Design and implementation of mission-oriented research and innovation policies

The Cross-ministerial Strategic Innovation Promotion Program (SIP)

OECD Science and Technology Policy Division

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MOIP Initiative template objectives and context

This MOIP initiative fiche was developed in the context of the OECD Committee for Scientific and Technological Policy (CSTP) project on mission-oriented innovation policies (MOIP) for addressing societal challenges. One key input to this project is the collection of data on MOIP initiatives, which feed into the MOIP decision support tool that aims to help policy makers in the design, governance and implementation of MOIPs, notably by expanding the range of potential options available to them and sharing experience on how to put in place such initiatives[1].

The data collected on initiatives are updated as needed. To make sure you have the latest data, please refer to the online version at https://stip-pp.oecd.org/stip/moip

Should you have any comment or additional information, please contact the project manager at Philippe Larrue at philippe.larrue@oecd.org

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[1] The MOIP decision support tool is funded by the European Commission under the Horizon 2020 Framework Programme.

Structure of the MOIP fiche

The structure of each MOIP initiative fiche is based on the analytical framework developed specifically in the context of the CSTP project (see online toolkit – Methodology). The main content is provided in the MOIP features that fall into three broad categories: Strategic orientation, Policy coordination, Policy implementation. For convenience, the definition of each MOIP feature is recalled in the fiche.
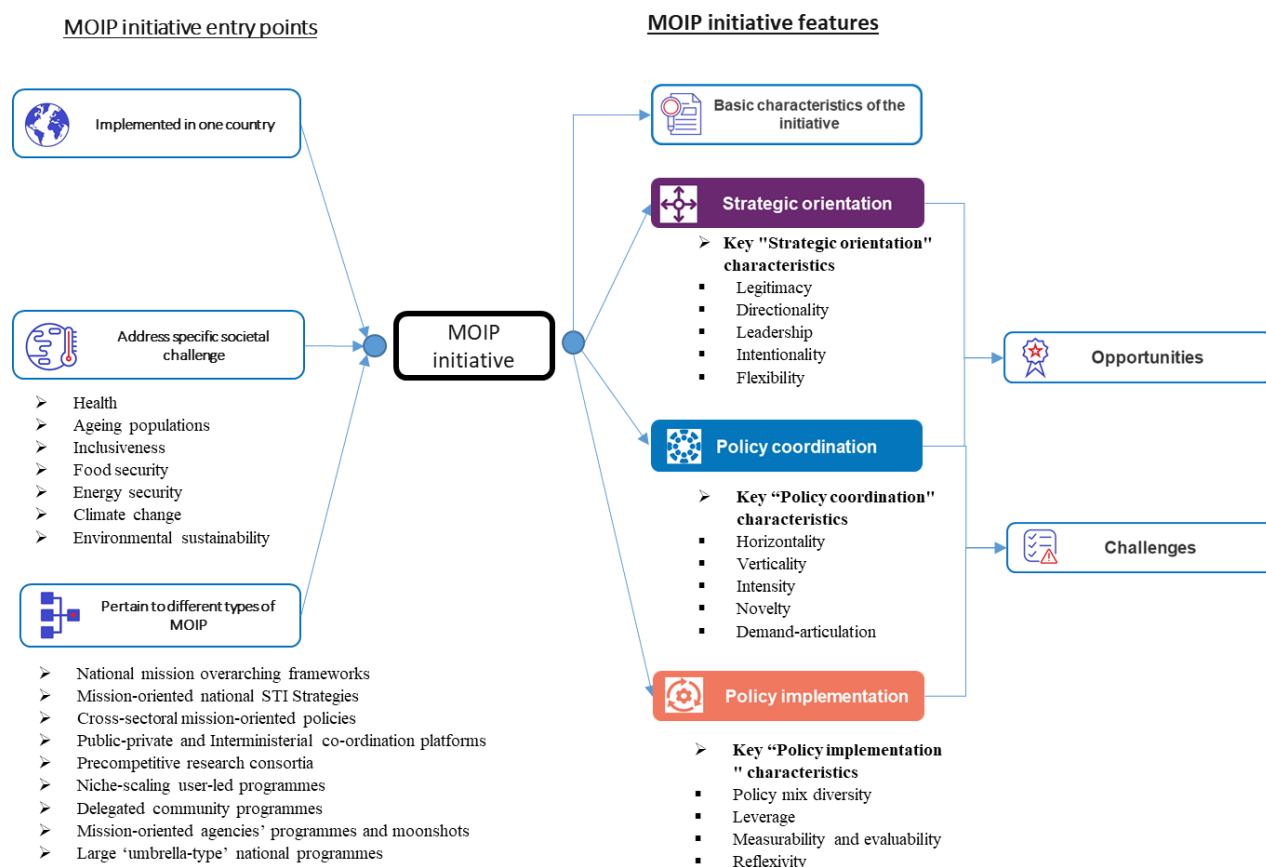
MOIP initiative entry points

MOIP initiative features

Implemented in one country

Address specific societal challenge

➢ Health
➢ Ageing populations
➢ Inclusiveness
➢ Food security
➢ Energy security
➢ Climate change
➢ Environmental sustainability

Pertain to different types of MOIP

➢ National mission overarching frameworks
➢ Mission-oriented national STI Strategies
➢ Cross-sectoral mission-oriented policies
➢ Public-private and Interministerial co-ordination platforms
➢ Precompetitive research consortia
➢ Niche-scaling user-led programmes
➢ Delegated community programmes
➢ Mission-oriented agencies' programmes and moonshots
➢ Large 'umbrella-type' national programmes

MOIP initiative

Basic characteristics of the initiative

Strategic orientation

➢ **Key "Strategic orientation" characteristics**
▪ Legitimacy
▪ Directionality
▪ Leadership
▪ Intentionality
▪ Flexibility

Policy coordination

➢ **Key "Policy coordination" characteristics**
▪ Horizontality
▪ Verticality
▪ Intensity
▪ Novelty
▪ Demand-articulation

Policy implementation

➢ **Key "Policy implementation" characteristics**
▪ Policy mix diversity
▪ Leverage
▪ Measurability and evaluability
▪ Reflexivity

Opportunities

Challenges

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Basic Characteristics

Date Beginning	2014 (1st term) 2018 (2nd term)
Date End	Programme term of 5 years
Total Budget per year	32.5bn yen per year from 2014 to 2017; 28bn yen in 2018 Individual SIP programmes receive between 1.5 and 4bn yen per year SIP is funded via a 4% 'haircut' on the STI budgets of all ministries
Main technological areas/themes	In its second term (2018-2022), the SIP focus upon 12 themes that address the most important social problems facing Japan and contribute to economic growth: 1. Big data and AI-enabled cyberspace technologies 2. Intelligent knowledge processing infrastructure integrating physical and virtual domains 3. Cyber physical security for the Internet of Things society 4. Automated driving for universal services 5. "Materials integration" for revolutionary design system of structural materials 6. Photonics and quantum technology for Society 5.0 7. Technologies for smart bio-industry and agriculture 8. Energy systems toward a decarbonised society 9. Enhancement of national resilience against natural disasters 10. Innovative AI hospital system 11. Smart logistics service 12. Innovative technology for exploration of deep sea resources
Main societal challenge targeted	The four target areas set at the inception of SIP were: o Clean and efficient energy system o Healthy aging society as a world leading nation o Cutting-edge next generation infrastructure o Resurgence of local region using regional resources and its potential o Reconstruction from the Great Earthquakes in 2011
Main missions	The SIP is not governed through formal missions but by cross-sectorial programmes in within which partners define a R&D Plan
Main policy institutions involved	Headed by the Council for Science, Technology and Innovation (CSTI), located under the Cabinet Office (CAO) Ministries participating in the individual programmes: Ministry of Education, Culture, Sports, Science and Technology (MEXT), Ministry of Economy, Trade and Industry (METI), Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Land, Infrastructure and Transportation (MLIT), Ministry of Internal affairs and Communication(MIC), National Police Agency (NPA) and other related ministries depending on the characteristics of the programs. Funding agencies: Japan Science and Technology Agency (JST), New Energy and industry technology Development Organization (NEDO), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), National Agriculture and Food Research Organization (NARD).

Main objectives of the initiative	The SIP programme aims to promote integrated research, innovation and demonstration activities to both address societal challenges and foster economic growth, in areas where strong interministerial coordination is needed.
Type of initiative	Cross-sectoral mission-oriented strategies and policies

Introduction

The Cross-ministerial Strategic Innovation Promotion Program (SIP) is a large multiannual national STI programme created in 2014 to promote research, innovation and demonstration activities in an integrated way. It aims to both address societal challenges and foster economic growth, in areas where strong interministerial coordination is needed. Interministeriality is seen as a way to implement continuous – end-to-end – activities from laboratories to early application, and better connect research and innovation activities with the social demand and sectoral context.

The overall SIP programme is directly led by the Council for Science, Technology and Innovation (CSTI), which role is to develop the overall national STI strategy and ensure interministerial coordination for its effective implementation. The CSTI is chaired by the Prime Minister and has 14 members including the Chief Cabinet Secretary and several ministers, as well as academic and industry experts. The SIP is one of the very few examples worldwide of a programme managed and funded by a high-level 'advisory' council.

The programme terms last 5 years. The first term, started in 2014, ended in 2018. The second term started in 2018, earlier than planned under strong demand from industry to avoid any discontinuation.

As its name suggests, the SIP has an overall interministerial governance structure that provides the basic operating rules, monitors the progress and allocate the funding to the different themes.

It is composed of individual programmes in the different themes. The first SIP had 11 programmes, the second SIP 12 programmes. Each of these programmes has its own R&D plan, budget and structures of governance. These programmes greatly vary with regards to the type of activities they support and their mode of support. Inspired to a certain extent by the DARPA model, each programme is led by a Programme Director with strong leadership and extended decision power.

Although some programmes are more long term and science-based than others, the SIP essentially supports "incremental innovation" (another programme named ImPACT implemented between 2013 and 2018 aimed specifically to encourage disruptive innovation). Specific IP rules encourage the use of R&D outcomes by companies.

Strategic orientation level

Key "Strategic orientation" characteristics

- The objective of the programme is to enhance Japan's economic competitiveness, while also addressing five important societal challenges
  - Clean and efficient energy system
  - Healthy aging society as a world leading nation
  - Cutting-edge next generation infrastructure
  - Resurgence of local region using regional resources and its potential
  - Reconstruction from the Great Earthquakes in 2011
- Each theme (11 in the first term; 12 in the second term) is dealt with in a dedicated SIP programme with its own 5-year strategy, budget, leadership and structure of governance
- Precise goals with deadlines and milestones for each SIP programme are negotiated between partners and policy makers within each programme, and formalised into each programme's R&D Plan
- The overall SIP programme is operated directly by the CSTI (chaired by the Prime Minister) and supported by a powerful secretariat established within the Cabinet Office (about 100 staff supports CSTI's activities). This provides the programme with a built-in authority vis-a-vis other stakeholders and partners
- Each individual programme is led by a Programme Director with proven leadership and strong expertise in the specific topic of their programme.
- Significant programme flexibility thanks to the decision-making power of each Programme Director.

Legitimacy

Legitimacy • A large group of stakeholders (inc. citizen) is engaged in building consensus on the societal challenge(s) to be prioritised.	o What stakeholders have been involved in the initial consultations and how? o What roles have they played in the initial decisions regarding the orientations and design of the initiative? o What diagnosis and/or foresight studies or other sources of information on needs, trends and opportunities have been used to feed into debates and decisions? o What have been the actions taken to achieve consensus and increase buy-in/ownership of the initiative?

At the origin of the SIP, consultations with the academic, industry and policy communities were held to agree on the different issues to focus upon. These issues became the 10 programmes of the first SIP. Currently, during the implementation of the SIP, there are several mechanisms for consulting with and involving stakeholders from the academic, industry and policy communities. These communities are also represented in the SIP Governing Board. However, consultation with the wider public remains limited.

The SIP emanated from the consultations held in the context of the first annual action plan (called the Comprehensive Innovation Strategy) in 2013. This document was developed by the Council for Science

and Technology Policy (CSTP, now Council for Science, Technology and Innovation [CSTI]) following consultations with several industrial association such as the Council on Competitive-Nippon (COCN), as well as representatives of the academic communities. The Comprehensive Strategy identified 5 important societal challenges.

1) Clean and efficient energy system
2) Healthy aging society as a world leading nation
3) Cutting-edge next generation infrastructure
4) Resurgence of local region using regional resources and its potential
5) Reconstruction from the Great Earthquakes in 2011

Based on this strategy, CSTI has set up committees under each of the five challenges to discuss more precisely the priorities to be addressed with experts from different background. Priorities should both address the most important social problems facing Japan; and contribute to the resurgence of the Japanese economy. As a result CSTI finally endorsed 10 subjects which have become the SIP individual programmes in 2014. In 2016, Cybersecurity was added to the research target taking into account the opinion from related ministries, technological and social trends as well the prospects of the 2020 Olympic/Paralympic Games in Tokyo.

In terms of citizen involvement, the Cabinet Office collected public opinions on these 10 targets in February 2014 in 'public workshops'. In 2014, the R&D Plans of the ten individual SIP programmes were made available on an electronic platform for public comments. They are also available in Japanese and English on the CSTI website.

During the course of the programme implementation, several governance bodies (notably the Governing Board) host significant discussions between researchers, industry leaders as well as representatives from different administrations. There is few occasions of interactions with the wider audience apart in some events such as the annual SIP Symposiums.

Depending on their objectives and areas, individual SIP programmes have specific consultation initiatives with stakeholders. For instance, in the SIP on 'Innovative Artificial Intelligence (AI) Hospital System' the doctors' and patients' associations are represented in the governance bodies. The SIP-ADUS also conducted specific consultations with potential users of automated vehicles as part of its 'public acceptance' pillar.

Directionality

Directionality	o What are the challenges addressed in the initiative?
• Clear orientation and strategic guidance for developing appropriate policy intervention are informed and selected.	o How are the orientations formalised?
	o What have been the debates surrounding the choices of the orientation of the initiative? Have the orientations been contested?

The SIP's main objective is to support in an integrated way the whole innovation cycle from research to early market application as well as any needed regulatory reforms and system changes. It is composed of individual programmes initiated in 'themes' that 1/ address societal challenges 2/ foster economic growth 3/ in areas where strong interministerial coordination is needed. In its first and second terms, the SIP has focused on respectively 11 and 12 themes. In each theme/programme, the precise interactions are presented in the programme R&D Plan (see intentionality).

In its first term, the SIP (2014-2018) has identified 11 themes where STI progress could help address the

most important social problems facing Japan and contribute to the resurgence of the Japanese economy.

1. Innovative Combustion Technology
2. Next-generation Power Electronics
3. Structural Materials for Innovation
4. Energy Carriers
5. Next-generation Technology for Ocean Resources Exploration
6. Automated Driving System
7. Infrastructure Maintenance Renovation and Management
8. Enhancement of Societal Renovation and Management
9. Technologies for Creating Next-generation Agriculture, Forestry and Fisheries.
10. Innovative Design/Manufacturing Technologies
11. Cyber-security for Critical Infrastructure (since FY 2016)

In its second term (2018-2022), the SIP focus upon 12 themes

1. Big data and AI-enabled cyberspace technologies

2. Intelligent knowledge processing infrastructure integrating physical and virtual domains

3. Cyber physical security for the Internet of Things society

4. Automated driving for universal services

5. "Materials integration" for revolutionary design system of structural materials

6. Photonics and quantum technology for Society 5.0

7. Technologies for smart bio-industry and agriculture

8. Energy systems toward a decarbonised society

9. Enhancement of national resilience against natural disasters

10. Innovative AI hospital system

11. Smart logistics service

12. Innovative technology for exploration of deep sea resources

Objectives of SIP second term's individual programmes

Big data and AI-enabled cyberspace technologies	Establish highly-sophisticated human interaction platform technology, a cross-domain data exchange platform, and AI based automatic negotiation platform technology which contribute to human-AI collaboration and conducts social implementation of a cyber-physical system utilizing big data and AI.
Intelligent knowledge processing infrastructure integrating physical and virtual domains	Develop the world's most advanced key technologies that enable high-functioning sensing, highly efficient data processing, and close cooperation with cyber domain, and apply and implement them in the real world.
Cyber physical security for the Internet of Things society	Develop and demonstrate 'Cyber-Physical Security Infrastructure' that can be used to protect IoT systems and services and the entire large-scale supply chain, including small and medium-sized businesses, in order to protect various IoT devices and to establish the safety and security of society as a whole, and also promote the social implementation of development results toward the realization of secure Society 5.0.
Automated driving for universal services	Establish core technologies first in the world, such as gathering and distributing technologies of road traffic information (traffic signal, vehicle probe data, etc.) as the cooperative domain among automakers in order to compete with global companies in the fierce automated driving market, and also develop base platforms and promote their commercialization to achieve SAE Level 3 automated driving system on arterial roads.
"Materials integration" for revolutionary design system of structural materials	Aim to significantly reduce cost and dramatically shorten the development period and Materials Integration (MI) system for the inverse design, which can create suitable materials, processing and structures from the required performance, and be constructed and be socially implemented in order to maintain and develop strength in the field of Japanese materials developments. Super high performance structural materials will be developed by MI and the reliability evaluation techniques for the structural materials will be also established.
Photonics and quantum technology for Society 5.0	Photonics and quantum technologies is an extremely important foundation technology for realizing Society 5.0, and Japan has strengths. We will develop the world's most advanced laser material processing, photonic and electronic information processing and photonic quantum

	communication utilizing photonics and quantum technologies, and implement it in society in order to further improve the international competitiveness of photonics and quantum technologies.
Technologies for smart bio-industry and agriculture	Aim at productivity revolution and enhancing competitiveness of agriculture, forestry and fisheries etc., realization of health-enhancing society by food, and realization of sustainable growing society by manufacturing using biological function by integration of biotechnology and digital and utilization of diverse and enormous data, in expectation of global expansion and intensifying competition of bioeconomy.
Energy systems toward a decarbonised society	Explore overall optimization of major technologies by examining energy management systems and carry out research and development (R&D) as well as introduce the following three technologies into real society as innovative technologies in the future: Wireless Power Transmission /Transfer (WPT) System, Innovative Technologies for Low-Emission Carbon Use, and Universal Smart Power Module (USPM).
Enhancement of national resilience against natural disasters	Develop an information system to support decision-making on a national and municipal level by making optimal use of satellites, IoT, big data, and other latest science and technology, and enhance national resilience for overcoming national crisis, thereby ensuring the safety and confidence of both today's and future generations.
Innovative AI hospital system	Aim to offer sophisticated and advanced medical services through developing, establishing and socially implementing "AI hospital system" with the use of AI, IoT and big data technologies, and improve efficiency at medical institutions with drastically reduction of the burdens on medical personnel such as doctors and nurses.
Smart logistics service	Build the world's first "logistics/products data platform" to be used to accumulate, analyze, and share data at the same time as we verify its effectiveness and introduce it to society. To achieve this goal improving the efficiency and productivity of overall supply chains including those inside and outside of Japan.
Innovative technology for exploration of deep sea resources	Utilize abundant marine mineral resources in exclusive economic zones of our country and strengthen and develop our marine resource exploration technology. Drastically improve productivity in this field, establish and demonstrate marine resources survey technology deeper than 2000 meters deep first in the world and implement it in society.

Leadership

Leadership • The endorsement of orientations and their translation in concrete actions (inc. budget appropriations) are set by a body (Parliament, high-level committee, cabinet, etc.) with strong authority	o What has been the political process in initiating and providing the orientations? o What is the type and status of political / executive bod(ies) endorsing the orientations? o What body is accountable for the initiative? To which high level authority is this body reporting?

The programme benefits from strong leadership at overall and individual programme level. The overall SIP programme is operated directly by the CSTI chaired by the Prime Minister and supported by a powerful secretariat established within the Cabinet Office (about 100 staff supports CSTI's activities). This provides the programme with a built-in authority vis-a-vis other stakeholders and partners, be they in ministries, universities or companies.

In each individual programme, the Programme Director is an essential factor of authority in the corresponding theme. Programme Directors (PDs) are responsible for each individual programme. Each PD has been selected for their proven leadership and expertise on the specific topic of their programme either from the industry or academia. PDs organise and promote an R&D plan in their respective programme. They have the power to organise R&D teams, made open calls or initiate activities as needed. They are appointed as executive government officers in the Cabinet Office, which participates to reinforce their leadership.

Intentionality

Intentionality • Specific and well-articulated goals, with a clear timeline and milestones, are derived from the broad objectives.	o Have the broad challenges and orientations been translated into clear and measurable objectives/target? o How precise/granular are these targets? o Are the objectives set against a clear timeline? o How distant are the targets from the current performance? How ambitious/transformative are they?

Each individual programme is built around a theme and its research and innovation challenges. These were initially defined in broad terms to gather a broad community of partners from research and academia. Precise goals with deadlines and milestones for each SIP programme were later negotiated between these partners and policy makers within each programme. They are formalised into each programme's R&D Plan and validated by the SIP overall Governing Board. R&D Plans also include 'exit strategies' or a 'commercialisation strategy'. The drafting of the R&D Plan in each SIP programme is supervised by the Programme Director (PD) with support from the Cabinet secretariat and the members of each programme's Promotion Committee. The PD also has the power to decide on the allocation of budgets to implement the R&D Plan. The PD has therefore strong prerogatives in terms of each programme's orientations, as long as it complies with the broad SIP objectives and principles established by the Governing Board.

Most SIP individual programmes have set some general statements as objectives. In most cases these objectives are research- or technology-based rather than demand-led. Precise goals with deadlines and milestones were formalised in the R&D Plan after the selection of Programme Directors. A R&D Plan is designed within each SIP programme and validated by the SIP overall Governing Board. For instance the R&D Plan of the Programme on 'Automated Driving for Universal Services' (SIP-Adus) (second term), which aims to achieve the practical implementation of automated driving, set the following objectives:
- Mobility services: Achieve high driving automation (SAE Level 4) for mobility services in limited regions (Operational Design Domain) by 2020.
- Logistical services: Achieve high driving automation in trucks (SAE Level 4) on highways around 2025 or later.
- Privately owned vehicles: Achieve high driving automation (SAE Level 4) on highways by 2025.
- Privately owned vehicles: Partial driving automation on general public roads (SAE Level 2 or higher).

(Note : the Society of Automotive Engineers (SAE) defines 6 levels of driving automation ranging from 0 (fully manual) to 5 (fully autonomous)).

The R&D Plan of the SIP Programme 'Development of Innovative Technologies for Exploration of Deep Sea Resources' has the following goal: "*Improving survey speed 30 times faster than that of current technology, developing survey system of the world's most advanced at the area shallower than 6,000m below sea level (equivalent to 94% of the EEZ), and transfer the technologies to industries.*"
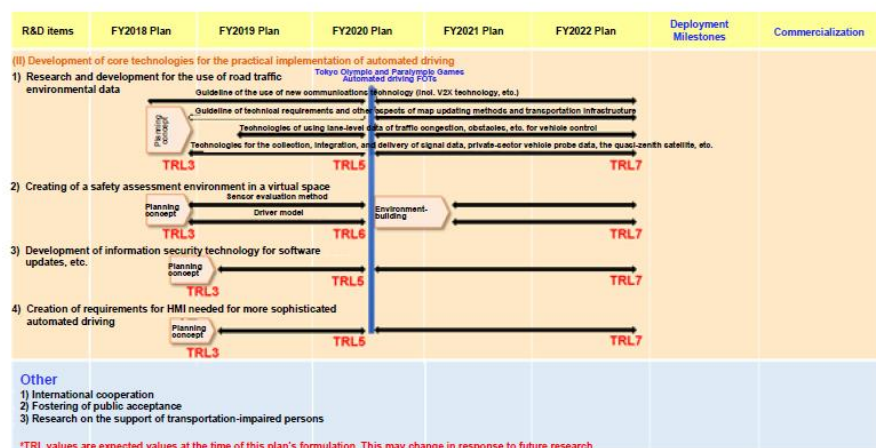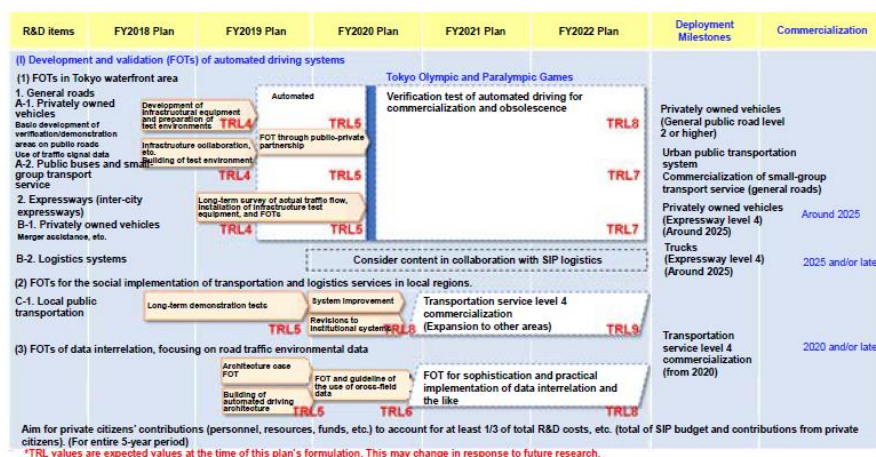
R&D Plans present systematically different types of goals: Social Goals, Industrial Goals, Technical Goals, Institutional Goals.

Some programmes have also collectively established strategies or roadmaps to guide activities towards the common goals. SIP-Adus for instance has designed and updated "Public-Private ITS Initiative/Roadmaps'.

Each programme has also identified and formalised 'exit strategies' or 'strategies for commercialisation" that present what they aim to deliver and how these advances could be exploited / commercialised. For instance, the second term's SIP programme 'Cyber Physical Security for IoT Society' has the following strategy for commercialisation:
- From demonstration testing to practical application: Demonstration testing of developed technologies will be carried out and test results will be fed back into R&D activities. In pursuit of

early practical application in society, the cycle of testing and feedback will be repeated. At the same time, use of developed infrastructure will be promoted across supply chains, including small and medium-sized companies, with the aim of disseminating products, services, and systems having a high level of security ensured by Japanese technology.

- Commercialization led by participating companies: Participating companies will take the lead for the commercialization and introduction of developed technologies in industrial fields. Activities will include licensing of technology to relevant vendors with the aim of technology dissemination.
- Coordination with US and EU frameworks as well as the system established by Japanese government ministries This project will be carried out in coordination with Japanese government measures regarding IoT devices and supply chains. It will contribute to the establishment of a system comparable to US and EU cybersecurity frameworks. In particular, it will be necessary to verify that project activities and achievements are in line with cybersecurity framework activities being accelerated in the US and Europe in order to ensure Japan's international competitiveness.

Figure 1. SIP-Adus R&D Roadmap (in the R&D Plan)

Flexibility

Flexibility	
• The targets and means of intervention to meet them can be revised at different stages of the process (predetermined milestones) based on feedback from monitoring and evaluation	o What are the established processes and information channels for monitoring progress toward goals? o What are the established process and rules for revising/updating goals? o *What are the arrangements in place to revise the objectives if needed?*

Each Programme's R&D Plan is developed by the Programme Director, and validated and monitored by the Governing Board. It can be adjusted during the course of the programme if needed, based on the results of the evaluations and self-assessments carried out annually. The allocation of the budget by the Cabinet Office following an annual decision of CSTI is also more flexible than it would be in the case of a traditional ministry's programme negotiating bilaterally with the Ministry of Finance. Finally, another factor of flexibility resides in the decision power of the Programme Director. He has substantial freedom to initiate and fund a range of activities within the scope of the allocated budget (including without open calls if there are rationales for this).

Policy co-ordination level

Key "Policy co-ordination" characteristics

- Each SIP programme has its own structure of governance
- The SIP programme focuses on areas where interministerial cooperation is needed for success. This key feature of the programme is implemented at overall SIP (CSTI meetings are headed by the Prime Minister and attended by several ministries) and individual programme (the Promotion Committee gather the different public authorities) levels
- The level of interministerial cooperation is one of the evaluation criteria at overall and individual SIP programme level
- The articulation with the demand-side is key in the SIP. Companies are partners in all programmes and R&D Plans of individual SIP programmes put the emphasis on expected results and their potential in terms of commercialisation. All R&D Plans include 'exit strategies', 'deployment milestones' or a 'commercialisation strategy'

Horizontality

Horizontality	
• Several policy bodies covering different policy fields (e.g. ministries, agencies) are involved in the governance of the initiative.	o What are the policy fields (sectors/thematic areas, stages of the innovation chain, represented by different bodies) covered in the governance and decision-making? o What is the governance structure to support horizontal coordination? o What are the main coordination bodies (with their functions)? o To what extent does the coordination process involve actors besides the policy arena?

The SIP programme is – as its name suggests – interministerial by design. This key feature of the programme is implemented at overall SIP and individual programme levels:

- **High level governance: the programme is led and managed by the CSTI, a high level and powerful council headed by the Prime Minister, which primary function is to ensure the holistic coordination of STI policies across ministries and agencies. The Secretariat of the Council (about 100 staff) is located in the Cabinet Office, which provides CSTI with additional central authority. Furthermore, the SIP Governing Board is in charge of the coordination of the entire SIP programme, which covers a wide range of sectors and policy areas.**
- **At programme level, several governance bodies allow holistic coordination (the Promotion Committees; several specific working groups for special issues in each program). The Programme Director, with extended decision power and leadership is also considered essential for the promotion and smooth operation of interministerial coordination and science-industry cooperation. Furthermore, the degree of interministerial coordination is one of the criteria for evaluation of individual SIP programmes. One SIP programme in which MEXT and METI kept their own team separate from each other was evaluated negatively and went through significant change of its governance.**

Another key dimension of SIP's contribution to interministerial coordination relates to the SIP budget: the programme is funded via a 4% 'haircut' on the STI budgets of all ministries. Ministries have therefore significant incentives to participate actively to the SIP programme in order to benefit from the programme they have partially funded.

The governance of the SIP is described in the "Basic principles on the implementation of SIP" drafted by the CSTI in 2014. The role of the SIP Governing Board, Program Directors, Promotion Committee are formalised in this document.

The **CSTI** has initiated and leads the SIP programme. It is one of the four most important councils of the Cabinet Office. It serves as the 'headquarters for STI policy', being responsible for developing the national STI Basic Plans every five years as well as annual action plans, and is also practically in charge of their overall coordination across ministries. Since 2014 it also implements specific programmes, such as the SIP. It has 15 members, including the Prime Minister and 6 other Cabinet members, and 8 members (including 1 appointed full-time to work for the Council). The role of CSTI with regards to the SIP is to decide / approve on:
- the selection of the SIP programs
- the designation of the Program Directors
- the fundamentals of the R&D Plan in each program
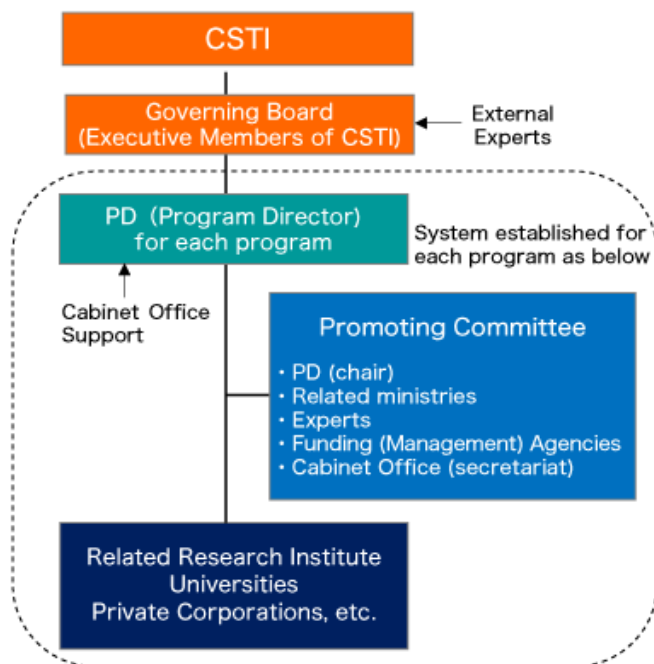- the allocation of budget to each program

(Note: The SIP programme "health and aging" is not supervised by CSTI but by the Headquarters for Healthcare Policy in the Cabinet Office)

The **SIP Governing Board** is composed of the executive members of CSTI. It ensures co-operation and consistency across the whole SIP programme, notably through the drafting of guidelines such as the programme 'basic principles'. Most of the important issues regarding the SIP programme are discussed in the Governing Board. This includes the approval of individual programmes' R&D Plans developed by the Programme Director, the evaluation of each program and special issues where coordination across ministries are necessary. The Governing Board invites experts from outside as needed, notably to review R&D Plan and undertake programme's evaluation. It meets about 20 times every year.

A **Promotion Committee** is set up in each SIP individual programme. This Committee is chaired by Program Director and consists of sub-directors (assisting the PD in sub-themes), related ministries, related government agencies and experts on the topic. The main role of the Promotion Committee is to discuss and monitor the execution of the R&D Plan and coordinate any issue related to the implementation of the program. Several SIP programmes have also been set up Working Group under the Promotion Committee in order to discuss in more details some topics. Each programme therefore builds upon extensive cross-ministerial Collaboration. The SIP Programme on 'Innovative Technologies for Exploration of Deep Sea Resources' involves collaboration between eight ministries and the Cabinet Office gathered in the Promotion Committee, including the Ministry of Education, Culture, Sports, Science and Technology (MEXT); Ministry of Economy, Trade and Industry (METI); Ministry of Land, Infrastructure, Transport and Tourism (MLIT); Ministry of Internal Affairs and Communications (MIC), Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Energy (MOE) and Ministry of Defense (MOD).

The **Program Director** in each SIP programme is responsible for the management of his programme and in charge of drafting the R&D Plan. PDs can also appoint sub-directors to support their work in sub-themes. The selection of Program Director is especially vital for the success of the SIP programme. As chair of the Promotion Committee, the PD is considered essential for the promotion and smooth operation of interministerial coordination and science-industry cooperation.

Figure 2.Generic implementation structure of the SIP and one SIP individual programme

Verticality

Verticality	o What is the governance structure to support vertical coordination?
• Several policy bodies covering different levels of government are involved in the governance of the initiative.	o What are the levels of government (national, regional, local) involved in the governance and decision-making, and how are they represented?

The SIP programme is essentially a national initiative, with involvement of national policy bodies and representatives of various communities at national level. However, there are a few examples of involvement of local authorities when needed in individual programmes.

The programme Automated Driving System (SIP-ADS, formerly SIP-ADUS during the first phase) supports regional and international cooperation. As SIP-ADS puts a priority on practical implementation, it interacts and conducts initiatives with local government bodies for setting the ground for demonstration activities and preparing the regulatory reforms that will allow automated vehicles on the roads.
There are also some examples of international cooperation. There have been efforts made to try and make international standards on ADS aligned with Europe and the US.

However, in general, regional and international aspects in SIP programmes are rather limited.

Intensity

Intensity	
• The decisions regarding the intervention (objectives, modalities, level of resources) are taken collectively by the involved policy bodies and are binding to them.	o What is the degree and form of co-ordination between the different policy actors (e.g. strong or weak coordination, binding or non-binding decisions, centralised or decentralised decision-making, etc.)? o What is the degree of integration of budgets (e.g. common pot/integrated budget, earmarked decentralised budget, decentralised budget, etc.)?

The coordination is strong within SIP. The decisions taken collectively by the partners in each SIP programme (and endorsed by the Promotion Committee and the Governing Board) are very precisely set out in the R&D plans and implemented and monitored by the Programme Director.

Exploratory

Exploratory	
• Policy bodies and stakeholders co-ordinate their plans (e.g. via a portfolio approach) to cover a larger spectrum of alternative options/development paths, share associated risks and learn from success and failure	o What is the range of (technological and non-technological) alternatives options supported to achieve the initiative's objectives? o What are the arrangements in place to scan/test different (technological or non-technological) options? o Is the initiative using a portfolio approach? o Is the initiative connected with relevant fundamental research and how?

The SIP essentially supports "incremental innovation", with a priority put on demonstration or commercialisation at the end of the 5-year period. However some programmes are more long term and science-based and include exploratory activities (such as for instance the SIP on 'Materials Integration' for revolutionary design system of structural materials). A distinct programme named ImPACT implemented between 2013 and 2018 aimed specifically to encourage disruptive innovation was run in parallel to SIP. In 2020 a new exploratory programme – Moonshot – was launched.

## *Demand-articulation*

Demand-articulation	
	o Are potential users and/or relevant policy/regulatory authorities involved in the governance of the initiative and what role do they have? o Are there any formal plans for regulatory reforms and support to market deployment (e.g. public procurement)? o How are the demand and need dimensions embedded in the initiative?

• Potential users (or related representatives of the demand side) and relevant regulatory authorities are involved in the initiatives from the beginning and participate in the decisions.	

The articulation with the demand-side is key in the SIP. Companies are partners in all programmes and R&D Plans of individual SIP programmes put the emphasis on expected results and their potential in terms of commercialisation. All R&D Plans include 'exit strategies', 'deployment milestones' or a 'commercialisation strategy'. The Programme Director, who originates from industry in about half of the SIP programmes, is also considered key to inquire on needs and ensure the connection with the demand-side.

The SIP Programme 'Big-data and AI-enabled Cyberspace Technologies' for instance aims to encourage programme partners to create new services and businesses in areas where collaboration between human and AI is considered effective (Nursing care, education, customer service, etc.). To do so, end-users (including companies) participate in programme activities from the initial stage of development. Developers and diverse users also conduct demonstration and experiments using developed technologies. A data exchange platform will be developed and demonstrated in different fields and areas (local governments, etc.). Once validated, the programme aims to gradually transfer the management of the infrastructure to the private sector, such as private consortiums, under the supervision of the national government, to form an ecosystem that can operate independently and sustainably. Furthermore, once developed, the AI based automatic negotiation platform will be handed over to private consortiums and other organisations to induce private companies to develop various applications.

Figure 3. Exit Strategy of the SIP Programme 'Big-data and AI-enabled Cyberspace Technologies
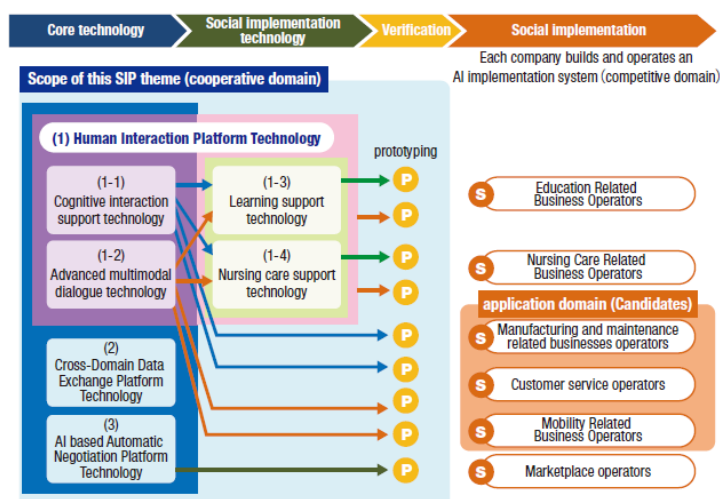
Policy implementation level

Key "Policy implementation" characteristics

- The SIP's main objective is to support in an integrated way the whole innovation cycle from research to early market application as well as any needed regulatory reforms and system changes.
- Each SIP programme uses different instruments and policy tools, from grants to demonstration programmes, regulatory reforms and public procurement. The mix of instruments is fine-tuned by the Programme Director in order to achieve the objectives of the R&D Plan.
- The SIP Programme as a whole and the SIP individual programmes are subject to ex ante and ex post evaluations, with several steps of self-assessment and peer reviews by specialists. The results of these evaluations are reflected in the allocation of the budget in the following year and can lead to significant change in the programme R&D Plan, governance or management.

Policy mix diversity

Policy mix diversity • A package of policy instruments supports a diverse set of activities mixing different disciplines, sectors and areas, across the whole space of the innovation spectrum, from (oriented) basic research to demonstration and early market creation, as needed to meet the objectives.	o What are the modes of intervention/policy measures available to achieve the objectives? o What are the arrangements in place to ensure the consistency (i.e. reduce overlaps, enhance complementarities) of the different policy instrument/measures?

Each SIP programme uses different instruments and policy tools, from grants to demonstration programmes, regulatory reforms and public procurement. The mix of instruments is fine-tuned by the Programme Director in order to achieve the objectives of the R&D Plan. This is negotiated with the policy making bodies that participate in the Promotion Committee. Each programme has a dedicated management agency that take charge of the practical administration and funding of the programme activities. They also deal with the expenditure management and IP support.

Various types of policy instruments by different ministries are implemented to achieve the objective of each programme; public funding, Promotion committee, deregulation, promotion of international standardization, support for intellectual property.

1) Public R&D grants to universities, public research institutions and private firms: these grants are provided through open calls (several grants per call, up to dozens of calls per programme) or without open call if the Programme Director considers there are good reasons for doing so.

2) Deregulation: Some SIP programmes collaborate for instance with national strategic special zones where they can experiment regulatory reforms and regulatory agencies in so-called regulatory sandboxes

3) International standardisation: international co-operation on standards, e.g. on automated driving safety.

4) Patent support through funding agencies assisting patent submissions

5) Public procurement in very few cases, for instance in the SIP 'Enhancement of National Resilience against Natural Disasters', in cooperation with local authorities

The Programme Directors (PDs) are essential to lead the implementation of the R&D Plan and discuss with public authorities, notably those attending the Promotion Committee and sub-theme working groups, the type of policy intervention needed to achieve the objectives. Alongside with the research/innovation track-record in the field, management skills/experience was therefore one of the main criteria for the selection of PDs. PDs are recruited through open calls launched by the Cabinet Office at the beginning of each SIP phase. They are appointed by the Prime Minister as executive government officers in the Cabinet Office. This system of appointment has provided PD with the needed status to lead their SIP programme. In the first phase of the SIP, 5 out of 10 were experienced decision makers from the private sector and the other half originated from universities or research institutions.

Leverage

Leverage	
• Public and private stakeholders involved in the different phases of the innovation process, are mobilised to contribute in decision-making and funding of the initiative.	○ How are partners and beneficiaries (inc. private sector, other public bodies and stakeholders) engaged in the initiative? ○ What are the incentives in place to raise funds and ensure other types of contributions from partners and beneficiaries? ○ *What are the factors fostering or hindering the level of engagement of (potential or actual) partners?*

Private firms provide funding for some parts of R&D through a matching fund system. While it was voluntary in the SIP's first term, this matching fund by private companies has be made mandatory in the second term in order to strengthen their investment and active participation in the programmes. This change results from the SIP overall evaluation. The details of the private contribution (financial and in-kind) are specific to each programme and presented in their respective R&D Plan.

The extent of the industry contribution varies significantly between programmes, depending on whether they are more or less industry-based. In the second term SIP programme on 'Automated Driving for Universal Services' (SIP-ADUS), the 2019 R&D Plan stipulates that contributions from the business sector for the entire programme period (i.e. 5 years) including both in-kind and financial contributions are expected to exceed 1/3 of the programme budget (i.e. the total of contributions from both the national government and the business sector). In a more science-based programme like the one on 'Research and Development Plan on Innovative Technologies for Exploration of Deep Sea Resources' future contributions from industry are expected to reach only about 3% of the total R&D expenditures during the course of the programme.

More generally, the SIP programme has been praised by private companies and industry associations (notably the Japan Business Federation 'Nippon Keidanren') for the simplicity of participation in the programme, its flexibility and its focus on innovation . This attractiveness of SIP for the private sector shows in the structure of leadership of the SIP programmes that are less science-oriented. This is for instance the case of the SIP programme "Technologies for Smart Bio-industry and Agriculture", where the Programme Director and two of the sub-Programme Directors are from industry (out of 3), as well as 3 Strategy Coordinators (out of 6).

The SIP programmes offer a forum that can host negotiations to fine-tune the rules and scope of cooperation. Some SIP programmes have clearly formalised the frontier between the issues and areas that can be dealt with cooperatively and those that must remain competitive. In the SIP-ADUS programme for instance, while the issues related to telecommunication technologies and the mapping for automated driving fall into the cooperative area, the R&D on sensors remain in the competitive area of the programme, where special rules apply to protect information on activities. The distinction between the cooperative areas and competitive areas is discussed and revised if necessary annual reviews. This is a very sensitive issue that necessitate to draw the boundaries between competition and cooperation in details. For instance, a participating company can provide a sensor equipment for the demonstration/experiment in a black box manner. Others can uses the data set which was produced by the equipment, but they can not access to the underpinning technology.

Figure 4. Leadership of the SIP programme "Technologies for Smart Bio-industry and Agriculture"

Position	Name	Institution
PD	Noriaki Kobayashi	Kirin Holdings Company, Limited
Acting PD	Noboru Noguchi	Research Faculty of Agriculture, Hokkaido University
Sub-program directors (sub-PDs)	Yoichi Kamagata	National Institute of Advanced Industrial Science and Technology
	Toshihiko Komari	Japan Tobacco Inc.
	Wataru Mizunashi	Mitsubishi Chemical Corporation
Strategy coordinators (Strategy Cs)	Izumi Okoshi	Dentsu Inc.
	Kouichi Kadowaki	National Agriculture and Food Research Organization
	Takayoshi Kawakami	Industrial Growth Platform, Inc.
	Shoji Masahiko	Musashi University
	Atsuhiro Hagiwara	Object of Null, Inc.
	Yasufumi Miwa	The Japan Research Institute, Limited

Measurability and evaluability

Measurability and evaluability • The policy is endowed at the outset with input and output indicators as well as evaluation procedures adapted to its systemic nature, in order to assess its results and learn from its implementation in view of continuous improvement.	o What are the indicators set to measure progress, outcomes and impact of the initiatives? o Were evaluation procedures developed and diffused at the outset?

The Governing Board is responsible for the evaluation of SIP. There are two types of evaluation: the policy evaluation for the whole SIP and an evaluation of each programme. How each programme fares is reflected in the allocation of the budget in the following year and can lead to significant change in the programme R&D Plan, governance or management.

The **policy evaluation of the SIP as a whole** takes place before, during and after it has been implemented. A first final evaluation, covering the 1st phase, was undertaken in 2019. The results of this evaluation helped define the second term. The evaluation criteria included:
● The effects of the implementation of SIP relative to target
● Management and execution of the budget
● Cooperation between ministries
● Research collaboration between industry, academia and other related programmes

Each SIP programme is evaluated at the end of every fiscal year, through self-assessment (by the PD and the whole structure of leadership), evaluation of the Governing Board and peer-review by external specialists who specialise in the respective areas of the programme. The most important annual evaluations are those carried out in year 1, 3 and the last year. SIP programmes have set up a dedicated Evaluation Committee composed of the Governing Board and external specialists. They perform their evaluation on the basis of their own judgement as well as the results of the programme self-assessment.

The evaluation criteria for each programme can vary but they generally follow the 2016 "General guideline for National R&D evaluation".
1. Significance of and conformity to the purpose of the SIP system
2. Validity of the goal (particularly the outcome goal), including the degree of achievement of the project in the targeted time schedule
3. Checking whether appropriate management has been performed, with particular focus on the effectiveness of cross-ministerial collaboration
4. Determining the strategies and degree of progress toward commercialization
5. Determining the expected effects and ripple effect at the final evaluation and after completion, checking whether the follow-up methods are clearly and appropriately defined
6. The achievement in the Technology Readiness Levels (TRL) in each research subject of each project

In addition the following items are considered in the programme evaluation:
1) Conformity to the Society 5.0.
2) Degree of priority in the field that requires production innovation
3) Contribution to the social innovation
4) Contribution to solving the social issues and for strengthening the Japanese economy and industrial competitiveness
5) Clarity of the exit strategy for the commercialization and social implementation (i.e. clear commercialization plan in five years)
6) Presence of the system related to the exit strategy including IP strategy, international standardization, regulatory reformation
7) Degree of cross-ministerial work that requires cross-ministerial collaboration
8) R&D strategy that considers the process from the fundamental research to commercialization
9) Existence of the distinction between "cooperation area" and "competitive area" settings (if open–closed strategy is present)
10) Degree of establishment of the industry–academia–government collaborated system and the participating businesses to commercialize the R&D results and the matching fund

It is clearly expected than these evaluations should not remain confined at assessing whether the objectives have been achieved but should also investigate what are the cause and factors of success and failures.

The mechanisms for the evaluation of the SIP programmes were assessed in the 2019 overall SIP evaluation. The ensuing recommendations were as follows:

- The effective allocation of budget by annual rigorous evaluation for each program by Governing Board has led to many R&D outcomes. This system was effective in maintaining the PECD cycle of the program.

- The evaluation for each program should be done by experts who have enough academic knowledge for the program.

- The result of the evaluation should be carefully communicated to Program Director including the clear reason for the budget increase/decrease.

- Program Director as well as cabinet office should aggressively communitate the information on R&D outcomes to the public.

Reflexivity

Reflexivity	
• Adequate arrangements are in place to allow policy learning from implementation and evaluation, which feed back into revisions of objectives and the design of interventions.	o What are the mechanism and procedures to use evaluation and monitoring results (and any other information stemming from steering and implementation) to inform decision-making (revision of objectives, adaptation of modes of intervention, stage-gate approach, etc.)?
	o Do the policy bodies have the sufficient absorptive capacity to analyse the information stemming from steering and implementation and translate this into actions?
	o *What are the arrangements in place to support learning and improvement of the initiative?*

The SIP Programme as a whole and the SIP individual programmes are subject to ex ante and ex post evaluations, with several steps of self-assessment and peer reviews by specialists. The results of these evaluations are reflected in the allocation of the budget in the following year and can lead to significant change in the programme R&D Plan, governance or management. The R&D Plans of each programme are also reviewed in the light of the progress accomplished and are revised if necessary, following agreement by the Programme Promotion Commitee and validation by the SIP Governing Board.

Main challenges

- **Transaction costs** – in many SIP programmes coordination cost can be very heavy. There are several meeting including Governing Board, Promotion Committees, working groups, etc. Given the cross-ministerial and cross-sectoral nature of the SIP, many people have to attend these meetings. Furthermore, with the flexibility of funding in each program, there are many recruitment meeting. In the case of "Automated Driving System", the Programme Director had to attend more than 200 meeting in 5 years. this programme is supported by 5 full-time staff in the Cabinet Office and 10 in the implementation agency (NEDO).

- **Support and treatments of Programme Directors** - The administrative support provided by the Cabinet Office was considered insufficient by several PDs with regards to their wide array of responsibilities of the Programme Directors, The salary of PD seems also not to be sufficient considering the effort and the type of skills and experience. However, their salary is under the constraint on the salary of government officer (they are hired as employees of the Cabinet Office).

- **Turnover of Cabinet Office agents** - In Japan officials in charge of each programs change every 2 or 3 years. This rule, which is meant to enhance officers' skills and improve inter-ministerial cooperation and communication, makes it hard to maintain the consistency of the program its 5 years term. While this is impossible to change this convention, the SIP tries at least to make clear who was the responsible officers In the R&D Plan, which is not usual in Japan.

- The 2019 overarching SIP evaluation emphasised the following areas for improvement:
  - **Some SIP programmes were considered too science-based** - SIP should focus only on areas where 1) demonstration would be feasible within the term of the programme 2) there is a clear need for inter-ministerial coordination, linking research, innovation and sectoral authorities. These conditions were not always realised and several programs in the 1st term SIP which were too much focused on basic research have had no impact in terms of practical application.
  - **Insufficient administrative support for Program Director** - Program Directors did not receive administrative support that is commensurate with the scope of their responsibilities and the number of tasks they must carry out. More staff would be needed.
  - **Insufficient financial contribution by industry -** Matching fund by private companies could be made mandatory to strengthen their investment and active participation in the programmes. This should be done without shifting the efforts towards short term economic returns.
  - **Regulatory reforms** - The necessary regulatory reforms in each program should be assessed and negotiated at high level, in CSTI, Cabinet Office and relevant ministries.
  - **Exit Strategy -** Program Director should dedicate more efforts to how the programme deliverables/intellectual property of the program should be managed after the end of the program.

Main opportunities

- **Improved cross-ministerial coordination** under the leadership of CSTI and the Cabinet Office.

- **Leadership of Programme Directors**: the strong leadership of the PDs has been identified a key success factor. PDs decide upon the R&D Plan of their SIP programme and allocate the funds, based on the results of the annual programme evaluation. They are also deem essential to help cross-ministerial coordination in the Promotion Committee.

- The active involvement of CSTI made possible **a continuous policy approach from basic research to demonstration** and good cooperation between research and industry.

- **Policy learning in implementation agencies.** The involvement of agencies as implementation organisations of the SIP program has induced some changes in the practices and culture of programme management. They tend to become more result oriented and more flexibility

- **Flexibility in SIP individual programmes** has been facilitated by 1/ the fact that each programme has its own structure of governance (while still complying with the basic SIP policy and implementation principle designed by the CSTI) 2/ the decision making power of each PD.

References

All information on the SIP (including the operational guidelines, the SIPs' R&D Plans, the overview of the programme, etc.) can be found on the CSTI website (Cabinet Office): https://www8.cao.go.jp/cstp/english/index.html