European Commission

Mutual Learning Exercise on Bridging the Gap Between Science and Policy

Final report

PSF CHALLENGE

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Research and Innovation

Mutual Learning Exercise on Bridging the Gap Between Science and Policy. Final Report

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Manuscript completed in May 2025
First edition

PDF	ISBN 978-92-68-26815-5	doi:10.2777/5299851	KI-01-25-096-EN-N

Luxembourg: Publications Office of the European Union, 2025

EUROPEAN COMMISSION

Mutual Learning Exercise on Bridging the Gap Between Science and Policy

Final Report

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2025

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Contents

List of Figures and Tables

List of abbreviations

AAAS	American Association for the Advancement of Science
AI	Artificial Intelligence
BELSPO	Belgian Science Policy Office
BOSA	FOD Beleid en Ondersteuning
COALESCE	Collaborative Alliances for Societal Challenges
COARA	Coalition for Advancing Research Assessment
DORA	San Francisco Declaration on Research Assessment
EIPM	Evidence-Informed Policy-Making
EPTA	European Parliamentary Technology Assessment network
ERA	European Research Area
ESAF	European Science Advisors Forum
EU-ANSA	EU Agencies Network on Science Advice
FECYT	La Fundación Española para la Ciencia y Tecnología, F.S.P.
FCT	A Fundação para a Ciência e a Tecnologia
FORWIT	Rat für Forschung, Wissenschaft, Innovation und Technologieentwicklung
IPA	Institute for Public Administration
JOP	Het Jeugdonderzoeksplatform
JRC	Joint Research Centre
MLE	Mutual Learning Exercise
NOU	Norges offentlige utredninger
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek
ONAC	La Oficina Nacional de Asesoramiento Científico
PLANAPP	Centro de Planeamento e de Avaliação de Políticas Públicas
PSF	Policy Support Facility
R&I	Research and Innovation
REF	Research Excellence Framework
REPLAN	Rede de Serviços de Planeamento e Prospetiva da Administração Pública
S4P	Science-for-Policy
SAM	Scientific Advice Mechanism
SAPEA	Scientific Advice for Policy by European Academies
SEP	Standard Evaluation Protocol
SIA	Flanders' Strategic Insights and Analyses unit
STRATA	VšĮ Vyriausybės strateginės analizės centras
VITO	Vlaamse Instelling voor Technologisch Onderzoek N.V.

Executive summary

Science-for-policy (S4P) initiatives aim to improve policy outcomes, promote innovation, ensure policy coherence, and strengthen democratic processes by effectively using research-based knowledge and integrating evidence-informed insights in policymaking. S4P faces significant challenges: fragmented advisory systems; difficulty integrating diverse sources of scientific knowledge; misaligned incentives for researchers and policymakers; complexity and uncertainty; and the evolving landscape of digital communication and disinformation. Overcoming these requires coordinated, system-level governance and dynamic integration between policymakers, researchers, and other stakeholders.

In line with the Better Regulation principles, which recognise scientific evidence as a cornerstone of policymaking in the EU, the Council of the EU has emphasised the importance of evidence-informed policy and S4P more broadly.[1]

The Mutual Learning Exercise (MLE) on **Bridging the Gap Between Science and Policy** was set up to facilitate the exchange of information, experiences, and lessons learned, and to identify good practices, policies and programmes that promote S4P. From June 2024 to February 2025, 15 Member States and Associated Countries participated in four MLE country visits to Belgium, Spain, the Netherlands, and Poland. Each country visit focused on a specific S4P topic, introduced through a discussion paper developed by external experts. Local S4P stakeholders and experts supported the MLE during country visits by describing national S4P mechanisms and ecosystems and by engaging the participants in discussions on their challenges and development opportunities. Four **Thematic Reports** detail outcomes of this work.[2]

Based on the Thematic Reports and extensive and intensive discussions during the country visits, this Final Report introduces **eight key recommendations** to improve existing S4P systems and facilitate their development. These recommendations are listed in the table below and discussed in detail in Chapter 2.

Recommendations
1. Govern S4P at the ecosystem level
2. Foster and institutionalise collaboration among S4P actors and facilitate public engagement
3. Integrate foresight and anticipatory policymaking in S4P
4. Recognise and reward policy engagement and redefine metrics for success
5. Develop S4P capacity for policymakers, researchers, and intermediaries
6. Increase transparency and accountability in S4P
7. Strengthen scientific integrity and quality-control systems
8. Evaluate ecosystems, not only their components or inputs

Table 1: Recommendations

The need to take into account and integrate the many often isolated processes and mechanisms that support S4P is reflected in the **central ecosystem** concept that underpins the exercise. The Final Report elaborates on this concept and its components, and suggests ways to govern S4P ecosystems and understand, improve and assess their effectiveness.

[1] Council of the European Union. (2023, December 8). Strengthening the role and impact of research and innovation in the policymaking process in the Union. https://data.consilium.europa.eu/doc/document/ST-16450-2023-INIT/en/pdf

[2] The reports are available at https://projects.research-and-innovation.ec.europa.eu/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-bridging-gap-between-science-and-policy

The value of the ecosystem concept is twofold. It emphasises the fact that there is a plurality of interacting and interdependent actors involved in S4P. It also highlights the point that S4P systems are not simple input-output machines, but rather consist of many relatively autonomous actors with multiple functions and interests. The complexity of S4P ecosystems requires new concepts for their governance, but complexity should not be understood as a problem, as most socially and politically important problems and challenges are themselves highly complex. To address this complexity, S4P ecosystems must be able to integrate knowledge from multiple disciplines and help policymakers make sense of important policy problems in rapidly changing environments.

This report emphasises a knowledge-based view on S4P, which contrasts with earlier views that saw S4P mainly as a process where scientists provide facts and evidence for policymakers to use. This linear flow of information along the so-called "science-policy boundary" has been called 'S4P 1.0'. According to current 'S4P 2.0' thinking, concepts from knowledge and innovation management have become more prominent. Common terms include "communities of practice," "co-creation", and "collaborative problem articulation". Recent developments in social media and artificial intelligence (AI) have also highlighted the importance of public participation, scientific literacy, and new deliberative policy processes.

This report builds on S4P 2.0 but also suggests possibilities for moving beyond semantics or deterministic language. S4P is understood here as a learning process. Instead of what the report calls the "old school" model of linear transfer of knowledge from learned experts to less-informed policymakers, the report emphasises the active role of policymakers in knowledge-creation and mobilisation. In this process, scientific knowledge is only one of the sources that policymakers must integrate in policy- and decision-making. Science-informed policymaking requires close collaboration and dialogue between researchers and policymakers. This more "downstream" model of S4P enlarges the scope and span of S4P beyond the domain of academic knowledge, and it also makes the "science-policy boundary" porous. The report argues that there are good reasons for that.

During the MLE, the participants reflected on ideas developed in the discussion papers and analysed the S4P systems in the participating countries. Different countries have different practical, institutional and historical contexts, and it is not possible to define "best practices" that would work in all contexts. It is, however, possible to describe principles and concepts that are both useful and inspirational.

The first of the four Thematic Reports offered a knowledge-based view on S4P and introduced concepts that underpin it. The report also discussed examples of S4P initiatives in the participating countries which helped to illustrate these concepts.

The second Thematic Report focused on mapping S4P ecosystems. It discussed actors, functions, roles, incentives, and competences that structure and shape the ecosystem. The report used examples from the participating countries to describe ways to implement these in practice.

The third Thematic Report focused on evaluating S4P ecosystems. It discussed the objectives and principles of evaluation and established an indicator system that can be used as a starting point in the development of context-specific assessment.

The fourth Thematic Report focused on the important concept of trust. As S4P ecosystems are often dynamic – where collaboration and formal/informal coordination underpin responsiveness – trust plays an important role on many levels. As such, managing trust and trustworthiness is a central challenge for S4P development and governance.

This Final Report is intended for three main types of readers, and it is organised accordingly. Followed by a brief introduction in Chapter 1 to the objectives and policy background of S4P and the MLE and its key insights, Chapter 2 introduces the recommendations. Readers who need a high-level overview of the areas where action is needed from policy developers and S4P actors may find Chapters 1 and 2 useful.

Chapters 3 and 4 provide an outline of the concepts that underpin the recommendations. These chapters should be useful for readers interested in the outcomes of the MLE process, and the ongoing transition of S4P and science advice towards S4P ecosystems.

Together, the four Thematic Reports provide valuable references to relevant policy and research literature, and they complement this Final Report which should be useful for readers planning to implement its recommendations locally.

1. Introduction

Science-for-policy (S4P) refers to the systematic use of scientific knowledge to inform and enhance policymaking processes. It aims to improve the quality, effectiveness, and societal impact of public policies by integrating evidence-based insights from various disciplines. This is not always easy, and countries have developed varying mechanisms and processes that help research-based evidence to be effectively created and used in policymaking and in evaluating policy options. By fostering informed decision-making and anticipatory policy development, S4P contributes to solving complex issues, strengthening democratic governance, and increasing public trust in government actions.

1.1. Objectives of S4P

The integration of scientific knowledge into policymaking is crucial for several reasons:

Integration of evidence-based knowledge in policy development: Modern societal challenges, such as climate change, public health crises, and technological transformations, require the best available scientific knowledge combined with inclusive dialogue on values and priorities. Policy-relevant knowledge is created in many disciplines and with different methodological approaches. S4P ecosystems integrate evidence and knowledge for use in policy development.

Improving policy outcomes: Policies developed without sufficient scientific input may fail to address underlying issues and could generate unintended consequences. Science provides a structured approach to understand policy problems and evaluate different options.

Promoting policy innovation, responsiveness, and anticipatory governance: Science plays a pivotal role in driving innovation. Complex societal challenges, such as the energy and digital transitions, generate demand for future-oriented and policy-relevant science. Evidence-informed policies create an enabling environment for scientific advancements, helping policy initiatives keep pace with technological progress and societal needs. In an increasingly complex world, science detects and conceptualises new social, technological, and political developments, and supports policies and society in governing them.

Ensuring policy coherence: Science-informed policymaking fosters coherence across different policy sectors and government administrations. Mobilising research and innovation (R&I) communities to promote cross-sectoral learning helps break down policy silos, enhances collaboration, and improves the effectiveness of public policies.

Improving democratic governance: A well-informed debate among policy stakeholders and the wider public, supported by accessible scientific evidence, is essential for democratic governance. Science provides a shared understanding of reality that underpins effective policymaking and allows decision-makers to develop policies that are both functional and widely accepted. The use of scientific evidence in policymaking enhances transparency, accountability, and long-term sustainability in governance.

Increasing public trust in policymaking: Policies rooted in scientific evidence can bolster public trust in government actions, thus increasing their effectiveness and contributing to implementation. When policy decisions are based on widely accepted, reliable and transparent sources, they are equipped to counter misinformation and disinformation, which are now often used to create societal discord.

S4P can, therefore, also be understood as the strategic development of social knowledge-creation, knowledge-sharing, and sensemaking systems. Building on evidence, knowledge and expertise from the sciences, including social and human sciences, it creates a shared understanding about policy development needs and possibilities to address these.

1.2. Policy background

In line with the Better Regulation principles,[3] the Council of the European Union has emphasised the importance of evidence-informed policy. Scientific evidence is recognised as a cornerstone of policymaking in the EU, supporting and improving decision-making, as well as the quality, effectiveness, efficiency and impact of public policies. Interdisciplinary science, including social sciences and humanities, is a key part in preparing, implementing and evaluating political decisions.[4] According to the Council of the EU Conclusions of December 2023,[5] scientific knowledge and advice should be reliable, verifiable, robust, pertinent and transparent, fully respecting scientific freedom, integrity, and ethical principles.

At the European level, several mechanisms and networks have been set up to provide scientific advice and connect advisory bodies. These include the Scientific Advice Mechanism (SAM), which consists of the Science Advice for Policy by European Academies (SAPEA) consortium, the Group of Chief Scientific Advisors, and the SAM secretariat; the European Science Advisors Forum (ESAF); the European Parliamentary Technology Assessment network (EPTA); and the EU Agencies Network on Science Advice (EU-ANSA).[6] Furthermore, the European Commission is actively supporting the development of Member States' S4P ecosystems by coordinating activities in this area, especially by advancing the European S4P ecosystem in the context of the next European Research Area (ERA) Policy Agenda 2025-2027,[7] and supporting the analysis and mapping of Member States' S4P ecosystems.[8]

1.3. The Mutual Learning Exercise

Since 2015, the Horizon Europe Policy Support Facility (PSF) has given Member States and countries associated to Horizon Europe practical support to design, implement and evaluate reforms that enhance the quality of their R&I investments, policies and systems. The Horizon Europe PSF Challenge instrument includes Mutual Learning Exercises (MLEs) that focus on specific and operational R&I challenges of interest to countries choosing to participate. MLEs aim to identify good practices, lessons learned and success factors.

The MLE on *Bridging the Gap Between Science and Policy* was set up to facilitate the exchange of information, knowledge and experience, while identifying good practices, policies and programmes that promote S4P. It assisted participating countries in identifying challenges and opportunities in their national S4P systems and provided ideas and insights on how to effectively address existing and emerging challenges in S4P. The results of the MLE also contribute to the implementation of European Commission policy activities supporting the uptake of science in policymaking through the establishment of a European S4P ecosystem in line with the principles and values of the Pact for R&I in Europe, which is key to meeting the ambitions of the ERA.

[3] European Commission. (2021). Better regulation: Joining forces to make better laws. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52021DC0219

[4] SAPEA. 2019. Making Sense of Science for Policy under Conditions of Complexity and Uncertainty. DE: Science Advice for Policy by European Academies. https://doi.org/10.26356/masos

[5] Council of the European Union. (2023, December 8). Strengthening the role and impact of research and innovation in the policymaking process in the Union. https://data.consilium.europa.eu/doc/document/ST-16450-2023-INIT/en/pdf

[6] European Commission. (2022). Supporting and connecting policymaking in the Member States with scientific research (SWD(2022) 346 final). https://knowledge4policy.ec.europa.eu/file/staff-working-document-supporting-connecting-policymaking-member-states-scientific-research_en

[7] European Commission. (2025). Proposal for the next European Research Area Policy Agenda 2025-2027, ERA Action 13. https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/commission-adopts-proposal-next-european-research-area-policy-agenda-2025-2027-2025-02-28_en

[8] European Commission. (2025). The 'Building Capacity for Evidence-Informed Policymaking in Governance and Public Administration in a Post-Pandemic Europe' project has looked at evidence-informed policymaking ecosystems in seven EU Member States and created roadmaps towards greater uptake of EIPM practices in each country. The country reports are available at: https://data.europa.eu/doi/10.2760/5012478

From June 2024 to February 2025, 15 Member States and Associated Countries – **Austria**, **Belgium**, **Czech Republic**, **Greece**, **Hungary**, **Ireland**, **Italy**, **Latvia**, **Lithuania**, **the Netherlands**, **Norway**, **Poland**, **Portugal**, **the Republic of Moldova**, and **Spain** – participated in the four MLE country visits starting in Belgium, followed by Spain and the Netherlands, and then concluding in Poland. Each of the country visits focused on a specific overarching S4P topic, introduced through a discussion paper developed by external experts. Local S4P stakeholders and specialists supported the MLE during country visits by describing national S4P mechanisms and ecosystems, and by engaging the participants in discussions on their challenges and development opportunities.

Figure 1: Timetable of the Mutual Learning Exercise

Key insights from the MLE were summarised in the final meeting organised in May 2025. These are shown in Figure 2.

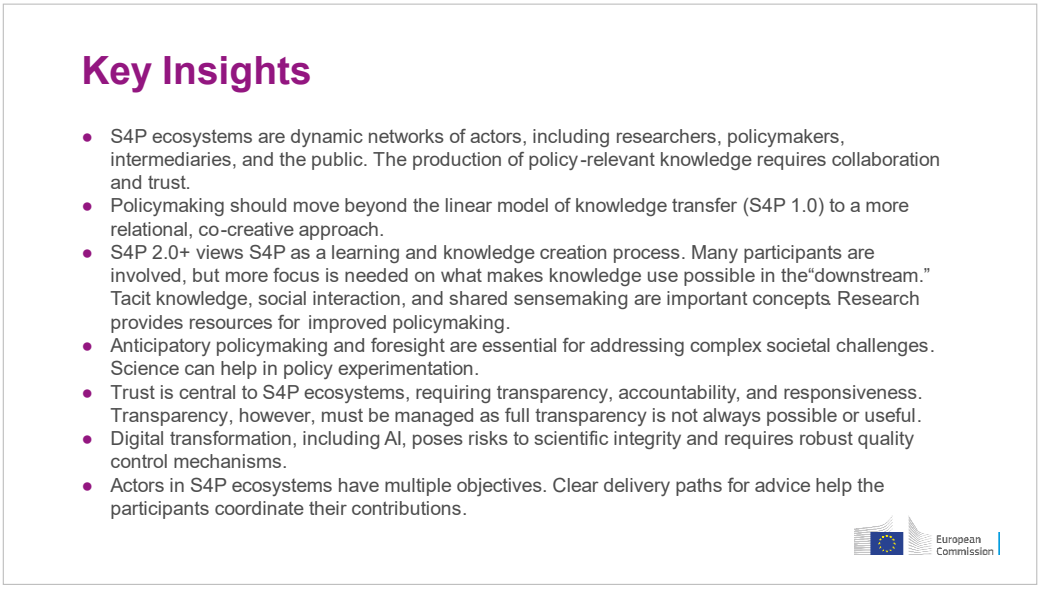

Figure 2; Key insights from the MLE

The thematic focus of the **first country visit** in Leuven was on providing a **knowledge-based view on S4P**. It highlighted the importance of understanding S4P from the policymaker's point of view and as a learning and knowledge-creation process. The discussion paper that provided an introduction to the topic and discussion points for the meeting in Leuven draws heavily on research in the knowledge management field. Business firms have developed computer-based executive information tools and decision-support systems over the past decades, but also organisational

processes and models that address the problem of effective knowledge use and organisational sensemaking in strategy development and operational decision-making. Experiences and research in this field have highlighted many concepts and insights relevant to the development of S4P ecosystems. In S4P, research-based knowledge must be integrated across disciplines and research communities, and policymakers and developers must interpret research-based knowledge and integrate it with other sources of policy-relevant knowledge. Whereas S4P has often emphasised the "upstream" processes of scientific knowledge creation, and the flow of research-based evidence from "science" to "policy" across the "science-policy boundary", the first discussion paper suggested that many S4P concepts, mechanisms and development opportunities can usefully be understood in a broader knowledge-based context. The first thematic report of the MLE discusses these relevant concepts, as well as the learnings from the first country visit. One of the key messages is that S4P should be understood as a dynamic learning process where various sources of scientific and political knowledge are used to create new knowledge.

The thematic focus of the **second country visit** in Madrid was on the **mapping of existing S4P ecosystems and their key elements**. A four-layer model of S4P ecosystems was introduced to distinguish actors, functions and roles, competences, and incentives that jointly define the structures and processes of S4P ecosystems. The participants used the framework to discuss and analyse the elements in the national S4P ecosystems, as well as to detect gaps and potential areas of improvement. The media was highlighted as an important enabling factor because the uptake of science advice also depends on public awareness of the importance of science in policymaking. In mapping the ecosystem, participants observed that the effective function actors play in an ecosystem is often more important than their formal mandates.

The **third country visit** in The Hague focused on the **assessment and evaluation of S4P mechanisms and ecosystems**. The discussion paper emphasised the importance of understanding the goals and objectives of S4P and measuring not only how specific actors and processes function in the ecosystem but also the functioning of the ecosystem itself. Evaluation helps to identify opportunities for improving the use of evidence in policymaking at different levels, but deciphering such complex systems can make evaluation challenging. Evaluation involves both summative assessments of the performance of the various S4P actors, their outputs and interactions, but also formative processes that help S4P actors and S4P developers to detect opportunities for improvement. The thematic report puts forward a series of both "performance" and "contribution" indicators for various S4P actors to apply, including funders, knowledge producers, intermediaries and brokers, knowledge users, and scrutiny bodies.

The **fourth country visit** in Warsaw focused on the important topic of **trust in S4P ecosystems**. There are different types of trust necessary for a functioning S4P ecosystem, including faith in institutions, experts and expertise, and also relational trust based on shared interests. At the ecosystem level, trustworthiness is fostered by the credibility of scientific knowledge and expertise – supported by the norms and practices of science – and responsiveness to the needs of policymakers and public values and interests, but also anticipatory capacity that increases both the responsiveness and robustness of advice. In S4P ecosystems, the trustworthiness of scientific information, expertise, advisory bodies, and science-informed decision-making must be maintained. Accountability mechanisms and transparent dialogue are important in fostering trustworthiness. A fundamental challenge, as noted in the first thematic report, is that there are often multiple "partially incompatible" sources of scientific knowledge that must be integrated. To address complex societal problems it is not always possible to have a consensus and agree on what evidence is relevant. The public may consider scientific disagreements as evidence that scientists lack independence, and interest groups may use such discord to promote their own objectives.[9] Policymakers may strategically select scientific evidence to promote particular political interests. To maintain trust in S4P, the reasons for dissent must be understood. Also because of this, mechanisms that support co-creation and joint policy formulation have gained increasing visibility also in S4P.

[9] OECD. 2023. 'Responsible Communication of Science to the Public'. DSTI/STP/GSF(2023)12/FINAL. https://one.oecd.org/document/DSTI/STP/GSF(2023)12/FINAL/en/pdf

The titles of the four Thematic Reports and some topics discussed in them are shown in the table below. Key concepts are described in more detail in Chapter 3. The reports also discuss the country-specific initiatives and learnings that were presented during the visits. Some of the main observations from the country visits are summarised in Chapter 5.

Title	Main topics discussed in the report
Fostering knowledge-sharing within and among S4P actors	Knowledge creation, epistemic communities, knowledge-based view of S4P, foresight and future-oriented knowledge
Science advice to policymakers: Roles, enabling conditions and incentives	S4P ecosystem actors, functions, competences, and incentives
Assessing the effectiveness and successful implementation of science-for-policy ecosystems	Role of evaluation, actor performance and contribution indicators, ecosystem assessment, and delivery routes for advice
Trust as a governance challenge for science-for-policy ecosystems	Types of trust in S4P ecosystems, scientific dissent, uncertainty, misleading science communication, what and who to trust, interest-based strategic use of scientific knowledge

Table 2. Thematic Reports and key topics discussed

1.4. Existing and emerging challenges in S4P

There are many obstacles and challenges that must be addressed to develop effective S4P ecosystems. Although the general objectives of S4P have remained the same over the years, there have also been some changes in how the functioning and nature of S4P is perceived. This has implications on present views concerning key problems that S4P development should address.

Policymaking takes place in a dynamic and politically charged context influenced by competing interests, knowledge claims, and even intentional disinformation. Strengthening the role of science in policy requires acknowledging that science is only one source of policy-relevant knowledge. In recent years, S4P has therefore moved from a simple “linear” model, where scientific facts are submitted across the “science-policy boundary” for policy use, towards more realistic models that emphasise the need to integrate research-based knowledge deeply into the policy process. Whereas S4P was sometimes viewed predominantly as a science communication problem, S4P is now increasingly understood to be a **process of mutual learning, where multiple research communities and policymakers need to interact and come up with research-informed policies**.

Early thinking in what has come to be known as S4P 1.0 tended to start from the assumption that there is – and should be – a clear boundary between the autonomous systems of science and policymaking. In practice, however, the use of evidence-based knowledge in policy development often requires the dynamic framing and interpreting of science in a broader context of policy-relevant knowledge. Effective S4P systems have to address the need to integrate scientific

knowledge created by multiple research communities that often have different views on what counts as evidence, and knowledge from policy-relevant communities. Dialogue and mutual learning across communities of knowledge and practice are deemed necessary, making the traditional "science-policy" boundary increasingly porous, and requiring new governance, trust and evaluation mechanisms.

Although terms such as ecosystems, co-creation and capacity development suggest movement towards new models of S4P governance and development, the existing S4P landscape in each Member State usually reflects the country's history and is **often very fragmented**. This was highlighted as a major challenge in the MLE, as multiple and frequently overlapping advisory systems and S4P actors were reported. Coordination challenges are often addressed by centralised support and control, and in some Member States similar approaches were also proposed for S4P development. Meanwhile, ecosystem principles are based on a relational view where centrality – or, more generally, position in the network – is not clearly defined. Coordination and control in S4P ecosystems, therefore, may require new approaches that must be aligned with more traditional administrative systems that have a hierarchical division of labour, communication channels, and accountability structures. Ecosystem thinking, therefore, may also require change in the management culture.

Complexity and uncertainty were also highlighted as key challenges in S4P. Uncertainty means that decisions must be based on judgement, and complexity means that multiple knowledge sources must inform policy. More fundamentally, many socially important problems are deeply complex, in the sense that they cannot be modelled using deterministic models. Such deeply complex systems are essentially unpredictable. This is generally the case for social systems, where expectations, innovation and anticipation can change not only the system dynamics, but also the system itself. This complexity is increased by the fact that addressing socially important challenges requires multi-disciplinary approaches and the integration of often highly advanced and specialised knowledge. The inherent unpredictability that characterises social and political interventions requires constant learning and epistemic humility. Effective S4P in deeply complex contexts may require cultural change both in policy- and decision-making, as well as among scientists.

Useful scientific knowledge needs to reach policymakers in the **right form and at the right time** to make its use in the policy process possible. Beyond content knowledge and expertise, S4P actors also need to have process and policy knowledge, and the system must be responsive to situations or context. Due to the inherent complexity of problems for which scientific advice is requested, it can rarely be given in the form of a simple answer. Responsiveness thus requires anticipatory knowledge and capacity development.

A major challenge facing current S4P systems is the **lack or misalignment of incentives**. For researchers, the production of policy-relevant knowledge is rarely rewarded within the academic sector. Although in many Member States there are established forms of research funding to address policy-related research, science usually has its own incentive systems. Moreover, policy involvement may be viewed negatively and harmful for scientific autonomy. Mixing science and politics is typically perceived as undesirable by scientists, especially those working in Member States where political control of science has been (or continues to be) an issue. This has sometimes led to the idea that scientific research should keep its distance from policy and avoid being too "policy-relevant" and actionable. Existing incentive structures often mean that science advice is produced by science experts who provide a menu of evidence and options, with the expectation or hope that policymakers choose the most relevant items based on policy needs. The limited uptake of such advice was recognised as a problem in the MLE, reflecting the misalignment between research activity and policy needs.

Science, politics and policymaking are at present being transformed due to the rapid advance in communication and knowledge technologies. The changing "infrastructures of knowing", including AI, require **new deliberative mechanisms** to enhance trust. Researchers have strong incentives to publish, and the rapid expansion of scientific publishing has grown at speed, outpacing scientific quality control mechanisms. While this has been a problem for many years, it is exacerbated by

open access mega-journals that publish tens of thousands of academic articles annually, often without rigorous review. Large language models can now pick the abstracts of these articles and everything that is available on the internet, generating convincing summaries of current knowledge claims. Researchers themselves increasingly use in their own work input from such models trained on unvetted source material (bodies of knowledge), thus risking the propagation of low-quality research results.

All this can undermine the trustworthiness of science at a time when scientific advice is needed more than ever as new areas of research emerge. Although the MLE did not focus on the impact of AI, it was recognised that trustworthiness, reliability, truthfulness and integrity, and the quality of research publications will become a major challenge as AI systems are used to generate summaries of research, draft policy briefs, and analyse policy options.

2. Recommendations

Key outcomes of the MLE include a set of actionable recommendations, which address the challenges detected and discussed. These recommendations crystallise some of the participants' learnings, but they are also aimed at S4P ecosystem developers who did not have the opportunity to participate in the exercise.

Countries have different institutional and historical contexts. The implementation of the recommendations, therefore, depends on that context. This includes the allocation of responsibilities and resources, but also the specific ways in which the recommendations are realised in the existing institutional and organisational settings. The recommendations can also be implemented at different levels where policymaking and decision-making occurs (e.g. local or regional).

Underpinning the recommendations is the assumption that S4P ecosystems are not static, and progress involves transitioning towards new models of S4P. The directions where S4P itself is moving are discussed in the following sections of this report. The recommendations, therefore, should not be read as guidelines on how the existing S4P ecosystems should be governed and developed. Instead, they reflect forward-looking conclusions from the MLE concerning the directions followed and actions needed to shape S4P. They do not only aim to address current challenges in existing science advice systems but also shape these systems so they adequately address emerging and unrecognised challenges. Building on the concept of S4P 2.0, introduced by the EU's Joint Research Centre,[10] emerging topics and concepts that could be further explored in what is called S4P 2.0+ were also discussed in the MLE. Therefore, the learnings from the MLE not only cover the very latest knowledge, or what is already known, but also new and emerging topics and concepts.

Some key challenges for S4P were highlighted in Section 1.4 above, and they are elaborated below as they relate to the recommendations. During the MLE many more challenges were identified, and these are further discussed in the Thematic Reports. The following

Table *3*summarises key recommendations and linkages that address the identified S4P development challenges.

[10] Šucha, Vladimír, and Marta Sienkiewicz. 2020. Science for Policy Handbook. Elsevier. https://shop.elsevier.com/books/science-for-policy-handbook/sucha/978-0-12-822596-7

Key development challenges addressed	Recommendation
• Reducing fragmentation; enabling system-wide support and evaluation mechanisms • Defining clear routes for policy impact	*Govern S4P at the ecosystem level*
• Integration of different sources of scientific knowledge, including policy knowledge • Increasing the acceptability of evidence-informed policies; mobilising stakeholders, building trust and generating commitment	*Foster and institutionalise collaboration among S4P actors and facilitate public engagement*
• Improving future-oriented capacity development in societally important areas; improving efficiency by avoiding crises • Increasing time for deliberation; expanding policy options • Creating shared research-informed visions and goals for future-oriented policy	*Integrate foresight and anticipatory policymaking in S4P*
• Improving incentives for individual researchers to produce and communicate policy-relevant research; creating legitimacy for research-policy interactions • Facilitating knowledge and research-oriented career paths in administration; acknowledging and valorising high-quality researcher contributions in public and policy domains	*Recognise and reward policy engagement and redefine metrics for success*
• Defining S4P competencies and support their development through training • Establishing fora where policymakers can inform themselves about scientific developments and potential policy impact • Promoting exchanges, secondments, and networking that builds tacit knowledge • Supporting the development of intermediaries who can integrate multiple sources of research knowledge in local political contexts and provide spaces for science-policy interactions	*Develop S4P capacity for policymakers, researchers, and intermediaries*
• Improving stakeholders' possibilities to contribute meaningfully to policy development; fostering trust in S4P	*Increase transparency and accountability in S4P*

Key development challenges addressed	Recommendation
governance and trustworthiness of S4P actors • Facilitating knowledge-sharing across epistemic boundaries; enabling learning; facilitating coordination in rapidly changing contexts • Increasing motivation for the creation of policy-relevant research and communication; increasing public trust in policy decision-making; reducing the impact of disinformation	
• Addressing the issue of how to identify credible knowledge sources in the context of a misalignment of codes for scientific integrity with publication incentives; preparing for wider use of generative AI systems in scientific research to improve their reliability and to reduce the impact of mis- and disinformation	*Strengthen scientific integrity and quality-control systems*
• Creating and agreeing upon a shared view on expected system-level S4P impact • Enabling ecosystem-level support mechanisms; justifying investments beyond actor-level objectives; prioritising among ecosystem and actor-related development initiatives; distributing costs and benefits fairly among ecosystem participants	*Evaluate ecosystems, not only their components or inputs*

Table 3. Recommendations and key ecosystem development challenges addressed

The recommendations are briefly expanded below, with key challenges and development needs that each recommendation addresses. Initiatives that have been launched in the participating countries are included to illustrate possible ways to address the challenges. As the local contexts vary, the examples present a variety of **inspirational initiatives**, but should **not** be considered as **"best practices"** that could be copied without adaptation.

2.1. Govern S4P at the ecosystem level

Viewing S4P as a knowledge ecosystem, or as multiple overlapping ecosystems, highlights the relational and dynamic nature of S4P processes. A proper understanding of the system and its development needs requires a systemic view. Governing S4P at the ecosystem level would thus address the following challenges:

- Reducing fragmentation
- Developing system-wide support and evaluation mechanisms, and ecosystem transition paths
- Aligning ecosystem actors' incentives and objectives

- Integrating S4P in the existing institutional structure
- Defining clear routes for policy impact

Fragmentation has been recognised as a problem in all the participating countries. In Portugal, **Centro de Planeamento e Avaliação de Políticas Públicas** (**PLANAPP**) is directly connected with the Prime Minister's office and aims to consolidate advisory services into one body to avoid duplication and better respond to policymaker needs. In Belgium, the **Flemish CE-Centre** is the research hub for the Circular Flanders initiative, bringing together researchers from universities and the **Flemish Institute for Technological Research (VITO)** to work on circular economy issues. It develops indicators such as the Flanders Circular Economy Monitor and conducts analysis for policymakers. As discussed in the first Thematic Report, the governance structure of Circular Flanders includes the **social pentagon** of government, industry, civil society, knowledge institutions, and finance. Based on a review of Austria's innovation policy conducted by the OECD, in 2023 three advisory councils for science and research policy were merged into one single **Council for Science, Research and Innovation**, thereby reducing redundancies and gaining strength and effectiveness in advice-giving. This new council counsels the federal government on the policy areas of research, science, innovation and technology development, and it takes a holistic perspective on the Austrian R&I system. In 2024, Lithuania established **Science and Innovation Adviser** positions at the government level, forming a network of experts to promote a more horizontal approach to STI policy and better integrate science and innovation into policymaking. In Spain, **La Oficina Nacional de Asesoramiento Científico (ONAC)** – National Office for Science Advice – supports a network of science advisors across Spanish government departments and facilitates access to expert advice during emergencies. **Oficina C - Oficina de Ciencia y Tecnología del Congreso de los Diputados** – Science and Technology Office of the Congress of Deputies – provides Spain's Congress of Deputies with scientific evidence on relevant topics to support informed decision-making. It collaborates with the **Spanish Foundation for Science and Technology (FECYT)**, producing policy briefs (Informes C) and organising pairing scheme programmes. Flanders has also set up a Youth Policy ecosystem that incorporates diverse stakeholders operating in that sector. The activities of the different ecosystem participants are coordinated by a jointly-created **Youth Policy Plan**. This can be understood as a "boundary object", further discussed in Section 3.1.1.

2.2. Foster and institutionalise collaboration among S4P actors and facilitate public engagement

Collaboration is necessary for the integration and shared articulation of what is needed to produce better knowledge, and it is the foundation for interdisciplinary knowledge co-creation across epistemic domains. Collaboration also fosters trust and provides opportunities for social learning and the sharing of tacit knowledge.

Fostering and institutionalising collaboration and public engagement would thus address the following challenges:

- Integrating different sources of scientific knowledge
- Integrating policy-relevant and research-based knowledge
- Increasing the political "serviceability" of evidence and acceptability of evidence-informed policies
- Mobilising stakeholders, generating commitment
- Building trust through recurrent interaction and dialogue

Norway has successfully institutionalised collaboration through structured networks and frameworks for multi-stakeholder dialogues that bring together researchers, policymakers, public administration, business, and civil society. **Strategies for the 21st century** (21-strategiene) are actor-driven national initiatives mandated by the government to promote research-based value

creation and development in key areas. This is a multi-stakeholder mechanism for aligning research with national priorities. In the Netherlands, the **Dutch Research Council (NWO)** employs an inclusive, **co-creative approach**, where research questions are co-constructed with policymakers, based on a national science agenda (NWA). In Portugal, **Rede de Serviços de Planeamento e Prospetiva da Administração Pública (REPLAN**) is an **inter-ministerial network** coordinated by PLANAPP for cooperation and knowledge-sharing in strategic planning, public policies, and foresight. A key function of the network is to nurture connections between experts with academia. Portugal has also set up collaborative laboratories or **CoLABs** where research units, interface entities, and companies develop common R&I agendas, promoting new forms of interaction between research, innovation, and social and economic development. The CoLAB status is awarded by the **Foundation for Science and Technology (FCT)** for a period of five years following an evaluation process. In Ireland, the **Collaborative Alliances for Societal Challenges (COALSCE)** scheme brings together researchers, government and policymakers, enterprise, and civil society to work on cross-governmental challenges, defined in key national strategies and aligned with the UN Sustainable Development Goals. The aim is to integrate research-based knowledge and evidence into the sphere of public policy, creating tangible and **enduring links between the publicly-funded research system and policymakers**. COALESCE encourages interdisciplinary collaboration between researchers from the arts, humanities and social sciences working and STEM researchers. Ireland has also set up the **Civil Service Research Network (CSRN)** comprised of research leads across all government departments, revenue commissioners, the Central Statistics Office (CSO) and the Irish Economic and Evaluation Service (IGEES). The network's key objective is to share good practices in accessing and utilising research evidence in policy development, and to identify priority areas for research-policy engagement. In Austria, at the level of scientific institutions, the University of Vienna has developed a **S4P hackathon** in cooperation with the City of Vienna. The target group was Masters' students and early-career researchers. Over several months, with support from a policy expert the participants worked in cross-disciplinary teams to develop policy drafts for specific challenges defined by the City. The pilot was successful and will be continued.

2.3. Integrate foresight and anticipatory policymaking in S4P

Policy development is oriented towards imagined futures that reflect perceived challenges, opportunities, and objectives. Beyond increasing the robustness of policies in a changing world, foresight opens new views on what is possible and desirable. Improved capacity to understand and prepare for future scenarios is important when defining, articulating and communicating expectations, values, and commitments. Such foresight activities also enable greater engagement in democratic processes. Lack of anticipation leads to inefficient and reactive policymaking. Research-based knowledge supports future-oriented policymaking by providing methodologies, perspectives and evidence that help in creating envisaged "futures" that society can intrinsically value.

Effective anticipatory policymaking requires:

- Improving future-oriented capacity development in societally important areas of research
- Reducing the need for reactive crises management
- Increasing time and resources for deliberation and collaborative knowledge-creation
- Providing and institutionalising support for policy learning and experimentation
- Creating shared research-informed visions and goals for future-oriented policy
- Building "futures" literacy and foresight capacity among the ecosystem participants

Foresight is a key S4P area or activity in several MLE participant countries. Foresight in R&I was the focus of an earlier MLE,[11] which also discussed the need to embed it throughout the governance architecture. Portugal has integrated foresight into its strategic planning processes via **PLANAPP**, facilitating forward-looking policymaking and enhanced preparedness for future challenges. The Flemish **Strategic Insights and Analysis (SIA) unit** is focused on enhancing the government's foresight capacity, and it organises S4P dialogues among policy stakeholders and researchers. The **S4Policy Programme** of the Belgian science policy office **BELSPO** differentiates between "flash research" for urgent policy questions and "**policy-driven research**" to support policy implementation and management. The research topics for policy-driven research are identified at the beginning and in the mid-term of each legislature. Norway's **Strategies for the 21st Century** align research with national priorities. Norway also produces Norwegian Official Reports (NOU) that present and discuss the knowledge base and possible actions for public measures to solve societal problems. Spain's Oficina Nacional de Prospectiva Estrategica (National Office of Foresight and Strategy) analyses future challenges and opportunities promoting strategic and anticipatory governance. In Spain, ONAC also designs funding programmes for research grants and **policy intervention trials** based on the joint collaboration between research groups and public administration (research grant call I+P). In Lithuania, the **Government Strategic Analysis Centre (STRATA)** has been set up to act as a knowledge broker and evidence supplier to governmental **institutions.** Its functions include conducting research, assessments, and **foresight activities related to public policy issues.** Meanwhile, the **Institute of Technology Assessment (ITA)** of the Austrian Academy of Sciences prepares **monitoring reports** for the Austrian Parliament, to support its forward-looking research, innovation and technology policy. The aim is to create awareness of important scientific and technical drivers for change which open up new options for action in the Parliament.

Section 3.2 suggests that a special challenge in future-oriented S4P is that two different types of evidence – experimental and hypothetical – need to be integrated to support anticipatory policymaking. This is discussed in more detail in the first Thematic Report.

2.4. Recognise and reward policy engagement and redefine metrics for success

S4P needs engagement and input from scientific researchers and experts. In highly competitive research environments, research careers and reputation are based on criteria that do not always include S4P activities or align with them. By recognising the societal importance of S4P activities, providing organisational support for them, and aligning existing incentive systems, researchers are better able to contribute to S4P.

The challenges addressed include:

- Improving incentives for individual researchers to produce and communicate policy-relevant research
- Creating legitimacy for research-policy interactions
- Creating opportunities for policy-relevant research and providing funding for it
- Facilitating knowledge and research-oriented career paths in administration
- Acknowledging high-quality research contributions in public and policy domains

Initiatives such as the **Coalition for Advancing Research Assessment (COARA)** encourage funding agencies and institutions to consider the **value and impact** of all research outputs. The Netherlands' **Standard Evaluation Protocol (SEP) 2021-2027** introduced "societal relevance" as a criterion, including impact on public policy, and recognises a more diverse set of research

[11] Mutual Learning Exercise (MLE) on R&I Foresight. https://projects.research-and-innovation.ec.europa.eu/en/statistics/policy-support-facility/psf-challenge/mutual-learning-exercise-mle-ri-foresight

outputs. In Spain, **Sexenio de Transferencia**, the six-year cycle for assessing researchers, has been piloted and will now include criteria for knowledge transfer, science advice and policy engagement. Ireland acknowledges and rewards academic involvement in policy through schemes like the **COALESCE research fund**. COALESCE was conceived with the ambition to fund excellent research addressing national, European and global challenges by bringing together researchers and policymakers, enterprise, and civil society. In 2024, the Irish Government published the Research and Innovation Bill that formalises the merging of two key national research funders (STEM and humanities/social sciences) into a new agency, called Research Ireland. Legislative requirements underpinning the establishment of Research Ireland include a requirement to support the undertaking of R&I that informs the development of public policy and the sharing of research findings for that purpose.

Also in Ireland, **Impact Assessment Case Studies** serve as a basis for additional funding for higher education institutions that demonstrate contributions to national priorities. At the federal level, Belgium has several financing schemes that support S4P. As noted above, BELSPO's **S4Policy Programme** differentiates between "flash research" for urgent policy questions and "policy-driven research" to support policy implementation and management. Portugal also launches small-scale inter-institutional research projects that address specific public policy needs through calls for **Science Studies for Public Policy**.

2.5. Develop S4P capacity for policymakers, researchers, and intermediaries

Making sense of scientific advances and their potential policy impact requires basic scientific literacy from policymakers, but also a broader understanding of the role of science and research in social, economic and cultural development. To support S4P, researchers must in turn be aware of policy-related knowledge needs and understand how scientific knowledge can be used in policy. S4P-related capacity development, therefore, is an important enabler for effective S4P.

The challenges addressed include:

- Defining S4P competencies appropriate for the different stakeholders, and supporting their development through training
- Promoting dialogues and establishing fora where policymakers can inform themselves about scientific developments and their potential policy impact
- Promoting exchanges, secondments, and networking that builds tacit knowledge
- Supporting the development of intermediaries who can integrate multiple sources of research knowledge in local political contexts and provide spaces for science-policy interactions

Government-oriented **PhD schemes and fellowship programmes** are important tools for building S4P competences and developing tacit knowledge. In the Brussels-Capital region, the **Innoviris Applied PhD** programme embeds doctoral students within administrations to work on policy-relevant theses. A **Public Sector PhD Scheme** in Norway allows civil servants and public-sector employees to pursue a doctorate on relevant topics, funded by the Research Council. In Portugal, the "**Doutor AP" scheme** co-funds PhDs for civil servants in active service, requiring the employer to dedicate 25% of the employee's capacity to the PhD project.

The Netherlands has built a S4P team in the ministry that works with pilot projects to develop methods for articulating the needs, mapping experts, and promoting different interaction models between policy and knowledge. The Netherlands is also testing a fellowship model based on the American Association for the Advancement of Science (AAAS) involving researchers in policy work. Ireland has developed a **competency framework** for policy practitioners that includes skills related to analysis and decision-making. In Ireland, the Institute for Public Administration (IPA) provides short **training modules** for core skills and capabilities needed in public service, although these are not yet focused on S4P. Similarly, in Belgium, the Federal Public Service Policy and Support (BOSA) developed a competence framework for federal administrations that incorporates

some evidence-informed policymaking skills. The JRC has also developed a detailed S4P competence framework and assessment tools. These were discussed during the Madrid meeting.

2.6. Increase transparency and accountability in S4P

S4P ecosystems incorporate many organisations and actors who need to collaborate and coordinate their activities and knowledge processes. Transparency is an important enabler for non-hierarchical collaboration. Transparency is also important for accountability and democratic decision-making. The provision of scientific advice must be based on high-quality research, and it is important that advice and evidence is actually used in the policy process. Both the provision of quality advice and its effective use require accountability. Clear responsibilities and processes describing how and when evidence is used help ecosystem participants organise their activities and manage expectations. Accountability is organically linked with transparency in S4P ecosystems operating in complex and rapidly changing environments.

Transparency and accountability in S4P thus address the following challenges:

- Improving stakeholder' possibilities to contribute meaningfully to policy development
- Fostering trust in public S4P governance and the trustworthiness of S4P actors
- Facilitating knowledge-sharing across epistemic boundaries
- Enabling social and policy learning
- Facilitating coordination in rapidly changing contexts
- Increasing motivation for the creation of policy-relevant research and communication
- Increasing public trust in policy decision-making and reducing the impact of disinformation

Transparency at the level of knowledge access is promoted, for example, by open science and the establishment of policy-oriented data and information repositories. To assess the relevance and trustworthiness of data and knowledge, traceability and information about data provenance is needed. Transparency about policy objectives and challenges is also important.

Norway's Official Reports provide access to policy-relevant knowledge and discuss policy objectives, and Ireland's **10 National Strategic Outcomes**, as set out in the National Planning Framework, are used to inform policy-oriented research. Institutionalised networking and co-creation initiatives – such as Portugal's REPLAN, the Flemish Youth network, and the extensive use of co-creation in the Netherlands – all provide transparency at this more context-specific level. In Spain, particular attention has been paid to **transparency in selecting scientific experts** for advisory roles. This is important for building trust within the scientific community. The transparency of processes, roles and responsibilities is also important in complex and changing environments, where being adaptable and responsive is vital. The **explicit mapping of S4P national ecosystems and their performance indicators**, as discussed in the second and third Thematic Reports, supports transparency goals. The third Thematic Report also highlighted the UK Evidence Transparency Framework that can be used to rate government departments on how transparent they are in evidence use. In the Netherlands, the government is **obliged to report on its use of scientific advice** within a given time limit. This provides important feedback to advisors and builds trust in evidence-informed policymaking.

2.7. Strengthen scientific integrity and quality-control systems

The volume of scientific publications is rapidly growing. New commercial open access mega-journals are publishing tens of thousands of academic articles with varying quality every year. AI tools are now widely used to generate publications with notable quality problems. Increasing numbers of low-quality articles are now being used to train generative AI systems, leading to a

potential erosion of the scientific knowledge base. Evidence-informed policy rests on the integrity of research and the trustworthiness of scientific quality control mechanisms.

The challenges addressed include:

- Addressing the issue of how to identify credible knowledge sources in the context of a misalignment of codes for scientific integrity with publication incentives
- Preparing for wider use of generative AI systems in scientific research and reducing the impact of mis- and disinformation

The fourth Thematic Report discusses the European Code of Conduct for Research Integrity (**ALLEA Code**). This is recognised as a reference for research integrity in EU-funded projects. The recognition of broader impact indicators, such as those in the Netherlands Standard Evaluation Protocol, potentially allow researchers to focus on quality instead of quantity. Countries such as Norway and Finland have set up **journal classification systems** that help researchers find publication fora with established scientific quality. An example of an initiative fostering the integrity of scientific advice is offered by the "**Vienna theses**" of the Austrian Academy of Sciences and the German Academy of Sciences Leopoldina. It is also a good illustration of a cross-border collaboration among national science academies in a European S4P ecosystem. In Austria, a **Memorandum of Understanding signed by major non-university research institutions** outlines the shared understanding of the principles of scientific integrity for commissioned studies, providing guidance for staff and clients to conduct projects in accordance with the highest standards of integrity.

2.8. Evaluate ecosystems, not only their components or inputs

S4P ecosystem actors, such as universities, research centres and policymakers, often have important social and private objectives beyond S4P. They contribute to the overall ecosystem functionality, directly and indirectly, and the functioning of the S4P ecosystem depends on relations and collaboration between system components. Evaluation, should thus be based on a "relational view". Assessing S4P at the participant level can create unproductive tensions with existing evaluation criteria and focus on easily measurable indicators that are not informative or useful for ecosystem development.

Effective ecosystem evaluation would thus require:

- Creating and agreeing upon a shared view on expected system-level S4P impact
- Developing S4P performance and contribution indicators for ecosystem actors
- Justifying investments beyond actor-level objectives
- Prioritising among ecosystem and actor-related development initiatives and distributing costs and benefits fairly among ecosystem participants

As discussed in Section 4 and in the third Thematic Report, S4P ecosystems are interconnected entities. Their evaluation requires the ability to assess not only the functioning of independent actors, but also the integration of ecosystem components and effectiveness of their interactions. The MLE worked on the topic of evaluation during the third country visit, based on a multi-level approach focusing on assessing individual components, system support, and overall system functioning. Good practices in this area remain a work in progress. For example, while advisory councils are systematically evaluated in the Netherlands, ecosystem-level evaluation is still an area under development. At the ecosystem level, clear system-level goals and well-defined delivery paths for S4P are important.

The following chapter introduces and briefly discusses concepts that underpin these recommendations and challenges. The concepts are discussed in more detail in the Thematic Reports, where references to relevant literature are also included. The first Thematic Report focused on the knowledge-based view on S4P, the second on S4P ecosystem components and

their functions, and the fourth report focused on trust in S4P ecosystems. The following section draws on information from these reports and from the discussions during the MLE country visits. It also reflects on insights from the third Thematic Report evaluating S4P ecosystems, as well as indicators needed for S4P assessment, but evaluation is mainly covered in Chapter 4.

3. Key concepts

3.1. Beyond the linear model of knowledge transfer and scientific advice: S4P 2.0+

In recent decades, three important insights have shaped the science-for-policy debate. The traditional approach to S4P made a clear and strong separation between science and policy. This led to S4P models where research-based evidence was created by scientists and consumed by policymakers. The term “old-school S4P” introduced in the first Thematic Report is considered an appropriate model because it resonates with *instructivist* views where knowledge and facts are conveyed from a teacher or book to a student. It suggests that a major challenge in S4P is to move objective evidence across the “science-policy boundary”. This linear model of S4P 1.0 is now largely dismissed; bidirectional interactions across this boundary are understood as key mechanisms in **S4P 2.0**. This more dialogical and interactive view on S4P is often expressed in calls for co-creation and participation. It has also emphasised the need to institutionalise “boundary organisations” that engage scientists and policymakers in the joint formulation of policy challenges and the interpretation of relevant scientific knowledge.

The emergence of S4P 2.0 has also partly resulted from the observation that for many socially important problems multiple sources of scientific knowledge must be integrated or formulated into policy advice. In addition to the science-policy boundary, there are also boundaries between and within scientific disciplines. Studies have shown that science has internal epistemic, practical, and ethical structures. **The epistemic world of science is not flat**. Boundaries exist within quantitative exact sciences, but they become even more visible when social sciences and humanities enter the mix. The field of S4P, therefore, is now increasingly understood to be populated by interacting knowledge communities.

The concept of “community of practice” emerged in the context of social learning at the end of the 1980s, and it was quickly adopted by knowledge management scholars and practitioners. Today, it is natural to view ideal S4P systems as **knowledge ecosystems** where multiple communities create knowledge. Such a knowledge-based view on S4P goes beyond “evidence-informed policy”, and suggests that deeper integration is needed among research and policy communities. The ecosystem view also leads to questions about whether only science and policy communities are key elements in this system, or whether knowledge communities within the broader public are also vital components in this overall S4P concept. Indeed, one of the learnings in the MLE was that a broad range of knowledge communities play a role in defining what scientific evidence policymakers can use. A specific challenge is that social media splinters the public sphere that underpins democratic policymaking. Comprehensive S4P ecosystems, therefore, must have mechanisms that also integrate the public in evidence-informed policymaking.

S4P has increasingly emphasised the importance of **anticipation**. Whereas in S4P 1.0 anticipation was sometimes viewed simply as long-term planning forecasting, foresight and futures studies have since moved beyond . Quantitative forecasts are based on data, which is usually collected only on things considered to be important in the past. It is not possible to have empirical evidence about “futures” that do not yet exist. Forecasts are also methodologically challenging for socially important problems that are deeply complex, and which require multidisciplinary analysis. Although policymaking can be made more robust by testing policies against commonly accepted megatrends or using reference scenarios, anticipatory governance and policymaking require

"hypothetical knowledge". This, in turn, requires new organisational capabilities and individual competences that make anticipatory policy development and governance possible.[12]

There is, therefore, no single "best practice" to organise S4P ecosystems. Member States have very different historical and political contexts from where their S4P systems have evolved. The shifting views on S4P, itself, mean the development of S4P ecosystems is a process of transitioning and learning. The concepts introduced in the first Thematic Report do more than help S4P developers to understand their existing S4P mechanisms in the context of knowledge management. The relevance of the concepts is rooted in the assumption that the data- and information-centric views on S4P 1.0 are shifting towards a knowledge- and learning-based conceptualisation of S4P 2.0+. **S4P is thus moving from data to knowledge**, and this requires deeper integration of knowledge processes across communities of knowing and practice. Joint sensemaking and dialogue are becoming key characteristics of S4P, and the mechanisms for these are still very much in the making. To guide the transition, concepts need to be tools for new practice.

This is why the first Thematic Report established concepts that can be used to understand what such deeper integration could mean in practice. Some of these concepts are outlined in the following pages.

3.1.1. Boundary infrastructures and organisations

Research on innovation systems, sociology of science and organisational knowledge management has shown that knowledge is tightly linked to communities of practice. The world of knowledge is not featureless. It is structured by practice-oriented activity and supported by social learning, where novices gradually become experts. The first Thematic Report discussed the concepts of boundary objects, boundary infrastructures, and boundary organisations, as these are some of the mechanisms that can be used to cross epistemic limitations. On the science side, such crossing is an important challenge when multiple sources of knowledge need to be integrated in scientific advice. Research has shown that collaboration is possible without consensus. As different "communities of knowing" usually also have different value systems and incompatible criteria for evidence, consensus is not always possible at the epistemic level. It is therefore unrealistic to expect that different disciplines could produce consensus on certain evidence and/or the relevance of data. It is, however, possible to build consensus on concrete action.

Boundary objects are the focus of such joint action. They allow people to work and coordinate their efforts even when full consensus does not exist. Boundary infrastructures, similarly, consist of information structures and processes that link actors and their epistemic worlds. Boundary organisations, in turn, institutionalise some of these knowledge integration processes as service providers who fulfil this bridging function. Whereas boundary objects can include material or informational objects, such as roadmaps and joint plans – and boundary infrastructures couple multiple domains of knowing through classification, simplification, and information exchange – boundary organisations do all this and provide an intermediary organisational layer that partly isolates the system of science from policy and vice versa.

3.1.2. The tacit knowledge component

An important concept for S4P is tacit knowledge. In its original form, the concept emerged as a distinction between focal and peripheral knowledge and perception. For example, to be able to see a cell on a specimen slide under a microscope, the focal object (the cell) must be distinguished from its surrounding context. Similarly, explicit knowledge only exists in a tacit context. The tacit

[12] Tõnurist, P., and A. Hanson. 2020. 'Anticipatory Innovation Governance: Shaping the Future through Proactive Policy Making'. OECD Working Papers on Public Governance 44. https://oecd-opsi.org/publications/aig-shaping-the-future/

component of knowing is usually taken for granted and provides the background that makes explicit knowledge possible.

Tacit knowledge is often learned by observation and social interaction, and it is not explicitly transferred. Explicit knowledge that is written down in documents and stored in computer databases, represents only a minor fraction of organisational knowledge. Knowledge creation, according to Nonaka,[13] therefore, requires a dynamic process, where tacit knowledge is converted into explicit knowledge. In the process of organisational knowledge-creation, such explicitly articulated knowledge is then integrated with already existing explicit knowledge, and finally again internalised in organisational processes as implicit shared practices and routines. This ongoing process of knowledge conversion is depicted in the figure below.

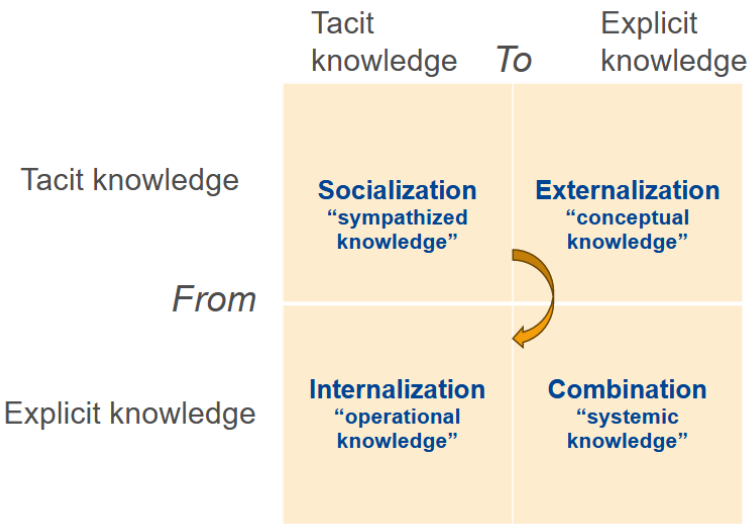

Figure 3: Nonaka's SECI knowledge conversion model (Source: Tuomi, 1999, p. 325.)

In S4P, the importance of tacit knowledge in knowledge creation has led to various mechanisms that support social learning and interaction. Sharing of "context" is then viewed as a key to sensemaking, knowledge-sharing, and the articulation of new knowledge. Locating scientists in administrations and vice versa, and setting up co-creation fora with researchers and policymakers, can be understood as ways to share context. Informal interactions that are not always immediately oriented to problems at hand may, therefore, be important for joint knowledge creation and shared understanding of evidence. More fundamentally, the interpretation of data always requires existing knowledge that makes data meaningful.

3.2. Anticipatory policymaking and knowledge about futures

All policymaking is oriented towards imagined futures. This makes foresight processes an integral part of S4P.

In S4P 1.0, forecasting models were often used to extrapolate trends and derive conclusions on possible outcomes of policy interventions. As it has been clear that such models may miss potentially important parameters, uncertainty has become a central concept for S4P. Modelling exercises often start with the assumption of *ceteris paribus* ("other things being equal"), acknowledging that the future is uncertain. Beyond uncertainty, possible surprises are introducing "wild cards" and "black swans".

[13] Nonaka, I. 1994. 'A Dynamic Theory of Organizational Knowledge Creation'. Organization Science 5 (1): 14-37.

In complex policy settings and changing worlds, *ceteris paribus* can rarely be justified. The future is not only uncertain but, in many ways, unpredictable. In contrast to uncertainty, unpredictability cannot be corrected by collecting more information or data. Because of the deep complexity of many social problems and the resulting unpredictability, foresight researchers have increasingly argued against efforts to eliminate uncertainty altogether but, instead, "embrace complexity". This implies "epistemic humility" and willingness to learn. It also highlights the point that S4P must explicitly manage complexity while addressing unpredictability. S4P ecosystems are not only knowledge ecosystems; they are also complex anticipatory systems. Effective mechanisms that support anticipatory processes in such complex systems, then, become important components of S4P 2.0+.

In practice, unpredictability means evidence must be combined with judgement, continuous learning, and fast experimentation. This need for judgement may be obvious to policymakers, but it is important to highlight as AI technologies are being used more and more in policymaking. Information systems, including AI, operate with known data and explicit knowledge, and tend to struggle with context. As knowledge communities make sense based on their shared and often tacit bodies of knowledge and shared value systems, the knowledge they produce is always associated with judgements. Replacing scientific expertise with state-of-the-art generative AI systems may look attractive because large language models incorporate huge amounts of textual information, and they can rapidly produce answers to complex questions. Nevertheless, at present, AI systems at best summarise historical averages of opinions found in their training data, with little capacity for policy-relevant judgement.

Policymaking has to be anticipatory also because policy processes take time. Without anticipation and in a rapidly changing world, decision-making becomes a state of constant crisis management, and policies risk becoming outdated before their expected impact can be realised. Anticipatory policymaking, therefore, requires capacity building that prepares the policy system for the emerging futures.

Scientific expertise plays an important role when possible and potential futures are articulated. This is not only by providing data and evidence, but also by helping to frame the issues at hand. In the reverse direction, policymakers can help researchers to understand where policy-relevant research is needed.

3.3. Trust in S4P ecosystems

Trust is a key concept in S4P for many reasons. Social scientists, organisational researchers, anthropologists, and economists have pointed out that trust is important for effective collaboration and the foundation of social life. More philosophically, it is always possible to ask what evidence supports given knowledge claims, and the infinite chain of reasons only stops when we trust that no more justification is needed. The concepts of trust and expertise are interlinked, and trust is contextual. We may trust a doctor to remove our appendix, but not to repair a car, give legal advice, or operate a nuclear reactor. Warranted trust and trustworthiness requires expected competence. Such expectations can be justified by historical track-record and information transparency, institutional trust mechanisms – including certifications, codes for conduct, deliberative mechanisms and accountability measures – and also propagation of trust across social networks.

Trust is the glue that makes or breaks ecosystems. Important forms of trust are developed through iterated and reciprocal interactions sustained across time. Some theories suggest that trust should be understood as "encapsulated interest" where the truster has reason to believe that the trusted party cares about the truster's interests. The reason can be based on incentives, for example, the social costs of breaking trust, institutional mechanisms, such as laws and norms that are known to be enforced, or thick social relationships and interdependencies that align participant interests.

Trust often requires time to develop, and it can erode quickly. In the age of social media, trust is increasingly based on reputation and visibility. Such trust can also be unwarranted. Mistrust on scientific and political institutions is now actively and intentionally created using social media platforms. Some nation states have recently been reported to publish propaganda online at large

scale with the intent to influence the training of generative AI systems and the outputs they produce. The European democratic model is rooted in the norms of rational argumentation, where evidence-informed judgements are central. Questioning scientific evidence is now often associated with attempts not only to discredit evidence and experts, but also to discredit the relevance of evidence and promote alternative authoritarian political systems. This has made trust an increasingly critical topic, and the management of trustworthiness is a central challenge in S4P.

In S4P ecosystems, trust can be understood as the reliance placed on various elements within this ecosystem to provide credible, reliable and relevant knowledge, and to inform the policymaking process in a legitimate and effective manner. The fourth Thematic Report identifies several objects of trust. These include trust in scientific information, trust in scientific expertise, trust in advisory bodies, as well as trust in science-informed decision-making.

Trust in scientific information requires policymakers to believe in the reliability of knowledge delivered through institutional frameworks. Credibility is established through internal scientific verification processes. Trust in scientific expertise extends beyond the information to include confidence in specific experts' ability to evaluate the quality and relevance of scientific knowledge within particular contexts. Trust in expertise includes having faith that the expert is also able to make high-quality judgements when evidence is lacking and uncertain. Trust in scientific advisory bodies involves confidence not only in the credibility of scientific sources but also in policy-embedded scientists to navigate the complexities of the policymaking process. This includes the capacity to integrate scientific knowledge with societal norms and practical constraints.

Trust in science-informed decision-making is particularly relevant in representative democracies where citizens entrust politicians to act on their behalf. Citizens may believe that their political representatives have objectives that are aligned with theirs, but trust requires that they believe policymakers work to achieve these (shared) objectives. This is a key characteristic of "encapsulated trust". Effective S4P also means managing the trustworthiness of political governance systems. Policymakers' ignorance, neglect of known facts and evidence, and corruption can rapidly erode trust in political decision-making, and render S4P ecosystem development difficult.

Trust can be fostered in S4P ecosystems by several key factors. These include managing the credibility of evidence and expertise. This resonates with the independence and scientific integrity of the experts and knowledge-production processes. The scientific community's self-regulation plays a role in guaranteeing the trustworthiness of scientific practice. Responsiveness, which resonates with transparency and accountability, indicates the extent to which scientific advice is based on socially accepted norms and the effectiveness of its implementation in policy. Governments should be able to explain how scientific evidence is considered in policymaking.

3.4. S4P ecosystems and their elements

Ecosystem has become a common term in innovation policy, organisation theory, and also in S4P. The use of the term is often metaphorical but also informative. In natural ecosystems, functional interdependencies support the maintenance and reproduction of ecosystem participants. Natural ecosystems are composed of living systems and are therefore inherently deeply complex. Ecosystem maintenance and reproduction depends on functional couplings between not only individual participants, but also the types of ecosystem participants. For example, in natural ecosystems predators depend on the existence and number of given types of prey, and these relationships cannot be described as recurrent between specific individual preys and predators. Complex causal relationships or interactions make ecosystems fundamentally different from linear and non-linear systems that are common in inanimate nature.[14] In ecosystem models, causal linkages connect system elements with functional wholes. Conceptually, therefore, ecosystems are not input-output machines, and it is not possible to "design" ecosystems for simple outputs,

[14] Functional linkages between system parts and wholes makes causal relations in logical terms "impredicative". All living systems share this characteristic. Cf. Rosen, R. (1991). Life Itself: A Comprehensible Inquiry into the Nature, Origin and Fabrication of Life. Columbia University Press.

such as science-informed policy. Ecosystem development is more about "gardening" and protecting processes that make vital ecosystems possible than about optimising for given outputs. This also means that traditional hierarchical models, such as "division of labour" and a "single line of authority/command" are not suitable for ecosystem governance.[15]

Although knowledge ecosystems in S4P, strictly speaking, are not natural ecosystems, the concept is useful as it highlights the importance of various types of actors and their interdependencies. Mapping S4P ecosystems improves understanding on how the different elements jointly produce inputs for policy development and decision-making. This makes it possible to see gaps and missing links and detect overlaps that suggest ways to improve the system's viability. Beyond actors and processes, ecosystem mapping can also make visible the roles of incentives and motives, as well as competences and expectations that underpin the ecosystem. As pointed out below, natural ecosystems are held together by functional interdependencies that are generated by recurrent interactions. S4P ecosystems, in contrast, are glued together by incentives.

No model or framework can provide a complete picture of a S4P ecosystem. There are many views, and the functions, roles and actors are in constant movement. In S4P, different actors often contribute to science advice, while having also many other roles and functions. For example, universities are key actors in producing research-based knowledge, but they are not fully embedded in S4P ecosystems. Policymakers may request advice for urgent policy issues from experts and stakeholders that are only temporarily involved in the policy process. S4P ecosystems are also often deeply rooted in the local environment, where informal connections between individuals and existing institutional and organisational arrangements may be important.

The second Thematic Report discussed several frameworks that have been used to depict S4P ecosystems. It highlighted the point that different types of scientific advice are often supported by different ecosystems. For example, regulatory advice used in assessing the potential impact of new regulations and laws is different from the use of evidence-based knowledge in anticipatory policy development or to address emergencies. Specific S4P policy actors, such as universities, scientists embedded in administration and think tanks, can play different roles in many such parallel S4P ecosystems. While the S4P actors often have official mandates, their effective roles and functions depend greatly on local conditions and circumstances. Despite this complexity, useful descriptions of S4P ecosystems can be developed by analysing their key actors, functions and roles, incentives and expectations.

The third Thematic Report highlighted the link between specific ways to map S4P ecosystems and indicators that can be used to monitor and develop their effectiveness, health, and maturity. Shared conceptual framing makes it possible for Member States to learn from each other. A challenge is that different Member States have organised their S4P systems differently, and some countries have more mature institutional structures for S4P than others. As a starting point, the third Thematic Report adopted the definition introduced in the Commission Staff Working Document on Supporting and connecting policymaking in the Member States with scientific research:[16]

> "A national ecosystem of S4P consists of an interlinked set of institutions, structures, mechanisms, and functions that interact at different levels to provide scientific evidence for policy."

This definition emphasises linkages and the richness of actors, and views S4P ecosystems from the point of view of their expected contribution to policy. It also suggests that the functioning of actors and their linkages are key to effective S4P, and should be used to develop indicators on the functioning and maturity of S4P ecosystems. The definition also leaves room for extensions that would include the private sector, industry, and third-sector participants, and ecosystem models

[15] This is important to note as public administrations are typically organised using the traditional hierarchical approach, as articulated by Fayol (1918) and others. Ecosystem "management", therefore, often requires linking two very different systems. Ecosystem models are inherently based on lateral networks and emerging engagement and commitments generated through dialogue and interaction.

[16] European Commission. (2022). Supporting and connecting policymaking in the Member States with scientific research (SWD(2022) 346 final). https://knowledge4policy.ec.europa.eu/sites/default/files/SWD_2022_346_final.PDF

where policymakers are actively participating in knowledge-creation and sensemaking processes. In the second Thematic Report, incentives and competences were also included to describe S4P ecosystems. The fourth Thematic Report, in turn, focused on trust, adding the mechanisms that maintain trustworthiness in the systems. In all mappings of S4P ecosystems, different types of actors with varying functions and roles can be usefully described. How effectively these actors perform or function depends on competence levels and incentives that glue the different parts of the ecosystem together.

Ecosystems are usually depicted as a set of boxes and arrows. It is important to note important limitations of such descriptions:

- First, they offer an over-simplified picture of the set of actors, processes, and interactions involved in the production, mobilisation, and use of evidence. S4P ecosystems operate at multiple overlapping levels, from local to supra-national, and no single visualisation can capture all relevant components and links.
- Second, any mapping exercise will be influenced by the purpose, perspective, and knowledge of those undertaking it.
- Third, the metaphor can imply that this complex set of actors share a common goal, for example that all are working together to deliver the best evidence for policy. Instead, actors in an ecosystem are motivated by a variety of reasons.
- Fourth, because of the potentially misleading sense of coherence, the metaphor can imply that actors with common goals share common functions. This can be interpreted to mean that interventions could be implemented in a relatively straightforward way. However, complex ecosystems often generate outcomes without central control, and interventions can sometimes lead to unpredictable outcomes.

It is not uncommon that system models represent beliefs about how the system should operate and what the relevant actors should do within it. It is often useful to take a closer look, and check whether such expectations are justified. In organisational contexts, it has been noted that formal structures and roles are complemented by informal organisational structures and functions that are often critically important for the functioning of the organisation. Such “invisible work” often becomes visible only when the reality is compared with its models.

Taking into account these potential limitations, ecosystem models, can nonetheless be both useful and necessary. Below, key components considered useful for mapping ecosystems are outlined. Further discussion can be found in the respective reports and, in particular, the second Thematic Report focused on roles, enabling conditions and incentives in science advice.

3.4.1. Actors

S4P knowledge ecosystems are comprised of three relatively independent arenas. The traditional focus in S4P has been on the academic arena, where research produces scientific knowledge and evidence. In the S4P 2.0, more emphasis has been placed on the government arena. Whereas policymakers were often understood as recipients and **users of scientific advice**, aligned with the discussion in the previous sections, policymakers are now increasingly viewed as active **constructors of knowledge**. There has also been more attention given to the societal arena, where citizens are not only consumers of science, but also potential participants in evidence-informed policymaking and contributors to “citizen science”. The media, including social platforms, play an important role in both informing the public and in enabling evidence-informed policy.

Concrete examples of S4P actors in Member States are described in Chapter 5. Some examples of common S4P actors are listed in the following table, which also highlights the point that the actors can have multiple and sometimes overlapping roles.

	Knowledge generators	Knowledge synthesizers	Knowledge brokers	Policy Evaluation
Individual academics	+++	++		+
Academic societies/professional bodies		+		
Government employed practicing scientists	+++	+		++
Scientists within policy agencies		++	++	++
Scientists within regulatory agency		++	++	
Independent think tanks		++		+
What works units etc		+++	+	++
National academies		+++	+	
Government advisory boards/science councils		++	+	
Science advisors to the executive of government		+	++++	
Science advice to legislators		+	++	

Figure 4: Different roles in the science advisory ecosystem (Gluckman, 2018)[17]

3.4.2. Processes, functions, and roles

The table above still reflects a relatively linear S4P 1.0 model of knowledge flows in S4P ecosystems. The second Thematic Report defines five types of functions for S4P actors and details their primary and sub-functions. The top-level functions are:

- Funding
- Knowledge production for policy advice
- Intermediation and brokerage
- Knowledge utilisation
- Science policy

Clearly, funding is a central enabler for S4P ecosystems. As the country-level examples discussed above show, funding can be used to direct knowledge-creation towards policy-relevant areas, to develop capacity and competences at individual and institutional levels, and to facilitate collaboration, coordination, and joint articulation of research objectives and policy options. Funding can be used to incentivise and direct research, but it is also an important enabler for the development and evaluation of S4P ecosystems and in understanding and improving their impact. As the country examples discussed above show, strategic and anticipatory funding, however, can also be used to direct academic research so that its results can be directly used in policy development. The time horizons in academic research, however, are most naturally aligned with policy impact evaluation, which usually requires longitudinal and long-term research. Private funding has a special role in S4P ecosystems as it can be rapidly deployed to channel internal and external expertise into policymaking. In many areas of the economy, commercial interests have had a substantial impact on the evidence base used in policymaking. Notorious examples, such as the tobacco and oil industry, are often highlighted but private money also plays a central role in

[17] Gluckman, P. (2018). The role of evidence and expertise in policy-making: The politics and practice of science advice. Journal and Proceedings of the Royal Society of New South Wales, 151(467/468), 91-101.

funding high-quality research and in attempts to address societal problems that are at the core of policymaking.

Researchers in academic and business contexts typically produce knowledge for reasons that are not directly related to S4P. Policy-related knowledge production, therefore, is often based on compiling and summarising results and "translating" them according to the present policy needs. Knowledge brokers, such as think tanks, consultants, and boundary organisations, often specialise in knowledge synthesis and production that fulfils this role. Knowledge brokers also tend to focus on specific policy domains, which allows them to develop networks and competences that can be rapidly mobilised when needed.

The second Thematic Report identifies many actors that act as intermediaries. These include university policy impact units, research units that specialise in policy-relevant research, advisory boards and councils, and individual "science advisors" tasked with coordinating and convening research advice within government units.

In the MLE, participants emphasised the importance of inter-organisational networks and boundary organisations as crucial for a functioning S4P ecosystem. Instead of simply "translating" research knowledge for policymakers, fora designed to stimulate dialogue and interaction play an increasingly important role. Facilitating and strengthening such fora is one important way to support S4P ecosystems at the system level.

3.4.3. Competences and capabilities

As was noted above, trustworthiness is often based on institutionally and reputationally guaranteed competence. Trust in expertise and related competence is critically important. However, there are also competences that are related to science communication, contextual understanding, and social interaction that are needed. Researchers often need understanding about the policymaking process, including policy cycles and the need to integrate and balance various interests and values. Policymakers, in turn, need to have basic scientific literacy, including how scientific methods are used in various disciplines and how their quality control systems work. As policy-relevant evidence is often based on statistical data that represent, for example, groups of people, policymakers should be able to interpret numbers and understand the models that generate these. Effective S4P, therefore, often requires capacity and competence development both for scientists and policymakers.

To help assess and develop competences for S4P, the Joint Research Centre has elaborated competency frameworks for researchers and for policymakers.[18] These highlight the many competences and abilities that are needed beyond scientific expertise. In practice, many competences required for effective S4P interactions can be developed by training and organising opportunities for learning. The latter include, for example, secondments, joint working groups, and networking opportunities. In general, although the Member States have developed competency frameworks for researchers and policymakers, they still only peripherally address S4P-specific competences. Although many S4P competences are generic transversal competences such as those needed for communication and collaboration, S4P competences specifically addressing the need to interact across the boundaries of science, policy, and the public could be strengthened. Scientists also need to understand the policy process, just as policymakers need to understand how sciences produce knowledge and control its quality.

[18] Schwendinger, F., Topp, L., & Kovacs, V. (2022). Competences for policymaking: Competence frameworks for policymakers and researchers working on public policy. Publications Office of the European Union. https://data.europa.eu/doi/10.2760/642121

3.4.4. Incentives and motives

In contrast to biological ecosystems, where interdependencies structurally connect the participants, and make them functionally dependent, in S4P ecosystems the participants need incentives for interaction. There is no natural need for a scientist to engage in policymaking. The S4P ecosystem is held together by incentives, norms, and trust. Policymakers may believe that policies should be informed by what is known and what can be anticipated based on available expertise. They also know that the world of science is complex, and that the extensive and rapidly growing bodies of knowledge are beyond comprehension even for professional scientists. It may not always be obvious for a policymaker that science-informed policy would be worth the time.

S4P ecosystems cannot, therefore, be taken for granted. Normative belief in rational decision-making and policy argumentation is the foundation for S4P. To protect the benefits of evidence-informed policymaking, the underpinning norms need to be enforced. In addition, the actors need incentives and enablers that make joint effort and cooperation possible and keep the ecosystem viable.

The second Thematic Report notes that contemporary research cultures focus on funding fundamental research and teaching, with less emphasis on incentivising “third-mission” activities, such as knowledge brokering and policy support. Performance measures in universities and research institutes often prioritise peer-reviewed publications over social impact.

To address this, several initiatives are contributing to a global trend of assessing institutions and individual scientists based on a wider set of factors beyond research volume and quality, including knowledge exchange. Examples include:

- San Francisco Declaration on Research Assessment (DORA), which encourages funding agencies and institutions to consider the value and impact of all research outputs (including datasets and software) and a broad range of impact measures, including influence on policy and practice.
- Coalition for Advancing Research Assessment (COARA), which aims for a research assessment that is more qualitative in nature, and which recognises diverse outputs such as data, software, and policy-relevant inputs, and rewards open science practices and tasks, such as peer review, training, mentoring, leadership, science communication, knowledge valorisation, and collaboration with societal actors.
- UK’s Research Excellence Framework (REF), which includes “impact” (effect on economy, society, culture, public policy, etc. beyond academia) as 25% of the overall result.
- The Netherlands’ Standard Evaluation Protocol (SEP), which has abolished quantitative bibliometric evaluations, such as citation and publication counts, and now includes “societal relevance” as a criterion, recognising a more diverse set of research outputs and activities, including impact on public policy.

There are also negative incentives for scientists to become involved in policy development. Scientific integrity has traditionally been largely based on the independence and objectivity of researchers. Politicising science is often viewed as a risk to scientific integrity, reputation, and credibility. Transparency in the use of science is necessary to allow the research community to control the integrity of science and to support democratic deliberation.

There is also a need to incentivise policymakers to utilise scientific research. This could involve outlining policies that formalise the use of research-based knowledge in policymaking, such as Better Regulation agendas and Research Impact Assessment requirements. In the Netherlands, for example, the government is obliged to report on its use of requested scientific advice within a given time limit. Many participants in the MLE noted that it is sometimes difficult to know whether scientific advice was used in policy and decision-making, or whether the advice had any impact. Transparency and formal requirements for policymakers to recognise when advice is acted upon could incentivise both evidence use and its production.

4. Evaluating and assessing S4P ecosystems

A shared understanding of how the S4P ecosystem is evaluated and assessed largely determines how it operates and develops. Evaluation is not only about external observation of the system. It also operationalises expectations and commitments among ecosystem actors. Indicators that are used to assess ecosystem functioning are therefore crucially important. They also reflect the different and sometimes conflicting interests and priorities of ecosystem participants, and therefore must be negotiated and articulated jointly, instead of fiat decisions coming from outside actors. Indicator development, therefore, is a key activity in developing the S4P ecosystem. It is important to recognise, however, that especially in the early stages of ecosystem development, rigid evaluation frameworks may hinder the transition towards new S4P practices. Evaluation, therefore, should be formative and designed to support learning, experimentation, and ecosystem change.

To evaluate S4P ecosystems and how well they achieve their objectives, it is useful to know the country-specific objectives of S4P. The third Thematic Report focuses on evaluation and discusses four common and generic objectives:

- Improving policy, services and population-level outcomes
- Improving the delivery of knowledge to policymakers
- Improving the capacity of decision-makers to use relevant knowledge
- Improving the decision-making process

Investing in S4P developments is often justified on the basis of its impact on policy targets or society. However, such impact depends on many factors other than scientific knowledge alone, and it is usually impossible to isolate and assess the specific contribution of S4P. Because of this, most evaluation frameworks focus on procedural goals and measure related capacities. The importance of decision-makers' ability to make sense of scientific knowledge in the context of policymaking was emphasised earlier in this Final Report. The third Thematic Report notes that evaluation frameworks have dominantly focused on scientific knowledge production and less on how it is used.

A number of characteristics and capabilities are often associated with effective science advice systems. These include ensuring that decision-makers have access to expertise drawn from a range of perspectives and disciplines, responsive networks that connect policymakers to trusted sources of advice and expertise, effective data and knowledge management, and quality assurance mechanisms that guarantee integrity, transparency, and openness.

In the third Thematic Report, the importance of clearly-defined impact routes was also highlighted. This does not mean that the actors and developers of S4P ecosystems should be able to measure the actual societal or policy impact of their activities; instead, it means that they must be able to clearly describe how S4P could produce measurable impact. This, in effect, describes the routes and channels through which S4P can make a difference. Defining such routes allows the stakeholders to assess the functioning of the ecosystem from the perspective of the policy process. Although ecosystems are not goal-oriented by their nature, S4P ecosystems do have objectives and goals. Clearly defining how these goals could be achieved is therefore important both for evaluating the ecosystem and for detecting opportunities to improve it. The overall goal of S4P ecosystems can, then, be defined as:

> *"*The delivery of relevant, robust evidence to people with the capacity to absorb and fully understand it, in order that it might inform their decision-making*."*[19]

[19] Oliver, K. (2022). Assessing national institutional capacity for evidence-informed policymaking: The role of a science-for-policy system. Publications Office of the European Union, p.3. https://doi.org/10.2760/951556

Although this definition emphasises the delivery of evidence, implicitly it also points to the need for ecosystem mechanisms that build capacity to absorb and understand knowledge produced in research.

In evaluating S4P ecosystems, it is important to distinguish between the performance of individual actors and system-level performance that is generated by the joint actions of ecosystem participants. It is also important to recognise that such summative evaluation is not necessarily useful for formative evaluation that facilitates ecosystem development. Formative evaluation does not measure outcomes; instead, it measures on a more detailed level the reasons that generated the outcomes.

In complex S4P ecosystems, impact channels are not linear. Ecosystems are not input-output dominated, although we may be able to define external objectives that characterise well-functioning ecosystems. In practice, this means that, rather than looking for direct impact and effects, it is often more useful to evaluate the contributions of ecosystem components to the overall system. This can be done at different levels of analysis, for example, looking at the contributions of actors, functions and incentives, but also considering the contribution of culture, governance, rules and norms, to name several examples. At this level of analysis, it becomes possible, for instance, to detect development needs in norms that unintentionally restrict data access and the use of expertise across government units.

Performance indicators both reflect expected outcomes and tend to become definitions and measures of outcomes. It is, therefore, important to carefully consider what should be measured. Often inputs are unintentionally used as measures of outputs. In S4P, it is easy to measure, for example, the number of policy briefs produced, total researchers trained on basic principles of science communication, or the amount of funding allocated for policy-relevant research. Such indicators can be useful, but the functioning of the system should be measured by expected outputs. The limitations of output measures, however, should also be acknowledged, simply because the ecosystem itself is not an input-output function; instead it depends on complex interactions that do not form linear chains of causality. It would, therefore, be an error to try to optimise the performance of S4P ecosystems based on some given criteria. In practice, many complementary indicators are needed, and judgement is necessary.

The development of S4P ecosystems occurs through initiatives that aim to improve the functioning of the system(s) underpinning them. Such initiatives should have clearly articulated objectives. These can be associated with defined evaluation criteria.

4.1. Evaluating components of S4P ecosystems

The third Thematic Report builds on the actor typology introduced in the second Thematic Report and proposes performance and contribution indicators for the different ecosystem actors. The report also outlines the types of information and data that should be collected to evaluate the key functions of each component. Performance indicators provide a view on how well the specific actor is aligned with good practice or performance criteria. Contribution indicators, in turn, aim to provide information on the kinds of contributions the actor makes to the wider S4P ecosystem. The types of actor groups covered in the Thematic Report include:

- Funders
- Knowledge producing organisations
- Individual researchers
- Intermediaries and brokers
- Scrutiny

For example, performance indicators for funders could include the availability of strategic plans that set out funding priorities, transparent processes for priority setting, regularly evaluated funding instruments for different research activities and knowledge communities, and policy-oriented funding schemes, including challenge-driven and curiosity-driven funding.

Contribution indicators for funders, in turn, could include: indications that government priorities are part of the funding prioritisation process, with clear mechanisms to engage transparently and effectively with policy teams; regular engagement with policy teams; capacity-building for S4P competences; and indications that activities around the science-policy interface are addressing policy needs and are based on evidence on the cost-effectiveness of different engagement mechanisms.

The indicators proposed in the third Thematic Report are intended to help S4P developers to interpret in concrete terms the more abstract maps of S4P ecosystems. For example, knowledge brokers do many things, but the proposed indicators show what they do for S4P and the ecosystem they participant in. Indicators help the participants communicate across the S4P ecosystem and to understand whether they are achieving their goals. The proposed indicators, therefore, can be viewed primarily as tools for the developers.

The indicator structure for ecosystem components is depicted in Figure 5 below.

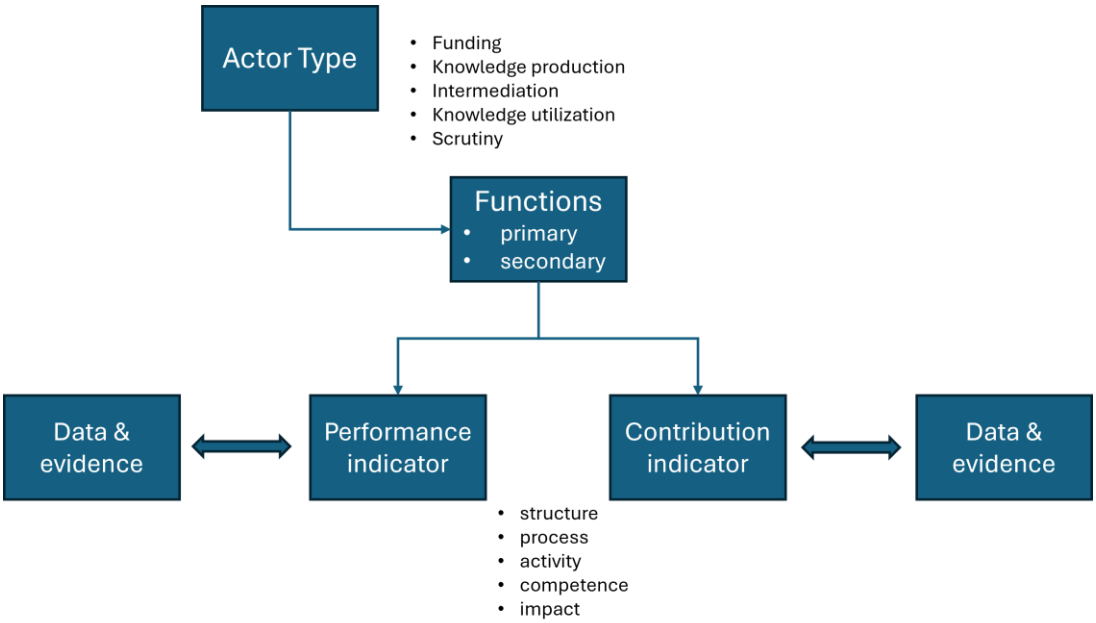

Figure 5. Ecosystem component indicator structure

4.2. Evaluating S4P at the system level

The actor indicators discussed in the previous section provide important information about the functioning of ecosystem components. The ecosystem, however, consists of many actors. Evaluating the ecosystem as a whole means assessing the relationship between ecosystem actors, and their impact on the objectives of S4P. Conceptually, it makes sense to talk about an ecosystem only if it has properties that are more than just a sum of the properties of its components. It is these “emergent” system-level features that are specific to a S4P ecosystem. These should be considered in a full assessment of the S4P ecosystem.

The overall objectives of S4P define or guide the expected benefits and outcomes. The main objectives, as listed above, are improved policymaking, enabled by better knowledge delivery and use, increased policymaker capacity to use research-based knowledge and information, and improved decision-making in the policy arena. It was also pointed out above that better evidence-informed policymaking requires the integration of multiple sources of knowledge, anticipatory capacity, and research-informed formulation of policy objectives. Knowledge integration, co-creation, stakeholder involvement, and system coordination and governance are, by definition, system-level processes.

According to the third Thematic Report, it is likely that at present no country has an "optimally operating" S4P ecosystem with well-coordinated actors and relationships. Generally valid indicators, therefore, cannot be suggested. In the MLE, some participants highlighted the lack of clarity in the overall objectives of S4P initiatives as an important challenge. In some cases, there seemed to be general policy-level consensus that S4P is important, but less clarity about what S4P should deliver.

It is, however, possible to identify likely properties of S4P ecosystems which support excellence in decision-making processes. Pedersen,[20] for example, suggests features that enable learning across the ecosystem. These include:

- A suitable mandate and joint vision, including a mandate to explore several alternative policy options in light of value diversity and uncertainty. For learning to take place, there needs to be flexibility for advisory institutions to formulate and communicate various possible outcomes and not only one majority recommendation.
- Transparency and integration of diverse normative viewpoints and uncertainties in the assessment of policy issues and communication of policy options (manifesting the generic principle of diversity).
- Open, professionally moderated deliberation with sufficient time and intensity (recurrent interactions) to facilitate peer learning among the actors involved. Open and exploratory conversations are more likely to build trust among the key actors at the science-policy interface than closed and "confidential" advice.

The third Thematic Report also highlights the importance of considering the balance between effort, expected benefits, and costs. If S4P is viewed as an objective in itself, there is a risk that S4P initiatives remain isolated and short-lived. S4P ecosystem-level indicators that can be used to evaluate and assess S4P are, therefore, an area where future work is needed.

5. Conclusion

Policymakers operate in a world marked by complexity, uncertainty, and fast-paced change. In this context, traditional models of S4P – where scientific advice is produced by experts and then delivered to decision-makers – are no longer adequate. The findings of this MLE point to a more dynamic and relational model of S4P: one that recognises science and policy as interdependent and co-evolving.

Policymakers in this ecosystem are not passive recipients of scientific advice; rather, they are active contributors to knowledge production and participants in a collaborative sensemaking process. Scientific evidence is only one component of effective policymaking – albeit a critical one. It must be integrated alongside political judgement, public values, administrative experience, and stakeholder expertise and insight. Scientific knowing and political action both need compromise.

[20] Pedersen, D. B. (2023). An evaluation framework for institutional capacity of science-for-policy ecosystems in EU Member States. Publications Office of the European Union. https://doi.org/10.2760/609597

This calls for the creation of boundary infrastructures and institutionalised mechanisms that support ongoing collaboration, foresight, and learning.

A key insight from the MLE on *Bridging the Gap Between Science and Policy* is the need to govern and organise S4P at this ecosystem level. This approach acknowledges that knowledge for policy is produced, interpreted, and applied across a distributed network of actors – research institutions, government bodies, intermediaries, and civic stakeholders. Ecosystem governance does not mean top-down rule-setting, as ecosystems are not hierarchical, and a more organic and co-creative approach is needed to support their development. Effective governance must, therefore, support coordination without excessive centralisation, incentivise collaboration across silos, and provide system-level evaluation tools that go beyond traditional performance metrics. Such systemic thinking is essential to reduce fragmentation, identify synergies, and ensure that science-based advice is relevant, legitimate, and timely.

Equally important is the integration of anticipatory policymaking and foresight into S4P systems. As governments are increasingly tasked with addressing grand challenges – from climate change to global security and conflicts, political change, and the economic and labour impacts of AI – they must be equipped to act not only reactively, but proactively. The ability to imagine, assess, and shape different futures must be institutionalised within the S4P ecosystem. This requires long-term capacity-building, access to interdisciplinary knowledge, and mechanisms for shared vision-setting with society at large. Evidence-based knowledge plays an important role in preparing for diverse futures, but as they cannot be empirically known, S4P also needs a broad concept of knowledge that extends beyond data and unambiguous facts. **Science in S4P is both qualitative and quantitative,** and it includes social and human sciences and their rich methodological and epistemological resources.

Policymakers play a crucial role in building and sustaining trust – both within the S4P ecosystem and with the public. Trust in evidence, experts, and institutions cannot be taken for granted. It must be earned and maintained through transparency, accountability, and responsiveness. Public engagement, inclusive dialogue, and clear communication of uncertainty are essential components. The MLE recognised trust as a form of social capital that enables collaboration, facilitates policy uptake, and increases the legitimacy of policy decisions.

This report and the Thematic Reports that underpin it also highlight the impact of ongoing digital transformation on S4P. The rapid growth of open-access publishing and the increasing use of generative AI tools in both research and policymaking introduce new risks to the reliability and interpretability of scientific evidence. This evolution demands urgent attention in order to maintain scientific integrity and quality control mechanisms. Policymakers must support reforms that strengthen peer review, foster responsible AI use, and increase the visibility of credible and robust policy-relevant research.

The MLE emphasised the need to recognise and reward policy engagement across sectors. The current incentive structures in both science and administration often discourage the kinds of long-term collaboration, interdisciplinary dialogue, and co-creation that effective S4P requires. Aligning evaluation criteria, funding, and career development pathways to value policy impact will be important for all Member States and Associated Countries when they develop their S4P ecosystems.

Recognising these challenges, and acting on the mandate received by the Council of the EU,[21] the European Commission has been taking active steps in supporting and working with Members States to strengthen S4P ecosystems across Europe. The proposal to embed S4P as a key action of the next European Research Area (ERA) Policy Agenda 2025-2027[22] emphasises the need to work with and mobilise the research sector to foster policy engagement and build synergies with

[21] Council of the European Union. (2023, December 8). Strengthening the role and impact of research and innovation in the policymaking process in the Union. https://data.consilium.europa.eu/doc/document/ST-16450-2023-INIT/en/pdf

[22] European Commission. (2025). Proposal for the next European Research Area Policy Agenda 2025-2027, ERA Action 13: https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/commission-adopts-proposal-next-european-research-area-policy-agenda-2025-2027-2025-02-28_en

other key R&I policy priorities, such as open science, research assessment, and science diplomacy that supports the development of robust S4P ecosystems.

This is further supported by a call in the 2025 Horizon Europe Work Programme[23] to further develop the concept of "Science for Policy" and improve the cross-cutting integration of scientific evidence and knowledge in public policies; advance and strengthen the European S4P ecosystem across sectors and governance levels; promote collaboration among networks of relevant actors; and foster the identification and exchange of best practices and mutual learning by nurturing and animating a Science for Policy Community of Practice, and creating an observatory of the European S4P landscape and its practices. In parallel, through its Technical Support Instrument (TSI) the Commission continues working with Member States and the OECD to map national S4P ecosystems and support mutual learning between national public administrations in order to produce tailored recommendations for institutional reforms as well as capacity-building activities.[24] Together, these efforts bring together EU institutions, national and local administrations, and the broader community of S4P practitioners, researchers and policymakers from across Europe and beyond, to make S4P 2.0+ a reality, strengthen S4P ecosystems, and bridge the gap between science and policy.

[23] Horizon Europe Work Programme 2025, 11. Widening participation and strengthening the European Research Area (European Commission Decision C(2025) 2779 of 14 May 2025). https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2025/wp-11-widening-participation-and-strengthening-the-european-research-area_horizon-2025_en.pdf

[24] European Commission. (2025). 'Building Capacity for Evidence-Informed Policymaking in Governance and Public Administration in a Post-Pandemic Europe' project has looked at evidence-informed policymaking ecosystems in seven EU Member States and created roadmaps towards greater uptake of EIPM practices in each country. The country reports are available at: https://data.europa.eu/doi/10.2760/5012478

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This Final Report summarises the key findings of the Horizon Europe - Policy Support Facility's Mutual Learning Exercise (MLE) on *Bridging the Gap between Science and Policy.* Fifteen countries participated in the MLE, exchanging information about national initiatives and approaches used to support and develop evidence-informed policymaking, and to discuss ways to improve national S4P ecosystems. Four key themes – knowledge-sharing, enabling conditions, evaluation and assessment of S4P ecosystems, and trust in S4P – structured the MLE work. This report highlights the key insights generated and recommends areas where action is needed to improve S4P ecosystems and related policies.

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