Implementation of Science, Technology and Innovation Policy Instruments towards the Sustainable Development Goals

Manuel Ricardo Galindo Moreno; Kornelia Tzinova; Zengmei Wang; Ana Peršić, UNESCO (sciencepolicy@unesco.org)

Abstract

This policy brief utilises data from UNESCO's Global Observatory of Science, Technology, and Innovation Policy Instruments (GO-SPIN) and relevant literature to explore the correlation between science, technology, and innovation (STI) policy instruments and the Sustainable Development Goals (SDGs). It also aims to identify good practices for implementing these policy instruments. An analysis of STI policy instruments from more than 90 countries indicates a concentration of efforts on the SDGs linked to SDG 9 (Industry, innovation, and infrastructure), SDG 8 (Decent work and economic growth) and SDG 4 (Quality Education). However, it is essential to target a broader set of SDGs for which mission-oriented policy instruments could be viable. The case studies from Paraguay and the United Republic of Tanzania describe their policy instruments and highlight practices for effective policy implementation, management, and evaluation. To maximise the impact of STI policy instruments on the SDGs, there must be a continued commitment to improving management practices and implementing rigorous evaluation and adaptive learning mechanisms.

Trends in the linkages between STI policy instruments and the SDGs

Science, technology, and innovation (STI) are essential in tackling global challenges such as climate change, food security, access to clean water, and, more broadly, achieving the Sustainable Development Goals (SDGs). Understanding the landscape of STI policies and their impact is key to maximising their potential. For this purpose, UNESCO's Global Observatory of Science, Technology, and Innovation Policy Instruments (GO-SPIN) serves as a comprehensive platform. It promotes evidence-based policymaking and brings together STI policies, institutions, legal frameworks and other policy instruments, together with indicators on research and development from more than 90 countries around the world. GO-SPIN includes more than 1,200 policy instruments linked to the SDGs, reported by government officials and curated by UNESCO (UNESCO, n.d.).

The analysis of STI policy instruments[1] using GO-SPIN (UNESCO, n.d.) reveals a significant emphasis on SDG 9 (Industry, innovation, and infrastructure), SDG 8 (Decent work and economic growth) and SDG 4 (Quality education). This emphasis suggests an implicit expectation that research and innovation will spontaneously converge to resolve critical societal challenges. Although such an approach may stimulate a wide range of scientific discoveries and innovations, it often lacks the direction necessary to address the specific complexities or requirements of the SDGs.

Even with these general trends, there is substantial potential for STI policy instruments to explicitly target broader SDGs. In 2020, the European Union embraced its own form of mission-oriented policy instrument by identifying five concrete missions, each with specific targets, for its research and innovation funding programme to 2027, Horizon Europe (UNESCO, 2021). Nonetheless, mission-oriented research and innovation policy instruments have yet to be widely adopted in other regions of the world.

Mission-oriented research and innovation policy instruments require a public sector with the capacity to support implementation, including via new skills, resources and policy function capabilities (Wu et al., 2018). Moreover, the UN Secretary-General has highlighted the necessity of equipping governments with the capacity to continually reassess and refine policy implementation (UN, 2023). The following sections delve into challenges for STI policy implementation and best practices, illustrating these with case studies.

[1] Policy instruments are technical and operational programmes required to solve the issues identified by a policy. They represent the micro view detailing solutions with greater refinement that focus on a public target, estimate resources, select indicators, and set short, medium, and long-term goals, respectively, for delivering products, results, and impacts (Lassance, 2020; UNESCO, 2015). Examples range from financial tools like grants and tax incentives to support services such as incubators, business advisory, and technology extension programs.

Table 1. Linkages between STI policy instruments and the SDGs*

Region	Indicator	SDG 1: No Poverty	SDG 2: Zero Hunger	SDG 3: Good Health and Well-being	SDG 4: Quality Education	SDG 5: Gender Equality	SDG 6: Clean Water and Sanitation	SDG 7: Affordable and Clean Energy	SDG 8: Decent Work and Economic Growth	SDG 9: Industry, Innovation and Infrastructure
Africa	Share of region's policy instruments	6.95%	9.27%	4.30%	23.51%	6.62%	0.99%	1.32%	32.12%	65.89%
	Number of policy instruments	21	28	13	71	20	3	4	97	199
Arab States	Share of region's policy instruments	-	2.35%	3.14%	8.24%	0.78%	2.35%	2.35%	32.16%	78.82%
	Number of policy instruments	-	6	8	21	2	6	6	82	201
Asia and the Pacific	Share of region's policy instruments	1.44%	0.72%	3.60%	8.63%	11.51%	1.44%	4.32%	30.22%	83.45%
	Number of policy instruments	2	1	5	12	16	2	6	42	116
Latin America and the Caribbean	Share of region's policy instruments	1.26%	2.52%	2.16%	13.49%	1.98%	1.26%	1.62%	28.42%	77.16%
	Number of policy instruments	7	14	12	75	11	7	9	158	429
North America and Europe	Share of region's policy instruments	-	1.69%	1.12%	3.93%	17.42%	-	3.37%	11.24%	82.02%
	Number of policy instruments	-	3	2	7	31	-	6	20	146
Total	**Share of total policy instruments**	**2.10%**	**3.64%**	**2.80%**	**13.01%**	**5.59%**	**1.26%**	**2.17%**	**27.90%**	**76.29%**
	Number of policy instruments	**30**	**52**	**40**	**186**	**80**	**18**	**31**	**399**	**1,091**

Region	Indicator	SDG 10: Reduced Inequality	SDG 11: Sustainable Cities and Communities	SDG 12: Responsible Consumption and Production	SDG 13: Climate Action	SDG 14: Life Below Water	SDG 15: Life on Land	SDG 16: Peace, Justice and Strong Institutions	SDG 17: Partnerships for the Goals
Africa	Share of region's policy instruments	0.99%	0.99%	1.99%	0.66%	0.66%	2.65%	-	8.61%
	Number of policy instruments	3	3	6	2	2	8	-	26
Arab States	Share of region's policy instruments	-	1.18%	-	-	0.78%	2.75%	-	15.69%
	Number of policy instruments	-	3	-	-	2	7	-	40
Asia and the Pacific	Share of region's policy instruments	-	0.72%	-	1.44%	-	0.72%	0.72%	7.19%
	Number of policy instruments	-	1	-	2	-	1	1	10
Latin America and the Caribbean	Share of region's policy instruments	1.26%	0.54%	0.54%	0.54%	1.80%	1.62%	0.18%	8.09%
	Number of policy instruments	7	3	3	3	10	9	1	45
North America and Europe	Share of region's policy instruments	0.56%	-	-	1.12%	-	0.56%	0.56%	8.99%
	Number of policy instruments	1	-	-	2	-	1	1	16
Total	**Share of total policy instruments**	**0.77%**	**0.70%**	**0.63%**	**0.63%**	**0.98%**	**1.82%**	**0.21%**	**9.58%**
	Number of policy instruments	**11**	**10**	**9**	**9**	**14**	**26**	**3**	**137**

* A single policy instrument can target multiple SDGs.
Source: UNESCO (forthcoming in 2024)

Challenges for STI Policy Implementation

Despite utilising various instruments to advance STI policy agendas, policymakers encounter significant challenges. One major hurdle is the limited amount of information available on the suitability of these instruments to tackle different problems and policy contexts (Cirera et al., 2020; Crespi et al., 2011). Additionally, even when the issue to be addressed by the STI policy is accurately identified and its causes recognised, the effectiveness of any intervention depends on the final design of the instrument. Furthermore, some challenges in implementing STI policies and policy instruments stem from issues within public sector administration. Key considerations for policymakers and officials involved in implementing STI policy instruments include the following:

(1) Implementation process

The process of implementing STI policy instruments determines whether a policy will realise its objectives. It is, thus, crucial to success. During the implementation process, theoretical plans are translated into tangible action. Consequently, the present brief describes best practices for each aspect of the policy instruments' implementation, from communication to the finalisation of participation (Aridi et al., 2019; Cirera et al., 2020; Rogers, 2017):

- *Communication*. Provide and disseminate clear information about eligibility criteria, benefits and terms.
- *Call for proposals and project management*. Ensure calls for proposals are transparent, detailing the nature of projects to be funded or supported, funding levels, participant eligibility criteria and the application and selection processes.
- *Target audience identification and servicing*. Clearly determine the target audience or customer base, estimate potential uptake rates, strategise on reaching and servicing these customers, identify supportive stakeholders and decide on mechanisms for collecting feedback and utilising it for programme operations.
- *Beneficiary selection practices*. Ensure that instruments have transparent and clear scoring systems. It is also important to implement an appeal system and disclose the names of award recipients.
- *Application procedures*. Ensure the availability of user-friendly application processes, preferably online with minimal documentation requirements. Implementing agencies should leverage existing applicant information. Mechanisms should be in place to re-invite or redirect unsuccessful applicants to other suitable initiatives.
- *Delivery mechanisms*. The appropriate delivery mechanism and implementing agency will vary depending on the nature of the programme. Some

might be best delivered centrally, whereas others should be delivered through regional channels or third parties. Minimise agency numbers for a single instrument to reduce coordination challenges. If funding is involved, balance reporting requirements to maintain programme integrity without overburdening beneficiaries.

- *Funding distribution*. If funding is being provided, the instrument should balance the reporting requirements necessary for programme integrity, in order to avoid imposing administrative burdens on beneficiaries, which often take the form of organisations with strained human resources and financial capabilities.
- *Capacity-building and specialised skills*. Assess the capacity needed for instrument implementation, especially if it is new or requires specific knowledge. Develop capacity-building and skill acquisition plans, if necessary. If delivery is being outsourced, evaluate the skills needed for effective management and delivery.
- *Stakeholder engagement*. Involve stakeholders during both the instrument design and implementation phases. Structures should ensure that stakeholder feedback is considered.
- *Programme information management*. An integrated digital information system is crucial for managing applications and determining whether firms benefit from other instruments. Ideally, this system should be integrated with financial management and M&E modules.
- *Finalisation of participation in the programme*. Clearly define the end of support criteria and necessary closure documents. Implement systems to collect follow-up information, especially for innovation projects with medium to long-term impacts.

(2) Management quality

Effective STI policy instruments require robust management to function well. This goes beyond simple administrative functions and targets all aspects of an organisation's operations. This brief presents the following dimensions of management essential to implementing STI policy instruments successfully (Aridi et al., 2019; Cirera et al., 2020; Rogers, 2017):

- *Budget and resources.* Make sure that adequate budgeting is available for the instrument, including management, outreach and monitoring activities. Align disbursements with programme objectives and ensure rigorous financial control mechanisms are in place.
- *Organisation management.* Implement high-quality organisational management practices. If design and implementation teams differ, they should collaborate closely.
- *Role definition and autonomy.* Design the system to prevent undue external interference. Clearly define authority lines and decision-making procedures.
- Human resources and training. Address role definitions, task autonomy, skills investment and strategic alignment, and implement merit-based reward systems.
- *Incentives management.* Offer proper incentives for continuous job performance improvement, including linking pay and benefits to individual performance and providing career advancement opportunities.
- Process monitoring. Implement process monitoring with quality indicators and reporting for potential internal process improvements.

Annex 1 introduces a case study from Paraguay focusing on the challenges and successful strategies implemented in the creation and strengthening of Master's degrees and doctorates to enhance the country's science and technology sector. This box details the policy instrument used to promote SDG 4 (Quality Education) and contribute to establishing postgraduate programs and contributing towards the SDG target 9.5 (Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, especially developing countries), and the good practices adopted for an enhanced implementation process and quality management.

(3) Monitoring, evaluation and learning

Impactful STI policy instruments require a robust monitoring, evaluation, and learning system. This iterative process ensures that policy instruments achieve their intended goals and adapt to changing circumstances. Monitoring involves continuously tracking the progress and outcomes of the instrument implementation. The evaluation assesses the effectiveness and impact of these instruments, while learning focuses on utilising the gathered information to improve future design and implementation. This ongoing learning process allows for adjustments and refinements to STI policy instruments, ensuring they remain relevant and impactful. This section emphasises the importance of not only conducting routine fact-finding missions to ascertain the STI policy instrument's effectiveness but also utilising these findings to generate a continual learning process. Relevant

dimensions include (Aridi et al., 2019; Cirera et al., 2020; Rogers, 2017):

- *Programme monitoring and evaluation.* Both external and internal evaluations are crucial for accountability and learning, including periodic monitoring of progress made against targets. Evaluation results should inform future instrument design and improvements. Establish clear evaluation guidelines and plans in advance.
- *Knowledge management.* When implementing policy instruments, consider processes for learning to improve performance. This involves the documentation of experiences and decisions to adapt to new circumstances, the determination of implementation challenges not identified in the original design, documentation of the specific solutions adopted and remaining problems, and relevant data showing performance improvement. Policy-makers and science and innovation managers are also encouraged to connect with peers from other regions and countries to exchange knowledge and experiences

Annex 2 presents a case study from Tanzania, where an STI Policy instrument takes a mission-oriented approach to support human development linking SDG 3 (Good Health and Well-Being), SDG 4 (Quality Education) and SDG 6 (Clean Water and Sanitation). It outlines the collaborative efforts between the UK government and Tanzania and highlights the importance of consistent monitoring, evaluation, and adapting the program's theory of change based on actionable insights for achieving sustainable results.

Conclusion and policy recommendations

The analysis of STI policy instruments gathered from more than 90 countries via the GO-SPIN platform reveals significant emphasis on SDG 9 (Industry, innovation, and infrastructure), SDG 8 (Decent work and economic growth) and SDG 4 (Quality Education). This is a consequence of the popularity of policy instruments focused on curiosity-driven research and the general development of specialised human resources.

However, through explicit alignment, these instruments could potentially target a broader range of SDGs, such as SDG 3 (Good Health and Well-Being), SDG 5 (Gender Equality), SDG 6 (Clean Water and Sanitation), and SDG 13 (Climate Action). This is where mission-oriented research and innovation policy instruments can offer an interesting alternative.

The implementation of STI policies and instruments faces challenges, including the limited availability of information and the complexity of public administrations. The implementation process must include clear communication, transparent application procedures, and effective delivery mechanisms, among other best practices.

Additionally, the quality of budgeting, organisational management and human resources management is critical for successful policy implementation.

Lastly, monitoring, evaluation and learning are essential to assess the effectiveness of policy instruments, inform future improvements and foster a culture of ongoing learning and adaptation. Overall, enhancing management quality and implementation processes, combined with continual evaluation and learning, can strengthen the impact of STI policies in advancing the SDGs.

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Annex

Annex 1. Case study on the Paraguayan instrument for creating and strengthening master's and PhD degrees

Paraguay's science and technology sector is evolving, despite facing ongoing challenges such as the low number of researchers per million population compared to neighbouring countries and constrained opportunities for advanced education. The 2017 STI policy seeks to improve postgraduate programmes for training in research and development training and make it easier for students to access postgraduate education.

Established in (year?), the Creation and Strengthening of National Postgraduate Programmes initiative provides financial support for education-related expenses at master's and PhD levels, such as student enrolment fees, the payment of faculty's salaries, material procurement, examination board costs and student graduation ceremony expenses. It also includes a scholarship programme for students enrolled in selected postgraduate courses.

This policy instrument led to the establishment of 35 postgraduate programmes from 2014 to 2022. A significant measure of its success is that most institutions have continued these programmes beyond the initiative's support period. Additionally, the master's and PhD programmes supported by the National Council of Science and Technology (CONACYT) are on track for accreditation, reflecting a deep commitment to maintaining high educational standards.

This policy instrument has been gradually fine-tuned. Better stakeholder communication has been achieved by improving the clarity of the general terms and conditions. The application process has also been improved by transitioning from paper to online applications. The digital systems put in place operate according to open data principles, enhancing the credibility and transparency of the application process. Applicants can create profiles, enter their basic information and upload documents which, once validated, do not require resubmission for future applications.

However, one challenge for Paraguay is that institutional knowledge is often person-dependent. Public organisations rarely maintain core implementation staff for these programmes. Consequently, when the funding ends, these skilled individuals often have to leave, resulting in a loss of accumulated expertise. This, in turn, necessitates the training of new individuals, a task that can be complicated due to the steep learning curves involved once funding is available again.

Source: UNESCO. (forthcoming in 2024).

Annex 2. Case study on the Implementation of the Human Development Innovation Fund in the United Republic of Tanzania

In the United Republic of Tanzania, leveraging technology and innovation is crucial to enhancing essential services such as education, water, and health. A key focus lies in engaging the private sector and ensuring that women and girls particularly benefit from these improved services.

Aligned with its mission to alleviate poverty and foster innovation for essential service delivery, the UK government supported the Human Development Innovation Fund (. This program directly reflects the Tanzanian government's priorities, as national policies emphasise strengthening essential service delivery with private sector involvement.

The Human Development Innovation Fund has been conceived and funded by the UK Foreign, Commonwealth and Development Office (formerly the Department for International Development), in collaboration with the Tanzanian government through the Commission of Science and Technology (COSTECH).

The Human Development Innovation Fund consists in three subprogrammes: Inspire, which fosters an environment conducive to innovation; Catalysing, which provides funding and connects innovators to additional financial resources; and Transform, which encourages collaboration among the government, funders and the private sector, along with the incorporation of innovative practices.

The Human Development Innovation Fund has allocated US$ 29.14 million to support 48 innovative projects in Tanzania's health sector primarily, with additional emphasis on education and water, sanitation and hygiene. The Fund has targeted 20 regions, providing non-governmental organisations with significant support and grantees with technical assistance.

In its final phase, the Fund has established its successor, Funguo, which will be advancing Tanzanian ventures with expected impact, in accordance with the national and global development goals, supported by the United Nations Development Programme and international donors.

One good practice with regard to monitoring, evaluation and learning is that the Fund’s theory of change and results framework have been updated several times in response to insights gained from the programme’s inception to the monitoring and reporting stages of its implementation.

For instance, the theory of change evolved from a traditional challenge fund structure to one that integrates components for strengthening the innovation ecosystem as an essential part of the Fund’s activities. This shift also led to the inclusion of financial and non-financial support for COSTECH, especially for capacity building.

Source: UNESCO. (forthcoming in 2024).