Case Study for Effectiveness Analysis on Nuclear Regulatory Infrastructure Support for Emerging Nuclear Energy Countries

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1. Introduction

The number of new entrants in the global nuclear construction market rose and consequently the need for effective and sustainable regulatory infrastructure has also risen. As a result, the new entrants have been requesting more assistance to the international nuclear communities to construct their own mature nuclear regulatory programs.

From the point of view of donor countries, due to the main commitment to maintain the safety of domestic Nuclear Power Plants (NPPs), it is not realistically possible to immediately respond to and fully support all the demands of newcomers' requests on regulatory assistance.

The donor countries need to make decisions on various steps such as whether to fully accept newcomers' requests, the depth of support, and how the supportive action will be carried out. Such is not an easy task due to limited time, resources, manpower, etc. Thus, creating an infrastructure to support emerging nuclear energy countries is needed.

This paper suggests the resource portfolio concept used in business management and aims to analyze the validity of supporting the new entrants' development of regulatory infrastructure as a case study. This study tries to develop a very simple Excel-based tool for assessing the supporting strategy quantitatively and screening the activities that is projected to be less effective and attractive.

Regulatory body invests its time and human resources to cooperate with the countries embarking NPPs and thus, they should draw up a strategy for such international cooperation. The preliminary results from this study can be extended to measure the performance, efficiency or effectiveness of the supporting action.

2. Background

2.1. Current Status of International Activities in KINS

KINS's mission is to protect public health and the environment against radiation risk and it has been well served by various international activity programs in collaboration with international agencies, regulatory bodies and technical support organizations worldwide. KINS's international activity programs have been focused on;

(i) the commitment to the global nuclear safety regime,
(ii) the build-up of a high level regulatory competency, and
(iii) the support for new entrants and potential countries to embark on their 1st nuclear power plant

These international activities have been accomplished based on the mid-term policy direction of KINS as well as the first national nuclear safety comprehensive plan as follows [1],[2];

(i) Collaboration with international agencies by creating opportunities to share and adopt their best practices as well as to exchange mutually beneficial information, which can improve KINS staffs on their technical competency
(ii) Collaboration with international agencies by participating in the development and implementation of international standards and joint research programs, which can allow KINS to understand and adopt the appropriate safety standards and to maintain up-to-date knowledge
(iii) Support for developing countries through the IAEA Global Nuclear and Safety Network (GNSSN) namely Arab Network of Nuclear Regulators (ANNuR) and Forum of Nuclear Regulatory Bodies in Africa (FNRBA) to build their nuclear safety infrastructure, which allows for a broad range of influence in global safety

The first two activities are ongoing and will continue through bilateral and multilateral networks for in-depth and targeted technical cooperation with international agencies and advanced nuclear countries. Likewise, the third activity, as an exporter and IAEA member state, has been continued to support newcomers.

2.2. Necessity of Effectiveness Analysis of Support for Emerging Nuclear Energy Countries

Shortly following the first export of four APR1400 reactors to the United Arab Emirates (UAE), the legacy of Fukushima Daiichi accident has been a sharper focus on nuclear safety worldwide. The widespread recognition that everything humanly possible must be done to ensure that no such accident ever happens again lays the great emphasis on ensuring the high level of nuclear safety of its own country.

The current and expected changes of KINS's workload and internal or external regulatory circumstances prompted the KINS's international activities to function more efficiently regarding the support for the new entrants. Gathering the opinions of the hands-on workers of KINS and evaluating the performance under the first national nuclear safety comprehensive plan recommends review of the effectiveness of support for the new entrants and gradual reduction in the scale of support.

The international activities for supporting new entrants will be either "Effective or Efficient" when KINS performs its function in a timely and cost-effective manner. However, KINS is influenced by various constraints such as limited regulatory man power, increased workloads due to the safety review and supervisory inspection for ensuring the safety of domestic nuclear facilities.

Therefore, an infrastructure is required to optimize and allocate the increasing regulatory demands from the emerging nuclear countries under the limited regulatory human resources and to discern the best way to prioritize the requests from the newcomers. Such infrastructure will allow KINS to become a technical supporting organization which implements international activities more effectively and efficiently and to commit to its main mission.

2. Methodology

One tool used in business strategy, which implements a quantitative technique, is applied to measure the attractiveness and priority of requests from the newcomers regarding the regulatory support. McKinsey developed a nine-cell portfolio matrix to screen a company's strategic business units, which enables the mapping of strategic business units on an industry attractiveness basis.

The result is a quantitative measure which can be expressed in circles which vary in size and location within the matrix. Attractiveness and strength are calculated by first identifying criteria as shown in Table 1, by determining the value of each parameter in the criteria and multiplying that value by a weighting factor.

The vertical axis of the matrix is the attractiveness criterion, determined though factors such as market size, market growth and etc. Each criterion can be given a different weighting in calculating the overall attractiveness of a particular industry.

Typically:

Attractiveness =

Attractiveness criterion $_1$ x Weighting $_1$ +
Attractiveness criterion $_2$ x Weighting $_2$ +
……..
Attractiveness criterion $_N$ x Weighting $_N$

The horizontal axis of the matrix is the strength, including the market share, production capacity and etc., which can be calculated by multiplying the estimated value of each criterion similar to the weighting as done for attractiveness.

Typically:

Strength =

Strength criterion $_1$ x Weighting $_1$ +
Strength criterion $_2$ x Weighting $_2$ +
…..
Strength criterion $_N$ x Weighting $_N$

Table 1: Typical Matrix Criteria

Factor	Criteria
Market Attractiveness	Market Size
	Market Growth
	Market Profitability
	Company Investments
	Overall of Risk of Return
	Entry Barriers
Competitive Strength	Market Share
	Strength of Assets
	Production Capacity
	Core Competencies

3. Case Study

3.1. Application to Strategic Planning for Supporting New Entrants

Direct application of this business concept to nuclear regulatory infrastructure support cannot be done because regulatory organizations are not organizations that seek profit maximization like business firms. Hence, several modifications are necessary for this methodology to appropriately fit this situation.

The main objectives proposed for the portfolio are;

(i) to identify and segment the regulatory needs,
(ii) to discuss 'what and where' of regulatory assistance to be provided, and
(iii) to research how to arrange and allocate the limited resources for the most effective regulatory assistance.

Before plotting the matrix, the concept of the term market can be understood as the needs or requirements of newcomers in the typical business portfolio and profitability can be regarded as the contribution to the global nuclear safety as well as the support to the nuclear industry as a national key export firm. Several problems can be issued in terms of regulatory independence when the regulatory body takes part in the promotion of the nuclear industry. This modification needs to be understood based upon a premise that the commitment to the global nuclear safety regime may contribute to the improvement of national stability and prosperity by taking a leading role in global nuclear safety.

To create a modified matrix, this paper suggests the four steps to proceed as follows; categorizing the

supporting countries, identifying the criteria for attractiveness and effectiveness, giving a priority to support, and defining the expected amounts of resource investment.

First, different needs of regulatory assistance are categorized as, for instance, countries which have already established their regulatory body and decided to import of foreign NPPs like the UAE, countries which are requesting international aid due to weak financial conditions like Jordan, and others which are still considering to launch their first NPP or expansion of the nuclear program and etc.

Second, the specific criteria as well as the market attractiveness and competitive strength can be defined as the attractiveness and effectiveness shown in Table 2.

Table 2: Criteria of Modified Portfolio Matrix for Nuclear Regulatory Support

Criteria for Attractiveness	**Condition to support**
Experience in NPP operation	A country with no experience in NPP operation
Status of Regulatory Organization	A country currently with no regulatory body or a supporting organization
Status of Nuclear Energy Policy	A country launching or expanding their nuclear power program in detail
Expectation of Growth of Nuclear Program	A country with increasing demand on nuclear application (electricity, desalination, research and so on)
Criteria for Effectiveness	**Condition to support**
Assistance of International Communities	A country not supported by bilateral cooperation or international cooperation programs such as ODA* or IAEA's Regional Network** (avoiding the dual support)
Reliance or Urgency on Korea's Support	A country highly and urgently relying on Korea's support
Interests in Korean NPP	A country with high interests in Korean NPPs and contributing to national prosperity in the enlarging nuclear market
Contribution to Regulatory Competence of KINS staffs	A country with demands on regulatory supports from the technical area (excluding one-time visiting or information exchange meetings)

- ODA* : official development program
- IAEA Network ** : ANNuR, FNRBA, etc.

Third, the strategy variation and the most preferable options are discussed to give a priority of support in the nine cells shown as Fig.1. In this paper, the specific country names are expressed as A thru E, and the weightings and values of the criteria in each factor are arbitrarily defined. The three cells in the upper right corner means 'green light 'to support actively. Three diagonal cells from the lower right to the upper left suggest to allocate resources on a selective basis. The three cells in the lower left corner may be divested from a portfolio.

Finally, the size of the circle shows the investment of time and human resources for the regulatory assistances.

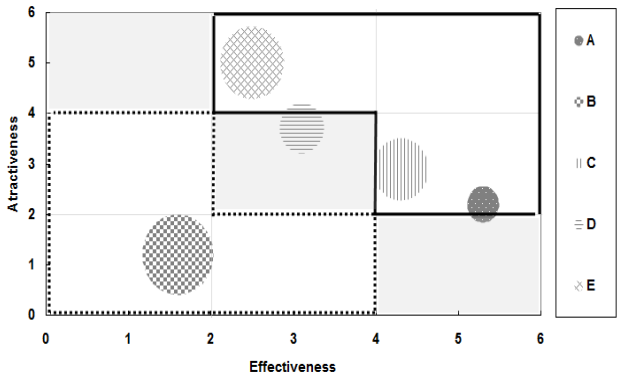

Fig. 1: Portfolio Matrix for Nuclear Regulatory Support

3.2. Results of Case Study

Currently many embarking countries have expressed their interests in bilateral cooperation with KINS. For the countries that have imported Korean technology, KINS needs to make a commitment to their requests as the country of origin. Others have requested for overall consulting services for establishing their own regulatory bodies or technical supporting organizations. Especially, there are numerous demands for financial assistance such in the name of scholarships.

To calculate the score, weighting factors are given differently to each sub-criterion, and values of each sub-criterion rank on a five-point scale. In this case, high scores represent good conditions for the support.

This paper selects five countries as random samples for calculation and country names and scores are assigned arbitrarily, due to the significance of keeping confidentiality.

As shown in Fig.2 and Fig.3, two countries (A and C) in the upper right corner are located in 'green light' cells, which means to support actively. For these countries, further investment can be considered. For two countries (B and D) in the diagonal cells from the lower right to the upper left, it is suggested that resources should be allocated on a selective basis. These countries can be managed at the current level of cooperation. One country (E) in the lower left corner may be divested

from the portfolio although this country does not require large amounts of resources. Moreover, investment for this country should be reduced.

Basically, countries A and C, occasionally including B have higher priority while country E would hardly receive any resources, even though it is a small scale of investment, due to its low ratings in both attractiveness and effectiveness.

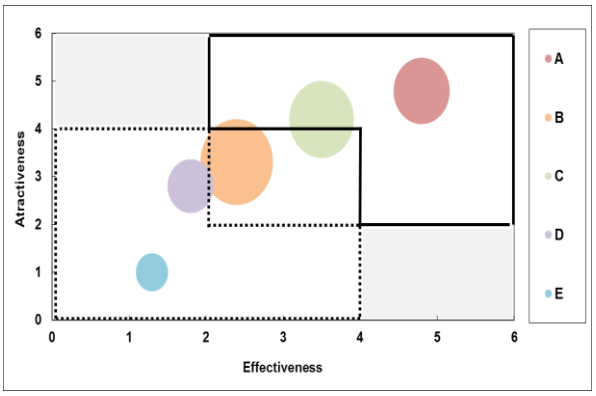

Fig. 2: Result of Portfolio Matrix for Nuclear Regulatory Support

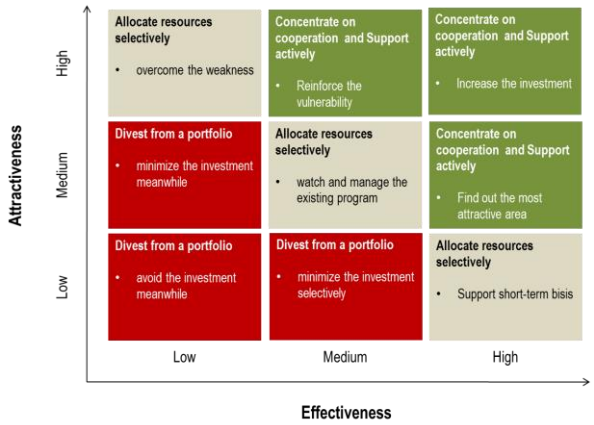

Fig. 3: Mapping of Strategic Implication

3.3. Limitation and Further Study

The first purpose of this study is to apply a tool used in business strategy to create an infrastructure for supporting and responding to the requests of the newcomers. In addition, this paper aims to suggest the procedure of identifying the effectiveness of arranging the regulatory assistances under limited resources. Nevertheless, more long term based academic research and literature survey in depth needs to be a prerequisite for identifying the criteria and enhancing the calculation accuracy in scoring values and weighting factors.

Before defining the sub-criteria, the feasibility and accountability that each sub-criterion is categorized into attractiveness and effectiveness should be assessed and the independency between sub-criteria should be checked as well. Sub-criteria should be mutually independent, i.e., they convey no information about each other. However, these issues are outside the scope of this study and they remain as further areas to be studied.

3.4. Policy Implications

Many countries that intend to develop nuclear power programs announced that nuclear energy is inevitable until new innovative energy technologies are developed. Also, they believe renewable energy such as nuclear energy is more economical and competitive in terms of generation capacity in the grid. In addition, in the case of the countries embarking on NPPs, their regulatory bodies should make efforts to increase regulatory resources and enhance technical excellence to strengthen nuclear safety via various international cooperation programs.

From the point of view of donor countries, because regulatory bodies as well as utilities should give top priority to securing the safety of NPPs, they need to establish means to evaluate the requests and react in an effective manner. International activities for supporting new entrants should be consistent with the degree of effectiveness improvements they achieve. Especially the use of regulatory resources should be optimized. Therefore, they need to measure the performance, efficiency or effectiveness of outcome after the regulatory bodies invest in cooperation with the countries embarking on NPPs. This study introduced one possible way, based on the strategic approach, to make a decision on whether regulatory bodies should fully accept newcomers' requests or not.

4. Conclusions

There are many countries, so called newcomers, which have expressed interests in developing their own nuclear power program. It has been recognized by the international community that every country considering embarking upon their own nuclear power program should establish their nuclear safety infrastructure to sustain a high level of nuclear safety. The newcomers have requested for considerable assistance from the IAEA and they already have bilateral cooperation programs with the advanced countries with matured nuclear regulatory programs.

Currently, the regulatory bodies that provide support are confronted with two responsibilities as follows; the primary objective of the regulatory bodies is to ensure that the operator fulfills the responsibility to protect human health and the environment in their respective

countries. Second, the regulatory bodies of nuclear power plant exporting countries, furthermore, should take a reliable role in supporting nuclear safety of importing countries and to contribute to global nuclear safety as an IAEA member state. The difficulties in supporting newcomers as well as regulating safety in domestic NPPs rely on the facts that the regulatory bodies of providing countries have constrained resources. Hence, they have to improve the effectiveness, efficiency and harmonization of regulatory approaches and need to optimize and allocate the limited human resources based on the strategic planning of using the quantitative assessment of their effectiveness.

This paper suggests the procedure on how to identify the effectiveness of arranging regulatory assistance under limited resources, and attempts to apply this procedure to some countries currently who have expressed their requests to Korea. Yet, this approach should be improved through further studies, including the selection of criteria and quantification of the value for each criterion through expert peer reviews.

REFERENCES

[1] KINS, Mid-term Strategic Plan for International Cooperation, 2015
[2] Nuclear Safety and Security Commission, the 1st National Nuclear Safety Comprehensive Plan (2012-2016), 2011