2.1.1 STI governance structure

SHIROYAMA Hideaki[1] KISHIMOTO Atsuo[2] MATSUO Makiko[3]

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Abstract

This paper first defines “governance” for the purposes of this paper, and then discusses why STI governance is needed. Factors that necessitate STI governance include (1) the nature of the issues STI addresses and (2) the complex structure of STI policy. In terms of the latter, the complex structure of STI policy, the balance between the differences and proximity between “policy for STI” (promotion) and “STI policy for policy” (responses to issues) points to the need for a mechanism by which to properly grasp and coordinate various sectoral policies, the intersection of various actors (including government and private actors), and even the social infrastructure whereby such policies are developed.

The perspective of governance analysis varies by level and scope (i.e., international, regional, and national levels, and individual sectors and disciplines). Its structure also changes in response to technological developments and social conditions. The question of how governmental and international organizations responsible for specific sectoral issues and related peripheral policies should communicate and coordinate is an important topic. Nonetheless, while the government still performs key functions such as STI management, R&D funding, and related regulation, there are limits to how much the government can promote and manage innovation on its own, and going forward, it will be even more important to build mutually complementary relationships with other actors.

Keywords

Governance, science, technology, and innovation (STI); “policy for STI” (promotion); “STI policy for policy” (responses to issues)

1 Professor, The University of Tokyo Faculty of Law Graduate Schools for Law and Politics
2 Professor, Osaka University Institute for Datability Science
3 Specially Appointed Associate Professor, The University of Tokyo Graduate School of Public Policy

1 Why STI policy requires governance

1.1 STI and governance in this paper

In order to discuss governance in STI policy, we first need to define "science, technology, and innovation" (STI)[4] and "governance" as used in this paper.

In respect to STI, "science" refers to activities that seek to discover laws and causal relationships in the natural world, "technology" refers to the means by which to achieve certain functions and objectives in society (with science and technology utilizing scientific knowledge),[5] while "innovation" refers to activities that introduce science and technology into society and lead to the creation of value. As such, STI policy[6] is not limited to policies related to science and technology research and development and infrastructure development, but includes a variety of policies related to implementing these developments in society and ensuring economic, social, and public value (Shiroyama Hideaki, 2018).

Next, "governance" is a social decision-making function, mechanism or institutional design that considers a horizontal relationship with organizations, including traditional government and a wide range of non-government actors (Shiroyama Hideaki, 2007). Although this paper defines "governance" in this way, definitions vary across disciplines[7]. Here, the term "governance" is defined as including a variety of actors not limited to the government, comprising various levels of relationships including both bottom-up and top-down relationships, and as encompassing various STI-related issues (intersectional fields not limited to a single sector) and institutional design (from hard to soft aspects).

1.2 The need for governance in STI policy: The issues and complex structure of STI policy

There are two reasons why the aforementioned governance perspective is needed in STI policies today: first, the nature of the issues that STI policies address; second, the complex structure of STI policies.

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4 Science, Technology and Innovation—often translated into Japanese as *Kagaku gijutsu inobēshon*—is more accurately articulated as "science, technology, and innovation" (not Science Technology Innovation). For this reason, the acronym "ST&I" has been used instead of "STI"; however, this paper uses the abbreviation STI as this is more commonly used in English. This means that STI did not originally mean "science and technology innovation" but "science, technology, and innovation"; likewise, STI policy means science policy, technology policy, and innovation policy. However, they are not completely independent of each other, as there are intersectional areas.

5 Technologies include empirical technologies that are not necessarily based on scientific knowledge (Shiroyama Hideaki, 2013).

6 Science, technology, and innovation refers to "the creation of intellectual and cultural value based on new knowledge through scientific discoveries and inventions, and innovation developing this knowledge and linking it to the creation of economic, social and public values" (Fifth Science and Technology Basic Plan).

7 Governance has a variety of perspectives and scopes depending on the field in question. In political science, and the field of international politics in particular, globalization, as typified by global governance (e.g., increase in trade and transboundary issues such as environmental problems), has transformed the vertical governance structure of sovereign states and increased the role of various actors besides states and governments. Consequently, it is often viewed as the totality of methods and processes (institutions, organizations) for managing and coordinating any and all issues. The concept of governance can be used to examine these structural changes in a descriptive and analytical way, or to discuss normatively what the structure should be and which principles it should follow. In the case of the latter, governance principles such as accountability, legitimacy, transparency, citizen participation and democratization, and efficacy are discussed. In other fields, like corporate governance, governance is sometimes used in a more restrictive way, such as the distribution of authority.

First, the characteristics of the issues covered by STI policy are as follows. As exemplified by digital technology in the information field, STI policies are increasingly cross-disciplinary in nature due to the accelerated speed of development, deeper integration and interaction with other technologies, simplification of technology, and reduced costs. Science and technology is also characterized by "uncertainty." In addition to the uncertainty of scientific knowledge itself, its social implications are not self-evident, its risks and benefits are multifaceted depending on the recipients and their framing, and trading-off between different qualities of risks is often an issue (Graham, John D. and Weiner, Jonathan B., 1998). In addition to judgments about risks and benefits, social judgments are most difficult to make when STI intersects with value issues such as bioethics. Another characteristic is the multi-purpose applicability of science and technology. This can have unintended consequences, such as dual use, which is the unintended military use of civilian goods. Science and technology is also inherently unpredictable. As evidenced by the Great East Japan Earthquake, the connection between science and technology and natural disaster risk(Natech) led to unexpected events. Traditionally, it has been pointed out that technologies have inherent dilemmas that cannot be predicted with any certainty at the time of their introduction (i.e., Collingridge's dilemma; see Collingridge, 1981). Moreover, it may become difficult to control the impact of technologies following their introduction to society, and the uncertainty and ambiguity of the effects brought about by the subjects of STI policy are even greater.

Second, regarding the complex structure of STI policy, such policies are characterized by the presence of ministries and agencies at various levels within the government with diverse objectives related to STI policy, as well as the increasing involvement of non-governmental actors due to the expansion of STI targets and impacts (specific forms are discussed in the next section of this paper).

Therefore, there is a need for a concept of "governance" that encompasses and coordinates the cross-sectoral and complex impacts of the issues addressed by STI policies, as well as the involvement of various actors beyond the government.

2 STI governance structure

2.1 Embracing both aspects of "policy for STI" (promotion) and "STI policy for policy" (responses to issues)

There are two aspects to STI policy. The first is "policy for STI" (promotion), which focuses on science and technology research and development and thus the promotion of innovation. The second is "STI for policy" (responses to issues), which aims to use STI to address social issues in policy in a variety of sectors, including healthcare and medicine, the environment, and energy. The term "science and technology policy" has traditionally been associated with the former. However, in Japan, problem-solving policies have traditionally been implemented by individual ministries (e.g., energy policy and healthcare policy) and their research institutes. Moreover, as noted, there has been a recent shift in emphasis toward STI, with innovation, and the social dimension in particular, becoming increasingly important.

Outcomes generated to promote STI may be useful for addressing individual policy issues, and STI generated for addressing policy issues may be useful for STI promotion. In support of this, consider how

fundamental technologies such as artificial intelligence (AI) and genome editing, which have become hot topics in recent years, can be applied to various policy fields on an interdisciplinary basis, and conversely, how research that is responsive to policy issues is pushing science and technology forward. Today, the points of interface between these two sides are becoming increasingly complex, and the range of intersectionality between them is expanding. In general, the former is more about promoting science and technology, while the latter takes a more regulatory perspective, including the development of related systems for introducing technology into society and risk management for dealing with emergent issues. However, it is important not to develop each of them in isolation, but instead strike a balance between promotion and regulation—that is, the accelerators and the brakes.

The perspective of "governance," as discussed in the previous section, is important to properly introduce science and technology into society and promote innovation. In other words, it is essential to have a mechanism to properly understand and coordinate the various sectoral policies related to "policy for STI" (promotion) and "STI policy for policy" (responses to issues), the intersection of various actors (including government and private actors), and the social foundation upon which such policies are developed.

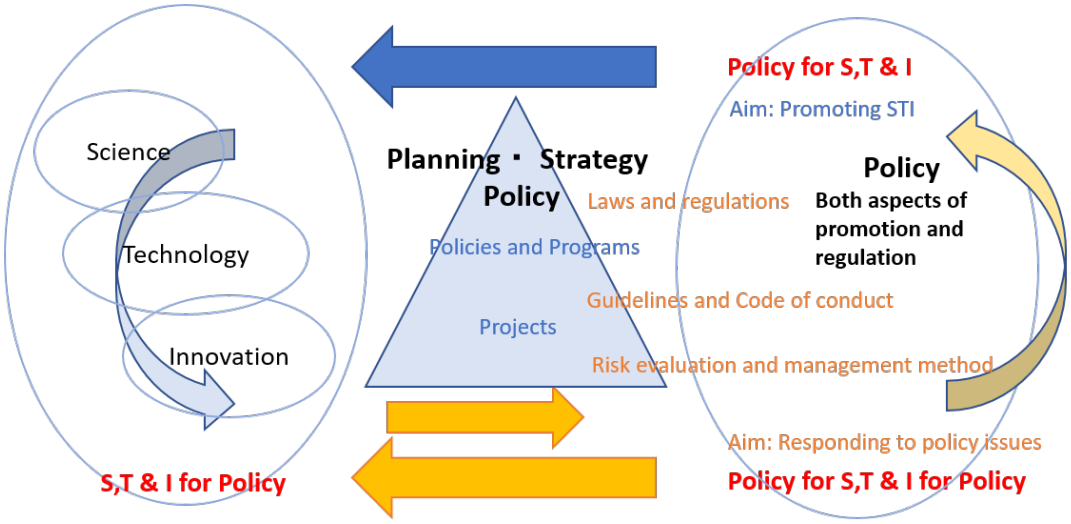

Figure 1. Relationship between STI and Policy.
(Created by the authors)

2.2 The diverse actors involved in the STI field

STI-related actors include parliaments interested in STI policies; relevant governmental organizations; universities, research institutes, and think tanks involved in research and development; industries and businesses seeking to market their products; media, NGOs, and NPOs that communicate these activities to society; and the general public and consumers who are the recipients and users of such activities.

In respect to policies for STI (promotion), these actors primarily include the Council for Science, Technology and Innovation (CSTI), which is chaired by the Prime Minister and which can be regarded as the nerve center for STI policies; the Ministry of Education, Culture, Sports, Science and Technology; the

National Institute of Science and Technology Policy (NISTEP) and the Center for Research and Development Strategy (CRDS) of the Japan Science and Technology Agency (JST), which are responsible for research and analysis functions (Tateo Arimoto, Yasushi Sato, and Keiko Matsuo, 2016, Chapter 8). Each ministry and agency also has departments and research institutes involved in technological development to some extent. Actors involved in STI policy for policy (responses to issues) include the individual ministries and their councils responsible for industry policy (e.g., energy, telecommunications, transportation, agriculture, environment, health, and medicine) as well as the funding agencies and research institutes of those ministries.

Non-government actors involved in STI include the Science Council of Japan, a cross-sectional organization based on academic societies that makes policy proposals from a standpoint with a degree of independence[8], universities and individual academic societies that conduct research and provide human resources from an independent standpoint, and various think tanks that conduct research and surveys for specific purposes or from a third-party standpoint.

Actors that play a major role in STI in practice include industry associations (e.g., Japan Business Federation, Council on Competitiveness Nippon), large and small businesses, and startup companies, which can be both the developers and users of the technology. Additionally, the media disseminates information about the introduction of science and technology to society, while environmental, consumer, and patient group NGOs and NPOs advocate from specific standpoints. Finally, society and the general public benefit from it.

2.3 Complex governance structures

The type of governance structure largely determines the allocation of resources to the various actors mentioned above. The analytical perspective of governance varies by level and scope. In other words, it depends on whether you look at the structure at the international, regional or national level, and whether you look at it by individual field or sector. In terms of STI policy in the national system as a whole, the governance structure is centered in the CSTI, which unites individual sectors, coordinates their relationships with one another, and plays the role of the nerve center. However, if we look at each field, the units of governance and the actors involved will change to reflect the characteristics of that field.

Even in the same field, governance structures can change to reflect technological developments and social contexts. For instance, Japan's space policy has undergone major changes in the last few decades. Through GPS, satellites have become associated with the control of various terrestrial infrastructures such as transportation, energy, and finance. This has both hard and soft security implications. The Space Basic Act was adopted in response to recent improvements in private sector technology, the emergence of startups, and expectations for various real-world applications, and focuses on development and utilization while also including a security perspective. Instead of the Ministry of Education, Culture, Sports, Science

8 The Science Council of Japan is tasked with responding to and making recommendations in response to government inquiries from a standpoint independent of the government; however, organizationally it is part of the government structure and is funded from the government budget (Arimoto Tateo, Sato Yasushi, and Matsuo Keiko, 2016, p. 152).

and Technology, the Space Development Strategy Headquarters and Space Policy Committee of the Cabinet Office are responsible for the overall budget, determining policy direction, and overall coordination of issues related to regulations, among other responsibilities (Shiroyama Hideaki, 2018). This is one example of how technological objectives and corresponding organizations have changed in response to their social context.

2.4 The importance of a complementary division of roles between government agencies and between the government and other actors

In light of the above, the governance issues surrounding STI policy can be summarized as follows. In STI policy, as the interface between policy domains becomes increasingly complex, the negative effects of vertical separation are fatal to STI promotion. Therefore, it is essential that administrative organizations with a top-down view, such as CSTI, literally play the role of a "control tower," communicating and coordinating with administrative organizations and international organizations responsible for specific sector issues and related peripheral policies.

On the other hand, while the government still performs key functions such as STI management, R&D funding, and related regulation, there are limits to how much the government can promote and manage innovation on its own. Going forward, it will be even more important to build mutually complementary relationships with other actors. As others have noted in the past, it is important to involve actors such as universities, academic societies, industry, and NGOs. At the same time, from an innovation perspective, we must pay attention to individual citizens who develop DIY activities in kitchen and garage labs as future new R&D actors. IT, open source, globalization, and the democratization of technology are driving the emergence of these diverse actors. The question of how to provide overall coordination between actors—each acting according to different principles—is more important than ever when considering what form governance should take.

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