many more things to consider in railroad projects than in road projects, and they require very complex approaches to cost estimation. The bulk of road project costs arise from civil engineering structures (roadbed and entrance facilities) and land acquisition, and when necessary, can be divided into the cost of supplementary facilities like rest areas, incidental costs, and O&M costs to allow relatively easy cost estimation. Railroad projects, however, should separately calculate system construction costs as well as roadbed facility costs and add costs for train car rail yards and train car purchases. They also have a relatively high ratio of operating costs.

Cost estimation at the step of preliminary feasibility study is for generating costs associated with railroad facility construction and maintenance to allow rational policy making and provide standards for budget execution.

Most railroad facilities are greatly affected by natural topography and social conditions, which leads to a great deviation among projects. Accurate calculation of project costs requires a great deal of time and effort. Accurate cost estimation is inevitably extremely difficult at a project design step like preliminary feasibility study. Cost estimation at this step inevitably involves errors compared to actual input costs, and to minimize such errors, the general guidelines for preliminary feasibility studies, handbook of investment evaluation of roads, and the like have continually been revised. These General Guidelines also conducted analysis keeping this in mind and strived to ensure realistic cost estimation. The previous General Guidelines (fourth edition) dealt with cost estimation only for general railroads, but this Fifth Edition also includes cost estimation for regional railroad networks, which are now becoming operational.

a. General Railroad Projects

The total project costs of general railroad projects are divided into construction costs (roadbed, tracks, buildings, electricity, systems, etc.), incidental costs, lot purchase costs, and initial car purchase costs. In consideration of errors in cost estimation, preliminary feasibility studies add contingencies of some ratio to the construction, incidental, and lot purchase costs.

The details of the Total Project Costs (TPC) of railroad projects suggested in the ‘Sectoral Guidelines for Road and Railroad Projects (fifth edition)’ are indicated in Table 3-9 as follows:

▌Table 3-9▐ Details of Total Project Costs (General Railroad Projects: Rough Standards)

- Total length: __km (existing: __km, newly laid __km)
- Stops: __ea
- Structures: Bridge __ea (__m), tunnel __ea (__m)
- Others: ___

Construction type	Standard	Unit	Quantity	Unit price (1 million won)	Amount (1 million won)	Remarks
A. Construction costs						
A-1. Roadbed(main route)						
A-1-1. Earthwork	General section	km				
	Others					
A-1-2. Bridge	Direct foundation	km				
	Pile foundation	km				
	Others					
A-1-3. Tunnel	NATM	km				
	Others					
A-1-4. Interchange	Overbridge	m				
	Underground road	m				
	Overhead walkway	ea				
	Others					
A-2. Roadbed (stop)						
A-2-1. Earthwork	2 homes, 2 lanes	ea				
	2 homes, 4 lanes	ea				
	Others					
A-2-2. Bridge	2 homes, 2 lanes	ea				
	2 homes, 4 lanes	ea				
	Others					
A-2-3. Underground	2-level excavation	ea				
	3-level excavation	ea				
	Others					
A-3. Track		km				

▌Table 3-9▌Continued

Construction type	Standard		Unit	Quantity	Unit price (1 million won)	Amount (1 million won)	Remarks
A-4. Building	Above rail	Way station	ea				
		Junction	ea				
		Start/terminal	ea				
	On ground	Way station	ea				
		Junction	ea				
		Start/terminal	ea				
	Below rail	Way station	ea				
		Junction					
	Underground		㎡				
	Others						
A-5. System			km				
A-5-1. Electricity facility			km				
A-5-2. Power line			km				
A-5-3. Substation facility			km				
A-5-4. Electrified line			km				
A-5-5. Signal facility			km				
A-5-6. Communication facility			ea				
A-6. Train car rail yard							
A-7. VAT							
B. Incidental costs	(A1～A6)×rate (%)		formula				
B-1. Basic design	(A1～A6)×rate (%)		formula				
B-2. Detailed design	(A1～A6)×rate (%)		formula				
B-3. Supervision	(A1～A6)×rate (%)		formula				
B-4. Research & survey	(B1～B4)×10%		formula				
B-5. VAT			formula				
C. Lot purchase costs	(A+B+C)×10%						
D. Contingencies	Initial year						
E. Car purchase costs	(A+B+C+D+E)						
F. Total project costs	Replacement investment costs						

Note: “E. Car purchase costs” need to be reflected after confirming whether they are included as part of the total project costs to manage.

B. Regional Railroad Network Projects

In general, the costs of regional and urban railroad projects can greatly vary, as do the benefits of investment depending on their characteristics. These differences arise from the numerous different constituents of railroads, and project costs show significant differences depending on the selection of such constituents. For estimation of construction costs, regional railroad networks are defined as either heavy, middle, or light rail transit systems, and the case of general railroads is used for the estimation of incidental costs, etc. With regard to regional railroad networks, there is no limit to the roadbed forms due to systems, but most are constructed as underground or overhead structures as locational conditions require. If they are built underground, project costs should be calculated in consideration of construction workability, safety of train operation, etc.

The details of the total project costs (TPC) of regional railroad network projects suggested in the 'Sectoral Guidelines for Road and Railroad Projects (fifth edition)' are indicated in Table 3-10 as follows:

Table 3-10 Details of Total Project Costs (Regional and Urban Railroad Projects)

- Total length: __km (existing: __km, newly laid __km)
- Stops: __ea
- Structures: Bridge __ea (__m), tunnel __ea (__m)
- Others: ___

Construction Type	Standard		Unit	Quantity	Unit price (1 million won)	Amount (100 million won)	Remarks
A. Construction costs							
A-1. Civil engineering							
A-1-1. Main route	Earthwork		km				
	Bridge		km				
	U-type		km				
	Excavation	10m or less at depth	km				
		20m or less	km				
		30m or less	km				
	Tunnel	NATM	km				
	Others		km				
A-1-2. Stop	On ground		m or ea				
	Elevated		m or ea				
	Underground (excavation)	2 levels	m or ea				
		3 levels	m or ea				
	Others		m or ea				
A-1-3. Ventilation hole	Ventilation holes on main route		ea				
A-1-4. Hold track	Excavation		km				
	NATM		km				
	Others						
A-2. Track							
A-2-1. Main route	Steel wheels		km				
	Rubber wheels		km				
A-3. Building							
A-3-1. Stop	On ground		㎡				
	Elevated		㎡				
	Underground	2 levels	㎡				
		3 levels	㎡				

Table 3-10 Continued

Construction Type	Standard		Unit	Quantity	Unit price (1 million won)	Amount (100 million won)	Remarks
A-3. Building							
A-3-1. Stop	On ground		㎡				
	Elevated		㎡				
	Underground	2 levels	㎡				
		3 levels	㎡				
A-4. System							
A-4-1. Electricity	Electricity facility		km				
	Power line		km				
	Substation facility		km				
	Electrified line		km				
A-4-2. Signal			km				
A-4-3. Communication			km				
A-5. Train car rail yard			car				
A-5-1. Train car rail yard							
A-5-2. Inspection facility							
A-6. VAT	(A1~A5)×rate (%)						
B. Incidental costs							
B-1. Basic design	(A1~A5)×rate (%)		formula				
B-2. Detailed design	(A1~A5)×rate (%)		formula				
B-3. Supervision (by government agency)	(A1~A5)×rate (%)		formula				
B-4. Research & survey	(A1~A5)×rate (%)		formula				
B-5. SE costs	A4×rate (%)		formula				
B-6. Test run	Initial operating costs ×rate (%)		formula				
B-7. VAT	(B1~B6)×rate (%)		formula				
C. Lot purchase costs			formula				
D. Contingencies	(A+B+C)×10%						
E. Initial car purchase costs							
F. Total project costs	(A+B+C+D+E)						
G. Additional car purchase costs	Replacement investment costs						

Note: “E. Car purchase costs” under “F. Total project costs” should be reflected only when they are included as part of total project costs to manage, unlike costs for economic analysis.

2. Water Resources Projects

Cost estimation for water resources projects should be divided for dam construction, river conservation work, etc. With regard to cost estimation, different types of construction comprise dam and river projects. For more details on cost estimation by construction type, refer to the 'Study on the Sectoral Guidelines for Preliminary feasibility Studies for Water Resources Projects (fourth edition)' (hereinafter 'Sectoral Guidelines for Water Resources Projects (fourth edition)').

A. Dam Projects

For the estimation of dam construction costs, flood volume is calculated through hydraulic analysis, and design flood discharge is determined for each structure to determine the form and size. Hydraulic calculation, etc. is conducted for each structure, structures are planned using standards determined by dam design standards, and details of construction works should be produced for each structure as much as possible.

Estimating costs for each structure is difficult at the step of preliminary feasibility study, but it should be done in as much detail as possible in consideration of its impact on future feasibility studies and changes in the construction costs of basic and detailed designs.

To help address difficulties in the estimation of construction costs, the 'Sectoral Guidelines for Water Resources Projects (fourth edition)' suggested unit construction costs and construction cost calculation methods for several types of structures for reference. Cost estimation results for each type of structure are to be suggested in a certain form, and the standard details of total project costs of dam construction are to be listed in the table of details of total project costs as in the following Table 3-11:

▌Table 3-11▌ Standard Details of Total Project Costs of Dam Construction

(Unit: 1 million won)

Construction type	Standard	Unit	Quantity	Unit price	Amount	Remarks
A. Construction costs						
A-1. Temporary facility	A-3 × 39%	sum	1			
A-2. Diversion of waterway		sum	1			
A-3. Main construction						
A-4. Spillway						
A-5. Discharge facility	Water supply amount	1 million m³	1			
A-6. Power plant	Power generation amount	kW	1			
A-7. Access road		km	1			
A-8. Appurtenant work	A-1~A-7 × 33%	sum	1			
B. Incidental costs						
B-1. Research and survey	Rate					
B-2. Design	Rate					
B-3. Construction management	Rate					
C. Lot purchase costs		sum	1			
D. Contingencies	A~C × 10%					
E. Maintenance costs						
F. Total project costs	A+B+C+D+E					

Note: The amounts include miscellaneous expenses and VAT.

B. River Projects

When calculating the costs of river work, both the specific quantity of structures to build and average construction costs should be considered. The location of a spoil bank, distance to carry revetment materials, and the characteristics of the river, etc. are very important. Since no standard unit price or the like has been defined, it is difficult to use the standard construction cost per unit length or area. Furthermore, at the step of preliminary feasibility study, routes on river banks, length of the embankment, locations and standards of structures, whether to establish cutoff walls, etc. are not determined. For this reason, cost items, quantities, unit prices, and other figures will need to be partially adjusted in the actual implementation step.

River conservation work involves the construction of five major components:

embankments, revetments, structures, cutoffs, and appurtenant construction. The quantity estimation method of each type varies depending on whether or not there is a basic plan. For rivers with a basic plan, the numbers of banks and revetments are estimated using the ground plan and cross section drawing. For rivers without a basic plan, the data of a similar district in terms of the shape and size of the basin, river characteristics, etc. is used, or a location on a 1/5,000 topographical map is chosen that can meet the planned river width and design flood discharge suggested in river design standards, etc. to assume a cross section that represents each section and estimate the numbers of revetments and banks.

The 'Sectoral Guidelines for Water Resources Projects (fourth edition)' require that cost estimation results for each structure be suggested in a certain form, and the standard details of total project costs of river conservation work are to be suggested in the table of details of total project costs as in the following Table 3-12.

Table 3-12 Standard Details of Total Project Costs of River Conservation Work

(Unit: mil won)

Construction Type	Standard	Unit Price	Quantity	Unit Price	Amount	Remarks
A. Construction Costs						
A-1. Embanking		Sum	1			
A-2. Revetment		Sum	1			
A-3. Structure						
A-4. Cutoff						
A-5. Appurtenant Work	A-1 ~ A-2 × 20%	Sum	1			
B. Incidental Costs						
B-1. Research & Survey	Rate					
B-2. Design	Rate					
B-3. Construction Management	Rate					
C. Lot Purchase Costs		Sum	1			
D. Contingencies	A~C × 10%					
E. Total Project Costs	A+B+C+D					

Note: The amounts include VAT.

3. Other Projects

Initial investment in forming cultural, tourism, sports, and science complexes includes construction costs, land acquisition costs, and other costs. The costs are to be estimated based on the size and characteristics of facilities, but unit prices need to be separately determined by the preliminary feasibility study team.

Construction costs include those to build the components of infrastructure like civil engineering, landscaping, electricity and communication, and roads, and those to build facilities. It is easier to separately estimate the number or scale of each cost item required and unit prices. The unit prices are estimated by referring to the 'Unit Price Table for Building Construction' of the Korea Appraisal Board and consulting with construction companies. To estimate the number or scale of each item required, the scale of construction indicated in the basic project design should be referred to, but if it is unrealistic or not suggested, similar cases should be referenced or construction companies consulted.

Land acquisition costs are estimated using the exact location of a complex in the project design and a map that indicates its lot number and area. If such is not indicated in the project design, the average land prices and relevant data of the project area should be used. It is still not easy to acquire such data, and even when acquired, the estimates may not be reliable.

Land acquisition costs are purchase costs of land and compensation for obstructions that must be demolished when exercising eminent domain, indirect compensation, and other incidental costs. First, market prices for different possession types and uses in the project area are estimated, and the prices are multiplied by the areas of different uses to estimate the land purchase costs. Compensation for obstructions and indirect compensation are estimated based on the past cases of compensation and the 'Enforcement Rule of the Act on Special Cases Concerning Acquisition and Loss Compensation of Public Lots.' In this light, due diligence should be conducted for the target district, and various obstructions and economic actions be confirmed. However, precise estimation is difficult at the step of preliminary feasibility study, and compensation costs may increase. This requires, in principle, that on-site investigation based on an arrangement map of facilities be conducted, but if the amount at issue is insignificant or cannot be confirmed at the time of study, precise estimation should be made at the full-scale feasibility study step.

To report total project costs, etc., forms used for road and transportation projects should be used as much as possible.

4. Calculation Standards for Land Acquisition Costs

Land acquisition costs in preliminary feasibility studies are purchase costs of land and compensation for obstructions when eminent domain is exercised. Purchase costs of land are those to buy lots required for public interest projects targeted by preliminary feasibility studies. Compensation for obstructions refers to money paid to remove things like buildings, structures, crops, trees and plants, and such on the concerned lots, being obstacles to their use.

The current guidelines for review of preliminary feasibility studies explicitly suggest methods to calculate land acquisition costs to offer reference prices that can be used at the implementation step. With the ratio of land acquisition costs continuing to increase in public projects like those for roads and railroads, such costs must be estimated as part of cost estimation for the financial feasibility analysis of projects

The current guidelines calculate purchase costs of land by applying a compensation ratio that is 1.766 times the official land value, and compensation for obstructions as 30% of purchase costs of land. As a result, the compensation ratio of total land acquisition costs is 2.296 times the official land value. Nevertheless, analysis of statistics on land acquisition results and average land prices reveals that the unit prices of land acquisition of different regions and projects in fact vary greatly, and there is also a significant difference between the rates of the unit prices of land acquisition in public projects and average individual official land values of different regions. The rate of compensation for obstructions to land acquisition costs has recently dropped to around 10%. As a result, the compensation ratio should reflect the differences among different regions and land categories. Compensation for obstructions also needs to be made realistic.[14]

To revise the current compensation ratios, new ratios were derived from the land acquisition results of the recent road and railroad projects. The data was mostly about non-Seoul metropolitan areas, and as such, it was impossible to divide the data into Seoul metropolitan, non-Seoul metropolitan, or regional economic zones. As a result, it was divided into cities and counties. The compensation ratios by city and county, and land category were mostly higher than those of the current guidelines.

[14] For details, refer to Chapter 12 of Part 2.

▌Table 3-13▐ Compensation Ratios Used in Land Acquisition by City and County and Land Category

Classification	Cities	Counties	Average
Lots	2.37	3.61	3.40
Rice paddies	2.45	3.21	3.12
Dry fields	2.50	2.94	2.89
Forest land	6.52	6.02	6.11
Others	3.38	4.49	4.28
Average	3.84	3.86	3.85

Next, in consideration of the fact that the official land value has increased four times on average in response to the recent rise in market prices for land, a survey on compensation ratios was conducted of appraisers who are responsible for land appraisal for compensation in the field. The survey divided regions into the Seoul metropolitan area, non-metropolitan area, and cities and counties, and asked about average compensation ratios for different land categories across the nation. The current compensation ratios applied by appraisers are some 1.5 to 2.7 times for regions and 1.5 to 2.0 times for land categories, a bit higher or lower than the current guidelines.

▌Table 3-14▐ Survey Results of Compensation Ratios of Land Categories

Region		Rice Paddies	Dry Fields	Lots	Forest Land
Seoul Metropolitan Area	City	1.51	1.52	1.37	1.98
	County	1.74	1.72	1.50	2.53
Non-Seoul Metropolitan Area	City	1.76	1.72	1.65	2.25
	County	1.81	1.81	1.65	2.49
City		1.58	1.57	1.41	2.09
County		1.86	1.90	1.57	2.69
Seoul Metropolitan Area		1.56	1.54	1.44	1.87
Non-Seoul Metropolitan Area		1.77	1.79	1.52	2.40
All		1.56	1.50	1.40	1.94

The following three alternative ways to estimate purchase costs of land can be suggested based on the compensation ratios of the above land acquisition cases and survey results. The first is to choose as samples some 5% of land within the project area in consideration of the land characteristics and ask the Korea Association of Property Appraisers or Korea Appraisal Board to perform a summary appraisal on

them. The second is to receive existing land acquisition data about areas surrounding the project area from the execution agency of a project that requested a preliminary feasibility study to drive a compensation ratio and calculate the land acquisition costs. The third is to apply standard compensation ratios below. Table 3-15 below has standard compensation ratios to use when calculating purchase costs of land based on compensation ratios. Compensation for obstructions is to be set at 10 to 15% as the conditions of each project site require.

| Table 3-15 | Compensation Ratios by City and County and Land Category

Region		Rice Paddies	Dry Fields	Lots	Forest Land
Seoul Metropolitan Area	City	1.50	1.50	1.40	2.00
	County	1.75	1.75	1.50	2.50
Non-Seoul Metropolitan Area	City	1.75	1.75	1.65	2.30
	County	1.80	1.80	1.65	2.50

5. Calculation Standards for Contingency Reserves

To review the feasibility of investment projects, contingency reserves must be included as a cost item. The process of pushing ahead with a project inevitably entails numerous unexpected events and contingency reserves should be set aside against them. Contingency reserves are to be set at 10% of the total project costs including VAT.

Ⅳ. Economic Feasibility Evaluation

Economic Feasibility is evaluated using the benefit and cost numbers from the above estimation of demand, benefits, and costs. Evaluation of economic feasibility basically depends on cost-benefit analysis.

1. Analysis Methods

A Benefit-Cost Ratio (BCR) is first calculated to evaluate economic feasibility. A BCR is the ratio of benefits to costs where both benefits and costs are expressed as discounted present values. In other words, costs and benefits to occur in the future are converted into present values, and the present value of benefits is divided by that of costs. A project is generally economically feasible if the BCR is at least 1.0.

Of course, it is inappropriate to simply determine that a government-financed project is economically feasible merely because the BCR is no less than 1.0. This does not apply, for example, in the U.S. The special standards for public investment analysis suggested by the U.S. Office of Management and Budget (OMB) explain that the BCR should be at least 1.25 for a project to be economically feasible in consideration of the excess burden resulting from tax distortion and the like[15]. Also, in Korea, the theoretical minimum BCR should be 1.10 to 1.15 for economic feasibility to be recognized in consideration of the marginal costs of public capital due to the difficult financial situation and tax distortion, etc. Nevertheless, it cannot be said that there is sufficient social overhead capital as Korea is still a developing country. Furthermore, it can cause unnecessary confusion to apply the minimum BCR of 1.10 to 1.15 at the step of preliminary feasibility study as other studies use a ratio of 1.0. In comprehensive consideration of the above, the figure of 1.0 will be used as the minimum BCR instead of the theoretically estimated BCR for the time being:

$$BCR = \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} / \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

Where B_t: Benefit at the time t, C_t: Cost at the time t, r: discount rate, and n: Duration of the concerned facility (period subject to analysis) .

Secondly, it is important to calculate the Net Present Value (NPV). The NPV is the total benefits minus total costs incurred by a project (both benefits and costs expressed in discounted present values of the base year). An NPV of at least zero means the project is economically feasible:

[15] The special standards for public investment analysis under Section 11 of Circular No. A-94 of the U.S. OMB explains that estimation of the marginal costs of public capital in consideration of the excess burden of taxation reveals that a public investment with the minimum BCR of 1.25 can be recognized for economic feasibility.

$$NPV = \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}.$$

The Internal Rate of Return (IRR) should be calculated, too. It is to calculate a discount rate R where the values of benefits and costs converted into present values become equivalent. It is the discount rate that reduces the NPV of the project to zero. It is believed there is economic feasibility if the IRR is higher than the social discount rate:

$$IRR \ : \ R \ \ such \ \ that \ \ \sum_{t=0}^{n} \frac{B_t}{(1+R)^t} = \sum_{t=0}^{n} \frac{C_t}{(1+R)^t}$$

Determination of feasibility is not always the same in BCR, NPV, and IRR calculation. First, NPV calculation evaluates the flow of net benefits with the value in the start year of a project, but it is not normalized with respect to the scale of projects, making it inappropriate for comparison among projects. For instance, when doubling both benefits and costs, the NPV automatically doubles. It is, therefore, inappropriate to compare the profitability of two different projects with the same characteristics only based on their NPV. Second, IRR calculation does not consider the scale of projects, but it has a shortcoming in that an IRR is not calculated according to the profit generation structure. Third, a BCR value differs according to which items are classified as benefits or costs, but this is the one that is generally used as an investment evaluation standard.

Preliminary feasibility studies are to calculate the BCR, NPV, and IRR without exception to evaluate economic feasibility, compare priority among projects, and for other such purposes.[16]

[16] In some cases, the BCR, NPV and IRR come up with different conclusions about feasibility. For details, refer to Kim (2008) "Cost-Benefit Analysis."

▌Table 3-16▌ Comparison of Economic Analysis Methods

Analysis method	Critical value	Merits	Demerits
BCR	B/C≥1	■ Easy to understand, can consider the scale of a project	■ An error of choosing mutually exclusive alternatives may occur
NPV	NPV≥0	■ Suggests clear standards when selecting an alternative ■ Suggests the present values of benefits to occur in the future ■ Considers marginal NPV ■ Can be used in other analyses	■ Difficult to understand ■ An error may occur when determining the order of priority among alternatives
IRR	IRR≥r	■ Can measure project profitability ■ Allows for easy comparison with other alternatives ■ Allows for easy understanding of the process and results of evaluation	■ Does not consider the absolute scale of a project ■ Multiple IRRs may simultaneously be deducted

2. Social Discount Rate

One of the most important parameters used in the economic feasibility evaluation of government-financed projects is the social discount rate. Discounted benefit and cost values are determined by the social discount rate, and as a result, the BCR. Determination of the social discount rate is an absolute determinant of economic feasibility.

The “General Guidelines” until the Third Edition determined the social discount rate based on the shadow price of capital. A real rate of 7.5% was applied to all projects except water resources projects, and a 6.0% real rate was applied to water resources projects as they should be considered for a longer term than other projects.

The “General Guidelines (fourth edition)” recognized the need to adjust the social discount rate due to the prolonged period of low interest rates and low growth and reestimate an appropriate discount rate to apply a social discount rate of 6.5%. For water resources projects, where a period under analysis is relatively long, a real rate of 6.5% was applied for the first 30 years of operation and 5.0% for 20 years afterwards.

The “General Guidelines (fifth edition)” takes into account change in the capital market due to the prolonged period of low interest rates and low growth to adjust the social discount rate. Instead of discussing the estimation process of the social

discount rate in depth,[17] this section looks at the value of the finally-set discount rate and several issues related to application of this value.

A. Need to Adjust the Social Discount Rate

In January 2007, the Ministry of Planning and Budget and the KDI began to study ways to improve the systems and execution of preliminary feasibility studies and RSF, relevant study, and analysis methods, etc. The need has risen to review the systems and devise ways to improve them in consideration of the changed conditions like the expanded scope of preliminary feasibility studies with the implementation of the National Finance Act and the experience of having operated them.

The need to adjust the social discount rate was raised when it was pointed out that there is a need to improve study methods to bolster the practicability of economic analysis (cost-benefit analysis) and to accord greater consideration to less developed regions. Also, looking at the interest rates and growth rate, the major economic indices, the persistently low interest rates and low growth were evident for the last three years. They should be monitored for a longer time to determine whether they are a temporary phenomenon or a major change in trend. Whatever the case, there is a need to change the values of parameters that have impact on the social discount rate.

The social discount rates of 7.5% and 6.5% suggested in the "General Guidelines (third edition)" and "General Guidelines (fourth edition)" were suggested at the time to avoid excessive adjustment considering that real rates of at least 10% were used in feasibility studies before preliminary feasibility studies were implemented. Taking into account the inflation rate from the 1990s to the present, the value of the real discount rate could be construed to be as low as around 5%. This lowered the social discount rate in phases, and the need to adjust it has come to the fore amid the persistently low interest rates and low growth.

A basic interest rate is a combination of a government bonds interest rate and a long-term yield spread. The long-term interest rate on government bonds is 5.63% for 5-year maturity and 5.81% for 10-year maturity. When supposing the long-term yield spread to be 1.0%, the nominal basic interest rate becomes about 7% and 7 to 8% even when the interest rate increases. The real basic interest rate is found to be 4 to 5% in consideration of the present inflation rate of 3% and the possibility of interest rate increases in the future.

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[17] Refer to the part about the social discount rate in Chapter 6, Part 2 for details on how to set the social discount rate.

Despite being based on a short time-series data, this has recently become apparent in the major economic indices. Growth is forecast to slow due to slower growth in per-capita GDP and a declining savings rate resulting from population aging and the low birth rate, while interest rates will remain low compared to before 2000. The current real interest rate of 6.5% is, therefore, somewhat high. Of course, the appropriate social discount rate with regard to public investment projects should not only consider simple figures but also qualitative factors.

B. Calculation of an Appropriate Social Discount Rate (Real Rate of 5.5%)

To estimate an appropriate social discount rate, a basic interest rate, social time preference rate ($STPR$), financial discount rate, and such were considered.

These "General Guidelines (fifth edition)" used the social time preference rate for estimation due to the facts that it can be used to calculate an appropriate rate with fewer parameters than the formula used in the "General Guidelines (fourth edition)" and the value estimated as such can be regarded as the lowest limit of the social discount rate:

$$STPR = \rho + \mu \cdot g$$

In the above formula, ρ refers to a discount rate of future consumption under the assumption that per-capita consumption does not change. g is an annual per-capita consumption increase rate, and μ is the elasticity of marginal utility of consumption. In the end, $\mu \cdot g$ is to reflect the diminishing effect of marginal utility due to consumption change.

Calculation of this social time preference rate according to the formula revealed that the appropriate range is 5.0 to 5.5%.

The basic interest rate based on the real interest rate of five-year government bonds and long-term premiums for the last five years also falls within this range.

Lastly, estimation of a real weighted average cost of capital as part of financial feasibility analysis revealed that 5.5% is proper for a real discount rate used in financial feasibility analysis as the spread between the interest rates of three-year corporate bonds and government bonds narrowed from 2% to no more than 1%, and thereby, the cost of debt capital decreased.

However, the current economic analysis does not fully review a project's risks except for some sensitivity analysis, which can require a higher discount rate. Also, the tendency to evade a sudden adjustment of the discount rate should be considered

in determining actual values to apply.

As explained so far, 5.5% is to be used for the real social discount rate.

C. Different Social Discount Rates in Consideration of the Long Term

The analysis period in water resources projects is 50 years, longer than in other projects. This is why a lower social discount rate has been applied. The "General Guidelines (third edition)" and "General Guidelines (fourth edition)" looked at how the results of current value calculation converted into consumption units differ according to the types of temporal patterns of benefit occurrence, and suggested that a lower discount rate should be applied in long-term projects like water resources projects. This lump-sum application of a lower rate than in other projects can be construed as differential application of social discount rates among the different types of projects. However, in principle, a common social discount rate should be applied to all types of government-financed projects. It is true that the theoretical basis for differential application among different types of projects is weak. Of course, the application of a lower rate in water resources projects in the "General Guidelines (third edition)" and "General Guidelines (fourth edition)" can be construed as differential application of a discount rate for long-term projects rather than that among different types of projects.

There is less need for differential application of a discount rate if it is a choice within a generation. However, if it is a choice between different generations, it is considered necessary to carefully introduce differential application. If a discount rate fixed as a rule is exponentially discounted, there may be criticism to the effect that it considers only the current generation, not a future generation. A theoretical basis for this can be found in studies by Weitzman (1998), Gollier (2002), and others. These studies show that the social discount rate decreases over time if the rate has uncertainty in itself or there is uncertainty over future growth.

In preliminary feasibility studies, water resources projects are the only ones that are long-term. Only in water research projects, therefore, should different discount rates be applied where the analysis period is no less than 30 years. According to analysis of the impacts of different discount rates, a real rate of 5.5% is to be applied for the first 30 years and 4.5% for the following 20 years of operation.

3. Processing of Transfer Payments Including Taxes

In economic analysis, transfer payments like taxes should not be regarded as pure economic costs. Transfer payments are transfers from one entity to another, and they can be costs or benefits depending on the relevant party in financial feasibility analysis. However, they do not have any effect on national finances in economic analysis. Preliminary feasibility studies should attempt analysis that excludes transfer payments like taxes as much as possible, but it is in practice difficult to determine how to deduct taxes in the different types of projects.

It is difficult in preliminary feasibility studies to calculate tax imposition details according to the types of inputs, so estimated total project costs minus VAT are regarded as economic costs to use for economic analysis.

A. Exclusive Projects like Expressway and Railroad Construction

In traditional cost-benefit analysis, benefits are evaluated as willingness to pay for public investment deliverables. This willingness to pay can be used as a market price if the conditions of competitive sourcing, etc. are met. There are two conditions of competitive sourcing for consumer goods: first, there should be no restriction like a distribution system so that all consumers should be able to freely purchase the goods. Second, there should be no monopsony and no single consumer should be able to affect the market price.[18]

The sacrifice individuals have to make to use an expressway (price they have to pay) is not limited to tolls, so tolls are not enough to evaluate their willingness to pay for the expressway. The sacrifice individuals make to use an expressway - user costs - should comprehensively consider and evaluate car operation costs, time value, traffic accidents, etc. A general method adopted to evaluate willingness to pay for use of an expressway (namely, all user costs) is indirect estimation of individuals' satisfaction from such use. The willingness to pay for private goods can be calculated by their market price if there is one or by estimating consumer satisfaction with them if there is no price.

For this reason, the willingness to pay for use of an expressway is calculated, as seen above, by evaluating individuals' satisfaction as 'cuts in car operation costs plus value of reduced travel time plus value of reduced traffic accidents.' Individuals' satisfaction from use of an expressway should, in principle, be

[18] UNIDO, Guidelines for Project Evaluation, 1972, pp.42~47.

estimated with focus on the consumer price (price paid by consumers, which is the supply price plus tax). When estimating reduced car operation costs, time value, value associated with traffic accidents, etc. they should be evaluated with focus on the price paid by consumers. Accordingly, it is appropriate to include tax in the benefit afforded by an expressway. The benefit of an expressway should be estimated as a consumer price that includes tax, and it is inappropriate to deduct tax again from the estimated benefit amount.

It should be noted, however, that costs have a different aspect with regard to analysis of expressway projects. In general, costs in public investments are evaluated as 'maximum alternative benefits forgone' of inputs. As long as the inputs of expressway construction (e.g. cement, sand, asphalt) meet the conditions of competitive sourcing, the market prices of these inputs should be regarded as social opportunity costs. However, if the prices of inputs already include tax (indirect tax), it can be handled in two ways: First, if inputs required in public investments are redirected from existing users, in other words, if the entire supply to society of the inputs is constant without regard to the implementation of a public investment, their prices including tax should be used in cost evaluation as they are. In this case, it is inappropriate to evaluate costs as market prices minus taxes. Second, if inputs are additionally produced and supplied for a public investment, in other words, if the entire supply to society of the inputs increases and the increased quantity is inputted in the public investment, tax should be deducted to appropriately evaluate the social opportunity costs. For instance, if tax is imposed on cement assuming a constant supply, the social marginal utility (willingness to pay) of cement exceeds its social marginal cost. If more cement is produced to lay an expressway, the social opportunity costs of cement should be calculated as social marginal costs. In this case, the market price of cement minus tax should be regarded as costs.

For this reason, textbooks on cost-benefit analysis state that the social value (opportunity costs) of inputs is evaluated as 'α × (market price including tax) + (1 - α) × (market price excluding tax).' '(1-α)' here reflects the additional production rate of inputs. That is, the 'α' rate of inputs in public investments refers to inputs redirected from existing users, and '(1-α)' is the rate of additional production. In other words, if inputs in public investments are all consumed by existing users, it is appropriate to conduct cost-benefit analysis based on the market price including tax. However, if only a portion of inputs (e.g. a portion corresponding to the α rate) is used by existing users, the market price including tax should be used in evaluation only for that rate. And the rest should be evaluated based on the price excluding tax.

At issue is how to estimate α, the rate of inputs redirected from existing users. It is very difficult to estimate how much of inputs are redirected from existing users in

a specific project. In conclusion, as it is in fact difficult to determine how much of inputs are used by existing or other users with regard to the cost estimation of expressway or railroad projects, these preliminary feasibility studies suggest that analysis exclude at least 10% VAT borne by the responsible parties like the Korea Expressway Corporation or Korea Railroad Corporation.[19]

B. Other Projects

When there is only one execution agency for a project like the Korea Expressway Corporation or the Korea Railroad Corporation, and the methods and items of cost estimation are relatively systemized based on existing data, tax deduction is possible to some degree using the existing data. In other projects, it is not obvious who the responsible parties are in most cases, and cost items vary greatly from one project to another, which serves to complicate tax deduction. Namely, how to deduct which taxes remains controversial. If there are multiple parties involved in projects, they bear various types of taxes, which leads to variable cost items and makes it very difficult to determine which tax is imposed on which cost item.

Accordingly, tax deduction in the economic analysis of other projects is to be temporarily left to the discretion of each study team. There should be further study on how to deduct taxes more systematically.

In the end, transfer payments such as taxes should be handled considering both producers and users. The KDI plans to conduct in-depth studies to come up with the most appropriate way to handle taxes in cost calculation.

4. Base Day of Analysis, Period of Analysis, Etc.

In economic feasibility evaluation, all the benefits and costs should be discounted at the same point of time. As benefits and costs occur at different points of time, they should be reconciled as the values of the same point of time using a discount rate. This makes them comparable. Preliminary feasibility studies under these Guidelines are to use the end of a year prior to a year when analysis of the concerned project commenced (e.g. the end of 2007 for a project which commenced

[19] Analysis that excludes from benefits 10% VAT borne by the Korea Expressway Corporation means analysis that deducts 10% taxes from the costs of building various facilities suggested by the Korea Expressway Corporation.

in 2008) as the base day of discount analysis.

The period of analysis for economic feasibility evaluation should depend on the characteristics of each project. The Third Edition observed the prevailing practices which required 20 years and 30 years after construction for roads and railroads, respectively. The revised guidelines lengthened the period of analysis for roads to 30 years.[20]

The period subject to analysis for port projects is set at 30 years. That for water resource projects like multipurpose dams is 50 years. For dam projects, domestic and foreign cases were considered that usually apply a very long analysis period. The period for projects to form cultural, tourism, sports, and science complexes is 30 years.

The same guidelines should be in place for annual expenditures of project costs during the analysis period. For instance, in expressway projects, 30% and 70% of lot purchase costs are set to be spent in the first and second year, respectively, and 5%, 15%, 25%, 35%, and 20% of construction costs are set to be spent in each year of the construction period of five years.

5. Processing of Salvage Value

Salvage value is closely related to the duration of the concerned facility and the analysis period of economic feasibility. For instance, a road is paved again some 15 years after completion. Such repaving does not require much reinvestment; only ordinary maintenance and operation costs are incurred each year. What preliminary feasibility studies, therefore, consider as salvage value in a road project is acquisition costs of land. The study team should set acquisition costs of land as salvage value in a road project and deduct them from the costs of the final year of analysis.

Unlike roads, railroads require a great deal of reinvestment. Additional train cars are input as demand increases and reinvestment is made to replace fully depreciated cars and facilities. Items that can be considered as salvage value 30 years after service opened are acquisition costs of land as well as cars, and facilities and equipment in which reinvestment is made. Preliminary feasibility studies in railroad projects are to consider the salvage value of both acquisition costs of land and items in which reinvestment is made. The period over which train cars in general railroads and urban railroads are depreciated is that specified in the 'Enforcement Rule of the

[20] For more details, refer to the "Study to Revise and Supplement the Sectoral Guidelines for Preliminary Feasibility Studies for Road and Railroad Projects (fifth edition)."

Railroad Safety Act' and 'Rules on Management of Urban Railroad Cars', respectively. For facilities of which the durability life is not specified by law, the durability life suggested in the "Investment Evaluation Guidelines for Transportation Facilities" (Ministry of Land, Transport and Maritime Affairs, 2007) is used as a standard to calculate reinvestment costs and salvage value. In any other case where salvage value can be realistically calculated and a sufficient basis can be stated, all possible salvage values shall be reflected.

In projects other than road and railroad projects, salvage value shall be reflected based on the durability life.

6. Sensitivity Analysis

The calculation of benefits and costs in economic analysis used to evaluate feasibility engenders many uncertainties. Sensitivity analysis is often conducted to deal with these uncertainties. This analysis looks at how economic feasibility changes when each important variable that can affect investment costs or economic feasibility like initial construction costs, operating costs, demand for transportation, discount rates, etc. changes by a certain degree.

Preliminary feasibility studies conduct sensitivity analysis about these variables. The scope and methods of sensitivity analysis can differ slightly depending on the type of a project.

Ⅴ. Ways to Attract Private Investment

1. Background and Purpose of Review

Preliminary Feasibility Studies are designed to transparently and fairly determine whether to invest in large-scale public investment projects based on priorities to prevent budget waste and help increase efficiency in public investment management. They also provide sufficient objective and neutral data in advance for project plans established by each ministry like their feasibility, review of alternatives, and considerations to make so that rational decisions can be made regarding whether to pursue them, a proper time to implement them, and their

optimal scale, etc.

Public-Private Partnership (PPP) projects solicited by the government where government financial support of no less than 30 billion are inputted proceed by the same process as public investment projects until announcement of a Request For Proposal (RFP). Therefore, if the details of an RFP can be reviewed in advance at the step of preliminary feasibility study, the project period of PPP projects solicited by the government can be greatly reduced.

The details of an RFP offer a practical blueprint for pursuing the concerned PPP project. As such, the competent government office can offer predictability about the project to a concessionaire to be designated later, which can have a big impact on the project's risk analysis, writing of financial models, and devising of financing and borrowing conditions.

The "General Guidelines (fourth edition)" saw that there was no need to review financial feasibility and the possibility of private investment for any project at the step of preliminary feasibility study. Still, financial feasibility evaluation was conducted for projects with the possibility that the private sector would participate voluntarily because of their economic feasibility and high business value.

These "General Guidelines (fifth edition)" intend more detailed analysis based on the Fourth Edition and to review the possibility of private investment in projects where the benefit-cost ratio of an optimal alternative exceeds 0.9 as a result of economic feasibility analysis. The Fifth Edition also suggests procedures to be used for appropriate projects.

Preliminary feasibility studies do financial feasibility analysis to provide basic data for determining whether or not to pursue a PPP project in such way as roughly suggesting the possibility of profitability and a minimum rate of government financial support when the concerned project is pursued as a PPP project. However, as far as financial feasibility analysis in preliminary feasibility studies is concerned, analysis to calculate a minimum amount of government financial support for each project fails to comprehensively consider qualitative elements like improvement in service, ease of management, risk distribution, and ripple effects other than profitability that help determine suitability as a PPP project. From the perspective of the government or nation, whether it is a public investment project that is 100% publicly financed or a PPP project partially funded by public finances, it is still the taxpayers' money, so there should be principles to systematically select projects in place in advance without regard to whether it is a public investment project or PPP project.

The 'Basic Plan for PPP Projects' (Ministry of Strategy & Finance, January 2008) stipulates that projects from among those pursued as public investment projects that are appropriate to convert into PPP projects in consideration of financing conditions, urgency, profitability, and such and need to secure profitability

with an appropriate level of government financial support can be turned into PPP projects. It also prescribes that whether to pursue a project with public finances or with private investment should be determined when conducting a preliminary feasibility study. To satisfy this regulation, there should, obviously, be a way to determine whether or not to pursue a project with public finances or with private investment at the step of preliminary feasibility study.

2. Review of the Possibility of Private Investment at the Step of Preliminary Feasibility Study

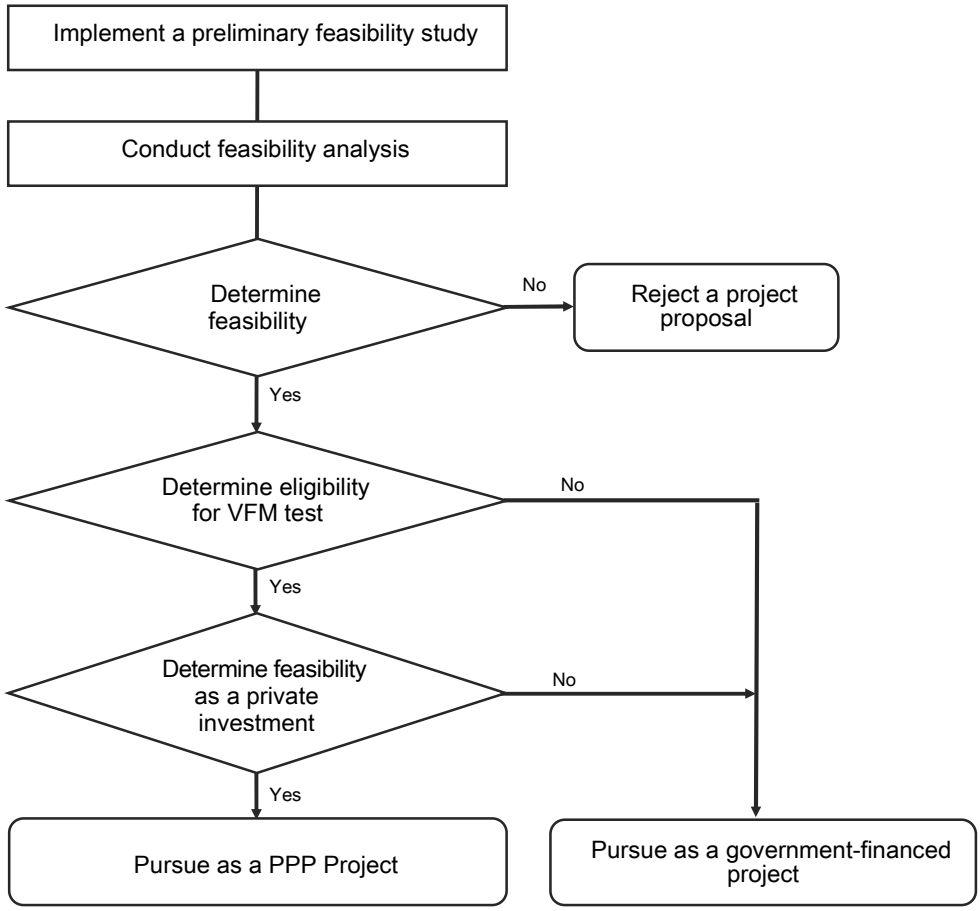
A. Process to Review the Possibility of Private Investment

This process is divided into two parts: ① review of the 'possibility of private investment' and ② study of 'feasibility as a PPP project (Value for Money (VfM) test)'. The following model in Figure 3-3 is used to ascertain whether a project should be pursued as a public investment project or PPP project.

First, projects subject to a checklist to review the possibility of private investment are those where the benefit-cost ratio of the optimal alternative exceeds 0.9 in the results of economic feasibility analysis. At the first step, their feasibility in terms of law and policy and a possible implementation method of private investment are determined. The second step reviews the possibility of private investment through qualitative and financial feasibility analysis with the checklist items of economic feasibility, ease of management, creativity & efficiency, risk distribution, and public nature. Financial feasibility analysis is conducted only for profit (Build-Transfer-Operate, BTO) projects. BTL (Build-Transfer-Lease) projects are an exception to the principles of users being willing to pay higher usage fees and profitability being secured, which are part of the principles of selecting PPP projects. The procedures to use a checklist as part of preliminary feasibility studies are indicated in Figure 3-4 below.

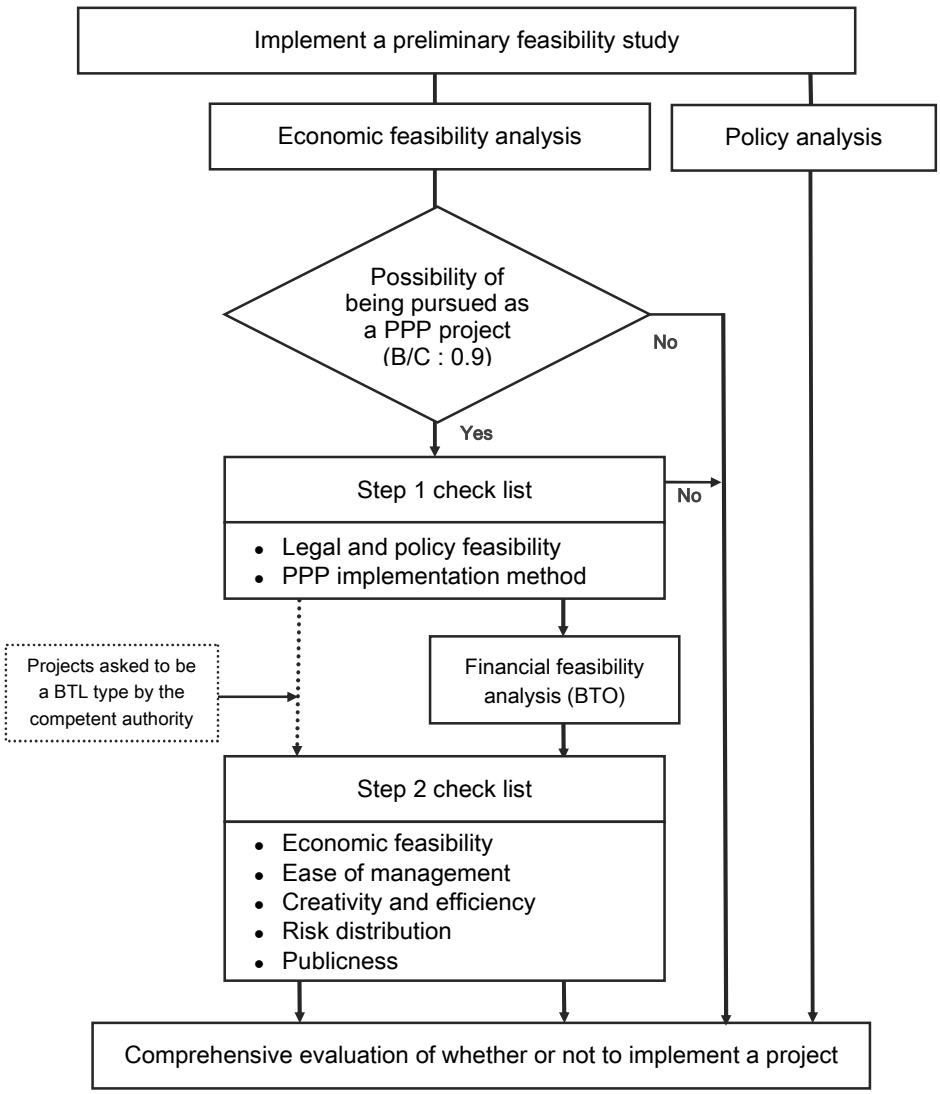
Second, a simplified VfM test can be performed informally for project proposals that are found to be very concrete as a result of a checklist of the possibility of private investment; that are believed to be more suitable as PPP projects than as public investment projects as a result of comprehensive evaluation; and that are found feasible by comprehensive evaluation at the step of preliminary feasibility study (AHP $\geq$ 0.5).

Figure 3-3 Preliminary Feasibility Study's Evaluation Model to Determine Whether to Pursue a Project as a Public Investment or PPP Project



Note: 1) PSC: public sector comparator
2) PFI: Private finance initiative

Figure 3-4 Procedures to Perform a Checklist in Preliminary Feasibility Studies



B. Checklist Items to Evaluate the Possibility of Private Investment

Feasibility in terms of law and policy, etc. is checked to ascertain the possibility of a project proposal being accepted from a national perspective and to determine whether to conduct a VfM test. The checklist items are as follows in Table 3-17:

▌Table 3-17▐ Preliminary Feasibility Study Checklist Items to Evaluate the Possibility of Private Investment

Step	Evaluation Items	Evaluation Details	How to Score	Remarks
Step 1	Feasibility in terms of law and policy	■ Legal feasibility of the concerned project including whether it is one of the 44 types of facilities subject to private investment as defined in Article 2 of the Act on Public-Private Partnerships in Infrastructure ■ Whether it is aligned with the mid- & long-term plan for SOC facilities, and the investment policy and priorities of the government or competent authority.	Required items	Can move to the next step only if "yes" is selected
	PPP project implemen-tation method	■ BTO or BTL depending on whether users are willing to pay higher usage fees and the project is profitable, which are two of the principles of selecting PPP projects		
Step 2	Economic feasibility	■ To determine feasibility as a PPP project, the possibility to secure value for money in total project costs and economic feasibility should be confirmed first.	Scoring survey results	The more items with high scores there are, the higher is the score to determine project implem-entation
	Ease of management	■ Whether the concerned service can be independently provided and the required level of performance can be met.		
	Creativity & efficiency	■ Whether the private sector's creativity is used to increase efficiency in SOC construction and operation and competition with other public investment facilities is facilitated to improve service quality		
	Risk distribution	■ Whether risks can be appropriately distributed when pursuing with private capital, and whether the scale and facilities of the project impose any restriction in providing service, when seen from the government's perspective		
	Publicness	■ Whether participation by a private party can generate the ripple effects of improvement in technology, management skills, etc. in the public sector		

C. First-Step Checklist Evaluation

Legal review checks whether projects are for infrastructure types that are subject to private investment under the Act on Public-Private Partnerships in Infrastructure. This checks whether the concerned project is one of the infrastructure types under Article 2 of the Act, and when necessary, applicable laws (e.g. Road Act, Toll Road Act) and cases suggested under the Act are referred to.

▌Table 3-18▌ Infrastructure Types (Article 2, Act on Public-Private Partnerships in Infrastructure)

Project Type	Responsible Ministry	Infrastructure Type
Road (3)	Ministry of Land, Transport and Maritime Affairs (MLTM)	Road and ancillary facilities, offstreet parking facilities, intelligent transportation systems
Railroad (3)	MLTM	Railroads, railroad facilities, urban railroads
Port (3)	MLTM	Port facilities, fishery harbor facilities, new port construction facilities
Airport (1)	MLTM	Airport facilities
Water resource (3)	MLTM	Multipurpose dams, river facilities
	Ministry of Environment	Waterworks systems and intermediate waterworks
Information & telecom-munications (5)	Korea Communications Commission	Telecommunications facilities, information and communications networks, super-high-speed information and communications networks, ubiquitous urban infrastructure
	MLTM	Geographic information systems
Energy (3)	Ministry of Knowledge Economy	Power supply facilities, gas supply facilities, integrated energy supply facilities
Environment (5)	Ministry of Environment	Sewage treatment facilities, public sewage disposal facilities & excreta treatment facilities, waste treatment facilities, wastewater terminal treatment facilities, recycling facilities, public livestock wastewater treatment facilities
Distribution (2)	MLTM	Logistics terminals and complexes, passenger car terminals
Culture & tourism (9)	Ministry of Culture, Sports and Tourism	Tourist resort and resort complexes, youth training facilities, professional sports facilities1) & public sports facilities, libraries, museums & art museums, international conference facilities, cultural facilities
	Ministry of Education, Science and Technology (MEST)	Science museums
	MLTM	Urban parks
Education (1)	MEST	Kindergartens and schools
National defense (1)	Ministry of National Defense	Military residential facilities and ancillary facilities
Housing (1)	MLTM	Public rental housing
Welfare (3)	Ministry for Health, Welfare and Family Affairs	Residential, medical, & home care facilities for the elderly, public health & medical facilities, nursing facilities
Forest (2)	Ministry for Food, Agriculture, Forestry and Fisheries (Korea Forest Service)	Natural and recreational forests

Note: Enforced three months after promulgation of a revision to the Act on Public-Private Partnerships in Infrastructure.
Source: 'Act on Public-Private Partnerships in Infrastructure' ([Enforced on July 31, 2009]).

Feasibility evaluation in terms of policy evaluates whether the concerned project is aligned with mid- & long-term SOC plans, the directions of investment policies, and investment priorities adopted by the government or competent authority, etc.

Comprehensively considered are a project plan submitted by the competent ministry together with a preliminary feasibility study request; raw data collected and analyzed while conducting the study; higher-level and relevant plans and policy data; interviews with interested parties; and main issues of the study. Feasibility in terms of policy is different from 'feasibility evaluation in terms of policy,' an evaluation item of preliminary feasibility studies. This is evaluated for projects that suit mid- & long-term SOC plans and the government's investment priorities; meet the principles of selecting PPP projects such as users being willing to pay higher usage fees,[21] the project being profitable,[22] beneficial,[23] and efficient;[24] and therefore are believed to be more efficiently pursued as a PPP project from the perspective of government policy.

Determining a PPP project implementation method is about choosing between BTO and BTL types. If all the questions under 'feasibility in terms of law and policy' are answered with 'yes,' the concerned project is to be pursued as a PPP project. Then a PPP project implementation method is to be determined. If all relevant questions are answered with 'yes,' the project is judged to be a BTO.

No financial feasibility analysis is conducted for projects that are evaluated to be BTLs in the above checklist. These projects are considered to have no possibility of attracting private investment at the step of preliminary feasibility study. Those asked to be BTL-type PPP projects by the responsible department in the project plans are checked to meet the BTL-type conditions.

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[21] The principle of users being willing to pay higher usage fees (except for BTL projects): Higher-quality service can be provided compared to that of the existing facility with lower usage fees, and users are willing to pay higher usage fees for such higher benefits.

[22] Principle of being profitable (except for BTL projects): The private investor can secure profitability that justifies investment in consideration of usage fees allowable by the government and payable by users and construction subsidies providable by the government.

[23] Principle of being beneficial: If the project is public investment, it is difficult to quickly complete facility construction and provide service due to budget limits, etc. If private investment is made, it can be completed by a scheduled time, quickly generating benefits.

[24] Principle of being efficient: The private sector's creativity is leveraged to increase efficiency in SOC construction and operation, and competition with other public investment facilities is facilitated to improve service quality

▎Table 3-19▎PPP Project Implementation Method: BTO and BTL

Type	1	2	3	4	5	6
1. Core Service	O	O	O	△	X	X
2. Usage Fee	O	O	X	O	O	X
3. Profitability	O	X/△	X	O	X	X
Case	Express-way, light rail transit, port	Environ-mental treatment facility, railroad	National road, sewer system	Theme park, public rental housing	Museum, science museum	School, military facility, welfare facility
PPP Project Implementation Method	BTO	BTL/BTO	BTL	BTL/BTO	BTL	BTL

First-step checklist evaluation is performed by the study team (three persons: project manager, researcher responsible for demand analysis, and researcher responsible for cost analysis). The project manager is to put evaluation results in an evaluation form Table 3-20 and write a report that is as concrete as possible about the basis for evaluation and comprehensive judgment.

▎Table 3-20▎First-Step Checklist Evaluation of Project A (example)

Evaluation Item	Survey Item	Evalu - ator 1	Evalu - ator 2	Evalu -ator 3	Compre-hensive judgment	Re-marks
Feasibility in Terms of Law and Policy	Whether it is a facility subject to private investment specified under Article 2 of the Act on Public-Private Partnerships in Infrastructure					
	Whether the project suits the government's mid- & long-term SOC plans, investment priorities, and policy directions, etc.					
PPP Project Implementation Method	Can a private party provide infrastructure and service under its responsibility without government support?					
	Can be a usage fee charged on facility use?					
	When charging a toll/usage fee, can users opt for alternatives?					

D. Financial Feasibility Analysis

Financial feasibility analysis is conducted only for projects of which feasibility in terms of law and policy was recognized at the first-step checklist evaluation and that can be pursued as BTOs.

It is not conducted for those which were found to be better as BTLs as a result of first-step checklist evaluation or were suggested as BTLs in their project plan. This kind of analysis is conducted in accordance with these Guidelines, and relevant details are indicated in the next section.

E. Second-Step Checklist Evaluation

Projects subject to second-step checklist evaluation are those that secured feasibility in terms of law and policy as PPP projects at the first-step checklist evaluation and are classified as BTOs or requested to be BTOs in the project plan.

The second-step checklist evaluation is qualitative evaluation of answers to survey questions (projects' economic feasibility, ease of management, creativity and efficiency, risk distribution, and public nature) in consideration of the results of economic and financial feasibility analysis, raw data, issues identified, and cases of similar projects.

The project manager is to write a report that is as concrete as possible about the basis for evaluation and comprehensive judgment.

▌Table 3-21▌ Second-Step Qualitative Evaluation of Project A (example)

Evaluation Item	Review Item	Remarks
Economic Feasibility	Are the total costs of this project high enough to secure value for money?	
	Is the project sufficiently economically feasible?	
Ease of Management	Can it stand alone without being connected with existing facilities (projects)?	
	Are the interested parties of this project clearly defined, and can opinions and information be effectively exchanged?	
	Are the purpose and scope of the project clear, and can it suggest a definite required service level for the concerned facility?	
Creativity & Efficiency	Is it believed that the private sector's creativity and efficiency will be exercised to substantially reduce life cycle costs at the construction and operation phases?	
	Is it believed that the private sector's creativity will be exercised to provide better service than if operated by the government?	
	Is this a facility that can guarantee autonomy in operation, management, and maintenance by the private investor and reduce costs?	
	Will this project invite many private companies in the bid to win it to generate sufficient competition?	
Risk Distribution	Will a considerable part of its demand risks be transferred to the private investor so that risk management will be more efficient?	
	Will its risks related to design and construction be transferred to the private investor to reduce the government's burden?	
	Are there any restrictions to consider in project implementation (design, construction, operation, acquiring approval, etc.)?	
Publicness	Is there a possibility that excessive benefits will accrue to a special interest party if this project is implemented?	
	Are considerable ripple effects expected with the private party's participation such as improvement in technology and management skills in the public sector?	
	Is this project sufficiently differentiated from other projects of the same type in relevant plans?	
Comprehensive evaluation		

VI. Financial Feasibility Analysis

Financial feasibility analysis is conducted for projects of which feasibility in terms of law and policy is recognized at the first-step of checklist evaluation and that can be pursued as BTO projects, or for those proposed as BTO projects in the project plan submitted by the responsible department. Even projects which are not profitable enough to be pursued by a private party can be pursued as PPP projects with some level of government financial support if they are more suitable to be pursued by such party in terms of creativity and efficiency. In this case, financial feasibility analysis needs to be conducted to ascertain an appropriate amount of government financial support.

1. Comparison between Economic Feasibility Analysis and Financial Feasibility Analysis

Economic feasibility analysis is to measure public projects' costs and benefits from the perspective of the entire nation (society) and accordingly to calculate their economic profitability and to determine their feasibility. In comparison, financial feasibility analysis estimates actual monetary costs and cash flows from the perspective of individual parties responsible for projects, not the entire society, and accordingly calculates financial profitability to ascertain projects' feasibility.

Financial feasibility analysis places utmost importance on the actual investment budget amount and cash flows. The differences in the calculation of income and costs between economic feasibility analysis and financial feasibility analysis are as follows:

First, as economic feasibility analysis calculates costs and benefits from the perspective of the national economy, it has to calculate product prices, exchange rates, wages, etc. as shadow prices, in principle. Financial feasibility analysis can use simple market prices as it calculates everything from the perspective of individual responsible parties.

Second, transfer payments like taxes and interest should be excluded from economic feasibility analysis but be included in financial feasibility analysis.

Third, economic feasibility analysis uses the social discount rate as a discount rate, but financial feasibility analysis uses the financial discount rate in consideration of market interest rates, project risks, etc.

| Table 3-22 | Comparison between Economic and Financial Feasibility Analysis

Classification	Economic Analysis	Financial Analysis
Perspective of evaluation:	National economy	Individual responsible party
Measured price:	Shadow price	Market price
Transfer payments:	Excluded	Included
Discount rate to apply:	Social discount rate	Market interest rate, project risks, etc. (financial discount rate)

2. Basic Assumptions

A. Investment Methods of Projects

Financing for public investment projects can be divided into cases where a separate corporation is established and those where an existing corporation serves as a responsible party. Both cases use equity capital and debt capital and can additionally consider government subsidies, government loans, etc. Equity capital is funds raised by the responsible party with reserve funds or capital increase, or funds by a separate corporation through equity participation by specific parties, IPOs, and such. Debt capital can be raised through borrowing from domestic and foreign financial institutions, issuance of corporate bonds, etc. As SOC construction is usually capital-intensive, the share of debt capital is often high.

In financial feasibility analysis, which often uses the discounted cash flow method based on conventional financial theories, different financing methods, strictly speaking, do not have a big impact on analysis results. Nevertheless, assumptions about the ratios of equity capital and debt capital, financing methods, etc. have an impact on the calculation of appropriate discount rates, so these should be determined in advance.

Public investment projects pursued with private capital usually take the form of BOT (Build-Operate-Transfer), BTO (Build-Transfer-Operate), BOO (Build-Own-Operate), and BTL (Build-Transfer-Lease), etc. Preliminary feasibility studies, in general, validate whether target projects are suitable to be pursued as BOT or BTO projects, if unless other implementation methods are economically persuasive.

B. Base Year of Analysis, Analysis Period, & Completion Rate

Assumptions to be used in financial feasibility analysis such as the base year of analysis, analysis period, and completion rate related to costs executed each year are basically the same as those used in economic feasibility analysis.

The base year of analysis is the end of the year before analysis is requested, as in economic feasibility analysis.[25]

Also as in economic feasibility analysis, the analysis period varies depending on the characteristics of each project. The analysis period is 30 years after the commencement of operation for transportation projects like roads, railroads, ports, and airports. It is 50 years for dam projects according to the practice at home and abroad of applying a longer period in water resource projects than in transportation projects. It is 30 years for projects to form industrial, cultural, and tourism complexes.

For the completion rate during the analysis period, the same standards are applied as those in economic feasibility analysis. In the first two years of a project, respectively, 30% and 70% of lot purchase costs are to be executed. Annual execution of project costs is to be in accordance with the completion rate from economic feasibility analysis.

C. Salvage Value

In general, salvage value is related to the duration of the concerned facility and period of economic feasibility analysis. In the case of facilities and equipment, the calculation and amount of salvage value can vary according to such project types as BOT, BTO, and BOO. It should, therefore, be calculated accordingly. In economic feasibility analysis, salvage value is included as part of negative costs at the final point of analysis. In financial feasibility analysis, as the ownership of a facility reverts to the government or a local government organization in a BOT or BTO project, the private party does not get to have salvage value. However, if the private party is granted facility ownership at the end of analysis, salvage value shall be considered as a negative cost.

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[25] As values estimated from economic feasibility analysis are used for income and costs, the analysis standards should be the same as those in economic feasibility analysis.

D. Taxes and Charges, Financing Costs, and Interest Rates

Economic feasibility analysis recognizes various taxes and charges as transfer payments and thereby does not include them in the analysis. They are included in financial feasibility analysis as acquisition taxes, registration taxes, corporate taxes, etc. and are clearly cash outflows from the perspective of the private party.

For an interest rate to apply when calculating interest costs for borrowings, an actual current market rate should be used rather than an interest rate predicted over a long term. In general, interest costs for general borrowings are calculated by reflecting the spread (e.g. within 3%) in the market interest rate (e.g. yield to maturity of five-year government bonds) at the time of analysis.

New stock issuance costs, another type of financing costs, can be calculated by applying a certain portion of the paid-in capital (e.g. 0.5%), but because they are not high, they can be excluded at the step of preliminary feasibility study.

E. Supplementary Projects

If the responsible party conducts not only the concerned project but also supplementary projects, the costs and revenues of the supplementary projects should be included in financial feasibility analysis. Supplementary projects here refer to the construction of supplementary facilities directly related to the concerned project. Minor supplementary projects should be excluded. These include shopping malls and the like that have little direct bearing on the characteristics of the project. Supplementary projects that can be reviewed in financial feasibility analysis as part of a preliminary feasibility study are those that can be directly handled by the government when the government is the implementation party of the main project.

The investment costs of supplementary projects should fall within the scope of the costs of the concerned PPP project. Supplementary projects should serve to increase benefits in the national economy and the business value of the concerned project, and be implemented at locations geographically close to that of the concerned project.[26]

Cases that can be considered as supplementary projects are, in road projects, the net income of advertising facilities and net income of amenities leasing. In railroad

[26] The upper limit on the amount of income from supplementary projects cannot be suggested by law or regulation. In the case of the Korea Expressway Corporation, income from supplementary projects (rest area lease) accounts for less than 3.0% of the total income. This can be used as a benchmark.

projects, an example is income other than fares such as the income of advertising in train cars and stations or of vending machines. The estimation of investment costs (e.g. installation costs), operating costs, and profits related to supplementary projects should consider the installation costs of rest areas from the Korea Expressway Corporation and income of advertising in subway cars of the Seoul Metro.

3. Analysis Methods

The most commonly used discounted cash flow methods are used for financial feasibility analysis.

The discounted cash flow methods estimate future cash flows and calculate present values discounted by the opportunity cost of capital (e.g. weighted average cost of capital). The discounted cash flow methods include the Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index (PI) methods, and more.

The NPV method is the sum of expected cash flows, both incoming and outgoing, that are discounted by the weighted average cost of capital. This means the amount by which corporate value increases when the concerned investment proposal is adopted. If the financial NPV is positive, the project is believed to be financially feasible.[27]

$$FNPV = \sum_{t=0}^{n} \frac{R_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

where R_t refers to the incoming cash flow of period t, and C_t to the outgoing flow of period t.

The IRR method calculates an IRR (FIRR), a discount rate that reconciles the present values of incoming and outgoing cash flows expected from investment into the planned project, and compares it with capital costs to evaluate an investment proposal. When the IRR exceeds the capital costs, the project is considered financially feasible.

[27] To distinguish from the NPV and IRR used in economic feasibility analysis, they are indicated as FNPV and FIRR in financial feasibility analysis.

$$0 = \sum_{t=0}^{n} \frac{R_t}{(1+FIRR)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+FIRR)^t}$$

The PI method is the ratio of the net value of incoming cash flows divided by that of outgoing cash flows (cash flows occurring from investment). If the PI is higher than 1, the project is judged to be financially feasible. While the NPV method measures the financial feasibility of an investment proposal as an absolute amount, the PI method measures the ratio of cost vs. profit in a proposal as a relative ratio.

$$PI = \sum_{t=0}^{n} \frac{R_t}{(1+r)^t} / \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

4. Cost & Income Estimation and Feasibility Analysis

A. Definition of Cash Flows

The cash flows used for financial feasibility analysis are free cash flows, which are calculated as follows:

Free Cash Flow = Operating cash flow - capital expenditure - increase in working capital
= Operating profit (1 - corporate tax rate) + depreciation cost - capital expenditure - increase in working capital

For financial feasibility analysis, all cash flows should be estimated as or converted into constant prices, and cash flows estimated as constant prices should be discounted by a real discount rate.

B. General Principles for Cash Flow Estimation

General principles for cash flow estimation are as follows:

First, the cash flows of all projects related to the concerned investment project should be simultaneously considered. For instance, the costs and income of

supplementary projects and environment-related costs are cash flows incurred due to the investment project and should, therefore, be included in the cash flow estimation of financial feasibility analysis.

Second, sunk costs are not considered. Such costs have already occurred without regard to implementation of the investment project, so they are not included in its financial feasibility analysis.

Third, opportunity costs resulting from the use of existing facilities, land, and buildings should be considered. Cash flows that can occur when existing facilities, land, buildings, etc. are used not for the investment project but for alternative purposes are lost as these assets are used for the investment project. They should be used as the opportunity cost of the investment project targeted for analysis.

Fourth, additional opportunities that occur in relation to the investment project should be considered. If there are expansion options that can further increase the scale of the project after its implementation, additional cash flows that can occur accordingly should be considered.

Fifth, expense distribution should be considered.

C. Guidelines for Income and Cost Estimation[28]

a. Income (Incoming Cash Flow)

1) Operating Revenue

Operating revenue uses the estimate of the operator's income included among benefits in economic feasibility analysis. However, in the case of an expressway project explained below, the operator's income can differ between economic feasibility analysis and financial feasibility analysis. This should be considered for calculation.

In the case of a road project, economic feasibility analysis as part of current preliminary feasibility studies looks at the difference in the operator's income before and after project implementation with regard to not only the roads and railroads subject to evaluation but also all the toll roads and railroads within the affected area. If this figure is fully reflected in financial feasibility analysis, the operating revenue of the concerned route can be overestimated.[29] In financial feasibility analysis, only

[28] Refer to the appendix for cash flow calculation and how to fill out pro-forma financial statements.

[29] Nevertheless, if a government agency and the Korea Expressway Corporation are the responsible party of the project, the figure from economic feasibility analysis can be used as it is.

the operator's income of the route subject to the study should be used from among the operators' income estimated in economic feasibility analysis. In this case, the operator's income can be calculated by using the traffic volume of the route (q) computed in economic feasibility analysis and the toll rate of the expressway (p) used in the generalized cost formula.[30]

The toll level (p) used at the step of preliminary feasibility study is a value based on the toll rate of the Korea Expressway Corporation in consideration of social benefits. As the toll level of privately financed expressways currently under operation is higher than that of the Korea Expressway Corporation, use of the Korea Expressway Corporation rate for financial feasibility analysis can distort the profitability of the project. When the assumption is that the project is to be conducted by a private party, a realistic toll level should be applied. If the traffic volume resulting from a preliminary feasibility study is used to calculate operating revenue, the demand can be overestimated. For this reason, the private party needs to analyze the traffic demand again to set the toll at a more rational level.

As a toll is determined through negotiations when it becomes certain that a project is to be implemented as a PPP project, usage fees including tolls should be reset at rational levels and traffic volume reestimated to conduct financial feasibility analysis again when the possibility of private financing of a project is strong.

2) Other Revenues

Other revenues can include cash flows from supplementary projects and ancillary projects, but it is difficult to estimate them at the step of preliminary feasibility study. In general, supplementary projects and projects to construct affiliated facilities are judged to be small enough to be disregarded. It is best to consider only indispensible ones from among them at the step of preliminary feasibility study and to consider income and costs from them when determining tolls and the length of the free-use period at the step of full-fledged evaluation or negotiations.[31] Nevertheless, if there is supplementary income that is definitely expected, it can be calculated by a rational method and included among other revenues.

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[30] As of 2007, the basic rate of a closed toll collection system of the Korea Expressway Corporation was 862 won; and the toll rate of a two-lane expressway was 40.50 won/km for type 1 vehicles, 41.30 won/km for type 2, 42.90 won/km for type 3, 57.50 won/km for type 4, and 68.00 won/km for type 5. The standards used in economic feasibility analysis should be consistent with these.

[31] 90.3% of the total revenue of the Korea Expressway Corporation is toll income; 6.0% is from supplementary projects like government projects and research outsourcing; and 3.7% is from ancillary projects like lease income. In case of a large-scale road project, the percentages of different items can be used in these feasibility studies or evaluation to select a responsible party.

b. Cost (Outgoing Cash Flow)

1) Total Project Costs

Total project costs are spending to build, extend, or improve SOC facilities. The items of total project costs include survey and research costs, design costs, construction supervision costs, construction costs, lot purchase costs, incidental costs, operating facility costs, various taxes and charges, and the operating reserve, etc.[32]

VAT is added to total project costs[33] unlike economic feasibility analysis, and when lots are purchased by the government in a lump sum or provided by the government or a local government organization, individual responsible parties do not have to consider lot purchase costs and salvage value.

- Survey and Research Costs: Survey and other costs in preparation for project implementation (based on the standard fees for compensation for engineering projects under Article 10 of the Engineering Technology Promotion Act)
- Design Costs: Costs of design for construction (based on the standard fees for compensation for engineering projects under Article 10 of the Engineering Technology Promotion Act or the standard fees for compensation under Article 19-3 of the Certified Architects Act)
- Construction Costs: Sum of costs of raw materials, labor, overhead, general administration, and contractors' profits [based on the criteria for determination of projected prices under Article 9 of the Enforcement Decree of the Act on Contracts to Which the State Is a Party, standard pricing criteria of the government, and unit prices (referring to official prices announced by the government when there are such)]
- Lot Purchase Costs: Costs associated with lot purchases (based on Articles 70 to 79 of the Act on the Acquisition of Land, Etc. for Public Works and the Compensation Therefore). In principle, the appraised value of the corresponding land is to be used for acquisition costs of

[32] Article 22(1) of the Enforcement Decree of the Act on Public-Private Partnerships in Infrastructure and Article 9 of the Basic Plan for PPP Projects (calculation of total project costs) are referred to.

[33] As there are cases where a zero tax rate is applied, like construction outsourcing of urban-railroad projects, analysis tables of profitability and financial statements should be written in consideration of VAT application for different areas.

land. If there is none, the 'Detailed Guidelines for VfM Test' shall apply mutatis mutandis.

- Incidental Costs: Project feasibility analysis costs, environmental impact evaluation costs, construction supervision costs, Construction/ Project Management (CM/PM) costs, review costs of construction unit prices, Value Engineering (VE) costs to review the economic feasibility of design, and financial incidental costs for financing
- Operating Facility Costs: Prices of equipment, facilities, and machinery and tools initially inputted for facility operation
- Taxes and Charges: All the taxes related to commencement and completion of construction, registration, and ownership transfer like acquisition taxes, registration taxes, and VAT; utility bills; and other charges imposed by other laws
- Operating Reserve: Initial necessary costs to establish a corporation for a PPP project required to prepare for facility operation

Meanwhile, there is interest during construction and contingencies (price fluctuations) as items that are part of a responsible party's total investment costs but not part of total project costs. Interest during construction is an actual outgoing cash flow but not included in the assumption of cash flows because, in the process of calculating a present value by discounting the cash flow by an appropriate discount rate under the discounted cash flow method, financial risks resulting from use of a debit are already reflected. Contingencies are divided into contingencies for price fluctuation and contingencies for design change (quantity change). As financial feasibility analysis under these Guidelines evaluates feasibility with constant prices, there is no need to consider the former. The latter is included as part of total project costs to ensure consistency with economic feasibility analysis.

2) Operating Costs

Operating costs are the sum of costs of facility operation during the operating period after facility completion. The items included are costs of sales, maintenance costs, selling and general administrative costs, corporate taxes (actual corporate taxes + interest costs × corporate tax rate), VAT, etc.

As in the assumption of total project costs, interest costs occurring in the operating

period are not included in the assumption of cash flows.

Depreciation cost (including amortization cost of goodwill, etc.) is also not accounted for as an operating cost item as it is preserved as recovery of total project costs during the service life of the facility.[34]

3) Additional Costs Related to Supplementary Projects

Additional costs related to supplementary projects are costs incurred from leasing of advertising boards and rest areas in the case of road projects; costs of construction and maintenance of station buildings in the case of railroad projects; costs of operation of cultural facilities that charge visitors in the case of port projects, etc.

The scale and form of supplementary projects can vary greatly depending on the nature of investment projects. Their share is expected to be negligible, so concretely determining the scale of supplementary projects and forecasting project costs and profits at the step of preliminary feasibility study is deemed unnecessary, except for special cases like projects where supplementary projects are certain to be executed.

Considerations for supplementary projects can be made in a feasibility study under these Guidelines or negotiations after the selection of a responsible party. It is desirable that their estimated profit does not exceed 5% of the project's total profit.

c. Order of Project Costs Being Spent and Debt Repayment Schedule

When covering the costs of a project, all equity capital is spent first before using any debt capital. If there is a government subsidy, the order is assumed to be equity capital, government subsidy, and then debt capital.

The debt repayment schedule can be a determinant of the corporate tax on interest income and cost. This has only insignificant impact on overall financial feasibility analysis and thereby is not given consideration. For ease of calculation, it is assumed that debt is repaid with new cash inflows at the end of the term.

[34] Depreciation cost is accounted for as a deduction item when calculating pre-tax profits, but as it does not accompany cash disbursements, it is not included in the assumption of cash flows. A reduction in corporate taxes due to depreciation cost should nevertheless be considered.

5. Financial Discount Rate Calculation[35]

To calculate the present value of cash flows expected from the concerned project, estimated cash flows should be discounted by an appropriate financial discount rate. The appropriate rate here is the weighted average cost of capital, which is the capital cost of each source of financing (equity capital and debt capital) average-weighted by its component ratio.

$$r_0 = [(1-T)\times r_b \times L] + [r_s \times (1-L)]$$

r_0 : Weighted average cost of capital
r_b : Cost of debt capital (capital cost of debt)
r_s : Cost of equity capital (capital cost of equity)
T : Corporate tax rate
L : Debt ratio (=debt/equity capital)

A. Assumption of the Capital Cost of Debt

a. Assumption of the Risk-Free Rate

The risk-free rate is to be assumed based on the Yield To Maturity (YTM) of five-year government bonds. Though it is desirable to use the YTM of a bond with a longer maturity as cash flows in investment projects occur over a period much longer than five years, the five-year government bond will most comprehensively reflect the market situation since it is so liquid. The average YTM of the five-year government bond for the last seven years is used as the risk-free rate taking into account the fact that the YTM of the present point can introduce bias due to a short-term imbalance between supply and demand. Analysis under these Guidelines uses a risk-free rate of 5.7%, the average YTM of the five-year government bond for the last seven years, from 2000 through 2006.

In the case of SOC investment, a liquidity premium needs to be added as compensation for capital being tied up for long. Taking account of the average interest rate spread of U.S. government bonds (three to 30 year maturity) (some 1.1%) from the past 20 years, 6.8% is to be used as a long-term risk-free rate.

[35] Refer to Section 3 of Chapter VII for detailed discussions on discount rate calculation.

b. Assumption of a Default Risk Premium

The capital cost of debt is calculated by adding a default risk premium (spread) to a long-term risk-free rate. The possibility of a PPP project falling into default is low, and the systemic risk of debt seems low. Nevertheless, since a relatively high amount of debt is used, a long-term risk-free rate is added with a spread for default risk (a difference between the rate of return on three-year government bonds and that on three-year corporate bonds from the past three years).

The "General Guidelines (fourth edition)" calculated the rate of return on corporate bonds by deducting the rate of return on government bonds from the average of AA-grade and BBB-grade bonds. These "General Guidelines (fifth edition)" used that of AA minus (-)-grade corporate bonds in the assumption that a PPP project has a low default risk, unlike private-sector companies.

When calculating the capital cost of debt by applying the spread of debt to a long-term risk-free rate, the recent narrowing of the interest rate spread between government and corporate bonds is reflected and the spread of debt is changed to 2% under the "General Guidelines (fourth edition)" to 1% under these "General Guidelines (fifth edition)." As a result, 7.8% is used for the capital cost of debt.

▎Table 3-23 ▎Interest Rates of Government and Corporate Bonds

Year	Government Bond (3 year)	Corporate Bond (off-board, three year, AA-)	Spread Between Government Bond (3 year)-Corporate Bond (3 year)
1995	13.39	13.79	0.40
1996	11.84	11.87	0.03
1997	12.26	13.39	1.13
1998	12.94	15.10	2.16
1999	7.69	8.86	1.17
2000	8.30	9.35	1.05
2001	5.68	7.05	1.37
2002	5.78	6.56	0.78
2003	4.55	5.43	0.88
2004	4.11	4.73	0.62
2005	4.27	4.68	0.41
2006	4.83	5.17	0.34
Overall average	7.97	8.83	0.86
1999 to 2006	5.36	6.14	0.83

B. Assumption of the Capital Cost of Equity

The capital cost of equity is the sum of the risk-free rate and a risk premium. A discount rate and a risk premium to determine it are calculated using the CAPM (capital asset pricing model):

$$r_j = r_f + \beta_j \times (r_m - r_f)$$

where r_i refers to the cost of equity capital for an investment project j; r_m to the market-expected rate of return; r_f to the risk-free rate; and β_j to the systemic risk of the investment project j.

a. Assumption of a Market Risk Premium

The market's risk premium, $(r_m - r_f)$ has a relatively stable time series, so a rate of about 6% is to be used, which is $(r_m - r_f)$ of the last roughly 30 years in 11 advanced countries.[36]

b. Assumption of Systemic Risk

As the systemic risk of equities reflects both the operating risk and financial risk, the operating risk is to be first calculated, and it is adjusted according to the financial risk. The operating risk is usually calculated as β_u of the asset, and these Guidelines use 0.515, which is the median value of the asset beta among the top 440 domestic companies.

When a project solicited by the government is pursued with private capital and the actual operating revenue (e.g. toll income of an expressway) fails to meet a certain level of the assumed operating revenue, the government covers the loss or provides assistance to meet the level. The actual loss borne by the private party is, therefore, considerably limited and the operating risk indicated as the beta is expected to be lower than 0.515.[37]

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[36] In the U.S., the $(r_m - r_f)$ of the last 100 years is about 8%.

[37] Under the 2004 "Basic Plan for PPP Projects" (Ministry of Planning and Budget), the maximum limit for the guaranteed operating revenue in PPP projects solicited by the government is up to 90% of the assumed operating revenue for five years after commencement of operation; 80% for six to ten years; and 70% for 11 to 15 years.

The equity beta (β_s) is affected by the debt ratio of each company, and the beta needs to be adjusted as follows according to the target debt ratio of a PPP project:

$$\beta_s = \beta_u \times [1 + (1 + T) \times (\text{target debt ratio})]$$

T refers to the corporate tax rate.

The upper limit of a debt ratio for large companies, especially subsidiaries of business groups, is set at 200%. If the debt ratio goes beyond 200%, default risk can become apparent, so SOC investment projects set 200% as the target debt ratio. If the government provides financial support and the operating risk is relatively low, a debt ratio of 300% can be allowed.

C. Assumption of the Weighted Average Cost of Capital

For estimation of the average cost of capital, a beta adjusted by the target debt ratio is used to calculate the capital cost of equity. It is average weighted by the already calculated capital cost of debt to estimate a weighted average cost of capital (WACC). The WACC (r_0) to be used as a discount rate is computed as follows:

$$r_0 = [(1 - T) \times r_b \times L] + [r_s \times (1 - L)]$$

Nevertheless, $L = B/(B + S)$ =66.7% (debt ratio of 200%)

The assumption is T =27.5%[38]

The process to calculate a nominal discount rate using the values of market parameters suggested above is as follows in Table 3-24.

[38] This 27.5% is a sum of the corporate tax rate of 25% to be applied from 2005 and residence tax (10% of the principal tax) (2.5%).

▌Table 3-24▌ Calculation Process of a Nominal Financial Discount Rate

Discount Rate	Calculation Process
Capital Cost of Debt	Long-term risk-free rate (r_f) = 6.8% (long-term liquidity premium of 1.1% reflected) Capital cost of debt (r_b) = (r_f) + debt spread (1.0%) = 7.8%
Capital Cost of Equity	Long-term risk-free rate (r_f) = 6.8% Market's risk premium $(r_m - r_f)$ = 6% Asset beta (β_u) = 0.515 Target debt ratio = 200% (share of debt=66.7%) Equity beta (β_s) = $\beta_s = \beta_u \times [1 + (1 + T) \times$ (target debt ratio) $]$ = 0.515 × (1 + (1-0.275) × 2.0) = 1.262 Capital cost of equity capital (r_s) = $r_f + \beta_s \times \lfloor r_m - r_f \rfloor$ = 6.8% + 1.262 × (6%) = 14.4%
WACC	WACC (r_0) = $[(1-T) \times r_b \times L] + [r_s \times (1-L)]$ = (1-0.275)×(7.7)×(0.667) + (14.4)×(1-0.667) = 8.56%

D. Calculation of a Real Discount Rate

For estimation of future cash flows, the (actual) cash flow of constant prices is discounted by a real discount rate as the cash flow of constant prices does not readily lend itself to arbitrary intervention in estimation compared to the cash flow of nominal prices. The relationship between the nominal discount rate (r) and the real discount rate (r^*) is as follows:

$$r^* = (1 + r) \div (1 + \text{expected inflation rate}) - 1$$
$$= (1.0856 \div 1.03) - 1 = 5.4\%$$

The real discount rate becomes 5.4% by deducting the expected inflation rate of 3% from the nominal WACC of 8.56%. The figure is derived from various assumptions. In future financial feasibility analysis of preliminary feasibility studies, an approximate value to the derived value - 5.5% - is to be used as a real financial discount rate.

Depending on the nature of PPP projects and changes in the economic situation, the beta value, target debt ratio, economic growth rate, and expected inflation rate

can differ. Table 3-25 shows the calculation results of a real discount rate according to changes in the economic growth rate, debt ratio, and beta. The study team can set an appropriate discount rate for individual projects in consideration of their risks and government assistance.

▎Table 3-25▎Calculation of a Real Financial Discount Rate

Risk-free rate	5.2%			5.7%			6.2%		
Target debt ratio	100%	200%	300%	100%	200%	300%	100%	200%	300%
β_1 = 1.157	8.88	8.53	8.35	9.30	8.92	8.73	9.72	9.32	9.12
β_2 = 0.671	6.44	6.21	6.10	6.86	6.61	6.49	7.28	7.01	6.87
β_{med} = 0.515	5.65	5.47	5.38	6.07	5.87	5.76	6.49	6.26	6.15
β_3 = 0.406	5.11	4.95	4.88	5.53	5.35	5.26	5.94	5.75	5.65
β_4 = 0.153	3.84	3.75	3.71	4.25	4.15	4.09	4.67	4.54	4.48

Note: Assumptions are as follows: inflation rate=3.0%; short-term risk-free rate=YTM of three-year government bonds; long-term liquidity premium=1.1%; long-term risk-free rate=short-term risk-free rate + long-term liquidity premium; default risk premium=2.0%; capital cost of debt=long-term risk-free rate + default risk premium.

6. Calculation of a Minimum Rate of Government Financial Support

Some public investment projects that are economically but not financially feasible are implemented as PPP projects with some level of government financial support. Financial feasibility analysis should assume cases where financial support is provided for some of the construction costs and cases where financial support is provided so that the FNPV becomes zero, except for cases when projects are 100% privately financed.

The basic framework to determine the amount of government financial support for public investment projects that are not financially feasible only with cash flows occurring from the projects themselves is to calculate (z, a) that meets the following condition:

$$FNPV = \sum \frac{CF_t + z_t}{(1+r)^t} - \sum \frac{Inv_t - sub_t}{(1+r)^t} \quad \text{and} \quad a = \frac{\sum Sub_t}{\sum Inv_t}$$

Each variable refers to the following:

CF_t : Cash flows from the investment project,
z_t : Government subsidy for operation, compensation for loss, income from supplementary projects, etc.,
r : Opportunity cost of capital (namely, cost of capital)
Inv_t : Investment cost occurring every year,
Sub_t : Government financial support from among the investment cost occurring in year t, and
a : Share of government financial support in the total investment costs.

A practical calculation method using the above formula can be summarized as follows:

① Indicate the government financial support rate as a and multiply this by the total investment costs to calculate a total support amount. Financial support is to be granted only after input of equity capital but before borrowing.
② Calculate the net present value of cash flows from investment projects, government financial support, and construction costs occurring each period.
③ By trial and error, change the government financial support rate, a, to a figure that makes the FNPV zero.

Financial feasibility analysis at the step of preliminary feasibility study is to calculate the FNPV by disregarding other revenues except for income from supplementary projects (z_t) in the above formula and assuming the share of government financial support among basic investment costs to be a certain level. This is for preliminary evaluation of financial feasibility.

CHAPTER 4

Policy Analysis

Ⅰ. Policy Analysis System

The analysis of preliminary feasibility studies entails economic feasibility analysis and policy analysis. Policy analysis includes elements that are not included in economic feasibility analysis but should be considered to evaluate the feasibility of projects. Economic feasibility analysis quantifies effects projects have on the national economy using the framework of cost-benefit analysis. Policy analysis is for elements that are among social benefits or costs resulting from projects, cannot be quantified by the framework of cost-benefit analysis, but should still be evaluated to determine whether to go ahead with the projects. For instance, to determine whether to carry out a project based on balanced regional development - for which there is a strong national consensus - the level of regional development, ripple effects on the regional economy, and such are analyzed.

Evaluation in policy analysis is divided into basic evaluation items and project-specific evaluation items depending on whether they can apply to any project subject to a preliminary feasibility study. Basic evaluation items are those that should be commonly included in the evaluation of any project subject to a preliminary feasibility study without regard to its characteristics. Predefining basic evaluation items is especially important in that there are generally common matters to consider when inputting the already limited central government funds into projects subject to preliminary feasibility studies without regard to their characteristics, and there should be some modicum of uniformity among evaluation items to ensure consistency in the evaluation of different projects.

At the step of preliminary feasibility study, considered as the ‘basic evaluation items’ of policy analysis, are the level of regional development and ripple effects on the regional economy for balanced regional development, consistency with relevant plans and policy directions, willingness to pursue and preference for projects,

possibility of financing, environmental impact analysis, etc. Project-specific evaluation items are special items to consider in the evaluation of the concerned project. They can differ depending on the project type like national defense, culture, and urban development.

The previous guidelines categorized the evaluation items of policy analysis into basic evaluation items and project-specific evaluation items. This categorization was intended to ensure consistency in evaluation among different projects, and it is for easy collection of consistent data. However this kind of evaluation structure can be restrictive in AHP (Analytic Hierarchy Process) analysis-based comprehensive evaluation. The evaluation items that are actually interrelated are divided into basic evaluation items and project-specific evaluation items, so evaluators not familiar with AHP analysis may fixate on individual evaluation items. To address this issue, these Guidelines divided policy analysis evaluation items into four mid-level categories: balanced regional development, consistency with policy and willingness to pursue projects, risks in pursuing projects, and project-specific evaluation items.

▎Table 4-1 ▎Categorization of Policy Analysis Items

Mid-level categorization	Detailed evaluation items
Balanced regional development	■ Level of regional development ■ Ripple effects on the regional economy ■ Additional evaluation items (elective)
Consistency with policy and willingness to pursue projects	■ Consistency with relevant plans and policy directions ■ Willingness to pursue and preference for projects ■ Level of project preparedness ■ Additional evaluation items (elective)
Risks in pursuing projects	■ Possibility of financing ■ Environmental nature ■ Additional evaluation items (elective)
Project-specific evaluation items	■ Additional evaluation items (elective)

Under the mid-level category ‘balanced regional development’ are the level of regional development and ripple effects on the regional economy. Added are project-specific evaluation items related to balanced regional development. Under ‘consistency with policy and willingness to pursue projects’ are consistency with relevant plans and policy directions, willingness to pursue and preference for projects, level of project preparedness, and other relevant evaluation items. Under ‘risks in pursuing projects’ are the possibility of financing, environmental nature, and other relevant evaluation items. Lastly, the ‘project-specific evaluation items’ category includes evaluation items not included in the above three categories.

Ⅱ. Analysis by Evaluation Item

1. Balanced Regional Development

When evaluating the feasibility of projects based only on the results of economic feasibility analysis that are represented as the B/C ratio at the step of preliminary feasibility study, imbalance among regions might become worse. This is because the least developed regions have less feasibility for projects under the structure of economic feasibility analysis. For instance, when evaluating the feasibility of a project to build a road in a less developed region, its economic feasibility is often low as the population and traffic volume are relatively low, with the result that there is little benefit of road construction. Investment opportunities in such a region are, therefore, lower, and investments are concentrated on other regions where economic feasibility is high, which serves to exacerbate the disparity in development among them.

To prevent this, preliminary feasibility studies consider balanced regional development, a higher-level government policy, to evaluate project feasibility. A regional development index was developed to reflect balanced regional development in evaluation, and a Multi-Regional Input-Output Model (MRIO) was developed to analyze the ripple effects of projects in regions. The fundamental purpose of this analysis is to prevent regional imbalances from worsening by granting some kind of additional scores to government-financed projects in less developed regions and projects with significant ripple effects in such regions so that even projects with somewhat lower economic feasibility can be pursued.

A. Level of Regional Development

a. Calculation of the Regional Development Index under Current Preliminary Feasibility Studies

In preliminary feasibility studies, the regional development index is calculated as follows:

$$UI^r = \sum_i Z_i^r \cdot W_i$$

UI^r = Regional development index of region r

Z_i^r = Value of the standardized index i in region r (i = 1, 2, ..., 8)

W_i = Weight of index i (i = 1, 2, ..., 8)

The regional development index is a weighted average of indices comprising the level of development. The following eight indices used for the designation of development promotion districts suggested in the Ministry of Land, Transport and Maritime Affairs' "Work Guidelines for Regional Development Projects" (2003)[39] are used to comprise the regional development index.

▌Table 4-2▐ Indices Used in the Calculation of the Regional Development Index

Area	Index	Measurement method	Data source	
			Before change	After change
Population	Population increase rate	Annual average population increase rate for the last five years	Statistics Korea, major city, county, gu-district statistical indices	Statistics Korea web site
Industry	Ratio of people engaged in manufacturing	(No. of people engaged in manufacturing/population)×100	Basic statistical survey report of businesses in cities and provinces	Statistics Korea, basic statistical survey report of businesses
Local infrastructure	Road ratio	(Length of legal roads/area of administrative district)×100	Statistics Korea, major city, county, gu-district statistical indices	Annual urban & provincial statistical report
Transportation	No. of registered passenger cars	(No. of registered passenger cars/population)×100	Statistics Korea, major city, county, gu-district statistical indices	Annual urban & provincial statistical report
Health . social welfare	No. of doctors per population	(No. of doctors/population)×100	Statistics Korea, major city, county, gu-district statistical indices	Annual urban & provincial statistical report
	Aging index	(Population of 65 years of age or older/ population of zero to 14 years of age)×100	Statistics Korea, major city, county, gu-district statistical indices	Statistics Korea web site
Government administration, finance, etc.	Degree of financial self-reliance1)	(Local taxes + non-tax revenue/total tax revenue under general accounting)×100; last three year's average	Ministry of Public Administration and Security (MOPAS), annual report on local finance	MOPAS, annual report on local finance
	Urban land use ratio	Land category (building lot + factory lot + school lot) / area of administrative district×100	Korea Appraisal Board, annual report on cadastral statistics	Annual urban & provincial statistical report

Note: According to the custom of calculating the degree of financial self-reliance of Seoul, six metropolitan cities, and nine provinces, the fiscal data of gross totals of the provincial and metropolitan city governments is used for calculation of the level of regional development of cities and counties; and the fiscal data of net totals of the provincial and metropolitan city governments, and lower-level local governments is used to calculate the level of regional development of cities and provinces.

[39] Ministry of Land, Transport and Maritime Affairs, "Work Guidelines for Regional Development Projects", February 21, 2003.

The scales of the eight indices are different but need to be reconciled to control the effects. For this purpose, the eight indices are standardized using the following unit normal scaling. Nevertheless, as a higher aging index is interpreted as a strong indication of low regional development, it is given a negative value when calculating the regional development index.

$$Z_i = \frac{X_i - \overline{X}_i}{S_i}$$

S_i refers to the standard deviation, $\overline{X}_i$ to the sample mean

For calculation of the regional development index, weights for indices should be set up. For this purpose, a survey was conducted of people working at appropriate academic societies and research institutes, who have experience in preliminary feasibility studies, etc. to set up weights for indices as in Table 4-3.

▎Table 4-3▎Weights for Indices to Calculate the Regional Development Index

Index	Weight (%)	Index	Weight (%)
Population increase rate	8.9	No. of registered passenger cars	12.4
Aging index	4.4	Road ratio	11.7
Degree of financial self-reliance	29.1	No. of doctors per population	6.3
Ratio of people engaged in manufacturing	13.1	Urban land use ratio	14.2

Source: KDI, "Study to Amend and Supplement General Guidelines for Preliminary Feasibility Studies (fourth edition)," 2004.

In comprehensive evaluation of preliminary feasibility studies, the level of regional development is reflected as follows: preliminary feasibility studies use the Analytic Hierarchy Process (AHP) method, one of the multi-criteria decision making analysis methods.[40] There are three categories of weights under AHP analysis: economic feasibility analysis, policy analysis, and balanced regional development. As in Table 4-4, weights of 15 to 25% are given to balanced regional development without regard to the project type.

Under Paragraph (2) of Article 38 (comprehensive evaluation) in the "2009

[40] The AHP method is one of the decision-making techniques for systematic evaluation of opposing alternatives when there are multiple and complex goals for decision-making or multiple and complex evaluation standards. It stratifies complex issues into major or detailed elements and derives their level of importance through pair-wise comparison. It is widely used in multi-criteria decision-making that includes qualitative evaluation items. For AHP, refer to the "Study on Multi-Criteria Analysis for Preliminary Feasibility Studies (2)" by Park et al. (2001) (KDI).

Operating Guidelines for Preliminary Feasibility Studies" (Ministry of Strategy & Finance (MOSF), 2009), the weight of each evaluation item is to fall in the range of weights of the following Table 4-4 by project type when conducting AHP analysis unless there is a reason not to do so. In the case of construction projects that include balanced regional development analysis, the upper limit of weights for balanced regional development increased from 25% to 30%. These "General Guidelines (fifth edition)," therefore, use the changed weights.

▎Table 4-4▎Weights in each Evaluation Area in Preliminary Feasibility Studies

(Unit: %)

Classifi-cation	Project Type	Evaluation Area		
		Economic Feasibility Analysis	Policy Analysis	Balanced Regional Development
Before Change1)	-	40 ~ 50	25 ~ 35	15 ~ 25
After Change 2)	Construction	40 ~ 50	25 ~ 35	15 ~ 30
	R&D, informatization	30 ~ 50	50 ~ 70 (Analysis of technical nature and policy nature)	-
	Other non-investment finance projects	25 ~ 50	50 ~ 75 (Analysis of technical nature and policy nature)	-

Note: 1) KDI, "Study to Amend and Supplement General Guidelines for Preliminary Feasibility Studies (fourth edition)," 2004.
2) MOSF, "2006 Operating Guidelines for Preliminary Feasibility Studies," April 2006.
3) MOSF, "2009 Operating Guidelines for Preliminary Feasibility Studies," April 2009.

b. Current Indices for Determining Less Developed Regions and Their Change

1) Standards for selection of less developed regions under the Special Act on Balanced National Development

Subparagraph 5 of Article 2 of the 'Special Act on Balanced National Development' defines less developed regions as follows:

① Remote areas under Article 2 of the 'Remote Area Development Promotion Act';
② Islands to develop under Paragraph 1 of Article 4 of the 'Island Development Promotion Act';
③ Border areas under Subparagraph 1 of Article 2 of the 'Border Area Support Act'
④ Development promotion districts under Article 9. (1) of the 'Balanced Regional

Development and Support for Local Small and Medium Enterprises Act′; and

⑤ Other areas where the standard of living and the level of development are very low and designated by presidential decree

Applicable laws suggest concrete standards for different kinds of less developed regions. Article 2 of the 'Remote Area Development Promotion Act'[41] classifies remote areas as those which are located far from cities; have underdeveloped transportation systems, low income levels, low standard of living; and meet conditions designated by presidential decree. Article 2 of the Enforcement Decree of this Act stipulates the designation standard of remote areas as myeon-level (village- or township-level) administrative districts that fall below the average of myeon districts across the nation in terms of the level of development (indices that indicate the population increase/decrease rate, population density, and income or development level. Result of comprehensive analysis as designated by the Minister of Public Administration and Security) as a result of a basic survey of myeon districts across the nation. Nevertheless, myeon districts that fall under the Island Development Promotion Act and those not inhabited or without a myeon district office are excluded from the scope of remote areas.

▎Table 4-5 ▎Designation Standards for Less Developed Regions

Type	Designation Standards	Remarks
Remote area	■ Administrative districts that fall below the average of myeon districts across the nation in terms of the level of development (indices that indicate the population increase/decrease rate, population density, and income or development level. Results of comprehensive analysis as designated by the Minister of Public Administration and Security) as a result of a basic survey of myeon districts across the nation (Article 2.(1) of the Enforcement Decree) - Three indices: Population increase/decrease rate, population density, and residence tax (income base) - Weights for the three indices: 1 : 1 : 1 - Composite index: Z (population increase/decrease rate) + Z (population density) + Z (income-base residence tax)	■ Islands to develop and uninhabited areas excluded ■ 399 myeon districts as of late 2003

▎Table 4-5 ▎Continued

[41] The 'Remote Area Development Promotion Act' was abolished (March 28, 2008, Act no. 9008), but its Enforcement Decree remained in effect until December 31, 2009.

Type	Designation Standards	Remarks
Island	■ Island districts constantly inhabited by no fewer than ten people which request to be developed	■ Uninhabited islands excluded ■ 410 islands
Border area	■ Eup, myeon, and dong districts belonging to cities and counties within 20km south of the Civilian Control Line (CCL) where no fewer than three out of the population increase/decrease rate, road pavement rate, water service penetration rate, ratio of people engaged in manufacturing, and occupation rate of areas subject to the Protection of Military Bases and Installations Act are lower than the national average in the last five years ■ Areas north of the CCL subject to improvement of agricultural base, and exchange and cooperation projects between South and North Korea ■ Five islands near the Northern Limit Line, namely Baengnyeongdo, Daecheongdo, Socheongdo, large Yeonpyeongdo, and small Yeonpyeongdo, and their surrounding islands	■ 15 cities and provinces 98 eup, myeon, and dong districts

Note: The standards for remote areas are rewritten according to the legislative revision on May 13, 2005.
Source: 1) MOPAS, "Development of Selection Indices of Less Developed Regions", July 2004.
2) MOPAS, "Basic Statistical Survey Guidelines for Designation of Remote Areas for Development", 2005.

Article 2 of the 'Island Development Promotion Act' defines the scope of islands as all the islands on the sea excluding the main island of Jeju. Islands that can be designated as less developed regions are those constantly inhabited by no fewer than ten people (Article 4 of the Enforcement Decree of the Act).

Article 2 of the 'Border Area Support Act' stipulates border areas as belonging to the jurisdictions of cities and provinces south of the CCL under Paragraph 3 of Article 2 of the 'Protection of Military Bases and Installations Act' and designated by presidential decree based on the distance from the CCL, geographical conditions, degree of development, etc. Paragraph 3 of Article 2 of the 'Protection of Military Bases and Installations Act' prescribes the designation standards of border areas as eup, myeon, and dong (small district units) belonging to cities and counties within 20km south of the CCL where no fewer than three out of the population increase/decrease rate, road pavement rate, water service penetration rate, ratio of people engaged in manufacturing, and occupation rate of areas subject to the Protection of Military Bases and Installations Act are lower than the national average in the last five years (Article 2 of the Enforcement Decree of the Act). Also, border areas are the areas located between the CCL and 2km south of the Military Demarcation Line (MDL), and Baengnyeongdo, Daecheongdo, Socheongdo, large Yeonpyeongdo, and small Yeonpyeongdo, and their surrounding islands south of the

Northen Limit Line on the sea.

Development promotion districts are defined in Article 10 of the 'Balanced Regional Development and Support for Local Small and Medium Enterprises Act'. The Act prescribes that development promotion districts be designated in consideration of Gross Regional Domestic Product (GRDP) or the degree of financial self-reliance that is notably lower than other areas, constantly decreasing or stagnant population, need to create a new income base, and need to improve the production and living environments. Article 12 of the same Act specifies designation conditions for a less developed region type for development of general less developed regions; town and village integrated type for structural improvement of farming and fishing villages; and balanced development type for privately-financed development of metropolitan and specific regions.

The less developed region type is districts which are in the nation's bottom 30/100 in terms of the population increase rate or degree of financial self-reliance, or both, and in the nation's bottom 30/100 in terms of one or more of the ratio of people engaged in manufacturing to the population, road ratio, ratio of registered passenger cars in possession, number of doctors per population, aging index, or urban land use ratio. The town and village integrated type is farming and fishing villages where local industries have rapidly declined and which need to be developed in connection with nearby cities to develop new income bases. Lastly, the balanced development type is districts belonging to metropolitan development zones or specific regions where private capital needs to be attracted for intensive development to ensure balanced regional development.

The less developed region type is a similar concept to the level of regional development in preliminary feasibility studies. Comparison between the changed indices for designation of the less developed region type in Table 4-6 and those of the level of regional development in preliminary feasibility studies reveals that items ③, ④, ⑥, and ⑧ are different.

▎Table 4-6 ▎Selection Standards for Development Promotion districts (Less Developed Region

Type)

Index	Detailed Standards
① Population density	Ratio of the population of 2004 divided by the area of administrative districts under Statistics Korea's "National Demographics"(2004) & MLTM's "Administrative Districts and Population in Local Governments" (2004)
② Annual average population increase/ decrease rate	Annual average population increase/decrease rate for 34 years ((population of a past year for comparison - population of the base year) ÷ period from the past year to the base year × population of the base year)) based on Statistics Korea's "Population & Housing Census" (1970 ~ 2004) and "National Demographics"(2004)
③ Total of income-base residence tax	Total of tax amounts imposed each year under MOPAS's "Annual Regional Tax Administration Report" (2001~03) (tax amounts in each city or county in the corresponding year=lease income+interest income+personal income like transfer+income subject to withholding tax+dividend income+pension income+temporary property income+other incomes <agricultural income tax and residence tax (corporate tax base) are excluded>)
④ Financial power index	Ratio of base revenue divided by base demand for finance from the last three years from 2003 to 2005 according to MOPAS' "Comprehensive Report on Analysis of Local Governments' Finances (2003~2005)" and the ministry's web site on local governments' finances (lofin.mogaha.go.kr) (2005)
⑤ Aging index	Ratio of the number of 65-year-old or older people divided by that of 14-year-old or younger people of the corresponding city or county under Statistics Korea's "National Demographics" (2004)
⑥ Ratio of the employed	Ratio of the total number of people engaged in businesses by the size of population of the corresponding city, county, or gu district under Statistics Korea's "Statistics on the Number of People Engaged in Each Industry" (2003) and major statistics on cities, counties, and gu districts (2003)
⑦ Road ratio	Ratio of the length of the roads of the corresponding city, county, or gu district by its population and administrative district area ((length of roads of base year ÷ $\sqrt{\text{populaton of base year } x \text{ administrative district area of base year} \times 100}$ under Statistics Korea's "Major Statistics on Cities, Counties, and Gu Districts" (2003) and MLTM's "Administrative Districts and Population in Local Governments" (2004)
⑧ Accessibility	Ratio resulting from multiplying the population of a large city by that of the corresponding city, county or gu district, and dividing this by the distance between them and the time spent to access them under Statistics Korea's "National Demographics" (2004), MLTM's "Administrative Districts and Population in Local Governments" (2004), and the portal site on national land (www.land.go.kr)(2005)

Source: Ministry of Land, Transport and Maritime Affairs, "Work Guidelines for Regional Development Projects", March 2006

2) Standards for Selection of less Developed Regions as Regions for Revitalization

Separate from the less developed regions discussed above, item (e) of subparagraph 5 of Article 2 of the 'Special Act on Balanced National Development' allows 'areas where the standard of living and the development level are very low' to be designed by presidential decree as less developed regions. Article 2 of the Enforcement Decree of this Act requires that the Minister of Public Administration and Security comprehensively evaluate such indices as the annual average population decrease rate, financial situation, and income level, and designate and announce areas where the standard of living and development level are very low every three years.

The Minister of Public Administration and Security named the areas under item (e) of subparagraph 5 of Article 2 of the 'Special Act on Balanced National Development' as 'regions for revitalization' and selected such in 2004 for the first time. Areas designated as regions for revitalization are those that are less developed. They have been largely passed over in the process of modernization, industrialization, and urbanization, and they are to receive support to hasten their development and ensure balanced regional development across the nation while retaining their regionality.

Regions designated for revitalization are those that have suffered industrial decline, declines in population, etc., lack an economic base, are in poor financial condition, and are thereby less competitive than developed regions. To ensure transparency, fairness, and credibility in designation, MOPAS outsources the development of indices to universities, research institutes, and other specialists. The appropriate ministers, city mayors, and provincial governors are consulted in the designation process, and deliberation by the Presidential Committee on Regional Development (PCRD) is held before selection.

Indices for selection of regions for revitalization were developed over two steps. The first-step selection was based on four indices in three areas as in Table 4-7.

▌Table 4-7▐ Indices for Designation of Regions for Revitalization (Step 1)

Area	Index	Data
Population	① Population increase/decrease rate ※ Linear population increase/decrease rate from 1970 to 2000 ② Population density ※ Population with resident registration as of late 2003	■ Population & housing census (Statistics Korea) ■ Analysis data of the population increase/decrease rate for 30 years ■ Demographics of registered residents as of late 2003 (MOPAS)
Industry. economy	③ Income-base residence tax ※ Average of 2000 to 2002	■ Annual regional tax administration report (MOPAS, 2001~2003)
Finance	④ Financial power index(base revenue/base demand for finance) ※ Average between 2000 and 2002	■ Comprehensive finance analysis report (MOPAS, 2002~2004)

Source: MOPAS, "Guidelines for Projects on Regions for Revitalization", October 2004.

A composite index for selection of regions for revitalization is calculated as follows: The weights of the three areas are set at 1:1:1, and those of the two indices in the population area to be 0.5:0.5. To reconcile the different scales of the indices, the individual indices were converted to a standardized Z (Z-Score) value.

Composite Index

$$= \frac{1}{2}\left[Z\left(\text{population increase/decrease rate}\right) + Z\left(\text{populaton density}\right)\right]$$

$$+ Z(\text{income - base residence tax}) + Z(\text{financial powerindex})$$

A composite index for 234 local governments was calculated, and the bottom 30% or the bottom 70 regions were designated as regions for revitalization. The amount of support for them was determined in consideration of special accounting for regional development, cases of support for less developed regions overseas, etc.

For the second step of designation, the PCRD announced in 2007 a draft proposal on regional classification according to the level of regional development (selection base: 14 indices in five areas). The proposal classified 234 local governments according to the development level in comprehensive consideration of 14 indices in the five areas of population, economy, finance, welfare and infrastructure. 234 cities, counties, and *gu* districts were divided into four groups, less developed regions (1), stagnant regions (2), growth regions (3), and developed

regions (4). Nevertheless, the special city, metropolitan cities (counties excluded), and Jeju Special Self-governing Province are each classified as one region by using the average value of their cities, counties, and *gu* districts. Also, in consideration of different levels of regional development, the grade for the Seoul metropolitan area is automatically raised one level. More specifically, a region which would be given grade 1 in the provinces is given 2 in the Seoul metropolitan area, and so on.

▌Table 4-8▌Indices and Weights

Classification	Weight		Index	Description
Population	1	0.33	■ Population increase/decrease rate	■ Population increase/decrease rate (10 years)
		0.33	■ Population density	■ No. of people per unit area
		0.33	■ Ratio of the aged to the population	■ No. of people 65-years old or older to the population
Industry, economy	1	0.25	■ Income-base residence tax per person	■ Income-base residence tax/population
		0.25	■ Average land value of individual appraised land values	■ Average of individual appraised land values of sample lots
		0.25	■ No. of employed people per 1,000 people	■ Total no. of employed people/population
		0.25	■ Increase/decrease rate of the total no. of employed people	■ Increase rate of businesses from 2001 to 2005
Finance	1	0.33	■ Financial power index	■ Revenue to base demand for finance
		0.33	■ Collected amount of local taxes per person	■ Total amount of local taxes collected/ population
		0.33	■ Increase/decrease rate of the collected amount of local taxes	■ Increase rate of the collected amount of local taxes for four years
Welfare	0.5	0.25	■ No. of hospital beds per 1,000 people	■ Total no. of hospital beds/population
		0.25	■ No. of public library seats per 1,000 people	■ Total no. of public library seats/population
Infra-structure	0.5	0.25	■ Road ratio	■ Road area to the total area
		0.25	■ Water and sewage penetration rate	■ Average no. of people with water service to the total population, no. of people with sewerage to the total population

Source: MOPAS' press release, presentation on a 'Draft Proposal on Regional Classification' according to the level of regional development, September 2007.

b. Need to Change Indices to Calculate the Regional Development Index[42]

1) Change of Indices and Weights

As seen above, Korea has adopted balanced regional development as an important policy goal and implements various regional development policies. These policies to develop less developed regions adopt standards to determine less developed regions according to their purposes. These standards to determine the degree of regional development depend on policy makers' transcendental experience or experts' opinions but empirical review as to whether they are appropriate is lacking. Knowing the level of development of each region is the most basic in establishing a regional policy. To increase the effectiveness of regional development policy, objective standards for determination of the current level of development should be in place first.

Nevertheless, it is difficult to prove the propriety of the selected indices and weights in applying the standards to define less developed regions by the regional development policies now in effect. The root cause of the difficulty in empirical review is that there is no consistent evaluation of the current level of development.

To solve this, the "Direction and Strategy of Regional Development Policy" (KDI, 2008) conducted a survey of those responsible for the regional development budget in cities and provinces on the ranking of their belonging cities, counties, and gu districts in terms of regional development. It came up with statistically significant indices that can best explain the ranking. There are various combinations of socio-economic indices to explain regional development ranking, and this study used MOPAS' indices to select regions for revitalization (2007), the MLTM's selection indices of less developed region-type development promotion districts, and three index groups currently under development by the Korea Rural Economic Institute to lay the foundation for agricultural statistics.

It was confirmed that a combination of statistically significant indices can be found through various regression analysis models that can explain the ranking of regional development resulting from the survey. However, review of the practical suitability of the chosen models revealed that the ranking of local governments in regional development can greatly differ depending on the combination of chosen indices. To address this issue, the ranking of regional development was set based on the average value of regional development ranking of multiple analysis models.

Table 4-9 compares the propriety of the ranking of the current preliminary feasibility studies with that of the ranking of combined models. Based on a difference of no less than 10%, the comparison showed that the ranking of combined

[42] For details, refer to Chapter 10, 'Calculation of Regional Development Indices' of the "Direction and Strategy of Regional Development Policy" (KDI, 2008).

models was slightly better, but based on differences of no less than 20% and 30%, that of the current preliminary feasibility studies was slightly better.

▎Table 4-9▎Propriety Evaluation of Preliminary Feasibility Studies and Combined Models

Classification		No. of cities, counties, & gu districts where difference occurs between survey and analysis rankings (b)			Ratio of no. of cities, counties & gu districts with difference to no. of cities, counties, and gu districts in the region ((b)/(a))		
	No. of cities, counties, & gu districts (a)	No less than 10%	No less than 20%	No less than 30%	No less than 10%	No less than 20%	No less than 30%
Combined models	158	41	17	7	25.9%	10.8%	4.4%
Current preliminary feasibility study	158	46	15	6	29.1%	9.5%	3.8%

Nevertheless, this approach is problematic in that analysis results change when individual statistically-significant models change, making it difficult to achieve the initial purpose of developing statistically significant regional development indices. The results of propriety review showed that an approach using average values has a similar capability to explain the reality to the regional development index of the current preliminary feasibility studies.

In conclusion, this study determined that regional development indices developed through quantitative analysis are not much better than the regional development index of the current preliminary feasibility studies, and that it is appropriate to use the regional development index of the current preliminary feasibility studies to explain the regional development index and ranking.

For this reason, for the level of regional development, these “General Guidelines (fifth edition)” are to use the eight indices of the MLTM’s “Work Guidelines for Regional Development Projects” (2003) and the weights of the “General Guidelines (fourth edition)” despite various index changes and the current situation.

Nevertheless, as the base year of the raw data of the eight indices from the “General Guidelines (fourth edition)” is 2002, these “General Guidelines (fifth edition)” recalculated them based on 2005 data. Also, as North Jeju County was recently integrated into Jeju City and South Jeju County into Seogwipo City, the number of cities and counties fell from 170 to 168.

The following are the results of regional development index calculation and the ranking of cities and provinces, and cities and counties in terms of regional development:

▌Table 4-10▌ Cities and Provinces' Regional Development Index and Ranking

Region		Population		Economy			Infrastructure			Compo-site	Compo-site
		Popula-tion increase ratio	Aging index	Financial self-reliance	Ratio of people in manufa-cturing	No. of registered passenger cars	Road ratio	No. of doc-tors	Urban land use ratio	Regional develop-ment index	Regional develop-ment ranking
Spe-cial city. metrop-olitan city	Seoul	-0.148	38.815	95.065	5.556	21.458	13.130	0.185	39.920	1.400	1
	Busan	-0.828	46.493	73.203	5.492	19.131	3.488	0.148	16.267	0.140	8
	Daegu	-0.098	37.403	73.923	6.156	24.814	2.407	0.152	11.806	0.469	5
	Incheon	0.538	30.805	71.876	8.837	21.946	2.704	0.117	10.986	0.387	6
	Gwangju	0.473	29.204	59.254	4.943	22.763	2.684	0.159	14.136	0.266	7
	Daejeon	1.010	30.171	73.406	3.236	26.479	2.982	0.153	13.456	0.590	4
	Ulsan	0.953	22.103	66.591	12.845	26.834	1.477	0.103	8.187	0.690	2
Province	Gyeonggi	3.132	29.836	76.897	9.173	23.942	1.090	0.122	5.467	0.649	3
	Gangwon	-0.493	60.141	23.536	2.769	23.365	0.466	0.126	1.044	-0.719	14
	Chungbuk	-0.041	53.121	29.938	8.152	22.951	0.709	0.100	2.692	-0.417	11
	Chungnam	0.534	64.770	39.610	4.509	22.290	0.787	0.114	3.749	-0.422	12
	Jeonbuk	-1.138	62.409	21.136	4.341	20.954	0.810	0.143	3.048	-0.787	15
	Jeonnam	-1.540	78.054	17.034	4.509	18.144	0.720	0.095	2.800	-1.172	16
	Gyeongbuk	-0.736	68.618	24.608	9.772	23.158	0.608	0.091	1.966	-0.533	13
	Gyeong-nam	0.498	46.803	33.203	10.943	23.435	0.882	0.104	3.013	-0.157	9
	Jeju	0.596	42.025	36.761	1.533	24.233	1.592	0.115	3.182	-0.384	10

Note: Gijang County belongs to Busan Metropolitan City; Dalseong County to Daegu Metropolitan City; Ganghwa County and Ongjin County to Incheon Metropolitan City; and Ulju County to Ulsan Metropolitan City.

▌Table 4-11▌ Cities and Provinces' Ranking in Regional Development Index

Region		Increase rate of registered residents	Ratio of people in manufa-cturing	Road ratio	No. of registered passenger cars per person	No. of doctors per person	Aging index	Urban land use ratio	Financial self-reliance	Develop-ment Index
Special city	Seoul	11	8	1	13	1	7	1	1	1
Metro-politan city	Busan (Gijang County)	14	9	2	15	5	9	2	5	8
	Daegu (Dalseong County)	10	7	6	3	4	6	5	3	5
	Incheon (Ganghwa, Ongjin County)	5	5	4	12	9	5	6	6	6
	Gwangju	8	10	5	10	2	2	3	8	7
	Daejeon	2	14	3	2	3	4	4	4	4
	Ulsan (Ulju County)	3	1	8	1	13	1	7	7	2
Province	Gyeonggi	1	4	9	5	8	3	8	2	3
	Gangwon	12	15	16	7	7	12	16	14	14
	Chungbuk	9	6	14	9	14	11	14	12	11
	Chungnam	6	11	11	11	11	14	9	9	12
	Jeonbuk	15	13	12	14	6	13	11	15	15
	Jeonnam	16	12	13	16	15	16	13	16	16
	Gyeongbuk	13	3	15	8	16	15	15	13	13
	Gyeongnam	7	2	10	6	12	10	12	11	9
	Jeju	4	16	7	4	10	8	10	10	10

Note: Gijang County belongs to Busan Metropolitan City; Dalseong County to Daegu Metropolitan City; Ganghwa County and Ongjin County to Incheon Metropolitan City; and Ulju County to Ulsan Metropolitan City.

▌Table 4-12▌ Cities and Counties' Regional Development Index and Ranking

Metro-politan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Popula-tion increase ratio (0.089)	Aging index (0.044)	Finan-cial self Reliance (0.291)	Ratio of people in manuf-acturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	Regional devel-opment index	Regional devel-opment ranking
Special city	Seoul	-0.148	38.815	98.958	4.600	21.458	13.011	0.205	39.920	2.862	1
Metropol-itan city	Busan	-0.878	46.202	75.157	5.346	19.069	4.443	0.154	21.257	1.320	14
Metropol-itan city	Daegu	-0.138	37.437	78.238	5.389	24.796	3.906	0.160	19.440	1.517	8
Metropol-itan city	Incheon	0.555	28.725	76.963	9.068	22.034	5.287	0.117	22.179	1.633	3
Metropol-itan city	Gwangju	0.473	29.204	59.780	4.943	22.763	2.684	0.181	14.136	0.979	21
Metropol-itan city	Daejeon	1.010	30.171	78.504	3.236	26.479	2.982	0.176	13.456	1.395	11
Metropol-itan city	Ulsan	0.898	19.288	71.859	11.533	26.895	3.256	0.107	19.181	1.556	6
Busan	Gijang County	1.547	58.257	38.937	11.968	21.886	1.094	0.066	3.754	0.327	53
Daegu	Dalseong County	0.500	36.969	31.631	17.459	25.077	0.802	0.051	3.628	0.364	49
Incheon	Ganghwa County	-0.482	129.223	16.916	1.903	19.509	0.728	0.055	3.236	-0.495	115
Incheon	Ongjin County	2.294	117.637	33.224	0.439	17.842	1.069	0.038	1.872	-0.220	81
Ulsan	Ulju County	1.239	36.410	48.735	19.666	26.515	0.765	0.067	3.788	0.781	31
Gyeonggi	Suwon	2.0f63	21.896	58.006	4.827	25.059	5.732	0.148	26.536	1.535	7
Gyeonggi	Seong-nam	1.345	31.279	73.221	4.064	24.375	3.367	0.166	15.307	1.326	13
Gyeonggi	Uijeong-bu	2.213	32.011	50.007	1.341	20.209	3.898	0.335	12.086	0.890	23

▌Table 4-12▌ Continued

Metro-politan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Popula-tion increase rate (0.089)	Aging index (0.044)	Finan-cial self-reliance (0.291)	Ratio of people in manufac-turing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	Regional develop-ment index	Regional develop-ment ranking
Gyeonggi	Anyang	1.524	27.420	61.406	5.486	22.643	5.697	0.163	24.348	1.469	9
Gyeonggi	Bucheon	2.032	25.933	64.447	8.354	20.421	9.624	0.145	38.886	2.102	2
Gyeonggi	Gwang-myeong	-0.547	29.835	47.156	3.743	18.907	4.225	0.224	18.041	0.814	30
Gyeonggi	Yongin	11.500	26.856	60.204	8.662	28.530	0.820	0.017	6.689	1.199	15
Gyeonggi	Pyeong-taek	1.728	35.182	43.114	16.472	26.833	1.265	0.130	7.947	0.828	28
Gyeonggi	Dongdu-cheon	1.946	47.769	21.471	5.160	19.956	1.086	0.636	5.625	0.378	48
Gyeonggi	Ansan	3.835	19.055	60.194	15.466	23.623	5.824	0.063	20.626	1.615	5
Gyeonggi	Gwache-on	-3.179	31.810	44.021	1.768	24.882	1.505	0.513	7.958	0.655	36
Gyeonggi	Guri	2.592	26.148	47.741	1.652	21.250	4.163	0.079	12.505	0.721	33
Gyeonggi	Namyang-ju	4.696	30.870	42.477	4.359	21.777	0.627	0.074	3.654	0.329	52
Gyeonggi	Osan	4.207	18.654	45.270	7.791	25.080	3.122	0.204	16.239	1.102	18
Gyeonggi	Paju	6.462	45.951	41.131	12.671	25.469	0.673	0.036	4.062	0.624	37
Gyeonggi	Siheung	4.209	17.733	55.259	20.425	24.827	3.573	0.054	13.466	1.365	12
Gyeonggi	Gunpo	0.666	25.889	52.911	10.349	22.590	3.981	0.058	17.962	1.048	19
Gyeonggi	Uiwang	3.756	28.645	46.302	6.305	23.816	2.598	0.099	8.232	0.727	32
Gyeonggi	Hannam	1.629	38.152	43.590	5.779	21.509	0.744	0.130	4.500	0.330	51

▌Table 4-12▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	Regional development index	Regional development ranking
Gyeonggi	Icheon	1.019	35.983	43.659	15.447	25.681	0.496	0.058	4.586	0.567	39
Gyeonggi	Goyang	2.582	29.356	59.926	2.821	24.929	2.606	0.028	10.046	0.857	25
Gyeonggi	Anseong	3.018	51.583	29.369	15.918	25.012	0.784	0.053	4.122	0.380	47
Gyeonggi	Gimpo	5.228	34.797	40.264	20.599	26.364	0.774	0.050	7.225	0.854	26
Gyeonggi	Yangju	6.591	34.054	36.996	18.055	22.608	1.226	0.087	5.853	0.709	34
Gyeonggi	Yeoju	0.242	61.849	32.917	6.221	24.149	0.699	0.049	3.022	0.076	66
Gyeonggi	Hwaseong	9.271	35.351	57.567	37.656	27.405	0.676	0.040	6.164	1.626	4
Gyeonggi	Gwangju	8.950	31.333	47.457	15.022	27.242	0.804	0.038	4.185	0.946	22
Gyeonggi	Yeoncheon	-2.094	88.799	21.309	4.430	20.539	0.423	0.130	1.202	-0.363	93
Gyeonggi	Pocheon	1.850	49.054	30.378	18.419	22.506	0.565	0.029	3.092	0.271	56
Gyeonggi	Gapyeong	-0.317	88.734	24.504	2.099	20.583	0.361	0.031	1.219	-0.382	96
Gyeonggi	Yangpyeong	0.751	93.744	16.973	1.534	23.309	0.484	0.037	1.870	-0.371	95
Gangwon	Chuncheon	0.351	50.959	33.378	1.688	26.298	0.779	0.183	1.844	0.166	60
Gangwon	Wonju	1.368	42.234	36.958	4.698	24.641	0.821	0.190	2.734	0.304	55
Gangwon	Gangneung	-0.716	55.343	29.259	2.436	25.652	0.596	0.168	1.898	0.027	70
Gangwon	Donghae	-0.954	47.932	25.381	2.611	24.156	1.069	0.095	5.672	-0.032	73
Gangwon	Taebaek	-1.625	62.360	18.218	1.838	22.532	0.638	0.110	1.405	-0.363	94
Gangwon	Sokcho	-0.589	43.140	32.670	1.467	22.697	1.312	0.091	5.980	0.057	68
Gangwon	Samcheok	-2.269	86.300	18.176	2.086	20.823	0.531	0.063	0.745	-0.517	117
Gangwon	Hongcheon	-0.908	85.316	19.735	2.639	19.475	0.339	0.101	0.691	-0.457	105
Gangwon	Hoengseong	-0.962	114.842	17.790	7.313	19.502	0.404	0.036	1.028	-0.461	107

▌Table 4-12▌ Continued

Metropo-litan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Popula-tion increase rate (0.089)	Aging index (0.044)	Finan-cial self-reli-ance (0.291)	Ratio of people in manufac-turing (0.131)	No. of register-ed passen-ger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	Regional devel-opment index	Regional devel-opment ranking
Gangwon	Yeongwol	-2.955	113.813	14.052	3.241	19.324	0.402	0.077	0.802	-0.652	133
Gangwon	Pyeong chang	-0.852	95.389	17.405	2.160	21.387	0.337	0.024	0.637	-0.517	118
Gangwon	Jeong seon	-2.626	98.800	24.377	1.766	20.206	0.372	0.068	0.624	-0.472	109
Gangwon	Cheorwon	-1.625	62.828	13.625	2.245	20.107	0.425	0.065	0.963	-0.573	123
Gangwon	Hwa cheon	-1.153	71.841	11.870	1.192	19.444	0.413	0.084	0.439	-0.632	132
Gangwon	Yanggu	-1.637	68.733	24.704	1.802	19.212	0.426	0.042	0.514	-0.460	106
Gangwon	Inje	-0.428	61.655	16.910	1.637	20.836	0.265	0.052	0.374	-0.500	116
Gangwon	Goseong	-1.958	99.137	18.741	2.372	19.063	0.493	0.022	0.840	-0.593	126
Gangwon	Yangyang	-0.568	102.541	23.710	3.377	22.799	0.430	0.044	0.920	-0.308	90
Chungbuk	Cheongju	1.682	26.635	51.108	4.821	25.138	4.072	0.130	19.281	1.118	17
Chungbuk	Chungju	-1.028	57.720	23.414	4.471	22.343	0.855	0.115	2.719	-0.156	76
Chungbuk	Jecheon	-1.308	61.115	23.559	3.123	22.077	0.645	0.088	1.735	-0.262	86
Chungbuk	Cheong-won	-0.599	81.332	30.077	20.174	22.994	0.665	0.027	4.238	0.237	58
Chungbuk	Boeun	-2.906	152.896	16.713	5.154	16.540	0.617	0.064	1.603	-0.665	135
Chungbuk	Jincheon	0.325	62.020	29.665	28.745	23.583	0.749	0.063	3.596	0.494	45
Chungbuk	Goesan	-1.955	108.790	16.619	6.979	19.102	0.545	0.054	1.804	-0.488	113
Chungbuk	Eum-seong	-0.208	66.779	28.438	21.920	22.363	0.729	0.098	4.661	0.324	54
Chungbuk	Danyang	-3.079	112.924	19.913	6.875	18.591	0.442	0.049	0.984	-0.523	119
Chungnam	Cheonan	3.983	26.841	52.651	12.810	26.339	1.425	0.176	7.358	1.019	20
Chungnam	Gongju	-0.801	83.482	20.494	4.327	20.790	0.768	0.108	2.382	-0.290	87
Chungnam	Boryeong	-1.775	81.823	25.902	3.396	19.807	0.690	0.087	3.051	-0.291	88
Chungnam	Asan	2.295	50.629	46.210	21.957	24.223	1.046	0.075	6.095	0.815	29

▌Table 4-12▌ Continued

Metro-politan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Popula-tion increase rate (0.089)	Aging index (0.044)	Finan-cial self-reliance (0.291)	Ratio of people in manufac-turing (0.131)	No. of register-ed passen-ger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	Regional devel-opment index	Regional devel-opment ranking
Chungnam	Seosan	0.127	56.449	32.668	6.062	22.436	0.947	0.079	3.589	0.069	67
Chungnam	Nonsan	-0.088	69.573	22.048	4.587	21.117	0.897	0.102	4.491	-0.163	77
Chungnam	Geumsan	-1.866	125.766	19.282	10.819	19.348	0.519	0.120	2.111	-0.307	89
Chungnam	Yeongi	1.094	74.547	27.303	13.823	21.998	0.717	0.080	4.629	0.150	62
Chungnam	Buyeo	-2.520	129.725	17.082	4.288	16.492	0.651	0.097	3.012	-0.586	124
Chungnam	Seocheon	-3.068	141.961	17.456	5.883	18.939	0.884	0.090	4.020	-0.465	108
Chungnam	Cheong-yang	-3.128	166.077	18.362	5.699	16.523	0.703	0.100	2.130	-0.597	127
Chungnam	Hong-seong	-0.892	97.879	18.727	3.517	19.256	0.661	0.098	3.554	-0.390	98
Chungnam	Yesan	-2.123	115.596	19.151	5.777	19.755	0.564	0.061	3.395	-0.420	101
Chungnam	Taean	-1.418	104.555	34.708	0.980	18.858	0.593	0.078	2.498	-0.257	85
Chungnam	Dangjin	-0.131	78.772	31.946	7.684	21.968	0.614	0.071	4.436	0.036	69
Jeonbuk	Jeonju	0.050	32.797	39.459	2.001	24.034	1.951	0.196	15.132	0.585	38
Jeonbuk	Gunsan	-1.018	48.721	28.185	5.562	22.871	2.045	0.086	9.405	0.174	59
Jeonbuk	Iksan	-0.966	47.323	31.742	6.305	21.628	1.527	0.254	6.548	0.255	57
Jeonbuk	Jeongeup	-3.223	90.746	17.529	4.643	16.889	0.787	0.105	3.184	-0.531	121
Jeonbuk	Namwon	-1.960	89.384	13.505	3.907	17.022	0.687	0.113	2.040	-0.590	125
Jeonbuk	Gimje	-2.327	122.629	17.554	6.787	18.807	0.863	0.075	3.997	-0.422	102
Jeonbuk	Wanju	0.055	87.347	24.213	13.154	20.871	0.474	0.061	2.348	-0.079	74
Jeonbuk	Jinan	-1.427	159.596	12.046	3.147	15.501	0.546	0.058	1.039	-0.794	152
Jeonbuk	Muju	-2.365	149.819	17.297	1.570	16.140	0.382	0.038	0.919	-0.773	146
Jeonbuk	Jangsu	-3.801	156.500	9.755	2.982	14.876	0.660	0.032	1.107	-0.947	166
Jeonbuk	Imsil	-2.807	194.572	13.932	2.656	15.082	0.740	0.049	1.430	-0.847	159
Jeonbuk	Sun-chang	-1.524	154.939	11.737	3.154	14.580	0.687	0.050	1.607	-0.813	154

▌Table 4-12▌ Continued

Metro-politan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Popula-tion increase rate (0.089)	Aging index (0.044)	Finan-cial self-reliance (0.291)	Ratio of people in manufa-cturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	Regional develop-ment index	Regional develop-ment ranking
Jeonbuk	Gochang	-2.965	147.527	14.142	2.352	14.939	0.720	0.081	2.785	-0.767	145
Jeonbuk	Buan	-2.747	135.154	14.441	2.356	16.360	0.806	0.083	2.705	-0.693	140
Jeonnam	Mokpo	-0.160	33.630	33.418	1.646	20.213	6.678	0.137	26.366	0.873	24
Jeonnam	Yeosu	-1.394	45.598	31.597	5.785	19.533	1.322	0.084	6.891	0.010	71
Jeonnam	Sun-cheon	0.093	39.369	31.420	1.940	21.675	1.074	0.117	2.454	-0.031	72
Jeonnam	Naju	-1.964	117.495	15.845	5.612	17.111	0.796	0.116	3.631	-0.491	114
Jeonnam	Gwang-Yang	0.091	30.628	47.337	9.043	25.069	1.186	0.050	6.042	0.524	43
Jeonnam	Dam-yang	-1.738	142.795	17.698	7.928	18.460	0.579	0.089	2.657	-0.441	103
Jeonnam	Gok-seong	-3.678	166.522	13.345	8.567	15.304	0.391	0.052	1.625	-0.754	143
Jeonnam	Guryeo	-2.514	144.547	15.654	1.438	15.845	0.445	0.057	1.522	-0.780	150
Jeonnam	Goheung	-3.695	193.910	11.431	3.300	12.116	0.687	0.099	2.024	-0.949	167
Jeonnam	Boseong	-2.840	177.794	16.829	3.181	14.547	0.592	0.086	2.146	-0.756	144
Jeonnam	Hwasun	-1.217	79.416	20.320	3.572	18.668	0.488	0.314	1.638	-0.249	84
Jeonnam	Jang-heung	-3.121	148.246	13.441	2.323	14.463	0.519	0.087	1.865	-0.829	156
Jeonnam	Gangjin	-2.820	151.274	13.348	2.510	14.376	0.521	0.084	2.219	-0.817	155
Jeonnam	Haenam	-2.774	124.845	13.422	2.803	14.397	0.589	0.089	2.136	-0.779	149
Jeonnam	Yeong-am	-0.822	90.377	16.011	19.444	18.070	0.629	0.056	4.049	-0.168	79
Jeonnam	Muan	-2.436	122.076	13.358	3.164	15.757	0.860	0.079	3.219	-0.682	139
Jeonnam	Ham-pyeong	-2.302	168.890	12.743	3.717	14.514	0.804	0.052	3.132	-0.782	151
Jeonnam	Yeong-gwang	-3.344	106.697	23.876	3.216	16.139	0.623	0.130	3.623	-0.477	110

▌Table 4-12▌ Continued

Metro-politan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Popula-tion increase rate (0.089)	Aging index (0.044)	Finan-cial self-reliance (0.291)	Ratio of people in manufac-turing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	Regional develop-ment index	Regional develop-ment ranking
Jeonnam	Jang-seong	-2.462	124.903	18.067	7.737	18.298	0.638	0.054	2.436	-0.485	111
Jeonnam	Wando	-2.531	136.165	14.432	4.021	12.181	0.651	0.049	2.544	-0.830	157
Jeonnam	Jindo	-2.863	153.328	13.848	1.461	14.315	0.724	0.055	1.714	-0.856	161
Jeonnam	Sinan	-2.670	205.192	12.485	1.567	10.149	0.582	0.026	1.615	-1.082	168
Gyeongbuk	Pohang	-0.316	38.057	47.518	7.454	26.499	0.759	0.111	4.286	0.504	44
Gyeongbuk	Gyeong-ju	-0.959	63.688	31.489	10.323	24.636	0.738	0.118	2.807	0.165	61
Gyeongbuk	Gim-cheon	-1.090	83.587	24.892	7.538	21.040	0.841	0.083	1.986	-0.178	80
Gyeongbuk	Andong	-1.357	84.530	18.950	1.869	21.020	0.617	0.134	1.445	-0.388	97
Gyeongbuk	Gumi	2.088	20.294	57.653	24.180	27.003	0.799	0.110	5.466	1.155	16
Gyeongbuk	Yeongju	-1.863	84.910	18.619	3.241	20.126	0.726	0.060	2.146	-0.451	104
Gyeongbuk	Yeong-cheon	-2.096	107.434	19.872	10.394	21.722	0.550	0.097	2.081	-0.242	83
Gyeongbuk	Sangju	-2.377	131.916	15.732	3.029	18.190	0.577	0.072	1.799	-0.629	131
Gyeongbuk	Mun-gyeong	-2.771	122.402	15.954	2.843	18.109	0.637	0.089	1.630	-0.622	129
Gyeongbuk	Gyeong-san	1.364	43.661	32.864	11.005	25.658	1.886	0.101	5.963	0.466	46
Gyeongbuk	Gunwi	-3.202	234.615	15.750	6.161	18.578	0.408	0.036	1.163	-0.719	141
Gyeongbuk	Uiseong	-3.318	241.741	11.797	2.868	16.335	0.431	0.052	1.331	-0.914	163

▌Table 4-12▌ Continued

Metro-politan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Popula-tion increase rate (0.089)	Aging index (0.044)	Finan-cial self-reliance (0.291)	Ratio of people in manufac-turing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	Regional develop-ment index	Regional develop-ment ranking
Gyeongbuk	Cheong-song	-3.077	176.797	15.798	1.415	17.714	0.433	0.065	0.814	-0.774	147
Gyeongbuk	Yeong-yang	-2.621	204.525	11.219	1.185	16.303	0.438	0.025	0.536	-0.945	165
Gyeongbuk	Yeong-deok	-2.492	174.335	11.583	3.145	15.652	0.523	0.058	1.063	-0.847	160
Gyeongbuk	Cheong-do	-2.230	210.263	14.725	3.423	19.090	0.521	0.070	1.496	-0.678	137
Gyeongbuk	Gorye-ong	-1.679	135.925	18.963	17.298	23.069	0.497	0.043	2.055	-0.131	75
Gyeongbuk	Seongju	-1.586	145.156	15.700	9.198	21.228	0.535	0.048	1.867	-0.411	99
Gyeongbuk	Chilgok	0.862	43.341	33.089	22.482	27.389	0.653	0.067	3.028	0.563	40
Gyeongbuk	Ye-cheon	-3.166	205.087	13.884	2.359	15.998	0.584	0.049	1.978	-0.844	158
Gyeongbuk	Bong-hwa	-3.119	191.615	11.479	3.590	15.012	0.400	0.035	0.715	-0.930	164
Gyeongbuk	Uljin	-3.066	109.896	24.700	1.918	18.888	0.406	0.060	0.946	-0.527	120
Gyeongbuk	Ulleung	-1.407	111.966	15.625	4.607	15.487	1.051	0.000	1.339	-0.673	136
Gyeongnam	Chang-won	-0.568	18.420	66.234	19.691	30.696	2.365	0.079	11.788	1.456	10
Gyeongnam	Masan	-0.324	40.390	38.500	4.723	23.497	1.659	0.151	5.906	0.331	50
Gyeongnam	Jinju	-0.283	44.819	31.058	3.965	22.780	0.904	0.213	3.463	0.113	64
Gyeongnam	Jinhae	3.292	37.243	32.391	6.886	25.410	2.164	0.088	11.362	0.562	41
Gyeongnam	Tong-yeong	-0.545	53.408	21.935	5.883	17.680	1.558	0.070	4.432	-0.233	82

▌Table 4-12▌ Continued

Metro-politan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Popula-tion increase rate (0.089)	Aging index (0.044)	Finan-cial self-reliance (0.291)	Ratio of people in manufac-turing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	Regional develop-ment index	Regional develop-ment ranking
Gyeongnam	Sa-cheon	-1.316	68.918	20.617	8.941	20.702	1.173	0.079	3.863	-0.167	78
Gyeongnam	Gimhae	5.141	22.631	42.983	15.518	24.867	1.458	0.091	7.433	0.842	27
Gyeongnam	Mil-yang	-1.776	97.918	18.738	4.249	19.882	0.790	0.087	2.222	-0.415	100
Gyeongnam	Geoje	2.502	27.277	32.431	20.322	24.097	1.100	0.073	4.280	0.535	42
Gyeongnam	Yang-san	2.914	28.972	44.911	18.177	23.322	1.262	0.085	3.751	0.698	35
Gyeongnam	Ui-ryeong	-2.003	211.768	14.535	5.820	17.430	0.836	0.057	1.790	-0.661	134
Gyeongnam	Haman	-0.941	98.785	23.182	20.816	22.784	0.828	0.064	3.554	0.131	63
Gyeongnam	Chang-nyeong	-2.330	140.504	15.863	5.977	19.538	0.588	0.098	2.635	-0.487	112
Gyeongnam	Go-seong	-2.377	141.558	17.278	6.705	17.120	0.976	0.062	2.414	-0.537	122
Gyeongnam	Nam-hae	-2.802	194.596	12.927	1.556	13.914	0.794	0.065	2.671	-0.879	162
Gyeongnam	Hadong	-2.257	142.842	17.169	1.931	17.121	0.628	0.056	1.678	-0.678	138
Gyeongnam	San-cheong	-2.364	198.799	14.252	2.803	17.002	0.512	0.030	1.187	-0.802	153
Gyeongnam	Ham-yang	-2.196	157.701	18.061	4.052	14.584	0.488	0.058	1.201	-0.730	142
Gyeongnam	Geo-chang	-1.470	108.853	14.671	2.793	17.988	0.468	0.072	1.298	-0.626	130
Gyeong-nam	Hap-cheon	-0.983	174.458	13.463	2.566	15.694	0.551	0.044	1.282	-0.778	148

▌Table 4-12▐ Continued

Metro-politan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Popula-tion increase rate (0.089)	Aging index (0.044)	Finan-cial self-reliance (0.291)	Ratio of people in manufac-turing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	Regional develop-ment index	Regional develop-ment ranking
Jeju	Jeju	1.166	36.757	24.567	1.653	24.990	2.055	0.129	3.535	0.097	65
Jeju	Seogwi-po	-0.790	57.442	16.846	1.226	22.300	1.072	0.072	2.786	-0.345	91

Note: 1) The indices are calculated as follows:
- Population increase rate = Annual average increase rate between 2000 and 2005
- Aging index = (No. of people 65 years old or older/no. people 0 to 14 years old)×100
- Degree of financial self-reliance = (Local tax + non-tax revenue)/budget under general accounting, three years from 2003 to 2005 combined.
- Ratio of people engaged in manufacturing = Monthly average no. of people in manufacturing/population (as of 2005)
- No. of registered passenger cars = (No. of registered passenger cars/population)×100 (as of 2005)
- Road ratio = Total length of roads (km) /area of administrative districts (km^2) (as of 2005). The total length of roads does not include the lengths of highways and high-speed national roads.
- No. of doctors = (No. of doctors/population)×100 (as of 2005).
- Urban land use ratio = [(Building lot + factory lot + school lot)/area of administrative districts]×100 (as of 2005).

2) The non-tax revenue items, which are used for calculation of the degree of financial self-reliance, have changed. Therefore, among the items comprising a local government's budget under the budget allocation guidelines for local governments, the 'fund to mitigate fiscal imbalance among administrative districts', which used to be part of non-tax revenues (subsidies from collections), became part of dependent financial resources in 2001.
3) Statistics on metropolitan cities do not include statistics on the counties belonging to them.
4) The Jeungpyeong branch in Chungbuk is included in Goesan County.
5) The Gyeryong branch in Chungnam is included in Nonsan County.
6) North Jeju County is now part of Jeju City.
7) South Jeju County is now part of Seogwipo City.
8) The figures in the parentheses in the first row of every table are the relative weights of the eight indices resulting from AHP analysis.
9) The regional development index is calculated by standardizing eight index values, multiplying them by the weights in the parentheses, and adding them together. Still, as the aging index has a negative (-) relationship with the level of regional development, it is multiplied by -1.

▌Table 4-13▌ Cities and Counties' Ranking in Regional Development Index

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Special city	Seoul	59	44	1	85	73	1	8	1	0	1
Metropolitan city	Busan	79	54	5	74	110	8	20	7	0	14
Metropolitan city	Daegu	58	41	3	73	31	13	19	9	0	8
Metropolitan city	Incheon	45	18	4	38	64	7	35	6	0	3
Metropolitan city	Gwangju	47	20	14	78	52	20	13	17	0	21
Metropolitan city	Daejeon	40	23	2	109	11	19	15	19	0	11
Metropolitan city	Ulsan	41	5	7	31	7	17	43	11	0	6
Busan	Gijang County	31	68	42	30	67	43	100	63	0	53
Daegu	Dalseong County	46	39	59	18	22	67	134	67	1	49
Incheon	Ganghwa County	67	127	122	144	100	84	123	76	4	115
Incheon	Ongjin County	21	119	49	168	126	48	150	116	4	81
Ulsan	Ulju County	36	37	23	13	9	77	99	62	0	31
Gyeonggi	Suwon	24	7	15	79	24	5	22	3	0	7
Gyeonggi	Seongnam	35	26	6	93	34	16	17	15	0	13
Gyeonggi	Uijeong-bu	22	29	22	163	89	14	3	21	1	23

▌Table 4-13▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Gyeonggi	Anyang	32	16	10	72	54	6	18	5	0	9
Gyeonggi	Bucheon	25	10	9	44	87	2	23	2	0	2
Gyeonggi	Gwangmyeong	69	22	28	98	113	9	6	12	0	30
Gyeonggi	Yongin	1	14	11	41	2	63	167	33	1	15
Gyeonggi	Pyeongtaek	28	34	36	20	8	37	28	28	0	28
Gyeonggi	Dongducheon	26	56	88	75	93	44	1	43	0	48
Gyeonggi	Ansan	12	4	12	23	41	4	107	8	0	5
Gyeonggi	Gwacheon	161	28	33	148	28	32	2	27	2	36
Gyeonggi	Guri	17	11	24	152	75	10	80	20	1	33
Gyeonggi	Namyangju	8	25	38	89	68	110	89	65	1	52
Gyeonggi	Osan	10	3	31	46	21	18	9	14	0	18
Gyeonggi	Paju	5	53	39	29	18	96	154	57	1	37
Gyeonggi	Siheung	9	1	18	9	30	15	127	18	1	12
Gyeonggi	Gunpo	44	9	19	35	56	12	115	13	0	19
Gyeonggi	Uiwang	13	17	29	57	40	22	49	26	0	32
Gyeonggi	Hanam	30	43	35	67	72	80	29	48	0	51

▌Table 4-13▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Gyeonggi	Icheon	39	36	34	24	15	140	116	47	1	39
Gyeonggi	Goyang	18	21	13	121	27	21	161	24	2	25
Gyeonggi	Anseong	15	62	67	21	25	73	129	56	1	47
Gyeonggi	Gimpo	6	33	40	8	12	75	136	31	1	26
Gyeonggi	Yangju	4	32	44	17	55	39	68	41	0	34
Gyeonggi	Yeoju	50	71	51	59	37	90	139	83	1	66
Gyeonggi	Hwaseong	2	35	17	1	3	95	148	35	1	4
Gyeonggi	Gwangju	3	27	26	25	5	65	151	55	1	22
Gyeonggi	Yeoncheon	118	94	89	88	86	155	27	144	2	93
Gyeonggi	Pocheon	27	59	64	15	58	124	160	80	2	56
Gyeonggi	Gapyeong	64	93	78	138	85	165	158	143	4	96
Gyeonggi	Yangpyeong	43	98	121	158	45	144	152	117	4	95
Gangwon	Chuncheon	48	61	48	150	14	74	12	120	2	60
Gangwon	Wonju	33	47	45	82	32	62	11	88	0	55
Gangwon	Gangneung	74	64	68	130	17	115	16	115	1	70
Gangwon	Donghae	83	57	73	127	36	47	56	42	1	73

▌Table 4-13▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Gangwon	Taebaek	103	73	106	146	57	105	40	137	2	94
Gangwon	Sokcho	72	48	53	159	53	36	58	38	1	68
Gangwon	Samcheok	124	91	107	139	82	132	108	160	4	117
Gangwon	Hongcheon	81	90	95	126	102	166	47	162	3	105
Gangwon	Hoengseong	85	116	110	51	101	159	153	151	3	107
Gangwon	Yeong-wol	151	115	145	108	105	160	85	159	4	133
Gangwon	Pyeongchang	78	99	115	137	74	167	165	163	4	118
Gangwon	Jeongseon	140	103	79	149	90	164	97	164	4	109
Gangwon	Cheor-won	104	74	149	136	92	154	102	153	4	123
Gangwon	Hwacheon	91	80	161	165	103	156	74	167	4	132
Gangwon	Yanggu	105	77	75	147	107	153	147	166	4	106
Gangwon	Inje	66	70	123	154	81	168	133	168	5	116
Gangwon	Goseong	114	104	101	131	111	141	166	157	4	126
Gangwon	Yangyang	71	105	82	105	49	152	145	155	3	90
Chungbuk	Cheong-ju	29	12	21	80	20	11	26	10	0	17

▌Table 4-13▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Chungbuk	Chungju	89	67	84	87	61	58	37	89	0	76
Chungbuk	Jecheon	93	69	83	116	63	103	63	124	1	86
Chungbuk	Cheongwon	73	84	65	11	47	97	162	54	1	58
Chungbuk	Boeun	150	144	126	76	137	113	105	132	5	135
Chungbuk	Okcheon	107	108	96	43	97	104	88	111	0	92
Chungbuk	Yeongdong	130	126	116	77	129	131	128	142	6	128
Chungbuk	Jincheon	49	72	66	2	42	79	106	69	0	45
Chungbuk	Goesan	113	110	127	52	108	129	125	121	4	113
Chungbuk	Eumseong	61	76	69	6	60	83	51	45	0	54
Chungbuk	Danyang	156	114	93	54	118	148	138	152	4	119
Chungnam	Cheonan	11	13	20	28	13	34	14	30	0	20
Chungnam	Gongju	76	86	91	90	83	76	42	99	0	87
Chungnam	Boryeong	109	85	72	104	95	91	66	81	0	88
Chungnam	Asan	20	60	30	5	35	50	87	36	0	29
Chungnam	Seosan	51	65	54	61	59	52	81	70	0	67

▌Table 4-13▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Chungnam	Nonsan	56	79	86	86	77	54	45	49	0	77
Chungnam	Geumsan	112	125	97	33	104	136	32	107	2	89
Chungnam	Yeongi	38	81	71	26	65	88	78	46	0	62
Chungnam	Buyeo	137	128	120	91	139	102	55	84	4	124
Chungnam	Seocheon	154	135	114	64	112	55	59	59	2	108
Chungnam	Cheongyang	159	150	105	69	138	89	48	106	3	127
Chungnam	Hongseong	80	100	103	102	106	98	52	72	0	98
Chungnam	Yesan	120	117	98	68	96	125	111	75	2	101
Chungnam	Taean	98	106	46	167	115	116	84	95	1	85
Chungnam	Dangjin	57	82	57	48	66	114	94	50	0	69
Jeonbuk	Jeonju	55	30	41	140	39	27	10	16	1	38
Jeonbuk	Gunsan	88	58	70	71	48	26	69	25	0	59
Jeonbuk	Iksan	86	55	58	58	71	31	5	34	0	57
Jeonbuk	Jeongeup	163	97	113	83	136	72	44	78	2	121
Jeonbuk	Namwon	115	95	150	97	134	94	38	110	2	125
Jeonbuk	Gimje	126	122	112	55	116	56	86	60	2	102
Jeonbuk	Wanju	54	92	80	27	80	145	110	100	1	74

▌Table 4-13▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Jeonbuk	Gimje	126	122	112	55	116	56	86	60	2	102
Jeonbuk	Wanju	54	92	80	27	80	145	110	100	1	74
Jeonbuk	Jinan	99	149	160	114	150	128	114	150	5	152
Jeonbuk	Muju	129	142	117	155	143	163	149	156	7	146
Jeonbuk	Jangsu	168	147	168	118	156	99	157	148	6	166
Jeonbuk	Imsil	146	159	146	125	153	81	141	136	7	159
Jeonbuk	Sunchang	101	146	163	113	158	93	137	131	5	154
Jeonbuk	Gochang	152	140	144	134	155	87	77	87	5	145
Jeonbuk	Buan	142	130	141	133	140	64	75	90	5	140
Jeonnam	Mokpo	60	31	47	153	88	3	24	4	1	24
Jeonnam	Yeosu	96	52	60	66	99	35	73	32	0	71
Jeonnam	Suncheon	52	45	62	141	70	45	34	96	1	72
Jeonnam	Naju	116	118	131	70	133	69	36	66	2	114
Jeonnam	Gwangyang	53	24	27	39	23	40	135	37	1	43
Jeonnam	Damyang	108	136	111	45	120	122	62	92	3	103
Jeonnam	Gokseong	166	151	156	42	152	162	130	129	7	143

▌Table 4-13▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Jeonnam	Gurye	136	138	136	161	146	147	120	133	8	150
Jeonnam	Goheung	167	158	166	106	167	92	50	112	4	167
Jeonnam	Boseong	148	156	125	111	159	117	70	104	4	144
Jeonnam	Hwasun	92	83	92	101	117	142	4	127	2	84
Jeonnam	Jang-heung	158	141	152	135	161	137	67	119	7	156
Jeonnam	Gangjin	147	143	155	129	163	134	72	102	6	155
Jeonnam	Haenam	144	123	153	123	162	118	61	105	5	149
Jeonnam	Yeongam	77	96	128	14	124	108	122	58	3	79
Jeonnam	Muan	133	120	154	112	147	57	83	77	4	139
Jeonnam	Ham-pyeong	125	152	158	99	160	66	132	79	5	151
Jeonnam	Yeong-gwang	165	107	81	110	144	111	30	68	2	110
Jeonnam	Jang-seong	134	124	108	47	121	106	126	97	4	111
Jeonnam	Wando	138	132	142	95	166	101	140	94	5	157
Jeonnam	Jindo	149	145	148	160	164	86	124	125	7	161
Jeonnam	Sinan	141	164	159	156	168	121	163	130	8	168
Gyeong-buk	Pohang	63	42	25	50	10	78	39	52	0	44
Gyeong-buk	Gyeongju	84	75	61	36	33	82	33	85	0	61

▌Table 4-13▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Gyeong-buk	Gimcheon	90	87	74	49	78	59	76	113	0	80
Gyeong-buk	Andong	95	88	100	145	79	112	25	135	2	97
Gyeong-buk	Gumi	23	6	16	3	6	68	41	44	0	16
Gyeong-buk	Yeongju	111	89	104	107	91	85	112	103	0	104
Gyeong-buk	Yeongcheon	119	109	94	34	69	127	54	108	2	83
Gyeong-buk	Sangju	131	129	134	117	122	123	92	122	6	131
Gyeong-buk	Mungyeong	143	121	129	120	123	107	60	128	6	129
Gyeong-buk	Gyeongsan	34	50	52	32	16	28	46	39	0	46
Gyeong-buk	Gunwi	162	167	133	60	119	157	155	147	7	141
Gyeong-buk	Uiseong	164	168	162	119	141	151	131	139	8	163
Gyeong-buk	Cheongsong	155	155	132	162	127	150	103	158	7	147
Gyeong-buk	Yeongyang	139	162	167	166	142	149	164	165	8	165
Gyeong-buk	Yeongdeok	135	153	164	115	149	133	118	149	6	160
Gyeong-buk	Cheong-do	122	165	138	103	109	135	95	134	5	137
Gyeong-buk	Goryeong	106	131	99	19	46	139	146	109	3	75
Gyeong-buk	Seongju	102	139	135	37	76	130	143	118	4	99
Gyeong-buk	Chilgok	42	49	50	4	4	100	98	82	0	40

▌Table 4-13▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Gyeong-buk	Yecheon	160	163	147	132	145	120	142	114	7	158
Gyeong-buk	Bong-hwa	157	157	165	100	154	161	156	161	7	164
Gyeong-buk	Uljin	153	112	76	143	114	158	113	154	4	120
Gyeong-buk	Ulleung	97	113	137	84	151	49	168	138	4	136
Gyeong-nam	Chang-won	70	2	8	12	1	23	79	22	0	10
Gyeong-nam	Masan	65	46	43	81	43	29	21	40	0	50
Gyeong-nam	Jinju	62	51	63	96	51	53	7	74	0	64
Gyeong-nam	Jinhae	14	40	56	53	19	24	64	23	0	41
Gyeong-nam	Tong-yeong	68	63	87	63	128	30	96	51	1	82
Gyeong-nam	Sacheon	94	78	90	40	84	41	82	61	0	78
Gyeong-nam	Gimhae	7	8	37	22	29	33	57	29	0	27
Gyeong-nam	Miryang	110	101	102	92	94	71	65	101	0	100
Gyeong-nam	Geoje	19	15	55	10	38	42	90	53	0	42
Gyeong-nam	Yangsan	16	19	32	16	44	38	71	64	2	35
Gyeong-nam	Ui-ryeong	117	166	140	65	130	60	119	123	5	134
Gyeong-nam	Haman	82	102	85	7	50	61	104	71	0	63

▌Table 4-13▌ Continued

Metropolitan city, province	City, county	Population		Economy			Infrastructure			Composite	
		Population increase rate (0.089)	Aging index (0.044)	Financial self-reliance (0.291)	Ratio of people in manufacturing (0.131)	No. of registered passenger cars (0.124)	Road ratio (0.117)	No. of doctors (0.063)	Urban land use ratio (0.142)	No. of indices including the bottom 50	Regional development ranking
Gyeongnam	Changnyeong	127	133	130	62	98	119	53	93	4	112
Gyeongnam	Goseong	132	134	118	56	132	51	109	98	3	122
Gyeongnam	Namhae	145	160	157	157	165	70	101	91	5	162
Gyeongnam	Hadong	123	137	119	142	131	109	121	126	7	138
Gyeongnam	Sancheong	128	161	143	122	135	138	159	146	8	153
Gyeongnam	Hamyang	121	148	109	94	157	143	117	145	5	142
Gyeongnam	Geochang	100	111	139	124	125	146	91	140	5	130
Gyeongnam	Hapcheon	87	154	151	128	148	126	144	141	7	148
Jeju	Jeju	37	38	77	151	26	25	31	73	1	65
Jeju	Seogwi-po	75	66	124	164	62	46	93	86	2	91

Note: 1) The ranking by index for 168 local governments is from higher to lower figures of each index. Nevertheless, the higher the ranking in the aging index, the lower the level of development. Thus, the ranking is from lower to higher figures.
2) The composite ranking of regional development is based on the regional development index in Table 4-12 calculated by standardizing the eight indices, multiplying by the weights, and adding them together.

B. Ripple Effects on the Regional Economy

Ripple effects on the regional economy are the quantified figures of increases in production volume, added value, employment, etc. resulting from projects. To measure ripple effects on the regional economy, the previous guidelines developed and used the KDI MRIO (Multi-Regional Input-Output) Model. This analysis model is applied to multiple projects to ensure consistency in the evaluation of ripple effects and to remove the inefficiency of spending so much in resources on building separate models for each individual project.

The KDI MRIO model is a table that, based on the Bank of Korea (BOK)'s 1995 national input-output table, divides the nation into 15 regions (Seoul special city, five metropolitan cities, and nine provinces) and classifies industries into 37 to have 555×555 endogenous sectors. Since most preliminary feasibility studies are about large-scale public construction projects, the KDI MRIO model subdivided the civil engineering and construction sector into 12 industries to measure the ripple effects of each area.

After the creation of the KDI MRIO, the BOK updated its IO table in 2000, so a new MRIO model needed to be built based on the more recent data. The Presidential Committee on Regional Development (PCRD) and the Presidential Committee on Northeast Asian Cooperation Initiative (PCNACI) devised an MRIO model based on the 2000 table to provide technical coefficients and trade coefficients among regions. These General Guidelines used the MRIO model built by the PCRD to analyze ripple effects on the regional economy.

The PCRD.PCNACI MRIO, a Chenery & Moses-type, competitive-type multi-regional input-output model, is similar to the KDI MRIO in the making, so it is believed that some degree of continuity can be guaranteed in the results. As it can also save a great deal of time and money, the PCRD.PCNACI MRIO is to be used in preliminary feasibility studies.

Compared to the KDI MRIO, the PCRD.PCNACI MRIO is based on the 2000 data and separated Ulsan, which became a metropolitan city independent of Gyeongnam Province in 1997, to reflect a more recent industrial structure and expand target regions. However, regarding industrial classification, while the KDI MRIO subdivides the construction industry into 12 industries, the PCRD.PCNACI MRIO deals with it as one.

This is because the PCRD.PCNACI MRIO is designed to analyze specialized regional industries and subdivided other industries. Nevertheless, it is possible to

analyze ripple effects into subdivisions of the construction sector as in the KDI MRIO. There is only a modest increase in the number of analysis steps. Ripple effects on the regional economy used in preliminary feasibility studies refer to effects to vitalize the regional economy. Using the PCRD·PCNACI MRIO is acceptable as focus is on regions, not on industries.

Interpretation of the induced effects of GRDP (Gross Regional Domestic Product), added value, employment, wages, etc., suggested as a result of MRIO model analysis of ripple effects on the regional economy, involves limitations as follows:

First, such effects do not directly translate into economic benefits. To convert economic ripple effects from an MRIO model into national economic benefits, the following conditions should be met: ① economic effects do not occur if the concerned project is not implemented; ② production factors inputted in the project are not used for other purposes if the project is not implemented; and ③ implementation of this project does not replace other economic activities43. It is believed that there are not many government-financed projects that can satisfy these conditions in Korea, where the unemployment rate is not high and land use is intensive. Nevertheless, as policy makers consider government-financed projects' ripple effects on the economy of underdeveloped regions, they are not reflected as economic benefits but considered in policy analysis.

Second, ripple effects on the regional economy from an MRIO model are limited to effects caused by project implementation. They only reflect direct effects and relevant effects that occur when government investment, an exogenous shock, is added in a demand-driven ripple effect model. For instance, induced effects of added value resulting from implementation of a road project only reflect effects occurring when total project costs to conduct the project are inputted in the concerned region. They do not reflect ex post facto effects resulting from laying of the road. To describe the economic induced effects through an MRIO model as 'ripple effects on the regional economy' would be to apply an overly broad definition of these ripple effects, but the term is still used because induced effects analyzed through an MRIO model have been used to describe the induced effects on the regional economy.

Accordingly, if it is believed that indirect economic ripple effects from project

[43] Adler, Hans A.(1987), Economic Appraisal of Transport Projects: A Manual with Case Studies, Revised and Expanded Edition, the World Bank, pp.33~37.

implementation are evident, the effects should be separately analyzed by a quantitative or qualitative approach. For instance, if a road project has noticeable effects like changing patterns of land use in the vicinity, increased regional investment, or revitalization of the tourism industry thanks to improved accessibility, separate evaluation items should be defined to be reflected in comprehensive evaluation.

a. Outline of the PCRD·PCNACI MRIO Model

Since the launch of the participatory government, a series of policies has been put into practice to develop Korea as the center of the Northeast Asian economy. Policies will likely be far less effective if they are worked out without considering the economic structure of regions and ripple effects inside and outside of them. As one way to maximize the effectiveness of policies to make Korea the economic center of Northeast Asia, the PCRD and PCNACI proposed to build an analysis model of ripple effects of policies and evaluate and reflect such effects in advance.

The PCRD and PCNACI provided an MRIO model, a general balanced statistical system built through model study, to the other areas of the public sector to help establish policy. The following looks at the structure, industrial classification, target regions, writing of input and trade coefficients, etc. of the PCRD·PCNACI MRIO model, major items that determine the characteristics of this model.

1) Model Structure

The PCRD·PCNACI MRIO model can be considered the most recent MRIO model as it is based on the 2000 national IO table announced by the BOK in the latter half of 2003.

An MRIO model is built by writing and combining estimates like regional technical coefficients, added value by region and industry, final demand by region, and regional trade coefficients. Table 4-14 is a simple example of two regions (L, M) and three industries (1, 2, 3).

▌Table 4-14▐ Example of an MRIO Structure (Two Regions, Three Industries, & Competitive Input Type)

Output / Input			Intermediate Demand		Final Demand		Total demand	Import	Net goods receipt	Total output
			Region L	Region M	Consumption, etc.	Export				
			Industry 1 Industry 2 Industry 3	Industry 1 Industry 2 Industry 3						
Intermediate input	Region L	Industry 1	10 15 20	5 10 15	40	15	130	5	-25	150
		Industry 2	20 10 40	15 25 20	50	35	215	10	5	200
		Industry 3	20 25 10	10 35 15	85	45	245	5	-10	250
	Region M	Industry 1	5 20 10	40 50 30	80	95	330	5	25	300
		Industry 2	25 10 30	70 30 90	70	30	355	10	-5	350
		Industry 3	10 35 30	60 80 80	100	25	420	10	10	400
Added value			60 85 110	100 120 150						
Total input			150 200 250	300 350 400						

Note: 1) Net goods receipt = Goods receipt —goods issued
2) Import and net goods receipt are deductions (A negative value means goods issued is bigger. When combined with total demand, total input by industry equals total output by industry).

2) Regional and Industrial Classification under the PCRD.PCNACI MRIO Model

The PCRD.PCNACI MRIO model covers the 16 regions of Seoul special city, six metropolitan cities, and nine provinces as in Table 4-15. In the model, each regional economy functions independently, affects the others, and is connected with the others through trade.

It is a competitive-type multi-regional input-output model with 34 industries as in Table 4-16, and the number of endogenous sectors is 544×544. The PCRD.PCNACI MRIO model's industrial classification is based on that of the BOK's 2000 IO table. It changed the IO table's classification to indicate 34 industries to measure the effects of regional strategic industries. Its classification added fine chemistry (including bioindustry) (no.9), machinery (including mechatronics) (no.12), precision instruments (including optical electronics) (no. 16), and culture (including tourism and IT software) (no. 28), etc.

▌Table 4-15▌ Regional Classification

Classification	Region
Special City	Seoul
	Busan
	Daegu
Metropolitan City	Incheon
	Gwangju
	Daejeon
	Ulsan
Province	Gyeonggi
	Gangwon
	Chungbuk
	Chungnam
	Jeonbuk
	Jeonnam
	Gyeongbuk
	Gyeongnam
	Jeju

▌Table 4-16▌ Comparison between the PCRD.PCNACI MRIO Model and National IO Table

	Trial Balance Classification	BOK IO Code (404)
1	Agriculture, forestry, & fishing industry	1101-1144
2	Mining	2101-2137
3	Food & beverages, tobacco	3101-3191
4	Textiles	3201-3219, 3231-3233
5	Clothing	3221-3226, 3241-3243, 3246
6	Footwear	3244-3245
7	Lumber & paper	3301-3319
8	Petrochemistry, rubber	3501-3604, 3621-3622, 3671-3683
9	Fine chemistry (including bioindustry)	3611-3612, 3631-3668
10	Non-metallic minerals	3701-3736
11	Primary metals and metals (steel)	3801-3911
12	Machinery (including mechatronics)	4001-4029
13	Electricity & home appliances	4101-4108, 4141-4145
14	Semiconductors	4113-4114
15	Information & communications devices	4111-4112, 4115-4132

▌Table 4-16▌ Continued

	Trial Balance Classification	BOK IO Code (404)
16	Precision instruments (including optical electronics)	4201-4206
17	Automobiles	4301-4307
18	Shipbuilding	4311-4313
19	Aerospace	4322
20	Other transportation equipment	4321, 4323-4324
21	Furniture and other manufacturing industries	4401-4417
22	Electricity, gas, and water supply	5101-5113
23	Construction	5201-5222
24	Wholesale & retail	6101-6102
25	Restaurant and lodging industry	6201-6202
26	Logistics	6301-6304, 6307-6308, 6310, 6312-6313
27	Seaborne logistics	6305-6306, 6309, 6311
28	Culture (including tourism and IT software)	3401-3404, 6404-6405, 6901-6906
29	Information & communications service	6401-6403
30	Finance and insurance	6501-6505
31	Real estate and industrial service	6601-6620
32	Public administration and defense	6701-6702
33	Education & social security	6801-6817
34	Social and other services	6911-6918

3) Characteristics of Estimation Methods

(1) Regional Technical Coefficients

Estimation of regional technical coefficients usually entails approaches like product mix, LQ (location quotient), RAS (bi-proportional adjustment), fabrication effects, etc. The PCRD·PCNACI MRIO model was written with the fabrication effects, LQ, and RAS approaches.

The product mix approach uses more segmentalized information by region and industry, but the difference among regions' industrial structures is determined only by the share of production volume of their downstream industries. Namely, the IO table's intermediate input rate of the downstream industries is applied to all regions, so the added value of the downstream industries uniformly applies to all regions. The LQ approach has the problem of disproportionality adjustment. The RAS approach is possible only with the intermediate input and demand data by regional industry, but as there is usually no available data on intermediate demand by

regional industry, the credibility of the entire model greatly depends on that of estimated intermediate demand data. The fabrication effects approach reflects the added value of each regional industry, but this greatly depends on the quality of added value data.

The PCRD·PCNACI MRIO model first applies the fabrication effects approach to reflect the difference in the added value ratio of each regional industry; then, the LQ approach to estimate the intermediate demand; and then the RAS approach to estimate technical coefficients for adjustment.

Estimation of regional technical coefficients depends largely on the availability of regional data. It is not an exaggeration to say that the evolution of the estimation methods has been determined by the availability of data, and for this reason, the credibility of a model likely depends on the quantity of regional data used, but not on the estimation method.

Use of more regional data, however, does not guarantee greater accuracy because the regional data is not trusted in Korea. This is because objective comparison and evaluation is difficult without an MRIO table resulting from direct investigation by a government institution with public confidence like the BOK.

As the model reflects the added value ratio by regional industry, it better suits the original goal of an MRIO table than the regional product mix approach, but the degree to which the fabrication effects approach is rectified by the RAS approach is unclear. In other words, the fabrication effects approach reflects the difference in the added value ratio among regions and thereby recognizes the difference in the productivity among regions. However, all intermediate inputs uniformly increase in the industries with a low added value ratio while all of them uniformly decrease in those with a high ratio. By estimating the initial intermediate demand amount by the LQ approach, the intermediate demand amount is underestimated in regional industries where its share is lower than the national average while it becomes the same as the national average in regional industries where its share is high. This gives rise to the problem of disproportionality adjustment. It is not clear how much this distortion is corrected in the RAS adjustment process.

The PCRD·PCNACI MRIO model has the merits of different methods, but their demerits become inherent in the model as well. It is significant as a new attempt, but it is too early to assess its usefulness. This matter requires more in-depth study.

In conclusion, we cannot know when building a model which methods can better explain the reality with regard to estimation of regional technical coefficients. Even so, the PCRD·PCNACI MRIO is very useful in that an MRIO table is written to ascertain the difference in the production structure of different regions, though this applies only when the data on the added value of each regional industry is credible.

(2) Regional Trade Coefficient

Trade coefficients among regions are the key to building an MRIO model. However, the data to learn about trade among regions is very limited and researchers choose different estimation methods.

The sectors of agriculture, forestry, fishing, and manufacturing use the Korea Transport Institute (KOTI)'s data on the quantity of goods transported for estimation, and the service sector depends on various methods for estimation. Existing models used KOTI's data from 1997 for the agriculture, forestry, fishing, and manufacturing sectors, and the simple LQ method, gravity model, entropy maximization model, etc. for the service sector.

The PCRD.PCNACI MRIO model used the entropy maximization model across all industries.

The major variables comprising the entropy model include production and demand by region and industry, transport cost per unit among regions, etc. Transport costs by product depend on researchers' arbitrariness. Total transport costs function like a budget constraint. An equilibrium solution that optimizes trade among regions is looked for within the scope of total transport costs. Data on production and demand by region and industry is earned through certain methods based on existing statistics, leaving almost no room for researchers' arbitrariness to intervene. However, transport costs among regions are calculated through various assumptions about distances among regions and transport costs by product, so each researcher will likely calculate a different figure. The entropy maximization model has been used for estimation of recent product transactions and transportation demand among regions, etc. It is regarded as the most developed model to learn about interregional trade. However, there are questions as to whether trade results among regions from the entropy model are realistic for the service industry. For instance, interregional trade happens in industrial service, etc., but it is difficult to know whether education, culture service and the like move among regions in a short time, even when their supply in a region is lacking.

In conclusion, it is very difficult to determine the relative superiority of any method without an actual survey due to the limited availability of data on interregional trade. Estimation by existing models is actual survey data but has limits in terms of interregional trade as well as the LQ method's general problem with regard to estimation of the service industry. In comparison, the entropy model is a theoretical model that induces optimization of interregional trade under the restrictions like production, demand, and transaction costs. It is a generally used and verified model.

(3) Model Validity

It can be said that the PCRD.PCNACI MRIO model has the integrity of an entire model in that it estimates and distributes the BOK's national IO table by the intermediate demand and final demand of each regional industry so that the total of regional IO tables equals the national IO table.

It also contains a relatively large amount of regional information with the estimation of final demand items like private consumption and fixed capital formation, allowing for more extensive use.

4) Analysis Methods for the Sub-Sectors of Construction

As explained above, the PCRD.PCNACI MRIO model has only one classification for the construction industry, which does not allow direct analysis by sub-sector of construction like buildings, roads, railroads, ports, and airports as in the KDI MRIO model.

This can be solved by an indirect method of using the intermediate input structure by sub-sector of construction under the BOK IO table and distributing investment expenditures into each industry.[44] Though this method adds one more step of analysis, it can subdivide the construction industry into 17 sub-sectors of Table 4-17 for analysis. This model is suitable for general use of regional IO tables, but it is also useful for more detailed analysis since its primary goal is the estimation of the ripple effects of public investment on the regional economy.

Investment expenditures in a road project, for example, are divided into each industry (34 industries here) according to the road facilities' intermediate input ratio by sub-sector (percentage based on total intermediate inputs being 1) under the BOK IO table for treatment as if exogenous demand increases so that the analysis process remains the same as before.

▎Table 4-17▎Classification of the Construction Industry under the BOK IO Table

Large-Sized	Medium-Sized (77 sectors)	Small-Sized (168 sectors)	Basic (404 sectors)
Construction	Construction & repair	Housing construction	Reinforced concrete/steel houses
			Other houses

[44] Refer to the distribution table of investment expenditures by industry when investing 100 billion won in the road sector in Table 4-18.

▌Table 4-17▌ Continued

Large-Sized	Medium-Sized (77 sectors)	Small-Sized (168 sectors)	Basic (404 sectors)
Construction	Construction & Repair	Non-housing Construction	Non-reinforced concrete/steel houses
			Buildings other than houses
		Repair	Repair
	Civil Engineering & Construction	Transportation Facility Construction	Road facilities
			Railroad facilities
			Subway facilities
			Port facilities
			Airport facilities
		Transportation Facility Construction	Road facilities
			Railroad facilities
			Subway facilities
			Port facilities
			Airport facilities
		Other types of civil engineering & construction	River anti-erosion work
			Water & sewage facilities
			Public works for agriculture, forestry, & fishing
			Urban civil engineering
			Electrical power facilities
			Communications facilities
			Other construction types

▌Table 4-18▌ Distribution of Investment Costs by Industry when Investing 100 billion won in the Road Sector

(Unit: 100 billion won)

	Classification	Investment Costs
1	Agriculture, forestry, & fishing industry	7.0
2	Mining	12.8
3	Food & beverages, tobacco	0.0
4	Textiles	0.5

▌Table 4-18▌Continued

(Unit: 100 billion won)

	Classification	Investment costs
5	Clothing	0.7
6	Footwear	0.3
7	Lumber & paper	14.0
8	Petrochemistry	36.4
9	Fine chemistry	5.9
10	Non-metallic minerals	303.4
11	Primary metals	242.0
12	Machinery	10.9
13	Electricity & home appliances	13.4
14	Semiconductors	0.0
15	Communications devices	0.7
16	Precision instruments	2.8
17	Automobiles	5.6
18	Shipbuilding	0.0
19	Aerospace	0.0
20	Other transportation equipment	0.0
21	Furniture and other manufacturing industries	0.4
22	Electricity and water supply	4.2
23	Construction	0.2
24	Wholesale & retail	31.0
25	Restaurant and lodging industry	0.0
26	Logistics	15.5
27	Seaborne logistics	2.1
28	Culture	2.7
29	Information communications	6.1
30	Finance & insurance	37.8
31	Industrial service	208.8
32	Public administration and defense	0.0
33	Education & social security	9.2
34	Social and other services	25.6
Total		1,000

b. Multiplier for analysis of ripple effects on the regional economy

IO analysis is to measure the direct and indirect ripple effects of change in final demand (consumption or investment) on the production activities of each industry. Economic ripple effects due to change in final demand are generally understood in three respects; effects on production inducement, effects on added value inducement, and effects on salaried employment & total employment inducement. Effects on added value inducement are divided into the induced effects of each item that comprises added value.

Here, each inducement coefficient will be explained to measure induced effects on wages, from among the production, added value, salaried employment & total employment, and added value items. Also looked at are ripple effects inside and outside regions.

1) Production Inducement Coefficient

(1) Ripple Effects in the Exogenous Area (Final Demand)

Inducement coefficients, namely the multiplier, vary according to the analysis purpose and the form of an IO table. An MRIO model is a competitive-type multi-regional IO model that does not distinguish between domestic products and import products. Its basic structure is shown in formula (4-1), and the production inducement coefficient is $(I-CA)^{-1}$, which is formula (4-1) without Y on the right. This form multiplies the general production inducement coefficient $(I-CA)^{-1}$ by a C matrix, where C distributes the final demand Y by region.

$$X=(I-CA)^{-1}C\cdot Y \qquad \text{..... (4-1)}$$

For instance, on the presumption of two regions (L, M) and two industries (1, 2) and the self-sufficiency rate of 70% in industry 1 of region L,[45] $C\cdot Y$ in this formula means that, if final demand of 10 billion won occurs in industry 1 of region L, 70% goes into industry 1 of region L and 30% into industry 1 of region M. Ripple effects are, therefore, measured by distributing in advance the final demand of 7 billion won in industry 1 of region L and 3 billion won in industry 1 of region M.

[45] This means 0.7 unit is supplied in region L and 0.3 unit in region M for one unit production in industry 1 of region L.

However, if new demand is limited to one region, $C \cdot Y$ should be Y and the production inducement coefficient should be $(I - CA)^{-1}$ as in formula (4-2).

$$X = (I - CA)^{-1} \cdot Y \quad \text{..... (4-2)}$$

The production inducement coefficient can use both formulas (4-1) and (4-2). Formula (4-1) distributes change in the final demand of a specific region through an input coefficient to not only the region but also all regions and all industries and then measures effects on production inducement. Formula (4-2) distributes the final demand change of a specific region only to all the industries of the region using an input coefficient to measure effects on production inducement. As such, if formula (4-1) is used as a production inducement coefficient, the final demand change of a specific region is distributed to the industries of other regions, so ripple effects within the region become markedly lower than in formula (4-2). To measure ripple effects on the regional economy, a production inducement coefficient as in formula (4-2) is generally used.

(2) Ripple effects in the endogenous sector (intermediate demand)

Multiplier to measure ripple effects in the endogenous sector is different from the case of final demand. For instance, when measuring ripple effects among industries due to investment into a specific area, the inducement coefficient is as follows:

$$X = (I - CA)^{-1} A_h \cdot Y \quad \text{..... (4-3)}$$

A_h here is the intermediate input coefficient vector of a specific area.

Instead of the inverse matrix of the inducement coefficient $(I - CA)^{-1}$ in formula (4-3), an inverse matrix that excludes a specific industry can be used.[46] This only considers the effects of a specific industry on other industries, and as the effects on its own industry are excluded, the ripple effects can be underestimated.

2) Added Value Inducement Coefficient

Increases in final demand create added value through production activities. The

[46] About this method, refer to p121~124 in the BOK's "IO analysis explanation - principles and practice" (1987).

added value inducement coefficient is to ascertain the functional relationship between change in final demand and added value using an IO model.

Added value belongs to gross production. When the coefficient matrix that diagonalizes the added value of each region is A^V (n×n diagonal matrix) and the gross production is X, the added value vector becomes $V = A^V \cdot X$. Substituting formula (4-1) into this formula produces formula (4-4), and the added value inducement coefficient is $A^V(I-CA)^{-1}$.

$$V = A^V (I-CA)^{-1} C \cdot Y \qquad \text{..... (4-4)}$$

The added value inducement coefficient becomes 1 in a model that does not distinguish between domestic and overseas areas. This is because the gross production X is as seen below from the perspective of supply and, when multiplying both sides by A^V, the added value becomes as in formula (IV-5).

$$X = (1-CA)^{-1} \cdot CY \qquad \text{..... (4-5)}$$
$$A^V X = A^V (1-CA)^{-1} \cdot CY$$

From the perspective of input, the gross production X is defined as in the first row: It becomes as in the second and third rows when written based on A^V:

$$\begin{aligned} X &= CAX + A^V X \\ A^V X &= (I-CA)X \\ A^V &= (I-CA) \end{aligned} \qquad \text{..... (4-6)}$$

Substitution of formula (4-6) into formula (4-5) produces:

$$\begin{aligned} A^V X &= (I-CA)\cdot(I-CA)^{-1} CY \\ A^V X &= CY \end{aligned} \qquad \text{..... (4-7)}$$

Substitution of formula (4-7) into formula (4-5) produces $A^V(I-CA)^{-1} = I$.

The sum of regional added values does not become 1 in a non-competitive-type MRIO model that distinguishes domestic products and import products. In this case,

the sum of the regional import inducement coefficient and the regional added value inducement coefficient becomes 1. This means some of the effect on production inducement resulting from change in regional final demand is regional imports and the rest is represented as regional added value.[47]

The added value items include remuneration for the employed (wages), operating surplus, consumption of fixed capital, indirect taxes, etc. To come up with an inducement coefficient for each of them, A^V of the added value inducement coefficient is replaced with each item's diagonal matrix.

3) Salaried Employment & Total Employment Multiplier

Production activity is basically made possible by combining intermediary goods with primary factors of production like capital and labor. As the production activity of relevant industries due to increased demand is accompanied by demand for labor, measuring labor's industrial ripple effects can provide important data for predicting labor demand and establishing relevant plans.

The salaried employment inducement coefficient is basically calculated by the same method as the added value inducement coefficient. Namely, it can be calculated by combining the production inducement coefficient and the labor coefficient. When the diagonal matrix of the labor coefficient is 1, $l \cdot (I - CA)^{-1}$ in the formula below is the labor inducement coefficient.

$$l \cdot X = l \cdot (I - CA)^{-1} \cdot Y \qquad \text{..... (4-8)}$$

The labor coefficient is a coefficient that divides the amount of labor inputted in production for a certain period (one year here) by gross production volume. As it means the amount of labor spent to produce one unit (one million won here), it is in a reciprocal relationship to labor productivity.

The labor coefficient can be divided into the salaried employment coefficient and total employment coefficient according to the scope of the amount of labor included. The salaried employment coefficient only covers salaried workers, and the total employment coefficient covers both the employed and the self-employed and unpaid family workers.

[47] Refer to p.30~31 of the BOK's '1990 IO table (making report)' (December 1993).

4) Multiplier of Ripple Effects Inside and Outside Regions

When demand occurs in a specific region, the production of regional industries causes production not only in the industries of the concerned region but also in those of other regions through goods receipt and goods issued. Overall induced effects can be divided into ripple effects within the industries of the concerned region and ripple effects outside the region.

Ripple effects inside and outside the region in an MRIO model can be known with the multiplier of all the areas like production, added value, wages, and employment. For instance, a production inducement coefficient matrix in two regions (L, M) and three industries is assumed as follows:

$$(I - CA)^{-1} = \begin{bmatrix} \alpha^{LL} & \alpha^{LM} \\ \alpha^{ML} & \alpha^{MM} \end{bmatrix}$$

$$= \left[\begin{array}{ccc:ccc} 1.126 & 0.447 & 0.300 & 0.479 & 0.418 & 0.153 \\ 0.628 & 1.317 & 0.606 & 0.552 & 1.115 & 0.323 \\ 0.512 & 0.526 & 1.100 & 0.335 & 0.470 & 0.247 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0.625 & 0.369 & 0.250 & 1.223 & 0.455 & 0.217 \\ 0.237 & 0.384 & 0.205 & 0.278 & 0.649 & 0.167 \\ 0.472 & 0.444 & 0.589 & 0.594 & 0.529 & 1.232 \end{array}\right]$$

Here α^{LL} refers to a production inducement coefficient that affects region L's industries when the final demand in region L's industries increases by one unit. When it is added together by column, this refers to the ripple effect inside the region on each industry of region L. When a vector (1×3) which adds up the α^{LL} matrix (3×3) by each column is O^{LL}, the intra-regional ripple effect on each industry of region L is as follows, and it is the same for (α^{MM}) of region M.

$$O^{LL} = [2.226 \; 2.902 \; 0.005], \quad O^{MM} = [2.094 \; 1.633 \; 1.615]$$

α^{ML} refers to effects on production inducement in region M brought about by final demand increasing by one unit in region L's industries. Namely, it means ripple effects outside the region (or interregional ripple effects) and α^{LM} is the opposite.

$$O^{ML} = [1.3341.1971.043],\ O^{LM} = [1.3652.0030.724]$$

When the overall effect on production inducement by increased demand for end goods in region L is O^{L} and that in region M is O^{M}, the total effect on production inducement inside and outside the regions is as follows:

$$O^{L} = O^{LL} + O^{ML} = [3.5993.4873.048]$$
$$O^{M} = O^{MM} + O^{LM} = [3.4593.6362.339]$$

c. Limits of Analysis Models and Cautions to note when Interpreting Them

It is true that an MRIO model provides useful information with regard to regional economic analysis, but it has its own limits, and the process of establishing a model and interpretation of estimation results also has many limits.

Two criticisms can be raised due to a model's own limits. First, it can be stated that an MRIO model faces the limit of the basic assumption of an IO table for the stability of input coefficients that products are homogeneous, and there is no economy of scale. However, this limit is inherent to IO analysis and is not unique to this model. Moreover, the assumption that there is no qualitative variance among products and no economy of scale is not unusual in economic analysis. In other words, this first criticism is not a serious issue.

The second criticism is that MRIO analysis only analyzes positive ripple effects from project costs and cannot consider together negative ripple effects from financing. Spending requires financing, and finances that would be invested somewhere else are inputted into the concerned project, limiting financing for other investments. This is the crowding out effect. The criticism is that even though opportunity costs occur, IO analysis fails to consider them. There is definitely a crowding out effect. However, a model that completely considers crowding-out effects is extremely rare, and to simultaneously analyze all ripple effects, a multi-regional, multi-sector model needs to be established. As very little regional time-series data is currently available, establishment of a multi-regional, multi-sector model is a task to be accomplished step-by-step.

Also, issues related to the process of establishing a model can be cited. Depending on the model used to estimate the trade coefficient of the interregional service sector, the estimation results can greatly vary. For instance, the MRIO model in this study used the entropy model but could have used the gravity model. It is a major shortcoming of models that the estimation results of regional trade volume depend on how a method to estimate interregional service trade is defined. Nevertheless, this is not a problem unique to this model, and it is not easy to find a better alternative when perfect regional data has yet to be developed to measure interregional trade volume.

Taking account of the aforementioned, the following should always be borne in mind when interpreting the estimation results of an MRIO table:

First, an MRIO model is to analyze indirect effects resulting from project spending and not to estimate economic benefits occurring due to the concerned project, namely ripple effects after project completion. Ripple effects on the regional economy are different from economic benefits after project completion that are used in cost-benefit analysis.

Second, related to the stability of input coefficients, the assumption is that input coefficients are constant during the analysis period of project spending. It is, therefore, impossible to learn about dynamic economic ripple effects that can occur due to change in the industrial structure, production technology, etc. over time. Analysis of dynamic ripple effects is possible only when dynamizing of the model precedes.

Third, as an MRIO model only analyzes positive ripple effects from project spending and does not consider together negative ripple effects from financing, relative comparison of economic ripple effects from project spending among projects is possible, but its usefulness is limited for absolute comparison among different projects or determining the absolute magnitude of effects of a specific project.

Even when comparing relative ripple effects among different projects, if the purpose of comparison is to know the relative size of interregional ripple effects, it should be borne in the mind that the difference of ripple effects is always inherent due to the difference in the input structure and investment distribution structure resulting from the different characteristics of projects, etc.

2. Consistency with Policy and Willingness to Pursue Projects

A. Consistency with Relevant Plans and Policy Directions

For large-scale government-financed projects to be selected for preliminary feasibility studies, they undergo multiple steps of planning by the central government or local governments. How systematically a responsible party pursues a project can be evaluated until a concrete project plan is produced. Cases where a responsible party establishes a plan and pursues a project alone in a short time are exceptional. A series of preparations until a concrete project plan is produced is reflected in high-level or relevant plans. As such, analysis on whether the concerned project is reflected in high-level or relevant plans can help determine whether the project has been pursued consistently with government policy.

As an example of relevant plans, there are plans of the corresponding sectors like the national backbone transportation network plan in the 'Comprehensive Land Development Plan' that suggests development directions for all of national land. Also, to review are the 'Basic Plan for Road Maintenance and Improvement' for road projects, 'Basic Plan for Nationwide Railroad Networks in the 21st Century' for railroad projects, and 'Second Mid-to-Long-Term Basic Plan for Airport Development' for port projects. Public sector plans held by the central government, local government, and Korea Expressway Corporation, etc. should also be reviewed. They may not be directly related to the concerned project but closely related to the process of pursuing and operating it.

A project's consistency with the policy direction of the competent ministry should be analyzed as well. Even when an explicit plan is in place, a policy goal set by the ministry is material to determining whether to push ahead with individual projects. On the contrary, the effectiveness of an existing long-term plan can decrease as the policy direction changes over time. In comprehensive consideration of this situation, consistency with relevant plans and policy directions is to be reviewed.

B. Willingness to Pursue and Preference for Projects

When determining whether to pursue a government-financed project, the attitude of the responsible ministry or local residents toward the project needs to be

considered for the following reasons: All government-financed projects have a spatial location where they are implemented, and ripple effects from project implementation can vary due to geographical proximity. Even when a project is essential from the perspective of the central government, it may not be acceptable to local residents. On the contrary, even if it has been long hoped for by local residents, it may have a low priority to the central government, which has to conduct policy across the nation.

If the target region or the responsible ministry objects to or is passive toward the project, problems can occur in the process of pursuing it even when the preliminary feasibility study finds it feasible. For instance, when a project opposed by local residents is pursued with priority given to the central government's needs, the project may become mired in social conflict in its implementation and come to a halt. On the contrary, even when the central government thinks a project is of low priority, it may still request a preliminary feasibility study in response to a petition by local residents.

It will not be easy to objectively analyze the degree of preference or objection of the parties interested in the project like the responsible ministry, local government, and local residents. In particular, when a project is not concretized, it is difficult to extensively investigate local residents' preference merely with one or two visits to the concerned region. It is possible to ascertain the authorities' willingness to pursue a project, but it is difficult to objectify it into an investigation report to be used to help make a policy decision.

Nevertheless, some basis for judgment can be secured in the process of visiting the responsible ministry and local government and hearing their opinions as part of a preliminary feasibility study. To reflect the interested parties' preference in the project, the study team requests data that is as concrete as possible like official documents that can be objectified to use as a basis for judgment. For instance, if a concrete basis that can reflect a target region's and responsible ministry's preference for and willingness to pursue a project is expressed in the form of a document like election pledges, it can be quoted in a report and the study team can add their opinions. If the interested parties show different attitudes toward the project, a survey can be conducted of them to ascertain their preferences.

As part of the evaluation of the willingness to pursue and preference for projects, the possibility of local residents' complaints about environmental problems is analyzed in 'environmental impact analysis.' As local residents' preference reflects political feasibility, the possibility of conflict due to environmental problems can be

included as part the 'willingness to pursue and preference for projects.' Since the importance of environmental issues continues to rise, there is a need to analyze environmental impact as a separate item. It will be difficult to separately judge the impact of project implementation on the ecosystem and the resulting attitude of local residents toward the project. Local residents' objection to the project due to environmental issues, etc. is, therefore, analyzed in 'environmental impact analysis' to be reflected in evaluation.

C. Level of Preparedness of Projects

The level of preparedness is about a project's concreteness. This concerns the level of detail of a project plan and the specific input of human and financial resources. In case of national road construction, once the decision is made to lay a specific section of a road, there is not much to change about the project and a regional construction management administration serves as a responsible party throughout the project. In such case, the level of preparedness may not be an important evaluation item. However, a concrete project plan is necessary in special projects like one for construction of a cultural facility.

A project plan needs to suggest the location of the project, its purpose, expected effects, strategy to pursue it, estimated project costs, ripple effects, etc. A higher level of preparedness can be interpreted as an indication that the purpose of a project and such are well aligned with policy and that the level of willingness to pursue is strong.

3. Risks in Pursuing Projects

A. Possibility of Financing

Public projects are generally funded with public money, by issuing bonds or attracting private investment. When the government is able to and willing to provide sufficient funds, the responsible party is able to issue bonds in the market or a private party willing to participate in the project can be found, financing is not a significant concern. This is the case for most national road construction projects.

For projects where local governments put up some of the necessary funds and

projects that are partially or wholly financed by a private party, the possibility of financing should be closely reviewed to ascertain whether they can proceed as planned. If projects impose significant financial strains on local governments in consideration of their fiscal condition, they can become delayed, suspended, or face other such problems. In PPP projects where the profitability is low, selecting a private investor and conducting negotiations can be time consuming. Even in the case of projects funded by the government, the possibility of raising necessary funds should be confirmed if the project costs are much higher than the given budget.

The evaluation of financing plans in the "General Guidelines (fifth edition)" excludes analysis on the suitability of government support which was conducted in the "General Guidelines (fourth edition)." This is because, in most projects subject to preliminary feasibility studies, the responsible ministry requesting the study suggests a legal and administrative basis for pursuing them, thereby justifying government support at least for the time being and rendering confirmation of every project for suitability of government support of little use. Also, such suitability is different in nature from the mid-level classification of 'risk factors in pursuing projects,' which can cause a problem in the evaluation structure.

For projects where the suitability of government support is raised as an issue due to their nature, this should be set as a project-specific evaluation item and be analyzed separately from a financing plan.

B. Environmental Nature

Environmental impact analysis roughly evaluates impact from project implementation. Environmental impact analysis does not have to be conducted for every project. In preliminary feasibility studies, environmental impact analysis is to ascertain in advance whether an environmental issue will occur in any step after preliminary feasibility studies and decide whether to pursue a project accordingly, and at the same time to raise the possibility of an environmental issue in the following steps and encourage more in-depth analysis.

For projects with potential environmental issues, the impact of project implementation is to be qualitatively and quantitatively evaluated through separate consultation with specialists, prior discussion, etc.

Also, as mentioned above, the possibility of local civil complaints due to an environmental issue when the project is implemented should be analyzed not in the

‘willingness to pursue and preference for projects’ item, but in the ‘environmental impact analysis’ item.

4. Project-Specific Evaluation Items

Unlike basic evaluation items, project-specific evaluation items are those that should be put into special consideration in the evaluation of projects. This renders defining and suggesting project-specific evaluation items in advance difficult. Nevertheless, categorizing project-specific evaluation items suggested in existing preliminary feasibility studies is helpful to select policy analysis items in future preliminary feasibility studies.

As the existing guidelines adopted a structure of basic evaluation items vs. project-specific evaluation items, the project-specific evaluation items suggested in the existing preliminary feasibility studies include those that fall under the mid-level classifications like ‘balanced regional development,’ ‘consistency with policy and willingness to pursue projects,’ and ‘risk factors in pursuing projects.’

Table 4-19 shows project-specific evaluation items from existing preliminary feasibility studies under new mid-level categories.

| Table 4-19 | Political Economy of Structural Reform Case Studies

Mid-Level Classification	Evaluation Items	Example
Balanced regional development	Fairness	Increased fairness between Yeongnam and Honam regions, development of border areas, investment equity in the Seoul metropolitan area, interregional fairness about the same section, etc.
Consistency with policy and willingness to pursue projects	-	Providing stable settlement conditions, security of water resources, etc.
Risk factors in pursuing projects	Propriety in methods of planning and implementing	Suitability of site selection, need to adjust project contents, suitability of the scale, problems with the responsible party and relevant ministries, issues of purchasing exhibits, possibility of pursuing relevant projects, etc.

| Table 4-19 | Continued

Mid-Level Classification	Evaluation Items	Example
Risk factors in pursuing projects	Technical feasibility	Possibility of technically difficult sections occurring, possibility of bottlenecks occurring due to project implementation, realizability, etc.
	Risks like civil complaints, diplomacy, national defence	Civil complaints, preservation of cultural assets, diplomatic issues, cooperation system with the military, opposition by the corresponding local government, etc.
Evaluation of projects' special characteristics	Suitability of government support	Suitability of government support, access roads meeting the purpose, etc.
	Unquantifiable benefits/additional effects	Reduced disruption of railroad service: When flood damage is prevented, disruption of railroad service due to rockslides, roadbed loss, etc. is also prevented, leading to road congestion prevention and efficient use of cargo by securing timeliness of cargo shipment.
	-	Overlapping investments with other projects, etc.

CHAPTER 5

Comprehensive Evaluation: AHP Method

Ⅰ. Multi-Criteria Analysis and AHP

1. Need for Multi-Criteria Analysis

The two major parts of preliminary feasibility study before this step are economic feasibility analysis and policy analysis. Economic feasibility analysis entails cost-benefit analysis as the basic methodology to estimate demand, benefits and costs, and then economic feasibility. Policy analysis entails analysis of basic evaluation items (estimation of ripple effects on the regional economy, evaluation of the level of regional development, evaluation of the possibility of financing, evaluation of consistency with relevant plans and policies, willingness to pursue and preference for projects, etc.) and analysis of project-specific evaluation items to reflect projects' specialty into evaluation.

The final step of preliminary feasibility study is synthesizing the results of economic feasibility analysis and policy analysis to make a final decision on whether to implement projects. Synthesizing the results of the two analyses involves the following difficulties:

The first difficulty is combining the results of the two analyses. The results of economic feasibility analysis are quantitatively represented by such figures as a BCR, NPV of net benefits, and IRR. Many evaluation items included in policy analysis are hard to quantify, including a region's willingness to pursue a project, possibility of getting fiscal support from the government, and consistency with relevant plans, and are, therefore, expressed qualitatively. For instance, it is not easy

to comprehensively evaluate the feasibility of a project which has a high BCR but is not consistent with high-level plans.

The second difficulty is about combining the same qualitative analysis items when they have different scales. For instance, if the BCR in a government-financed project is 0.9, which is less than 1.0, but the project can generate a significant number of jobs, say 2,000 jobs, it is difficult to decide whether to go ahead with the project or cancel it and by which standards.

The third difficulty is to both ensure consistent evaluation and reflect a project's specialty. Among projects subject to preliminary feasibility studies are national strategy projects, cultural asset protection projects, and the like where special evaluation items, not quantified within the framework of economic feasibility analysis, are much more important. Policy analysis in preliminary feasibility studies reflects such specialty in the framework of evaluation. There is, however, the risk that consistency in evaluation with other projects may decline if the special nature of a project assumes too much weight in comprehensive evaluation. For the preliminary feasibility study framework to retain its value as a general analysis framework, the impact that the special nature of a project has on determining whether to pursue it should be objectively evaluated.

The fourth difficulty is to collect and reconcile the opinions of multiple evaluators participating in comprehensive evaluation and draw a final conclusion. When there is only one evaluator performing comprehensive evaluation, only the feasibility of such judgment matters. But when putting together several people's opinions, issues arise such as how to come up with a representative comprehensive judgment and how to reach a final decision when individual researchers have opposing opinions on whether to pursue a project.

Multi-criteria analysis is suggested to overcome these difficulties. This is a decision-making method that considers multiple attributes to devise an optimal alternative that satisfies multiple objectives. The comprehensive evaluation of preliminary feasibility studies also considers multiple quantitative and qualitative evaluation items to distinguish projects that are feasible in terms of both economy and policy.

To find the most suitable methodology for comprehensive evaluation as part of preliminary feasibility studies, KDI compared and evaluated various methods of multi-criteria analysis, and adopted the Analytic Hierarchy Process (AHP) method. It has adjusted and applied the AHP method in a way that suits preliminary feasibility studies.

2. Outline of the AHP Method

The AHP method is one of the decision-making methods that help systematically evaluate alternatives with different levels of preference[48] when there are multiple decision-making goals or evaluation criteria.[49] It was developed by Thomas Saaty in the early 1970s and has been widely used for qualitative, multi-criteria decision-making. The AHP method gathers together evaluation attributes considered in decision-making as a homogeneous group, stratifies them into multiple levels, and analyzes and puts them together by each level to come to a final decision.

The most salient characteristic of the AHP method is that it divides and stratifies various evaluation items that comprise an issue into main items and detailed items, and performs pair-wise comparison of the items by stratum to know their relative level of importance. This method is recognized for its usefulness in that it breaks down and structuralizes issues in a way similar to human thinking and measures on a ratio scale the level of relative importance among evaluation items and preference for alternatives to come up with quantitative results. Despite the simplicity of its application, it is also well regarded theoretically as it uses techniques adopted by other various methods used in scale selection, weight calculation, and sensitivity analysis through empirical analysis and thorough mathematical verification. Thanks to these merits, the AHP method has been widely used in the transportation system design in Sudan carried out by Saaty in 1997 and in other areas like new technology selection, hospital service system design, and political issue resolution.[50]

The AHP method reflects qualitative characteristics of government-financed projects in evaluation and properly induces professional judgment by researchers participating in evaluation. Considering that a preliminary feasibility study is a step prior to a regular feasibility study and carried out in a short time with a small budget, the AHP method is significant in that it is simple and helps systematically analyze issues where decision-making is complex. The significance of the AHP method in conducting comprehensive evaluation in preliminary feasibility studies can be defined as follows:

First, it helps build social consensus and clarifies such process. By structuralizing a decision-making process, it can objectively collect socially-

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[48] This term represents how alternatives are evaluated according to the evaluation criteria and is called alternatives' preference, performance, attractiveness, etc. according to the need.

[49] This term represents the subject by which the preference of alternatives is compared and is called criteria, attributes, elements, etc. according to the need.

[50] Cases using the AHP method around the world can be found on the web site of Expert Choice at http://www.expertchoice.com/ and domestic cases at http://www.expertchoice.co.kr/.

recognized values about government-financed projects to come up with social consensus. It also clarifies the process to put together study results by evaluation item and come to a final decision and a basis for it so that a third party can evaluate the rationality and feasibility of the comprehensive judgment.

Second, it secures reliability for a decision to invest in the public sector. There has been criticism that government-financed projects are conducted according to political considerations or evaluators' arbitrary judgment. The government has invited such criticism against it to some degree due to its authoritative way of performing administrative works in the past. There were also no consistent standards for decision-making for government-financed projects. To overcome this criticism, consistent standards should be applied to many projects for a long time to increase confidence in decisions to invest in the public sector.

Third, it helps reduce evaluation errors among projects. In comprehensive evaluation, each evaluator engages in decision-making considering not only the characteristics of the concerned project but also basic standards for judgment common with other projects. For instance, the BCR is used as an important standard for judgment in most projects, and if the same BCR is differently interpreted among projects, there is the risk of a bigger evaluation error among them. In consideration of this, multi-criteria analysis suggests objective standards that can minimize evaluation errors among projects so that inconsistency in project evaluation due to different interpretation of the same standards can be reduced.

Fourth, it is used as data for evaluation of subsequent projects. Once a standard draft is suggested through a multi-criteria analysis model, it has the status of a kind of null hypothesis. In principle, this standard draft is to be applied to all projects, and unless specialty of a region or project is proven to change this standard, the same standard is to always be applied. This helps solve the problem of different evaluation results of similar projects when they are evaluated at different times.

In general, the AHP method entails the following steps:[51]

① Conceptualizing evaluation (conceptualizing)
② Finalizing evaluation standards and setting up a hierarchy structure (structuring)
③ Measuring the weights of the evaluation standards (weighting)
④ Measuring the preference of alternatives (scoring)
⑤ Calculating a weighted sum (synthesizing)

[51] Refer to the AHP analysis process under Section 2 of this chapter for the detailed guidelines on how to conduct each step.

⑥ Feedback
⑦ Drawing a comprehensive decision and policy suggestions (concluding)

3. Evaluator Selection

A preliminary feasibility study team consists of a project manager and multiple specialists, and their opinions are reflected in comprehensive evaluation to have group decision-making characteristics. The AHP method is a proper methodology not only for individuals' decision-making but also as an aid to group decision-making to put together group members' opinions and come to a final decision.

In group decision-making, the selection of group members directly impacts the decisions made, so evaluators should be carefully selected to comprehensively evaluate preliminary feasibility by the AHP method. Evaluators to perform comprehensive evaluation of preliminary feasibility should satisfy the following two conditions:

First, evaluators should be specialists with sufficient knowledge about the concerned project. They should be knowledgeable about the purpose of the project, requirements to meet the purpose, project details, relevant areas, etc. and be in a position to predict the project's socio-economic and policy ripple effects.

Second, they should have objectivity to evaluate government-financed projects from the perspective of the public interest. Even when one has specialized knowledge, thereby meeting the first condition, he may distort the decision-making if he has a personal interest in the project, with the result that the ultimate decision does not maximize the public interest.

Parties involved in government-financed projects can be divided into the following four groups: The first is the group of public officials, which includes those of the ministry of the central government responsible for the concerned project; the budget authorities that mediate different interests among ministries and set priorities among projects to assign a budget; and the local government of the city and province or the city, county, and *gu* district in the region where the project will be implemented. The second is the group of researchers in charge of government-financed projects, which includes those at the KDI performing preliminary feasibility studies; professors or researchers of research institutes in the concerned field; researchers of the KDI PIMAC (Public and Private Infrastructure Investment Management Center) responsible for preliminary feasibility studies; and researchers of private companies like engineering companies performing technical research and

consultation, etc. The third is local residents living in the region affected by the implementation of the project. The fourth is interest groups with interests in the project.

Among these, those who best satisfy the professionality and objectivity conditions required of evaluators of AHP-based comprehensive evaluation are central government officials responsible for budgets, projects managers of the KDI, researchers of the KDI PIMAC, professors in relevant fields, etc. Ultimately, these Guidelines excluded public officials responsible for budgets and included as evaluators researchers of private companies responsible for the technical part of preliminary feasibility studies. Public officials responsible for budgets are excluded because the comprehensive opinion of preliminary feasibility studies is that of participating researchers, and the budget authorities that decide the preliminary feasibility of projects have an opportunity to finally and directly reflect their opinion. Researchers of private companies in relevant fields like engineering are included to reflect the fact they are not only part of preliminary feasibility studies but also participate in social decision-making in various forms. Interested parties affected by government-financed projects like local residents and interest groups are excluded as they are believed not to be in a position to objectively judge the interests of all of society. Nevertheless, the various voices of interested parties in a diverse society are reflected in the decision-making process through various channels, which affects the political feasibility of project implementation. In consideration of this reality, evaluators in comprehensive evaluation are required through the AHP method to comprehensively evaluate the impact of project implementation on regional development to reflect the concerned region's opinions. They must consider, for example, the importance of regional development on the feasibility of a project; the demand of local residents and local governments for project implementation; ripple effects on the regional economy from project implementation; and development of less developed regions.

To reflect this, preliminary feasibility studies usually had three or four evaluators participate in AHP analysis for individual projects. However, this was cited as problematic in that one evaluator in such a small group could unduly bias the overall decision-making. These Guidelines, therefore, call for a group of seven or eight researchers to include more KDI evaluators and separate reviewers in AHP evaluation. The highest and lowest scores given by any two evaluators are excluded, and the results from the remaining five or six evaluators are used to come up with a weighted sum.

Ⅱ. AHP Analysis Process[52]

1. Conceptualizing

The first step of AHP analysis is conceptualization to form a conceptual framework about evaluation including its goal, evaluation items, alternatives, restrictions, evaluators, and interested parties. This conceptualization process allows evaluators to better understand the overall project like its characteristics and issues and to share information and critical thinking about the project. This step should be carried out at the early stage of a preliminary feasibility study to ensure clear understanding of the project along with the rest of the study.

Brainstorming is often done for efficient and effective conceptualization. It is a group creativity technique to uncritically enumerate as many considerations as possible about the concerned project and consider them one by one.

Preliminary feasibility studies entail the two following steps of brainstorming: The first step is brainstorming at the level of individual projects to increase the understanding of them and know about their characteristics through meetings among the project manager and joint research teams, visits to the responsible ministry and involved agencies, and visits to the concerned region. The second step is brainstorming at the level of all the projects of the corresponding type. The KDI preliminary feasibility study management team discusses the research results of the project with all the researchers participating in projects of the same type to find issues that are not found at the level of individual projects. This provides an opportunity to hear expert opinions from researchers performing preliminary feasibility studies on relevant or similar projects to ensure exchange of valuable information.

This two-step brainstorming allows the project manager to obtain information to comprehensively understand projects. The first type of brainstorming is conducted through official and unofficial procedures under the supervision of the project manager. The second type is performed under the supervision of the KDI preliminary feasibility study management team that comprehensively coordinates and manages preliminary feasibility studies.

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[52] For details on AHP analysis, refer to the 'Study to Supplement Comprehensive Evaluation Using AHP' of the "General Guidelines for Preliminary Feasibility Studies (fourth edition)."

2. Structuring

Next is structuring to review evaluation items identified at the conceptualization step and finalize evaluation standards, gather them into homogeneous groups, and hierarchize these groups at an appropriate level.

Evaluation items identified at the conceptualization step can vary in terms of importance and scope, ranging from the trivial to the important and from the detailed to the comprehensive. Also, as no terms were precisely defined in advance, evaluators may have different understandings of the same terms. For instance, economic feasibility analysis can mean cost-benefit analysis, and in some cases, can include aspects like ripple effects on the regional economy. As such, to finalize evaluation standards, the meaning of identified evaluation items should be clearly defined first to minimize potential for confusion and misunderstanding.

Once evaluation items for comprehensive evaluation are finalized, it is time to gather items with different levels of importance and scopes into homogeneous groups and stratify these groups at an appropriate level. In general, the items at a low level become detailed evaluation standards that concretize high-level items. At the highest stratum is comprehensive evaluation of preliminary feasibility, the final goal of decision-making. Preliminary feasibility is evaluated based on the results of economic feasibility analysis and policy analysis. Policy analysis involves basic evaluation items and project-specific evaluation items: basic evaluation items are those included in any preliminary feasibility study, and project-specific evaluation items are those which should be given due consideration in evaluating the concerned project.

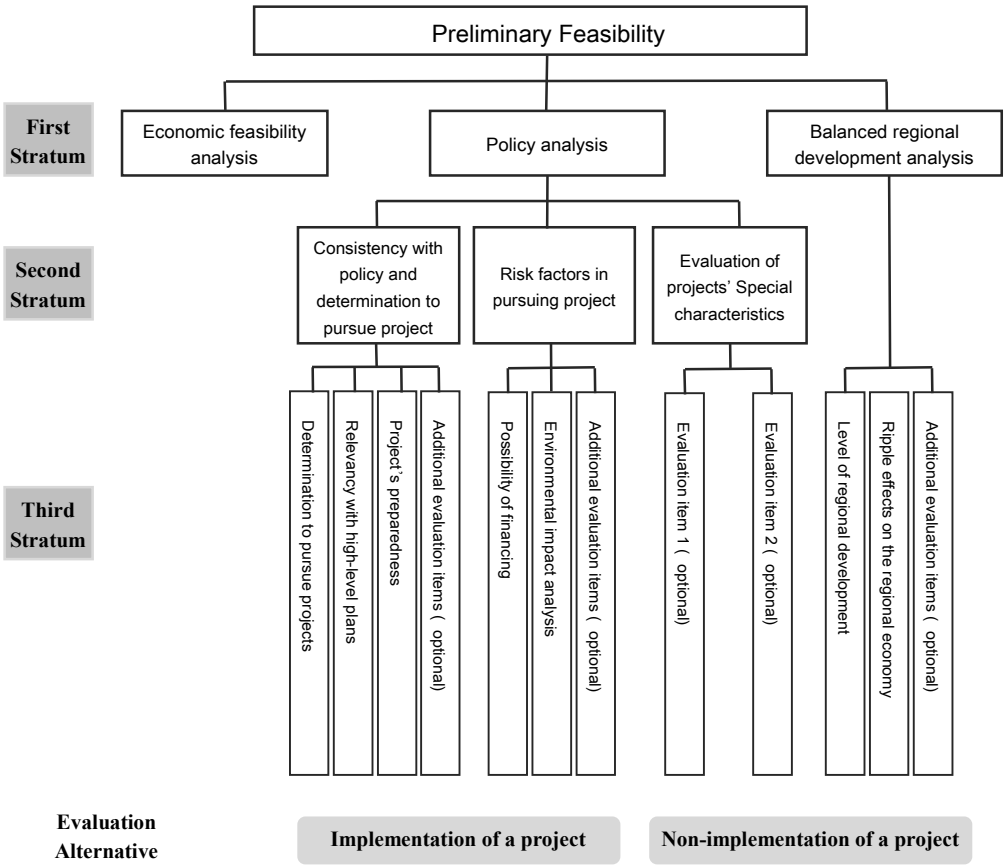
These Guidelines define the basic structure of AHP analysis in preliminary feasibility studies as in Figure 5-1. The final goal of AHP analysis is to evaluate the feasibility of projects. The first stratum consists of economic feasibility analysis, policy analysis, and balanced regional development analysis. The second stratum is of consistency with policy and willingness to pursue projects; risk factors in pursuing projects; and evaluation of projects' special characteristics (mid-level classification) comprising policy analysis. The third stratum is of the detailed evaluation items under the mid-level classification of policy analysis, and those under balanced regional development analysis.

These Guidelines partially changed the stratification system of the basic AHP structure in preliminary feasibility studies from the previous General Guidelines (fourth edition). Balanced regional development analysis, which had been included in policy analysis in the previous guidelines, was moved to the first stratum. It was first applied to preliminary feasibility projects in 2007 due to change to the "2006

Operating Guidelines for Preliminary Feasibility Studies" and was reflected in these Guidelines.[53]

The AHP structure separates items of which evaluation is connected, and this may render focusing on evaluation items difficult for evaluators who are unfamiliar with AHP analysis. Therefore, the previous guidelines set up an AHP structure with the evaluation items of three mid-level classifications and project-specific evaluation items according to evaluation details. These Guidelines adopted the meaning and operation of project-specific evaluation items without change from the previous guidelines.

▌Figure 5-1▐ Basic AHP Structure of Preliminary Feasibility Studies



[53] In case of R&D projects, the first stratum includes technical analysis items instead of balanced regional development, and balanced regional development is placed under policy analysis of the first stratum.

When setting up project-specific evaluation items in a structure survey and defining an AHP structure, the following two AHP axioms should be satisfied.[54] The first is the axiom of homogeneity and it should be possible to express the level of importance by a bounded scale within a limited scope. In other words, third-stratum evaluation items under a second-stratum mid-classification should have the homogeneity of a level that allows comparison. The second is the axiom of dependency, which means items under one stratum should be subordinate to those of an adjacent higher-level stratum. This, nevertheless, does not mean that there should be independence among all items within an adjacent low-level stratum with regard to all the items of a high-level stratum.[55]

In the structure survey process of preliminary feasibility studies, the study team should suggest an AHP structure in the structure survey questionnaire and concretely describe evaluation items, contents, etc. in a way that fits the form of Table 5-1. This is to clarify the meaning of identified evaluation items so that evaluators have the same understanding of them.

| Table 5-1 | Evaluation Items in a Structure Survey Questionnaire (e.g. Project to Improve a Railroad in a Mountainous Area)

Project-Specific Evaluation Items		Evaluation Details
Evaluation Item 1	Improving driving safety	Sections with less than a 400m curve radius exist intermittently along the railroad of which design standard is fourth grade. Even sections with a 250m radius span 10.5km, making improvement of driving safety urgent.
2	Reducing losses due to service disruption	When flood damage is prevented, disruption of railroad service is also prevented due to rockslides, roadbed loss, etc., which in turn prevents road congestion and allows efficient use of cargo by securing timeliness of cargo shipment.

The KDI preliminary feasibility study management team reviews whether the structure and evaluation items set by the study team are proper and suggests possible additional evaluation items to the study team.

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[54] There are also other AHP axioms like reciprocality and expectation. Under the reciprocal axiom, decision makers should be able to pair and compare two items within the same stratum and express the strength of preference. This strength of preference should satisfy the reciprocal condition. For instance, if A is regarded to be x times as important as B, it means B is 1/x times as important as A. The expectation axiom is based on the assumption that the stratums should comprehensively include matters about the goal of decision-making.

[55] Jo, Geuntae, Jo, Yonghyeon, and Hyeonsu Kang, 2003, "*Analytical Hierarchy Decision-Making*," Donghyeon Publishing Company, Seoul, Korea, p.4

The lowest stratum of the AHP hierarchy is divided into an alternative to 'implement a project' and an alternative 'not to implement a project.' Project proposals of which implementation is determined at this step are those judged to be the best from among multiple alternatives presented for preliminary feasibility study. This means the final goal of decision-making is that researchers participating in preliminary feasibility study decide whether to implement an optimal alternative of their choice.

3. Weighting

This step is where the level of relative importance is determined among evaluation items at each stratum of the hierarchy structure. Evaluators repeatedly answer questions that compare the relative importance (or preference) between evaluation items regarding all the pairs of two evaluation items belonging to the same group and stratum. This pair-wise comparison process represents evaluators' judgment as verbal expressions and grants quantified scores corresponding to such expressions. Relative evaluation through pair-wise comparison requires a credible evaluation scale. This scale should be set in a scope that can reflect the maximum differences that humans tend to sense. The AHP method uses a scale of nine points as a basic type based on research results in the cognitive psychology area.

▎Table 5-2▎Scale of Importance used for Pair-Wise Comparison

Verbal judgment	Quantitative scoring
Extreme preference	9
Between extreme preference and very strong preference	8
Very strong preference	7
Between very strong preference and strong preference	6
Strong preference	5
Between strong preference and weak preference	4
Weak preference	3
Between weak preference and equal preference	2
Equal preference	1

Note: Saaty and Vargas, 1982.

As the weights of economic feasibility analysis and policy analysis at the highest stratum have a big impact on the weighted sum, the previous guidelines set the scope of preliminary weights (45%-56%) for economic feasibility analysis to reduce motivational bias in case of road and railroad projects.

These Guidelines set the calculation scope of weights for different analysis areas as in Table 5-3 according to the change in the "2009 Operating Guidelines for Preliminary Feasibility Studies":

▌Table 5-3▐ Scope of Preliminary Weight Calculation

Classification	Economic feasibility	Technical feasibility	Policy feasibility	Balanced regional development
Construction project	40~50%	-	25~35%	15~30%
R&D · informatization	30~50%	50~70%		-
Other non-investment finance areas	25~50%	-	50~75%	-

For the weights of low-level evaluation items, Saaty's nine-point scale is used to measure the relative importance between two items through pair-wise comparison and ultimately estimate the relative weights among the items. When an evaluator performs a pair-wise comparison a total of ${}_nC_2$ times for n number of evaluation items in one level, he can know the actual relative weights, and using these, compose the following pair-wise comparison matrix $A_{n\times n}$:

$$A=\left[a_{ij}\right]=\begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & & & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix} \quad (5\text{-}1)$$

where a_{ij} that comprises matrix A is the estimate of w_i/w_j, the relative weight of element i to element j. Matrix A is a reciprocal matrix where the element values of the principal diagonal all become 1 $\left(a_{ji}=1/a_{ij}\right)$.

When multiplying matrix A by column vector $w=(w_1,w_2,\cdots\cdots,w_n)^T$, the weight that represents the level of relative importance among evaluation items, it becomes formula (5-2).

$$\begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & & & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix} \cdot \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = \begin{bmatrix} nw_1 \\ nw_2 \\ \vdots \\ nw_n \end{bmatrix} \quad (5\text{-}2)$$

$$A \cdot w = n \cdot w \quad (5\text{-}3)$$

Here n is the maximum eigenvalue of matrix A and the number of rows (or columns). Formula (5-3) is an eigenvalue problem to calculate a non-zero value from a series of n number of simultaneous equations. The w value calculated from formula (5-3) is used as a weight vector by evaluation item.

Matrix A is calculated based on pair-wise comparison by determining the relative importance of elements above the diagonal, using the level of importance of elements in each row as 1. If the original a_{ij} of matrix A obtained from pair-wise comparison has the value of w_i / w_j, cardinal consistency should obtain. In other words, $a_{ij} \times a_{jk} = a_{ik}$ should be valid. The meaning of $a_{ij} \times a_{jk} = a_{ik}$ is that if i is thought to be x times as important as j and j is thought to be y times as important as k, i is evaluated to be $x \times y$ times as important as k. However, it is difficult to maintain such consistency completely in actual answers, so there is a need to verify the cardinal consistency of matrix A. If answers to pair-wise comparison do not maintain complete consistency, their credibility can be questioned.

In AHP analysis, the degree of consistency in answers is represented as an 'inconsistency ratio.' An inconsistency ratio of zero means the answerers keep perfect consistency in pair-wise comparison. According to Saaty, if the inconsistency ratio is less than 0.1, pair-wise comparison is judged to have rational consistency, and if it is less than 0.2, an acceptable level of inconsistency is recognized. If the ratio is 0.2 or higher, consistency is lacking, suggesting the need for re-study. These Guidelines set the maximum allowable inconsistency ratio at 0.15, and answerers who exceed the 0.15 ratio are to increase consistency through feedback.

4. Scoring

This step is to score preferences for alternatives based on each evaluation item. Table 5-4 shows scoring standards for preliminary feasibility studies. From among

evaluation items chosen in advance, economic feasibility analysis and balanced regional development analysis (level of regional development, ripple effects on the regional economy), etc. use quantitative indices like the BCR, regional development index, and index of ripple effects on the regional economy. Other evaluation items are qualitatively evaluated based on information collected in the study process.

▎Table 5-4▎Evaluation Description and Scoring Standards for AHP Evaluation Items

Evaluation Item	Evaluation Description	Scoring Standards	Remarks
Economic feasibility analysis	■ Project feasibility from an economic aspect	■ BCR, NPV, IRR, etc. resulting from analysis	■ The higher the BCR, the higher the project implementation score.
Balanced regional development analysis			
Level of regional development	■ Need for the project from the aspect of balanced regional development	■ Regional development index and ranking (Based on the level of development of the representative city .county if the project spans over multiple cities.counties)	■ The less developed the region, the higher the project implementation score; and the more developed the region, the lower the project implementation score.
Ripple effects on the regional economy	■ Ripple effects on the regional economy resulting from implementation of the project	■ $\frac{\text{Amount of added value within region}}{GRDP}$ and information collected in the study process is used for qualitative evaluation	■ The greater their share and the stronger the effects, the higher the project implementation score.
Policy analysis			
Consistency with policy and willingness to pursue projects			
Consistency with relevant plans and policy directions	■ Reflection of high-level and relevant plans ■ Consistency with policy directions pursued by the competent ministry	■ Qualitative evaluation of information collected in the study process	■ The more concretely they are reflected and the higher the consistency, the higher the project implementation score.
Determination to pursue projects and preference	■ Central government, local government, and local residents' willingness to pursue, preference for and level of long-standing demand for the project	■ Qualitative evaluation of information collected in the study process	■ The greater the determination, the higher the project implementation score; and the greater the opposition, the lower the project implementation score.
Project's preparedness	■ A project's concreteness such as a concrete plan, input of human and financial resources, etc.	■ Qualitative evaluation of information collected in the study process	■ The greater the preparedness, the higher the project implementation score.
Risk factors in pursuing projects			
Possibility of financing	■ Realizability of the financing plan	■ Qualitative evaluation of information collected in the study process	■ When there is no problem with financing, the AHP score is '1', and if there is a problem, the project implementation score declines.
Environmental nature	■ Rough evaluation of the project's impact on the surrounding environment and the possibility of environmental issues occurring when the project is implemented ■ Possibility of local conflicts due to environmental issues	■ Qualitative evaluation of information collected in the study process	■ When there is no problem with the environment, the AHP score is '1', and if there is a problem, the project implementation score declines.
Project-specific evaluation items			

During the scoring process, special care should be taken to ensure that scoring of specific evaluation items is independent from that of others. For instance, a general attitude toward project feasibility should not be reflected in the scoring of individual evaluation items. The evaluation items of regional development and ripple effects on the regional economy have different scoring standards, but their scoring is often connected because they belong to the same mid-level classification: 'balanced regional development.' One of the strengths of the AHP method is increasing information processing ability of humans in that it determines whether to pursue a project based on one characteristic by evaluation item.

As in the step of setting up weights, AHP analysis in preliminary feasibility studies is done to learn the relative suitability between an alternative to implement a project and an alternative not to implement a project through pair-wise comparison based on each evaluation item, and perform scoring. In principle, Satty's 9-point scale is used as a scoring scale here too. Nevertheless, the following two considerations should be made in scoring.

First, a problem arises in evaluating the relative suitability of an alternative to implement a project and an alternative not to implement a project when scoring the evaluation items of 'possibility of financing' and 'environmental nature,' which are not problematic in most projects. For instance, it should be determined whether to give a score of 9 points for the suitability of an alternative to implement a project in terms of environmental nature if there is no environmental issue when the project is implemented, or give 1 point to be neutral with an alternative not to implement a project. In the case of a project to lay a short national road with no problem of financing, there can be a problem with evaluation of the suitability of an alternative to implement the project. The AHP analysis of preliminary feasibility studies sets the maximum score of possibility of financing and environmental nature at 1 in both cases. This means that the fact there is no problem with environmental nature or financing does not facilitate implementation of the project but does not negatively impact its implementation.

Second, standard scores are granted to quantified evaluation items to ensure consistency in the evaluation of different projects. These Guidelines have standard score conversion formulas for economic feasibility analysis and the regional development index where consistent evaluation is especially required. Economic feasibility analysis uses cost-benefit analysis in all preliminary feasibility studies to resolve the issue of researchers making different judgments about the same BCR.

The following standard score conversion formulas are used for the BCR and regional development index:

- Standard score conversion formula for the BCR:

$$\text{BCR Standard Score} = 5.11532 \times \ln(B/C) + i \quad (5\text{-}4)$$

$$B/C \geq 1 \rightarrow i = 1, \quad B/C < 1 \rightarrow i = -1$$

- Standard score conversion formula for the regional development index:

$$\text{Standard score of the regional development index} = \alpha + i \quad (5\text{-}5)$$

$$\alpha = 0.81220 + 2.23298 \times LIR - 0.29626 \times LIR^2 + 0.74302 \times LIR^3 + 0.32728 \times MIR^2$$

$$\alpha \geq 0 \rightarrow i = 1, \quad \alpha < 0 \rightarrow i = -1$$

LIR is the standardized value of the ranks of cities.counties in terms of the level of regional development

MIR is the standardized value of the ranks of cities.provinces in terms of the level of regional development

One of the important goals of preliminary feasibility studies is to increase the objectivity of decision-making about public investments by applying consistent evaluation standards to various government-financed projects. As such, it is desirable to ensure consistency in the evaluation of comparable, quantified indices calculated based on common standards.

5. Synthesizing

This step entails calculating the weighted sum of each alternative by multiplying the weight of each evaluation standard by the score of alternatives for each standard. An alternative with the highest weighted sum from among alternatives compared is chosen by the AHP model.

As mentioned in the discussion of evaluator selection, comprehensive evaluation of preliminary feasibility by the AHP method has a group decision-making characteristic. As such, a process is necessary to combine the weights of evaluation items, scores of alternatives, and weighted sums used and given by individual evaluators into the evaluator group's common weights, scores, and weighted sums.

The first way to combine individual evaluators' evaluation is to convert the results of all pair-wise comparison matrixes determined by individuals into the group's pair-wise comparison matrixes using a geometric mean, and then apply the eigenvector calculation method. The second is to apply the eigenvector calculation method to individuals' pair-wise comparison matrices to come up with priority vectors for weights and scores, and then determine a geometric mean on these vector values. These Guidelines adopted the second way because it is more appropriate for reflecting comprehensive judgment by an expert group.

6. Feedback

Feedback is another feature of AHP analysis that renders it more useful. This review process provides respondents with low consistency in their answers with information on inconsistency and allows them to perform decision-making again to reduce inconsistency in decision-making. If a decision-maker fails to properly answer formalized questions, the AHP hierarchy structure should be reconsidered. This is also true when the definition and explanation of any element comprising the AHP hierarchy structure is wrong. If the degree of inconsistency is severe and consistency does not improve in the feedback process, the hierarchy structure of evaluation items needs to be reorganized or the concepts of stratums and elements need to be defined or explained again before an AHP survey is conducted again.

In preliminary feasibility studies, data for AHP analysis is collected through two structuralized questionnaires: the 'structure questionnaire' and 'answer questionnaire.' This data collection method involves risk that a deviation may occur depending on the evaluators' level of understanding of the AHP method, evaluation items, prior attitude toward the projects, etc. Of course, the KDI preliminary feasibility study team explains the AHP method in detail to all team members and has in-depth discussions to build up an AHP structure. Nevertheless, it is true that the AHP method entails restrictions in communication for decision-making, as a tool that supports decision-making by experts, compared to direct AHP analysis by researchers

When consistency is high in decision-making as a result of AHP analysis, for instance, when all evaluators judge that it is appropriate to go ahead with or reject a project, it is not difficult to draw a conclusion on the feasibility of a project despite the above limitations of the AHP method. There are cases, however, where the AHP score of one evaluator is very high and adversely affects the overall scoring results, despite the fact that the evaluators are split 2:2 or 1:3. In such cases and other cases where the robustness of decision-making is low, there is a need for an additional

procedure where the evaluators discuss evaluation results.

When the opinions of evaluators do not coincide in a group decision-making process and thereby conflicts occur, it is desirable to use a group dynamics management technique. The assumption behind group dynamics is that a small group has interactions where its members affect each other in a process to resolve issues or make decisions, and to manage this is to maximize the process gains and minimize the process losses that occur as a result of the interactions. A group decision can be achieved through consensus building, negotiation, voting, etc. If comprehensive evaluation is drawn merely by combining individual evaluations, which is a form of voting, without an effort to build a stronger consensus, a single uniform conclusion is produced, but the evaluators may not accept that their opinions are duly reflected.

A project manager of a preliminary feasibility study should use a group dynamics technique to draw a comprehensive opinion by consensus. Specifically, if the results of decision-making drawn from AHP analysis are not robust, all evaluators can get together and explain the basis for their evaluation through discussion and debate to build a stronger consensus. Also, AHP analysis can be conducted again in the process of discussion and debate to narrow differences in evaluators' opinions.

7. Concluding

The last step of the AHP method is to choose between an alternative to implement a project and an alternative not to implement a project based on weighted sums drawn from feedback, and to come up with policy suggestions.

The final deliverable from AHP analysis is the weighted sum of an alternative to 'implement a project' and an alternative 'not to implement a project,' each calculated by multiplying the weight of each evaluation standard by the scores of the alternatives for each standard. Under the previous guidelines, if the 'project implementation' alternative receives a higher weighted sum (higher than 0.5) than the alternative 'not to implement a project,' the project was considered feasible. This mechanical way of drawing a conclusion was instituted because the final results of a preliminary feasibility study are basic data to be used for a binary decision as to whether or not to allocate a budget to pursue a project.

However, there are limitations as follows when judging whether to implement a project based on AHP analysis results: the first is when evaluators' opinions do not coincide. In particular, when their opinions are divided into 2:2, though the weighted

sum of AHP analysis produces a score indicating whether or not to implement a project, it is difficult to conclusively determine whether or not to pursue the project without consensus among the evaluators. In such case, rather than making a binary decision, it is desirable to state each evaluator's opinion and the reasons therefor in the report.

The second is when the difference between the alternative to implement a project and the alternative not to implement a project based on their weighted sums is insignificant, with the result that there is no robustness in decision-making. Often asked when deciding whether or not to implement a project based on an AHP weighted sum is 'whether the difference between AHP weighted sums of 0.51 and 0.49 is big enough to make a binary decision about a project's feasibility.' The previous guidelines required a binary decision despite the fact that this question cannot be stated with confidence because the ultimate goal of preliminary feasibility studies is to ascertain whether or not the project is feasible. Nevertheless, the previous guidelines tend to rely excessively on AHP analysis results despite the limits of AHP analysis.

In consideration of this, these Guidelines establish a grey area as follows to ensure a cautious approach in making a final decision:

$0.5 - 0.05 <$ AHP weighted sum $< 0.5 + 0.05$,

Namely, $0.45 <$ AHP weighted sum < 0.55

The grey area refers to an area where the weighted sum may change if the researchers change. If the AHP score falls in a grey area, the researchers need to take a cautious approach in making a comprehensive conclusion through AHP analysis.

There is also a need to change this grey area according to the level of consistency among evaluators' opinions. We can assume some level of confidence because coincidence in the opinions of the evaluators means that the evaluators' population mean is not very different from the sample mean. However, when their opinions do not coincide, their population mean can be very different from the weighted sum. Accordingly, it is necessary to establish a wider grey area if the consistency among evaluators' opinions is lower. In consideration of all this, a grey area is to be applied according to the following principles:

First, when all of four evaluators agree, their opinions are combined to come up with a comprehensive opinion depending on whether the AHP score is higher than 0.5.

Second, if they are divided by 3:1, a confidence interval of 84% is to be applied. If the sample mean is higher than 0.55, the project is considered to be feasible, and if the AHP score is lower than 0.45, the project is considered to be unfeasible. If the

AHP score is no lower than 0.45 and lower than 0.55, the interpretation is that it falls in the grey area.

Third, if they are divided by 2:2, a confidence interval of 95% is to be applied. If the AHP score is higher than 0.58, the project is considered to be feasible, and if the AHP score is lower than 0.42, the project is considered to be unfeasible. If the AHP score is in between, the tone of results should be brought down and a grey area acknowledged, and a conclusion should be drawn cautiously.

If the ratio of evaluators for and against project implementation is 3:1 and the AHP score of the alternative to implement the project is lower than 0.45, or the ratio is 1:3 and the AHP score of the alternative to implement is higher than 0.55, then one evaluator's judgment throws excessive weight. This cannot be seen as decision-making where a consensus was established through sufficient discussion. In this case, the feedback process should be performed so that evaluators achieve a consensus through group dynamics management. If the same result occurs even after feedback, a conclusion should be cautiously drawn.

▎Table 5-5 ▎Opinion Consistency among Evaluators and Conclusion According to AHP Scores

Weighted Sum Implementation: Non-Implementation	AHP < 0.45	0.45 ≤ AHP <0.5	0.5≤ AHP <0.55	0.55 ≤ AHP
4 : 0	-	-	Feasible	Feasible
3 : 1	Feedback	Very cautious	Slightly cautious	Feasible
2 : 2	AHP<0.42 Not feasible AHP>0.42 Slightly cautious	Cautious	Cautious	AHP>0.58 Feasible AHP<0.58 Slightly cautious
1 : 3	Not feasible	Slightly cautious	Very cautious	Feedback
0 : 4	Not feasible	Not feasible	-	-

Note: 1) 'Implementation: non-implementation' refers to a ratio of evaluators deciding to implement a project to those deciding not to do so (based on four persons).
2) 'AHP' refers to the AHP weighted sum of the project implementation alternative
3) The '-' means that nothing is applicable.

In the end, a conclusion differs depending on the consistency of opinions among evaluators and whether the weighted sum is within or outside the grey area. If the score is outside the grey area, a comprehensive conclusion can be more clearly made on whether or not to implement the project. If not, the researchers should make it

clear that the score falls in the grey area and use a reduced tone or be cautious when making a conclusion. The more divided the opinions, the more cautious the conclusion should be.

Ⅲ. Matrix Tables Summarizing Preliminary Feasibility Study Results

The last step in a preliminary feasibility study is to write summary tables of the study, include them in a preliminary feasibility study report, and submit relevant files to the KDI preliminary feasibility study management team. The summary tables can show all the contents of the study in a condensed and concise way. Having the tables consistent with the input formats of the preliminary feasibility study database which has been built since 2004 can facilitate the construction of the database. The summary tables to be included in a preliminary feasibility study report and computer data to be submitted to the KDI preliminary feasibility study management team are as follows:

1. Summary Tables to be Included in a Preliminary Feasibility Study Report

Summary tables to be included in a preliminary feasibility study report are as follows:

- <Summary 1> Comprehensive summary of Preliminary Feasibility Study
- <Summary 2> Request for Preliminary Feasibility Study
- <Summary 3> Summary of assumptions of Economic Feasibility Analysis
- <Summary 4> Summary of main issues of Preliminary Feasibility Study
- <Summary 5> Summary of Policy Analysis
- <Summary 6> AHP Analysis Results
  - <Summary 6-1> Weights by Evaluator and Evaluation Item
  - <Summary 6-2> AHP Scores by Evaluator
- <Summary 7> Conclusion and Policy Suggestion

For convenience of explanation, the case of the “Preliminary Feasibility Study on a Mountainous Railroad Improvement Project” published in 2006 is used.

▌Summary 1 ▌Comprehensive Summary of Preliminary Feasibility Study for Mountainous Railroad Improvement Project

<table>
<tr><th>Classification</th><th colspan="2">Alternative Ⅰ</th><th colspan="2">Alternative Ⅱ</th></tr>
<tr><td>Main contents (within 2,000 letters)</td><td colspan="2">■ Line that goes via Yemi, Jungnyeom, and Sabuk. It is a plan to improve the alignment by closing the Jodong, Jamiwon, and Jungsan stops and the existing Hambaek line and directly connecting Yemi and Sabuk. The new line will allow for horizontal alignment and greatly reduce the length.
■ The line is characterized as follows:
✓ A signal station needs to be set up at Jungnyeom for direct connection to the Jeongseon line.
✓ A double track for railroad and subway is planned for the section from Jungnyeom to Byeoreogok to prevent any disruption on the Jeongseon line.
✓ Horizontal alignment can be generally achieved except for the Byeoreogok to Sabuk section, where a 23% steep slope is inevitable.
✓ For direct connection with the Jeongseon line, the Jungnyeom to Byeoreogok section needs to be double tracked and 86% of the entire length is tunnels, increasing project costs.
✓ With the closure of the Jungsan station, opposition by the residents near the station is expected.</td><td colspan="2">■ Line that goes via Yemi, Jungsan, and Sabuk. It is a plan to improve the alignment between Jungsan and Sabuk by closing the Jodong and Jamiwon stops and the existing Hambaek line and directly connecting Yemi and Jungsan. The new line will allow for horizontal alignment and greatly reduce the length.
■ The line is characterized as follows:
✓ It will be generally a gentle slope alignment, allowing for high driving efficiency.
✓ Unnecessary signal stations and stops will be closed, increasing efficiency in the operation and maintenance of the tracks.
✓ Generally horizontal alignment except for the R=600 section before Jungsan.
✓ Single tracking for the entire line and tunnels will account for 92% of the entire length.
✓ - There will be fewer local petitions because the stations to be closed are not heavily used.</td></tr>
<tr><td rowspan="2">Project description & scale summary</td><td colspan="2">Railroad alignment improvement
(existing line length: km/length in this project: km)</td><td colspan="2">Railroad alignment improvement
(existing line length: km/length in this project: km)</td></tr>
<tr><td>33.200km</td><td>18.900km</td><td>33.200km</td><td>18.640km</td></tr>
<tr><td>Project costs</td><td colspan="2">372.112 billion won</td><td colspan="2">288.126 billion won</td></tr>
<tr><td>BCR</td><td colspan="2">0.34</td><td colspan="2">0.47</td></tr>
<tr><td>NPV</td><td colspan="2">-109.981 billion won</td><td colspan="2">-62.426 billon won</td></tr>
<tr><td>IRR</td><td colspan="2">-</td><td colspan="2">-</td></tr>
<tr><td>Feasibility</td><td colspan="2">No</td><td colspan="2">No</td></tr>
<tr><td>Optimum</td><td colspan="2">No</td><td colspan="2">Yes</td></tr>
<tr><td>AHP score</td><td colspan="2">-</td><td colspan="2">0.452</td></tr>
</table>

Note: Regarding feasibility, it is the feasibility of an alternative comprehensively evaluated (economic feasibility, policy aspects, etc.) by the study team, and there can be multiple feasible and infeasible alternatives. Regarding the optimum, it is an alternative judged to be the best (even when it is not feasible) from among those considered by the study team, so there should be only one alternative falling under this item.

Summary 2 Request for Preliminary Feasibility Study for Mountainous Railroad Improvement Project

Classification	Description	
Project region	Gangwon, North Gyeongsang Province	
Sub region	Jeongseon County, Bonghwa County	
Project description & scale summary	Mountainous railroad improvement project (Taebaek & Yeongdong lines)	
	Taebaek line (Yemi to Sabuk) : 33.2km	Yeongdong line (Yeongju to Seokpo) : 76.8km
Responsible party	Government (Ministry of Land, Transport and Maritime Affairs)	
Total project costs	550.9 billion won	
Financing method	Entirely financed by the government	
Project period	7 years (3 years for design, 4 years for construction)	2010
Project purpose (within 500 letters)	■ Flood damage and disruptions to safe service occur every year due to the steep slopes and curves of the mountainous region and deterioration of facilities like bridges. ■ Disaster prevention can reduce restoration costs for flood damage and ensure safe railroad operation.	

Note: All the resulting amounts are calculated to the unit of 1 million won and recorded in the unit of 100 million won to the second decimal place. For instance, 72.035 billion won is expressed as 720.35.

Summary 3 Summary of Assumptions of Economic Feasibility Analysis for Mountainous Railroad Improvement project

Classification	Description
Base year	2004
Analysis period	30
Discount rate	6.5
Main assumptions (Within 4,000 letters)	■ Demand is estimated and benefits are calculated until 2031, the final target year in the KTDB network and O/D. The annual benefits outside the target years are calculated using the interpolation method, and benefits and costs after 2031 are supposed to be the same as the values of 2031. ■ As most of the line of this project will be tunnels, no cost to restore flood damage is assumed to occur after the implementation of this project in the calculation of the benefit of flood damage reduction. ■ For benefits from reductions in maintenance and improvement costs, present value conversion is done to calculate an average mean only in projects where no more spending will be required when this project is implemented based on data on maintenance and improvement costs inputted before (the detailed items do not overlap with maintenance costs calculated under the cost estimation of Chapter IV). ■ For benefits from sale of sites to be closed, tracks and streetcar tracks need to be removed, but their main materials, rails, and steel will be sold along with wooden railroad ties. As a result, separate removal costs are not considered.

▌Summary 4▐ Summary of Main Issues of Preliminary Feasibility Study for Mountainous Railroad Improvement Project

Classification	Description
Main issues (Within 4,000 letters)	(Example omitted)

▌Summary 5▐ Summary of Policy Analysis for Mountainous Railroad Improvement Project

Policy Analysis Items		Analysis Description (within 2,000 letters, each)
Balanced regional development		
	Level of regional development	(Example omitted)
	Ripple effects on the regional economy	(Example omitted)
	Additional evaluation items	(Example omitted)
Consistency with policy and willingness to pursue projects		
	Consistency with relevant plans and policy directions	(Example omitted)
	Willingness to pursue and preference for projects	(Example omitted)
	Additional evaluation items	
Risk factors in pursuing projects		
	Possibility of financing	(Example omitted)
	Environmental nature	(Example omitted)
	Additional evaluation items	
Project-specific evaluation items		
	Improving driving safety	■ Though the design standard of fourth grade is applied to the Taebaek line, sections that do not meet the minimum curve radius of 400m suggested in the 'Rule on National Railroad Construction' for fourth-grade railroads occur intermittently along the line. Even sections with a 250m radius span 5.261km, making improvement of driving safety urgent.
	Reducing losses due to service disruption	■ When flood damage is prevented, disruption of railroad service is also prevented due to rockslides, roadbed loss, etc., in turn preventing road congestion and allowing efficient use of cargo by ensuring timeliness of cargo shipment.

▌Summary 6▐ AHP Analysis Results for Mountainous Railroad Improvement Project

▌Summary 6-1▐ Weights by Evaluator and Evaluation Item

Evaluation Items	Compre-hensive	Evaluator 1	2	3	4	5	6
Economic feasibility analysis	0.470	0.450	0.500	0.500	0.400	0.500	0.450
Policy analysis	0.317	0.300	0.250	0.350	0.350	0.350	0.300
Consistency with policy and willingness to pursue projects	0.143	0.077	0.114	0.155	0.250	0.223	0.043
Consistency with high-level plans	0.114	0.058	0.095	0.103	0.219	0.186	0.032
Willingness to pursue projects	0.030	0.019	0.019	0.052	0.031	0.037	0.011
Risk factors in pursuing projects	0.063	0.031	0.023	0.059	0.050	0.090	0.129
Possibility of financing	0.037	0.024	0.006	0.044	0.006	0.068	0.107
Environmental impact analysis	0.027	0.008	0.017	0.015	0.044	0.023	0.021
Project-specific evaluation items	0.111	0.191	0.114	0.136	0.050	0.037	0.129
Improving driving safety	0.088	0.143	0.085	0.108	0.044	0.027	0.107
Reducing losses due to service disruption	0.022	0.048	0.028	0.027	0.006	0.009	0.021
Balanced regional development	0.213	0.250	0.250	0.150	0.250	0.150	0.250
Level of regional development	0.142	0.167	0.167	0.100	0.167	0.100	0.167
Ripple effects on the regional economy	0.071	0.083	0.083	0.050	0.083	0.050	0.083
Inconsistency ratio	0.007	0.033	-	0.016	-	0.033	-

Note: When regional balance is separated, the weights of the level of regional development and ripple effects on the regional economy under the classification of balanced regional development are set at 2:1.

▌Summary 6-2▐ AHP Scores by Evaluator

Evaluator	Decision to Implement	Decision not to Implement
Comprehensive	0.452	0.548
Evaluator 1	0.495	0.505
Evaluator 2	0.466	0.534
Evaluator 3	0.426	0.574
Evaluator 4	0.442	0.558
Evaluator 5	0.454	0.546
Evaluator 6	0.440	0.560

Classification	Description
Conclusion (within 2,000 letters)	(Example omitted)
Policy suggestion (within 2,000 letters)	(Example omitted)

2. Computer Data to Submit to the KDI Preliminary Feasibility Study Management Team

Computer data to submit to the KDI preliminary feasibility study management team is as follows:

- <Computer data 1> Annual cost-benefit flow (Excel format)
- <Computer data 2> Financial feasibility analysis table (Excel format)
- <Computer data 3> AHP analysis results (Excel format)
  - <Computer data 3-1> Weights by evaluator and evaluation item
  - <Computer data 3-2> AHP scores by evaluator
- <Computer data 4> Survey results to review the possibility of attracting private investment and financial feasibility analysis
- <Computer data 5> Project region and alternative line map: in an image file format that can be used on a PC (*.bmp, *.jpg, *.png, etc.)
- <Computer data 6> Raw data to estimate total project costs (Excel format)
- <Computer data 7> Raw data for transportation analysis
  - O/D and network data
  - Bank file
- <Computer data 8> Meeting presentations
  - <Computer data 8-1> Presentations, review opinions, and comparison tables at progress reporting
  - <Computer data 8-2> Presentations, review opinions, and comparison tables for interim reporting at PIMAC
  - <Computer data 8-3> Presentations, review opinions, and comparison tables for interim reporting at MOSF
  - <Computer data 8-4> Presentations, review opinions, and comparison tables for final reporting at PIMAC
  - <Computer data 8-5> Presentations, review opinions, and comparison tables for final reporting at MOSF
- <Computer data 9> Interim and final reports, and comprehensive summary table

- <Computer data 9-1> Interim report
- <Computer data 9-2> Final report
- <Computer data 9-3> Comprehensive summary table

Acronyms

AHP	Analytical Hierarchy Process
BCR or B/C	Benefit-Cost Ratio
BOK	Bank of Korea
BOO	Build-Own-Operate
BOT	Build-Operate-Transfer
BTL	Build-Transfer-Lease
BTO	Build-Transfer-Operate
CAM	Conjoint Analysis Method
CAPM	Capital Asset Pricing Model
CCL	Civilian Control Line
CVM	Contingent Valuation Method
GRDP	Gross Regional Domestic Product
IRR	Internal Rate of Return
ITS	Intelligent Transportation System
KDI	Korea Development Institute
KOTI	Korea Transport Institute
KTDB	Korea Transport Database
KWRC	Korea Water Resources Corporation
LQ	Location Quotient
MEST	Ministry of Education, Science and Technology
MDL	Military Demarcation Line
MLTM	Ministry of Land, Transport, and Maritime Affairs
MOPAS	Ministry of Public Administration and Security
MOSF	Ministry of Strategy and Finance
MRIO	Multi-Regional Input-Output
NPV	Net Present Value
OMB	U.S. Office of Management and Budget
O/D	Origin/Destination
O&M	Operation & Management
P/A	Production-Attraction
PB	Payback Period
PCNACI	Presidential Committee on Northeast Asian Cooperation Initiative
PCRD	Presidential Committee on Regional Development

PFI	Private Finance Initiative
PFS	Preliminary Feasibility Study
PI	Profitability Index
PIMAC	Public and Private Infrastructure Investment Management Center
PPP	Public-Private Partnerships
PSC	Public Sector Comparator
RFP	Request for Proposal
RSF	Reassessment Study of Feasibility
TAZ	Traffic Analysis Zone
TPC	Total Project Costs
VAT	Value Added Tax
VfM	Value for Money
WACC	Weighted Average Cost of Capital
WSS	Water Service Statistics
WTP	Willingness to Pay
YTM	Yield to Maturity

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Appendix 1

Survey to Evaluate the Possibility of PPP Project at the Preliminary Feasibility Study Step

(First-Step Checklist)

This survey is to comprehensively evaluate the possibility of private investment for Project A at the step of its preliminary feasibility study. Please answer each question from the perspective of a specialist.

Name: _____

Organization: _____

Position: _____

Contact no.: ☏_____ fax: _____e-mail:_____

A. How to Answer Survey Questions

1. This questionnaire is intended to preliminarily decide whether to pursue the optimal alternative selected by the study team as a PPP project.
2. If the optimal alternative falls under each question, mark √.
3. Please read the evaluation guidelines, structure, and details, and summary of the study before answering the questions.
4. Examples of answers

| Table 1 | Checklist Evaluation (First-Step) at Preliminary Feasibility Study of Project A (example)

Evaluation item	Survey question		Check box	
Feasibility in terms of law and policy	1	Is this a facility subject to private investment under Article 2 of the Act on Public-Private Partnerships in Infrastructure?	Yes	No
	2	Does the project suit the government's mid- & long-term SOC plans, policy directions, investment priories, etc.?	Yes	No

B. Evaluation Items

1. First-Step Evaluation Items

▌Table 2▐ First-Step Checklist Evaluation Items at Preliminary Feasibility Study of Project A

Step	Evaluation item	Evaluation item description	How to score	Remarks
Step 1	Feasibility in terms of law and policy	▪Legal feasibility of the concerned project including whether it is one of the 45 types of facilities subject to private investment under Article 2 of the Act on Public-Private Partnerships in Infrastructure ▪Whether it suits mid- & long-term SOC plans, and the investment policy and priorities of the government or competent authority.	Required items	Can move to the next step only if "yes" is selected
	PPP project implemen-tation method	▪BTO or BTL according to whether users are willing to pay higher usage fees and there is profitability, which are part of the principles of selecting PPP projects		

2. PPP Project Implementation Method

▌Table 3▐ PPP Project Implementation Method: BTO vs. BTL

Type	1	2	3	4	5	6
1. Core service	O	O	O	△	X	X
2. Usage fee	O	O	X	O	O	X
3. Profitability	O	X/△	X	O	X	X
Case	Expressway, light rail transit, port	Environment treatment facility, railroad	National road, sewer system	Theme park, public rental housing	Museum, science museum	School, military facility, welfare facility
PPP project implementation method	BTO	BTL/BTO	BTL	BTL/BTO	BTL	BTL

3. Study Results Summary

The following is the summary of analysis results of the optimal alternative in terms of economic feasibility and policy. Please refer to the following to answer the questions.

□ Optimum alternative of this project:

Summary of the optimum alternative

□ Economic analysis results of the evaluation draft

- Total project costs (100 million won):
- BCR:
- IRR (%):
- NPV (100 million won):

4. Questions for Checklist Evaluation

□ The following questions are intended to determine whether this project can be pursued as a PPP project.

- Please refer to the 'study results summary' above.
- Please mark √ on 'Yes' or 'No' to the following questions:

a. Feasibility in Terms of Law and Policy

Evaluation item		Survey questions	Check box (√)	
Feasibility in terms of law and policy	1	Is this a facility subject to private investment specified under Article 2 of the Act on Public-Private Partnerships in Infrastructure?	Yes	No
	2	Does the project suit the government's mid- & long-term SOC plans, policy directions, investment priories, etc.?	Yes	No

※ Can be a PPP project if all the answers are 'yes.'

b. PPP Project Implementation Method

Evaluation item		Survey questions	Check box (√)	
PPP project implementation method	1	Can the private party provide infrastructure and service under its responsibility without government support with regard to the construction and operation of facilities?	Yes	No
	2	Can a usage fee be charged on facility use?	Yes	No
	3	When charging a toll/usage fee, can users opt for alternatives?	Yes	No

※ It is a BTO project if all the answers are 'yes.'

Appendix 2

Survey to Evaluate the Possibility of PPP Project at the Preliminary Feasibility Study Step

(Second-Step Checklist)

This survey is to comprehensively evaluate the possibility of private investment for Project A at the step of its preliminary feasibility study. Please answer each question from the perspective of a specialist.

Name: _____

Organization: _____

Position: _____

Contact no.: ☏_____ fax: _____e-mail:_____

A. How to Answer Survey Questions

☐ Please perform qualitative evaluation of each item (projects′ economic feasibility, ease of management, creativity and efficiency, risk distribution, and public nature) in consideration of the results of economic and financial feasibility analysis, basic data, issues identified, and cases of similar projects.

☐ The competent project manager is to write a report that is as concrete as possible about the basis for evaluation and comprehensive judgment by the study team.

B. Evaluation Items

1. Second-Step Qualitative Evaluation Items

▎Table 1▎Second-Step Qualitative Evaluation Items at Preliminary Feasibility Study of Project A

Step	Evaluation item	Evaluation item description	Remarks
Step 2	Economic feasibility	To determine feasibility as a PPP project, the possibility to secure value for money in total project costs and whether the project is economically feasible should be checked first.	Write a concrete report about the basis for evaluation and comprehensive judgment
	Ease of management	Whether the concerned service can be independently provided and the required level of performance can be met.	
	Creativity & efficiency	Whether the private sector's creativity is used to increase efficiency in SOC construction and operation and competition with other public investment facilities is facilitated to improve service quality.	
	Risk distribution	Whether risks can be appropriately distributed when pursuing with private capital, and the scale and facilities of the project have any restriction in providing service, when seen from the government's perspective	
	Publicness	Whether participation by a private party can generate the ripple effects of improvement in technology, management skill, etc. in the public sector	

Appendix 3

Guidelines for Writing an Analysis Table of Financial Feasibility

▎Table 1▎ Detailed Table of Total Project Costs/Investment Costs

Classification	Total	First year	Second year	Remarks
Research cost				
Design cost				
Construction cost				
Lot purchase cost				
Incidental cost				
Operating facility cost				
Various taxes & charges				
Operating reserve				
Total project costs				
Interest during construction				
Contingencies				Contingency reserves for price fluctuation
Total investment costs				

▎Table 2▎ Summary of Financial Feasibility Analysis (e.g. Road Project)

		Usage fees	
		1.5 times the toll of the Korea Expressway Corporation	2 times the toll of the Korea Expressway Corporation
Government financial support ratio	30% of construction costs	PI/FNPV/IRR	PI/FNPV/IRR
	50% of construction costs	PI/FNPV/IRR	PI/FNPV/IRR
FNPV = 0		Financial support ratio	Financial support ratio

Note: Different rates of government financial support and usage fees are to be applied to different areas.

Table 3 Analysis Table of Profitability

Year		Income					Cost					Total of present values
		Financial support	Operating revenue	Other revenues	Total		Construction costs	Operating costs	Corporate tax *	Total		
					Before discount	After discount				Before discount	After discount	
2008	1st year of construction											
2009	2nd											
2010	3rd											
2011	4th											
2012	5th											
2013	6th											
2014	7th											
2015	1st year operation											
2016	2nd											
2017	3rd											
2018	4th											
2019	5th											
2020	6th											
2041	27th											
2042	28th											
2043	29th											
2044	30th											
Total												

Note: * Different from the corporate tax of the income statement.

Different projects use different items for operating revenue and operating cost (including cost of sales) as follows:

Table 4 Operating Revenue and Operating Cost (Including Cost of Sales)

Sector	Operating Revenue Items	Operating Cost Item (Cost of Sales)*
Road Project	Toll Income	Road Maintenance Cost
Railroad Project	Fare Income	Operating Cost
Port Project	Usage fee of port facilities or of loading and unloading service	Operating Cost of Loading and Unloading Equipment or Facility Maintenance Cost
Lease Project	Lease Income	Facility Maintenance Cost, etc.

Note: Whether there are other revenues like those of supplementary projects, operating costs to generate them should be added.

Table 5 Estimated Income Statement

	Operating period										Total
	2015	2016	2017	2018	2019	·····	2041	2042	2043	2044	
	1st	2nd	3rd	4th	5th	·····	27th	28th	29th	30th	
Sales (A=B+C)											
Operating revenue (B)											
Other revenues (C)											
Cost of sales (D=E+F)											
Amortization cost of operation rights (E)											
Maintenance costs (F)											
Gross profit (H=A-D)											
Selling and general administrative costs (I)											
Operating profit (J=H-I)											
Interest income (K)											
Paid interest (L)											
Net profit before corporate tax (M=J+K-L)											
Corporate taxes (N)											
Current-term net profit (O=M-N)											

Table 6 Estimated Statement of Financial Position

	Construction period					Operating period				
	2008	2009	·····	2013	2014	2015	2016	·····	2043	2044
	1st	2nd	·····	6th	7th	1st	2nd	·····	29th	30th
Assets										
Current assets										
Cash and cash equivalents										
Non-current assets										
Construction-in-progress										
Management and operation rights										
Liabilities										
Current liabilities										
Short-term borrowings										
Corporate tax payable										
Current portion of long-term debts										
Long-term liabilities										
Long-term borrowings										
Shareholders' equity										
Capital stock										
Retained earnings/ accumulated deficits										
(Current-term net profit)										
Liabilities and shareholders' equity										

Table 7 Estimated Statement of Cash Flows

	Construction period					Operating period				
	2008	2009	·····	2013	2014	2015	2016	·····	2043	2044
	1st	2nd	·····	6th	7th	1st	2nd	·····	29th	30th
Cash flows from operating activities										
Incoming cash flows										
Operating revenue										
Other revenue										
Interest income										
Outgoing cash flows										
Cost of sales (maintenance cost, etc.)										
Selling and general administrative costs										
Paid interest										
Corporate taxes, etc.										
Cash flows from investing activities										
Incoming cash flows										
Outgoing cash flows										
Investment costs (interest during construction included)										
Purchase of tangible assets										
Cash flows from financing activities										
Incoming cash flows										
Increase in capital stock										
Increase in borrowings										
Increase in government subsidies										
Outgoing cash flows										
Repayment of borrowings										
Payment of dividends										
Increase in cash										
Cash at the beginning of the term										
Cash at the end of the term										

The following are guidelines to fill out the above tables. To draft an analysis table of profitability and financial statements, the sheets of financial analysis provided by the KDI are to be used.

A. Overall Order

① The sheets of financial analysis include the analysis table of profitability, statement of cash flows, income statement, and statement of financial position. The analysis table of profitability is the basis, and the other three sheets are to be automatically filled out.
② The values of the analysis table of profitability and the inflation rate are used to come up with values for the income, cost, government subsidy items in the statement of cash flows and income statement.
③ Interest income and interest cost for accumulated borrowings are calculated from the statement of cash flows.
④ Corporate tax from which a tax shield on the interest income and interest cost computed from the income statement are removed is a current price. It should be discounted by the inflation rate to convert it into a constant price. This is to be used as corporate tax in the analysis table of profitability.
⑤ All the items of the analysis table of profitability are filled out as above, and the FNPV is to be calculated at the time of analysis to come up with the PI, NPV (FNPV), IRR (FIRR), payback period (PB), and discounted PB.
⑥ The statement of financial position is not directly related to the analysis table of profitability. It is written to come up with operation rights by accumulating construction costs and interest during construction, and divide it by the free use (operating) period to calculate depreciation cost.
⑦ The items of the analysis sheets are used according to the type and characteristics of the concerned project.
⑧ The unit of each analysis table is 100 million won.

B. How to fill out the Analysis Table of Profitability

① For NPV analysis, income and cost items are filled out with values. The fields to be filled in by the user (yellow cells) are the selling and general administrative cost rate, government subsidy rate, income items (operating revenue and other revenues), and cost items (construction costs, maintenance costs, and selling and general administrative costs).

② The 2008 'Basic Plan for PPP Projects' is referred to in order to determine the financing ratio of equity capital by the investor as no less than 25% of total PPP costs.

③ First calculate the FNPV for a case where no government subsidy is paid (government subsidy rate of 0%) and for a case where a certain level of government subsidy is provided (e.g. 30% for a road project). Then, by trial and error, calculate a rate of government subsidy that makes the FNPV zero. This analysis sheet is composed in a way to automatically calculate the government subsidy of the corresponding year of the construction period according to the order of fund inputs (equity capital→government subsidy→borrowings) once the subsidy rate is set for all construction costs.

④ The income items consist of operating revenue and other revenues generated from ancillary projects or supplementary projects. Users are to directly enter values they separately calculated into the corresponding item fields.

e.g. 1) Road Project

- Enter toll income into the operating revenue field. Multiply the traffic volume of each transportation means estimated for the road section of each year by the length of the section and then again by the toll per km.
- Reflect the differences in the toll rates and traffic volume between the Korea Expressway Corporation and a private party as the responsible party.
- For supplementary income, lease income from advertising boards and convenience facilities can be considered.

e.g. 2) Railroad Project

- Deduct the number of free passengers from the net number of passengers and multiply the resulting number by the toll (average toll of the section, etc.) to come up with operating revenue.

⑤ The cost items consist of construction costs and operating costs (maintenance costs + selling and general administrative costs + replacement costs of tangible assets), and values from economic feasibility analysis are used.

- Construction Costs (sum of research costs, design costs, construction costs, lot purchase costs, incidental costs, operating facility costs, taxes and charges, and operating reserve from among the details of total investment costs) are distributed over the construction period according to the rate of completion used in economic feasibility analysis.
- Enter a value from economic feasibility analysis for the maintenance costs. When computing operating costs by considering selling and

general administrative costs, replacement costs of tangible assets, etc. in addition to maintenance costs in economic feasibility analysis, do not distinguish among cost items and integrate them into operating costs as one item.
- When considering other revenues like that of supplementary projects for operating revenue, corresponding operating costs must be factored in.
- Additional costs and reinvestment costs should be reflected according to the characteristics of other projects.
- When the concerned project is exempted from VAT under the Value-Added Tax Act and Restriction of Special Taxation Act, 10% VAT must be included in calculation to use costs calculated from economic feasibility analysis. Nevertheless, if a zero tax rate is applied as in urban railroad construction projects, such should be considered.

⑥ Deduct a tax shield on interest income and cost from the corporate tax computed in the income statement and apply the inflation rate to the resulting corporate tax.

⑦ Come up with a PI, FNPV, and FIRR according to ①~⑥. For a PB and a discounted PB, the user is to find years when the 'accumulated profit and loss becomes zero' and the 'net accumulated profit and loss becomes zero' by looking at the 'accumulated profit and loss' and 'net accumulated profit and loss' rows.

C. How to fill out the Income Statement

① The sales, maintenance costs under the costs of sales, and selling and general administrative costs in the income statement are computed by increasing the corresponding items of the analysis table of profitability by the inflation rate.

② Calculate amortization cost of management and operation rights and depreciation cost based on the acquisition costs of the target assets using the straight-line method.
- The depreciation base is computed based on the statement of financial position.
- The depreciation period is 30 years for transportation projects like roads, railroads, ports, and airports; 50 years for water resource projects like dams; and 30 years for formation projects of cultural and tourism complexes.

③ The interest income and paid interest (interest cost) are the same as the corresponding values in the statement of cash flows. The base of interest income is the amount calculated by deducting repaid borrowings from 'cash

flows from operating activities + cash flows from investing activities + incoming cash flows from financing activities - dividend payment under outgoing cash flows from financing activities.'

④ Paid interest is the same as the paid interest amount from the statement of cash flows.

⑤ For corporate tax, apply 13% (14.3% when residence tax is included) for a taxable amount of no more than 100 million won and apply 25% (27.5%) for an amount exceeding 100 million won. For deficits carried forward, apply the carryover of deficits for five years.

⑥ The net profit before corporate tax (ordinary profit) excluding the paid interest and interest income of the analysis sheet is to calculate corporate tax to be used in the analysis table of profitability by adding the paid interest to the net profit before corporate tax and deducting the interest income. Apply a corporate tax rate to this value to come up with a corporate tax for profitability analysis.

D. How to fill out the Statement of Financial Position

① Cash and cash equivalents are the same as the cash amount at the end of the term in the statement of cash flows.

② Construction in progress is an amount calculated by deducting government subsidies from the sum of investment costs and accumulated interest during construction. Once the construction is completed, it is replaced with the operation rights account.

- 'Construction in progress = Investment costs + accumulated interest during construction - government subsidies'
- The construction costs and government subsidies of each year in the analysis table of profitability are increased by the inflation rate. Calculation is made in the statement of cash flows.
- Accumulated interest during construction is based on the outgoing cash flows under the cash flows from investing activities in the statement of cash flows (balance at the end of the previous year and that of the current year).
- The value of assets that are replaced to the operation rights account at the point of construction completion becomes the acquisition costs of the assets, and this becomes the amount targeted for depreciation.

③ The acquisition cost of operation rights is what replaces ② when the construction is completed. Operation rights are amortized during the free-of-charge operating period with the direct (write-off) method (that deducts

depreciation cost from the acquisition cost of operation rights).

- In the analysis sheet, it is depreciated over 30 years by the straight-line method. The salvage value is assumed to be zero.
- The depreciation period is 30 years for roads; 30 years for railroads, ports, and airports, 50 years for dams; and 30 years for cultural and tourism complexes.

④ Borrowings are the financing amount of debt capital after deducting equity capital and government subsidies from total construction costs according to the order of fund inputs. They are accumulated from cash flows from financing activities in the statement of cash flows.

⑤ Capital stock is accumulated from increases in capital stock among cash flows from financing activities in the statement of cash flows. Namely, the capital stock amount of the corresponding year is calculated by adding the increased capital stock amount of the corresponding year to the ledger amount at the end of the previous year.

⑥ Retained earnings/accumulated deficits are accumulated current-term net profits/losses from the income statement. Namely, the ledger amount of retained earnings/accumulated deficits of the corresponding year is the sum of the ledger amount at the end of the previous year and the current-term net profits/losses of the corresponding year.

⑦ The current-term net profits/losses are the amounts from the income statement.

⑧ Check to ascertain whether the asset items on the debit side are the same as the liabilities and shareholders' equity items on the credit side in the statement of financial position.

E. How to fill out the Statement of Cash Flows

① The operating revenue and other revenues of the analysis table of profitability are increased by the inflation rate.

② Interest income is interest earned on retained earnings and is calculated by applying an interest rate (e.g. time deposit interest rate of 3% in 2003).

③ Maintenance costs from among the operating costs in the analysis table of profitability are increased by the inflation rate.

④ Selling and general administrative costs from among the operating costs in the analysis table of profitability are increased by the inflation rate.

⑤ Purchase costs of tangible assets from among the operating costs in the

analysis table of profitability are increased by the inflation rate.

⑥ Paid interest is interest paid on borrowings. Calculation is based on the accumulated borrowings at the beginning of the year and an annual interest rate of 6% is applied in consideration of the average interest rate on debt in PPP projects as of 2004 (annual 7 to 8%) and YTM of the Korea Expressway Corporation′s ten-year bonds (annual 5.2%).

⑦ The corporate tax, etc. in the statement of cash flows are calculated based on the assumption that the corporate tax expense of the income statement is paid the following year.

⑧ Investment costs are construction costs from the analysis table of profitability increased by the inflation rate.

⑨ Capital stock and government subsidies are indicated in current prices by increasing by the inflation rate the values derived according to the order of financing from the analysis table of profitability. The assumption is that investment costs are replenished in the order of equity capital, government subsidies, and borrowings.

⑩ When the sum of cash flows from operating activities and cash flows from investing activities is negative (-), the amount of borrowings increases. When the sum is positive (+), repayment of borrowings increases. The assumption is that the cash flows from operating and investing activities are all used to repay borrowings until all the accumulated borrowings are repaid.

⑪ Increases in cash are the sum of cash flows from operating, investing, and financing activities. Add cash at the beginning of the term to this to derive cash at the end of the term.