United Nations
Educational, Scientific and
Cultural Organization

UNESCO
INSTITUTE
for
STATISTICS

## UIS DATA ON RESEARCH & EXPERIMENTAL DEVELOPMENT

# FREQUENTLY ASKED QUESTIONS

### What is R&D?

Research and experimental development (R&D), as defined by the OECD Frascati Manual[1], comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of humanity, culture and society, and the use of this stock of knowledge to devise new applications.

The basic criterion for distinguishing R&D from related activities is the presence of an appreciable element of novelty and the resolution of scientific and/or technological uncertainty, when the solution to a problem is not readily apparent to someone familiar with the basic stock of common knowledge and techniques for the area concerned.

### What is excluded from R&D?

Activities to be excluded from R&D include:

- Education and training (however, research by students at the PhD level carried out at universities should be counted, whenever possible, as a part of R&D);
- Other related scientific and technological activities;
- Other industrial activities; and
- Administration and other supporting activities.

### Where can I find the Frascati Manual?

*Frascati Manual*[1]*: Proposed Standard Practice for Surveys on Research and Experimental Development* lays down the main definitions and guidelines for collecting R&D data. The 6th edition of the manual was published by the OECD in 2002 and can be found here: http://oe.cd/frascati

### Which are the basic R&D indicators?

Personnel data measure the resources going directly to R&D activities. Expenditure data measure the total cost of carrying out the R&D concerned, including indirect support (ancillary) activities.

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[1] OECD Frascati Manual has been revised in 2015. The next update of 'Frequently Asked Questions' will reflect the definitions from Frascati Manual 2015.

## Which are the sectors of performance?

To facilitate the collection of data, the description of institutional flows of R&D funds, and the analysis and interpretation of R&D data, statistical unit(s) should be grouped by sectors of the economy, following as closely as possible standard classifications of economic activities. R&D data can be classified into four sectors of performance:

- **Business enterprise**: all firms, organizations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price, as well as the private non-profit institutions mainly serving them. Includes public enterprises.
- **Government**: all departments, offices and other bodies which furnish, but normally do not sell to the community, those common services, other than higher education, which cannot otherwise be conveniently and economically provided, as well as those that administer the state and the economic and social policy of the community, as well as non-profit institutions controlled and mainly financed by government, but not administered by the higher education sector. Public enterprises are excluded.
- **Higher education**: all universities, colleges of technology and other institutions of post- secondary education, whatever their source of finance or legal status; all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education institutions.
- **Private non-profit**: Private individuals, households and non-market, private non-profit institutions serving the general public.

## Which are the sources of funds?

To facilitate the collection of data, the description of institutional flows of R&D funds, and the analysis and interpretation of R&D data, statistical unit(s) should be grouped by sectors of the economy, following as closely as possible standard classifications of economic activities. R&D data can be classified into five sources of funds:

- **Business enterprise**: all firms, organizations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price, as well as the private non-profit institutions mainly serving them. Includes public enterprises.
- **Government**: all departments, offices and other bodies which furnish, but normally do not sell to the community, those common services, other than higher education, which cannot otherwise be conveniently and economically provided, as well as those that administer the state and the economic and social policy of the community, as well as non-profit institutions controlled and mainly financed by government, but not administered by the higher education sector. Public enterprises are excluded.
- **Higher education**: all universities, colleges of technology and other institutions of post- secondary education, whatever their source of finance or legal status; all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education institutions.
- **Private non-profit**: Private individuals, households and non-market, private non-profit institutions serving the general public.
- **Abroad**: all institutions and individuals located outside the political borders of a country, except vehicles, ships, aircraft and space satellites operated by domestic entities and testing grounds acquired by such entities; all international organizations (except business enterprises), including facilities and operations within the country’s borders.

## What are the types of R&D activity?

R&D covers three activities: basic research, applied research and experimental development.

- **Basic research** is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.
- **Applied research** is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.
- **Experimental development** is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed. R&D covers both formal R&D in R&D units and informal or occasional R&D in other units.

## Which are the fields of science?

R&D data can be classified by fields of science, using the OECD 2007 Fields of Science and Technology classification, as shown in **Table 1**.

**Table 1. Fields of Science and Technology Classification in the Frascati Manual**

**1. Natural sciences**
1.1 Mathematics
1.2 Computer and information sciences
1.3 Physical sciences
1.4 Chemical sciences
1.5 Earth and related environmental sciences
1.6 Biological sciences
1.7 Other natural sciences

**2. Engineering and technology**
2.1 Civil engineering
2.2 Electrical, electronic, information engineering
2.3 Mechanical engineering
2.4 Chemical engineering
2.5 Materials engineering
2.6 Medical engineering
2.7 Environmental engineering
2.8 Environmental biotechnology
2.9 Industrial biotechnology
2.10 Nano-technology
2.11 Other engineering and technologies

**3. Medical and health sciences**
3.1 Basic medicine
3.2 Clinical medicine
3.3 Health sciences
3.4 Health biotechnology
3.5 Other medical sciences

**4. Agricultural sciences**
4.1 Agriculture, forestry, and fishery
4.2 Animal and dairy science
4.3 Veterinary sciences
4.4 Agricultural biotechnology
4.5 Other agricultural sciences

**5. Social sciences**
5.1 Psychology
5.2 Economics and business
5.3 Educational sciences
5.4 Sociology
5.5 Law
5.6 Political science
5.7 Social and economic geography
5.8 Media and communications
5.9 Other social sciences

**6. Humanities**
6.1 History and archaeology
6.2 Languages and literature
6.3 Philosophy, ethics and religion
6.4 Art
6.5 Other humanities

## Who are R&D personnel?

R&D personnel cover all persons employed directly in R&D, as well as those providing direct services such as R&D managers, administrators and clerical staff. Persons providing an indirect service, such as canteen and security staff, should be excluded, even though their wages and salaries are included as an overhead cost when measuring expenditure.

## How are R&D personnel classified by occupation?

R&D personnel can by classified by the following three types of occupation:

- **Researchers**: professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and also in the management of the projects concerned.
- **Technicians:** persons whose main tasks require technical knowledge and experience in one or more fields of engineering, physical and life sciences, or social sciences and humanities. They participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers. *Equivalent staff* perform the corresponding R&D tasks under the supervision of researchers in the social sciences and humanities.
- **Other supporting staff:** includes skilled and unskilled craftsmen, and secretarial and clerical staff participating in R&D projects or directly associated with such projects.

## How are R&D personnel classified by level of formal qualification?

ISCED provides the basis for classifying R&D personnel by formal qualification. Five classes are recommended for the purposes of R&D statistics. They are defined exclusively by level of education, regardless of the field in which personnel are qualified.

- ISCED level 8 – Doctoral or equivalent level. Programmes at ISCED level 8 are designed primarily to lead to an advanced research qualification. Programmes at this ISCED level are devoted to advanced study and original research and are typically offered only by research-oriented tertiary educational institutions such as universities. Doctoral programmes exist in both academic and professional fields.
- ISCED level 7 – Master's or equivalent level. Programmes at ISCED level 7 are often designed to provide participants with advanced academic and/or professional knowledge, skills and competencies, leading to a second degree or equivalent qualification. Programmes at this level may have a substantial research component but do not yet lead to the award of a doctoral qualification. Typically, programmes at this level are theoretically-based but may include practical components and are informed by state-of-the-art research and/or best professional practice. They are traditionally offered by universities and other tertiary educational institutions.
- ISCED level 6 – Bachelor's or equivalent level. Programmes at ISCED level 6 are often designed to provide participants with intermediate academic and/or professional knowledge, skills and competencies, leading to a first degree or equivalent qualification. Programmes at this level are typically theoretically-based but may include practical components and are informed by state-of-the-art research and/or best professional practice. They are traditionally offered by universities and equivalent tertiary educational institutions. First degree programmes at this level typically have a duration of three to four years of full-time study at the tertiary level.

- ISCED level 5 – Short-cycle tertiary education. Programmes at ISCED level 5 are often designed to provide participants with professional knowledge, skills and competencies. Typically, they are practically-based, occupationally-specific and prepare students to enter the labour market. However, these programmes may also provide a pathway to other tertiary education programmes. Academic tertiary education programmes below the level of a Bachelor's programme or equivalent are also classified as ISCED level 5.
- ISCED level 4 or below. This includes ISCED 4 (post-secondary non-tertiary education), ISCED 3 (upper secondary education) and below.

Full details of ISCED can be found on the UIS website at:
http://www.uis.unesco.org/education/pages/international-standard-classification-of-education.aspx

### What is gender parity?

Gender parity is achieved when the share of females in the total stand between 45% and 55% for an indicator.

### What are headcount data?

The measurement of personnel employed in R&D can be done in headcounts and in full-time equivalence (person-years).

Headcount (HC) data provide the total number of persons who are mainly or partially employed in R&D.

Headcount data allow links to be made with other data series, for example education or employment data or the results of population censuses. This is particularly important when examining the role of R&D employment in total stocks and flows of scientific and technical personnel. Headcount data are the most appropriate measure for collecting additional information about R&D personnel, such as age, gender or national origin.

### What are full-time equivalent data?

The measurement of personnel employed in R&D can be done in headcounts and in full-time equivalence (person-years).

The Frascati Manual does not provide a concise definition of full-time equivalence. Essentially, full-time equivalent (FTE) data provide the number of hours that represent what a full-time employee would work over a given time period, for example, a year or a pay period. Series based on the number of full-time equivalent staff are considered to be a true measure of the volume of R&D.

R&D may be the primary function of some persons (e.g. workers in an R&D laboratory) or it may be a secondary function (e.g. members of a design and testing establishment). It may also be a significant part-time activity (e.g. university teachers or postgraduate students). To count only persons whose primary function is R&D would result in an underestimate of the effort devoted to R&D; to do a headcount of everyone spending some time on R&D would lead to an overestimate. The number of persons engaged in R&D should, therefore, also be expressed in full-time equivalents on R&D activities.

The following formula can be used to calculate R&D personnel in FTE:

FTE = (dedication to the employment: FT/PT) x (portion of the year active on R&D) x (time or portion spent on R&D)

### What are the possible breakdowns of R&D personnel?

R&D personnel can be broken down by:

- Sector of performance
- Occupation
- Level of formal qualification
- Field of science
- Age
- Type of activity

These breakdowns can be calculated in headcount and full-time equivalence, and can be further disaggregated by gender.

### Which indicators are usually calculated for R&D personnel?

The following indicators are usually calculated for R&D personnel:

- R&D personnel per million population
- Researchers per million population
- R&D personnel per 1,000 employment
- Researchers per 1,000 employment
- R&D personnel per 1,000 labour force
- Researchers per 1,000 labour force

### How is R&D expenditure measured?

The basic measure of R&D expenditure is “intramural expenditures”.

Intramural expenditures are all expenditures for R&D performed within a statistical unit or sector of the economy during a specific period, whatever the source of funds.

The most important national total is gross domestic expenditure on R&D (GERD), which is defined as total intramural expenditure on R&D performed on the national territory during a given period.

Extramural expenditures cover payments for R&D performed outside the statistical unit or sector of the economy.

R&D expenditure refers to resources actually spent on R&D activities, rather than only what is budgeted. Therefore, the way to obtain sound data is to rely on responses of R&D performers, rather than funding agencies.

### What is GERD?

GERD refers to gross domestic expenditure on R&D.

## What are the possible breakdowns of R&D expenditure?

R&D expenditure can be broken down by:

- Sector of performance
- Source of funds
- Type of activity
- Field of science
- Type of cost (current vs. capital cost)
- Socio-economic breakdown

## Which indicators are usually calculated for R&D expenditure?

The following indicators are usually calculated for R&D expenditure:

- Gross domestic expenditure on R&D as a percentage of GDP
- Gross domestic expenditure on R&D in current national currency
- Gross domestic expenditure on R&D in constant national currency
- Gross domestic expenditure on R&D in current US$ purchasing power parities
- Gross domestic expenditure on R&D in constant US$ purchasing power parities
- Gross domestic expenditure on R&D per capita
- Gross domestic expenditure on R&D per researcher