The Cost-Saving Effects of National Information Infrastructure

KIM, DONG-WOOK
Assistant Professor, Seoul National University

Abstract

In this paper, we estimate the socio-economic impacts the National Information Infrastructure(NII) will bring to our society and recognize the importance of the NII construction project. We estimate the quantatitive cost-saving effects of NII, through we admit the methodology contains a lot of constraints. We expect NII will increase efficiency in almost every aspect of our society and choose only 7 sectors in which the cost-saving effect of NII will realize vividly; medical service, environmental management, disaster management, civil affairs administration, manufacturing, distribution & shipment, and education. The estimates for the net-benefit of cost-saving effects in the seven sectors in the period 1996-2015 are 6.7~20.4 trillion won for medical service, 3.6~8.0 trillion won for environmental management, 0.2~0.6 trillion won for disaster management, 0.6~1.0 trillion won for civil affairs administration, 61.3~152.7 trillion won for manufacturing, 11.7~15.3 trillion won for distribution & shipment, and 1.9~6.2 trillion won for education.

I. Introduction

Information and telecommunication infrastructure becomes a basic social overhead capital(SOC) in modern society by enabling various information and services to be provided to people very fast and without time and spatial costraints. It does not include only physical and technical broad-band communication network but also the

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application, institution, and culture which cover the high-speed information interchange. So called Information Super-highway already began to have significant impacts in political, economic, social, educational, and cultural sectors and to change the behavior and work-process in government, business, and school.

The overall benefits of NII include the increased economic efficiency, increased information accessibility, improvement of equal opportunity for eduction, and resource sharing. But there are a number of hurdles theoretically and empirically in estimating the benefit of NII quantitatively. The NII project and its effects are expected to take very long time to be realized and assume the high technology and overall changes in our future life, which obstructs the estimation of the quantitative benefits of NII.

Though we admit a lot of theoretical and data problems in estimating quantitative effect of NII, we should agree on the urgency for recognizing that the NII construction project is very important and should be implemented with sincere efforts of our government. This paper estimates the quantitative cost-saving effects of NII in seven sectors in which the cost-saving effect of NII will realize vividly; medical service, environmental management, disaster management, civil affairs administration, manufacturing, distribution & shipment, and education.

II. Analytical Model

1. The Concept of Benefit

The benefit is defined as the cost-savings resulting from the construction and utilization of NII. For example, NII reduces the average waiting time for applicants in civil affairs administration from 1 hour to 20 minutes, and then the economic value of the reduced waiting time(40 minutes) can be defined as one of the benefits of NII.

We need two scenarios to estimate the benefit of NII in two decades(1996-2015); one scenario is for successful construction and full utilization of NII, and the other is for non-construction of NII. Under full information society scenario, almost every aspect of our daily life is related to information superhighway, of which impacts are realized fully. The level of NII's utilization will increase consistently during the period 1996-2015. The other scenario is that our society makes no efforts for NII construction and uses current level('95) information and communication devices and networks.

The traces for the effects of current informatization in our society can be drawed as three different lines. One is that the effects of 1995 present level of informatization will increase and another is that the effects will decrease, and the other is that the effects will be constant. The gross benefit of NII can be defined as the whole benefit of informatization in the future of our society including the benefits resulting from the

current informatization up to 1995, while the net benefit of NII can be defined as the benefit of informatization in our society in the future excluding the benefit resulting from the current informatization. Net benefit calculation assumes the benefit of current informatization will be constant over the NII project period.

2. Estimation Model of Gross Benefit

The estimation model for gross benefit of NII is as follows.

$$GPB_k = \sum_{t=1}^{k} (C \times Dt \times It \times R) / (1+r)^t$$

- GPB_k: presnt value of expected gross benefit up to year k in the future
- C: cost in one sector in 1995 before NII construction
- D_t: cost change coefficient for year t
- I_t: informatization level of year t
- R: cost-saving ratio in year 2015
- r: time discount rate(8%)

The components in the model C, D_t, I_t, R are calculated as follow. The cost-saving ratio(R) is the maximum rate of cost savings resulting from NII in 2015 when NII is fully utilized. The estimate for each sector is obtained by consulting with a group of experts in each sector or collecting policy research data published in developed countries. For example, In disaster management, cost-saving ratio(R) in 2015 is 20% and the informatization level in 1995 is 30% of the level in 2015. We benefit 6% cost-savings from the current level of informatization already and the cost saving ratio continues to grow up to 20% in 2015.

Informatization level for year t(I_t) is relative index, while the level in 2015 is 1. We call the informatization level in 1995 initial level and obtain the estimates for initial levels from experts' judgment. The shape of informatization level growth is either exponential or logistic function.

Estimate for Cost in 1995(C) in each sector is based on statisics recently published by government or research institutes. Annual adjustment coefficient(D_t) is a relative index in year t to C in 1995 and expressed as follows;

$$D_t = (1+\delta)^t$$

δ: annual growth rate of C

Each sector has different C and δ, and estimation methods are different. For instance, we can assume cost in one sector grows in proportion to GNP growth and calculate δ as follows.

$$\delta = p \times g$$

g: expected annual GNP growth rate
p: relative ratio of cost growth to GNP growth

The time discount rate is assumed as 8% which is generally adopted for public projects.

3. Estimation Model of Net Benefit

Gross benefit includes the cost savings brought by the initial informatization level but net benefit excludes those cost savings, which is more relevant concept in perspective of benefit-cost analysis. Net benefit is only the portion on account of utilization of NII which is conceptually separated from current level of informatization. The effect of initial informatization level is assumed to be fixed over the period 1995-2015.

Presnt Value of Net Benefit(NPB_k)

$$= \sum_{t=1}^{k} (C \times D_t \times I_t \times R)/(1+r)^t - \sum_{t=1}^{k} (C \times D_t \times I_{1995} \times R)/(1+r)^t$$

$$= \sum_{t=1}^{k} (C \times D_t \times (I_t - I_{1995}) \times R)/(1+r)^t$$

I_{1995} : informatization level in 1995

III. Cost Saving Effect of NII in Seven Sectors

1. Medical Service Sector

Estimation model in medical service is revised as follows.

$$GPB_K = \sum_{t=1}^{k} (C \times (1+G)^t \times [Y \times (1+X)^t] \times R)/(1+r)^t$$

$$NPB_K = \sum_{t=1}^{k} (C \times (1+G)^t \times [Y \times ((1+X)^t - 1)] \times R)/(1+r)^t$$

$D_t=(1+G)^t$, G is growth rate of economy or population

It = $Y \times (1+X)^t$, Y is initial informatization level

and X is growth rate of informatization level

We estimate the benefit brought by medical MIS and medical services based on information superhighway. We use growth rate of economy and population(G=6%, 4.4%, 1%), informatization level(X=0.1, Y=0.15) and discount rate(r=8%) and finally estimate the gross benefit as 21.7 trillion won(ranged 10.7 - 33.0) for 20 years up to 2015 and the net benefit as 13.4 trillion won(ranged 6.5 - 20.4) for 20 years.

The largest item of cost savings in gross benefit estimation is benefit from reduced number of death and disease on account of tele-medicine, emergency network and blood distribution system. The next items are cost savings in hospital management and reduced waiting time of patients.

2. Environmental Management Sector

We use the same estimation model and procedure in environmental management as in medical service. For economic growth rate, informatization level and its growth rate, discount rate, the same estimates as those in medical service are used. The gross benefit of the 20 year period estimates 8.2 trillion won ranged from 5.2 to 11.6 and the net benefit estimates 5.7 trillion won ranged from 3.6 to 8.0.

The largest item of cost savings in environmental management brought by NII is cost savings in increased efficiency of re-use of resources, and next ones are reduced number of death and disease due to decreased pollution level, budget savings in environmental information management.

3. Disaster Management Sector

Our nation has paid huge amount of socio-economic cost because of natural catastrophic disaster every year. The cost due to disaster includes human loss, property damage and maintenance cost of emergency-relief materials.

The paper focuses on the property loss and damage caused by natural disaster and the estimation model for the gross benefit of NII in disaster management sector is revised as follows.

$$GPB_K = \sum_{t=1}^{k} (C \times D_t \times I_t \times R)/(1+r)^t$$

$$= \sum_{t=1}^{k} (C \times (1+g \cdot p \cdot w)^t \times (e^x/1+e^x) \times R)/(1+r)^t$$

C; base cost, g; expected GNP growth rate,

p; property loss coefficient

w; property loss weight, e=2.72828...

$x = t^2/50 + \log(L)$, r; discount rate

We use 660,540 million won for C, 0.8628 for p, 0.92 for w, 10-20% for cost saving rate(R), 50-60% for initial informatization level (I_{1995}), 6% for g, 8% for discount rate(r). The estimate for the gross benefit(GPB) of the 20 year period ranges from 772,090 million won to 1,639,972 million won.

4. Civil Affairs Administration Sector

This study selects construction permit issuing administration because lots of citizens apply construction permits, the process and related public agencies are complex, and the NII would improve the efficiency of administration in this area. We focus on the benefit of civil affairs applicants on account of reduced waiting time.

The estimation model for the gross benefit in construction administration due to NII is revised as follows.

$$GPB_K = \sum_{t=1}^{k} (C \times G_t \times I_t \times R_t)/(1+r)^t$$

$$= \sum_{t=1}^{k} (C \times (1+g \cdot p)^t \times (e^k/1+e^k) \times R)/(1+r)^t$$

GPB_k: present value of gross benefit up to year k

C= base cost in 1995

G= growth rate of domestic construction contracts

g= expected GNP growth rate

p= relative growth ratio of construction contract to GNP

e= 2.72828...

$k = t^2/50+\log(L)$, L=1/9, 1/19

R= reduction rate of construction permit issuing period

We estimate that construction contract grows by 1.32% as GNP grows by 1% and calculate 6% for GNP growth rate, 8% for discount rate, 222,495 million won for base cost. We use 37% and 50% for R, 0.05 and 0.1 for initial informatization level and obtain four estimates for the benefit of NII during the 20 year period. The gross benefit of NII ranges from 726 billion won to 1,176 billion won and the net benefit of NII ranges from 645 billion won to 956 billion won.

5. Manufacturing Sector

The introduction of NII will change the industrial structure and improve the management efficiency within each firm. Rapid informatization in industrial sector will increase the information processing capacity and provide the infrastructure for information sharing among employees, divisions, companies, and consumers. The cost savings on the bases of NII utilization in manufacturing sector is numerous. We classify manufacturing cost into three categories; marketing & general management cost, production cost, and financing cost. The estimation model for the gross benefit of NII in one of manufacturing costs is revised as follows.

$$GPB_K = \sum_{t=1}^{k} (C \times D_t \times I_t \times R)/(1+r)^t$$

GPB_k : present value of cost savings in each category of manufacturing cost

C : base cost of each category in manufacturing cost

D_t : adjustment coefficient based on economic growth

$D_t = (1+g)^t$, g is expected economic growth rate

I_t : informatization levelt in year t

R : cost saving rate in 2015

r : discount rate

We estmate 6% for expected economic growth rate and assume 0.3 for initial informatization level of our manufacturing industry and informatization trend as logistic function. We obtain the cost saving rates in 2015 by surveying experts in industrial information system with Delphi method. The estimates of cost saving rates are 40~60%(50% mode) for marketing & general management, 10~30%(10% mode) for production, and 10~30%(20% mode) for financing. Using mode cost saving rate, we estimate the gross benefit of NII as 50.1 trillion won in marketing & general management, 73.5 trillion won in production, 9.0 trillion won in financing, and the

total sum of gross benefit is 132.6 trillion won. The net benefit of NII in manufacturing sector is 26.0 trillion won in marketing & general management, 38.1 trillion won in production, 4.7 trillion won in financing and the total sum of net benefit of NII is 68.8 trillion won.

6. Distribution and Shipment Sector

The demand for highway, seaport, and airport grows rapidly and the distribution cost due to traffic jam increases the production cost. The cost for distribution and shipment composes up to 17% of total production cost in our economy. Recently Korea Railroad, National Port Authority, Customs Services, and Group Hanjin are developing information management systems and networks.

The gross benefit of NII in distribution & shipment sector is estimated based on the estimation model as follows.

$$GPB_k = \sum_{t=1}^{k} (C \times D_t \times I_t \times R)/(1+r)^t$$

$$= \sum_{t=1}^{k} (C \times (1+g)^t \times R \times Y(1+X)^t)/(1+r)^t$$

GPB_k : present value of gross benefit of NII
C : base cost
g : expected cost growth rate in distribution & shipment industry
R : cost saving rate in 2015
Y : initial informatization level
X : informatization growth rate
r : discount rate

The sender or receiver of material shipped would save costs in production, logistics, and storage because of reduced shipping time and accurate information on material movement but we do not include the benefit of customers(individuals and companies) in our estimation.

The estimate of the gross benefit of the period 1996-2015 ranges from 13.6 trillion won to 15.9 trillion won. The cost savings are distributed over four areas; 4.4 trillion won in inland transportation, 0.3 trillion won in railroad, 7.3 trillion won in sea-shipping, and 6.7 trillion won in air-transportation. Using lowest cost saving rate

among obtained by experts' Delphi, we estimate the 20 year net benefit of NII in each area; 3.3 trillion won in inland transportation, 0.2 trillion won in railroad, 4.7 trillion won in sea-shipping, and 3.5 trillion won in air-transportation. The estimate of the net benefit of NII in distribution & shipment sector during the project period ranges 11.7 trillion won to 15.3 trillion won.

7. Education Sector

We focus on cost savings in public school education and expect time savings in students' study in school and at home, teachers' preparation for class, and school administration. Using the estimation model similar to distribution & shipment model, we estimate the cost savings in elementray school and secondary school.

Base costs(C) are 3,657 billion won for elementary school, and 5,046 billion won for secondary school. Using experts' Delphi method, we estimate 5~15% for cost saving rate in 2015(R), 5~10% for initial informatization level and assume GNP growth rate is 6% and discount rate is 8%. The gross benefit of NII over 2 decades estimates from 2.3 trillion won to 8.3 trillion won and the net benefit estimates from 1.9 trillion won to 6.2 trillion won. This estimate is quite conservative because we focus only on management efficiency and time savings but does not consider the long term and intangible benefits of improved diversity, autonomy, and creativity of students due to NII utilization in school or at home.

Ⅳ. Conclusion

Our estimation results for benefits due to NII are summarized in table 1 and 2.

〈**Table 1**〉 expected gross benefit of NII in 7 Sectors

unit: 100 million won

Sector	1 year('96)		10 years('96-2005)		20 years('96-2015)	
	lower	upper	lower	upper	lower	upper
Medical	19,929	63,425	39,602	124,067	106,893	329,501
Environment	9,569	22,582	15,481	35,532	51,618	115,789
DisasterMgt	324	775	3,679	8,255	7,720	16,399
Civil Affairs	42	113	964	2,342	7,258	11,759
Manufacture	33,720	83,400	418,480	1,042,220	1,180,970	2,941,550
Dist & Ship	3,232	4,180	48,494	66,336	180,759	238,373
Education	250	1,440	4,800	23,050	22,600	83,500

〈**Table 2**〉 expected net benefit of NII in 7 Sectors

unit: 100 million won

Sector	1 year('96)		10 years('96-2005)		20 years('96-2015)	
	lower	upper	lower	upper	lower	upper
Medical	296	937	14,587	45,534	66,531	204,014
Environment	121	282	6,399	14,574	35,735	79,728
DisasterMgt	3	6	762	1,749	2,352	5,696
Civil Affairs	0.8	2	555	1,238	6,446	9,564
Manufacture	380	950	107,960	268,910	612,940	1,526,630
Dist & Ship	257	336	19,932	25,997	117,251	153,090
Education	35	156	2,832	11,251	18,999	61,920

As seen in the table 1 and 2, the cost savings resulting from the information superhighway or NII in our socio-economic lives in the future are quite big amount. The estimates for the net-benefit of cost-saving effects in the seven sectors in the period 1996-2015 are 6.7~20.4 trillion won for medical service, 3.6~8.0 trillion won for environmental management, 0.2~0.6 trillion won for disaster management, 0.6~1.0 trillion won for civil affairs administration, 61.3~152.7 trillion won for manufacturing, 11.7~15.3 trillion won for distribution & shipment, and 1.9~6.2 trillion won for education. But these results do not surprise us because we agree that NII will function as infrastructure for various aspect in economy and social life and improve efficiency and quality of life.

This study starts with the assumption that high speed broad-band information network called NII is constructed around our country in the year 2015, and that it is normal for people to communicate with multi-media in home, school, office, and any place. In order to maximize the benefit of NII, open access to network must be quaranteed. NII system should be open to every consumer and service provider and the user-fee should be minimized. Government should secure the competitive system in communication service industries, open government information to public, and provide basic communication service to lower income class.

This study has a lot of limitations. There are a number of benefits we can not quantify or data for which we can not collect. We mention the categories of benefit we can not count in the benefit estimation and believe our estiamates underestimate somewhat the benefit which NII will bring to our society. The experts' judgment collected by delphi method has some limitations because the effect of NII is so broad and spill over long term period that even an expert has difficulty in answering our

questionaire over the future scenario.

Notes

1) This paper extracts from the research report of four colleagues(Byungsun Choi, Dongwook Kim, Giheon Kwon, Dongkun Kim), 「Construction of National Information Infrastructure and Cost-Saving Effect Analysis」 (in Korean), National Computerization Agency, December, 1995.

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