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# Economic Analysis of the EDISON (EDucation-to-Industry Integration through Simulation on the Open Platform and Net) - Focused on Direct Benefits

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***Abstract***

*The EDucation-to-industry Integration through Simulation on the Open platform and Net (hereinafter the "EDISON") is a program designed to develop an open integrated platform which can converge next-generation education and research by allowing college professors, students, researchers and industry workers to freely upload or execute simulation programs and contents in computational science and engineering based on cyber infrastructure such as computing and network resources. There have been a lot of efforts to improve the manufacturing productivity of small & mid-sized enterprises, using the natural phenomenon-like computational science & engineering (simulation) around the world. Therefore, it is likely that the EDISON program would be very valuable in that it could provide the latest field training environment needed to foster talented practical manpower which can be inputted to R&D and industrial practices immediately. This study is aimed to estimate the economic benefits of the EDISON program. For this, it analyzed economic efficiency by classifying the program into quantitative benefits (direct benefits)*

***Keywords:*** *Simulation education, Computational science, Computational engineering, supercomputer, Cyber infrastructure, Open platform, EDISON, Economic analysis*

## 1. Introduction

The purpose of this study is to estimate the economic benefits of the EDISON program. For this, the quantitative benefits were divided into direct and indirect benefits while qualitative ones were classified into scientific & technological and educational effects.

The EDISON is a program designed to develop an open integrated platform which can converge next-generation education and research by allowing college professors, students, researchers and industry workers to freely upload or execute simulation programs and contents in computational science and engineering based on cyber infrastructure such as computing and network resources. The computational science and engineering is a field targeted to accomplish scientific discovery and technology innovation, using mathematical equations, data and computing resources without physical experiment apparatus.

For the economic analysis of this program, this study investigated the details and technology developments from Year I to Year V and analyzed its progress and utilizations in five sectors: Computational fluid dynamics (CFD), Nano physics, Computational chemistry, Computational structural dynamics and Computational design.

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The quantitative benefits were divided into direct benefits arising from the direct results of the program and indirect ones which were estimated based on its ripple effects on national economy. For the estimation of direct benefits, they were divided into cost saving and value creating benefits according to the KISTEP's Preliminary Feasibility Study Standard Guidelines (2nd Edition) in R&D Program. In particular, this program has the effect of substituting foreign software programs which have been used in college. In terms of cost-saving benefits, therefore, substitution effects were estimated in two different categories: software and hardware [1].

## 2. What is EDISON?

The purpose of the EDISON program is to develop talented manpower by helping undergraduate (or graduate) students from science and engineering departments adapt themselves to the latest science and technologies and establish the ground for the localization and commercialization of educational & research purpose simulation software programs in science and engineering. The specific goals are as follows:

First, to develop an EDISON computational science & engineering platform and use it to install and utilize diverse computational science & engineering tools in supercomputer in easy and fast fashion through web; Second, to develop computational science & engineering programs and contents to solve problems in application fields such as CFD, nano physics, computational chemistry, structural dynamics and computational design; Third, to provide web-based user services which enable education and research on basics and converged fields of study in five application sectors and perform a requirement & satisfaction survey to support them in a user-friendly manner; Fourth, to facilitate communities for the spread of performances in practices and support infrastructure to provide user services in stable fashion) [2].

The roles of the central center (control tower) are as follows: program planning, control and supervision and collaboration with specialized centers, expansion of the utilization of program performances, development of PR and improvement plan, development of EDISON platform, web-based user services in five fields, development and supply of infrastructure, development of strategies for the spread of performances.

The roles of the specialized centers are to developing computational science & engineering programs & contents, secure users, facilitate communities, promote collaboration with the control body and handle the tasks needed to utilize undergraduate (graduate) curricula in science and engineering [3].

## 3. Computational science and engineering

The computational science and engineering is a field targeted to accomplish scientific discovery and technology innovation, using mathematical equations, data and computing resources without physical experiment apparatus. This study introduces the five major fields handled in the EDISON program.

First, the CFD is a sector which analyzes fluid flow phenomena and applies them to product design after calculating mass and momentum on the fluid and energy conservation equation, using computer.

Second, Nano physics refers to a field which analyzes the properties of nano sized materials and devices using computational science methodology based on the understanding on atomic and molecular physics phenomena.

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Third, Computational chemistry is a branch of chemistry that studies the properties of molecules in broad ranges from molecular structure to new materials & biomolecules, using computer-based computational chemistry methodology.

Fourth, Computational structural dynamics is a branch of structure mechanics that analyzes the static and dynamic behavior characteristics of structures, using numerical techniques based on the understanding of structural mechanics and dynamics.

Fifth, Computational design is a field which establishes and utilizes an optimum design framework for education, research and industries after developing the UI specialized for product CAD design soft-ware, optimum algorithm and robot products.

## 4. Economic analysis

### 4.1. Analysis procedures

This study performed economic analysis after going through the following procedures for the purpose of estimating the economic effects of the EDISON program which has been operated for five years since June 2011.

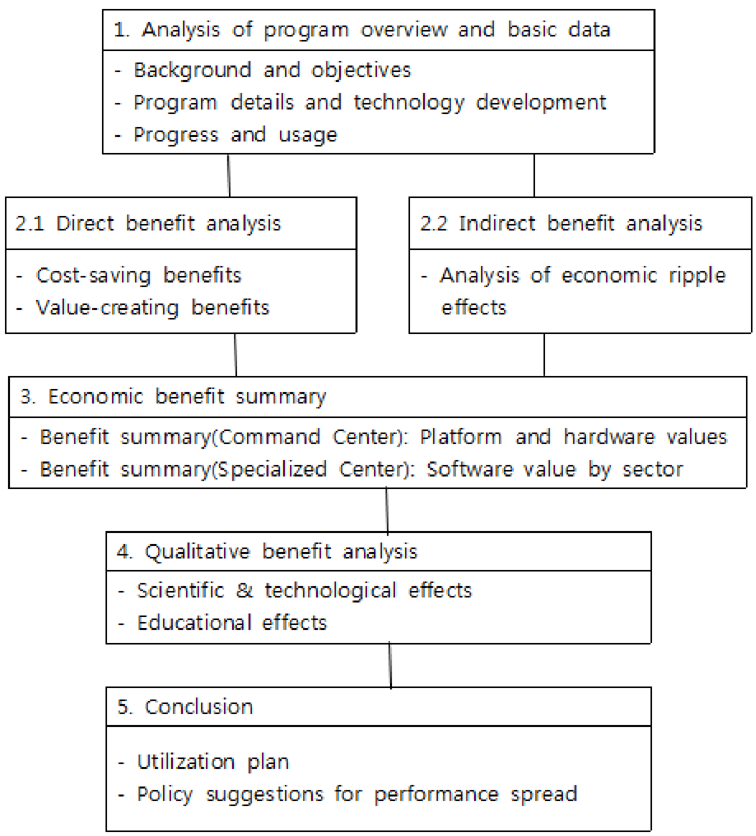


Figure 1. Economic analysis procedures

 

### 4.2. Performance analysis

The outcome of the EDISON program includes the followings: i) stabilization of application framework, ii) R&D on EDISON middleware, iii) establishment and management of EDISON infra-structure, iv) supply of real-time user services and stable services through the establishment of system & network monitoring environment, v) execution of 550,859 simulation trials (1,735,985,331 hours), using 275 colleges, 785 courses and 32,298 people (as of February 2016) by facilitating user services and community activities in five fields and vi) promotion of international communities by discovering Pacific Rim Applications and Grid Middleware Assembly (PRAGMA)-based overseas users and operating English-language websites.

Figure 2. Development of open EDISON system and community promotion

### 4.3. Current usage

The economic benefits of the EDISON program have substituted foreign software which has been used for educational and R&D purposes prior to the launching of the program. As basic data for this matter, therefore, the current use of applications in five fields by year is analyzed in this section.

In the EDISON program, there have already been a lot of studies on most applications in five major fields. In addition, the purpose of the program is to develop educational computational science applications. Since the substitution effects of foreign software immediately occur, a gestation period wasn't considered. According to the Korea Development Institute, if a gestation period is suggested in the program plan, it should be observed. Unless otherwise mentioned, it is reflected in consideration of program characteristics as follows: 5 years for basic studies, 3 years for development and application studies. In software development, for example, 3 years were adopted for the gestation period of middleware. In the EDISON program, in contrast, software-substituting effects by education are primary economic benefits. As stated in the table above, it is immediately used for education and research. Therefore, it appears that it is reasonable not to consider a gestation period, reflecting the characteristics of the program.

## 5. Economic benefits-direct benefits

The In direct benefits, cost saving benefits were derived by measuring the effects of substituting foreign software by import, using the cost approach [4]. First, minimum benefits were estimated in assumption that the software program is purchased and shared by agencies, not by individual users. For this, the usage history of the software by each agency is needed.

Second, maximum benefits were acquired by estimating substitution costs in assumption that each software program is leased to all users for one year. For accurate calculation, the time of the software used by user and price policy by the software provider should be considered. Because of information limitations, however, cost substituting effects were measured in the range of minimum and maximum benefits.

Value creating benefits refer to the economic values valued by the market in applications or platform, and they can be measured, using the income approach. The development of computational science & engineering software in application fields brings diverse performances and external effects. In addition to the applications, related science technologies are developed as well. The formation of application development related communities can facilitate the improvement of app functions by accumulating technologies. Furthermore, it would become possible to earn patents and copyrights relating to application development. According to the KISTEP's Preliminary Feasibility Study Standard Guidelines (2nd Edition) in R&D Program, value creating benefits in R&D programs are generally estimated by considering the diverse variables needed to limit the direct benefits which are created by the contribution of R&D programs by predicting a future market size, using the income approach [5][6].

However, not all these economic values are measurable. In case of value creating benefits, in particular, final benefits should be estimated in consideration of technical cycle time (TCT) In this study, initial intrinsic values are used for cost-saving effects. Therefore, 8 year-long TCT is considered based on year 2015 [7]. After setting cost saving effects by two benefits (minimum and maximum benefits) as the initial benefits, value creating effects were analyzed by applying 5.5% social discount rates and 8 years as TCT. Then, the following results were found:

Table 1. Value creating benefits

| | Cost saving Benefits (2015) | Value creating Benefits |
|---|---|---|
| Scenario #1<br>Min. benefits | KRW 7.87 billion | KRW 52.6 billion |
| Scenario #2<br>Max. benefits | KRW 43.06 billion | KRW 287.77 billion |

## 6. Conclusions

This study targeted to analyze the economic performances of the EDISON program during the 1st and 2nd stages. According to the Preliminary Feasibility Study Standard Guidelines in R&D Program, the benefits of the program were divided into economic and qualitative benefits. Then, the former was reclassified into direct and indirect benefits. The direct benefits were estimated under two different categories: cost saving benefits generated by the substitution of foreign software programs, value creating benefits generated for a certain period of time by the software development. For the estimation of indirect benefits, in addition, the results of the input-output analysis obtained through other studies were referred to. Regarding qualitative benefits, it was impossible to estimate them in currency. However, their sufficient influence was confirmed by analyzing the effects that must be considered for the purposes of the program.

This study suggested two economic benefit estimation scenarios. In Scenario #1, minimum benefits are estimated, considering the common utilization by agency when estimating the costs of conventional foreign software programs. Scenario #2 reveals the results obtained after considering maximum benefits by calculating them by user if there is no software price policy on the software which would be jointly used. After deriving total benefits, this study suggested the results by classifying the portion of the benefits between the command center and specialized centers.

Considering the research results, the purpose of the study was not to analyze preliminary feasibility. In addition, costs weren't considered in this study. Therefore, cost benefit ratio, net present value (NPV) and internal rate of return (IRR) weren't separately estimated [8]. However, it appears that the EDISON program is very attractive from an economic perspective. In addition, qualitative benefit analysis (e.g., paper, rewards, domestic and international cooperation, educational achievements, etc.) on the education and scientific & technological effects of the programs such as the supply of an integrated platform which can connects and converges education, research and industry in flexible fashion was very effective.

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