Monitoring and Evaluation: R&D Data and indicators

UN-Wide Training Course

Amman, Jordan, 15-19 April 2018
Overview

- What do we measure: R&D and Innovation?
- Why do we measure?
- How do we measure? Inputs R&D
- What is the process?
- Challenges for developing countries?
- R&D indicators and SDGs
First edition published in 1963!

Just revised

7th edition published in October 2015

De facto world standard

Including context of developing countries mainstreamed in 2015 manual

Measuring Innovation: Oslo Manual

- **Oslo Manual**: Guidelines for collecting and interpreting innovation data
- Joint publication of OECD and EU
- 1st edition 1992
- 2nd edition 1997 → coverage expanded to services
- 3rd edition 2005 → expanded to organizational and marketing innovation
- UIS - Annex measuring innovation in developing countries (OM, 2005)
- 4th edition: Revision is underway (*OM4*)
- Used for CIS and national innovation surveys

[http://www.oecd.org/innovation/inno/oslomanualguidelinesforcollectingandinterpretinginnovationdata3rdedition.htm](http://www.oecd.org/innovation/inno/oslomanualguidelinesforcollectingandinterpretinginnovationdata3rdedition.htm)

[www.uis.unesco.org](http://www.uis.unesco.org)
Examples of reports

UN Statistical Year Book

UNDP: Human Development Report

WB: World Development Indicators
Why data is needed? Why measuring?

- Accountability for spending of public funds
- Informed strategy and forecasting; evidence-base
- Coordination of plans and budgets
- Monitoring policies and activities
- Evaluation of programmes and projects
- Benchmarking and international comparisons

**Indirect benefits:**

- Learning; bringing stakeholders closer
- Improving management of R&D
Data needed for SDGs

17 SDGs - 169 SDG targets, 40 selected with greatest relevance to STI, covering innovation, health, ecosystems, food security, habitat and education.

- **SDG 9**: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

- **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.
Indicators tell a story

✓ In which areas should I invest predominantly?
✓ In which areas am I already investing?
✓ Which are important economic sectors, in mining, agriculture, industry, services, etc?
✓ What are national or regional peculiarities? (health, environment, utilities, defense,…)
✓ Are there sufficient links of universities and institutes to industry?
Measuring Science, Technology and Innovation (STI):

Definitions from a statistical perspective
Scientific and Technological Activities (STA) can be defined as all systematic activities which are closely concerned with:

generation, advancement, dissemination, and application of scientific and technical knowledge

and applies to:

all fields of science and technology.
Scientific and technological activities comprise:

- Research and experimental development (R&D)
- Scientific and technical education and training (STET)
- Scientific and technological services (STS)
An indicators “framework”
Common features of R&D

- Novel (aimed at new findings)
- Creative (based on original concepts; not obvious)
- Uncertain (outcome, cost, time allocation not known a priori)
- Systematic (planned and budgeted)
- Transferable and/or reproducible (should be the potential to transfer results)

-- All five criteria are to be met, at least in principle, every time an R&D activity is undertaken whether on a continuous or occasional basis --
STET: Definition
(from UNESCO Manual for STA)

Scientific and technological education and training at broadly the third level (STET) can be defined as all activities comprising:

- Specialized non-university higher education
- All university education
- Organized lifelong training for scientists and engineers
Scientific and technological services (STS) can be defined as any activities:

- Concerned with scientific research and experimental development
- Contributing to the generation, dissemination and application of scientific and technical knowledge

Ex: information and documentation activities provided by libraries, archives, databanks; services provided by museums, botanical and zoological gardens; Extension, advisory services, feasibility studies; patents, licenses
Back to R&D activities:

Examples:

- **Routine tests** such as blood and bacteriological tests carried out for **medical checks** are **not R&D**; **special programme of blood tests** for patients taking a new drug is **R&D**.

- **Keeping daily records** of temperatures or of atmospheric pressure is **not R&D**; **investigation of new methods** of measuring temperature is **R&D**, as is the **study and development of new models** for weather prediction.

→ **novelty and uncertainty about the final results of the study, transferability of the results for broader use, apply here.**
Examples (1): how to differentiate types of R&D - natural sciences

- The development of a new method for the classification of immunoglobulin sequences → **Basic research**

- Investigations undertaken in an effort to distinguish between antibodies for various diseases → **Applied research**

- Devising a method for synthesising the antibody for a particular disease on the basis of knowledge of its structure and clinical tests of the effectiveness of the synthesised antibody on patients who have agreed to accept an experimental advanced treatment → **Experimental development**
Examples (2): how to differentiate types of R&D - history

- Historians study the history and human impact of glacial outburst floods in a country → **Basic research**

- Historians examine past societies’ responses to catastrophic natural events in order to understand how contemporary society might better respond to global climate change → **Applied research**

- Using research findings, historians design a new museum exhibit on the adaptations of past human societies to environmental changes; this serves as a prototype for other museums and educational installations → **Experimental development**
BOUNDARIES AND EXCLUSIONS FROM R&D

- Product development vs Experimental development
- Limits between R&D and teaching and training
- Service or indirect support activities
- R&D and traditional knowledge
Exercise:

R&D – S&T Activities – Innovation
Measuring (R&D)

Data collection
Data collection: R&D Survey

### R&D Personnel

- By sector of employment, function, qualification, seniority, age and field of science
- In headcount and FTE
- By gender

### R&D Expenditure

- By sector of performance and source of funds
- By type of activity, type of cost and field of science

→ Both inputs are necessary to secure an adequate representation of the effort devoted to R&D
## UIS 2015 and 2016 Surveys on R&D: response rates & published data

<table>
<thead>
<tr>
<th>Regions</th>
<th>Countries &amp; territories covered</th>
<th>Q2015</th>
<th>Q2016</th>
<th>Published data (as of June 2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Effective responses (i.e. only with data)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>44</td>
<td>4</td>
<td>9%</td>
<td>5</td>
</tr>
<tr>
<td><strong>Arab States</strong></td>
<td>21</td>
<td>6</td>
<td>29%</td>
<td>8</td>
</tr>
<tr>
<td>Central and Eastern Europe</td>
<td>8</td>
<td>5</td>
<td>63%</td>
<td>7</td>
</tr>
<tr>
<td>Central Asia</td>
<td>9</td>
<td>5</td>
<td>56%</td>
<td>7</td>
</tr>
<tr>
<td>East Asia and the Pacific</td>
<td>22</td>
<td>6</td>
<td>27%</td>
<td>6</td>
</tr>
<tr>
<td>South and West Asia</td>
<td>9</td>
<td>2</td>
<td>22%</td>
<td>2</td>
</tr>
<tr>
<td>Latin America and the Caribbean</td>
<td>9</td>
<td>1</td>
<td>11%</td>
<td>1</td>
</tr>
<tr>
<td>North America and Western Europe</td>
<td>2</td>
<td>0</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td><strong>Sub-total (only from UIS R&amp;D survey)</strong></td>
<td>124</td>
<td>29</td>
<td>23%</td>
<td>36</td>
</tr>
<tr>
<td>OECD + Eurostat countries</td>
<td>46</td>
<td>45</td>
<td>100%</td>
<td>45</td>
</tr>
<tr>
<td>RICYT countries</td>
<td>26</td>
<td>19</td>
<td>73%</td>
<td>19</td>
</tr>
<tr>
<td><strong>Total countries &amp; territories (incl. OECD, Eurostat, RICYT)</strong></td>
<td><strong>196</strong></td>
<td><strong>93</strong></td>
<td><strong>47%</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Input indicators

- **R&D Personnel**
  - All persons engaged **directly in R&D**, as well as those providing direct services for the R&D activities
    - Researchers
    - Technicians
    - supporting staff
  
Classification that refers to the ‘**actual function**’

Key to distinguish R&D personnel…
Researchers

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.
Technicians and equivalent staff

- tasks require **technical knowledge** and experience (in engineering, physical and life sciences, or SHS and arts)

- perform scientific and technical tasks involving the **application** of concepts and operational methods, and the use of research equipment, normally **under the supervision of researchers**
Other supporting staff

skilled and unskilled craftsmen, and administrative, secretarial and clerical staff participating in R&D projects or directly associated with such projects
How to measure R&D personnel?

1. Measuring their number in headcounts (HC): total number of individuals contributing to R&D

2. Measuring their R&D activities in full-time equivalent (FTE): person-years

R&D: primary or secondary function; part-time activity
(e.g. university teachers or postgraduate students)

Including only individuals whose primary function is R&D → underestimation;
Including everyone spending any time at all on R&D → overestimation

The number of persons engaged in R&D must, therefore, also be expressed both in HCs and FTEs
Full-time equivalents (FTEs) of R&D personnel

One FTE = one individual full-time on R&D, or more persons part-time or for a shorter period on R&D, corresponding to one person-year.

**FTE is the true measure of the volume of R&D and is considered the main R&D personnel statistic for international comparisons**

Use of HCs is mostly recommended in terms of exploring the characteristics of R&D personnel, such as age, gender or national origin.
FTE calculations

- A full time employee spending 100% of time on R&D during a year → (1 x 1 x 1) = 1 FTE
- A full time employee spending 30% of time on R&D during a year → (1 x 1 x 0.3) = 0.3 FTE
- A part-time employee (working 40% of a full time year) spending 60% of time on R&D during half of the year (person is only active for 6 months per year) → (0.4 x 0.5 x 0.6) = 0.12 FTE
FTE is key to adequately calculating GERD

- Researcher’s salaries are a significant part of GERD
- GERD should only include the proportion of the salaries devoted to R&D, i.e. FTE R&D salaries
- Including HC salaries would lead to significantly overestimated GERD
Exercise:

R&D personnel:

Calculation of Headcounts (HC) and Full-time equivalents (FTE)
Why measure R&D expenditure?

- **Amount spent** of big interest to national and international policy makers

- **Statistics** used to:
  - measure who conducts, who funds R&D, where it takes place, level and purpose of such activities, and interactions and collaborations between institutions and sectors
  - inform the development of fiscal and financial incentives to stimulate R&D
  - understand **how R&D contributes to econ growth, defence and socio well-being**
Categories: current and capital R&D expenditures

Current expenditures:

• Labour costs of R&D personnel
  annual wages and salaries and associated costs

• Other current costs
  purchases of materials, supplies and equipment (incl. water, gas and electricity); books, journals, subscriptions; materials for laboratories;
  administrative costs; costs for external R&D personnel

Capital expenditures:

land, buildings, machinery and equipment; capitalised computer software; intellectual property products
Measuring R&D funding flows

- R&D involves significant transfers of resources among units, organisations and sectors
  - In particular between government and other performers
- R&D expenditure = resources actually spent on R&D activities, rather than only budgeted.
- For sound data → rely on responses of R&D performers rather than funding agencies (Performers know best about actual expenditures)
Step-by-step approach

- Simplified step-by-step approach for measuring expenditures:
  - Identify the expenditures on R&D performed within each statistical unit
  - Identify the sources of funds for these R&D expenditures (Business, Government, Higher education, Private non-profit and abroad)
  - Identify the amount of funding flows between units

Aggregate the data by sectors of performance and sources of funds to derive significant national totals
National totals

- **Gross domestic expenditure on R&D (GERD):** expenditures on R&D performed on the **national territory**
  - but excludes payments for R&D performed by the rest of the world.
  - constructed by adding together the expenditures of the four performing sectors.

- **Gross national expenditure on R&D (GNERD):** expenditures on R&D financed by a country’s institutions
  - it excludes R&D performed within a country but funded from the rest of the world.
Exercise:

Calculating GERD by sector of performance and source of funds the ‘GERD Matrix’
Carrying out R&D surveys: procedures and guidelines
Scope and Challenges of R&D surveys

- Each country and its innovation system are unique: size and structure of R&D capacities vary. Every country has different constraints.
- One size does not fit all: advice is therefore of general nature.
- Each sector has different management styles, approaches and institutional culture.
- Consider the existing norms in relation to data exchange.
- Costly exercise

Exhaustive surveys not possible in most countries.
Survey procedures by sector

- Government sector
- Higher education sector
- Business enterprise sector
- Private non-profit sector
Who should be included?

- Public research institutes; Department-based research institutions; general administrations; statistical, meteorological, geological services, museums, hospitals; municipality level.

These institutions are usually well known. Identification generally easy.

- Conduct a census of relevant organizations/units known or assumed to perform R&D.
- Sources for survey: registers, databases, patents etc
Higher education sector

- Higher Education institutes (HEIs) are the main seat of R&D activity.
  - every effort must be made to ensure good coverage of these bodies

- The primary function of HEIs is teaching, not research:
  - good estimate of the time spent on research and research expenditure is key

Units to cover: All universities and corresponding institutions, especially those awarding degrees at the doctorate level.

Sources to identify generally easy: lists, publications databases

Contact point: VC/President or Deputy VC, Dean of Faculties, Dean of Research or, Head of Departments, etc.
The enterprise is recommended as the main statistical unit in the BE sector.

- Some enterprises perform R&D on a regular basis, and may have one or several R&D units
- Other enterprises perform R&D only occasionally

Units to cover: All enterprises performing R&D, either continuously or occasionally

- A census-based survey of large enterprises and a sample of smaller ones to identify R&D performers and request the information from them.

Contact point: through CEO, or a divisional head.
Business enterprise sector

- **Some typical issues:**

  - R&D performed in business sector low in developing economies; Even in developed countries, 5-10% of firms carry out 90% of R&D.

  - Although business sector is central to the goal of innovation, small percentage of firms are engaged in regular R&D activities. Many firms that innovate do not carry out in-house R&D.

  - Large firms/MNC - discussion with the Chief Financial Officer or Chief Technology Officer; Missing a large firm might result in significant error.

  - Publicly-owned businesses play a major role in R&D in some developing countries

  - Service sector often under-reported: try to engage with leading banks, insurers, mobile telephony and ICT companies.
Private non-profit sector

- Differs significantly country by country; same challenges as in business.
- Difficulty in identifying PNPss engaged in R&D; Not clear about, status, ownership.
- Perform in-house R&D as well as contract R&D.
- Sources for identifying possible survey respondents: mainly the same as for the government sector.
Who is the right respondent?

- **Government**: PRIs, DBRIs: Head of research or research manager(s) incorporation with Accountant/personnel manager.

- **Higher education**: Dean of Faculties or Dean/Head of research/departments in collaboration with Account/personnel departments.

- **Business enterprise**: might be the CEO, or a technology/production manager. It is rare for staff in human resources or finance to have such knowledge and information.
The R&D Survey: governance, logistics and process

- **The R&D Survey as a Project**: The Survey is a project studying peer institutions (stakeholders) of the NIS.

- The R&D Survey is conducted over a fixed time period, results in a final product (the R&D Survey Report).

- It is recommended to carry out the R&D survey according to an accepted project management methodology.
  - Clear beginning and deadline, logical sequence, defined objectives, verifiable indicators, specified deliverables,
  - Agreed budget and human resources.
  - Mechanisms for learning and adjustment (M&E).
An R&D Survey is structured along three result paths each with its series of Project Milestone

**Governance:** oversight, advice, and authority.

- **Process:** main work from design through implementation/carry out and close out.

- **Logistics:** financial, human and material resources.
Conclusions

- Definitions / classifications / methods of calculation are key
- Conducting R&D surveys is challenging / need for building capacities
- Countries to establish **sustainable and coordinated STI statistics systems**, involving line ministries (S&T Ministries or Research Councils) and National Statistical Offices, business sector
Some publications

- Data publicly available at: http://www.uis.unesco.org
  http://stats.uis.unesco.org/
- UNESCO Science Report 2015
Thank you!

Kornelia Tzinova

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