

Postprint: Development and Application of Scientific and Technical Intelligence Data Resources Supporting Evidence-Based Decision-Making in Japan

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Abstract

[Purpose/Significance] The advent of the big data era has transformed the data sources and application architecture of scientific and technological intelligence, making evidence-based decision-making one of the theoretical foundations for the construction and application of scientific data resources. By analyzing the SciREX program, this study provides references for the construction and application of scientific and technological intelligence data resources that support evidence-based decision-making. [Method/Process] This paper introduces the basic overview of the SciREX program, its data resource construction process, and its decision-support process. [Results/Conclusions] The characteristics of the SciREX program include being oriented toward serving national policy formulation, having diverse and extensive data sources with meticulous processing, and emphasizing collaborative association analysis among data resources. The insights from the construction and application of the SciREX program's data resources are as follows: policy goal orientation and the evidence-based decision-making concept constitute the theoretical foundation for data resource construction; data collection capabilities and sharing mechanisms serve as the construction safeguards; and large-scale data integration analysis represents its future application direction.

Full Text

Construction and Application of S&T Intelligence Data Resources Supporting Evidence-Based Policymaking in Japan

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Abstract: *[Purpose/Significance]* The advent of the big data era has transformed the data sources and application architecture of science and technology (S&T) intelligence, with evidence-based policymaking becoming one of the theoretical foundations for S&T data resource construction and application. By analyzing the SciREX program, this study provides references for the construction and application of S&T intelligence data resources that support evidence-based decision-making. *[Method/Process]* This paper introduces the basic situation of the SciREX program, its data resource construction process, and its decision-support mechanisms. *[Results/Conclusions]* The SciREX program is characterized by its orientation toward serving national policy formulation, its diverse and extensive data sources with meticulous processing, and its emphasis on collaborative association analysis among multiple data resources. The insights from the SciREX program's data resource construction and application are: policy goal orientation and evidence-based decision-making concepts serve as the theoretical foundation for data resource construction; data collection capabilities and sharing mechanisms provide the construction guarantee; and large-scale data integration analysis represents the future direction of application.

Keywords: construction of S&T data resources; evidence-based policymaking; Japan SciREX program

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1. Introduction

Science and technology policy refers to government measures and actions used to guide, incentivize, and regulate scientific and technological innovation activities. In recent years, major countries worldwide have continuously enriched their S&T policy tools to enhance national S&T innovation capabilities [1]. Against the backdrop of the big data era, comprehensive lifecycle “panoramic” data collection for public policies, including S&T policies, has become possible. By mining hidden knowledge from massive data to drive public affairs analysis, public management decision-making mechanisms are moving toward greater refinement [2]. As public policy formulation increasingly emphasizes obtaining scientific evidence from data, intelligence research and S&T intelligence work, grounded in the disciplinary development of information science, have seized the opportunity of the research paradigm shift dominated by data analysis and knowledge discovery, promoting the development of intelligence science that serves decision support [3]. This trend also aligns with the gradual strengthening of decision-support functions in domestic S&T intelligence institutions [4]. Data resources are the foundation for promoting scientific government decision-making; therefore, exploring the construction and application processes

of S&T intelligence data resources oriented toward decision support holds both academic value and practical significance.

Evidence-based policymaking (EBPM), also translated as evidence-based decision-making model, refers to incorporating the best available evidence from research fields into policy formulation and implementation, thereby providing effective information support for decision-making [5]. It helps address the challenge of information overload facing S&T intelligence work in the data era and better meets the demand for high-value evidence in S&T decision support [6]. Most scholars currently agree that the concept of evidence-based decision-making should be introduced into S&T intelligence research and practice, and have conducted corresponding theoretical analyses and case studies. For instance, Liu Xiwen pointed out that data-driven, evidence-based strategic intelligence research will become the mainstream of future intelligence research [7]. However, implementing evidence-based concepts in actual S&T intelligence work still faces obstacles, with evidence acquisition and evaluation being one of the greatest difficulties. As “data” serves as the fundamental source of “evidence” in evidence-based decision-making, how to construct S&T intelligence data resources that support evidence-based policymaking and how to apply them after construction remain valuable and necessary research topics.

Domestic research already exists on theories supporting evidence-based decision-making in S&T intelligence work, as well as case studies on government S&T policy formulation and evaluation based on evidence-based concepts in other countries. However, theoretical construction research on decision-making systems mostly focuses on conceptual analysis and macro-framework building, offering weak guidance for practical work. Case studies of other countries often emphasize detailed introductions but provide weak summarization of evidence-based processes, and rarely address data resource construction. Therefore, to address these research gaps, this paper aims to explore the construction and application processes of S&T intelligence data resources that support evidence-based decision-making, thereby providing methodological references and case support for domestic data-driven S&T intelligence work.

This study selects the evidence-based S&T policy data resource construction and application components of Japan’s Science for RE-designing Science, Technology and Innovation Policy (SciREX) program as the case study. The rationale for selecting this program includes: due to relatively scarce natural resources, Japan considers information resources as a special productive force to support its “science and technology creation nation” strategy [8], and thus emphasizes mining objective data to support government S&T decision-making. For example, Japan’s Science and Technology Basic Plan, promulgated every five years, involves evidence collection regarding the selection of key R&D fields and the design of S&T system reform plans. Furthermore, from the overall operation of Japan’s SciREX program, Japan places great emphasis on formulating new planning schemes based on evaluation results from previous S&T plans, thereby forming a PDCA cycle (Plan-Do-Check-Action). After several iterations and

improvements, it has now developed a relatively complete system. In summary, the SciREX program focuses on supporting government decision-making from a data perspective and has achieved effective resource construction, thus providing effective case support for this study. Additionally, its S&T planning system shares certain similarities with China's, offering valuable lessons for China's S&T intelligence data resource construction.

In terms of specific research approach, this paper focuses on explaining the basic situation of Japan's SciREX program, its data resource construction process, and its process of supporting S&T policy decision-making, and then derives implications for China's evidence-based decision-making-oriented S&T intelligence data resource construction through summarizing its experiences.

2. Overview of Japan's SciREX Program

In 2010, the Japan Science and Technology Agency (JST) proposed developing the "Science of Science and Innovation Policy (SciSIP)," emphasizing the need to advance the science of S&T policy while greatly improving the transparency of the policy formulation process. Building on this foundation and aligning with Japan's Fourth Science and Technology Basic Plan, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) launched the SciREX program in 2011. The program aims to grasp and analyze economic and social conditions from multiple perspectives, focusing on how to formulate effective S&T innovation policies based on evidence to solve problems [10].

The SciREX program has gradually formed a certain system, primarily comprising five components: Construction of data resource infrastructure, led by the National Institute of Science and Technology Policy (NISTEP), aiming to systematically and continuously accumulate data for research and analysis to build data infrastructure. To ensure infrastructure construction, the program also aims to build an environment for systematically and continuously maintaining and using existing information, data, and research results, and will disclose data results as much as possible on the basis of legal and personal privacy considerations when advancing the program. Conducting policy issue-oriented research (also called Coevolution Research). This represents a new practice of EBPM, where policymakers and researchers jointly set research topics based on specific national policy issues and collaboratively advance research. Such research is neither purely based on researchers' academic interests nor government-commissioned studies, but rather represents collaborative research where both parties cooperate from the topic-setting stage. Open recruitment R&D projects. This component, managed by the Research Institute of Science and Technology for Society (RISTEX), is primarily used to publicly solicit and promote R&D of new analytical methods, models, and comprehensive indicators to facilitate objective evidence-based S&T innovation policy formulation. Building cooperative networks. This component aims to form cooperative net-

works among researchers, government S&T innovation policymakers, and business personnel, while also facilitating the collection and creation of data needed for S&T innovation policies. Human resource development and training. This component, funded by MEXT for universities, aims to provide training for policymakers and researchers according to project needs, thereby promoting relevant talent development. Additionally, the SciREX program has produced numerous research outcomes, which can be divided into two categories: academic achievements such as reports, papers, and monographs, and data analysis toolkits built on the foundation of data resource infrastructure construction. These toolkits aim to facilitate better utilization of data resources by policymakers and researchers to better support decision-making [11]. The main components of Japan's SciREX program are shown in Figure 1 [Figure 1: see original paper]. This paper focuses on the program's data resource construction, analysis tool integration, and process of supporting S&T policy decision-making.

3. Data Resource Construction in Japan's SciREX Program

The data resource construction component of Japan's SciREX program is organized and implemented by NISTEP under MEXT, primarily responsible for organizing and disclosing various types of data needed for S&T policy formulation and research. Its construction revolves around three purposes: providing objective evidence as the foundation for S&T policy formulation to improve policy quality; facilitating S&T innovation policy research by scientific researchers in various fields; and demonstrating to the public in an accessible manner the impact of government S&T innovation on society and corresponding achievements. After several years of construction, the SciREX program has formed a relatively complete data resource construction system, specifically divided into three components: policy research basic data resources, enterprise data resources, and university and public research institution data resources. Among them, policy research basic data resources are further divided into four modules: basic resources for S&T innovation policy research, Delphi survey data resources, NISTEP fixed-point survey data resources, and a collection of links to S&T websites of various countries, which are introduced respectively below.

3.1 Construction of Policy Research Basic Data Resources The construction purpose of policy research basic data resources is to: serve as a data source for demonstrating the basic direction of government S&T policy; serve as the basis for policy formulation (such as technology foresight); and facilitate subsequent policy research. The data resource construction includes five types of data: texts related to government S&T policy plans; policy implementation information extracted from S&T white papers; survey data from the policy formulation process, such as future S&T research predictions using the Delphi method; survey and interview data from industry-academia-research personnel; and relevant texts from domestic and foreign websites [12]. During

policy research, NISTEP extracts corresponding evidence from the above five types of data according to policy research needs, as specifically shown in Figure 2 [Figure 2: see original paper].

The scope and content of policy basic research data resource construction include: NISTEP extracts information from policy texts related to government S&T plans, with specific sources including the Science and Technology Basic Plan formulated every five years by the Council for Science, Technology and Innovation (CSTI), the Comprehensive Strategy for Science, Technology and Innovation formulated annually based on the Basic Plan, and CSTI's response reports to the Prime Minister's inquiries. NISTEP extracts key information from these S&T plan texts regarding plans, basic policies, priority fields, and system reforms; the S&T white paper published by MEXT includes specific S&T policy measures, from which NISTEP extracts important information such as the establishment of major R&D programs, revision of legal systems, establishment and reorganization of national research institutions, implementation and promotion of key research projects, and cutting-edge content in specific research projects; NISTEP has organized technology foresight using the Delphi method since 1971, extracting technology foresight content and themes, research implementation timelines, and importance rankings from foresight reports to create an electronic database system called "Delphi Survey Search"; NISTEP fixed-point survey reports mainly target topics difficult to clarify through statistical methods, such as diversification levels in basic research, including two types of information: unstructured information like expert interview reports and structured charts similar to questionnaire results, with the data resource already implementing field retrieval functions; NISTEP also integrates links to S&T data-related websites of international organizations (such as the World Bank, WIPO) and countries including the United States, China, United Kingdom, Germany, and France, totaling over 110 links, and supports retrieval by dimensions such as country, input, output, and achievements [12].

3.2 Construction of Enterprise Data Resources The purpose of enterprise data resource construction is to analyze the actual situation of industrial R&D and innovation processes, specifically including data on domestic Japanese enterprises' intellectual property, R&D investment, and business operations, thereby forming an "Industrial R&D and Innovation Database." For ease of use, it has been built into an enterprise information retrieval index system called the "NISTEP Enterprise Database." This data resource includes data on enterprise R&D input, output, and achievements to facilitate analysis and research on the innovation process at the individual enterprise level, specifically including information on enterprises' scale, type, location, listing status, parent companies, and subsidiaries that meet certain criteria. As of Q3 2018, the enterprise data resource database had collected information on 10,064 enterprises, which would reach 20,703 enterprises if merged enterprises were included. To address the challenging issue of frequent and complex changes in enterprise names, two measures were emphasized during the construction of the NISTEP Enter-

prise Database: existing records of Japanese enterprise names exist in various forms, requiring unification of enterprise names; when enterprises undergo integration or reorganization, their names change, requiring documentation of these changes. Additionally, this data resource has established links with external data sources (such as paper databases and patent databases). In terms of data resource utilization, the NISTEP Enterprise Database has achieved five functions: analysis of enterprise changes; analysis of enterprise scale and industry; analysis of enterprise listing; analysis of cooperation between enterprises and local universities; and joint analysis of enterprise changes and patent applications. The first three analysis methods belong to data retrieval, the fourth involves visualization of data, and the fifth is based on joint analysis of enterprise data resources with external paper databases, patent databases, and financial databases. For example, by combining enterprise industry attributes with IPC classification numbers in patent databases, one can obtain analysis of the number growth and technological structure changes of invention patents in different industries [13].

3.3 Construction of University and Public Research Institution Data Resources

The construction purpose of university and public research institution data resources is to grasp R&D situations at the institutional level, thereby facilitating quantitative comparison of government S&T investment results or analysis of S&T innovation policy implementation effects from an institutional perspective. Objects included in this data resource database mainly consist of universities and public research institutions. The former includes junior colleges, colleges of technology, and inter-university research institutions, while the latter mainly includes various national research and development corporations, S&T-related independent administrative institutions (such as JST), and local public research institutions. Additionally, it collects information on local governments, enterprises, and non-profit corporations that actually organize and conduct research work. Due to problems such as insufficient understanding of subordinate institutions' situations and difficulties in tracking institutional changes, two main measures were adopted during the specific construction process: (j) collecting information not only on parent institutions but also on various subordinate institutions, including university-affiliated institutions, university hospitals, and joint research bases; (k) for institutions that no longer exist due to integration, abolition, or merger (including their subordinate institutions), in addition to collecting information on new institutions that inherited their original resources and functions, old institution information is also retained. Furthermore, this data resource has already achieved links with enterprise data resources, paper databases, and patent databases. In terms of data resource utilization, the construction of university and public research institution data resources is mainly divided into two methods: standalone application and joint application with other data resources. Standalone application is primarily based on data retrieval functions, with results serving as authoritative information sources for universities and public research institutions; joint application mainly achieves

data analysis functions, such as enabling precise analysis of institutional achievements by linking the university and public research institution database with paper databases like WoSCC and Scopus or patent databases [14].

3.4 Data Resource Sharing, Linkage, and Integration Based on PDCA management and decision-support needs, the Japanese government has implemented structural unification, linkage sharing, and platform integration of policy research basic data resources, enterprise data resources, and university and public research institution data resources. Specifically, the Japanese government stipulates that various institutions must not only organize and clean historical data but also reasonably store current data, and organize different types of data by institution type to facilitate data sharing. PDCA management cycles have been constructed at both the national overall policy level and in the operations of various research funding agencies. Additionally, Japan places special emphasis on metadata construction to assist the application of various databases. For data description, it provides accurate definitions of proper nouns, specific survey plans, and content. Ultimately, it has built an interconnected S&T intelligence system from policy (S&T plans, comprehensive strategies, etc.), input (funding, talent, etc.) to output (papers, patents, standards, etc.) and impact (economic impact, social impact, etc.), as shown in Figure 3 [Figure 3: see original paper].

Meanwhile, to facilitate policymakers' analysis of data according to policy needs, the SciREX program has also developed various toolkits that play important roles in real-time tracking, scanning, and evaluating S&T policy implementation effects by S&T managers, effectively supporting S&T policy decision-making. These specifically include the SciREX Policymaking Intelligent Assistance System (SPIAS), the disciplinary distribution and influence visualization tool SciLandViewer, the regional S&T innovation policy support system RESIDENS, and search tools for S&T white papers, Delphi survey reports, and NISTEP fixed-point surveys [15].

Taking the SPIAS system as an example, it integrates and develops a data platform with search, visualization, and predictive analysis functions by connecting research objects, researchers, research institutions, papers, patents, and press release data.

4. Decision Support by SciREX Program Data Resources

One of the purposes of SciREX program data resource construction is to serve national S&T innovation policy formulation. In Japan's S&T policy system, CSTI is primarily responsible for formulating S&T innovation policy outlines and coordinating the allocation of national S&T innovation resources. CSTI formulates S&T policies based on evidence formed from research on key areas (such as S&T resource allocation, key disciplinary areas, private S&T invest-

ment, and the impact of science and technology on the economy and society), as shown in Figure 4 [Figure 4: see original paper].

In April 2019, NISTEP's Second Research Group released a report analyzing the relationship between research funding and S&T innovation policy effectiveness, using the establishment of AMED (Japan Agency for Medical Research and Development) as a case study [17]. The report identified eight key areas positioned in the Second Science and Technology Basic Plan and visually presented the government's funding allocation to them since 2004 (Figure 5 Figure 5: see original paper) and the funding support from various funding agencies for related research projects (Figure 5 Figure 5: see original paper). Based on the above data, NISTEP's report pointed out that JSPS's research funding surged starting in 2013, and believed this change might be based on two reasons: the scale of JSPS itself doubled; and after 2015, part of JSPS's funding flowed into AMED. To verify this hypothesis, NISTEP compared AMED's funding allocation-related policy documents before and after fiscal year 2015 (Figure 5 Figure 5: see original paper) with operational data (Figure 5 Figure 5: see original paper), and successfully confirmed that part of the funds originally allocated by JSPS indeed flowed into AMED. Accurately analyzing the inflow and outflow of AMED's research budget represents a major challenge, and addressing this challenge depends on the Cabinet Office's accurate organization and disclosure of budget information for over 1,000 funded projects between 2016 and 2018. Previously, administrative personnel could only obtain static information on annual research budgets of various agencies, but now they can achieve dynamic tracking of research funding and analyze the impact of new funding agencies' establishment on funding allocation, thereby enabling real-time tracking and outcome analysis of S&T policies and R&D activities.

In terms of search and visualization, SPIAS supports retrieval in three dimensions: research institutions, research topics, and researchers. Searching by research institution can display a list of researchers and research projects of a certain institution; research topic search supports setting conditions for implementation cycle, research funding, number of outcome papers, and number of outcome patents, and also supports displaying knowledge transfer paths based on paper citation information; researcher search supports searching by number of research outcome papers, number of outcome patents, number of international cooperation papers, number of industry-academia cooperation papers, and number of times research outcomes are cited by patents.

In terms of predictive function analysis, to understand how to allocate limited S&T resources to better promote socio-economic development, the SPIAS platform has established a model for analyzing the impact of S&T policy on the economy. This model can be used to analyze the impact of R&D investment on industries under different policy models (such as funding allocation to various departments at different stages of S&T planning), and can calculate relevant economic data up to 2050, including GDP and total factor productivity [16].

On July 17, 2020, CSTI released the "Comprehensive Innovation Strategy 2020,"

which reviewed changes in Japan's domestic and international situation over the past year and proposed S&T innovation policy goals for the coming period. The report pointed out that the number of Japanese papers and highly-cited papers has grown slowly, and the domestic research environment struggles to attract talent. In response to these issues, CSTI introduced the "Comprehensive Policy Package for Strengthening Research Capabilities and Supporting Young Researchers." The measurement and improvement of this policy's implementation effects (such as whether it has improved Japan's overall research capabilities) rely on various databases constructed by the SciREX program [17].

With the continuous improvement of SciREX program data resource construction and application, CSTI further clarified in a discussion on formulating the Sixth Science, Technology and Innovation Basic Plan (2021-2025) on December 14, 2020, how to transform data resources from the SciREX program into evidence for evaluating S&T plans, policies, and measures, and pointed out three future development directions: further connecting S&T innovation databases under various departments to achieve real-time data sharing; building a sustainable system for collecting effective data information from university and public research institution management information systems while minimizing the burden on researchers; and achieving think tank functions such as automatic analysis based on data collection [19].

5. Characteristics of SciREX Program Data Resource Construction and Application

5.1 Data Resource Construction Oriented Toward Serving National S&T Policy Formulation National-level support facilitates data connectivity among multiple stakeholders. Japan's S&T strategic intelligence data construction is a national-level initiative. The SciREX program was first determined by the national S&T strategy "Science and Technology Basic Plan" and then implemented by MEXT, thereby achieving cross-institutional data integration and connectivity. Furthermore, analysis of the SciREX program's composition and construction methods reveals that S&T data resource construction is not about building isolated databases one by one, but rather about forming an S&T data resource construction system based on top-level S&T policy planning design. This ultimately integrates the entire process from early-stage S&T data resource organization to later-stage S&T decision support, thereby truly playing a role in serving national policy formulation.

5.2 Diverse Data Resource Types with Meticulous Processing The SciREX program includes not only traditional S&T statistical data resources but also specialized processing of diverse data such as S&T texts, expert interview results, and foreign website links. Based on different data types, corresponding storage databases have been established, and meticulous processing has been conducted according to their respective characteristics. For exam-

ple, for enterprises and public institutions like universities, NISTEP established separate enterprise data resources and institutional data resources, and meticulously recorded situations such as institutional abolition, splitting, merger, or establishment of subordinate institutions. For S&T policy texts, a unified text organization structure was formed to support keyword searching. For data from Delphi methods and fixed-point surveys, structural adjustments were made to facilitate final retrieval.

5.3 Collaborative Association Analysis Among Data Resources As mentioned earlier, enterprise data resources and university and public institution data resources can be used not only for data analysis of individual databases but also for association analysis across multiple databases. The SciREX program enables tracking and analysis of the entire spectrum of industry-academia-research cooperation by establishing data mapping relationships among institutional data resources and between them and external data resources.

6. Implications for China's S&T Intelligence Data Resource Construction

6.1 Policy Goal Orientation and Evidence-Based Decision-Making Concepts as Theoretical Foundation S&T strategic intelligence should be closely integrated with government S&T innovation goals and replanned from the perspective of the government S&T management system and innovation capability enhancement [20]. This requires that S&T strategic intelligence data resource construction adhere to “problem orientation” and “evidence orientation,” that is, taking S&T policy goals as the starting point for judgment, fully collecting information and data generated during S&T policy implementation processes, and objectively describing and evaluating policy effects to provide evidence for S&T policy adjustment and improvement.

6.2 Comprehensive Data Collection and Cross-Institutional Data Sharing as Construction Guarantee Without high-quality, comprehensive raw data, data analysis is impossible. Therefore, when constructing S&T data resources, attention must be paid to collecting data at finer dimensions. Simultaneously, strengthening joint analysis of cross-institutional data resources is also a means to maximize the value of S&T data utilization. To this end, the collaborative capabilities of departments related to S&T intelligence data resource construction must be enhanced, and unified resource construction standards must be implemented to facilitate future integrated applications.

6.3 Large-Scale Intelligent Data Integration Analysis as Future Development Direction Using artificial intelligence technology for intelligent integration and analysis of large-scale data is the goal of future S&T strategic intelligence data resource construction and application. With the development

of data analysis technologies, it has become possible to integrate and analyze multi-source, low-value-density data to extract high-value information, and the data mining process is gradually becoming automated and intelligent. Against the backdrop of the big data era, large-scale intelligent data integration analysis may solve new problems and challenges.

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References

- [1] He Defang, Zhou Huadong, Chen Tao. Main progress in the construction of China's scientific and technological innovation policy system and reflections on policy directions[J]. Science Research Management, 2020, 41(10): 81-88.
- [2] Huang Xinzhuo. Directions, paths, and methods for the transformation of social science research driven by data: A discussion on the theme of "big data and the transformation of social science research"[J]. Journal of Public Management, 2019, 16(2): 159-167.
- [3] Liu Xiwen. On the development direction of strategic intelligence research in the big data era[J]. Journal of Intelligence, 2019, 38(5): 1-7.
- [4] Zhang Xianwen, Li Mengyang, Cheng Hui. Research on the evidence-based decision-making mechanism of China's scientific and technological innovation policies[J]. Science Research Management, 2020, 41(5): 1-9.
- [5] Head BW. Evidence-based policymaking: Speaking truth to power?[J]. Australian Journal of Public Administration, 2016, 75(1): 61-65.
- [6] Boaz A, Davies H, Fraser A, et al. What works now? Evidence-informed policy and practice[M]. Bristol: Policy Press, 2019.
- [7] Liu Xiwen. Data-driven evidence-based strategic intelligence research will become the mainstream of future intelligence research[J]. Journal of Intelligence, 2018, 37(1): 1-5.
- [8] Ministry of Education, Culture, Sports, Science and Technology. Science and Technology Basic Plan[EB/OL]. [2021-10-10]. https://www.mext.go.jp/en/policy/science_{technology}/.
- [9] National Institute of Science and Technology Policy. SciREX program overview[EB/OL]. [2021-10-10]. <https://www.nistep.go.jp/en/>.
- [10] Japan Science and Technology Agency. Science of Science and Innovation Policy (SciSIP)[EB/OL]. [2021-10-10]. <https://www.jst.go.jp/kisoken/scisip/en/>.
- [11] National Institute of Science and Technology Policy. SciREX program components[EB/OL]. [2021-10-10]. <https://www.nistep.go.jp/en/>.
- [12] National Institute of Science and Technology Policy. Policy research basic data resources[EB/OL]. [2021-10-10]. <https://www.nistep.go.jp/en/>.
- [13] National Institute of Science and Technology Policy. Enterprise data resources[EB/OL]. [2021-10-10]. <https://www.nistep.go.jp/en/>.

- [14] National Institute of Science and Technology Policy. University and public research institution data resources[EB/OL]. [2021-10-10]. <https://www.nistep.go.jp/en/>.
- [15] National Institute of Science and Technology Policy. SciREX analysis tools[EB/OL]. [2021-10-10]. <https://www.nistep.go.jp/en/>.
- [16] National Institute of Science and Technology Policy. SPIAS system introduction[EB/OL]. [2021-10-10]. <https://www.nistep.go.jp/en/>.
- [17] National Institute of Science and Technology Policy. Analysis of the relationship between research funding and S&T innovation policy effectiveness[EB/OL]. [2021-10-10]. <https://www.nistep.go.jp/en/>.
- [18] Cabinet Office. Comprehensive Innovation Strategy 2020[EB/OL]. [2021-10-10]. <https://www8.cao.go.jp/cstp/tougousenryaku/index.html>.
- [19] Cabinet Office. On grasping and evaluating the progress of the Science, Technology and Innovation Basic Plan[EB/OL]. [2021-10-10]. <https://www8.cao.go.jp/cstp/tyousakai/kihon6/11kai/siryoy10.pdf>.
- [20] Zeng Jianxun. Melancholy at the age of sixty: Reflections on the 60-year history of S&T intelligence work[J]. Information Studies: Theory & Application, 2017, 40(11): 1-4.

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