EOSC Future

D2.3

Mapping of observatories and classification analysis

The EOSC Future project is co-funded by the European Union Horizon Programme call INFRAEOSC-03-2020, Grant Agreement number 101017536

Version 1.0
September 2021

D2.3 / Mapping of observatories and classification analysis

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Dissemination Level of the Document

Public

Abstract

Selected Science, Technology, and Innovation (STI) observatories were analysed to understand their governance, collection and quality assurance means, and website functionalities. This serves as inspiration for the EOSC Observatory development. Then, a preliminary analysis of the SRIA indicators -as potential KPIs for the dashboard section of the observatory- were analysed in view of a conceptual framework, that would set monitoring indicators for EOSC into a wider evaluation framework. Following, different aspects for the technical development of the observatory were brainstormed and put together. Finally, ideas on a classification were collected and a preliminary assessment started.

Version History

Version	Date	Authors/Contributors	Description
V0.1	22/09/2021	Viola Peter (TGB)	First draft
V0.2	25/09/2021	Natalia Manola (OpenAIRE)	Second draft
V0.3	27/09/2021	Ron Dekker (TGB)	Review
V0.4	27/09/2021	Viola Peter (TGB)	Amended addressing reviewers comments
V0.5	28/09/2021	Viola Peter (TGB), Robert van der Vooren (TGB)	Document Finalisation for circulation
V1.0	30/09/2021	Viola Peter (Technopolis Group), Natalia Manola (OpenAire), Ron Dekker (TGB), Mike Chatzopoulos (ATHENA)	Final Version submitted to EC

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Table of Contents

Table of Tables

Table of Figures

List of Abbreviations

Acronym	Definition
AC	Associated country
DG	Directorate General
EC	European Commission
EIS	European Innovation Scoreboard
EOSC	European Open Science Cloud
ERA	European Research Area
KPI	Key Performance Indicator
MS	Member State
OECD	Organisation for Economic Co-operation and Development
QR	Quality review
PATHS	Proximity, Attribution, Traceability, Holism, and Stability
SDG	Sustainable Development Goals
SRIA	Strategic Research and Innovation Agenda
STI	Science, Technology, and Innovation
WEF	World Economic Forum

1 Introduction

This document, prepared in the context of WP2, Task 2.1.1 of EOSC FUTURE has several aims:

- Provide a systematic comparison and analysis of existing observatories, which can serve as information basis for decision-making of the planned EOSC Observatory.
- Provide a critical analysis of the development of an indicator system which will help an effective monitoring of EOSC across its many facets of policies, data, infrastructures, skills/people.

EOSC Future is compiling work currently being discussed and experimented with several projects and by various stakeholders (EOSC MS/AC Steering Group, EOSC Landscape, EOSC Association, INFRAEOSC-5b projects, EOSC Secretariat). The EOSC Observatory will include indicators as on overarching synthesis for the ongoing discussions and the decision-making process.

2 Analysis of monitoring/observatory tools

The need to develop an observatory on EOSC has been described in the EOSC Future proposal. Over the years, and with the evolving concept of open science, several monitoring tools were piloted or developed. The observatory aims to expand on existing models without replicating them.

The observatory aims to fulfil the needs of several users such as the EOSC Association and the EOSC partnership, but also to provide an entry point for policymakers and interested researchers and research and innovation actors.

The needs of these groups of people may vary. Therefore, it is necessary to understand the needs, attempt to align the needs and design a portal that remains flexible in including new developments.

There are many policy observatories that can be analysed to understand existing models. Such as analysis can also inspire and guide the discussions on its implementation and sustainability. The following section draws from selected policy observatories and provides a systematic analysis.

2.1 Introduction

A Google search for the term 'policy observatory' produces about 104K hits, if limited to 'Europe', there are still 65K hits. Thus, where to begin? To obtain a useful basis for analysis, Technopolis screened the web for policy observatories and drew from own experiences as managers of several monitoring exercises for various Directorate Generals (DGs).

Many individual institutions or projects have created an 'observatory'. There are numerous websites on specific policy topics ranging from very recent technological inspired observatories such as the Artificial Intelligence Policy Observatory[1] from the OECD, international science, technology, and innovation (STI) ones such as the Global Observatory of STI Policy Instruments[2] by UNESCO or the STIP Compass[3] of the OECD. Numerous observatories of employment, trade, regional, fiscal, public, or environmental policies (to name only some prominent policy fields) can be found on the web. Many observatories are however not maintained or up to date but tend to remain available on the web or they have a time-bound lifespan from the beginning.

The aim of observatories and their content suggests a wide range: they range from presenting findings such as reports, data (in form of reports or downloadable data), and as such function as a source of *documentation and information*.

Several observatories are equally used as means of *communication*. This can be addressed through fora, blogs, or other ways to interact with the user, but in several cases, the communication is also at an ultimately prior level, namely at the collection level: in particular, the international observatories apply several collection avenues and communicate with relevant stakeholders to feed the observatory with relevant information and news regularly.

Since there are many European, international, or global organisations such as the EC, the OECD, or the UN, we selected a few interesting and creative examples, which will be analysed in terms of structure and functionalities to ultimately serve as good examples and inspiration for the planned EOSC Observatory.

In the following, we analyse in greater detail:

- OECD: STIP Compass;
- World Economic Forum: intelligence forum[4];
- ESPON: SDG Tool[5];
- ERAWATCH (discontinued).

[1] https://www.oecd.ai/.
[2] https://en.unesco.org/go-spin.
[3] https://stip.oecd.org/stip.html.
[4] https://intelligence.weforum.org/.
[5] https://sdg.espon.eu/benchmark.

2.2 OECD STIP Compass

2.2.1 Introduction

The STIP Compass is a 'policy analysis and discovery tool for better decision-making'[6]. It is a joint initiative by the OECD and the EC. From the descriptions provided, 'The portal supports the continuous monitoring and analysis of countries STI policies and seeks to become a central platform for policy research and advice supporting government officials, analysts and scholars. Through its various interfaces, you may seamlessly explore and download data to analyse country policies on a wide range of STI policy issues. Data is freely accessible following the FAIR principles'.

The STIP compass has two main areas with an *interactive dashboard* and a *policy explorer* area. Furthermore, there is a possibility to *download data*. Due to the Covid19 pandemic, a new focus was introduced with the Covid-19 Watch. Finally, the about section provides information *About* the service.

2.2.2 Content basis/data collection

There are STI policies descriptions of about 50 countries incl. OECD member states and observer countries. The content is mainly drawn from the bi-annual EC-OECD STI policy survey[7]. The latter is 'addressed to national government officials working on STI policies in a range of public administrations, including ministries and agencies'.

The OECD has developed templates which are the basis for the descriptions and characterisation of policy initiatives. The template uses taxonomies of *policy instruments* (e.g., 'Networking and collaborative platforms', or 'Procurement programmes for R&D and innovation') as well as *target groups*. The latter are for example the 'research and education organisations', 'researchers, teachers, and students', 'firms by size', or 'social groups'. *Themes* provide a further way to search for specific aspects such as 'STEM skills' or 'Public research strategies'.

Further content is provided through linking open data sources, to data and to publications from Science Direct and RePEc Econ Papers[8]). The linking is done semantically. Currently, there are only links to few sources, but the aim is to enable a linking to hundreds of indicators.

2.2.3 Functionalities

Interactive dashboard

'Interactive dashboards allow you to discover and explore the database through visualisations that aggregate STIP Compass's policy data across its several dimensions'. On the landing page, there are four interactive widgets, each allowing to either change the layout and/or to drill down further. The widgets are on:

- Territories;
- Themes;
- Policy instruments, and
- Target groups.

By selecting under 'Themes' for example the field 'AI', a new page opens, and the user obtains information on AI initiatives by country or related themes. The latter, in form of a simple network, shows proximity to other subjects.

[6] All quotes in this section stem from the OECD's Stip website (homepage, specific services, or the about section).
[7] https://community.oecd.org/community/cstp/stip.
[8] *RePEc* is the world's largest collection of on-line Economics working papers, journal articles and software, see https://econpapers.repec.org/.

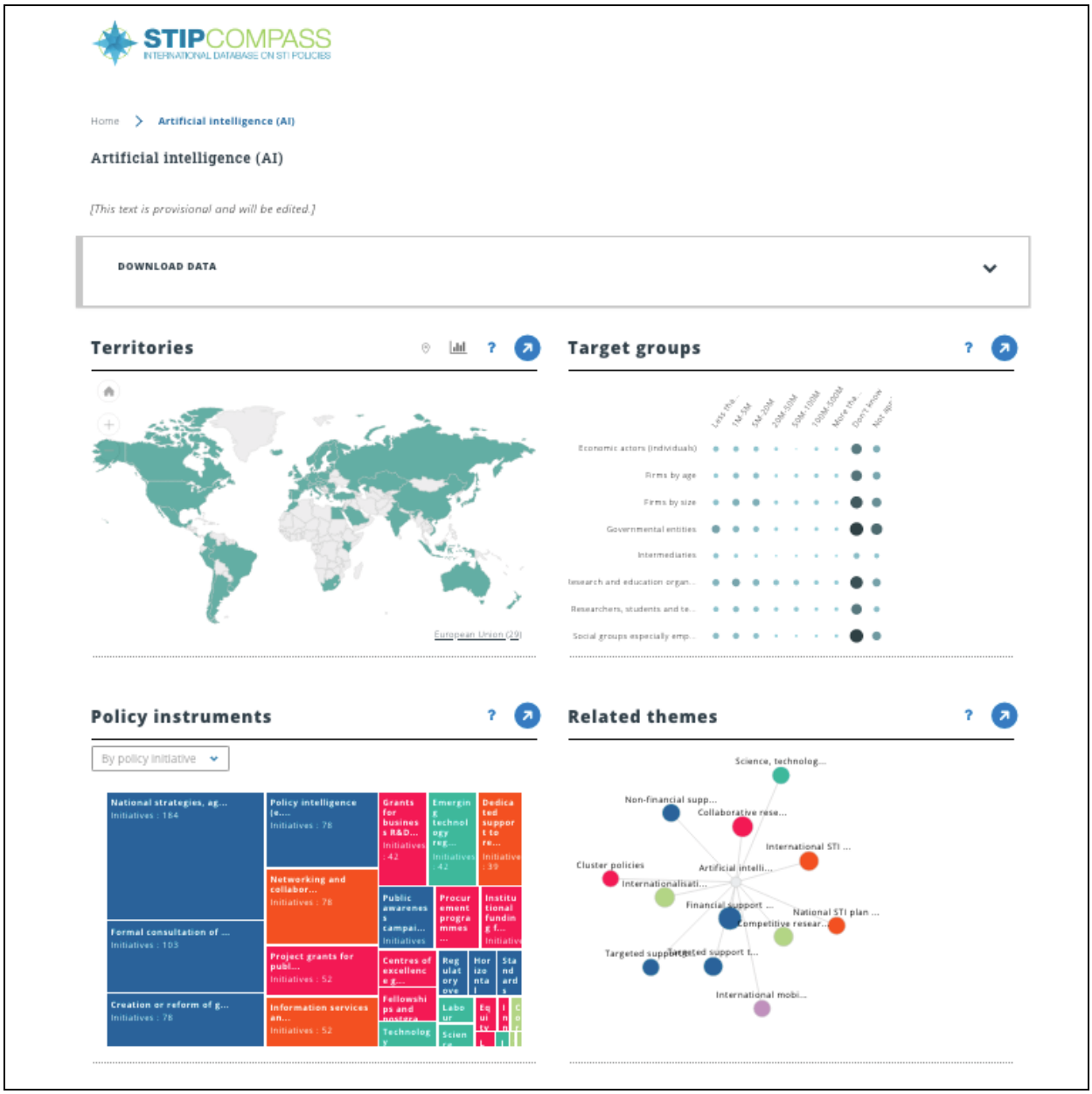


Figure 2.1: Key widgets of the OECD's STIP Compass 'Interactive dashboard' [9]

Policy Explorer

The policy explorer option lets the user start by selecting whatever keyword he or she aims at. The example below took 'open science' and the identified documents are displayed.

[9] Source: OECD STIP Compass, https://stip.oecd.org/stip.html.

Figure 2.2: Outcomes of the search with the 'Policy Explorer' function [10]

Further developments

With the Covid-19 topic, the website has already integrated a specific focus. Scrolling down the homepage, one can discover more dedicated, exploratory areas with a 'Knowledge transfer and co-creation policy explorable guide', and a 'Mission-oriented innovation policies online toolkit'. In the former, in addition to the main widgets, widgets based on external data are included such as from the European Innovation Scoreboard or identified publications.

[10] Source: OECD STIP Compass, https://stip.oecd.org/stip.html.

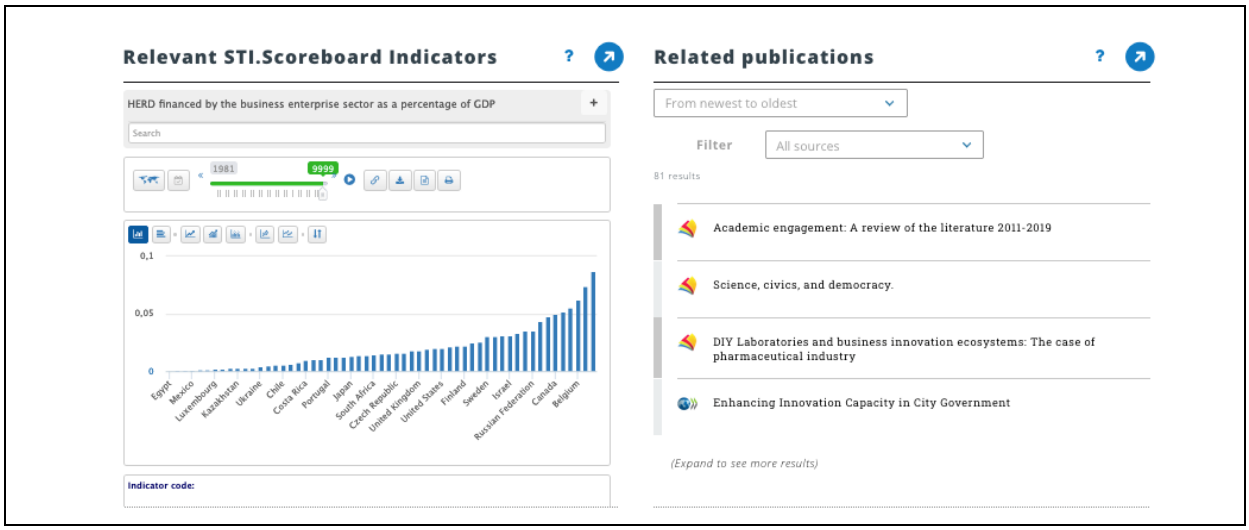


Figure 2.3: Integration of third party data and information [11]

2.2.4 Why is the STIP Compass of interest for the EOSC Observatory?

The STIP Compass is interesting for several aspects:

- Information is provided by public organisations on a bi-annual basis using a common reporting template and guidelines through an online questionnaire tool. However, the level of detail provided on initiatives is rather basic and a large share of them are incomplete.
  EOSC is considering complex reporting and could profit from the OECD experience in having set up an online tool.
- The collected information can be fully open access and be downloadable, see query builder tool[12].
- The website is intuitive, however, when drilling down or selecting, a new window opens and there is no possibility to go back.
- This is a technical aspect that needs to be considered.
- Extensive tagging of information allows for impressive agility of the system's content provision.
- The taxonomies[13] used are publicly available.
  The taxonomies and tagging allow for a very agile way of presenting and combining information in different widgets. This will allow for the development of tailored solutions for stakeholders and specific users (potentially accessible only to specific registered users or user groups). The tagging can also be linked to the structure of 'themes' (see WEF example below).
- The OECD STIP Compass is funded partly by the EC and the OECD members provide the information. There tends to be a designated ministry that acts as a national information provider (or individual designated organisations under the national representative).
  There is a dedicated budget from DG RTD which is allocated to the OECD for the overall management. The country information on initiatives is then provided pro-rata by the members.
- Intelligent linking of collected material and open-source data. This model puts less pressure on member states or stakeholder organisations to provide content and could potentially lead to a low commitment of stakeholders. A balanced approach with limited administrative burden – the OECD survey is done only every two years – could however prevent such a development.

2.3 The World Economic Forum's Intelligence platform

2.3.1 Functionalities

The World Economic Forum's (WEF) website has a very broad coverage open to everyone with sections on Agenda – Events– Reports – Platforms. But it has also a section for which a login is needed. There are two access points, one called 'Scale up' and the other called 'Strategic Intelligence'.

[11] Source: OECD STIP Compass, https://stip.oecd.org/stip.html.
[12] https://stip.oecd.org/stip/query-builder.
[13] https://stip.oecd.org/assets/downloads/STIPCompassTaxonomies.pdf.

The WEF[14] has changed its access and business policy during the last year and access to many advanced features are now through paid membership. In this 'Strategic intelligence' section, the registered community has access to advanced features such as:

- receive customised alerts on emerging trends;
- create own transformation maps to explore the strategic context most relevant for the individual user;
- export dynamic PDF briefings to facilitate presentations and outreach;
- participate in select virtual Forum events.

The whole website is structured around 'topics'.

Besides the WEF's network of experts, these topics are *curated* by individual universities and international organisations. Additional content is collected through machine analysis of the data provided by content *content partners* (global think tanks, research institutes and publishers).

Together, this leads to more than 250 topic areas which bring together a visual of the most relevant content areas, a summary of the topic and publications, videos, data that can be clicked and read.

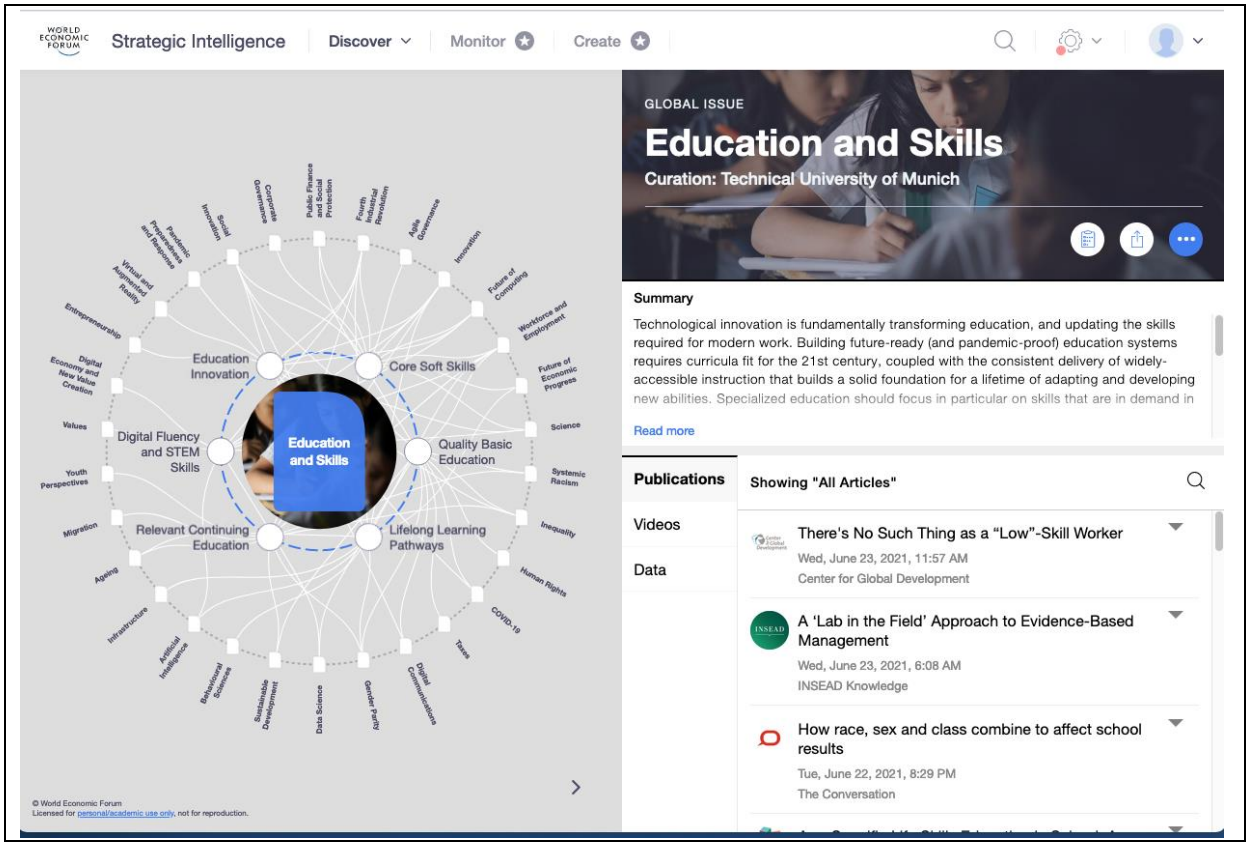


Figure 2.4: Topic area, WEF Strategic intelligence

Why is the Strategic intelligence feature of interest for the EOSC Observatory?

While the 'topics' of the intelligence portal could be the different areas (such as 'architecture', 'FAIR', 'Interoperability', but also a dedicated 'Dashboard' with specific features, the different topics are *curated* by a dedicated Member - a role that could be delegated or mandated to individual EOSC ecosystem members. Since it would be a dedicated topic and given interest and knowledge of the curating organisation, the whole system would be based on a distributed allocation of responsibilities, but also visibility and a sense of ownership.

[14] Source: WEF, https://intelligence.weforum.org/topics

An interesting feature is the transformation map. There are three levels, all linked to each other. The first level is the topic. By clicking on any of the second level topics, one obtains a visual, which 3rd level topics are tackled. By clicking, the identified publications (on the right of the page), adapt accordingly. If one then clicks on a third level term, the identified publications change and the second level key terms. This is all highly intuitive and user oriented. The value of visuals and analytic power comes with linking different data.

Given that new material is added frequently, and the material is (most likely) tagged, the transformation wheels are dynamic and can be used to make the service attractive and relevant, in particular, if questionnaires/surveys to member (states) would only follow on a bi-annual basis.

The website is also interesting due to its *paid* features. It offers personalised experiences. However, this feature was established after the website existed for some years and gained in content and use. It shows however that not all content needs to be offered for free and that a suitable business model can be created in the longer run.

2.4 ESPON: SDG Tool

ESPON, the European Spatial Planning Observatory Network has included in its observatory SDG libraries[15]. There are three libraries with *Initiatives*, *Policies*, and *Tool*. With initiatives, a user can select an SDG, a country or a region and search with or without keywords for relevant initiatives. Initiatives are fed from open sources. The least user-friendly library is the one of the 'Policies'. Here, policies of any kind are listed alphabetically. Below each policy, a link to their homepage is provided but no further functionality.

In the following, we want to focus on the third library, the SDG benchmarking tool. This is interesting for the *geographic visualisation* within an indicator-based dashboard.

The tool asks to select an SDG, then a relevant indicator under the given SDG, then the user can choose a region and in the last step, benchmarking regions. It leads to a visualisation.

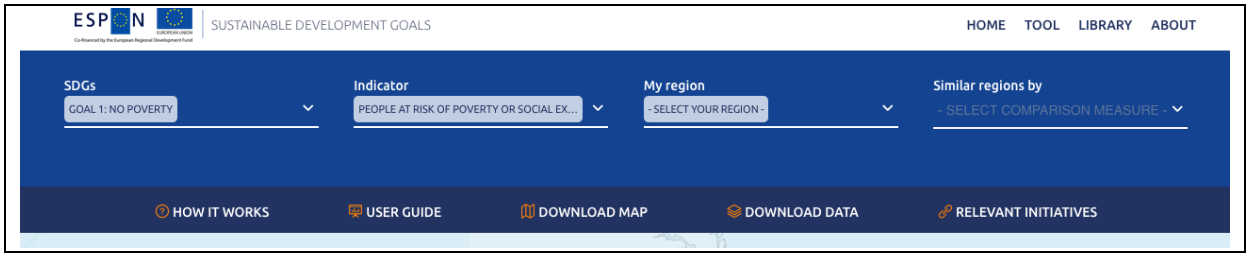
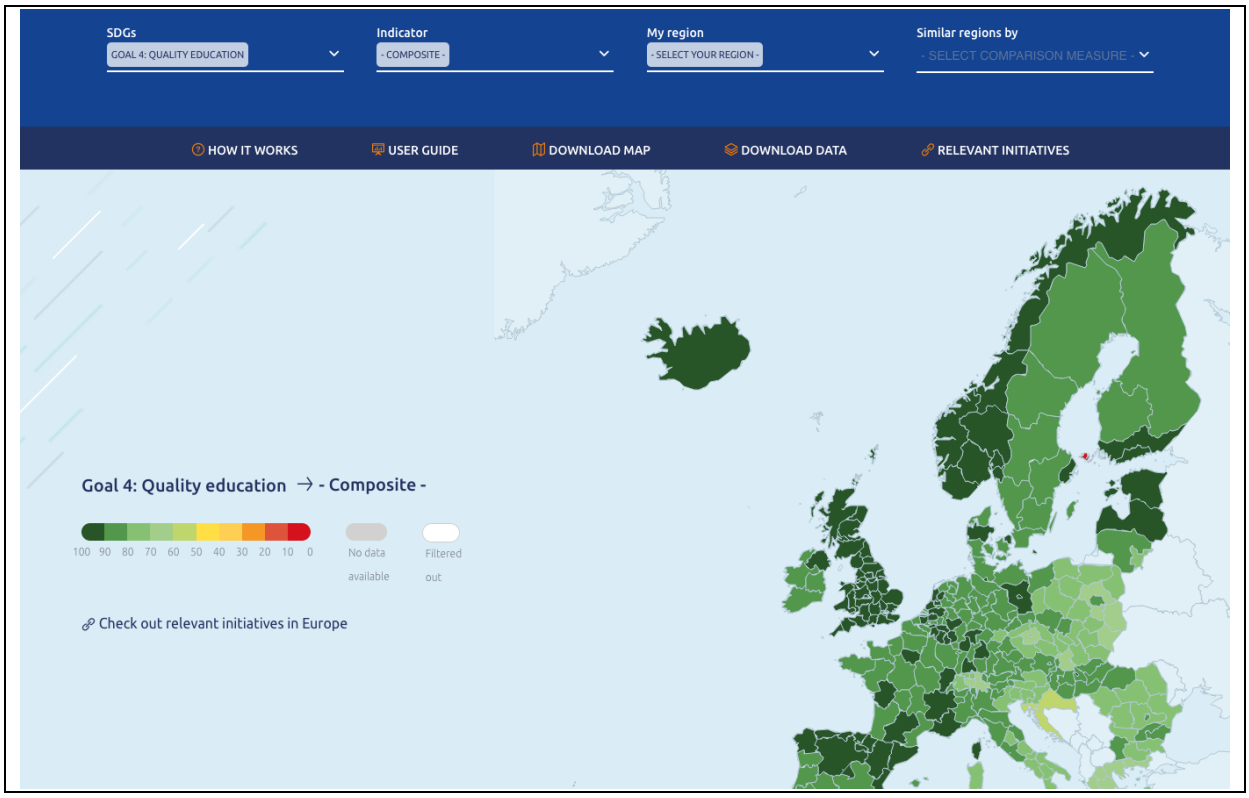


Figure 2.5: ESPON's SDG tool [16]

The visualisation is a tool to show how a region or country is currently performing on an individual indicator or on composite indicators. There is no absolute data displayed, instead, the graphics are based on relative performance measures.

[15] https://sdg.espon.eu/library/initiatives.
[16] Source: ESPON, https://sdg.espon.eu/library/initiatives.



Source: ESPON

Figure 2.6: Graphical view of a given indicator without

There is an option to use benchmarks, and for the choice of the benchmark, one cannot choose specific regions but again indicators such as population density, rural-urban, etc. which compares like with like.

Further benchmark information is provided in terms of SDG and the key indicators in an SDG as well as developments over time.

With the visualisation of 'Distance to target', a region can see where it stands compared to a measurable goal. The figure below indicates where region AT11 stands in terms of four education indicators, while shows the progress over two periods and the position of the region vis a vis the average of the selected peer group.

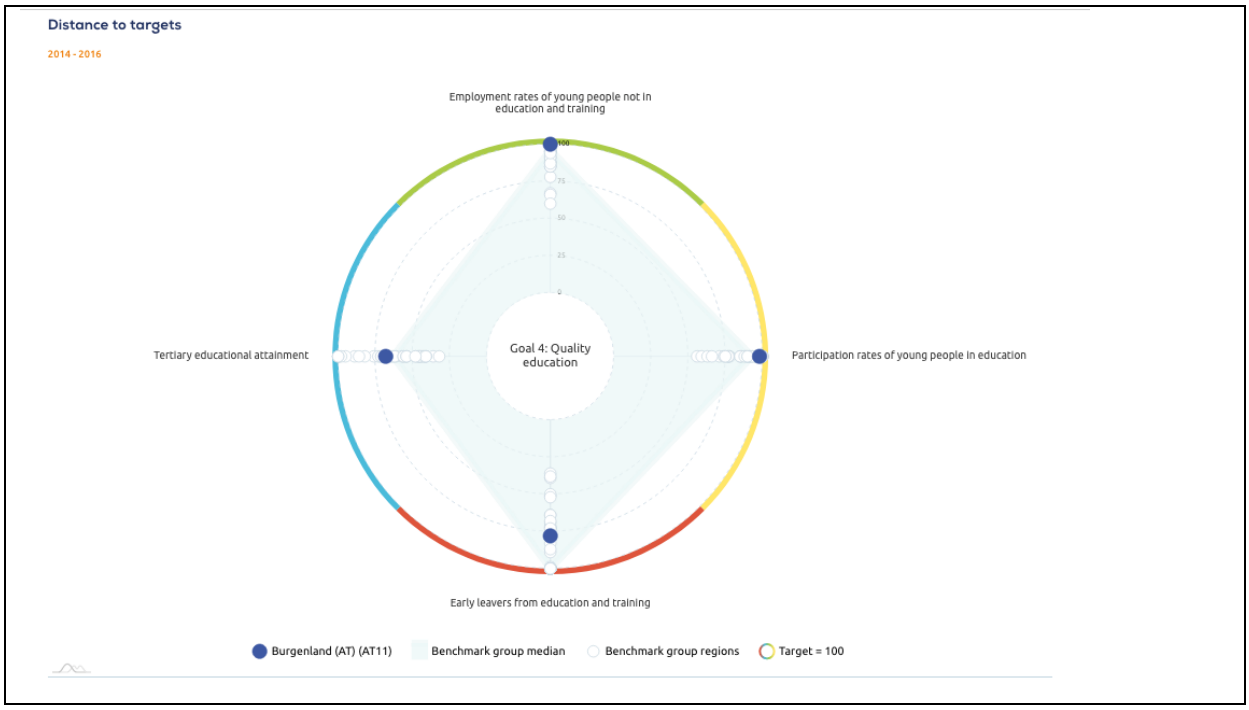


Figure 2.7: Distance to target visualisation (Source: ESPON)

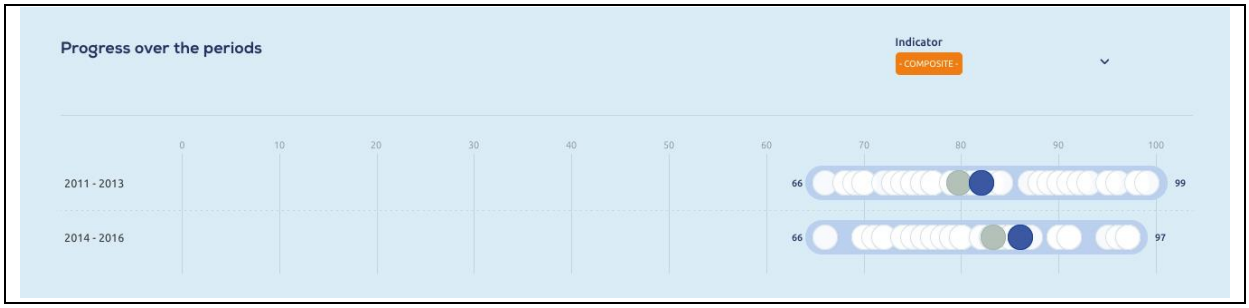


Figure 2.8: Visualisation of progress (Source: ESPON)

2.4.1 Background

The SDG tool is a procured service. The website was developed by a commercial provider and the content was collected by a service provider. The total cost of the development of the tool and provision of content was €114.000.[17]

2.5 ERAWATCH

ERAWATCH has been a large policy monitoring exercise funded by DG JRC from 2006-2012/13. It was designed to monitor the STI developments of the European Research Area (ERA) and as such included all EU-MS, Associated countries, and several 'international countries' such as the USA, Japan, Brazil. From the ERAWATCH legacy, only the country reports survived, and they were moved to the JRC's RIO[18] website. The bulk content–detailed information on STI policies, was lost and by now (2021), also the country reports are not anymore available. The collection of policies has however started again with the STIP Compass, described above. The ERAWATCH example is chosen since content development followed a different model than the ones explained above. Furthermore, Technopolis managed the network and the repository and has drawn some lessons from the approach.

[17] https://www.espon.eu/localise-SDG.
[18] Until the start of Horizon Europe, the content was included in the so-called H2020 Research and innovationm observatory (RIO), maintained by DG-JRC. The systematic data collction is not anymore available.

Information collection approach

Given that ERAWATCH covered from the beginning more than 35 countries, the EC (RTD and JRC) initiated the monitoring as a public procured service. Different contracts were awarded, among those, one on the development of the website and a content management system (CMS), and another one for the development of a structure and the collection of the content. For the latter, a network of individual country experts was hired to collect information in the expert's country. Having country experts with language capacity enables interviews with different stakeholders in the country, and to collect relevant national language material.

The project management, together with the EC services developed template structures. They were then tested in a prototyping phase by 2-3 experts and for a few countries. Following their finalisation and the development of reporting guidelines, the country experts were asked to collect relevant information. The monitoring included:

- a **country fiche** with the basic elements of the research system including key indicators such as population, GDP, GERD/GOVERD, number of scientific publications etc.
- **support measures** which were all important research (and later also innovation) support programmes in the national policy mix;
- **organisations** to cover all major institutional policy actors and intermediaries;
- **policy documents,** covering all reference documents (including the National Reform Programmes Strategy documents etc).

The dedicated templates and guidelines were developed and -over time- amended as needed.

All country experts had a specific target -which was developed according to the size of the country. A small country such as Cyprus has fewer organisations and policy measures than for example the Netherlands. The experts were encouraged to provide content through the CMS whenever there was a new policy measure to report. In the first years, there were planned updates twice a year, but it turned out that this updating schedule was too ambitious and not much new could be reported every six months.

Given that constant monitoring was not realistic-new policies and programmes are developed, sporadically, it was decided to have a dedicated annual updating phase. Updating included the inclusion of new measures-but also to update existing ones, for example, programme changes. All deliveries of the country experts that were new or adapted were *quality controlled* twice:

- First, at the level of the service provider as following: the (very detailed) country fiche was quality controlled by a small set of external Senior policy advisors. They reviewed the content based on a few quality criteria.
- The other type of deliverables was reviewed by a set of consultants who checked mainly for language, completeness of the information and internal coherence of any deliverable.

Second, the content was transmitted to the JRC through the CMS who added another check – very often by colleagues with knowledge about a country. This two-step quality control proved to be not without caveats - while the quality was ensured, it hampered a speedy publication on the web. In many cases, JRC colleagues were swamped with deliverables that they had to approve individually, but they also had their other tasks to perform which was often prioritised. Thus, extensive additional quality control may lead to bottlenecks and late dissemination of information. Yet, given rigorous quality control, the ERAWATCH website was a highly trusted source of information. At that time, JRC did not implement website statistics, therefore, the overall use was not measured systematically.

Why is the ERAWATCH experience relevant for the EOSC Observatory?

Much of the information collected under ERAWATCH was *qualitative*. A measure-such as a funding programme or a policy document on a new strategy-included qualitative information on the content. ERAWATCH was thus able to provide a holistic picture that enabled policy makers and other user groups such as researchers alike to obtain not only factual information but also the background that explains developments and measurable KPIs.

The EOSC Future proposal description of the Observatory has stressed that it would aim to provide a holistic picture about EOSC related developments which include the wider EOSC ecosystem as much as the EOSC Association's needs to steer the development of the partnership approach.

2.6 General observations

By analysing different approaches to observatories and monitoring of public policies, the previous descriptions have shown different models of data and information collection, quality control, funding models, and presentation modes.

In all analysed observatories, there are possibly key success factors, from which the EOSC Observatory could learn from:

- A dedicated pool of people that steer and provide oversight;
- Clear guidelines and an online platform to submit information;
- Regular surveys-the longer and the more detailed they are the less frequent they should be;
- Dedicated curators for sections/themes with 'ownership';
- Distributed quality assurance system for swift and smooth quality control;
- Various selection options-widgets, indicators-let the user choose.

Table 2-1: Recap key features of analysed observatories

Key features	STIP Compass	WEF	ESPON	ERAWATCH
Data collection				
- **Overall coordination budget**	✓	✓		✓
- **survey data | mainly through own resources**	✓			
- **network of designated experts | mainly through dedicated third-party resources**			✓	✓
- **Members | Partners**		✓		
- **Open sources**	✓	✓	✓	✓
Quality control				
- **By dedicated organisation**				
- **Distributed competences**		✓		✓
Access				
- **No restrictions**	✓		✓	✓
- **Login areas**		✓		

3 Conceptual framework for developing and applying an intervention logic for EOSC, open science interventions and their monitoring

To develop and use a conceptual framework for the observatory and its use, borrowing ideas from evaluation approaches and evaluation thinking may be instructive. Furthermore, the Horizon Europe Regulation includes a new approach with 'impact pathways' – which need to be used for all funded instruments in the foreseen evaluations.

Evaluations are often based on a logic model. A logic model is a way of establishing the basis of the activities and structuring the approach. It shows the key links in the logic behind the activity and how the resources are used to meet the needs and achieve the objectives. It also enables the identification of the barriers and success factors. It is based on a causal logic that there are a set of issues or problems to be addressed, a set of inputs that are applied to a series of activities that generate outputs which in turn lead to outcomes or the resolution of the problems.

This logic informs and relates to a 'theory of change' i.e., an assumption or hypothesis of why an intervention will succeed in producing the desired outcomes and impact(s). A 'theory of change' specifies how activities are expected to lead to interim and longer-term outcomes. The elaboration of the theory of change can strengthen the case for attributing observed changes to an action and is thus an important aspect of the method of approach to the evaluation – an aspect also EOSC needs to bear in mind given that the partnership will be evaluated. An important item of the logical model is the identification and description of key contextual, external factors that could influence the intervention either positively or negatively.

Logic models also incorporate short-term and long-term analysis. General objectives are often envisaged in a long-term perspective whereas specific objectives may be achieved in the short- or medium-term. The latter can be broken down into operational objectives which lead to outputs and (wider) outcomes.

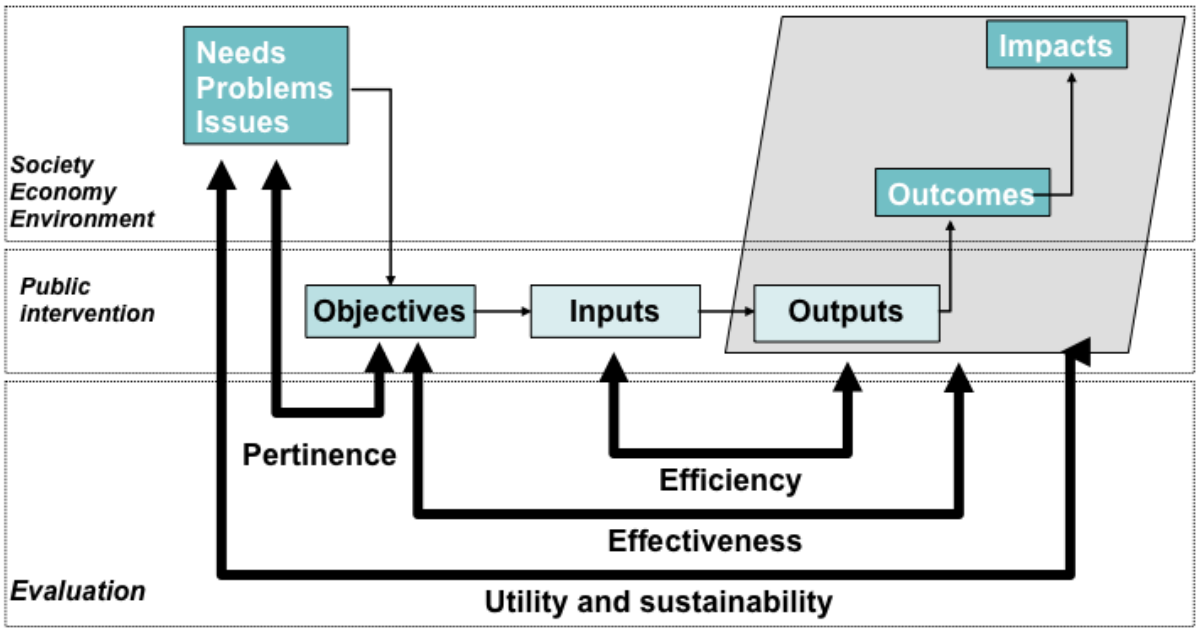


Figure 3.1: Generic logic model (Adapted from the EC)

Among the difficulties of attributing impacts to interventions (and thus establishing a direct causal relationship), the concept of 'impact pathways' (see Figure 3.2) has gained in prominence during the past years. For the evaluation of Horizon Europe for example, the concept addresses the deficiencies of a static logic model with the integration of five key principles, namely the Proximity, Attribution, Traceability, Holism, and Stability (the PATHS principles).

Overall, Horizon Europe aims to address three main impact domains through respectively three main impact pathways:

1. **Scientific impact**, through the creation of high-quality new knowledge, the strengthening of human capital in R&I and the fostering of the diffusion of knowledge within the scientific community and open science.
2. **Societal impact**, through addressing EU policy priorities with the means of R&I, the delivery of benefits and impact through mission-oriented R&I and by strengthening the uptake of innovation in society.
3. **Economic impact**, through generating innovation-based economic growth, creating more and better jobs and by leveraging further investments in R&I. Even though not explicitly, this pathway implies the importance of knowledge diffusion beyond the scientific sector.

Furthermore, the pathway approach suggests classifying future indicators along a theory of change-based time perspective into three categories, namely short-term indicators, mid-term indicators and long-term indicators.

The following figures suggest a stylised EOSC partnership pathway which includes the inputs (the financial and other resources of the partnership), activities of the partnership, as well as outputs and outcomes. These tend to be the focus of monitoring activities. Furthermore, the pathways include the economic, environmental, and social impact areas, here with key SDGs[19]. The model also acknowledges external factors that are included as wider framework conditions. The scope and scale of the overall EOSC partnership activities and outcomes depend on the national contributions and endowments which again are bounded by national frameworks. Therefore, the overall monitoring will go hand in hand with analysis and monitoring of national or regional level inputs, activities, and outputs. In Figure 3.3, one specific potential pathway is highlighted.

In the case of open science, the EC has demonstrated with the co-programmed EOSC partnership *one major instrument* to address a high-level objective to make open science 'the new normal'. The partnership has included in the SRIA its objectives and indicated a number of KPIs. Nevertheless, by making a clear distinction between activities, outputs, results and outcomes, the conceptual framework allows us to identify at which level and in which areas progress has been made - or not.

Figure 3.3 indicates a hypothetical pathway for training. If for example EOSC partnership is involved in the training of data stewards and one of the goals is that EOSC members employ data stewards, then this activity of training people in this area could have direct effects on the organisation the person is (then) working in since he or she would provide a new service to the other researchers. Thus, a direct output of the intervention would be a number of data stewards employed in the EOSC member organisations. Through this work, there would be several outcomes. For example, the data stewards transmit new knowledge to the other researchers of how they should approach/deal with open science and other related aspects. In the longer run, this may lead to behavioural changes in the organisation's research-community, and everyone becomes knowledgeable about the new way. In terms of wider economic impacts, one may have employment effects but also social effects in terms of a wider skill-base and possibly also on gender.

With the pathway framework, the beneficiaries of an intervention as well as policymakers are invited to envisage wider short-term and long-term effects, think about expected and wanted effects, but also unwanted effects. This provides a sound basis for the development of KPIs.

[19] Horizon Europe, and therefore also the funding of the EOSC partnership, serves ultimately high-level policy goals based on identified problems. These are the policy priorities of the European Commission with the twin transition, but in the end, they come to the UNs Sustainable Development Goals (SDG). One may ask how does EOSC funding relate to SDGs? The SDGs are in the area of outcome and impacts in Figure 3.1 and indeed, tend to be outside the monitoring of an intervention but nevertheless, they guide the expected impacts.

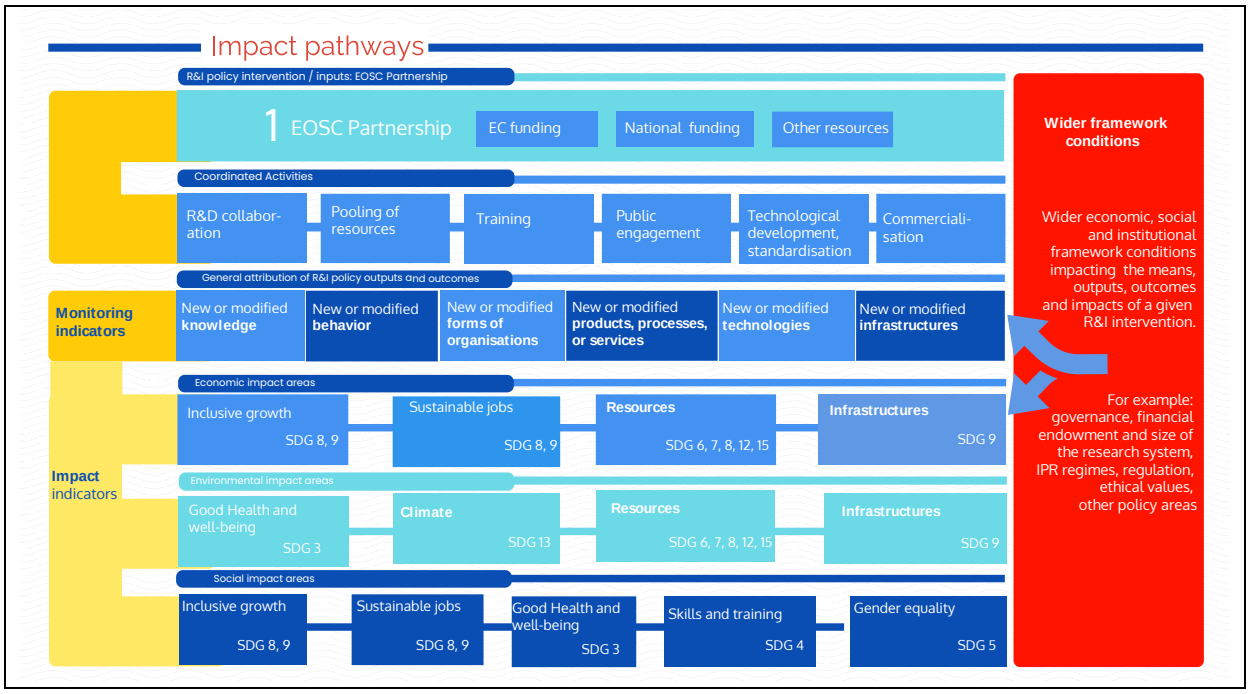


Figure 3.2: Stylized EOSC Partnership pathway model (Source: Technopolis Group)

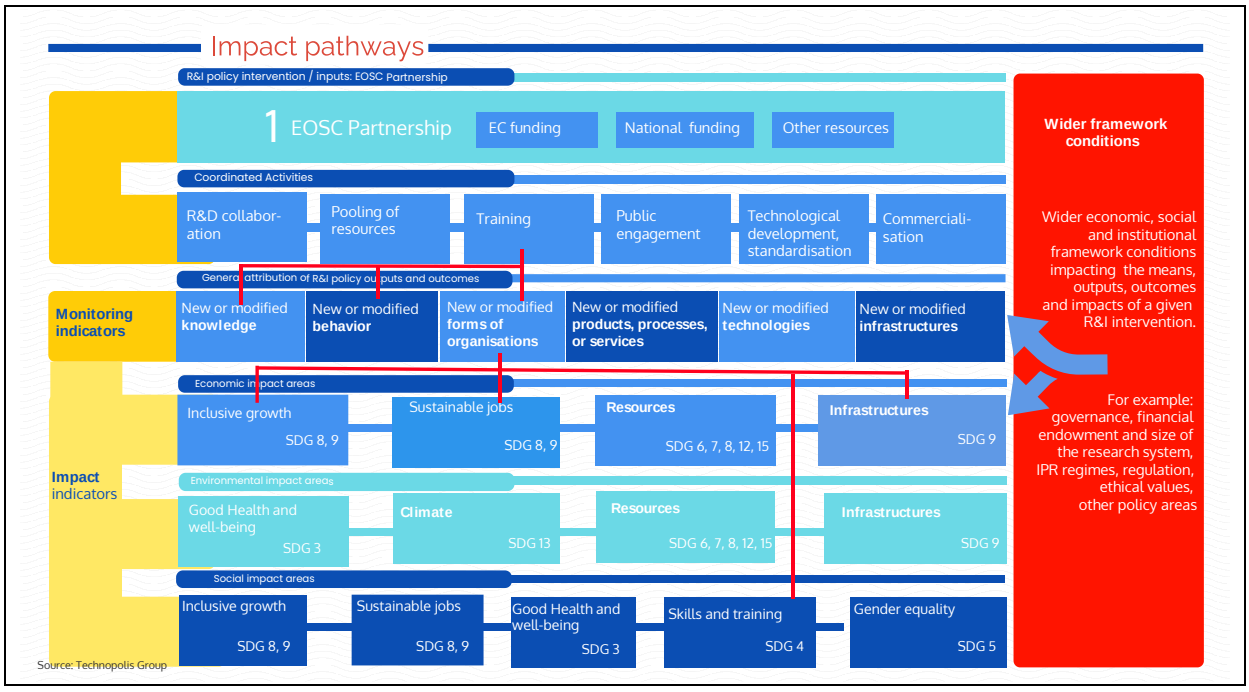


Figure 3.3: EOSC partnership example pathway (Source: Technopolis Group)

Before analysing the KPIs in a conceptual framework, the next section draws on the point of indicators and the monitoring framework.

4 Indicators in a monitoring framework

Monitoring can be defined as a thorough and regular analysis of resources, outputs, and results of interventions. It is based on the collection of information such as reports or indicators. Examples of monitoring exercises for specific policies, economic developments, environmental issues etc. are widespread and are wider spreading as suggested with the examples presented above. Simple monitoring or monitoring systems accommodate the needs to demonstrate performance and effects of public interventions.

Monitoring does require:

- A collection system allowing for objective, reliable and valid data;
- Common definitions and a common understanding;
- Transparent indicators;
- A sound organisational approach.

Monitoring the effects of interventions can be closely associated with evaluation goals, and evaluation concepts can indeed be borrowed for the development of monitoring systems. There are several past and ongoing monitoring activities at the EU level – some very broad ones such as the ProInno Trendchart[20] exercise which ran for more than 10 years and through with a large repository of innovation policies was collected. Similar monitoring was the Erawatch, Masis[21], or Metris[22] exercises which all aimed to provide overviews at the country level on particular research issues. A different approach is followed with the various scoreboards, such as the European Innovation Scoreboard (EIS). In particular, the EUI is an example where a core, limited set of indicators in several fields is collected and reported on an annual basis. The data is predominantly extracted from existing data sources. This scoreboard is quite established and pursued for many years. But the data parts are complemented by explanatory reports aiming to provide the context.

Open science so far is a concept that brings along several questions to be addressed such as what does it cover in terms of content but also in terms of scope (the public research sector only? Private research? etc.).

Most monitoring exercises are built on a difficult and limited data situation and collection needs to cope with heterogeneous structures and functioning of the public sector actors and budgeting in the EU-MS. A rather pragmatic approach that can be seen with some monitoring systems is a rather modest start with long-hanging fruit, namely available data, or proxy indicators, while more data and indicators are included once data is available. One can observe that establishing a monitoring system is challenging and requires flexibility in terms of what can be monitored against what should be monitored.

Indicator definitions

Indicators are core for monitoring and evaluations. We can distinguish:

- Direct indicators, and
- Indirect indicators (proxy indicators).

Direct indicators provide an accurate measurement based on metrics (such as cubic metres of water consumed, the Euro spent on teaching or the number of graduates). In programme evaluations, a chain of direct indicators is often used distinguishing between *input, output, outcome, and impact* indicators. For example, the number of euros spent on creating Open Access repositories can be used as a direct measure of inputs. The number of OA publications in these repositories is a direct outcome indicator of the measure and the number of citations of these publications can be used as a direct outcome indicator. An impact indicator of this could be the number

[20] TrendChart was a service funded by (then) DG Enterprise (now DG GROW) that collected information on innovastion measures. It was integrated in 2007 under the PRO INNO Europe programme.
[21] MASIS – Monitoring policy and research activities in science and society was a project funded by DG RTD. It lead to a monitoring report.
[22] METRIS - Monitoring European Trends in Social Sciemnces and Humanities, was an initiative commissioned by DG RTD. Its website aimed to become an entry and reference point for the social sciences and humanities landscapes in Europe (discontinued).

of patents that cite this non-patent literature but also a reduction of specific health/ environmental/ economic/ social concerns on which the publication contributed.

While policymakers and funding organisations are interested in causality between inputs, outputs, outcomes and in particular impacts, the links are often non-causal, cumulative, and arbitrary. In the example above, OA publications may lead to an increase of patents or add to the quality of the patents but its causal relationship is hard to prove. To overcome this limitation, Horizon Europe is focussing on impact pathways in the evaluation of its instruments.

In many cases, *indirect, proxy indicators* are used to demonstrate changes when direct measures are not available or feasible to collect. In particular, the mentioned impact objectives are difficult to monitor. Therefore, indirect indicators may be developed that are feasible to be collected and provide a similar level of information.

Indicators as measures are by definition of a *quantitative* nature (absolute number, share, rate, ratio). However, one can define *qualitative indicators* in terms of judgements or perceptions on a given subject. In the open science context, several aspects seem to be available only through qualitative indicators.

Ideally, a long-term monitoring passes along pathways and considers that measurable impacts can take several years to happen from the initial intervention. Throughout the pathway, different indicators may become relevant and available. Therefore, our work on the monitoring indicators and development of metrics should be *flexible to adapt to the changing circumstances*.

For the EOSC observatory users-and in particular policymakers-, we envisage a dedicated monitoring tool in form of a dashboard. This will include a range of quantitative and qualitative, direct, and indirect indicators.

Previous EOSC indicators' work

Various groups and persons have suggested a range of indicators. These include general indicators on open science, indicators to show the development of an EOSC ecosystem or of the EOSC partnership, The EC's expert group on partnerships – to name some prominent ones.

The EOSC FUTURE indicated in its proposal to aim at an observatory that provides a *holistic view of open science*. In that sense, it aims to cover 'the broad picture'. This does include sub-levels, namely the EOSC ecosystem and the EOSC partnership alike. But this also risks aiming at too much and to provide insufficient guidance. It is useful to consider the lessons learned from other monitoring exercises such as the ERA Monitoring, which was performed for about a decade. From early on, methodological work started *to limit the number of indicators* and to use the SMART criteria for their design. The latter requires indicators to have certain qualities. They need to be *Specific, Measurable, Achievable, Relevant, and Time-bound*. This is equally important for performance indicators such as the SRIA KPIs which were put forward and, as we will see, would benefit from more clarity.

An important decision on the ERA monitoring indicators was the selection of one *input, process, and output* indicator respectively for each of the various ERA priorities.

4.1 Integrating SRIA KPIs in a conceptual framework

In the following, we have started with the SRIA performance indicators of the EOSC partnership. The partnership-and much of the existing preparatory work of the various groups- have focused on so-called *readiness* indicators. Readiness as such is not defined but a few KPIs are circulating which are intended to be used.

The conceptual model exercise is useful since it helps to reflect if the KPIs put forward in the SRIA (or elsewhere) are linked to the activities of the partnership, or of the wider framework conditions such as the EOSC ecosystem, or other open science policies that help rendering organisations to become open science 'ready'.

In the following Figure 4.1 the visualisation shows one of the three objectives and the KPIs indicated in the SRIA. What we can see from the activities level -a reformulation of what the KPIs aim to show-, suggests much less specific, measurable, and even attributable activities. To measure either EOSC partnership KPIs or broader EOSC ecosystem KPIs, both require more clarification through a definition. Furthermore, clear descriptions of the activities and on which level they are provided, is needed.

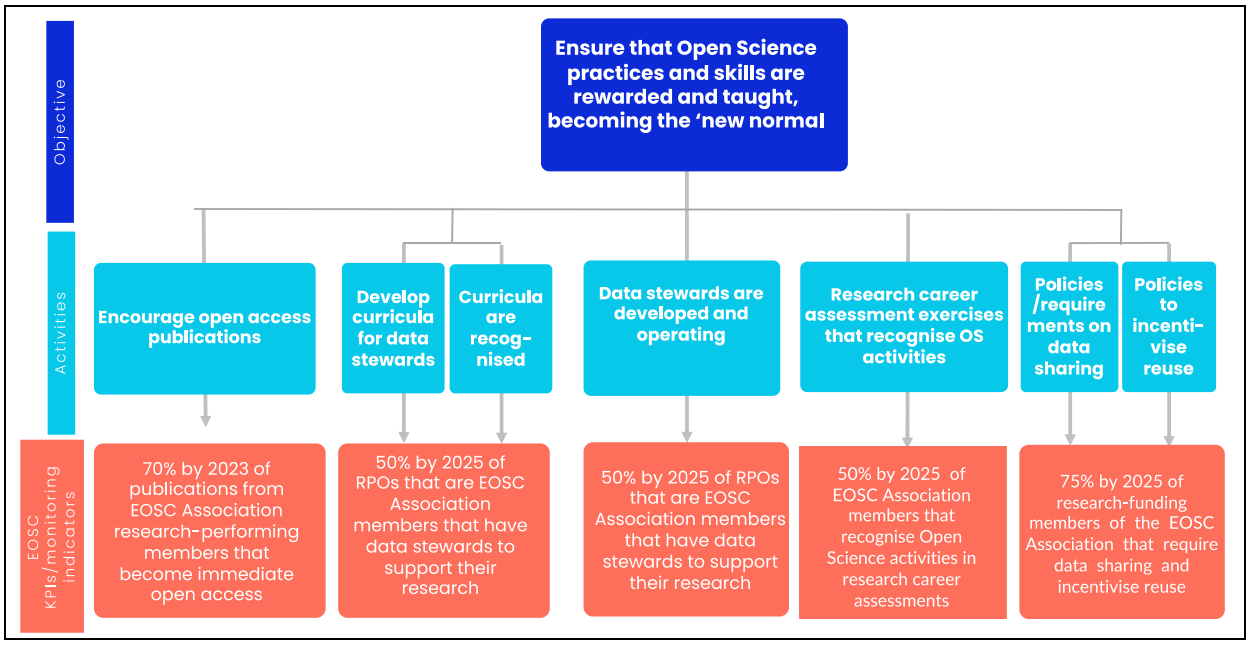


Figure 4.1: EOSC partnership SRIA objective rebuilding of activities (Source: Technopolis Group based on EOSC partnership SRIA)

In the conceptional framework proposed, there is a distinction between inputs, activities, and outputs which can be expressed with input indicators (such as the funding and other resources of the EOSC partnership which is used for specific activities), process indicators that reflect the activities (such as infrastructures built, open data repositories made available, or the number of beneficiaries from funding or training programmes established), and finally, output indicators, namely the number of trained persons, built infrastructures, terabytes of data made available etc.

Table 4-1 below lists the SRIA KPIs put forward to measure the success of the partnership. So far, the KPIs are a mix of potential EOSC partnership process and outcome indicators (such as the number of open access publications or the data deposited in public repositories) and potentially some from the wider ecosystem (e.g., development of curricula for data stewards). In that case, the inclusion of the latter should be marked as a non-strictly speaking EOSC partnership KPI[23].

If EOSC ecosystem -and thus potentially a much wider public intervention in open science policies that go beyond the funding of the EOSC partnership- is considered but cannot easily be distinguished.

Table 4-1: SRIA indicators – clarification needs

SRIA Objective	KPI	To be clarified	Type of KPI	Potential indicator for EOSC Observatory?
Ensure that Open Science practices and skills are rewarded	Percentage of publications from EOSC Association research-performing members that	Which types of publications? -Peer reviewed articles only? - Distinguish open access (green/gold/hybrid)?	Output indicator	Yes Suggest to define as: EOSC research performing members' share of gold OA publications (requires total number of

[23] If for example the profile of data stewards and its definition in terms of competencies is developed and accredited elsewhere, this is an external factor for the partnership and does not provide a process indicator of the EOSC partnership but of national or EOSC ecosystem interventions. If there is a mix, say the funding for the development of competencies and training material comes from a dedicated training budget from education ministries but members of the EOSC partnership are involved in the implementation, then a more specific monitoring indicator should be developed for the EOSC partnership monitoring.

and taught, becoming the 'new normal'	become immediate open access			publications in order to calculate the share)
	Number of national education systems that recognise European curricula for data stewardship	- Really only national? In federally organised systems, there may be no national recognition - this indicator seems to be independent from EOSC partnership since it measures what a MS decides (recognition of curricula and skills)	Indirect indicator. Direct link to EOSC partnership if relevant EOSC activities can be linked.	Yes Could be qualitatively collected through identification of relevant programmes/initiatives at MS/regional level
	Percentage of RPOs that are EOSC Association members that have data stewards to support their research	For the collection, the 'data steward' needs to be defined The job may also be called differently. The type of 'support' could also be made more precise through examples in guidelines	More of an indirect indicator and use as an enabling indicator. It may be an output indicator if the inclusion of a data steward is sth in response to be in EOSC. Otherwise, hard to see why this is a KPI	Yes Collected qualitatively via targeted surveys.
	Percentage of EOSC Association members that recognise Open Science activities in research career assessments	- Seems to address performing and funding organisations ; needs clarification on the focus (or potentially split indicator in two) - needs a definition of 'OS activities' - (could be anything) but not anything may be worth being recognised in career assessments	Indirect indicator, there is no immediate link for being in EOSC and the recognition of OS in carreer assessments if a benchmark is already a yes. Then it would be rather an input indicator	Yes Collected qualitatively via targeted surveys.
	Percentage of research-funding members of the EOSC Association that require data sharing and incentivise reuse	- could possibly be defined as existing guidelines by RFOs should be split in two to distinguish between 'data sharing requirements' and 'incentivising use'. Combination may blur the information	Input and output indicator depending on the number at benchmarking date.	Yes Collected qualitatively via targeted surveys or through a policy registry.
Enable the definition of standard, and the developme	Percentage of EOSC Association members that have policies which require FAIR to be implemented in	- this should be applicable to all projects not only FP funded ones since this is maybe a normal requirement under the grant agreement. This is	input or output indicator depending on benchmark and if this would be	Yes Collected qualitatively via targeted surveys or through a policy registry.

nt of tools and services, to allow researchers to find, access, reuse and combine results	project design via Data Management Plans	thus not necessarily an EOSC specific activity that is linked to performance	new or already available	
	Percentage of research data from EOSC Association members which is deposited in repositories that is made as open as possible	- - potentially difficult to measure the benchmark - the share of the non open data. Data is not useful to measure in terms of %. Data quantity alone is also not a quality indicator. This should be made more precise, for example including curated data. - the quantity only KPI invites to deposit all kinds of (including rather rubbish) data, a quality aspect needs to mitigate shear quantities	Output indicator	Yes. Via quantitative strategies (which may include assessment of FAIRness or usage data)
	A first generation of pan-European federation of infrastructures for preservation, management and sharing of research software is available	- not clear if this only includes EOSC association members or if this is wider. A description of what are the characteristics (governance) of this federation would be useful however, this may require some indicators on its own Seems to replicate the main objective of the next group of indicators	If this is envisaged as a result of EOSC, it would be an output indicator but it is also mentioned as an objective	Yes. Quantitatively via their onboarding to various EOSC portals.
	Percentage of the active data spaces that take up data management practices, including the FAIR data principles, and provide into the EOSC ecosystem	needs clarification on what is meant by ' active data space', 'management practices' and what is meant by 'providing into the EOSC ecosystem'. Does it address all national/regional actors? Benchmark most likely not attainable since 'active data spaces' would ned to be defined in a measurable form before calculations - such as a share - could be made	Process indicator – could be seen as pull indicator for broadening EOSC	
Establish a sustainable and federated infrastructu re enabling open sharing of	Number of core functions of Minimum Viable EOSC that are developed to make the EOSC ecosystem accessible to researchers across	which are the core functions - can organisations chose? Is this limited to EOSC members or wider? This is a rather unclear KPI which would benefit a lot from clarification	Output/impact indicator	Yes Qualitatively via targeted surveys and quantitatively via the EOSC onboarding.

scientific results	disciplines and countries			
	Number of additional functionalities and services dedicated to the requirements of end users from the public sector in the EOSC-Core and EOSC-Exchange	needs list of potential functionalities and services (ideally descriptions as a basis for the monitoring). Not clear who is the target	Output indicator	Yes Qualitatively via targeted surveys and quantitatively via the EOSC onboarding.
	Percentage of the repositories in EOSC that will have a certification such as CoreTrustSeal	needs clarification if repositories managed by EOSC members only is the benchmark? Which certificate will be accepted? Needs lists of certificates	Output indicator ('will have')	Yes. Need to establish a list of certificates and compliance metrics. Qualitatively via targeted surveys and quantitatively via the EOSC onboarding.
	Percentage of research disciplines that have documented standards and protocols for data sharing and reuse	needs clarification of the entity - disciplines by EOSC members, only? All FRASCATI fields of sciences? All countries? EU-average? Geographic level not identified… Will there be model standard and protocols?? This KPI requires by far more clarification		Yes. Qualitatively via targeted surveys and quantitatively through registries of metadata.
	Percentage of the metadata related to publicly funded research datasets which are defined as Open Data that are discoverable through EOSC federated infrastructure	very difficult to measure and monitor: who defines datasets as open data, this is ultimately a quantitative indicator without a quality of the data concept behind. It invites to publish whatever. It is unlikely to be measured since the starting volume, nor the growth of the volume are known variables	Output indicator	Yes. Mostly quantitatively.
	Number of geographically spread observer organisations that have joined EOSC from outside EU MS/AC		Output/Impact indicator	
	Number of non-EU initiatives with which EOSC establishes connections, offering additional	needs clarification of : 'additional resources'. Does this mean available infrastructures, or datasets,…? Which EOSC	Output/Impact indicator	

	resources to the EOSC ecosystem	is meant, the partnership? The ecosystem?		

5 Preliminary ideas/needs of EOSC observatory

Based on the initial findings above and experience from the EOSC WG Landscape report, the OpenAIRE country pages[24] the Open Science Observatory EOSC observatory[25], EOSC Future will build the EOSC observatory following a mixed approach, to design a platform capable of satisfying needs by the EOSC community and the two DGs involved in the partnership (RTD and CNECT).

Different types of indicators: The EOSC Observatory will include indicators that showcase the intent, readiness, investments and direct outcomes of both MS/AC and individual organizations, starting from an initial set of indicators as illustrated in the table below:

Table 5-1: EOSC Observatory first set of indicators.

Policies (intent & readiness)	
Existence/Pending of National Strategy for OS	Qual. Indicating period
Existence of Roadmap for OS	Qual. Indicating timeline
Type of policy in existence/pending	Qual. Indicating publications, data, assessment etc.
Regulatory framework in place	Qual. Based on a simple vocabulary
Input/resources (readiness & investment) – *entries are accompanied by funding information (qual)*	
# OA repositories	Quantitative, including typology and certification
# OA journals	Quantitative, including certification
Existence of CRIS	Quantitative
# and type of core infrastructure in place	A vocabulary for e.g., PID, AAI,
# Computing and storage resources available	Qual & quant. Definition of simple units
# Services offered to the research community	Quantitative. Include simple classification
# Skilled supporting personnel	# based on a vocabulary of roles (e.g., stewards, data librarians, curators, research engineers, IPR and DPO officers)
Outcomes (actual progress)	
# OA and FAIR results and their uptake	Quantitative, including detailed metrics for OS facets such as the use of CC, metadata, PIDs, etc.
# Computing and storage resources used	Quantitative, indicating the use of resources from the community (if possibly broken down by sector)
# Services used by the research community	Quantitative, indicating the use of resources from the community (if possibly broken down by domain discipline)

Flows of data and quality assurance processes: For the quantitative approach EOSC Future has already identified several authoritative sources to consider:

[24] https://www.openaire.eu/os-eu-countries.
[25] https://osobservatory.openaire.eu/home.

- OpenAIRE Research Graph[26] and Open Science Observatory (outcomes and usage);
- National open science observatories (outcomes);
- EOSC Portal with registered services (service outcomes and usage);
- Global registries such as re3data, ORCID, DOAJ, OpenDOAR (input and investments).

For the qualitative approach (validation of collected data via automated methods and survey data) the EOSC Observatory plans to enable a multi-user entry approach by giving permissions to *designated* users from the community (e.g., members of networks from Research and e-Infrastructures such as NOADs, NGIs, NRENs and RI nodes) and to *authoritative* users at the organization level (e.g., designated by an EOSC-A member) and MS/AC (e.g., member of the Steering Board) who will be able to, consolidate, validate and approve final records.

Presentation: EOSC Observatory will include a mixed presentation format with aggregates (and potential benchmarks) in Europe or regions of Europe and individual countries, with most indicators open to all, while providing the possibility to have more complex indicators and detail benchmarks on a private space.

[26] https://graph.openaire.eu/.