United Nations E/CN.3/2018/29

Economic and Social Council

Distr.: General
21 December 2017

Original: English

Statistical Commission
Forty-ninth session
6–9 March 2018
Item 4 (i) of the provisional agenda*
Items for information: statistics on science, technology and innovation

Report of the Institute for Statistics of the United Nations Educational, Scientific and Cultural Organization and the Directorate for Science, Technology and Innovation of the Organization for Economic Cooperation and Development on statistics on science, technology and innovation

Note by the Secretary-General

In accordance with Economic and Social Council decision 2017/228 and past practice, the Secretary-General has the honour to transmit the report of the Institute for Statistics of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Directorate for Science, Technology and Innovation of the Organization for Economic Cooperation and Development (OECD) describing their work on science, technology and innovation statistics. The report presents recent developments in the measurement of science, technology and innovation, with particular emphasis on the recent revision and ongoing implementation of the OECD *Frascati Manual*, which was published in 2015 and is the worldwide recognized standard for measuring research and development. Another key feature is the progress of work to revise the *Oslo Manual*, which provides guidelines for collecting data on business innovation and offers a pathway for extending the measurement of innovation to other sectors. In addition, the report provides an overview of the revision process that is being carried out on the concept of scientific and technological activities, defined in the 1978 UNESCO Recommendation concerning the International Standardization of Statistics on Science and Technology. Among other things, the report also highlights efforts to develop a thematic set of scientific, technological and innovation indicators for the Sustainable Development Goals, in order to provide broader information on those components of the Goals and targets than is currently included in the core set of Goals. The Commission is invited to take note of the present report.

* E/CN.3/2018/1.

Report of the Institute for Statistics of the United Nations Educational, Scientific and Cultural Organization and the Directorate for Science, Technology and Innovation of the Organization for Economic Cooperation and Development on statistics on science, technology and innovation

I. Introduction

1. The present report has been produced in response to the regular request of the Statistical Commission on the status of science, technology and innovation statistics. Previous reports were presented to the Commission in 2004 (E/CN.3/2004/15), 2008 (E/CN.3/2008/21) and 2013 (E/CN.3/2013/22). The present report outlines the current situation and highlights some challenges and selected future developments. It has been jointly prepared by the United Nations Educational, Scientific and Cultural Organization (UNESCO) Institute for Statistics and the Organization for Economic Cooperation and Development (OECD) Directorate for Science, Technology and Innovation, with inputs from the statistical office of the European Union (Eurostat), the Ibero-American Network on Science and Technology Indicators and the New Partnership for the Development of Africa (NEPAD) Planning and Coordinating Agency of the African Union.

2. Science, technology and innovation are among the main drivers of economic growth and play a crucial role in poverty alleviation. Their importance in achieving development was emphasized in the 2030 Agenda for Sustainable Development, which positions science, technology and innovation at the heart of development as drivers and facilitators. Statistics on science, technology and innovation are fundamental to understanding the processes by which development has an impact on societies and their economies. Two key indicators related to research and development are now among the core indicators for monitoring target 5 of Sustainable Development Goal 9, which calls on countries to "enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending". Statistics on research and development efforts and outputs, innovation, and human resources for science and technology are discussed in the present report.

II. Modus operandi for work on science, technology and innovation statistics

A. United Nations Educational, Scientific and Cultural Organization Institute for Statistics

3. The UNESCO Institute for Statistics is the lead agency in the United Nations system for the collection of data on science, technology and innovation. The main lines of action of the Institute in statistics relating to science, technology and innovation are: survey operation and data guardianship; training and capacity-building; standard-setting and methodological development; and analysis and publications. This work is carried out in the framework of extensive collaboration and

partnerships with national, regional and international governmental and civil society organizations.

B. Organization for Economic Cooperation and Development

4. Work by OECD on scientific, technological and innovation statistics is principally conducted by the Working Party of National Experts on Science and Technology Indicators under the aegis of the Committee for Science and Technology Policy. The agenda of the Working Party is set out by an annually elected bureau from its membership, which is currently chaired by Norway. The Working Party is supported by a secretariat from the OECD Directorate for Science, Technology and Innovation. Work carried out by the Working Party is based on its long-term road map and shorter biennial schedules of projects that are reviewed, debated and prioritized by both the Working Party and the Committee, resulting in an overall programme of work. Statistical activities on science, technology and innovation have consistently ranked among the top priorities of the Committee, and scientific and technological methodologies, indicators and quantitative work have been rated by countries as among the highest in terms of quality and impact across the whole organization. Such groups are currently working on reviewing the innovation measurement framework, as well as on measuring and analysing business research and development structures and dynamics and the impact of public support for business research and development.

5. The Daejeon Declaration on Science, Technology and Innovation Policies for the Global and Digital Age,[1] which emanated from the OECD ministerial meeting of October 2015 in Daejeon, Republic of Korea, recognized the unique role of the OECD as an international forum for science, technology and innovation policy analysis and invited the OECD to continue improving statistics and measurement systems to better capture the key features of science, technology and innovation, including by ensuring a successful 2016 OECD Blue Sky Forum on Science and Innovation Indicators, which could make a major contribution to that goal.

C. Other organizations

6. Eurostat carries out data collection on research and development several times a year. It also collects innovation statistics by means of the Community Innovation Survey from the European Union and European Economic Area member States and affiliate and candidate countries. Through European Union statistical legislation, the most important elements of such data collection have been made mandatory for European Union member States. The Eurostat Working Party on Science, Technology and Innovation Statistics is also involved in methodological work in various scientific and technological domains. It has worked closely with OECD in the revision of the *Oslo Manual* and the *Frascati Manual* and other technical guidelines. The Community Innovation Surveys, prepared and coordinated by Eurostat, implement the central *Oslo Manual* innovation measurement guidelines in a comparable way across European Union countries. This preparation in particular consists of agreeing on a harmonized survey questionnaire to guide each biennial survey wave. The most recent Community Innovation Survey data released are for reference years 2012 to

[1] See www.oecd.org/sti/daejeon-declaration-2015.htm.

2014. The 2016 Community Innovation Survey is under way, while preparations for the 2018 survey are at an advanced stage.

7. The Ibero-American Network on Science and Technology Indicators collects and publishes statistics on research and development and innovation from Latin American countries, and is also active in studies relating to methodological issues and training at the regional level.

8. Between 2011 and 2017, the Science and Technology Consolidated Plan of Action was replaced by the first 10-year strategy for Africa, namely the Science, Technology and Innovation Strategy for Africa 2024,[2] supporting the implementation of the 50-year continental action plan entitled Agenda 2063: The Africa We Want.[3] To monitor and evaluate scientific, technological and innovation activities, a set of indicators for the Strategy was set up, among which are all the indicators produced in the 2010 and 2014 editions of *African Innovation Outlook*, as well as in the third edition, which is to be published in early 2018. The African Science, Technology and Innovation Indicators Initiative is also implemented back-to-back with the Science Granting Councils Initiative, which is aimed at strengthening the capacity of 15 science granting councils in sub-Saharan Africa. The councils are expected to sustain the collection of data on science, technology and innovation for the production of robust indicators to manage research and to inform the policymaking and decision-making process. Finally, the ministerial conferences on science, technology and innovation have been replaced since 2015 by the Specialized Technical Committee on Education, Science and Technology to coordinate matters related to the Science, Technology and Innovation Strategy for Africa 2024 and the Continental Education Strategy for Africa 2016–2025.[4] Thus, matters related to education and training, and to scientific, technological and innovation indicators, are handled by the Association for the Development of Education in Africa, the NEPAD Planning and Coordinating Agency and the African Union Commission through both the African Observatory of Science, Technology and Innovation in Equatorial Guinea and the education observatory in the Democratic Republic of Congo.

D. Publications and databases

9. The UNESCO Institute for Statistics provides research and development statistics to the Statistics Division of the Department of Economic and Social Affairs of the Secretariat (for the *Statistical Yearbook*), the United Nations Development Programme (for the *Human Development Report*), the World Bank (for the world development indicators), the *UNESCO Science Report*, *the World Social Science Report*, the *Global Innovation Index* and other stakeholders. Its global research and development statistics database is available online.[5] With the adoption of the Sustainable Development Goals, the Institute has been the custodian for two global indicators to monitor the Goals (indicators 9.5.1, on research and development expenditure as a proportion of GDP, and 9.5.2, on researchers per 1 million inhabitants). It has been providing these indicators for inclusion in the Statistics Division's Sustainable Development Goals monitoring report and the Sustainable Development Goals indicator database, from data collected through its global

[2] Available from www.au.int/web/sites/default/files/documents/29957-doc-stisa-published_book.pdf.

[3] Available from http://archive.au.int/assets/images/agenda2063.pdf.

[4] Available from https://au.int/sites/default/files/documents/29958-doc-cesa_-_english-v9.pdf.

[5] Available from http://data.uis.unesco.org.

research and development survey and/or data compiled from its data partners (OECD, Eurostat and the Ibero-American Network on Science and Technology Indicators). It has published thematic fact sheets on topics such as the evolution of research and development personnel and expenditure in the world, and women in science and technology. It released the UNESCO eAtlas of Research and Experimental Development,[6] which allows the user to explore and adapt maps, charts and ranking tables for more than 75 indicators on the human and financial resources devoted to research and development. Further, it has published interactive data tools on women in science and research and development expenditure. The interactive tool on women in science[7] helps the user explore the gender gaps in the pipeline leading to a research career, from the decision to obtain a doctorate degree to the fields of research that women pursue and the sectors in which they work. The tool on research and development expenditure[8] provides a global perspective on spending patterns, as well as time series data on regional and country-level commitments to research and development, in absolute and relative terms.

10. The Institute also publishes online its database for innovation statistics, which includes global innovation data for the manufacturing sector[5] and metadata, as well as a catalogue of innovation surveys carried out worldwide.[9] It released a number of information papers related to the results of the 2011 pilot data collection of innovation statistics,[10] 2012 innovation metadata collection[11] and the collection of global innovation statistics data in 2013[12] and 2015.[13] The results of the two collections of data on global innovation have been presented in various international forums and incorporated in many international reports, including the *UNESCO Science Report*. In 2017, the innovation survey was suspended owing to financial constraints.

11. Over time, the core science, technology and innovation statistical infrastructure delivered by OECD through the Working Party of National Experts on Science and Technology Indicators has grown to comprise the long-standing OECD Main Science, Technology and Innovation Indicators, the OECD Research and Development Statistics database, the Analytical Business Research and Development database, OECD innovation statistics, biotechnology and nanotechnology research and development data, and bibliometric indicators that are produced every two years.

[6] Available from www.tellmaps.com/uis/rd/#!/tellmap/187250920.

[7] Available from http://uis.unesco.org/apps/visualisations/women-in-science.

[8] Available from http://uis.unesco.org/apps/visualisations/research-and-development-spending.

[9] Available from http://nada.uis.unesco.org/nada/en/index.php/catalogue/innovation.

[10] Available from http://uis.unesco.org/sites/default/files/documents/results-of-the-2011-uis-pilot-data-collection-of-innovation-statistics-en_0.pdf.

[11] Available from http://uis.unesco.org/sites/default/files/documents/summary-report-of-the-2012-uis-innovation-metadata-collection-2013-en.pdf.

[12] Available from http://uis.unesco.org/sites/default/files/documents/summary-report-of-the-2013-uis-innovation-data-collection-2015-en_0.pdf.

[13] Available from http://uis.unesco.org/sites/default/files/documents/ip37-summary-report-of-the-2015-uis-innovation-data-collection-2017-en.pdf.

Core Organization for Economic Cooperation and Development science, technology and innovation databases managed by the Working Party of National Experts on Science and Technology Indicators

STI databases and publications	*Hyperlink to database*	*Nature of source*
Research and Development Statistics database and metadata, including research and development expenditures, personnel and budget	http://oe.cd/rds	Data collection, macro
Analytical Business Enterprise Research and Development database	http://oe.cd/anberd	Macro, industry-level
Research and development tax incentives statistics	http://oe.cd/rdtax	Data collection, macro
Innovation Statistics database	http://oe.cd/inno-stats	Data collection, macro
Main Science and Technology Indicators	http://oe.cd/msti	Macro and micro
Key biotechnology and nanotechnology indicators	http://oe.cd/kbi and http://oe.cd/kni	Data collection, macro
Scientometric and bibliometric indicators	http://oe.cd/scientometrics	Commercial, micro
Scoreboard on contributions to science, technology and innovation	www.oecd.org/sti/scoreboard.htm	Multiple sources

12. The OECD Main Science and Technology Indicators database and publication are released on a biannual basis and currently provide the most timely available source of information on research and development and other key scientific, technological and innovation indicators for the OECD area. The Research and Development Statistics database is based on an international data collection coordinated with Eurostat, comprising data on research and development expenditures and human resources and is available from the OECD statistics portal. Work is under way to increase the update frequency of the Research and Development Statistics database, which will make it the source of the most up-to-date data on research and development in the OECD area, while the Main Science and Technology Indicators database will continue to provide a biennial set of indicators. The Research and Development Statistics Database is accompanied by the Sources and Methods database, a metadata tool that provides detailed information on how research and development statistics are collected on a country and topic basis.[14] The Analytical Business Enterprise Research and Development database is produced by the OECD secretariat by adjusting research and development data, broken down by main economic activity and industry orientation, as presented in the Research and Development Statistics Database, to align it as well as possible with economic

[14] Available from http://webnet.oecd.org/rd_gbaord_metadata/default.aspx.

indicators in the OECD structural analysis family of industry structural databases. The OECD Innovation Statistics database was released in 2013 and is now in its third edition (2017). It comprises a series of key indicators on innovative firms and innovation activities for OECD countries and partner economies, comparing manufacturing and services, as well as large firms with small and medium-sized enterprises.

13. OECD patent and other intellectual property statistics are produced under the responsibility of the OECD Working Party on Industry Analysis. Statistics on human resources by occupation and educational attainment level are incorporated in the biennial science, technology and innovation scoreboard and are primarily produced across different parts of the organization. Statistics on the careers of doctorate holders are now produced on an ad hoc basis.

14. These databases and associated publications are freely available online. The contribution to the production and dissemination of the OECD scoreboard on contributions to science, technology and innovation is another major component of the contribution of the Working Party of National Experts on Science and Technology Indicators to the evidence infrastructure relating to science, technology and innovation and to the Committee for Scientific and Technological Policy. The OECD scoreboard provides a vehicle for developing and disseminating thematic indicators on various dimensions of the scientific, technological and innovation system, including indicators related to industry, trade and competitiveness. The latest edition was published in November 2017, with a focus on digitalization.

15. The G-20 Innovation Report 2016 also made extensive use of data and indicators related to science, technology and innovation to assess the innovation performance of Group of 20 (G-20) countries.[15]

16. For new and emerging work of both a statistical and a methodological nature, OECD uses its working papers series as a dissemination tool. Recent reports include studies on measuring design and its role in innovation; identifying factors influencing the international mobility of research scientists; measuring the link between public procurement and innovation; creating a revised OECD taxonomy of economic activities based on research and development intensity; and analysing links between *Frascati Manual* research and development and the System of National Accounts.[16]

17. Eurostat releases all its science, technology and innovation statistics for free on its website.[17] Together with the data from European Union member States, these releases also consist of data for other European and other countries depending on the availability of reasonably harmonized data and needs for showing comparisons. Database release is supported by short web articles on the “Statistics explained” web page and compendium publications of Eurostat. Science, technology and innovation statistics data are further reported in a variety of standard publications of the European Commission, such as the European Innovation Scoreboard. Data on research and development intensities (gross domestic expenditure on research and development as a percentage of GDP) belong to a set of Europe 2020 strategy headline indicators whose progress towards the target is closely monitored.

[15] Available from www.oecd.org/china/G20-innovation-report-2016.pdf.
[16] Available from www.oecd.org/sti/publicationsdocuments/workingpapers.
[17] Http://ec.europa.eu/eurostat.

III. Current work and future challenges

18. There have been many significant changes in scientific, technological and innovation statistics since the previous report by UNESCO Institute for Statistics and OECD to the Statistical Commission. The present section provides a summary of the key developments by thematic area.

A. Methodological developments in measuring research and development and other related activities

1. Revision and implementation of the *Frascati Manual*

19. The *Frascati Manual* was originally written by and for the national experts in OECD member countries who collect and issue national research and development data (see *Frascati Manual 2015*, chap. 1, para. 1.3). Over the years, it has become the standard of conduct for research and development surveys and data collection not only in OECD countries and the European Union, but also in other United Nations Member States, particularly through the science and technology surveys of the UNESCO Institute for Statistics. The revision process was initiated in 2013 and completed with the publication of the seventh edition of the *Frascati Manual*, in 2015.[18] This edition addresses various challenges in the collection, interpretation and international comparability of research and development data, taking stock of best practices and proposing clearer guidelines that are easier to implement, which are in the process of being broadly applied by OECD and other countries.

2. Measuring research and development in developing countries

20. The UNESCO Institute for Statistics encourages all countries to use the *Frascati Manual* international standard for research and development statistics. It disseminates the Frascati methodology throughout the world, including its main definitions in its research and development survey instruction manuals, and discusses the details of its application in workshops. As noted in the previous report, in 2012, the Institute produced the technical paper Entitled *Measuring R&D: Challenges Faced by Developing Countries*,[19] which led to the publishing of an online annex to the previous edition of the *Frascati Manual* on measuring research and development in developing countries.[20] That annex addressed particular issues by providing suggestions to practitioners in developing countries on how to apply the *Manual* given their specific circumstances. In the process of revising the *Manual*, the guidance contained within that annex has been integrated within the core sections of the *Manual*. The Institute has invested considerable effort to ensure that the revised manual reflects the contexts and needs of developing countries, by attending revision workshops and meetings, being part of several revision groups and commenting on draft chapters.

21. The Institute published in 2014 a guide to provide hands-on guidance to countries on how to carry out a research and development survey,[21] targeting in

[18] Available from http://oe.cd/frascati.

[19] Available from http://uis.unesco.org/sites/default/files/documents/measuring-rd-challenges-faced-by-developing-countries-2010-en.pdf.

[20] Available from www.oecd.org/science/inno/49793555.pdf.

[21] Available from http://uis.unesco.org/sites/default/files/documents/guide-to-conducting-an-rd-survey-for-countries-starting-to-measure-research-and-experimental-development-2014-en.pdf.

particular countries that are starting or seeking to measure research and development. While addressing common issues encountered in data collection, the guide also provides a project management template to conduct a research and development survey, in addition to model questionnaires for all performance sectors. Countries can download the model questionnaires, adapt them to their own needs and use them in their survey practice.

3. Revision of the concept of scientific and technological activities

22. The Institute has been in the process of reviewing the concept of scientific and technological activities, which was adopted by UNESCO in 1978. According to the original concept, such activities comprise research and experimental development, scientific and technological education and training, and scientific and technological services. While the *Frascati Manual*, which outlines the methodology for measuring research and development, has been updated regularly, the other two components of scientific and technological activities (services, and education and training) have not been reviewed since 1978. Concerns have been expressed that these two components should be re-examined for various reasons. The process of reviewing the concept began with scientific and technological services, which proceeded with the development of various proposals in close consultation with national science and technology statisticians and measurement experts over the past three years. A draft technical paper on measuring scientific and technological services which proposes revised and updated guidelines has been prepared. This is now undergoing a global consultation to gain the final perspective of national and regional experts and will be published in 2018. The review work related to the other component of scientific and technological activities, i.e. education and training, and the overall concept of such activities will be continued in 2018.

4. Development of thematic list of scientific, technological and innovation indicators for the Sustainable Development Goals

23. The Institute has been engaged in the process of developing a thematic set of scientific, technological and innovation indicators for the Sustainable Development Goals. To better reflect the role of science, technology and innovation in achieving the 2030 Agenda, there is a need for a fuller set of information than currently included in the core set of Goal indicators, to provide broader and more detailed information on the scientific, technological and innovation components of the Goals and targets, as well as on the science, technology and innovation commitments made in the Addis Ababa Action Agenda of the Third International Conference on Financing for Development. Accordingly, the Institute has been leading the process of developing the indicators. An initial proposal for such indicators is being finalized at present in order to bring it to the next level of consultation in 2018. The main output of this process will be the thematic list of indicators, accompanied by technical guidelines on how to collect or collate them, which will be important for countries to conduct national assessments. This would also provide an integrated approach covering all aspects of science, technology and innovation, provide a means of advocacy for science, technology and innovation and raise their visibility, provide information to policymakers on where to focus their efforts to achieve the Goals, and indicate areas where there is the greatest need for capacity-building.

5. Research and development capitalization

24. Through its involvement in the Expert Group on the Measurement of Non-financial Assets, the Working Party of National Experts on Science and Technology

Indicators played a key role in the latest revision of the System of National Accounts (the 2008 SNA) and the decision to treat expenditures on research and development as gross fixed capital formation. Following this, the Working Party of National Experts on Science and Technology Indicators helped the OECD Working Party on National Accounts prepare the OECD *Handbook on Deriving Capital Measures of Intellectual Property Products*, published in 2010, which includes a chapter on research and development and the implementation of the new System of National Accounts requirements. The 2015 edition of the *Frascati Manual* incorporated methodological guidelines to assist in offering a bridge between Frascati data and National Accounts concepts, and to enable improvement of the quality of National Accounts estimates of research and development output and assets. These are highlighted in the 2017 working paper entitled "*Frascati Manual* R&D and the System of National Accounts",[22] which also elucidates important differences between research and development expenditure and National Accounts research and development aggregates. In further support of these efforts, the Working Party of National Experts on Science and Technology Indicators actively participate in the task force on intellectual property products, which is run jointly by the OECD Statistics Directorate and Eurostat, and which is undertaking a stocktaking exercise to understand important differences in the way countries have applied the guidance to estimate National Accounts research and development figures.

6. Measuring the incidence and impact of public support for research and development and innovation

25. Over the past decade, OECD has successfully introduced regular data collection on the design of tax incentives for research and development and their financial cost to Governments.[23] These experimental indicators have been very influential in policy debates in several countries. The experiences accumulated over the past series of data collection fed into the 2015 edition of the *Frascati Manual*, which for the first time included guidelines on the measurement of government tax relief for research and development, alongside existing guidelines on measuring government budget allocations for research and development.

26. Building upon this comprehensive and internationally comparable evidence base on the size and nature of tax incentives provided by Governments to support research and development and innovation, OECD is carrying out a new microdata project which applies a "distributed" approach to the empirical analysis of microdata. The microBeRD project investigates and models the incidence and impact of public support for business research and development in collaboration with national experts with access to confidential microdata on research and development and on public support. This approach facilitates a coordinated statistical analysis of the impact of tax relief features and their interaction with direct forms of public research and development funding by exploiting variations in support within and among countries.[24]

7. Delivering the Blue Sky data and indicators agenda

27. The 2016 OECD Blue Sky Forum on Science and Innovation Indicators represented an important step for OECD and the Working Party of National Experts on Science and Technology Indicators, as it brought together very different

[22] Available from http://oe.cd/FMSNA.
[23] See http://oe.cd/rdtax.
[24] See http://oe.cd/microberd.

viewpoints and approaches towards the production and use of data and indicators on science, technology and innovation. Key recommendations made by the diverse group of participants currently being assessed by OECD are reported in the box below.[25]

Recommendations made by participants of the 2016 Blue Sky Forum to the Organization for Economic Cooperation and Development

Connect communities sharing an interest in evidence and analysis of science, technology and innovation

Connect the various communities with an interest in evidence and intelligence on science, technology and innovation.

Develop participatory data futures and gap analysis and data and evidence development road maps for the international community, producing and using scientific, technological and innovation evidence.

Promote international policy coordination for better and better use of science, technology and innovation evidence

Contribute to national efforts to develop an evidence culture among the international science, technology and innovation policymaking community, in areas such as:

- Empowering national statistical offices to secure access to and use of relevant commercial and administrative data
- Making administrative data on science and research funding more openly available and interoperable to benefit not only statistical evidence but also governance of science and innovation systems
- Providing more hands on guidance to practitioners.

Consolidate and extend work across different thematic areas, strengthening and contributing to developing the new generation of data infrastructure where it is uniquely placed to do so

- Continue developing statistical frameworks intended to reflect the broad and connected nature of science, technology and innovation, the process and implications of digitalization, and the plurality of actors involved, based on available experiences and tools and in partnership with the relevant organizations
- Collect evidence on the role of individuals in the scientific, technological and innovation system as a major priority
- Secure statistical information directly from key scientific, technological and innovation actors worldwide to identify, on a timelier basis, key emerging challenges and possible responses
- Extend the framework for conceptualizing and measuring innovation beyond business
- Build up international secure infrastructure and secure institutional agreements that facilitate the linking and analysis of microdata sources
- Map public efforts to support research and innovation towards a range of societal objectives and challenges so that global funding gaps can be identified

[25] See http://oe.cd/blue-sky.

- Provide evidence on the incidence and impact of known and hidden forms of public support for innovation
- Promote the integration of science, technology and innovation in economic statistics and in developing database models to account for the contribution of knowledge to economic performance within and among countries
- Ensure that statistics on science, technology and innovation capture globalization phenomena in spite of national jurisdictional approaches to statistics. Prioritize international comparability.

B. International research and development data collection activities

28. UNESCO has been collecting scientific and technological statistics from its member countries since the 1970s. After an absence in the 1990s, the UNESCO Institute for Statistics re-established a regular global research and development survey in 2004. After that, the survey was conducted biennially until 2014. From 2015 onwards, it turned into an annual collection of data; the ninth survey is currently being carried out. In order to avoid duplication in data collection, data-sharing agreements have been established with OECD, Eurostat and the Ibero-American Network on Science and Technology Indicators, and are in negotiation with the NEPAD Planning and Coordinating Agency. The questionnaire can be downloaded from the Institute's website and data can be submitted electronically using an Excel-based statistical data and metadata exchange questionnaire. The survey addresses 200 countries and territories, and data are available for 157 countries. Most of the non-responding countries are small island developing States, or less developed countries, which often have less developed scientific and technological systems.

29. OECD has collected research and development statistics for over 50 years for its member countries, and since 1997 has also covered selected non-member economies. A series of non-member economies are currently covered in the Main Science and Technology Indicators database. The coverage and content of those indicators is expected to be reviewed in the coming years.

C. Innovation statistics and indicators

1. Methodology and worldwide usage

30. Innovation surveys were developed primarily to increase knowledge about innovation in businesses, with the dual purpose of improving the understanding of the processes and outcomes of innovation and developing effective innovation policies. A revision of the *Oslo Manual* is ongoing, with the revised version due to be published in 2018. The G-20 Innovation Action Plan agreed in Guangzhou, China, in 2016 encouraged broad-based participation in the revision process,[26] which has been conducted through a series of workshops, meetings and webinars, as well as through an online community space. This process has included OECD members and representatives from international organizations and non-member countries. The membership of the steering group directing the revision membership also reflects the diverse range of producers and users of innovation data.

[26] See www.mofa.go.jp/mofaj/files/000185872.pdf.

31. By the agreement of the Working Party of National Experts on Science and Technology Indicators, the next edition of the *Oslo Manual* will remain primarily focused on understanding and measuring business innovation, although the concept of innovation itself, which can be applied across sectors, is also included. New content on business innovation capabilities, external factors that influence innovation, object-based approaches to measuring innovation, and indicators and analysis will also be incorporated. The revised framework will also address key shortcomings in the earlier framework by seeking to better cover firms that are not active in innovation so that differences can be understood and is aimed at finding synergies with the knowledge-based capital framework.

32. As highlighted in the previous report, in line with its medium-term strategy, the Institute started working on innovation statistics in 2010. The first activity undertaken was to make an inventory of innovation surveys carried out worldwide, where survey instruments and information on the methodological procedures followed to carry out these surveys had been collected. The inventory contains the main variables and methodological information of all surveys collected. Over the years, the Institute has continued to expand its inventory of innovation surveys to serve as a resource for countries seeking to start new national surveys or improve existing data collection. Most of the information collected has been included on the Institute's website, since March 2013 as an online catalogue of innovation surveys. In the framework of revising the *Oslo Manual*, the role of the Institute has been to ensure that the perspectives of developing countries are integrated in the text. This has been done by participating in the steering group on revision of the *Manual* and attending revision workshops and meetings, as well as commenting on the draft chapters.

2. Data collection

33. The most recently released Community Innovation Survey data are for reference years 2012 to 2014. This adds up to nine waves of the Survey, of which six have been released in tabular format. The 2016 Community Innovation Survey is under way, while preparations for the 2018 Survey are at an advanced stage. Together with the tabular output, Eurostat has been offering microdata from the Survey for research use, consisting of enterprise-level data from more than 20 countries, for the past four survey waves. This dataset can be accessed at the Eurostat Safe Centre in Luxembourg (or in a more anonymized form through CD-ROM release) against a signed research contract.

34. OECD incorporated into its core indicator offer a range of innovation indicators in 2013. The database is updated every two years with a number of indicators that feature in the biennial OECD scoreboard on contributions to science, technology and innovation. The Innovation Statistics database provides links to other international resources, as well as methodological guidance and analysis carried out by OECD.

35. With the start of innovation statistics programmed at the UNESCO Institute for Statistics in 2010, a pilot data collection in preparation for this new activity was carried out in 2011, targeting 19 countries. Responses were received from 12 countries.[10] Furthermore, a metadata collection was carried out in 2012,[11] which fed into the inventory and provided the necessary contact information for the first global innovation data collection, in 2013. Accordingly, the first global data collection was carried out in August 2013 and the results were successfully released in July 2014.[12] Following a biennial strategy, the second global innovation data collection was launched in June 2015. The results of the second global data collection were released

in August 2016, and contained data for 71 countries.[13] The survey has been temporarily suspended owing to financial constraints.

D. Intellectual property data and statistics

36. OECD intellectual property data, statistics and analysis are used by a range of decision makers. Patent-related indicators are available from the OECD.Stat database. Selected indicators on patents, trademarks and design are presented in the OECD scoreboard on contributions to science, technology and innovation. The OECD microdata lab on science, technology and innovation contains records on intellectual property rights documents from several administrative sources, encompassing patents, trademarks and design rights. While patent data rely mainly on the Worldwide Statistical Patent Database maintained by the European Patent Office, trademarks and design registrations are gathered from different intellectual property offices (IP Australia, the Japan Patent Office, the European Union Intellectual Property Office (formerly the Office for Harmonization in the Internal Market) and the United States Patent and Trademark Office). Several patent-related datasets are made available to researchers upon request (from a secure password-protected server). The datasets can be used as a complement to other existing patent data sets, e.g. the Worldwide Statistical Patent Database.

37. A series of methodological documents has been published by OECD to help design and interpret intellectual property statistics in an accurate manner. This includes a new taxonomy of information and communication technology patents based on the international patent classification; a report on measuring patent quality and indicators of technological and economic value; and data and analysis on the intellectual property bundles of the world's top corporate research and development investors.

38. The patent statistics task force that was created involving representatives from OECD, Eurostat, the European Patent Office, the Japan Patent Office, the Korean Intellectual Property Office, the United States National Science Foundation, the United States Patent and Trademark Office and the World Intellectual Property Organization has evolved from its initial objective of promoting the coordination of activities related to the production of statistics on patents to cover other types of intellectual property-based statistics and analysis. The task force, now renamed the Intellectual Property Statistics Task Force, has grown to incorporate several other national intellectual property offices and agencies.

39. The Intellectual Property Statistics for Decision Makers conference takes place every year, and has become a major event for science, technology and innovation statisticians, practitioners and data users. The conference is organized by OECD and the European Patent Office, in cooperation with national intellectual property offices. The most recent conference took place in Mexico City on 14 and 15 November 2017, and was co-organized by the Canadian Intellectual Property Office, the Mexican Institute of Industrial Property, the United States Patent and Trademark Office and OECD.

E. Human resources in science, technology and innovation

40. The mobility and labour market performance of highly skilled people has continued to be a major policy issue for all countries. In response to policy evidence

needs, OECD, the Institute and Eurostat developed an initiative on measuring the careers of doctorate holders. Guidelines, including a model survey and output tables, were updated in 2013 and 2014. Although collection of data on the such careers had gained traction in various OECD countries, as well as in some developing countries, the initiative has not achieved its stated aim of promoting dedicated primary data collection amid a context of budget cuts for new survey data collection. Eurostat deprioritized the collection of such data in 2013. OECD has since continued collecting data every two years with some partial success. The activity is currently under review following a "light" data collection carried out in partnership between the OECD Directorate for Science, Technology and Innovation and the OECD Directorate for Education and Skills, drawing principally on labour force statistics.

41. With its new pilot initiative, the International Survey of Scientific Authors,[27] OECD in 2015 directly contacted a large sample of corresponding authors who have published work in peer-reviewed scientific journals to collect information on their activities, from the underpinning research to its ultimate outcome, covering the review, publication and dissemination processes. As such, it is a key avenue for understanding the individuals engaging in science and innovation, as highlighted for investigation at the Blue Sky Forum in 2016.

42. The first online, email-based pilot project was based on a stratified random sample of authors of publications listed in a major global scientific publication index across seven diverse, hand-picked scientific domains. It investigated the research and publishing activities of scientific authors and the extent to which new approaches can be used to collect statistical data on the behaviour and impact of scientists. The outcomes of the survey were reported in 2016 in an OECD policy paper, providing evidence on the extent of journal- and repository-based open access data-sharing practices, the nature of the citation advantage conferred by different forms of open access, and the relationship of this advantage with the quality accreditation role played by journals and their reputation. The results also highlight the importance of considering economic incentives and social norms in developing policy options for open access, and provide new insights on scientific careers, mobility, and gender participation and pay biases. The anonymized microdata have also been released for use by researchers.

43. A second pilot project is under preparation to be carried out in the first quarter of 2018. It will collect statistical evidence on the use of digital tools for science and on their impact on different scientific activities. The adoption of new information and communication technologies is having a major impact on the processes underpinning the collection, generation, access, use and reuse of research and scientific material. Information and communication technologies are not only modifying the way scientific material is generated, collected and stored, but also helping promote deeper analysis of data through new software and applications. These allow a faster and more exhaustive use of data in scientific research, as well as encourage the adoption of different research paradigms, which raise a broad number of issues that are of relevance to all stakeholders with an interest in the governance of science. The pervasive use of data and data tools raises questions about research integrity and incentives. The development of information and communication technologies has been in turn propelled by scientific applications, also raising questions about the role of science as a driver of digitalization.

[27] See http://oe.cd/issa.

44. While educational statistics at the UNESCO Institute for Statistics give priority to basic education and Sustainable Development Goal 4 on education, some attention has been given to higher education. In 2014, the Institute released a report entitled *Higher Education in Asia: Expanding Out, Expanding Up — The Rise of Graduate wEducation and University Research*, combining tertiary education data with research and development data in order to analyse trends in graduate education across Asia. The report includes a chapter on the contribution of university-based research to national economic development.[28]

45. Since 2015, UNESCO and the Institute have been carrying out a joint project, with support from the Government of Sweden, on improved measurement of gender equality in science, technology, engineering and mathematics, entitled SAGA (Science, Technology, Engineering and Mathematics and Gender Advancement). The project is designed to contribute to improving the situation of women and reducing the gender gap in scientific, technological, engineering and mathematics fields in all countries at all levels of education and in research. To achieve these objectives, the project proposes methodologies to determine, measure and assess sex-disaggregated data, as well as to support the design and implementation of scientific, technological and innovation policy instruments that affect gender equality in those fields. Accordingly, during the first stage of the project, a new methodology and a set of instruments were produced and published as working papers. This includes, among other things, the SAGA toolkit,[29] which contains proposed surveys on policies and indicators, namely the survey on gender equality in scientific, technological and innovation policies and instruments, and the survey of drivers and barriers to careers in science and engineering", and methodological guidelines on drawing indicators from various data sources. Multiple partnerships have been maintained with several organizations to obtain their feedback and to continue with the development of necessary survey instruments. In the second stage of the project, which is being carried out at present, capacity-building activities in selected pilot countries from around the world are being implemented to test and improve the SAGA approach through the components of the toolkit, as well as to build national capacity for data collection on gender in science, technology, engineering and mathematics. Further, the SAGA project has been presented in many conferences around the world in order to introduce its methodology and tools, communicate its progress and results, and raise awareness among countries on the importance of reducing the gender gap in these fields. As a result, the SAGA methodology is also being used in a number of institutions and organizations around the world. In the final stage of the project (in 2018), the indicators from countries that have participated in the project will be synthesized and incorporated into the UNESCO Institute for Statistics database and the UNESCO Global Observatory of Science, Technology and Innovation Policy Instruments. Further, a technical paper containing methodological approaches, lessons learned and best practices will be published and widely disseminated.

F. Statistical capacity-building

46. Statistical capacity-building is part of the mandate of the Institute. In order to improve the availability and the quality of scientific, technological and innovation statistics in various regions of the world, capacity-building and training are needed.

[28] Available from http://uis.unesco.org/sites/default/files/documents/higher-education-in-asia-expanding-out-expanding-up-2014-en.pdf.

[29] Current version available from http://unesdoc.unesco.org/images/0025/002597/259766E.pdf.

The Institute has designed and delivered an extensive series of regional and national workshops since 2005, addressing statisticians in developing countries. These workshops were often carried out in partnership with UNESCO headquarters; its regional offices; regional networks such as the Ibero-American Network on Science and Technology Indicators and the NEPAD Planning and Coordinating Agency; funding agencies such as the Islamic Development Bank; and other interested partners.

47. Between 2013 and 2017, a number of regional workshops involving many developing countries took place in several regions. Workshops were held in 2013 in Colombia for Latin American and Caribbean countries and in the Islamic Republic of Iran for member States of the Economic Cooperation Organization; in 2014 in Morocco for North African countries; in 2015 in El Salvador for Central American countries; in 2016 in South Africa for countries of the Southern African Development Community; and in 2017 in Trinidad and Tobago for Caribbean countries. The goals were to increase the number of countries regularly producing quality scientific and technological indicators; to create local capacity for the production of such indicators; to promote evidence-based policymaking with regard to science and technology; to facilitate discussion between countries, addressing problems they may have encountered; to learn about the characteristics of the collection of scientific, technological and innovation statistical data in countries of the same region; and to identify examples of good practice to be shared with other countries. The workshops were targeted at the statisticians involved in the collection and analysis of data in each country, but also included policymakers and decision makers from a variety of national authorities.

48. From 2014 onwards, there was a strategic shift in direction, away from regional workshops to more targeted assistance at the national level. To reinforce country-level capacities, technical assistance for the conduct of research and development and/or innovation surveys were provided to a number of developing countries during this period: Algeria, Angola, China, Indonesia and Mongolia in 2014; the Bahamas, Cabo Verde, Guyana, Jamaica, Panama and Viet Nam in 2015; Iran (Islamic Republic of) and Mongolia in 2016; and the Gambia in 2017.

49. In addition, the Institute has contributed significantly to the content of several events on scientific, technological and innovation indicators organized by partners during the period of 2013–2017. Further, in 2013 the Institute was engaged in a project on the quality of research and development and innovation data in the western Balkan countries, the outcome of which was a proposal for a regional strategy for improving scientific, technological and innovation statistical systems in western Balkan countries.

IV. Conclusion

50. There has been considerable progress since the publication of the previous report to the Statistical Commission (E/CN.3/2013/22), as demonstrated by the increasing importance of statistics on science, technology and innovation to the global user community. The inclusion of two key indicators related to research and development among the core indicators to monitor target 5 of Sustainable Development Goal 9 and the work towards the development of a thematic set of scientific, technological and innovation indicators for the Goals will provide the global community with more detailed information on the scientific, technological and innovation components of the Goals and guidance to conduct related assessments.

51. There has been a significant convergence in the application of measurement standards developed by OECD and partner organizations, supported by an effective coordination of activities between the various global and regional organizations. Research and development statistics have been used to document the relative resilience to date of research and development investments in the face of the economic crisis, tracking the rapid emergence of several developing economies as global research and development powerhouses. Changes in the way that research and development takes place and is accounted for in business and other organizations are key factors that have been taken into account in the revision of the *Frascati Manual*, while digitalization processes and the growing importance of services have been reflected in the ongoing revision of the *Oslo Manual*.

52. The forthcoming *Oslo Manual* will not directly address user requests to measure innovation economywide, beyond the domain of market-based companies, but it will facilitate a more cohesive approach to developing such guidance.

53. The work towards the establishment of revised guidelines for measuring scientific and technological services, such activities being one of the components of the UNESCO concept of scientific and technological activities, will contribute to better measurement of a wide range of other science- and technology-based activities, other than research and development, for which the *Frascati Manual* outlines the related methodology.

54. The development of improved measurements of gender equality in science, technology, engineering and mathematics, through the UNESCO SAGA project, will provide countries with a variety of tools to help decrease the current global gender gap in these fields, which exists at all levels of education and in research.

55. The recent experience confirms warnings in the previous report that many national statistical organizations and bodies in charge of science, technology and innovation statistics would face financial difficulties and pressures to identify priorities and potential areas for savings. The potential integration of different statistical surveys continues to be high on the agenda of several organizations as a possible mechanism for reducing survey burdens and increasing response rates, but this may also be stifling innovation within national statistical organizations in this rapidly changing statistical domain. As demonstrated by the range of presentations at the OECD Blue Sky Forum, there is a growing number of actors outside national statistical organizations involved in developing data, indicators and analysis on science, technology and innovation. Two major conclusions for members of the international community specializing in scientific, technological and innovation statistics are the need to be at the forefront of the digital transformation of science, technology and innovation data and statistics, as well as to engage directly with the development and adoption of administrative and operational standards, on which the future production of statistics will increasingly rely.

56. Cooperation between the main agencies active in this area (the Institute, OECD and Eurostat) has been increasingly close, with excellent results. There is also a very good relationship with regional agencies, such as the Ibero-American Network on Science and Technology Indicators, the African Observatory of Science, Technology and Innovation and the NEPAD Planning and Coordinating Agency. This avoids burdening countries with multiple requests for the same data and duplication of effort at the level of international and regional agencies. Cooperation between international agencies and national statistics organizations has also been good, with active participation in both OECD and UNESCO activities.

57. Nevertheless, in developing countries national statistical organizations are less involved in the area of scientific, technological and innovation statistics; line ministries, such as ministries of science and technology, often take the lead. National statistics organizations should be encouraged to become involved in order to improve data quality, since increasing policy emphasis on science and technology suggests a need for regular collection of data on science and technology in national statistical plans and strategies. In many countries, increased resources are needed for the collection of timely and relevant scientific, technological and innovation statistics of high quality, based, where applicable, on international methodologies. Engagement with policy users will continue to play a major part in ensuring the sustainability of statistical activities in the area of science, technology and innovation.

58. The community of statisticians needs to continue to work together to make a better case for the importance and relevance of such data.

V. Action required by the Statistical Commission

59. The Statistical Commission is invited to take note of the present report.

Annex

Methodological manuals and relevant documents

UNESCO

Recommendation concerning the International Standardization of Statistics on Science and Technology UNESCO (Paris, 1978)

Manual for Statistics on Scientific and Technological Activities (Paris, UNESCO 1984)

Measuring Research and Development: Challenges Faced by Developing Countries, Technical Paper No. 5, (Montreal, UNESCO Institute for Statistics, 2010)

Guide to Conducting an R&D Survey: For Countries Starting to Measure Research and Experimental Development, Technical Paper No. 11 (Montreal, UNESCO Institute for Statistics, 2014)

Organization for Economic Cooperation and Development-Eurostat

The Frascati family: *The Measurement of Scientific and Technological Activities Series*

Research and development	*Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development* (Paris, OECD Publishing, 2015)
	Fernando Galindo-Rueda and Fabien Verger, "OECD taxonomy of economic activities based on R&D intensity", OECD Science, Technology and Industry Working Paper No. 2016/04 (Paris, OECD Publishing, 2016)
Links to national accounts research and development aggregates	Daniel Ker and Fernando Galindo-Rueda, "*Frascati Manual* R&D and the System of National Accounts" (OECD, 2017)
Technology balance of payments	*Manual for the Measurement and Interpretation of Technology Balance of Payments Data — TBP Manual* (OECD, 1990)
Innovation	*Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, *3rd ed.* (OECD-Eurostat, 2005)
Scientific authors	OECD International Survey of Scientific Authors (see http://oe.cd/issa)
Science and technology personnel	*The Measurement of Human Resources Devoted to Science and Technology — Canberra Manual* (OECD, 1995)
Biotechnology	*A Framework for Biotechnology Statistics* (OECD, 2005)

Other methodological frameworks for science and technology

Globalization	*OECD Handbook on Economic Globalisation Indicators* (OECD, 2005)
Information society	*OECD Guide to Measuring the Information Society (OECD, 2011)*

Digital Economy	*Measuring the Digital Economy: A New Perspective* (Paris, OECD Publishing, 2014)
Education statistics	*OECD Handbook for Internationally Comparative Education Statistics* (OECD, 2004)
Doctorate holders	Laudeline Auriol, Martin Schaaper and Bernard Felix, “Mapping careers and mobility of doctorate holders: draft guidelines, model questionnaire and indicators”, 3rd ed., OECD Science, Technology and Industry Working Paper No. 2012/07 (Paris, OECD Publishing, 2012)
Patents	*OECD Patent Statistics Manual* (Paris, OECD, 2009)