

# Explanatory Notes

## National Survey of R&D in Singapore

### Year 2007

#### PURPOSE OF SURVEY

The Agency for Science, Technology and Research (A\*STAR) and the Department of Statistics (DOS) conduct the National Survey of R&D in Singapore. The survey results are published by A\*STAR annually. The National Survey of R&D in Singapore collects comprehensive data on Research and Development (R&D) activities in the private sector, higher education sector, government sector and the A\*STAR research institutes. Data in the survey have been collected and presented in line with the standard OECD methodology for R&D statistics as prescribed in the Frascati Manual. The purpose of this survey is to collect data which are useful measures of the scale and directions of R&D in Singapore. Information from the survey is useful to the Government and the private sector for policy formulation or corporate decision-making.

#### INSTRUCTIONS

These notes will clarify the questions and terms used, and will facilitate completion of the questionnaire. If you are unable to provide an exact response to a question, please provide your best estimate to each question. You are encouraged to call our hotline at **6826 6177**, fax your queries to **6779 4679** or email us at [A-star\\_RnDSurvey@a-star.edu.sg](mailto:A-star_RnDSurvey@a-star.edu.sg) if further clarification is required.

#### Definition of R&D

Research and development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge and the use of this stock of knowledge to devise new applications. This is based on the definition published by OECD in the Frascati Manual (2002). R&D covers the following activities: basic research, strategic basic research, applied research and experimental development. The scope of the definition of R&D for this Survey extends to R&D in science and technology only and excludes the social sciences and humanities.

R&D is related to a number of other activities with a scientific and technological basis, which are often very closely linked to R&D through flows of information or in terms of operations, institutions and personnel. The basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty and resolution of scientific and/or technological uncertainty, i.e. 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.

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**R&D includes**

- Construction/operation of pilot plants not operated as (or intended as) commercial units
- Research into and original development (or substantial modification) of computer software such as application software, programming languages and operating systems
- Feedback R&D directed at solving problems occurring beyond the R&D phase, for example technical problems arising during initial production runs
- Design, construction and operation of prototypes where the main objective is technical testing or to make further improvements
- Research leading into the discovery and production of improved or new chemical, pharmaceutical or food products, or special investigation to establish new medical treatments and the side effects of medical treatments/products.

**R&D excludes (except where used primarily for the support of, or as part of R&D projects)**

- scientific and technical information services, routine quality control and testing
- policy related studies, management studies and efficiency studies
- general purpose or routine data collection, consumer surveys and market research
- pre-production testing for commercial viability, tooling up and trial production runs
- prospecting, exploring or drilling for minerals, petroleum or natural gas
- cosmetic modifications or style changes to existing products
- routine computer programming, systems maintenance or software application
- operations research and mathematical or statistical analysis
- commercial, legal and administrative aspects of patenting, copyrighting or licensing
- activities associated with standards compliance
- research in humanities and social sciences

**R&D ends when ...**

the work is no longer experimental, and pre-production begins. This is when the material or product is substantially developed and the primary objective of the work is to develop markets, do pre-production planning or get production or control systems to work smoothly, then such work is no longer R&D and should not be included. However, if the primary objective is to make further technical improvements, then the work comes within the definition of R&D and should be included.

**Scope of R&D**

**Your report should include...**

- R&D carried out by your organisation on its own behalf or on behalf of others (intramural R&D).

**And should not include...**

- R&D funded by your organisation but carried out by others using their own facilities (extramural R&D).

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**REPORTING UNIT**

In this survey, the reporting unit should be an establishment, defined as a business unit in one location under a single ownership. Head office and branches of the same enterprise that perform R&D are requested to submit separate returns. Similarly, for a multi-activity enterprise, business units engaged in separate activities in the same location constitute distinct establishments. Kindly report separate returns for each establishment that performs R&D if distinction can be made for each activity and separate data are available. Subsidiaries or associated companies that perform R&D are also requested to submit separate returns.

If you are unable to submit separate returns for each establishment and are reporting consolidated data for all R&D performing establishments within your enterprise as well as for your subsidiaries or associated companies, please list down all the R&D performing units that are reported in this return. Please also estimate the percentage of R&D expenditure that each has contributed towards the total R&D expenditure (reported in Section II, Question 10).

**REPORTING PERIOD**

The preferred reporting period for this questionnaire is 1 Jan 2007 to 31 Dec 2007.

If your reporting period is not from 1 Jan – 31 Dec 2007, please specify a reporting period of 12 months applicable to your organisation.

**The same reporting period should be used throughout the survey.**

**SECTION I: GENERAL INFORMATION**

**Question 1**

Indicate the total number of persons employed by the organisation, not only those involved in R&D.

**Question 2**

Indicate the total gross sales revenue of your organisation for reporting period in 2007.

**Question 3**

Indicate the total net book value of fixed assets of your organisation for reporting period in 2007.

**Question 4**

Indicate the total depreciation of fixed assets of your organisation and the percentage of total depreciation of the fixed assets that were used in R&D for reporting period in 2007.

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**Question 5**

Indicate total indirect tax of your organisation for reporting period in 2007. Indirect taxes refer to compulsory payments levied by the government on the establishment or enterprise for the use of factors of production and for importing goods and services to be used in the production of goods and services. They include taxes on products and services such as import and excise duties, foreign workers' levy, business registration fees, stamp duties, road tax and property tax, excluding GST, cess and COE/ARF.

**Question 6**

Indicate net operating profit after taxes of your organisation for reporting period in 2007.

**Question 7**

Indicate expenditure on total manpower, not only those involved in R&D.

**Question 8**

For Part A, tick in the appropriate box which best describes your organisation's institutional type. The category "Private Sector" includes **business enterprises** and **non-profit organisations**.

<b>Institutional Classification</b>
<b>Government Sector</b> This comprises all government ministries and statutory boards, but excludes public institutions of higher education and the A*STAR research institutes.
<b>A*STAR Research Institutes</b> This comprises the A*STAR research institutes (e.g. IMCB, IMRE, DSI).
<b>Higher Education Sector</b> This comprises all institutions of higher education, including the universities and polytechnics.
<b>Private Sector</b> This comprises all business enterprises and non-profit organisations, excluding institutions of higher education. <i>Non-profit organisation</i> means an organisation or an association or persons, whether corporate or unincorporate, that is not operated or conducted for profit.

**Part B is only applicable for private sector organisations.** Tick the box that describes most closely the proportion of local equity ownership in your organisation.

**Question 9**

Only private sector organisations need to indicate the percentage of foreign ownership (if any) in descending order.

## **SECTION II: EXPENDITURES ON R&D PERFORMED WITHIN ORGANISATION**

### **Question 10 – R&D Expenditures**

Indicate research expenditure data for your reporting period in 2007.

#### **Types of Expenditures on R&D**

##### **• CAPITAL EXPENDITURES**

- Capital expenditures are the annual gross expenditures on fixed assets used in the R&D programmes of the organisation, i.e. on (i) land, buildings and other structures, and on (ii) vehicles, plants, machinery and equipment.
- The acquisition of new and second hand fixed tangible assets either on your own account or under a finance lease with an expected life of greater than one year.
- Include major alterations to R&D facilities/environment.
- Exclude depreciation provisions, repairs and maintenance.

##### **• MANPOWER EXPENDITURES**

**(for definition of R&D Manpower, please refer to Section III)**

- Annual wages and salaries and all associated expenditures for R&D Manpower
- Include gross payments before taxation and other deductions, CPF contributions, overtime payments, shift allowances, bonuses, annual wage supplements, welfare expenditure, and payments to contract staff on your payroll.

##### **NOTE:**

Expenditure on personnel who provide an *indirect* service to R&D should be categorised under Other Operating Expenditures.

All reported figures on Manpower Expenditures should be on a full-time-equivalent basis (For definition of full-time equivalents, please refer to Question 13B, Page 9 of explanatory notes).

**Only HIGHER EDUCATION institutions need to fill in Manpower expenditure on Full-time Post-graduate Research Students (FPGRS).**

##### **• OTHER OPERATING EXPENDITURES**

- Include materials, fuels, rent and hiring expenses; data processing; payments to external organisations for use of specialised testing facilities; commission work/sub-contract work expenses (but excluding labour costs for sub-contractors on your payroll);
- Include activities which are not themselves R&D but which provide support for R&D (e.g. storage, transportation, cleaning, repair, maintenance and security activities, administration and clerical activities undertaken exclusively for R&D, such as activities of central finance and personnel departments)
- Include the payments for the current purchase of books, periodicals, and annuals for R&D related purposes.

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Please also indicate the percentage of total R&D expenditure attributable to software development. Software development refers to the research into and original development (or substantial modification) of computer software such as application software, programming languages and operating systems.

**Question 11**

Indicate the breakdown of how your Total R&D Expenditure was funded, according to sources of funds. Note that sources should be the original sources providing funds, such as grants, contracts, etc. for R&D activities. Funding on project basis should be declared according to how much has been spent for 2007 (or the reporting period) only. Funds that are not utilised for year 2007 (or the reporting period) should not be included.

Please ensure that the "Total R&D Funds" indicated here tallies with the "Total R&D Expenditure for 2007" in Question 10.

**Question 12A**

Please give a brief description of the nature of the R&D activities in your organisation. If your organisation engages in a wide spectrum of R&D activities, a short list of main activities would suffice. Generic responses are "product development", "process development", "software development", and "design". Other common responses include "Phase 1 and 2 clinical trials", "development of internet technology for home banking", "development of Integrated Circuits". The above examples are non-exhaustive.

**Question 12B**

Indicate the breakdown of your R&D Expenditure by strategic focus and area of research undertaken. Please ensure that the "Total R&D Expenditure" indicated here tallies with the "Total R&D Expenditure for 2007" in Question 10.

**Types of Strategic Focus**

Research and development (R&D) includes pure basic research, strategic basic research, applied research and experimental development.

**What is pure basic research?**

Pure basic research is carried out for the advancement of knowledge, without seeking long-term economic or social benefits or making any effort to apply the results to practical problems or to transfer the results to sectors responsible for their application.

**What is strategic basic research?**

Strategic (or oriented) basic research is carried out with the expectation that it will produce a broad base of knowledge likely to form the basis of the solution to recognised or expected, current or future problems or possibilities.

**What is applied research?**

Applied research is original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific aim or objective.

**What is experimental development?**

Experimental development is systematic work, drawing on the knowledge gained from research and practical experience that is directed to producing new materials, products and devices; to installing new processes, systems or services; or to improving substantially those already produced or installed.

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Private sector organisations may treat “Pure Basic Research” and “Strategic Basic Research” as a single field and fill in the R&D Expenditure under “Strategic Basic Research”.

**Areas of Research (Fields of Science and Technology)**

<b>1.</b>	<b>NATURAL SCIENCES</b>
1.1	<b>Chemical Sciences</b> Chemistry and related sciences.
1.2	<b>Computer &amp; Related Sciences</b> Computer programming; computer studies; electronic data processing; information sciences; system analysis; and areas related to software development.
1.3	<b>Earth &amp; Related Environmental Sciences</b> Geology; geophysics; mineralogy; meteorology; physical geography and other geosciences; other atmospheric sciences including climate research; oceanography; vulcanology; palaeoecology and related sciences.
1.4	<b>Physical Sciences &amp; Mathematics</b> Physics; mathematics; astronomy and space sciences and related sciences.
<b>2.</b>	<b>ENGINEERING &amp; TECHNOLOGY</b>
2.1	<b>Aeronautical Engineering</b>
2.2	<b>Biomedical Engineering</b>
2.3	<b>Civil Engineering &amp; Architecture</b> Architecture engineering; building science and engineering; construction engineering; municipal and structural engineering.
2.4	<b>Computer Engineering</b> (Hardware only)
2.5	<b>Electronic &amp; Electrical Engineering</b> Electrical engineering; electronics; communication engineering and systems.
2.6	<b>Infocommunication &amp; Media Technology</b>
2.7	<b>Marine Engineering</b>
2.8	<b>Materials Science &amp; Chemical Engineering</b>
2.9	<b>Mechanical Engineering</b>
2.10	<b>Metallurgy &amp; Metal Engineering</b>

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<b>3.</b>	<b>BIOMEDICAL &amp; RELATED SCIENCES</b>
3.1	<b>Basic Medicine</b> Anatomy; pharmacology; physiology; cytology; pharmacy; toxicology; immunology and immunohaematology; pathology; neuroscience.
3.2	<b>Biological Sciences</b> Biochemistry; biology; biophysics; genetics; microbiology; molecular biology; bioengineering; bioinformatics.
3.3	<b>Clinical Medicine</b> Anaesthesiology; dentistry; internal medicine; obstetrics and gynaecology; paediatrics; surgery; neurology; psychiatry; radiology; therapeutics; otorhinolaryngology; ophthalmology; oncology; geriatrics; cardiovascular; dermatology; urology; infectious diseases.
3.4	<b>Health Sciences</b> Public health services; social medicine; hygiene; nursing; epidemiology.
3.5	<b>Pharmaceutical Sciences &amp; Manufacturing</b>
3.6	<b>Other Biomedical related sciences</b>
<b>4.</b>	<b>AGRICULTURAL &amp; FOOD SCIENCES</b>
	Agronomy; agrotechnology; animal husbandry; fisheries; forestry; horticulture; bacteriology related to animals; veterinary medicine; botany; zoology; food and other related sciences.
<b>5.</b>	<b>OTHER SIGNIFICANT AREAS OF RESEARCH</b> your organisation is involved in but not listed above

**SECTION III : R&D MANPOWER**

**Question 13A**

Indicate your R&D Manpower headcount as at the end of the reporting period in 2007, according to their Citizenship and Qualification Level.

**Definition of R&D Manpower**

**R&D MANPOWER**

R&D manpower comprises all persons *directly* employed on R&D and those providing *direct* services. It includes persons who are *mainly* or *partially engaged* in R&D. The following occupational groups are considered as R&D manpower: researchers, technicians and other supporting staff.

- (A) Researchers:** R&D personnel principally engaged in research (as opposed to purely technical support work). They include:
- Professionals engaged in the conception and/or creation of new knowledge, products, processes, methods and systems, or in the management of the projects concerned.
  - Managers and administrators engaged in the planning or management of scientific and technical aspects of R&D projects or a researcher's work;
  - Software developers/programmers involved in R&D projects; and
  - Full-time postgraduate research students, at both master and PhD level

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Researchers are further *subclassified* as follows:

- **Research Scientists and Engineers (RSEs)** refer to researchers who hold formal qualifications at the university degree level. Excludes full-time postgraduate research students.
- **Full-time Post-graduate research students (only applicable for HIGHER EDUCATION institutions):** Master degree and above students who are expected to prove their competence by undertaking a relatively independent study or project and by presenting its results. As a general rule, these studies contain the elements of novelty required for R&D projects.
- **Non-Degree Researchers** refer to researchers without formal university degree level qualifications. Excludes full-time postgraduate research students.

**(B) Technicians:** Persons doing technical work in support of R&D, normally under the direction and supervision of a researcher.

- Typical activities of technicians include preparation for experiments, taking records, preparation of charts and graphs and coding data.

**(C) Other supporting staff:** Other staff who participate in or are *directly* associated with R&D projects. Includes managers and administrators dealing mainly with financial and personnel matters and general administration, skilled and unskilled craftsmen, secretarial and clerical staff, insofar as their activities are a direct service to R&D.

**NOTE:** Persons providing an indirect service should be excluded.

### Question 13B

Indicate the Full-Time Equivalence (FTE) of the Total R&D Manpower reported in Q13A. Please note that under "Manpower Expenditure" indicated in Question 10, there should be a corresponding value in FTE and vice versa.

**NOTE:** Full-time equivalents may be given to one decimal point.

**Full-time equivalents (FTE)** are measured in terms of full-time equivalent years. One FTE may be thought as one person-year. A person who normally spends 30% of his/her time on R&D and the rest on other activities should be considered as 0.3 FTE. Similarly, if a full-time R&D worker is employed at an R&D unit for only six months during a one-year reporting period, this results in 0.5 FTE.

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For example:

In XYZ company, Researchers spend about 75% of their time on R&D, the Technicians 50% and support staff 25%. The FTE calculation will be the amount of time spent multiplied by the number of headcount.

Citizenship	Researchers				Technician	Other Support Staff	Total R&D Manpower
	Degree			Non-Degree			
	PhD	Master	Bachelor				
<b>By Headcount</b>							
Total R&D Manpower	20	10	6	4	2	2	40
<b>By FTE</b>							
Total R&D Manpower	15	7.5	4.5	3	1	0.5	31.5

**Question 13C**

The section on Headcount for Full-time Postgraduate Research Students is only applicable for HIGHER EDUCATION institutions.

**Question 13D**

Indicate breakdown of R&D Manpower by Age Group and Qualification for (I) Singapore Citizens; (II) Singapore Permanent Residents (PRs) and Foreigners; and (III) Total R&D Manpower. The total headcount figures reported for Total R&D Manpower should tally with the values given in Q13A.

Breakdown for Full-time Postgraduate Research Students is only applicable for HIGHER EDUCATION institutions. Please ensure that total headcount tallies with values given in Q13C.

**Question 13E**

Indicate breakdown of R&D Manpower by Gender and Qualification for (I) Singapore Citizens; (II) Singapore Permanent Residents (PRs) and Foreigners; and (III) Total R&D Manpower. The total headcount figures reported for Total R&D Manpower should tally with the values given in Q13A.

Breakdown for Full-time Postgraduate Research Students is only applicable for HIGHER EDUCATION institutions. Please ensure that total headcount tallies with values given in Q13C.

**Question 14A**

Indicate the Researchers' headcount by their educational qualification and area of research. The total headcount figures reported should tally with the values given in Q13A.

Breakdown for Full-time Postgraduate Research Students is only applicable for HIGHER EDUCATION institutions. Please ensure that total headcount tallies with values given in Q13C.

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**Question 14B**

Indicate the R&D Researchers' Full-Time Equivalents (FTE) by their educational qualification and area of research. For the definition of Full-Time Equivalent (FTE), please refer to the explanatory notes for Q13B. The total Full-Time Equivalent FTE figures reported should tally with the values given in Q13B.

**Breakdown for Full-time Postgraduate Research Students is only applicable for HIGHER EDUCATION institutions.**

**SECTION IV: TECHNOLOGY INDICATORS**

**Question 15A**

Please indicate the total number of primary patent applications in the reporting period for 2007, as a result of R&D conducted in Singapore. The applicant of the patent can be your organisation or an overseas headquarters / affiliate. Note that only first filings of patent applications are counted, and patent applications for the same invention in numerous countries should be entered as one.

The sum of the entries in the breakdown table should be equal to the total number of primary patent applications.

**Question 15B**

Please indicate the total number of patents awarded in the reporting period for 2007, as a result of R&D conducted in Singapore. The awardee of the patent can be your organisation or an overseas headquarters / affiliate. Note that patent awards for the same invention in numerous countries should be counted as one.

The sum of the entries in the breakdown table should be equal to the total number of patent awards.

**Question 15C --- 15E**

Please fill in the values as requested, for your reporting period in 2007.

**Question 15F**

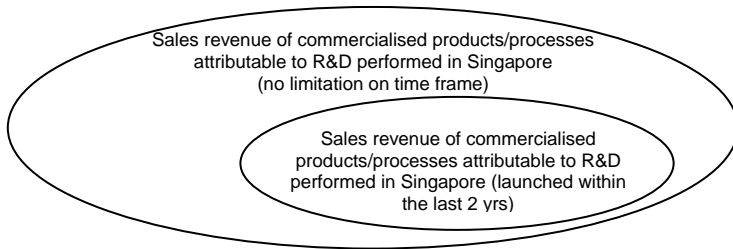
Indicate the sales revenue generated from commercialised products/processes attributable to R&D performed in Singapore (no limitation on time frame, that is, regardless of the year that the product is launched). See diagram below.

**Question 15G**

Indicate the sales revenue generated from commercialised products/processes launched within the last 2 years (2006 & 2007) and attributable to R&D performed in Singapore. This value should be equal or less than the value indicated in 15F. See diagram below

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**SECTION V: EXPENDITURES ON R&D PERFORMED BY OTHER ORGANISATIONS**

**Question 16**

Please tick whether your organisation has funded any R&D that was carried out at other organisations for reporting period in 2007. Subcontractors working on R&D projects carried out by your organisation should be excluded as they are already captured under Other Operating Expenditure in Question 10.

**Question 17**

Indicate the amount of funds that your organisation has given or paid for R&D carried out at other organisations within Singapore and outside Singapore for the reporting period in 2007. Funding on project basis should be declared according to how much has been given or paid to the other organisations for the reporting period in 2007 only. Funds that have been agreed on but not given or paid during the reporting period should not be included.

**Only organisation that has funded or paid for R&D that was carried out at other organisations for the reporting period in 2007 need to answer this question**