# 14

Vigorously Advancing Science, Technology, and Innovation

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Advancing science, technology, and innovation (STI) in the country through increased use of scientific and technological breakthroughs will institutionalize improvements in production, health, education, energy, and infrastructure systems, among others.

The government will promote and accelerate technology adoption and stimulate innovation to advance the country's STI. Four subsector outcomes are tracked namely STI utilization in the agriculture, industry, and services sectors improved; investments in technology-based start-ups, enterprises, and spin-offs increased; creative capacity for knowledge and technology generation, acquisition, and adoption enhanced; and open collaboration among actors in the STI ecosystem strengthened *(See Figure 14.1).*

Figure 14.1 Strategic Framework to Leverage Science, Technology, and Innovation
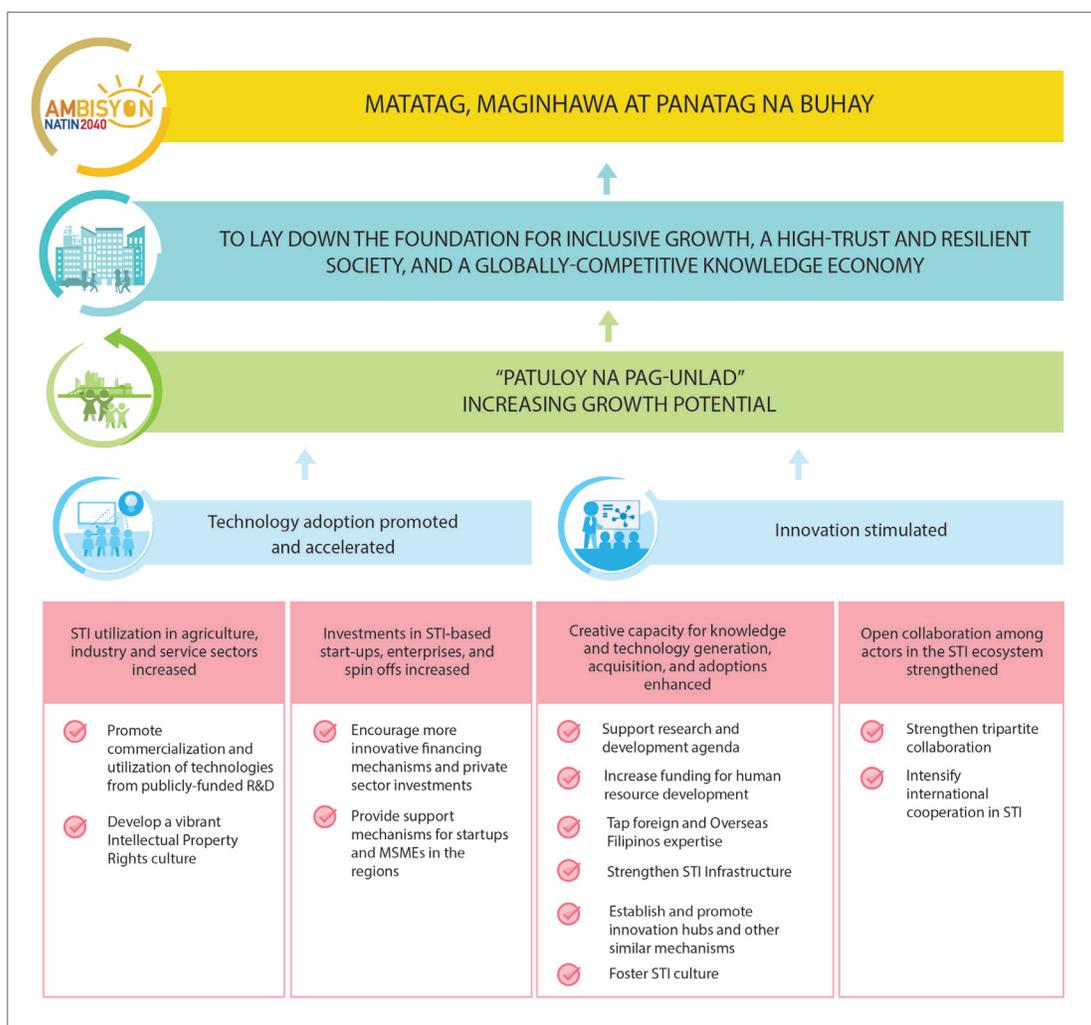
Accomplishments

In general, the country's performance in achieving the desired outcomes for the STI sector has been moderate. Latest available data indicate that four out of nine targets with available data have been exceeded.[1]

As part of developing a vibrant Intellectual Property Rights (IPR) culture in the country, the government is strengthening the implementation of a Patent Incentive Package, providing funding support on intellectual property protection, and conducting various awareness campaigns on the importance of IPR. In 2017, the country reached the top 33 percent percentile rank in the World Intellectual Property Organization–Knowledge and Technology Outputs Index, beating the top 34 percent target. In terms of industrial designs, there were 909 registrations, surpassing the target of 542. However, in 2017, there were only 19 new Filipino patents and 455 new Filipino utility models registered, falling short of the 33 and 594 targets, respectively.[2]

One of the main goals of the Philippine Development Plan (PDP) 2017-2022 is to support the development of the sectors that used to lag behind – especially farmers, fisherfolks, and micro, small, and medium enterprises (MSMEs). For the STI sector, the government targeted to provide start-ups and MSMEs with platforms for technology commercialization such as the establishment of new technology business incubators (TBIs). This pushed the number of TBI graduates to 56 in 2017, as compared to the 41 graduates recorded in 2016.

To foster a culture of inventiveness and creativity, government has been promoting STI and the creative arts to young students. In Academic Year 2016-2017, the number of Science, Technology, Engineering, and Mathematics (STEM) enrollees in higher education institutions (HEIs) reached 1.27 million, higher than the target of one million enrollees for 2017.

Moreover, the country has established a total of 30 innovation hubs as of end-2017. Although this slightly fell short of the target of 33, the 43 targeted innovation hubs for 2018 is still achievable as the government seeks to strengthen STI infrastructure development.

Open collaboration among actors in the STI ecosystem is also being strengthened to some extent. In 2017, the government engaged 33 new *Balik* Scientists, only a tad lower than the target of 39. The country is still on track of its target of top 50 percent in the University – Industry Collaboration percentile rank (in the World Economic Forum Competitiveness Report), despite dropping from 52.5 percent in 2016 to 51 percent 2017.

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[1] Only 9 out of 26 indicators for Chapter 14 Results Matrices (RMs) have available data. The RMs can be accessed through: www.neda.gov.ph/pdp-results-matrices/2017-2022/

[2] Examples: For patents, apparatus for reducing the risk of developing decubitus ulcers and adjunct to treatment thereof on immobile patients invented by Sonny Wilson R. Merioles and biogas from water lily invented by Dr. Virgilio L. Malang and Yasmin E. Malang; For utility models registration, combined motorcycle helmet and a locking mechanism by Miguel A. Timor and methods of preserving coconut water and fruit extracts by Cristovin M. Caralde; for industrial designs registrations, LED streetlight luminaiare (Skyled V2 – Big) by Joel T. Alegre and combined vertical axis wind powered turbine and solar power system by Engr. Tito J. Paalan.

Moving Forward

Promoting and accelerating technology adoption

STI utilization in the agriculture, industry, and services sectors increased

Outputs of STI activities are not brought to the market at once. The commercialization or the transfer of outputs of innovation activities to the mainstream market and to the public remains difficult. Many innovation outputs lie dormant and underutilized. The information dissemination activities particularly on available technologies remain low, while government campaigns are fragmented.

Acknowledging these challenges, the government will aggressively facilitate promotion, marketing, and commercialization of STI outputs. Higher budget will be earmarked for technology transfer and commercialization programs such as science fairs, exhibits, invention contests, technology transfer days, etc. Full use of the said budget will be ensured. The Technology for Innovation and Commercialization Program will continue to provide financial and technical support for the improvement and commercialization of research and development (R&D) results. In addition, the Department of Science and Technology (DOST), in partnership with the Department of Information and Communications Technology (DICT), will establish a central online repository of technology information for the sharing of and access to technologies and knowledge. The government will also actively promote the online repository to the public.

The Commisssion on Higher Education (CHED) with the Department of Trade and Industry (DTI), will formulate the Implementing Rules and Regulations guiding HEIs in intellectual property protection and utilization based on sound intellectual property valuation, landscape analysis, and business analytics. HEIs, state universities and colleges (SUCs), and research and development institutions (RDIs) will also be encouraged to put up their own technology licensing office to increase the commercialization of R&D outputs.

CHED will also monitor knowledge generation in CHED-funded HEIs doing research and development and extensions by implementing a real-time monitoring system based on quantitative indicators under the R.I.P.E. metrics.[3]

To facilitate the process of knowledge creation, technology transfer, and transformation of research results into products and services, the Intellectual Property Office of the Philippines (IPOPHL) will strengthen the Mind to Market Program which assists individuals and enterprises by linking them to a network of services (e.g., protection, commercialization, etc.) of partners (e.g., government, private sector, etc.). The Intellectual Property Hub and Spokes system will also be promoted to provide intellectual property infrastructure, enable linkages, and facilitate transactions among partners.

Disruptive[4] and/or emerging technologies may change the way things are done, create new industries and new jobs, and at the same time, cause job losses (e.g., low-skilled, repetitive jobs, assembly workers, as well as jobs in the IT-BPM, banks, advertising, health, research and development, and retail sectors).

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[3] Research management, leadership, and ethics; Integration in pedagogy leading to new understanding and coaching of young scholars; Productivity, innovation, research excellence, and global visibility; Engagement with the general public, local community, and industry.

[4] Disruptive technologies can be defined as new ways of doing things that disrupt or overturn the traditional methods and practices of conducting business (e.g., development of internet) (D. Chishakwe, W. Smith. 2012. An analysis of the impact of disruptive technology on the success of small and medium enterprises (SMEs) in a developing nation. A case of King Williams Town, South Africa)

The rate at which these technologies are being developed/adopted in many countries is very fast. In contrast, the country has not yet fully developed its own capabilities to produce/adopt these technologies. This constrains the country's ability to utilize disruptive technologies to raise economic growth potential.

Thus, the government will utilize promising and potentially disruptive technologies and minimize its potential adverse impact. The country will develop its capabilities to produce and utilize these types of technologies by conducting capacity building, conducting R&D programs, and adopting programs on the internet of things, artificial intelligence, big data analytics, robotics, 3D printing, nanotechnology, next-generation genomics, digital health, cloud computing, and blockchain, among others.

Investments in STI-based start-ups, enterprises, and spin-offs increased

The lack of awareness on the results of R&D activities and the lack of government's support mechanisms to help firms become more innovative still persist. Hence, technologies are not yet used extensively among MSMEs.

Accordingly, the government will strengthen support for spin-offs, start-ups, and MSMEs in the regions by providing, among others, technology business incubators, consultancy services, and financial support. It will establish more innovation hubs and shared service facilities; and undertake efforts to improve R&D productivity and to help bring down the costs of engaging in innovation activities.

The Small Enterprise Technology Upgrading Program (SETUP) will be relaunched as SETUP 2.0 to include both firm and industry-level interventions, as well as encourage smarter and more productive MSMEs. The implementation of the Startup Research Grant Program will be scaled up to help overcome R&D roadblocks, strengthen intellectual property protection, establish initial market traction, and refine business models. Enhancements to the program should be geared towards translating early stage technologies into market-ready products.

The Business Innovation through Science and Technology for Industry Program will facilitate the acquisition of high-tech equipment and foreign technologies by Filipino companies for their R&D activities. It will enhance their technological capacity to undertake R&D through funding, technology licensing, and acquiring patent rights. Moreover, the Inventor Assistance Program will be bolstered to connect small businesses and inventors to patent attorneys who provide pro bono legal assistance in securing patent protection.

Stimulating innovation

Creative capacity for knowledge and technology generation, acquisition, and adoption enhanced

Increasing R&D expenditure continue to be a great challenge. The country remains one of the lowest among ASEAN countries in terms of R&D gross expenditure as a percentage of gross domestic product (GDP). It has stayed at a low level (estimated to be less than 0.10% of GDP) and barely expanded for some time, preventing the country from taking full advantage of technological developments that could be leveraged to boost growth in the agriculture, industry, and services sectors. The 1 percent R&D spending share to GDP benchmark recommended by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) is still far from being achieved.

R&D budget and spending will be increased across regions to support R&D activities on new and emerging technologies. The government will also strongly pursue the implementation of the Harmonized National Research and Development Agenda (HNRDA) 2017-2022.[5] Roadmaps to harness identified new technologies such as the internet of things, artificial intelligence, big data analytics, and nanotechnology will be formulated in consultation with the private sector. Approval and rollout of these roadmaps will be targeted in 2019.

The government will conduct and encourage research activities in the Philipine (Benham) Rise and West Philippine Sea. Marine scientists and geologists will be trained and research vessels will be acquired to enable deep sea resource assessment and monitoring, and to conduct studies on oceanography and connectivity, coastal erosion and bathymetry, and connectivity of reefs along Eastern Luzon and Benham Bank.

The country is still characterized with weaknesses and inadequacy in STI human capital. Latest data showed that the country has only 270 researchers for every one million population in 2013. This is below the UNESCO norm of 380 per million population and the 1,020 researchers per million population average in East Asia and the Pacific.

More funding will be provided for Science, Technology, Engineering, Agriculture, and Mathematics (STEAM) scholarships. Science and Technology (S&T) scholarship programs[6] will be strengthened to encourage students to pursue STEAM. Specialized STI training will also be expanded. Student Financial Assistance Programs will be used to shepherd more scholars/enrollees to get into STEAM areas. Improving the K to 12 Transition Program should also lead to more study grants for STEAM scholars *(See also Chapter 10)*. Moreover, the government should establish more science high schools and science section institutions to help increase STI employment in the country.

CHED will launch new policies and standards for Philippine Graduate Education that will produce advanced competencies, spur leadership and innovation, drive scientific and technological growth, and creative learning. It will promote an ecosystem for digital technology in education, such as the development of online and blended learning, the introduction of massive online open courses, and other opportunities for open online education. To promote awareness and appreciation of STI, the government will aggressively promote the DOSTv[7] to the public through various marketing strategies including quad media.

The country still lacks STI infrastructures, while existing ones need upgrading/improvement. Furthermore, research institutions are still not widely dispersed across the regions and are still concentrated in Luzon.

The government will upgrade and establish research facilities to accommodate anticipated increase in R&D activities. In partnership with different sectors, the government will build more FabLabs,[8] laboratory facilities, R&D centers, and technology parks to increase R&D activities and hire more researchers, scientists, and engineers. Burdensome processes under the procurement law will be removed to facilitate

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[5] It articulates the country's priorities and guides public investment in R&D while ensuring a cohesive convergence and integration of R&D efforts. HNRDA 2017-2022 is organized into five sectors namely National Integrated Basic Research Agenda; health; agriculture, aquatic, and natural resources; industry, energy, and emerging technologies; disaster risk reduction and climate change adaptation.

[6] Example, Expanded Specialized Science Secondary Education Scholarship; Expanded Undergraduate S&T Scholarships for Inclusive Development; Expanded S&T Graduate (Masters/PhD) Scholarships, etc.

[7] DOSTv is the "official weather and science program of the DOST to communicate Science For the People, promote a culture of science and technology, and raise the aspirations to our youth to pursue careers in Science, Technology, Engineering, and Mathematics, and be the leaders of the future." Definition retrieved from http://www.dostv.ph/about.php

[8] FabLabs or fabrication labs are "technical pro-typing platforms for innovation and invention that allow local manufacturers to make prototypes and products such as equipment, machinery, and electronic gadgets; create scale models; illustrate graphic designs; and mass-produce products, among others." Definition retrieved from http://www.manilatimes.net/dti-launches-fabrication-laboratory-in-bohol/96298/

the acquisition of equipment and other materials needed for these infrastructures. The OneLab Network, a platform which integrates DOST research laboratories and other laboratories, will be strengthened to provide easy access to testing and calibration services. The implementation of the Information and Communications Technology (ICT) and Electronics R&D for Resilient Infrastructures Project will also be strengthened.

The following programs under DOST's Science for Change Program will also be boosted:

1. **Niche Centers in the Regions for R&D (NICER)** to capacitate regional HEIs through R&D funding that will improve regional research and S&T infrastructure, enabling HEIs to integrate regional development needs with R&D and local resources.

2. **R&D Leadership (RDLead)** will engage experts with strong leadership, management, and innovative policy-making proficiency to strengthen research capabilities of HEIs or RDIs. The experts will take the lead in establishing new and upgrading existing R&D centers and RDIs under the NICER Program. HEIs will also be capacitated in improving and speeding up the use of research results in addressing the pressing challenges in agriculture, industry, and emerging technologies.

Currently, data has not been sufficient to track the STI sector's progress and performance (e.g., absence of data on the following: R&D expenditure per sector; R&D budget utilization rate; technology transferred/ commercialized; number of researchers, scientists, and engineers; collaborations/cooperations between the government, industry, and academe; activities/pursuits of TBIs and STEM graduates; and number of STI-based start-ups). As a result, there are no existing targets for some indicators. The lack of these data impedes the anticipation of potential problems and better assessment of government interventions for the sector.

As a basic element for the formulation of national R&D and innovation strategies, the government will accelerate the process of gathering accurate and timely data to track the developments in STI. This will entail further strengthening of the Inter-Agency Committee on Science, Technology, and Innovation.

Open collaboration among actors in the STI ecosystem strenghthened

Problems in collaborative linkages among the government, academe, and industries still exist. The difficulty in finding cooperation partners for innovation activities is cited among the barriers to innovation.[9] Limited linkage between industry and academe in product development, incubation facilities, and R&D activities is also emphasized.[10] This is one of the reasons why many R&D outputs of the academe are not market-oriented.[11]

The government will strengthen coordination among the academe, industry, and the government. Linkages between knowledge producers and users will be bolstered. It will establish STI-related collaborations with business/entrepreneurial schools, firms, and other institutions. CHED will also establish a higher education network for research and innovation that will strengthen innovation and academe-industry partrnerhip. The network will push for equitable regional growth of RDI funding and outputs, and support HEIs towards their development as veritable research universities capable to meet international standards.

The Collaborative Research and Development to Leverage Philippine Economy Program will be promoted to help create a synergistic relationship between the academe, as producer of knowledge, and human resources and the industry, as translators of technologies to real world applications.

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[9] Mentioned in the Results of the 2015 Philipine Institute for Development Studies Survey of Innovation Activities
[10] Department of Trade and Industry Policy Brief Series No. 2017-05: Philippine Inclusive Innovation Industrial Strategy
[11] Catibog, N. (2016). Challenges Faced by Government Research Institutions & Public Universities in the Commercialization of Agricultural Innovation in the Philippines. Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development.

The implementation of the Converge, Network, and Collaborate for Economic and Technological Development will be augmented to facilitate the utilization and commercialization of intellectual property assets through the provision of opportunities for the academe and industry to meet, interact, and discuss possibilities of collaboration, either in terms of research or technology utilization, or commercialization.

International R&D collaborations on the following areas will be pursued: (a) nanotechnology, intelligent transport system, drug discovery, modern agriculture, food processing, electronics and computer, space technology, metrology, and innovative start-ups; (b) nuclear science; and (c) building start-up ecosystem.

The government will continue to encourage foreign experts to share their knowledge and expertise with the government, academe, and industry. The *Balik* Scientist Program and other related initiatives will be strengthened including: (a) the passage of the Act Strengthening the *Balik* Scientist Program[12]; (b) reduction, if not elimination, of hiring restrictions (e.g., Civil Service Commission [CSC] and Professional Regulation Commission [PRC] rules on hiring foreign experts and overseas Filipinos with foreign citizenship); (c) effective implementation of the Inclusive Innovation Industrial Strategy (i³S) and Inclusive Innovation Roadmap; (d) match priority sectors and technologies with the skills of the awarded Scientists under the program; and (e) ensure appropriate funding for the enhanced program.

The i³S will be implemented to help grow innovative and globally-competitive manufacturing, agriculture, and services sectors while strengthening their linkages to the domestic and global value chains. It prioritizes the growth and development of 12 major industries.[13] It entails the establishment of an inclusive innovation and entrepreneurship ecosystem that would strengthen industry-academe collaboration focusing on market-oriented research; faciliate the revision of the engineering curricula; equip universities to carry out research relevant to industries; encourage intellectual property protection; and provide incentives (i.e., tax credit, accelerated depreciation, etc.) and shared facilities for rapid prototyping and demonstration.

The government will also formulate the Inclusive Innovation Roadmap that will lay down the vision, goals, targets, priorities, and strategies to be implemented to create a collaborative and innovative ecosystem.

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[12] Seeks to strengthen the scientific and technological human resources of the academe, public institutions, and domestic corporations

[13] The major industries are: automotive; electronics and electrical; aerospace parts; chemicals; iron and steel and tool and die; garments, textiles, and furniture; shipbuilding; tourism; IT-business process management, particularly knowledge process outsourcing and E-commerce; agribusiness; construction; and transport and logistics.

Recommendations

In addition to the strategies that are currently implemented to advance the country's STI sector, the National Economic and Development Authrotity (NEDA) also recommends the following strategies to ensure that initial efforts are sustained.

Table 14.1. Supplemental Strategies to Leverage Science, Technology, and Innovation

CHALLENGES	RECOMMENDED STRATEGIES	IMPLEMENTING AGENCIES
Promoting and accelerating technology adoption		
STI utilization in the agriculture, industry, and services sectors increased		
• Outputs of STI activities are not brought to the market at once » The commercialization/transfer of the outputs of innovation activities to the mainstream market and to the public remain difficult » Many innovation outputs lie dormant and underutilized » Low information dissemination activities, particularly on available technologies and fragmented government campaigns	• Pursue more promotions and advocacy activities for STI by organizing regular fora, fairs, and exhibits which feature the innovation activities and outputs of the government, primary and secondary schools, SUCs/HEIs	CHED/ Department of Education
Investments in STI-based startups, enterprises, and spin-offs increased		
Stimulating innovation		
Creative capacity for knowledge and technology generation, acquisition, and adoption enhanced		
• Increasing the R&D expenditure continues to be a great challenge, preventing the country from taking full advantage of technological developments that can be leveraged to boost growth in the agriculture, industry, and services sectors	• Identify capacity constraints to undertake research in the academe—public and private— industry, business, government	NEDA, DOST, CHED, DTI, CSC, Department of Budget and Management
• Disruptive and/or emerging technologies may change the way things are done, create new industries and new jobs, and at the same time cause job loss » The country has not yet fully developed its own capabilities to produce/adopt these technologies, constraining our ability to utilize disruptive technologies to increase potential economic growth	• Formulate roadmaps on other promising and potentially disruptive technologies such as advanced robotics, next-generation genomics, digital health, autonomous and unmanned vehicles, energy storage, blockchain, cloud computing, among others. • Include R&D on new/emerging technologies in the research areas under the HNRDA 2017-2022. • Conduct activities that will ensure the effective implementation of the roadmaps on selected disruptive technologies (e.g., technology transfer events, promotional activities, central online repository of technology information, enhanced collaboration in the STI ecosystem, etc.). • Make changes in educational curriculum to prevent the potential adverse impacts of disruptive technologies. » For affected industries, retraining programs and skills development will be conducted to help workers develop and enchance their skills to enable them to adapt to other industries.	DOST/DTI DOST/IPOPHIL/ DTI/CHED/DICT
• Implementation of changes in the higher education curriculum of the country takes too long due to constraints in hiring of qualified instructors, purchasing/upgrading of equipment, and creating/amending policies in SUCs and HEIs	• Address the constraints in changing/updating curriculum on STEAM to respond to disruptive technology and other advancements.	CHED

CHALLENGES	RECOMMENDED STRATEGIES	IMPLEMENTING AGENCIES
• Brain drain problem in the country continues, as the supply of STEM graduates exceeds local demand » Many researchers, scientists, and engineers cannot find opportunities in the country, hence they seek employment opportunities abroad	• Craft a strategy/plan/roadmap on how to establish industries that can absorb researchers, scientists, and engineers (e.g., similar to the Silicon Valley).	DOST/DTI
• Lack of national framework that integrates sustainable consumption and production initiatives in the country *(See also Chapter 20)*	• Implement programs/projects on how STI can be utilized to establish a circular economy in the country.	DOST
• Insufficient data to track the STI sector's progress and performance, which impedes the anticipation of potential problems and better assessment of government interventions for the sector	• Identify new members of the Inter-Agency Committee on STI Statistics to ensure that statistics needed to monitor the performance of the STI sector will be idenitifed and produced. • Resolve problems encountered in producing the data needed for the STI sector. • Implement the NEDA R&D funded project on "Formulating a Statistical Framework for and Improving Statistics on STI."	PSA / DOST PSA
Open collaboration among actors in the STI ecosystem strengthened		
• Restrictive regulations delaying the implementation of R&D programs and projects, including CSC and PRC rules which make hiring of foreign and overseas Filipinos with foreign citizenship difficult	• Reduce, if not eliminate, restrictions in hiring foreign experts	DOST and other NEDA Board Member Agencies