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A Study on the Government's Investment Priorities for Building a Supercomputer Joint Utilization System

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Abstract The purpose of this paper is to analyze the Korean government's investment priorities for the establishment of a supercomputer joint utilization system using AHP. The AHP model was designed as a two-layered structure consisting of two areas of specialized infrastructure, a one-stop joint utilization system service, and four evaluation items for detailed tasks. For the weight of each evaluation item, a cost efficiency index considering the annual budget was developed for the first time and applied to the weight calculation process. AHP analysis conducted a survey targeting supercomputer experts and derived priorities with 22 data that had completed reliability verification. As a result of the analysis, the government's investment priority was high in the order of dividing infrastructure for each Specialized Center and building resources in stages. In the future, the analysis results will be used to select economic promotion plans and prepare strategies for the establishment of the government's supercomputer joint utilization system.

Keywords Supercomputer, Joint utilization system, Government investment, AHP, Priority

I. Introduction

The supercomputer is used to produce, process, and utilize large amounts of information that are difficult to solve with general computers at high speed. In the Republic of Korea, it is used for industrial purposes in various fields such as academic research, weather forecasting, health, and public service. Recently, with the convergence of artificial intelligence and big data technologies, the scope of application is gradually expanding from calculation to data analysis, from basic science to industry.

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At the national level, supercomputers have emerged as a key infrastructure in the era of the 4th industrial revolution that drives the economy and society. This is because massive computing resources must support them in order to promote policies with great social necessity and high difficulty, such as fostering national strategic technology, digital transformation, and realization of carbon neutrality. Recently, major leading countries in the field of supercomputers are making efforts to create an ecosystem for joint use to expand supercomputer resources as a key infrastructure for preoccupying national future technology competitiveness. The United States has established a partnership XSEDE for joint use of supercomputers, and Europe has invested heavily in expanding resources to provide intensive supercomputer infrastructure and services for national strategic areas, such as forming EuroHPC JU. In Korea, efforts are being made to establish a joint utilization system consisting of a national center, Specialized Center, and unit center. The joint utilization system refers to a system in which supercomputing resources installed in domestic governments, companies, research institutes, schools, etc. are linked to joint utilization resources in accordance with Article 17 of the “Act on Utilization and Fostering of National Super-computers”. In 2021, the Ministry of Science and ICT established a “Supercomputer Innovation Strategy,” selected 10 national strategic areas, and designated Specialized Centers for 7 areas so far. In addition, a project plan for the operation of the joint utilization system is being established, and the feasibility of the project will be reviewed in 2023 and will be launched in 2025. This paper aims to verify which promotion method is efficient and effective in achieving the goal, based on the project's purpose and promotion system. In order to enhance the reliability of the hierarchical model in deriving the priority of the project promotion method, evaluation items were constructed, and detailed tasks were implemented to reflect economic feasibility in the hierarchical model. An index representing cost-efficiency was developed and applied. The results will be used as basic references for prioritizing financial input into this project.

This paper consists of a total of 6 chapters. In the introduction of Chapter 1, the academic value was explained by presenting the background and necessity of the research and the purpose of the research. In Chapter 2, previous studies related to AHP (Analytic Hierarchy Process) are investigated, and academic values such as differentiation and novelty from this paper are reviewed. Chapter 3 explains the core theory related to the research method, and Chapter 4 explains major policies and projects for national supercomputing infrastructure promoted by the Korean government. In Chapter 5, the analysis outline, analysis process, and results were written, and in the conclusion of Chapter 6, the analysis results were summarized and implications and future utilization plans were mentioned.

II. Literature review

Banwet (2008) is to evaluate and compares the performance of national R&D organizations in India in terms of their relative efficiencies using multiple output measurement criteria. An integrated DEA (Data Envelopment Analysis) and AHP have been used. The relative efficiency for national R&D organizations is obtained not only based on the quantity of output but also on the basis of the quality of the output and provides more comprehensive and realistic results to the decision-makers in identifying the benchmark national R&D organizations and inefficient organizations. Feng (2004) is to develop a tool for the assessment of the management performance of R&D activities in research-oriented universities, a combination of AHP and DEA is proposed for the assessment of the efficiency of R&D management activities in universities. The measure consists of the measurement of a university's previous and present R&D strength by AHP and the assessment of the relative efficiency of its growth in R&D strength against those of other universities by DEA, in which the management basis of the measured universities is taken into consideration. Rimantho (2019) is to identify the factors potentially that lead to the high potential hazards in the R&D division. In addition, it also formulates the alternative to decision-making strategies. The research method used the SWOT method and AHP to determine the priority of selecting strategies for reducing the potential for occupational hazards. This study used questionnaires and distributed them among five experts in the company. Vellore (1991) is about the necessity for construction and engineering firms to acquire and develop expertise in state-of-the-art computer systems. Because many system configurations are available, the selection of CADD systems is an important decision, requiring consideration of a number of objectives. AHP is used to combine cost factors with subjective factors and also is used to consider the impact on end users as a group and central data processing. Arunraj (2010) presents an approach to maintenance selection based on the risk of equipment failure and the cost of maintenance. AHP and goal programming are used for maintenance policy selection. A case study in a benzene extraction unit of a chemical plant was done. The AHP results show that considering risk as a criterion, condition-based maintenance is a preferred policy over time-based maintenance as condition-based maintenance has better risk reduction capability than time-based maintenance. In Radevito (2021), to support the policy-driven adoption of EVs, incentives shall be given to stimulate EV users. Current regulations have not yet explained regulations for EVs, direct and indirect consumer benefits, infrastructure for charging, and complementary policies. This paper will compare the world's best EV policy, which will determine the main policy criteria to be developed for Jakarta's regulation using the analytical hierarchy process and entropy method in giving scaled preferences of sets of standards and alternatives with acceptable inconsistency. AHP is used to determine initial subjective weights from experts, while then entropy will enhance AHP's weights into objective weight.

Prior research has been using the AHP methodology for the prioritization of most government policies and the establishment of investment strategies. In addition, studies that propose new AHP analysis methods by developing new indicators or applying theories to suit the purpose of research are continuously being published. However, very few AHP models have been developed that consider the budget part for evaluation items in prioritizing the projects the government wants to invest in. In Korea, the proportion of economic feasibility in the implementation and non-implementation of government projects is very large. Therefore, the prioritization of government projects must consider the required budget for each evaluation item. Considering this, this paper applied the AHP methodology with cost efficiency indicators.

III. Theoretical background

AHP is a multi-criteria decision-making model that stratifies the evaluation model by using factors that evaluate alternatives for decision-making when two or more alternatives exist. In addition, the priority of alternatives is estimated through pairwise comparison of evaluation factors and alternatives (Altuzarra, 2007). The AHP model is used as a means of estimating the importance of each factor through pairwise comparison of evaluation factors targeting a group of experts who fully understand the stratified evaluation model and deriving the priority of alternatives (Li, 1998).

The AHP analysis procedure is shown in Figure 1. In the first step, the decision-making goal, influencing factors, and alternatives for stratification of the evaluation model are discovered. In general, brainstorming is performed by a group of experts, and when there are multiple influencing factors derived through brainstorming, the hierarchical level of influencing factors in the same hierarchy must be the same. Alternatives, as a means to achieve the decision-making goal, must be directly related to the influencing factors. Second, design the hierarchical structure through the results of the first step. Select the number of layers and influencing factors for each layer, and verify the structure through a group of experts. In the verification stage, if there is a difference in the hierarchical level of the influencing factor, it is supplemented. Third, the weight is estimated by performing a relative level comparison of influence and importance through a pairwise comparison of influencing factors of each class.

Derivation of decision-making goals and influencing factors

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Design Two-level hierarchical structure

↓

Estimation of weight

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Derivation of priorities

Figure 1. AHP procedure

In general, the relative level is expressed as a level of 1 to 9 with 1 as the center, and responses are performed $n(n-1)/2$ times considering the number n of influencing factors. The pairwise comparison results collected from multiple experts are converted into a single geometric average value and coded into a comparison matrix for each influencing factor, as shown in Table 1. The comparison matrix has the form of an inverse matrix having the property that all element values of the main diagonal are equal to 1. A is the influencing factor, X_{ij} is the geometric mean value, and X_{ij} is an estimate of the relative weight of i to the influencing factor j.

Table 1. Comparison matrix by influencing factors

	A	B	C
A	1	X_{AB}	X_{AC}
B	$1/X_{BA}$	1	X_{BC}
C	$1/X_{CA}$	$1/X_{CB}$	1

Weights for each influencing factor are standardized based on the columns of the comparison matrix, and then arithmetically averaged again based on the rows of standardized values. Pairwise comparison of alternatives by influencing factor is performed in the same process as weight calculation. Next, the CR(Consistency Ratio) is reviewed to verify the logical consistency of the analysis results. The consistency ratio can be defined as the value obtained by dividing the consistency index CI by the probability index RI as shown in Equation (1), and generally, if it is less than 0.1 to 0.2, it can be judged to be consistent. λ_{Max} is the maximum eigenvalue of the matrix, n is the eigenvalue of the matrix, and RI is the random index representing the tolerance of consistency (Liu, 2017).

$$\mathrm{CR} = \frac{CI}{RI} = \frac{\lambda_{Max} - n}{(RI) \cdot n - 1} \quad (1)$$

Finally, the overall score for prioritization of each alternative is finally derived by comprehensively considering the weight of each influencing factor and the preference for alternatives for each influencing factor.

IV. Korean government's supercomputer joint utilization system policy

The national supercomputer infrastructure is built as a unified system centered on the national center. The National Center is designated by the Ministry of Science and ICT and performs the forecasting of national supercomputer demand, securing and operating resources, and managing and operating advanced research networks. Starting with the 4th supercomputer with 363.6TF performance, the 5th unit with 25.7PF performance was built, and the construction of the 6th unit with 600PF level has begun. Recently, with the introduction of big data and AI technologies following the 4th industrial revolution, demand for supercomputing is rapidly increasing in most industries. Accordingly, problems regarding the efficiency and usability of resource utilization according to the domestic single system are emerging. First, in terms of infrastructure, the level of domestic supercomputing service is remarkably low compared to major foreign countries. In terms of the total resources, as of 2022, it is 84PF, much lower than 2084PF in the US, 890PF in Europe, and 628PF in Japan. And in terms of the number of units owned, Korea has 8 units, showing a large gap with 127 units in the US, 162 units in China, and 102 units in Europe. The resource allocation time per research task of the 5th supercomputer is only 1/3 of that of leading countries such as the United States, Germany, and Switzerland. In terms of technology, the development of convergence technologies by field due to the recent application of AI technology is rapidly increasing. In the field of materials and nano, for example, AI technology is applied to the discovery of semiconductor devices and secondary battery materials and measurement of physical properties and is used for machine learning of large complex systems. The field of life and health has begun to utilize AI technology to respond to the explosive increase in bio information due to the development of genome decoding technology. And in the fields of weather, climate, and environment, a new architecture based on AI is being introduced to improve the speed of prediction models in the traditional CPU-based calculation method. Therefore, there is a limit to responding to the rapidly growing demand for AI computing and specialized tasks with only the national center.

In 2021, the government of the Republic of Korea announced the "National Supercomputing Innovation Strategy" and established specific long-term detailed plans for building supercomputer resources by fields (Shim, 2023). From 2022, we are preparing a joint utilization system establishment project for efficient construction and utilization of supercomputer resources. The joint utilization system refers to a system that utilizes common resources as needed at the national level by linking the existing national center single supercomputer resources with resources of Specialized Centers and unit centers. The Specialized Center plans to build specialized infrastructure and services for 10 core fields, including materials/nano, life/health, and ICT, and plans to build a service platform and dedicated network to connect them. This project consists of two detailed tasks: the establishment and operation of specialized infrastructure for each field and the establishment and operation of one-stop service based on a common utilization system. By 2026, 479.3PF (Table 2) of supercomputing infrastructure for each field, joint utilization platform, and dedicated network will be established and operated until 2031.

Table 2. Supercomputing infrastructure size by field (PF)

Field	Resource
Materials/Nano	85.3
Life/Health	81.7
ICT	77
Weather/Climate/Environment	73.7
Autonomous-driving	49.2
Space	49.1
Nuclear Fusion/Accelerator	27.7
Manufacturing	11.8
Disaster	20.9
Defense/Security	2.9
Total	479.3

V. Derivation of government investment direction and investment priorities

1. Hierarchical structure design

The hierarchical structure for decision-making was derived through a discussion between a committee composed of about 30 experts from the government, academia, and industry and the staff of the Specialized Center participating in the supercomputer joint utilization system. Considering the supercomputer classification system, the committee divided it into three subdivisions: infrastructure, platform, and service, and reviews about three times or more for each subdivision from February 2022 to January 2023. As a result of the expert review, the hierarchical model should follow the task system diagram that can well reflect the project's purpose, goals, and performance indicators. Therefore, the evaluation factors were set in the unit of tasks of the project and designed by dividing them into two layers. In the first layer, two items were set as the main task, specialized infrastructure for each field, and a one-stop service based on the joint utilization system. The second layer consists of Specialized Center computing resources, Specialized Center infrastructure, service/data platform, integrated service, and dedicated network corresponding to the detailed tasks of each main task. Looking at the evaluation factors by layer in detail, the specialized infrastructure for each field includes the "specialty center computing resource" item, which builds a computing system with a total size of 480PF for Specialized Centers in 10 fields, and power, cooling, etc. for stable resource operation and service provision. The one-stop service includes the "Service and Data Platform" section, which provides a platform for cloud-based virtual resource services and parallel work services, as well as data collection, management, and analysis support functions, and the "Integrated Service and Dedicated Network" section, which uses the science and technology research Network to build a dedicated network backbone linked to the center and regional network centers. Alternatives should consider all possible cases from the government's point of view and should have the greatest ripple effect and be economical when the selected alternative is implemented. The four alternatives selected in this paper are shown in Figure 2. The first alternative is to not undertake the project to cover all the growing demand with the existing supercomputing infrastructure. The second alternative is to expand the infrastructure step by step in line with the annual increase in demand in each field. This alternative has the advantage of being able to build infrastructure that meets demand but has the disadvantage of increasing the time and cost because the infrastructure needs to be designed and constructed again every year. The third alternative is to build infrastructure for all fields in a single specific institution. Compared to the second alternative, it takes relatively less time and cost, but accessibility to infrastructure is reduced, and infrastructure use may be concentrated in a specific field. The fourth and final alternative is to divide the infrastructure for each field into Specialized Centers. This alternative predicts the demand by the field for the next five years and secures all capacity on a one-time basis. It is more economical than the second alternative and more accessible than the third alternative. However, if demand decreases in the future, the operational efficiency of the infrastructure may decrease. All four alternatives apply common 1st and 2nd layer evaluation items, and priorities are selected in the order of highest overall score as a result of the survey.

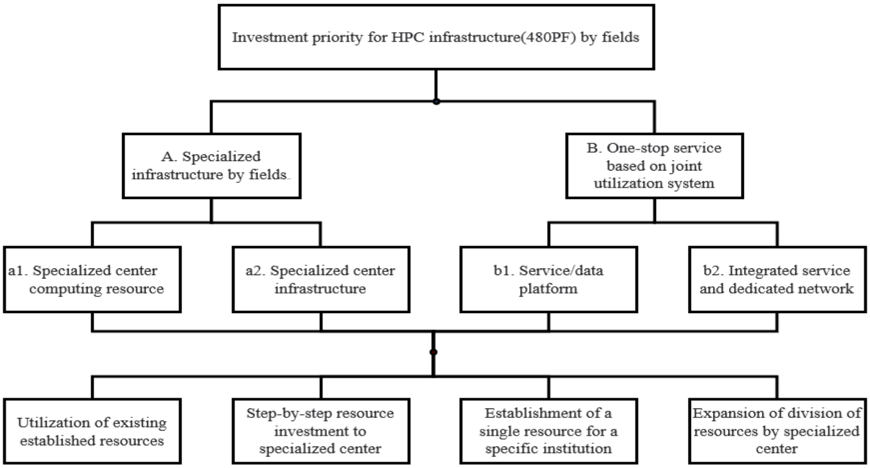

Figure 2. AHP Hierarchical Structure

2. Survey

The survey conducted a pairwise comparison (5-point scale) by evaluation items through a Delphi survey targeting 30 domestic supercomputer experts. Respondent characteristics are shown in Table 3. The experts participating in the survey were composed of those who had a high understanding of the domestic supercomputer industry and had experience using supercomputers. In addition, efforts were made to increase the fairness of the results by including both experts who participated in the project and those who did not participate. To secure consistency in the survey results, a public hearing was held to share the project plan so that the experts participating in the survey could fully understand the hierarchical model and the four alternatives. The survey was conducted online, and SSRA (Social Science Research Automation) Web-based program (www.ssra.or.kr) was used. The reliability analysis of the AHP survey results applies a method of calculating and verifying the consistency ratio. The reliability of the comparison matrix for the 23 experts who responded to the survey is judged by using the consistency index of the survey results, and if the consistency ratio is less than 0.1 to 0.2, it is judged to be reliable.

Table 3. Descriptive

		Frequency	Percentage
Gender	Male	22	100
	Female	0	0
	Sum	23	100
Age	35-39	2	9.1
	40-44	7	31.8
	45-49	3	13.6
	50+	10	45.5
	Sum	22	100
Education	College graduation	1	27.3
	Graduate school+	21	59.1
	Sum	22	100
Occupation	Private Research	6	27.3
	Government research	13	59.1
	Etc	3	13.6
	Sum	22	100

3. Weight estimate

In many papers using AHP, appropriate analysis models are developed and used according to the purpose and subject of research. This paper aims to review the investment feasibility of government projects, and the evaluation factors are composed of detailed tasks that make up the project. Therefore, when evaluating the priority of alternatives, the feasibility of national financial input must also be evaluated, and the government is also applying a system to evaluate the economic feasibility of financial input. Taking it into account, a cost-efficiency index was developed to reflect the economic feasibility, and the analysis method was improved to reflect the index when calculating the weight. From a government's point of view, cost efficiency is higher when the budget size fluctuates less and maintains a certain level within the allowable budget size. For example, if a certain amount of budget is invested for the next five years, if the annual budget size fluctuates greatly, it may not be possible to secure the entire budget for project promotion depending on the national financial situation.

As shown in Equation (2), the cost-efficiency index is expressed as $L_{i,j}$. i is a layer, and j is an evaluation item. $L_{i,j}$ is calculated as the ratio between the maximum cost and the average cost input during the project period, and the larger the indicator, the more efficiently the budget is executed. C_{Avr} represents the annual average cost over the total project period, and C_{Max} represents the maximum cost.

$$L_{i,j} = \frac{C_{Avr}}{C_{Max}} \tag{2}$$

The cost-efficiency index has been calculated, and the weight of the existing evaluation items, $W_{i,j}$ should be improved using the index. The weight improvement is shown in Equation (3) as $K_{i,j}$, and is calculated by multiplying the existing weight by this indicator.

$$K_{i,j} = W_{i,j} \times L_{i,j} \tag{3}$$

Finally, the weights are standardized through Equation (4) and converted into values, $M_{i,j}$ that can be applied to derive priorities.

$$M_{i,j} = \frac{K_{i,j}}{\sum K_{i,j}} \tag{4}$$

4. investment priority

The investment priority for alternatives is calculated using Equation (5). a_1, a_2, b_1, b_2 mean weights for each evaluation item, and $x_{1n}, x_{2n}, x_{3n}, x_{4n}$ indicate weights for each alternative. n is the number of alternatives. Considering the comprehensive score for each alternative, priorities are determined in the order of relatively high scores.

$$\mathrm{Y}_n = a_1 \cdot x_{1n} + a_2 \cdot x_{2n} + b_1 \cdot x_{3n} + b_2 \cdot x_{4n} \tag{5}$$

5. Analysis Result

Table 4 shows the descriptive statistics of the evaluation items for the survey results. The sample is the result of a survey of 22 people who responded to the survey. The average of the first-class pairwise comparison survey results was 2.59, and the variance was 7.4. In the second layer, an average of 3.23 and a variance of 3.24 were derived from the $a_1 - a_2$ pairwise comparison, and the values of $b_1 - b_2$ were 1.18 and 3.08, respectively.

Table 4. Descriptive Statistics of the Evaluation Items

	Sample	Min	Max	Avr	SD	Var
$A-B$	22	-5	5	2.59	2.72	7.40
a_1-a_2	22	-2	5	3.23	1.80	3.24
b_1-b_2	22	-5	5	1.18	3.08	9.49

Table 5 shows the geometric mean reference matrix and weights of the first layer. In the case of layer 1, the weight of evaluation item A was calculated as 0.71, and the weight of B was 0.29.

Table 5. 1-layer geometric mean matrix and weights

	A	B	weight
A	1	2.4	0.71
B	0.42	1	0.29

The two-layer geometric mean standard matrix and weights are shown in Tables 6 and 7. The values of a1 and a2, which are the evaluation items of the lower class for the A evaluation item, were derived as 0.74 and 0.26, respectively, and the B evaluation item was 0.59 and 0.41.

Table 6. 2-layer geometric mean reference matrix and weights (a_1, a_2)

	a_1	a_2	Weight
a_1	1	2.86	0.74
a_2	0.35	1	0.26

Table 7. 2-layer geometric mean reference matrix and weights (b_1, b_2)

	b_1	b_2	Weight
b_1	1	1.45	0.59
b_2	0.69	1	0.41

Complex weights for the evaluation items of the lowest layer can be calculated using the weight calculation result for each layer. The calculation results are shown in Table 8, and the composite weight of a_1 was 0.53, a_2 was 0.18, b_1 was 0.17, and b_2 was 0.12.

Table 8. Addition of comprehensive weights (1st layer * 2nd layer)

Weight of Layer 1	Weight of Layer 2	Weight of Layer 3
A (0.71)	a_1 (0.74)	0.53
	a_2 (0.26)	0.18
B (0.29)	b_1 (0.59)	0.17
	b_2 (0.41)	0.12

In order to calculate the overall score for deriving priorities, weights for each evaluation item are required at the lowest level. Table 9 shows the weights of the alternatives in the same way as the weights for the previous evaluation items.

Table 9. Alternative weight

	X_{1n}	X_{2n}	X_{3n}	X_{4n}
Alternatives 1	0.11	0.15	0.13	0.15
Alternatives 2	0.34	0.34	0.32	0.32
Alternatives 3	0.16	0.16	0.17	0.18
Alternatives 4	0.39	0.35	0.38	0.35

Finally, the cost-efficiency index for determining the investment priorities of alternatives should be applied. Table 10 shows detailed tasks annual budget and index calculation results to calculate cost-efficiency indexes.

Table 10. Annual Budget and Cost Efficiency Index for Detailed Tasks

(Unit: KRW 100 million)

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	L_{ij}
a_1	55.0	244.9	319.6	319.6	319.6	264.6	74.7	0.83
a_2	469.6	281.7	222.5	84.9	64.2	71.4	67.1	0.45
b_1	3.7	33.6	96.7	120.9	122.2	101.7	28.4	0.70
b_2	16.7	61.5	92.0	92.0	92.0	83.1	47.3	0.88

Table 11 shows the developed weight of the lowest evaluation item reflecting the cost-efficiency index.

Table 11. Correction weight

	$W_{i,j}$	$L_{i,j}$	$M_{i,j}$
a_1	0.53	0.83	0.58
a_2	0.18	0.45	0.11
b_1	0.17	0.70	0.16
b_2	0.12	0.88	0.15

The priority of the alternatives using the hierarchical model was derived using Equation (5). The priorities for each alternative are shown in Table 12, and alternative 4, which divides and builds infrastructure for each Specialized Center, has the highest priority at 0.38. The 2nd priority was 0.33, which was derived from the step-by-step establishment of Specialized Center resources, and the 3rd and 4th priority came from the establishment of the entire infrastructure in a single specific institution and the utilization of resources for each Specialized Center.

Table 12. Priority by alternative

	Comprehensive Score	Priority
Alternatives 1	0.13	4
Alternatives 2	0.33	2
Alternatives 3	0.16	3
Alternatives 4	0.38	1

In order to verify and supplement the results of deriving priorities, it was compared with the implementation strategy of the "3rd National Supercomputing Fostering Basic Plan", the highest-level plan in the supercomputing field of the government (Table 13).

Table 13. 3rd National Supercomputing Fostering Basic Plan

<table>
<tr><th>Main Direction</th><th>Key Strategies</th><th>Key Tasks</th></tr>
<tr><td rowspan="5">Strengthening access to supercomputing</td><td rowspan="3">Expansion of supercomputing infrastructure</td><td>Establishment of world-class national center supercomputing resources</td></tr>
<tr><td>Building Specialized Center resources for each field and providing specialized services</td></tr>
<tr><td>Reinforcement of supercomputing linkage infrastructure</td></tr>
<tr><td rowspan="2">Establishment of a national joint utilization service system</td><td>Establishment of a user-customized one-stop co-utilization service system and platform</td></tr>
<tr><td>Expanding the base of joint utilization by improving the supercomputing equipment introduction system</td></tr>
</table>

As a result of the comparative analysis, alternative 4 was able to confirm similarities with the government's "Basic Plan" recently. The government plans to promote the establishment of a joint utilization system as a key strategy, and the main contents include the establishment of Specialized Centers for each field and the provision of customized calculation services for each field. In particular, it plans to establish resources for special purposes such as AI, weather forecasting, and national defense and connect them with national infrastructure. This content is ultimately partly the same as the direction of building individual infrastructure for each specialized center in Alternative 4. However, the government is emphasizing the provision of specialized services for each Specialized Center in addition to infrastructure. Therefore, it is considered that a follow-up study supplementing the results of the analysis of policy priorities, including the results of establishing service provision plans for each Specalized

Center, is needed in the future.

VI. Conclusion

In this paper, to verify the feasibility of the government's promotion plan related to establishing a supercomputing joint utilization system, various alternatives were discovered and investment priority analysis was performed for each alternative using AHP. Direct evaluation of the project was possible by constructing a hierarchical model considering the government's joint utilization system project promotion system and detailed tasks, and the economic feasibility of the investment could be verified by developing a cost-efficiency index.

As a result of the analysis, priority was given to the plan to divide and build the infrastructure of Specialized Centers by field, and through this, it was possible to confirm the appropriateness of the project promotion plan that the government was trying to promote. The limitation of this thesis is that AHP analysis was performed with the promotion plan of the national center and the Specialized Center at a time when the unit center constituting the joint utilization system had not yet been designated. Therefore, in order to supplement this, the government plans to conduct a reanalysis of the promotion plan after the government's detailed plan for the designation of unit centers is established in the future.

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