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Governmental Science and Technology Policy-Making on Technology-Intensive Industry Based on Allison's Models : Focused on the Nuclear and Radiation Field

앨리슨모형을 기반으로 한 기술집약적 산업의 정부 과학기술 정책결정: 원자력 및 방사선 분야를 중심으로

Seokki Cha
Hanyang University, 222, Wangsimni-ro, Seongdong-gu, Seoul, Republic of Korea

차석기
한양대학교, 서울특별시 성동구 왕십리로 222

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Technology-intensive industries can be used as a major growth engine for resource poor country in the territories. For example, in the case of Korea, nuclear power and radiation technology industry was highly developed, and it was possible to obtain national interests such as solving energy problems within the country and exporting nuclear power plants. On the other hand, there are cases where national damage is caused by erroneous governmental policy-making on technology-intensive sectors. In this study, we analyzed cases of misguided governmental policy-making for technology-intensive industry and three factors were identified. And we tried to develop a rational policy-making model using three types of allison's model in combination. The results of this study are expected to be useful for rational governmental policy-making processes for technology-intensive industries.

Keywords: Allison's models, Policy-making, Technology-intensive industries, Nuclear and radiation

*Corresponding Author.
Seokki Cha, Hanyang University, E-mail: kcha0476@naver.com, Tel: +82-10-5286-0671

ORCID
Seokki Cha http://orcid.org/0000-0003-0979-7055

기술집약적 분야 산업은 영토 내 가용할 수 있는 자원이 극빈한 국가의 주요 성장 동력으로 활용되어질 수 있다. 예로, 한국의 경우 원자력 및 방사선 기술 산업을 고도로 육성시켜 자국 내 에너지 문제의 해결과 원자력발전소 수출 등 국익을 얻을 수 있었다. 반면 기술집약적 분야 산업에 대한 잘못된 정부정책결정에 의하여 국가적 손해가 발생한 경우도 존재한다. 본 연구에서는 기술집약적 산업에 대한 잘못된 정부정책사례를 분석하여 3가지 요인을 도출하였다. 그리고 3가지 모형의 앨리슨모델을 복합적으로 이용하여, 사례분석에서 도출된 3가지 요인의 문제점을 해결할 수 있는 합리적 정책결정 모형을 개발하고자 하였다. 궁극적으로, 본 연구의 결과는 기술집약적 산업에 대한 합리적인 정부정책결정 과정을 위해 향후 활용될 수 있을 것으로 기대한다.

중심단어: 앨리슨모형, 정부정책결정, 기술집약적 산업, 원자력 및 방사선

1. Introduction

Recently, the issue on the nuclear power plants has been highlighted by the new regime, which is why the entire nation is has its eyes transfixed on the political populism that has emerged in connection with the current government's nuclear phase-out policy. While nuclear and radiological technologies can be dangerous if misused or abused, they present the advantage of generating energy efficiently. Scientists and engineers from South Korea may be regarded as major industrial resources of the nation as they work within a technology-intensive industries. However, recent government policy-making is causing the nation to be led by industrial resources poorer than those attributable to nuclear and radiological technology. Analysis of this policy-making can be regarded as the 'Rational Actor Model' of allison's models as the reader with absolute power, without 'Nuclear Safety Act' and the procedure of the national assembly, decided it by administrative order.

Recent R&D, 'Pyro-Processing' research into the next generation of spent fuel has had its budget cut and scientists and engineers who possess major skills have been out of industry. Table 1 shows the level of reduction in the budget for nuclear research.

In this paper, we analyze the policy-making of technology intensive field based on the allison's models. 'Jonathan Bendor and H. Hammond (1992)' [2] used the 'Bureaucratic Politics Model' for government policy-making; however, in this study, we developed a new model by combining three types of models and we hope to applied them to policy decision-making. Through the use of the mixed model developed in this study, we hope that government fail or policy fail in the field of technology intensive will not be happen.

2. Materials and Methods

The main materials used in this study were the three types of allison's models; a theoretical model related to government policy-making; and the case of policy fail in the field of technology intensive field. Using such materials,

Table 1. Research Budget Changes in Korea's Nuclear and Radiological Technologies [1]

R&D	2012	2016	Reduction
Nuclear Safety and Advancement	$77 million	$45 million	40% ↓
Innovations in nuclear power generation	$13 million	$5 million	60% ↓
Radioactive waste management and technology development	$11 million	$10 million	10% ↓

the study hoped to put forth a critique of government fail or policy fail and assess these on the basis of theories of the three different types of allison's models. After a theoretical definition of the three different types of allison's models, by way of criticism and evaluation, the decision-making process and the expected outcome of the policy could be inferred. The ultimate purpose of this study is to model the rational policy decisions that could be applied to technology-intensive industries areas such as nuclear and radiation.

3. Identification and Definition of Allison's Models

Allison's models have been used as a key model for the nation's policy decisions. It was derived from the analysis of the U.S. and Soviet policy decisions on the Cuban Missile Crisis. There are three main types. It can be differentiated by looking at the following three models: the 'Rational Actor Model', the 'Organizational Process Model', and the 'Bureaucratic Politics Model'[3]. In this study, we propose this concept to the application of policy decisions in technology-intensive industries.

'Rational Actor Model': The 'Rational Actor Model' assumes that human beings are rational and that the government is an organism. The 'Rational Actor Model' assumes that the leader of the organization acts as the brain and that policy decisions made among policy-making participants will be the most effective choices in the interest of the nation. According to this theory, the government is regarded as having complete information-processing ability and computing capacity, as well as being an important player in the policy-making process. Therefore, it is believed that the government's actions are solely intended to maximize the interests of the nation and that this way a solution can be reached to maximize profit at a cost lower than that afforded by the various possible alternatives. This requires the following rational approach. The first is accurate information, and the second is perfect knowledge of outcomes and probabilities. With regard to this, government organizations assume that the government's goal is to match the objectives of the government with those of government officials. The highest leaders are considered to be the best decision makers with the assumption that the government runs a well-organized and well-controlled organism. Furthermore, policy decisions are always consistent, and members of the organization are thought to do their best to determine rational policies in the interests of the nation.

'Organizational Process Model': This model adopts the proposed policy in a unique sector of a sub-organization. The main leader believes in the model and adopts the proposed policy in the sub-organization. To efficiently respond to a broad range of issues, each sub-organization has the right to do so and each sub-organization is therefore independent. Even if an independent sub-organization presents different solutions, the policy is not determined by the choice of the main leader, who is only able to control partially. As this model is based on standard operating procedures, it can lead to gradual changes through organizational learning processes rather than drastic changes in government policies. Thus, such a model may be deemed to be more suitable for matters such as policy-making on technology-intensive industries. On the other hand, it may be difficult to apply it in case of an emergency.

'Bureaucratic Politics Model': In this model, policies are not defined as measures to solve problems. Instead, policies are defined as a result of political competition among government members. This model, which considers individual participants as the arbiters of policy decisions, is very different from those described earlier. In fact, in this model, policy-makers may tend to pursue individual goals. A combination of a macro perspective and a micro-controlled focus can occur. This can reduce the extent to which objectives are shared, as well as the consistency of policy decisions. Thus, instead of treating government policy decisions as the best way to solve the problems faced by the entire organization, it is characterized by the perception of the participants resulting from conflict and compromise because of political strife.

4. A Case Study of Nuclear Policy Decision Process

Despite the fact that nuclear energy is a very efficient energy resource, the psychological adverse effects other than the biologic adverse effects of accidents can spread widely over a long period of time, resulting in psychological fluctuations. Furthermore, it is a field with very specific distinctiveness such as environmental adverse effect and possibility of damage after a long time. In addition to the risk factors, very complex stakeholders are formed due to the nature of the industrial structure. Therefore, in policy making 'Social Relation Factors' should be considered carefully.

Nuclear power is used in various fields, but it is most frequently used as energy producing technology. As energy is an essential element in the survival of mankind and the prosperity of the national economy, 'Economic Factors' should be carefully considered when making nuclear policy decisions.

Nuclear and other energy sources are very technology-intensive. In addition physics, chemistry, biology, and even medical knowledge are required. Furthermore, R&D for efficient new energy that can replace nuclear power is a project that is being carried out with a very large budget at national level. Therefore, 'Technological Factors' should be carefully considered when deciding nuclear policy.

The case of Taiwan's nuclear phase out is a major policy decision error case. In 2016, Taiwan's electricity consumption has increased by 3%, but the nuclear phase out, which is being pursued by the 'government of Tsai Ing wen', has not reflected enough opinions from experts on the fluctuation of power consumption, one of the 'Economic Factors'. As a 'Technological Factors', there was not enough energy resources to replace nuclear power plants that were shut down. As a result, the disruption of electric power supply in taiwan has been extreme, resulting in great damage to the nation. Repeated national major losses are expected by re-starting shutdown nuclear reactors as a result of anticipated heat waves due to climate change.

In the case of the German nuclear phase out, discussions began in earnest after the chernobyl nuclear power plant accident in 1986, and the nuclear phase out was conducted for the first time in 2000. At this time, it was considered that some of the 'Technological Factors' could be that the rich lignite reserves of their own countries and energy could be exchanged at all times through the grid connected to the neighboring countries [4, 5]. It can be seen that the 'Technological Factors' has been sufficiently solved. Since the debate on the nuclear phase out began in 1986, the policy has been finalized for about 40 years through the process of consensus formation by the government, the people, and the industry in order to solve the problem of 'Social Relation Factors'. Nonetheless, there are problems with 'Economic Factors' such as increased electricity rates due to renewable energy subsidies and transmission networks, insecure power supply due to intermittent renewable energies, confusion in neighboring power systems in the process of exporting and importing excess or under-produced electricity etc.

Unlike germany, south korea is a poor country of energy resources, and neighboring countries and power networks are not connected. There is not enough solution for 'Technological Factors'. In order to solve the problem of 'Social Relations Factors', germany has undergone a process of dispute settlement and traffic cleanup among stakeholders about nuclear phase out for about 40 years. In the case of 'Economic Factors', even germany, which has reached a relatively successful nuclear phase out compared to taiwan's case, has failed. Especially, in case of Korea, as the export industry based on manufacturing is the core revenue source of the country, there is a risk that the profit structure of the whole country will collapse if this 'Economic Factors' is not solved. If power supply instability persists like taiwan, there will be huge losses in the semiconductor manufacturing, shipbuilding, and automobile manufacturing sectors, which are korea's major growth engines is that manufacturing.

5. Explanation of Three Types of Allison's Models by Korean Industries

This paper sought to critically analyze the problem stated in the preceding content and the problems inherent in the recent policy-making decision process, on the basis of allison's models. In conclusion, to aid decision-making in technology-intensive industries, political determination should reflect professional opinions. Also, political determination requires consistent and sustainable goals through an 'Organizational Process Model'. Hence, this study intends to establish a policy-making process of technology-intensive industries by partially using the 'Organizational Process Model'. Korea's policy on the advancement of nuclear and radiological technologies is controlled by the 'Ministry of Science and ICT'. Scientists at the 'Korea Atomic Energy Research Institute (KAERI)' and the 'Korea Institute of Radiological and Medical Science (KIRAMS)' carry out R&D on nuclear and radiology advancement. In addition, the 'Korea Energy Information Culture Agency (KEICA)' serves as a window for conducting reviews, enhancing public awareness of nuclear and radiological technologies, and gathering people's opinions on nuclear energy and radiation technologies. On the other hand, the 'Nuclear Safety and Security Commission' reserves the right to regulate nuclear and radiological technologies. Government regulators, such as the 'Korea Institute of Nuclear Safety (KINS)', the 'Korea Institute of Nuclear Nonproliferation and Control (KINAC)', and the 'Korea Foundation of Nuclear Safety (KoFONS)' are responsible for R&D management of nuclear radiation safety regulation technology. In addition, with the specialized in radiological hazards and the biological risks, the 'National Radiological Emergency Center (NREMC)' at the 'Korea Institute of Radiological and Medical Science (KIRAMS)', which is co-operated by the 'Ministry of Science and ICT' and the 'Nuclear Safety and Security Commission', fulfills the role in the special areas that need to combine engineering and medical science. Based on these highly sophisticated configurations of expertise, it is a highly desirable political decision-making model armed with which experts with specialized expertise in professional institutions compete mutually for political effectiveness, using the 'Bureaucratic Politics Model'. The policies determined by this competition can be improved under the 'Organizational Process Model' with consistent reviews of the organization.

6. Development of Decision Model for Policy

This study try to design a new policy decision process by adopting a mixture of three types of allison's models. This has been preceded in the field of policy research that needs to be considered such as 'Social Relation Factors', 'Economic Factors', and 'Technological factors' such as the construction of urban highways and the development of advanced medical complexes. As described above, nuclear field requires highly specific knowledge in various fields due to its distinctiveness. Therefore, as introduced in chapter 5, there are several specialized agencies in korea in only one specific nuclear field. Each specialized institution owns a common theme of nuclear field, but its tasks are very different in detail. As mention again, this is due to the distinctiveness of nuclear.

First, this study propose the use of Fig. 1 'Organizational Process Model' in order to solve 'Technological Factors'. This is to ensure that a specific organization, each with a highly sophisticated knowledge, can provide a professional view of the policy, and that the expertise provided is generously reflected. In order to solve the 'Economic Factors', this study proposes the use of the 'Organizational Process Model' as well as to solve 'Technological factors'. The reason for this is that, in the field of predicting the economic situation after considering the past economic situation, highly specialized expertise is required. Analysis

Fig. 1. Applying to 'Organizational Process Model' to Solve 'Technological Factors'.

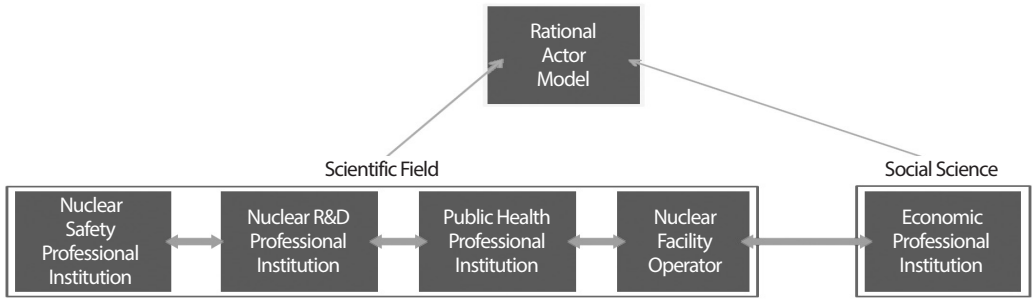

Fig. 2. Applying to 'Rational Actor Model' to Solve 'Social Relation Factors'.

Fig. 3. Applying to 'Bureaucratic Politics Model' by experts.

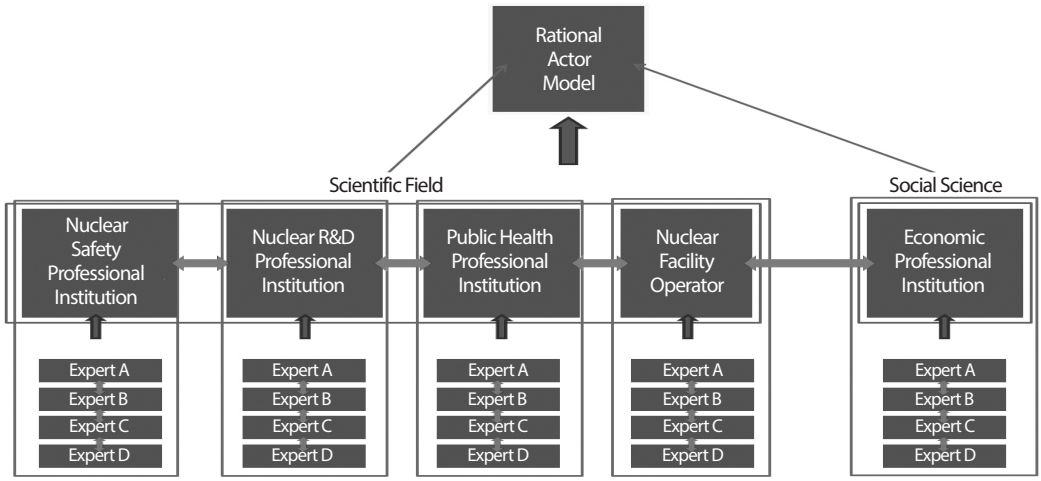

Fig. 4. Overall Scheme of Policy-making Process for Technology-Intensive Industries.

of various 'Technological factors' for policy making and countermeasures for resolution can be made by institutions with different expertise like Fig. 1 'Organizational Process Model'.

This model can solve two problems of 'Economic Factors' and 'Technological factors'. On the other hand, in addition to the final decision to synthesize expertise sufficiently converged by the 'Organizational Process Model', this study proposes the use of Fig. 2 'Rational Actor Model' to solve the problem of 'Social Relation Factors'. This is based on the results of previous studies using the 'Rational Actor Model' to address complex stake holders such as Jung Ok Lee (2001) and Lee Hun-Kyung (2005) [6, 7].

The Professional Institution has a large number of specialists who have a slightly different specialty in common areas. The Professional Institution, which consists of highly specialized experts, suggests that the Fig. 3 'Bureaucratic Politics Model' is used for the decision making process. This is based on the results of policy research conducted in the context of only those experts with high level of expertise, such as the North Korean Nuclear Crisis, South Korea's North Korea Policy, and the European Union's Common Trade Policy [8, 9].

In order to take account of the specificity of nuclear power, the 'Bureaucratic Politics Model' is used in 'Step 1' to reflect the opinions of the experts in the professional organization and to reflect the opinions in the final decision through political and expertise competition. In 'Step 2', the finalized decisions in 'Step 1' are presented by the 'Organizational Process Model', with each specialized organization responding to its characteristics. Thus, 'Economic Factors' and 'Technological Factors' can be solved. In Step 3, the final decision must be made based on the opinions presented in Step 2. In addition, it is necessary to clarify the situation of the top leaders who have the best power and leadership and who are outside among the stakeholders. It is necessary to distribute profits and resolve complaints by top leaders. Therefore, 'Rational Actor Model' is applied in Step 3. As a result, it can be expressed as Fig. 4.

7. Conclusion

The governmental policy-making in the technology intensive industries should not be made by the single absolute power. It can also be used as political populism. And as we explain this phenomenon with the allison's model, it can be defined as an incorrect policy decision process which is used only for the 'Rational Actor Model'. This is based on opinions from non-professionals with no professional knowledge or experience working with experts. This study was aimed at recognizing the need to reflect the opinions of professional organizations to develop proper policy-making in technology-intensive industries by following the 'Organizational Process Model'. The process of determining opinions within a professional organization is, in particular, based on the 'Bureaucratic Political Model' as step 1. On the other hand, this study proposes that the 'Organizational Process Model' should be used to determine opinions as step 2. The final decision is completed by step 3. In step 2, the final decision is made by the 'Rational Actor Model' reflecting the results obtained in the process, and the 'Social Relational Factors' are solved. In order to verify the policy decision process designed through this study, previous research results were used. In this study, the time efficiency of policy decision was abandoned because it is reasonable to make a complicated discussion process over a long period of time for a national policy decision in a technology-intensive industries such as nuclear and radiation industry. The different opinions generated in each step can be processed through the following process. Step 1, the dissent or adoption of opinions may be determined by political competition. Step 2, the different opinions that may arise at each specialized agency (Institute) may be finally determined through Step 3. Because the allison's models assumes that 'Rational Actor Model' can make a reasonable final decision after collecting all the information.

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