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Science and technology for development: Priority themes

Global cooperation in science, technology and innovation for development

Report of the Secretary-General

Summary

A review of the status of global cooperation in science, technology and innovation (STI) for development in four key areas, namely, strategic planning, STI enablers, research and development and innovation, is provided in this report in order to highlight specific channels for international collaboration. Collaboration mechanisms, advances, lessons learned and good practices are presented and recommendations are provided of how STI organizations might better collaborate, to scale up impacts based on equitable partnerships and to empower less technologically advanced countries in catching up with rapid technological change.

As suggested in this report, member States, the international community and the Commission on Science and Technology for Development should consider the following six areas of work: reinforcing efforts to build an inclusive global STI agenda; developing a multilateral STI foresight and assessment system; building enabling digital and skill environments; fostering investment in STI and public–private partnerships; strengthening research networks and collaboration among different actors; and promoting technology and knowledge transfer. It is important to scale up existing efforts and increase synergies through enhanced international solidarity and cooperation, to ensure inclusive and equitable collaboration mechanisms that can speed up technological uptake in developing countries.

Introduction

1. At its twenty-sixth session, in March 2023, the Commission on Science and Technology for Development selected "Global cooperation in science, technology and innovation for development" as one of its priority themes for the 2023–2024 intersessional period.

2. The secretariat of the Commission convened an intersessional panel meeting on 6 and 7 November 2023 to contribute to a better understanding of this theme and to assist the Commission in its deliberations at its twenty-seventh session. This report is based on the issues paper prepared by the secretariat, the findings and recommendations of the panel, country case studies contributed by Commission members and contributions from United Nations entities.[1]

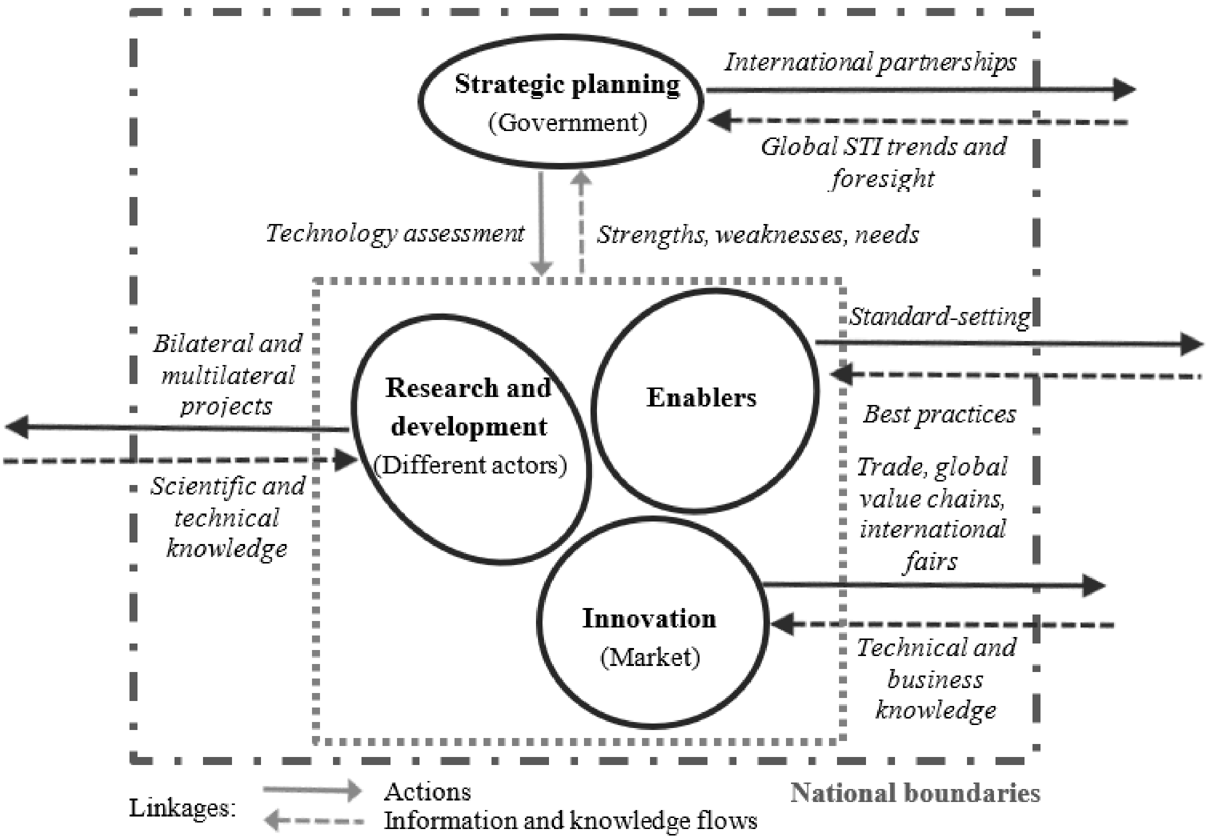
3. The growing complexity of new technologies and their fast pace of change, as well as the significant transformation brought about by recent waves of innovation, highlight the urgent need for a collaborative approach to STI. In view of the scale of global challenges and the significant potential of STI to deliver responses, global cooperation in STI is indispensable in order to achieve the international community's commitment to leave no one behind. Global partnerships, particularly on STI, including the Global Partnership for Sustainable Development addressed under Sustainable Development Goal 17, are necessary to mobilize financial and knowledge resources from Government, business, academia and civil society, including the talent and knowledge available in developing countries and to facilitate the co-creation of global solutions to global challenges. Strengthening the national capacities of developing countries in STI is therefore integral to the achievement of the 2030 Agenda for Sustainable Development, which is the road map of the international community for a prosperous and sustainable future for all. Implementing the inclusive 2030 Agenda will require collaborative efforts to accelerate the development of the national innovation systems of countries in which such systems are still emerging, in order that truly global STI networks can thrive and deliver results.

I. Key elements for science, technology and innovation development

4. The national innovation system approach represents a framework to conceptualize and identify the many factors contributing to the innovative capabilities of a country. Given the increasing interconnectedness of STI activities at the international level, it is important to consider the national innovation system approach from a global perspective, emphasizing the needs, capacities and interconnections of the relevant innovation systems beyond national actors. A national innovation system is characterized by four key elements, namely, strategic planning, STI enablers, research and development and innovation, with connections and knowledge flows that cross national boundaries (figure 1). The dynamic interactions among the four key elements and the stakeholders involved require constant feedback and revision according to the state of the technological landscape (there are many other interactions and actors in a national innovation system; the figure highlights the main components and external relationships).

[1] Contributions from the Governments of Belize, Brazil, Burundi, Cameroon, China, Cuba, Ecuador, the Gambia, Hungary, Japan, Latvia, Peru, the Philippines, Portugal, the Russian Federation, South Africa, Türkiye, the United Republic of Tanzania and the United States of America, as well as the Economic and Social Commission for Asia and the Pacific (ESCAP), the Economic and Social Commission for Western Asia, the International Atomic Energy Agency, the International Telecommunication Union (ITU), the United Nations Educational, Scientific and Cultural Organization, the United Nations Office for Outer Space Affairs, the World Food Programme, the World Tourism Organization and the World Trade Organization are gratefully acknowledged. For all documentation from the intersessional panel meeting, see https://unctad.org/meeting/commission-science-and-technology-development-2023-2024-inter-sessional-panel.
Note: All websites referred to in this report were accessed on 10 January 2024.

Figure 1
Key elements of a national innovation system: International linkages



Source: UNCTAD.

5. Setting specific, achievable goals is the first step towards success. National strategies to achieve the Sustainable Development Goals can be set through multi-year plans, which should include STI as a driver of change. The overall direction can be formulated through strategic planning accompanied by instruments such as frameworks, policies, guidelines, standards and regulations. Careful consideration of the strengths and weaknesses of a national innovation system with regard to global trends in STI, as well as a comprehensive overview of the status and needs of the STI enablers available in the country, are the foundations of successful strategic planning. In addition, the international dimension and the growing impact of accelerated technological change requires coordinated responses that necessitate the development of global institutional frameworks. This requires a shared understanding of the implications of current technological change, to build consensus on a common vision that reflects the needs and aspirations of all countries. Global cooperation supporting the sharing of best practices and lessons learned, as well as the results of technological foresight exercises, plays a key role in this regard.

6. Each technological revolution has set greater requirements for STI enablers, which include both tangible (physical and digital) and intangible (human and knowledge) resources. The current economic paradigm not only requires the provision of stable and affordable electricity or functioning transport and mobile networks, but also has high standards with regard to bandwidth and latency,[2] and the increasing complexity of technologies often necessitates expensive research facilities and supporting services. Industry 4.0 technologies blur the boundaries between the physical and digital realms, and their integration into STI

[2] ITU, 2022, *Global Connectivity Report 2022* (Geneva).

and production strongly depends on a supportive digital infrastructure. Intangible resources are also increasingly critical.[3] Competencies and skills are needed at all levels, from those required to use new applications and products to those needed to develop new technologies or adapt imported ones to better fit particular needs and conditions. The lack of tangible and intangible resources in developing countries hinders the development of an enabling environment for STI, making international financial and technical cooperation critical, in particular for disadvantaged groups.

7. STI enablers are indispensable for the performance of the basic functions of a national innovation system. In this regard, it is useful to distinguish between research and development and innovation. Research and development includes basic and applied research, as well as experimental or incremental development conducted by universities, research institutions or firms. Innovation, which is the practical implementation of ideas that result in the introduction of new goods or services in the market or improvements related to enhanced production processes, marketing strategies and the overall organization of businesses, is mainly performed by firms. Research and development is characterized by a high degree of uncertainty about the results of a given endeavour and by a long-term horizon. For this reason, private actors that traditionally invest in research and development are generally large companies and highly specialized firms, and the private sector tends to focus on applied research with the aim of creating profitable products and services relying on particular industry knowledge. Basic research without dedicated commercial applications is largely funded by Governments and is conducted mainly by universities and research institutions. In both cases, competing at the technological frontier requires the significant accumulation of human and financial capital, practical experience and critical mass that takes place over time horizons that, in the absence of more intense international collaboration, are too distant to be relevant to global challenges.

8. With regard to innovation, many promising projects and new technologies never reach the market because the transition from the laboratory to successful innovation is particularly challenging; this failure is known as the “valley of death”.[4] Stronger public–private partnerships such as through university–industry collaborations, can help pass the valley of death, and connecting local industry with the international community can further stimulate technological uptake. In addition, incubators and accelerators play an important role in fostering innovation and knowledge-sharing by providing the necessary support to speed up the business process from ideation to commercialization. Test environments that mimic real-life conditions, such as testbeds and sandboxes, can facilitate product trials and enhance the fit with customer needs. Finally, interactions among firms through trade and participation in global value chains may be leveraged through dedicated programmes favouring knowledge transfer among the involved parties. The benefits of technology and knowledge transfer are manifold and can lead to enhanced competitiveness for both the source and the recipient.[5]

II. Status of global science, technology and innovation cooperation

9. Global challenges need global solutions, as shown by the threat of pandemics or climate change. In this regard, inclusiveness is not merely a matter of equity but also of effectiveness. The development of significant STI capabilities on a truly global scale is therefore a shared interest of the international community. International collaboration to support inclusive international innovation and research networks can help provide the critical mass that many countries are not able to build internally at the required speed. With regard to the four key elements for STI development, a review of the status of different areas of global collaboration (see table) is provided in this chapter, including key examples from the

[3] Corrado C, Hulten C and Sichel D, 2009, Intangible capital and United States economic growth, *The Review of Income and Wealth*, 55(3):661–685.

[4] Hudson J and Khazragui HF, 2013, Into the valley of death: Research to innovation, *Drug Discovery Today*, 18(13–14):610–613.

[5] UNCTAD, 2021, *Technology and Innovation Report 2021: Catching Technological Waves – Innovation with Equity* (United Nations publication, Sales No. E.21.II.D.8, Geneva).

United Nations system, regional and international organizations, research institutions and members of the Commission on Science and Technology for Development, highlighting collaboration mechanisms, areas of progress, lessons learned and good practices. Possible approaches to fostering international collaboration in STI at different levels are illustrated, which can promote the emergence of global solutions to accelerate progress towards achieving the Sustainable Development Goals.

Four key elements for science, technology and innovation development: Areas of global collaboration

Key element	*Main components*	*Areas of global collaboration*
Strategic planning	Agenda setting	International STI agenda
	Policies, standards and regulations	Multilateral STI foresight and assessment system
		Supportive international rules
STI enablers	Physical and digital resources	Digital infrastructure and interoperability
	Human and knowledge resources	Capacity-building activities
Research and development	Basic and applied research	Research funding
	Experimental development	International research collaboration
		Alternative modes of technology creation and distribution
Innovation	Production and logistics	Technology and knowledge transfer
	Marketing and sales	Testbeds
		Incubators and accelerators

Source: UNCTAD.

A. Strategic planning

(a) Inclusive international science, technology and innovation agenda

10. The formulation of an international STI agenda and evolution of the global innovation system have historically been skewed towards the perspective of developed countries. Instead, the development of an international STI agenda needs to be driven by more inclusive forces. This requires active and equitable participation by all countries and a diverse set of stakeholders. A multi-stakeholder approach can ensure the holistic treatment of increasingly complex and interconnected STI-related questions. Fostering inclusivity can also help enhance the legitimacy and credibility of STI activities by large actors that are increasingly subject to critical scrutiny.

11. A shift towards a more inclusive and participatory approach requires stakeholder engagement and practical support measures in order to create a collaborative setting facilitating exchanges of knowledge among different actors and recognizing the needs of less endowed countries. An example of a well-coordinated regional effort, with policies and mechanisms developed to support active cooperation in STI, is the Association of Southeast Asian Nations Plan of Action on Science, Technology and Innovation 2016–2025, which provides guidance to various subcommittees, to improve the monitoring and evaluating mechanisms of activities and resource mobilization. International collective research can equitably incorporate the views and priorities of different partners. For example, the European Organization for Nuclear Research (CERN) employs inclusive and equitable collaboration mechanisms based on open science and open data, in order for science to assist the achievement of the Goals, and adopts a partnership-oriented approach with clear common goals and a light leadership approach based on consensual governance among member States, to effectively manage multi-polarity and avoid gridlocks. In addition, CGIAR (formerly the

Consultative Group for International Agricultural Research), which works with over 3,000 partners in nearly 90 countries, offers a reference for the co-identification and co-creation of solutions to priority challenges related to global food security with the global South, whereby research is led by national partners, to address national priorities in Goals-related impact areas and guarantee inclusive and participatory approaches.

12. Rapid technological change and the global impact of emerging technologies challenge the design of science and technology policies. Inclusive discussions about emerging issues and possible alternative solutions at the international level are key in increasing the capacity of countries to leverage STI for sustainable development. The Commission on Science and Technology for Development provides a forum for such strategic STI policy processes, and its inclusive agenda-setting and in-depth analysis and consensus-building process on emerging topics represent a major comparative advantage. The Technology Facilitation Mechanism plays an important role in linking national innovation approaches to those at the regional and international levels and the annual Multi-stakeholder Forum on STI for the Sustainable Development Goals, in particular, facilitates discussions on STI-related cooperation on selected Goals. STI road maps for the Goals developed under the Mechanism provide policy and planning tools to support country-level actions to accelerate the achievement of the Goals.

(b) Multilateral technology foresight and assessment system

13. Technological foresight supports strategic planning by looking into possible longer-term scenarios of science and technology, while technology assessment focuses on the particular implications for a given national innovation system. Both are key in selecting priorities and shaping the STI agenda. Strategic STI planning requires capacity among national policymakers and other stakeholders to evaluate the implications for economies and societies of the development and deployment of certain technologies. Technical support to assess national STI systems and design or reframe national STI policies and plans is key in countries with limited resources. In this regard, UNCTAD conducts national STI policy reviews and pilot projects on technology assessment.[6]

14. National technology foresight and/or assessment exercises may be delivered through an international standing mechanism that includes different approaches, to support a well-informed decision-making and consensus-building process. The mechanism may leverage regional organizations through consultations and regional technology assessment exercises, to foster convergence on priority themes and needs and to share issues in implementing STI agendas that may be elevated at the international level in order to foster mutual learning. The system may be further reinforced by the monitoring of emerging technologies at the global level. An international system of technology foresight and assessment could offer a comprehensive analysis of global STI development, thereby providing directionality to technological change, promoting the alignment of national, regional and international STI agendas with the Sustainable Development Goals and fostering international collaboration.

(c) Supportive international rules

15. Supportive international rules and standards in a wide range of domains are essential to facilitate international collaboration and the diffusion and transfer of knowledge. For example, the set-up of international standards and regulations by ITU helps ensure the compatibility of telecommunications systems worldwide, underscoring the importance of harmonization and coherence in the global digital landscape. World Trade Organization rules governing international trade have direct effects on STI activities. In addition, efforts to align trade and intellectual property regimes with the needs of developing countries have been made, yet a more ambitious agenda is needed to support STI development at a scale commensurate with global challenges.

[6] See https://unctad.org/project/technology-assessment-energy-and-agricultural-sectors-africa-accelerate-progress-science and https://unctad.org/topic/science-technology-and-innovation/STI4D-Reviews.

16. International trade rules with a bearing on technology transfer could be made more consistent with the Paris Agreement under the United Nations Framework Convention on Climate Change, in particular articles 10 and 11, which advocate the importance of fully realizing technology development and transfer to improve resilience to climate change and reduce greenhouse gas emissions, as well as the necessary capacity-building.[7] Article 66.2 of the Agreement on Trade-Related Aspects of Intellectual Property Rights states that "developed country members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least developed country members in order to enable them to create a sound and viable technological base". Developed countries submit annual reports on related actions, yet reporting on implementation is not harmonized, making it difficult to map and compare existing initiatives. Defining reporting standards could help structure information and facilitate analyses, to enable learning from knowledge transfer experiences. In addition, extending more flexibilities to developing countries in the context of the Agreement, particularly for environmentally sound technologies, could support the implementation of an STI agenda for sustainable development and help make the multilateral trade regime more consistent with international climate change agreements.[8] For example, the World Trade Organization adopted a ministerial decision on 17 June 2022 to allow eligible members to produce and supply vaccines without the consent of the right holder to the extent necessary to address the pandemic; this shows how flexibility regarding intellectual property rights can make significant contributions to addressing global challenges.

B. Science, technology and innovation enablers

(a) Digital infrastructure and interoperability

17. Digital infrastructure is an important area of global collaboration. Beyond building infrastructure for connectivity to bridge digital divides, collaboration is needed to ensure interoperability across systems. This requires international standards and regulations. The work of ITU and the Broadband Commission for Sustainable Development contributes to both supporting seamless global connectivity and promoting inclusivity in the digital realm, by fostering public–private initiatives and targeting areas lacking digital infrastructure and improved connectivity for marginalized groups.

18. The fast growing value of digital data as an economic resource makes international cooperation in data governance, and cross-border data flows in particular, crucial, given the risk of fragmentation in the regimes applicable to data and concerns about the implications for the capacity of countries to harness data for development.[9] In the report of the Secretary-General on data for development, an in-depth analysis is provided from the development perspective of, among other areas, data governance, interoperability and security at both the regional and international levels.[10]

19. With the increasing digitalization and automation of production, the adaptation of physical infrastructure and linkages with digital infrastructure are becoming more important for the deployment of connected devices. Coordination between different sectors, such as energy and information and communications technology (ICT), is essential in building integrated infrastructure systems that enhance access to stable and affordable electricity, mobile networks and the Internet, thereby addressing a long-standing limiting factor in many developing countries. In this regard, the multisectoral Central Asia Regional Economic Cooperation Programme and the Programme for Infrastructure Development in Africa include efforts to boost regional integration by facilitating interconnected infrastructures,

[7] UNCTAD, 2023, *Technology and Innovation Report 2023: Opening Green Windows – Technological Opportunities for a Low-Carbon World* (United Nations publication, Sales No. E.22.II.D.53, Geneva).

[8] Ibid.

[9] UNCTAD, 2021, *Digital Economy Report 2021: Cross-Border Data Flows and Development – For Whom the Data Flow* (United Nations publication, Sales No. E.21.II.D.18, Geneva).

[10] E/CN.16/2024/2.

highlighting the importance of a coordinated approach to infrastructure development that serves common regional needs and interests.

(b) Capacity-building activities

20. Human capital is key for technological development, and a skilled workforce can drive the transition to a digital and knowledge-based economy. Mastering skills in science, technology, engineering and mathematics (STEM), including coding and data analytics, is critical, to empower the workforce to adopt and adapt to technological advances. In particular, digital competencies concern not only technical skills, but also the cognitive, social and emotional aspects of working and living in a digital environment. Such competencies are needed at various levels of complexity, from basic adoption and use to those needed to create new digital technologies. Building complementary skills such as in complex problem-solving, critical thinking and creativity, is also essential, to create the flexibility required for current and future demands for the workforce.

21. Inclusive education and training programmes should target the needs of different groups and ensure the development of digital skills for all and a fully inclusive digital society. For example, women represent less than one third of researchers globally, yet the participation of women in STI is key in reducing gender bias and increasing diversity in research. For example, Okayama University, Japan, in partnership with UNCTAD, launched the Young Female Scientist Programme to strengthen the research capacity of women in developing countries working in STI fields, offering opportunities to engage in cutting-edge research activities. In addition, the promotion of STEM skills can help address regional and international challenges. For example, the Africa Higher Education Centres of Excellence Project, a collaboration between the World Bank and Governments in Africa, stresses the promotion of regional specialization, to address common development challenges and the strengthening of high-quality training and applied research in areas vital for economic growth in Africa. The Global Learning and Observation to Benefit the Environment Programme, sponsored by the National Aeronautics and Space Administration (NASA) of the United States, couples the promotion of STEM literacy with environmental awareness and the scientific understanding of the Earth, and has, since its launch in 1995, provided environmental science learning experiences for over 1 million students, educators and scientists from 127 countries.

22. The capability to effectively design and implement STI policy is a key asset, requiring programmes dedicated to public institutions. UNCTAD offers customized training for developing countries integrating STI with trade, finance and investment perspectives, to support the development of the coherent integration of STI into an overall national development strategy.[11] Synergy and efficiency across different training experiences are ensured through collaboration with the United Nations Inter-Agency Task Team on STI for the Goals. Training courses and workshops on STI policy for the Goals help ensure equal gender representation and include a global repository of training materials and case studies, to facilitate mutual learning on STI policy implementation.

C. Research and development

(a) Research funding

23. Research funding is key in order to support the unfolding of STI in developing countries. The research and development investment gap for low-income and middle-income countries is wide not only in absolute terms but also when compared with gross domestic product (GDP), at 0.53 per cent, compared with the global average of 2.63 per cent. Uncertainty about returns and a lack of critical mass limits private sector investment; it is therefore important to mobilize both public and private funding. A collaborative research funding mechanism should take into account the specificities of and the synergies between different research areas, as well as mechanisms to ensure stakeholder commitment.

[11] See https://unctad.org/topic/science-technology-and-innovation/STI4D-Capacity.

24. To strengthen innovation ecosystems, STI funding should cover the full spectrum of research and innovation activities, from curiosity-driven research to the set-up of partnerships with industry for advanced demonstrators.[12] For example, Horizon Europe is the largest public fund for research and innovation, with a budget allocation of about €95 billion for the period 2021–2027 and from an international perspective, the programme has an explicit collaborative design, aimed at the creation of integrated research areas through multi-country projects, as well as the principle of co-financing, a focus on global challenges and openness to countries not members of the European Union, to ensure shared financial responsibility among member States and other stakeholders, as well as the inclusion of STI topics that may have an international outreach.[13]

25. To favour participation and the success of international experiences, international STI projects should be aligned with the priorities and plans of the countries involved. The Green Climate Fund, the largest international public climate fund, operates on the principle of country ownership, requiring countries to lead and engage, build institutional capacity and share responsibility and accountability for initiatives in which they are involved.[14] However, public funding alone is not sufficient to address climate change and support climate-resilient development pathways; greater private sector participation could help strengthen the effectiveness of international climate-related initiatives. Public–private collaboration is fundamental for the success of STI cooperation mechanisms, particularly in considering global challenges. In addition to financial considerations, the reduction of administrative burdens and introduction of greater flexibilities in project agreements, such as in responding to changing business environments, could incentivize participation by private partners. For example, the Bill and Melinda Gates Foundation offers references on how to facilitate co-funding schemes and cooperation involving the public and private sectors and, by allowing for flexibility in projects, particularly regarding research contracts and intellectual property rights (e.g. arrangements that allow pharmaceutical companies to keep exclusive licences and sell at market price in developed countries if they commit to selling at marginal prices in developing countries), the Foundation helps make collaborative initiatives attractive to the private sector.

(b) International research collaboration

26. International research collaborations play an important role in promoting the sharing of scientific and technological resources, improving efficiency and helping to achieve research breakthroughs.[15] Key elements of international collaboration are as follows: sharing data and material; common academic and business standards; and the removal of administrative burdens, including the international mobility of researchers. Collaborations should focus on building the capacity of participating countries to effectively address their development priorities. Global research collaborations, from the exchange of ideas and sharing of data to close partnerships for particular projects, could be arranged in different formats based on the goals and commitment levels of stakeholders. For example, Eureka, the world's largest public network for international cooperation in research and development, involving 45 countries, promotes collaboration among enterprises and research institutes and contributes to the growth of market-led research and development, with a bottom-up approach that enables stakeholders to achieve market-oriented outcomes through strategically targeted industry-led research and development projects, which are reflected in the improved return of assets of participating firms.[16]

27. Cooperative scientific research is facilitated when scientific advances are considered a global public good and initiatives aim to bring together varied scientific communities,

[12] Bogers M, Chesbrough H and Moedas C, 2018, Open innovation: Research, practices and policies, *California Management Review*, 60(2):5–16.

[13] See https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en.

[14] See https://ieu.greenclimate.fund/evaluation/coa2019.

[15] Zu L, Dong B, Zhao X and Zhang J, 2011, International research and development networks, *Review of International Economics*, 19(2):325–340.

[16] Bayona-Sáez C and García-Marco T, 2010, Assessing the effectiveness of the Eureka Programme, *Research Policy*, 39(10):1375–1386.

promoting knowledge exchanges and co-designing future scientific agendas. Following this approach, the International Science Council mobilizes the academic community towards achieving the Goals and promoting data stewardship, sharing and dissemination.[17] Other examples of regional research collaboration, such as the ESCAP Asia-Pacific Research and Training Network on STI Policy and the Ibero-American Programme of Science and Technology for Development, underscore the importance of equitable partnerships, commitment to knowledge-sharing and open and inclusive collaboration mechanisms. In addition, the Grand Challenges initiatives can help direct STI towards particular development goals, with an approach that helps to spur the imagination of the public towards solving important national or global problems by linking local communities to a global network of problem solvers. Many countries and organizations, such as the United States Agency for International Development, adopt this approach, to spark innovation and accelerate development by identifying challenges linked to particular development needs. Doing so can be particularly relevant in addressing needs such as those related to diseases affecting people living in poverty, who are less likely to attract the attention of business innovators.

(c) Alternative modes of technology creation and distribution

28. Beyond the traditional model of research collaboration, open innovation, which leverages external research and development and market solutions in a non-proprietary manner instead of relying solely on internal resources, has received increased interest in recent years.[18] The use of open innovation can increase the efficiency of STI ecosystems by reducing the duplication of innovative efforts and incorporating different perspectives in the design of innovative solutions.

29. One pioneering concept is the open-source model, namely, the promotion of the free and open sharing of software source codes, to encourage collective improvement and distribution by users, for example by Firefox, Linux, My SQL[Structured Query Language] and Wordpress. Beyond software, the concept is applicable in diverse areas such as hardware and scientific research, such as in the Human Genome Project. Another concept is the crowdsourcing approach, which utilizes collective intelligence to generate ideas or solve particular problems. The potential uses of crowdsourcing are significant, ranging from data collection to solution ideation and from microtasking to testing. However, open-source approaches may be limited by a lack of incentives and recognition; developing income-generating models, based on open approaches and other forms of financial and non-financial incentives, is therefore important. For example, the Open Science Recognition Award of the American Geophysical Union brings recognition to researchers who incorporate and advance elements of open science and the NASA Transform to Open Science initiative is designed to transform agencies, organizations and communities towards an inclusive culture of open science and the development of open science curricula.[19]

30. The United Nations has launched many initiatives to leverage such new approaches to drive global STI collaboration for sustainable development, such as the Big Data Hackathon, the Open Sustainable Development Goals Data Hub and Unite Ideas, as well as the Building Blocks project of the World Food Programme. The United Nations Global Pulse, the innovation laboratory of the Secretary-General, supports responsible and inclusive innovation across the United Nations system, collaborating with partners on new solutions to speed up the transformation to United Nations 2.0. Experimenting, and supporting others in experimentation with new capabilities and tools, is key, to enable innovation and encourage a culture of creativity.

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[17] Dibbern TA and Serafim MP, 2021, The mobilization of the academic community towards the Sustainable Development Goals: Mapping the initiatives of international scientific associations, *Current Research in Environmental Sustainability*.

[18] Chesbrough HW, Vanhaverbeke W and West J, 2006, *Open Innovation: Researching a New Paradigm* (Oxford University Press, Oxford, United Kingdom of Great Britain and Northern Ireland).

[19] See https://science.nasa.gov/researchers/open-science/.

D. Innovation

(a) Technology and knowledge transfer

31. Technology and knowledge transfer is a multifaceted process involving the conveyance of knowledge, skills, procedures and equipment from one organization or country to another. In recent decades, there has been a shift, from a liner North–South knowledge transfer process to a more networked process, involving South–South transfers within and between sectors and involving both public and private partners.[20] The benefits derived from interactions vary according to the capacity to absorb and effectively utilize transferred technologies, and wide disparities in technological capabilities may impede effective transfers. In addition, a lack of commitment by stakeholders and limited financial resources can threaten the sustainability of transfer mechanisms.

32. Experiences from the United Nations system show that a better understanding of the socio-technological context can help facilitate the adoption of technology and create transformative change, compared with a technology-centred approach with weak stakeholder engagement.[21] International programmes supporting technology and knowledge transfer could be promoted as part of initiatives targeting developing country challenges or their integration into the global economy, as done for example through the Global Environment Facility, for the transfer of environmentally sound technologies; the United Nations Climate Technology Centre and Network, for capacity-building in technologies for climate change-related adaptation and mitigation; and the UNCTAD Automated System for Customs Data (ASYCUDA; see box).

Technology and knowledge transfer for trade facilitation

ASYCUDA is the largest technical cooperation programme at UNCTAD, working collaboratively since the 1980s to help developing countries access and use technologies to modernize and automate trade processes and procedures and to better capitalize on the growth and development potential of international trade. The ASYCUDA Programme helps Governments create systems that connect partner government agencies involved in the customs clearance process, for example through an electronic single window.

The ASYCUDA Programme collaborates with other international organizations, such as the United Nations Environment Programme, the United Nations Office for the Coordination of Humanitarian Affairs and the World Customs Organization, to design and build systems supporting mutual objectives, such as the software system built in collaboration with the secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, to help preserve ecosystems and biodiversity through the digitalization of trade-related procedures, and currently implemented in Mozambique and Sri Lanka.

A key part of the ASYCUDA Programme is the transfer of technology and know-how. The Programme responds to Government requests for technical assistance, delivering customized solutions in order to digitalize trade processes and procedures that meet particular needs. Local information technology, customs and partner government agency staff are upskilled to use, adapt and manage the new tools through comprehensive training. The aim is to eventually hand over ownership of customized systems to the countries that receive technical assistance.

Source: UNCTAD.

33. The importance of tailoring technology and knowledge transfer to national needs is shown through the Technology Bank for the Least Developed Countries, which aligns technology demands in these countries with appropriate solutions through the following three

[20] See https://www.worldbank.org/en/region/lac/brief/south-south-knowledge-exchange-latin-america-caribbean-region.

[21] See the science, technology and innovation policy reviews available at https://unctad.org/topic/science-technology-and-innovation/STI4D-Reviews.

pillars of work: country-specific technology needs assessment, to map key development challenges in STI ecosystems; identification of appropriate technologies for transfer guided by the assessment; and capacity-building, to ensure the technologies transferred are sustainable and that the recipient country develops technological and innovative capabilities for seamless and sustainable development.

(b) *Testbeds*

34. Testbeds, which are controlled experimental platforms that mimic conditions for conducting the testing of new technologies, products or services, play a critical role in ensuring that technologies are thoroughly evaluated and refined before widespread implementation. As the innovation landscape has grown more interconnected, testbeds have expanded beyond individual institutions or corporations and are now often open and shared platforms. They contribute to reducing the cost and difficulty of setting up individual testing environments and collecting user feedback, particularly in developing countries, by pooling resources and existing knowledge.

35. Open access to physical facilities and services represents a promising approach to serving start-ups and small and medium-sized technological enterprises with limited financial resources to test and develop new products. Such facilities should be designed to capture existing and potential demand from industry. For example, the European Union launched Open Innovation Test Beds to offer, including to non-European Union firms, a single entry point to the testbed facilities, capabilities and services required for the development, testing and upscaling of nanotechnology and advanced materials in industrial environments, and the initiative has helped bring innovation to the market faster, more easily, at a lower cost and with fewer technological risks.[22]

36. In the digital economy, a common architectural framework is needed to ensure the interoperability of systems for diverse applications and across a broad spectrum of industries. The Industry Internet of Things Consortium is a global partnership of Government, industry and academia dedicated to accelerating the adoption of the Internet of things and providing an industrial Internet reference architecture to address needs and support the development and adoption of related technologies; a major initiative, the business deployment accelerator, identifies end-user business “pain points” and technologies to address them and advises on deployments such as testbeds and test drives that can help resolve them, thereby coupling technical and business aspects.

(c) *Incubators and accelerators*

37. In transforming a new product or service into a thriving business, innovators often face a challenging financial gap from ideation to scale-up in the early stages, along with other difficulties related to both technical and business aspects.[23] To stand out in a competitive market with rapid technological development and business dynamics, innovators need to quickly build viable products and services from ideas. To speed up the process from ideation to commercialization, incubators and accelerators offer financial, technical, organizational and marketing solutions, such as seed funding, business support, market insights and networking opportunities, to help innovators build a successful business. An example of a successful public accelerator is Start-up Chile, based on a lean organizational setting with a prominent role for entrepreneurs in co-managing, which has supported over 2,200 innovative start-ups, attracting business ideas from across the globe, thereby highlighting the important role that the private sector can play in partnership with public initiatives.

38. The success of incubators and accelerators depends on the capability to create sustainable and competitive start-ups over time and link them with the rest of the economy. In this regard, it might be beneficial to target small businesses providing services to firms

[22] European Commission, 2021, Promoting the huge potential of open innovation test beds for European competitiveness, available at https://op.europa.eu/en/publication-detail/-/publication/bc29de66-7586-11eb-9ac9-01aa75ed71a1/language-en.

[23] Clayton P, Feldman M and Lowe N, 2018, Behind the scenes: Intermediary organizations that facilitate science commercialization through entrepreneurship, *Academy of Management Perspectives*, 32(1):104–124.

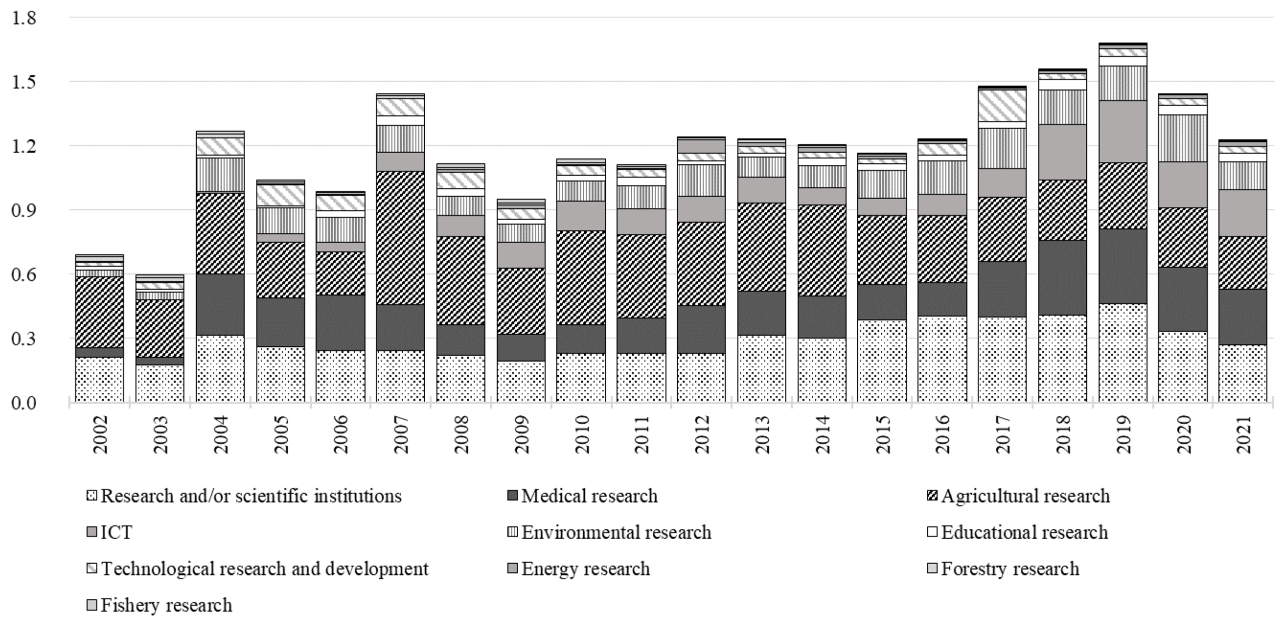
integrated in international markets, which are usually more dynamic, or local entrepreneurs seeking to apply globally available technologies to providing key services to local consumers, such as off-grid electricity or potable water. Through the latter, accelerators and incubators can also contribute to achieving the Sustainable Development Goals.

E. Official development assistance for science, technology and innovation

39. The concept of international STI collaboration extends beyond funding issues. However, collaboration is not possible between partners separated by significant capability gaps, and financial support from the international community, including through official development assistance, is critical to strengthening STI capacities in most developing countries. If channelled towards collaborative projects, it could strengthen the inclusion of developing countries in international research and innovation networks.

40. In 2022, official development assistance by Development Assistance Committee members amounted to $204 billion, or about 0.36 per cent of their combined gross national income and below the target of 0.7 per cent.[24] Progress towards the target has been limited in the last 15 years and only a few countries meet the target each year. In addition, the share of official development assistance dedicated to STI-related projects is marginal. The share of STI in total official development assistance has fluctuated at 1.2 per cent over the last two decades (figure 2). After showing a positive trend following the adoption of the Addis Ababa Action Agenda, with a peak of 1.7 per cent in 2019, the share declined in 2020 and 2021 to the level in 2012. The decline has been particularly marked with regard to assistance supporting research and scientific institutions, but has affected all categories, including medical research, despite a high ranking on the policy agenda due to the pandemic.

Figure 2
Share of science, technology and innovation in total official development assistance by category of main purpose
(Percentage)



Source: UNCTAD secretariat calculations, based on data from the Organisation for Economic Co-operation and Development on development finance and gross disbursement by official Development Assistance Committee donors.

41. The low budgetary relevance of STI in official development assistance does not reflect the increasing importance that research and development and innovation have in determining national development performance. In addition, it does not reflect increasing research and

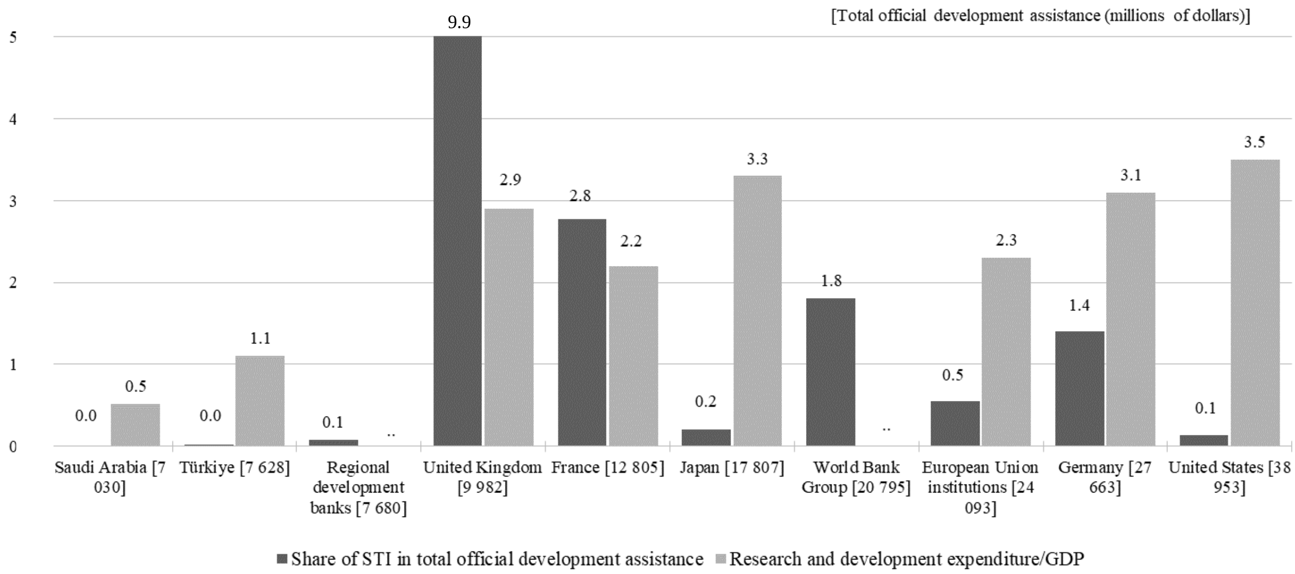
[24] See https://www.oecd.org/dac/financing-sustainable-development/ODA-2022-summary.pdf.

development investment among advanced economies. In most donor countries, the share of STI in total official development assistance is much smaller compared with their domestic research and development intensity, particularly in Japan and the United States (figure 3). In addition, institutional donors such as regional development banks invest a marginal share of their budgets in STI projects. However, the World Bank has a strong focus on ICT, which makes up 76 per cent of official development assistance in STI by the World Bank. France and the United Kingdom show strong engagement in supporting STI activities. Given the gap in official development assistance for STI, relatively small re-allocations from existing budgets could make a significant difference in overall assistance towards the strengthening of STI capacities in developing countries and, thereby, to the achievement of the Goals.

Figure 3

Share of science, technology and innovation in total official development assistance compared with share of research and development in gross domestic product: Top 10 official donors, 2021

(Percentage)



Note: Research and development over GDP cannot be computed for the World Bank Group and regional development banks.

Source: UNCTAD secretariat calculations, based on data from the Organisation for Economic Co-operation and Development on development finance and gross disbursement by official Development Assistance Committee donors.

III. The role of the Commission on Science and Technology for Development in facilitating global science, technology and innovation cooperation

42. The Commission contributes to facilitating global cooperation in science and technology by acting as a forum to discuss STI policy issues from a development perspective, providing an important international link to the strategic planning processes of developing countries, and an open platform for strategic planning, to impart directionality to international STI collaboration. It acts as a forum for strategic planning and the sharing of lessons learned and best practices, providing foresight about critical trends in STI in key sectors of the economy, the environment and society, and drawing attention to new and emerging technologies.[25] In addition, the Commission provides in-depth analysis and proposes recommendations on priority themes, with the aim of leveraging STI for sustainable development, and contributes to advancing the understanding of science and technology policies, particularly among developing countries. In this regard, the Commission could coordinate the international standing mechanism to deliver national technology foresight

[25] E/RES/2023/4.

and/or assessment exercises within the United Nations system, to continuously update countries on recent developments (see chapter II).

43. The Commission provides a platform for all STI actors in the international system to present, discuss and coordinate initiatives and partnerships. Interaction among members in response to the priority STI-related concerns of developing countries raised at the Commission has resulted in several programmes for international collaboration in STI, ranging from knowledge and technology-sharing to research capacity-building. Recent activities include the following: Crop Watch innovative cooperation programme, which aims to facilitate and stimulate agricultural monitoring in developing countries, to advance progress on achieving Sustainable Development Goal 2; Young Female Scientist Programme and Young Scientist PhD Programme, aimed at building human capital in STI-related fields in developing countries through educational programmes; South–South cooperation training workshop on the bio-circular-green economy model for inclusive and sustainable growth; technical cooperation activity on satellite technologies for sustainable urban development; and a workshop on harnessing STI for disaster risk reduction co-organized by UNCTAD with the Governments of the Philippines and the United States.

IV. Suggestions for consideration

44. STI offers transformative solutions that can accelerate progress towards an inclusive, sustainable and resilient world. Yet the opportunities and benefits brought by technological advancement are not distributed equally. Business as usual will increase rather than decrease inequalities, making it more difficult for latecomers to catch up. The absence of a truly global innovation system also implies that global challenges will not be dealt with in an optimal way. There is an urgent need to enhance international solidarity and cooperation, revitalize global partnerships and give renewed impetus to open, inclusive and equitable collaboration mechanisms.

45. Good practices and lessons learned from STI cooperation models that can inform possible approaches to strengthening international collaboration on STI are highlighted in this report. The findings stress the importance of guaranteeing open, inclusive and equitable collaboration mechanisms that take into account the needs and priorities of developing countries. Key features include a good governance structure, strong political will coupled with funding commitment, clear and transparent decision-making and implementation processes and mechanisms that consolidate feedback from different stakeholders.

46. The suggestions in this chapter cover the following six areas of work: reinforcing efforts to build an inclusive global STI agenda; developing a multilateral STI foresight and assessment system; building enabling digital and skill environments; fostering investment in STI and public–private partnerships; strengthening research networks and collaboration among different actors; and promoting technology and knowledge transfer. It is important to scale up existing efforts and increase synergies through enhanced international solidarity and cooperation, to ensure inclusive and equitable collaboration mechanisms that can speed up technological uptake in developing countries.

47. Member States may wish to consider the following suggestions:

(a) Formulate strategic plans for STI with clear, specific and measurable goals to seize the opportunities brought by technological advancement. Planning should reflect a country’s strengths and weaknesses in STI and highlight the connections and missing links between national needs and objectives and the international STI agenda;

(b) Conduct assessments of the strengths and weaknesses of national innovation systems, as well as technology assessment exercises, at regular intervals, drawing on experiences from regional and international foresight exercises. The results should be shared with other countries, to foster mutual learning and favour the creation of synergies on common issues and provide inputs for strategic planning on international STI collaboration;

(c) Create the conditions for accessible, affordable and high-quality digital infrastructure that supports STI development, which involves bridging the digital divide within a country, engaging in international standard-setting and building a regulatory environment that ensures sound competition in the telecommunications sector;

(d) Reinforce efforts to upgrade STI skills and those required by the digital revolution, from mathematics and statistics to coding and data analytics, at all levels, including among government officials, for the effective design and implementation of STI policy;

(e) Mobilize domestic resources by facilitating co-funding schemes and cooperation involving the private sector, as well as targeting the attraction of foreign direct investment in knowledge-intensive activities in particular areas of interest. Synergies between research and education and ministries of industry and economy could be leveraged to finance STI-related efforts closer to commercial applications;

(f) Engage with key private actors in the innovation ecosystem and promote collaboration between public and private entities to overcome the gap between science and technology and the introduction of innovations into the market. Affiliates of foreign companies could be leveraged to strengthen knowledge exchanges with international partners;

(g) Develop collaborative mechanisms to incentivize technology and knowledge transfer among universities, research institutes and the private sector, including at the international level. Priority could be given to the transition from basic to applied research and the application and diffusion of technologies and innovations in the economy.

48. The international community may wish to consider the following suggestions:

(a) Support the inclusion of developing countries in international research networks both financially and by providing assistance on how to participate and benefit from particular international settings. Regional mechanisms should put more effort into mediating between national STI needs and challenges and international opportunities;

(b) Cooperate to establish a mapping system to review and make sense of different technology foresight outcomes, making use of existing regional mechanisms and in collaboration with relevant stakeholders;

(c) Support the establishment of monitoring, evaluation and accountability mechanisms to foster international STI collaboration through enhanced trust, transparency, inclusivity and directionality;

(d) Strengthen funding and technical assistance to support digital infrastructure and to upgrade STI and skills in developing countries. Capacity-building activities could include international training programmes, the international mobility of researchers and public–private partnerships dedicated to particular areas, such as digital or entrepreneurial training, while emphasizing the empowerment of disadvantaged groups;

(e) Increase the share of official development assistance dedicated to STI. Funding could be also channelled to support the exchange of technical personnel between public and private institutions at the international level;

(f) Support the participation of researchers from developing countries in international research networks, including through mobility schemes, and the organization of international scientific events in developing countries;

(g) Explore ways to ensure that the transfer of technology from the private sector benefits the development of STI capabilities and enables innovation in receiving countries.

49. The Commission is invited to consider taking the following steps:

(a) Support coordination among different international bodies active in STI and facilitate the sharing of respective STI agendas and initiatives to address needs and issues common to different countries, thereby building consensus on a shared vision and objectives to guide global STI development;

(b) Facilitate coordination and convergence among different technology foresight approaches within international organizations, and leverage regional organizations through consultations on technology assessment exercises;

(c) Advocate increased efforts in promoting the development of capabilities related to STEM subjects in developing countries and remove obstacles limiting the international mobility of researchers;

(d) Explore the potential for innovative financing models, public–private partnerships, open-source and open-science approaches and other resources to strengthen the position of developing countries in collaborative STI projects and initiatives;

(e) Enhance collaboration with institutions providing project finance and resources, to ensure that STI initiatives are supported by adequate and sustained funding;

(f) Partner with existing STI collaboration schemes to extend them in order to include developing countries and design global collaborative schemes to pool resources from existing fragmented experiences;

(g) Establish a dialogue with organizations monitoring technology transfer activities on possible common reporting standards, to enable the collection of structured and harmonized information for the systematic analysis of knowledge transfer mechanisms.