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Institute for Statistics

SDG 9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

METADATA

Target 9.5 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

9.5.1 Research and development expenditure as a proportion of GDP

Definition

Research and experimental development (R&D) expenditure as a proportion of Gross Domestic Product (GDP) is the total intramural expenditure on R&D performed in the national territory during a specific reference period expressed as a percentage of GDP of the national territory.

The following concepts, taken from the Frascati Manual (OECD, 2015)[1] are relevant for computing the indicator:

- Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge. The term R&D covers three types of activity: Basic research, Applied research, and Experimental development.
- Intramural R&D expenditures are all current expenditures plus gross fixed capital expenditures for R&D performed within a statistical unit during a specific reference period, whatever the source of funds. Intramural R&D expenditure is synonymous

[1] The main methodological guide, which provides international standard guidelines for measuring R&D is the Organisation for Economic Co-operation and Development (OECD) Frascati Manual (Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development: http://dx.doi.org/10.1787/9789264239012-en).

with the performance of R&D within a statistical unit. The aggregation of intramural R&D for all units within a sector is synonymous with the performance of R&D within a sector of the economy; the summation of intramural R&D for all sectors is synonymous with the performance of R&D for the entire economy (GERD: Gross domestic expenditure on research and development).

Purpose
This indicator provides a comprehensive perspective on the financial resources that a country devotes to R&D, and its relative share with GDP.

Calculation method
The indicator is calculated by dividing the total intramural expenditure on R&D performed in the national territory during a given year by the GDP and multiplied by 100.

R&D expenditure as a proportion of GDP ($R\&D_{Intensity}$) is calculated as:

$$R\&D_{Intensity} = \frac{\text{The total intramural expenditure on R\&D}}{GDP} \times 100$$

Interpretation
This indicator is a direct measure of the R&D spending, which is to be increased as per target 9.5.

Type of data source
National R&D surveys, and/or data compiled through administrative data sources.

Disaggregation
R&D expenditure can be broken down by sector of performance, source of funds, field of R&D, type of R&D activity and type of cost.

Data required
R&D expenditure by sector of performance and source of funds (amount): Total amount of expenditure on R&D and its breakdown by the institutions corresponding to each sector (business enterprise, government, higher education and private non-profit organizations), with further disaggregation by source of funds (by business enterprise, government, higher education, private non-profit organizations, and funds from the 'Rest of the world').

Data sources
At the national level, data sources for R&D statistics are nationally representative R&D surveys, and/or data compiled through administrative data sources or data derived by a combination of the two, by the National Statistical Offices or relevant line ministries such as the Ministry of Science and Technology.

Quality assurance

The UNESCO Institute for Statistics (UIS) maintains a set of data processing guidelines/standards as well as data processing tools to facilitate processing of data and ensure the quality of data.

The process of quality assurance includes review of survey documentations/metadata, examination of reliability of data, making sure they comply with international standards (including the OECD Frascati Manual), and examining the consistency and coherence within the data set as well as with the time series of data and the resulting indicators. During the data processing stage, for each questionnaire received from countries where UIS sends questionnaires to, the above quality aspects are looked into and a data report is produced identifying problematic issues/inconsistent data for each respective country. The UIS sends such data reports, including the calculated indicators for target 9.5, providing the countries with the opportunity to review the data/indicators and submit any clarifications or modifications/additions before releasing data at the UIS Data Centre and submitting the data to UN Statistics Division for inclusion in the global SDG Indicators Database.

The underlying R&D data compiled at the national level should comply with the concepts/definitions provided in the international standards (i.e., Frascati Manual). According to the guidelines, the reported data should cover all sectors of performance (government, higher education, business enterprise and private non-profit sectors, as defined in the Frascati Manual), representing all institutions, which are engaged in R&D activities in a particular country. Criteria for quality assessment include: data sources must include proper documentation; data values must be nationally representative, if not, should be footnoted; data are plausible and based on trends and consistency with previously published/reported values.

Limitations and comments

R&D data need to be collected through surveys, which are expensive. In addition, they are not collected on a regular basis in many developing countries and not all sectors of R&D performance (those mentioned above in the section of 'Data required') are fully covered. In some cases, certain sectors are partially covered, and in particular, the business enterprise sector is often not covered.

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9.5.2 Researchers (in full-time equivalent) per million inhabitants

Definition

The researchers (in full-time equivalent – FTE) per million inhabitants is the total number of researchers, measured in full-time equivalent – FTE, in the national territory during a specific reference period expressed as a proportion of a population of one million.

The following concepts, taken from the Frascati Manual (OECD, 2015)[2] are relevant for computing the indicator:

- Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge. The term R&D covers three types of activity: Basic research, Applied research, and Experimental development.
- R&D personnel include all persons engaged directly in R&D, as well as those providing direct services for the R&D activities (such as R&D managers, administrators, technicians and clerical staff). R&D personnel are classified according to their R&D function: Researchers, Technicians and Other supporting staff. They are measured in Full-time equivalent (FTE) and Headcounts (HC).
- Researchers are professionals engaged in the conception or creation of new knowledge. They conduct research and improve or develop concepts, theories, models, techniques instrumentation, software or operational methods.
- The Full-time equivalent (FTE) of R&D personnel is defined as the ratio of working hours actually spent on R&D during a specific reference period (usually a calendar

[2] The main methodological guide, which provides international standard guidelines for measuring R&D is the Organisation for Economic Co-operation and Development (OECD) Frascati Manual (Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development: http://dx.doi.org/10.1787/9789264239012-en).

year) divided by the total number of hours conventionally worked in the same period by an individual or by a group.
- The headcount (HC) of R&D personnel is defined as the total number of individuals contributing to intramural R&D, during a specific reference period (usually a calendar year).

Purpose
This indicator provides a comprehensive perspective on the human resources that a country devotes to R&D, and its relative share with population.

Calculation method
The indicator is calculated by dividing the total number of researchers (measured in full-time equivalent – FTE) in the national territory during a given year by the total population and multiplied by 1,000,000.

Researchers (in full-time equivalent – FTE) per million inhabitants (*$RES_{Density}$*) is calculated as:

$$RES_{Density} = \frac{Total\ researchers\ (FTE)}{Total\ population\ of\ the\ country} \times 1{,}000{,}000$$

where '*Total researchers (FTE)*' is calculated as:

$$Total\ researchers\ (FTE) = Number\ of\ full-time\ researchers + \left[\frac{Number\ of\ working\ hours\ spent\ on\ R\&D\ by\ part-time\ researchers}{Number\ of\ normative\ or\ statutory\ working\ hours\ of\ a\ full-time\ researcher}\right]$$

Interpretation
This indicator is a direct measure of the number of R&D workers per million people, which is to be increased as per target 9.5.

Type of data source
National R&D surveys, and/or data compiled through administrative data sources.

Disaggregation
Researchers can be broken down by sector of employment, sex, field of R&D, level of qualification, and age.

Data required
R&D personnel by function, sector of employment and sex (number): Total number of R&D personnel and its breakdown by function (Researchers, Technicians and equivalent staff, and Other supporting staff) and sex, with further disaggregation by the sectors they are

employed in (business enterprise, government, higher education and private non-profit organizations). They are measured in headcounts (HC) and full-time equivalents (FTE).

Data sources

At the national level, data sources for R&D statistics are nationally representative R&D surveys, and/or data compiled through administrative data sources or data derived by a combination of the two, by the National Statistical Offices or relevant line ministries such as the Ministry of Science and Technology.

Quality assurance

The UNESCO Institute for Statistics (UIS) maintains a set of data processing guidelines/standards as well as data processing tools to facilitate processing of data and ensure the quality of data.

The process of quality assurance includes review of survey documentations/metadata, examination of reliability of data, making sure they comply with international standards (including the OECD Frascati Manual), and examining the consistency and coherence within the data set as well as with the time series of data and the resulting indicators. During the data processing stage, for each questionnaire received from countries where UIS sends questionnaires to, the above quality aspects are looked into and a data report is produced identifying problematic issues/inconsistent data for each respective country. The UIS sends such data reports, including the calculated indicators for target 9.5, providing the countries with the opportunity to review the data/indicators and submit any clarifications or modifications/additions before releasing data at the UIS Data Centre and submitting the data to UN Statistics Division for inclusion in the global SDG Indicators Database.

The underlying R&D data compiled at the national level should comply with the concepts/definitions provided in the international standards (i.e., Frascati Manual). According to the guidelines, the reported data should cover all sectors of performance (government, higher education, business enterprise and private non-profit sectors, as defined in the Frascati Manual), representing all institutions, which are engaged in R&D activities in a particular country. Criteria for quality assessment include: data sources must include proper documentation; data values must be nationally representative, if not, should be footnoted; data are plausible and based on trends and consistency with previously published/reported values.

Limitations and comments

R&D data need to be collected through surveys, which are expensive. In addition, they are not collected on a regular basis in many developing countries and not all sectors of R&D performance (those mentioned above in the section of 'Data required') are fully covered. In some cases, certain sectors are partially covered, and in particular, the business enterprise sector is often not covered.

Data on R&D personnel (including 'researchers') are typically compiled/reported in headcounts (HC) and full-time equivalent (FTE). These are two different units of measurement to account for human resources devoted to R&D. However, the unit of underlying data (i.e., number of researchers) used for SDG Indicator 9.5.2 (researchers per million inhabitants) is in FTEs. In some developing countries, data on the number of researchers are only collected/reported in HCs and they lack the data based on FTEs.