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Preface

This Manual on Science, Technology and Innovation (STI) statistics in BIH (hereinafter: the Manual) is a technical document whose significance goes beyond its narrow professional character. It shows a shift in public policy in BIH which has accepted STI as an important part of its activities. BIH is lagging far behind its neighbours and the new EU Member States in this area. The STI statistics monitoring system is not developed in BIH. This Manual represents an important step towards introducing an STI statistics monitoring system in BIH, which is one of the prerequisites for the approximation to EU standards in this area. We expect that studying this Manual and its application by statisticians, as well as its implementation by a broader professional community and decision-makers will significantly speed up the process of catching-up with EU practice.

The Manual is a unique document as it has not been developed for other countries to date. It is the result of the work by a number of local and international experts engaged within the EU-funded project: "Capacity Building and Institutional Strengthening of Science and Research in BIH", implemented by Technopolis Consulting Group (Belgium), in cooperation with LOGOTECH SA (Greece), Zentrum für Soziale Innovation (Austria) and European Profiles (Greece). The following team of authors and editors were involved in developing this Manual (in alphabetical order): Adela Poprženović, Đuro Kutlača, Edin Jahić, Emira Bečić, Gunnar Westholm and Slavo Radošević.

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List of abbreviations

ANBERD – Analytical Business Enterprise Research and Development

BE – Business Enterprise Sector

BEMP – Total R&D personnel of the BE sector (expressed as head-counts or full-time equivalence)

BERD – Total intramural R&D expenditures of the BE sector

BERSE – Total R&D scientists and engineers engaged in the BE sector (idem)

BiH – Bosnia and Herzegovina

CDH – Careers of Doctorate Holders

CIS – Community Innovation Survey

COBIB – Cooperative Bibliographic Database

COBISS – Co-operative Online Bibliographic Systems and Services

COLIB – Co-operative Online database on libraries

EA – External Applications

E-CRIS – E-Current Research Information Systems

EPO – European Patent Office

EU – European Union

EUROSTAT – European Union Statistical Office

FBIH – Federation of Bosnia and Herzegovina

FDI – Foreign Direct Investment

FMON – Federal Ministry of Education and Science

FTE – Full-time equivalent

FZS – Federal Office of Statistics

GBAORD – Government Budget Appropriations or Outlays for R&D

GERD – Gross domestic expenditure on R&D

GNERD – Gross National Expenditure on R&D

GOVERD – Total intramural R&D expenditures of the Government sector

GOVMP – Total R&D personnel of the Government sector (expressed as head-counts or full-time equivalence).

GOVRSE – Total R&D scientists and engineers engaged in the Government sector (idem)

GUF – General university funds

HE – Higher Education

HEMP – Total R&D personnel of the HE sector (expressed as head-counts or full-time equivalence).

HERD – Total intramural R&D expenditures of the HE sector

HERSE – Total R&D scientists and engineers engaged in the HE sector (idem)

HES – Higher Education Sector

HRST – Human Resources in Science and Technology

IA – Innovation Activities

ICC – Information and Communications

ICT – Information and Communications technologies

ILO – International Labour Organization

IMF – International Monetary Fund

IPC – International Patent Classification

ISCED – International Standard Classification of Education

ISCO – International Standard Classification of Occupations

ISIC – International Standard Industrial Classification of All Economic Activities

ISO – International Organization for Standardization

JPO – Japanese Patent Office

KIS – Knowledge-intensive Services

KMON – The Ministries of Education and Science in the Cantons

MOCA – The Ministry of Civil Affairs

MNT –The Ministry of Science and Technology in Republika Srpska

NA – National Application (on patents)

NABS – The Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets

NACE – Nomenclature générale desactivités économiques dans le communautés européennes (The European Union Classification of Economic Activities)

NESTI – OECD National Experts on Science and Technology Indicators

NRA – Non-resident Applications

NRG – Patents granted to non-residents

NSF – National Science Foundation

NUTS – Nomenclature of Territorial Units for Statistics

OECD – Organisation for Economic Co-operation and Development

PCT– Patent Co-operation Treaty

PNP – Private non-Profit

R&D – Research and Development

RA – Resident Applications

RS – Republika Srpska

RSE – Research Scientists and Engineers

SEO – Socio-Economic Objectives

SITC – Standard International Trade Classification

SNA – System of National Accounts

STAN – Structural Analysis Database

STI – Science, Technology, Innovation

TBP – Technology Balance of Payments

UIS – UNESCO Institute for Statistics

UNESCO – United Nations Educational, Scientific and Cultural Organization

US – United States

USPTO – United States Patent and Trademark Office

WIPO – World Intellectual Property Organization

Introduction: Reasons for STI data collection in BIH

The post-war economic growth of Bosnia and Herzegovina (BIH) was based on domestic demand, stimulated by foreign investment, raw materials and relatively cheap labour. With the onset of the worldwide financial crisis in 2008-2009, foreign investment reduced considerably thus exacerbating the problem of the country's low economic competitiveness. The issue of the future sources of economic growth is one of the most important matters for the country to address. Future economic growth requires an increased efficiency or productivity, as well as a larger share of domestic know-how in export products and services. The period between 1997 and 2007 witnessed an important level of industrial restructuring in terms of reconstruction and modernisation of the pre-war industrial base, based on wood-processing, metal-working, textile and motor-car industries1.

This process needs to continue, although this is not yet possible as there is no national innovation system in place. Improvements in quality, adaptation of foreign technologies to national conditions, as well as continued product and process innovations will not be possible without innovative companies, an educated labour force and a more complex research and development (R&D) system. BIH will be unable to achieve long-term growth on the basis of cheap and unskilled labour; rather it has to increase the share of professional labour, quality and national innovativeness, as well as a quality adaptation to and use of foreign technologies and software. This shift will not be possible only at enterprise level without reforming the higher education and vocational education and training systems or without support to companies to increase innovation activities. The BIH R&D system has almost fully disappeared, which is a consequence of the past war. It needs to be re-built, not only at universities and institutes, but in the business enterprise sector in the first place.

The R&D function in the environment of a very low income per capita in BIH of $4,625 (the IMF data for 2008) is not only the creation of one's own know-how, but a far more efficient absorption and diffusion of new technologies. This means that R&D and the innovation system of BIH cannot be a sheer imitation of the system of developed countries; rather, they have to be oriented much more to mastering, adapting to and applying successfully the old know-how and technologies. It is necessary to strengthen national research and development capabilities, as well as the role of universities and institutes in technology transfer. Catching-up with developed countries is not the issue of imitation, but the issue of adaptation and innovation, which requires increased investments in R&D as well the creation of preconditions for innovations in the business enterprise sector. In this context, not only does science in BIH need to contribute to scientific development but also to increased educational attainment, successful

[1] Bartlomiej Kaminski and Francis Ng (2010), Bosnia and Herzegovina's Surprising Export Performance. Back to the Past in a New Veil but Will It Last?, *World Bank Policy Research Working Paper* 5187, Washington

use of new instruments or tools and technologies, and to enterprise start-up and expansion.

This shift or the building of a national science, technology and innovation system integrated into the EU cannot take place overnight. It requires a social consensus and full stakeholder agreement, as well as much better knowledge of national restrictions and abilities and also a better knowledge of BiH's position in the international environment. This in turn implies the existence and use of more advanced information and indicators. It is not possible to mobilise social institutions and organisations without a precise identification and quantification of problems and potentials. In this sense, quality statistics appears as the first precondition of any social action towards restructuring and development. As BiH can only develop in the long run on the basis of the knowledge and professional skills of its citizens, or its labour force, the establishment of a system of science, technology and innovation (STI) indicators is the precondition for any social action in this area.

The existence of STI indicators shows that this area is recognised as a public policy area of strategic interest. The importance of this Manual should be considered precisely in this context.

The goal of this Manual is to inform the broader professional public, the decision-makers (the Science Councils, Ministries) and statisticians in particular about the area of the statistics on science, technology and innovation. In order to be useful to a broader range of users, the Manual is divided into four parts.

A Guide Through the Manual

Part One of the Manual presents the basic concepts and methodologies in the area of STI statistics. Chapters 1 and 2 give the basic concepts and definitions, and an overview of the most important international organisations in this area, as well as their standards and instruments. The goal is to give readers a relevant overview of the situation around the world, and also provide further references for individual study. Chapter 3 contains international classifications used in the area of the STI statistics. Chapters 4, 5 , 6 and 7 deal in greater detail with the measurement of R&D expenditures and personnel, innovation activities, patents, as well as the measurement of public budgetary expenditures.

Part Two of the Manual provides an analysis of the present situation in the STI statistics in BiH, as well as a comparative analysis benchmarking the EU/OECD member states and BiH.

Parts One and Two should be welcome to the beneficiaries of STI statistics, and also to the experts in the Science Councils, Ministries, the academic community and a broader professional public. At the same time, the first two parts should be useful for those working in the institutes and the Agency for Statistics in order to develop a better understanding of the conceptual basis of numerous operational issues which they are facing in this area.

Part Three - Statistical Instruments – should be the most useful section for statisticians who are involved either directly or indirectly in STI data collection. Chapter 9.1 provides methodological instructions for statistical survey and issues of sampling, questionnaires and estimation. Chapter 9.2 provides the basic instructions for calculation and estimation of the main indicators in accordance with EU/OECD standards.

Part Four of the Manual contains recommendations for the establishment of STI statistics in support of decision-making in STI policy in BiH. This part provides a proposal for future activities arising from the analysis in Part Two.

Annex I is the innovation suvey of EUROSTAT for the EU Member States, the Community Innovation Survey (CIS), while Annex II

The Manual does not intend to produce indicators or to offer responses to all questions but rather to guide and recommend to those who are already involved or will be involved in the future in STI statistics in BiH the relevant methodologies, classifications, questionnaires, technical guides, indicators, definitions and good practice. This is particularly important for those working in the institutes and the Agency for Statistics who work or will work on statistics and STI surveys.

Successful implementation of the Manual requires proper training of the people who already perform or will perform those tasks. Also important is a campaign to raise awareness on the importance of monitoring STI statistics in order to receive as many completed questionnaires as possible on a regular basis from all organisations which have that component within their respective activities (public and private sectors).

Part One – Methodology

This part of the Manual introduces the basic terms of categories, provides an overview of international agencies in this area, an overview of internationally accepted classifications which are important for STI data collection, a summary of the basic issues related to the measurement and sectoral classification of R&D expenditures and personnel, as well as the issues relating to the measurement of innovation and patent activities and other databases.

1. Basic concepts and definitions

1.1 General

Policy makers in all areas of society and economy need tools for assessing the current status of their areas of action, for the planning of their future activities, for priority setting and selection amongst options, for project evaluations, in brief, at all stages of their policy resolutions. Statistics and indicators are their principal quantitative instruments that must necessarily be employed together with other tools, including qualitative evaluation.

Science, Technology and Innovation (STI) have for many years been recognised as the principal driving force for economic, industrial, social, cultural and ecological developments and for the promotion of general well-being in society, both in the industrialised world and in countries still lagging behind in the global economy.

The need for indicators is pertinent and perhaps even more so than for most other areas, given the close links within the broad STI concept itself with, for instance, higher education and training of scientists and engineers, industrial production, employment, domestic and foreign trade, creation of new knowledge and intellectual property in all sectors of the nation and their diffusion, alongside with intensified international globalisation.

The importance of statistics and indicators to support S&T activities in their broadest sense was recognised already in the early 1960's when both the (predecessors of) OECD (the Organisation for Economic Cooperation and Development) and UNESCO (the United Nations' Educational, Scientific and Cultural Organisation) initiated work on developing guidelines for the measurement of research and experimental development (R&D) and other scientific and technological activities (STA). The concept of "innovation", as another S&T endeavour to be systematically measured, was launched approximately thirty-five years later.

Over time these agencies – and notably OECD - have developed a series of technical guidelines on the measurement of various STI activities with a view to promoting the international comparability of data but also to serve national purposes. Some of the principal STI concepts will be presented in this introductory chapter and then discussed in more detail later.

1.2 Statistics vs. Indicators – A Confusing Concept?

In the interest of the discussions, it is worthwhile to briefly examine the distinction between the concepts of ”statistics”, on the one hand, and that of ”indicators”, on the other.

“Statistics” can be described as:

“Numerical data relating to an aggregate of individuals; the science of collecting, analysing and interpreting such data.”[2].

“An indicator”, can be defined as:

“A statistical indicator is a data element that represents statistical data for a specified time, place, and other characteristics[3].

Indicators are typically obtained by associating some original “raw” data (statistics) with some other internal or external variable(s) – including that of time - and have it transformed into, for instance, ratios, percentages, growth rates or seen in relation to GDP, to population or some other pertinent statistical variable. The principal purpose of the exercise is, in other words, to confer some “value added” to the basic statistical figure and make it more exploitable for comparisons and analytical purposes. It is evident that movements in either the nominator or the denominator of the equation may have an impact on the final result.

Example: According to OECD statistics (drawing on “Main Science and Technology Indicators”) the total R&D expenditures in 2007 (“GERD”), expressed in national currency, were some 39.489,5 million Euros in France and 35.1 billion kronùr in Iceland, i.e. two not really comparable expenditures figures.

Expressed in current US dollars (calculated at PPP = purchasing power parity rates) the corresponding expenditures were 43.359,5 million dollars in France but 305 million dollars in Iceland, i.e. here we get a somewhat better relative indication of the R&D efforts of the two countries that, however, does not really take into account their size (population).

An additional step in the indicators’ calculation then shows us that, seen as a percentage of GDP, France was that year clearly less R&D intensive than Iceland (2.08 and 2.75 per cent respectively) and this difference is confirmed also if we look at another commonly used indicator, that of national R&D expenditures per capita of total population (680 and 980 dollars, respectively).

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[2] OECD Online Dictionary

[3] OECD Online Dictionary

The above presentation shows that, despite the very limited comparability of the original "raw" data, their transformation into one or several "derived" indicators considerably improves their utility for analytical purposes and, accordingly, for subsequent policy decisions.

There are three principal criteria for choosing the best indicators; they should be policy-relevant, be analytically sound and be useful and measurable.

For the preparation of internationally comparable indicators, the conversion of national "raw" data (statistics) is usually undertaken centrally at the principal international agencies (OECD, UNESCO, EUROSTAT, World Bank), thereby ensuring procedural and methodological consistency for different economic indicators such as GDP, deflators, purchasing power parity, exchange rates, population series, etc.

1.3 The Key Terminology in Science and Technology Policy

1.3.1 General

This document will deal with several issues directly or indirectly related to scientific and technological activities and to research and innovation. The coverage and the meaning of some of these activities has already been specifically defined in some of the manuals that will be discussed later. Some basic definitions and terminology will be given below and then further developed in the respective Chapters.

1.4 The UNESCO Definitions of "Scientific and Technological Activities" "(STA)

The principal concept of the broad area of "scientific and technological activities" (STA) was first described in a systematic way by UNESCO in cooperation with OECD in its "Recommendation concerning the International Standardization of Statistics on Science and Technology » (UNESCO 1978)[4]. The broad sphere of "STA" was defined as follows:

S&T Activities ("STA") are:

Systematic activities which are closely concerned with the generation, advancement, dissemination, and application of scientific and technical knowledge in all fields of science and technology. These include such activities as R&D, scientific and technological education and training (STET) and the scientific and technological services (STS).

The coverage (basic definitions) of the three sub-classes of the "STA" is the following:

Research and experimental development – "R&D" (definitions from the OECD "Frascati Manual")

"Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications".

[4] http://portal.unesco.org/en/ev.php-URL_ID=13135&URL_DO=DO_TOPIC&URL_SECTION=201.html

R&D covers both formal R&D in R&D units and informal or occasional R&D in other units. The prime criterion whether an activity is R&D or not is that it should involve "a considerable element of novelty" (in contrast to the routine character of S&T activities in general).

For the measurement of R&D expenditures and personnel there will necessarily be "borderline problems" in relation to the "other STA" activities below and these borderlines are in many cases very complicated to describe. The Frascati Manual has, therefore, opted for an approach where it discusses, with numerous practical examples, what is not R&D rather than suggesting some complex and intricate definition likely to add to the confusion.

Within the broad area of STA activities it is anyhow the collection of data on R&D expenditures and personnel that has the longest and the most widespread tradition and this is also where the best international comparability has been achieved.

The basic definition of R&D furthermore suggests three sub-classes, by "type of activity"

- Basic research (or "fundamental research") is defined as:

"…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 defined as:

"…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 defined as:

"…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".

The UNESCO Scientific and Technical Education and Training at Broadly the Third Level ("STET") consists of:

"…all activities comprising specialized non-university higher education and training, higher education and training leading to a university degree, post-graduate and further training, and organized life-long training for scientists and engineers. These activities broadly correspond to ISCED levels 5 and 6".[5]

[5] ISCED stands for the United Nations « International Standard Classification of Education » which was first issued by UNESCO in 1976 but revised in 1997. The original level descriptions have been modified in the revised ISCED and the above "levels 5, 6 and 7" are no longer relevant. However, the notation "broadly the third level" should still be understood as "higher education" level. The original (1978) UNESCO "Recommendation" has never been updated and, accordingly, does not reflect these ISCED modifications. (International Standard Classification of Education, Abridged edition, UNESCO, Paris, 1975 (ED/3lE/CONFINTED.35/Ref.8)

Scientific and Technological Services (STS): are:

"…activities concerned with research and experimental development and contributing to the generation, dissemination and application of scientific and technical knowledge ".

This is the largest category in the UNESCO "STA" group. The "Recommendation" provides a list of nine broad classes of "STS", many of which may be operating at the borderline of R&D (the problems of borderline activities and institutions are discussed at length in the OECD and UNESCO guidelines).

It should, however, be noted that this UNESCO list, going back to the S&T situation in the late 1970's, is far from up-to-date. There is, for instance, no mention of information, computers and communication services, space activities, innovation services, biotechnologies, nano-technologies, environmental services, etc. Notwithstanding this, the list can still serve as an "inventory" for the creation of various types of registers of institutions.

The UNESCO List of Scientific and Technological Services (STS)

i) S&T services provided by libraries, archives, information and documentation centres, reference departments, scientific congress centres, data banks and information processing departments;

(ii) S&T services provided by museums of science and/or technology, botanical and zoological gardens and other S&T collections (anthropological, archaeological, geological, etc.);

(iii) Systematic work on the translation and editing of S&T books and periodicals (with the exception of textbooks for school and university courses);

(iv) Topographical, geological and hydrological surveying; routine astronomical, meteorological and seismological observations; surveying of soils and of plants, fish and wildlife resources; routine soil, atmosphere and water testing, the routine checking and monitoring of radioactivity levels;

(v) Prospecting and related activities designed to locate and identify oil and mineral resources;

(vi) The gathering of information on human, social, economic and cultural phenomena usually for the purpose of compiling routine statistics, e.g. population census; production, distribution and consumption statistics; market studies, social and cultural statistics, etc.;

(vii) Testing, standardisation, metrology and quality control; regular routine work on the work on the analysis, checking and testing, by recognised methods of materials, products, devices and processes, together with the setting up and maintenance of standards and standards of measurement;

(viii) Regular routine work on the counselling of clients, other sections of an organization or independent users, designed to help them to make use of scientific, technological and management information. This activity also includes extension and advisory services organized by the State for farmers and for industry but does not include the normal activities of projects planning or engineering offices;

(ix) Activities relating to patents and licences; systematic work of a scientific, legal and administrative nature on patents and licences carried out by public bodies[6].

[6] Recommendation concerning the International Standardization of Statistics on Science and Technology » (UNESCO 1978)

1.5 Definition of Innovation Activities

The economic impacts of innovation are increasingly recognised and numerous countries are now engaged in measuring innovative activities, in line with the recommendations of the OECD/EUROSTAT Oslo Manual(s) and, notably, following EUROSTAT initiatives. The scope of these measurements has increased over time. At first, interest focused on just technological product and process innovation in manufacturing enterprises but this has also come to include various types of innovation in services and non-technological innovation in other sectors. Some additional EUROSTAT/OECD innovation issues are also presented in the Oslo Manual.

1.5.1 The principal definitions of Innovation

The following section consists of selected extracts from the third edition of the "Oslo Manual" (2005):

"An innovation is the implementation of a new or a significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations".

Technological innovations comprise implemented technologically new products and processes and significant technological improvements in products and processes.

An innovation has been implemented, if it has been introduced on the market (product innovation) or used within a production process (process innovation).

The product or process should be new (or significantly improved) to the enterprise (it does not necessarily have to be new to the enterprise's market).

Innovation activities are all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Some innovation activities are themselves innovative, others are not novel activities but are necessary for the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation.

An **innovative firm** is one that has implemented an innovation during the period under review.

A **product innovation** is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.

A **process innovation** is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.

A **marketing innovation** is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.

An **organisational innovation** is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

2. The principal agencies for the collection, analyse and dissemination of R&D statistics and indicators and their guidelines

2.1 Introduction – How it all started

The initial OECD guidelines were laid down in a first "Frascati Manual" issued in 1963 (Frascati is a small village outside Rome/Italy where the first experts' meeting took place) and concentrated on the measurement of R&D expenditures and personnel though there were already some first proposals for more vast S&T data collection than for just R&D.

After some purely statistical exercises (surveys, data processing and publication of tables) the OECD became the prime user of its own R&D statistics. These analytical studies helped to identify methodological inconsistencies in the guidelines that were then amended in the following versions of the manual, thanks to continuous interaction between producers and users of the statistics.

Broadly at the same time, UNESCO initiated its very ambitious work on measuring the much broader concept of "STA" where R&D only constitutes a very small, though essential, part. At the time, in contrast to the situation of UNESCO, all the OECD Member countries were already industrially well-advanced, with efficient national bureaus of statistics and well-established survey practices (including business registers, etc). This made data collection easier for the sectors of R&D performance and finance suggested in the Frascati Manual and Member countries soon fully complied with data reporting to the regular OECD surveys.

UNESCO, on the other hand, had to meet the requirements of a much wider and varied membership audience, besides the OECD countries. This included the socialist bloc and developing countries where the OECD breakdown (or "sectoring") into enterprises, government, higher education and private-non-profit was of little relevance (only the higher education sector was identical between the two agencies). UNESCO had to develop its own sectoring for measuring R&D performance and finance that was difficult to follow. Thus, the quality of the UNESCO collected data and published was uncertain, especially for international comparisons. UNESCO undertook important methodological work to collect information also on the broad STA activities referred to above. However, for a number of practical and financial reasons UNESCO soon had to limit most of its data collection to R&D only.

It was not until the collapse of the socialist bloc that these countries adopted Western statistical standards, including those of the "Frascati Manual" (now also fully recommended by UNESCO) which today are the basis for virtually all R&D data reported in the world even if, for domestic reasons, there may be deviations from the same norms.

Several years later, EUROSTAT, the statistical agency of the European Communities, also got involved in the collection, management, analysis and diffusion of various kinds of S&T data.

In the early days of R&D/S&T surveys the data collection was frequently the responsibility of national policy agencies, such as research councils, that were themselves principal "consumers" of their own data. Over time, however, national bureaus of statistics have been increasingly engaged in the collection of R&D/S&T data that has become an integrated part of regular data collection.

There are many factors in support of this path, especially following the tendency of work going from pure data collection (statistics) into the development of indicators, involving comparisons of the R&D/S&T statistics with other statistical series (GDP, population, production, employment, education, etc.) where the national bureaus of statistics are in the best position to provide the complementary economic background series. Business registers facilitate survey work, they are legally responsible to statistical secrecy rules (which may facilitate respondents' answering propensity) and, in particular, they are as a rule less confronted with the frequent staff mobility problems observed in policy agencies. The national bureaus of statistics are also in the best position to collect new S&T-associated data such as information and communications statistics.

Policy makers have also increasingly become interested in the outcomes or "outputs" of the resources allocated to the S&T system. For the enterprise sector, use is made of a "proxy series" of information that, at the outset, had never been intended to serve S&T analysis. These include patents statistics, technology balance of payments data or information on trade in "high-tech" goods and services. For the university sector the principal "output" indicators refer to statistics on numbers of S&T publications produced and/or to citation counts ("bibliometrics"). All the above series allow the transformation of basic data into numerous series of derived indicators.

"Output" data of this kind are hardly ever collected by national survey agencies but are provided by institutions such as the principal international patents and other intellectual property agencies, or are extracted from foreign trade databases. The bibliometrics series are collected and processed (frequently on a commercial basis) by firms but also increasingly by "science policy units" in large universities or by research councils all over the world.

2.1.1 Organisation for Economic Cooperation and Development (OECD)

The OECD is an important international economic agency (headquarters in Paris) with currently over 30 Member countries. OECD operates like any traditional government organisation with mission-oriented Directorates (like ministries) for economy, energy, agriculture, education, labour, social affairs, environment, etc.; all engaged in specific economic analysis of their main activities. OECD statistics and analysis are renowned for international comparisons in the main economic areas but the organisation is also involved in large numbers of individual country or topic studies.

For many years the OECD covered the interests of the industrialised Western world but it now has a more global focus following the collapse of the Eastern Bloc. The OECD cooperates closely with the main global economic organisations such as the United Nations and the European Community and their specialised agencies.

One of its largest OECD Directorates is for Science, Technology and Industry which has become world leader in the development of R&D/S&T statistics and indicators.

2.1.2 The OECD "Frascati Family" of S&T Manuals

2.1.2.1 General

With a view to encouraging the use of statistics for S&T policy purposes, the OECD has over the years, besides the "Frascati Manual", issued a number of additional technical guidelines/manuals, in close cooperation with its group of "National Experts on Science and Technology Indicators – "NESTI", where UNESCO, EUROSTAT and other international agencies are represented as well. Several of these manuals and analytical documents may be downloaded at no cost from the websites of the principal agencies.

The Principal OECD Methodological Manuals (the "Frascati family") on the measurement of scientific and technological activities are:

Research and experimental development:

"Frascati Manual: Proposed Standard Practice for Surveys of Research and Experimental Development" – 6th Edition (OECD 2002); (http://ec.europa.eu/eurostat/ramon/statmanuals/files/Frascati_Manual_2002_EN.pdf)

"R&D Statistics and Output Measurement in the Higher Education Sector" – Frascati Manual Supplement (OECD 1989);

Revised Field of Science and Technology (FOS) Classification in the Frascati Manual (http://www.oecd.org/dataoecd/36/44/38235147.pdf)

Innovation:

"Guidelines for Collecting and Interpreting Innovation Data Oslo Manual" (3rd Edition, OECD 2005); (http://ec.europa.eu/eurostat/ramon/statmanuals/files/9205111E.pdf)

S&T Personnel:

"The Measurement of Human Resources Devoted to Science and Technology - Canberra Manual" (OECD 1995); (http://ec.europa.eu/eurostat/ramon/statmanuals/files/Canberra_Manual_1992.EN.pdf)

Patents:

"Using Patents Data as Science and Technology Indicators - Patents Manual" (2008); (http://ec.europa.eu/eurostat/ramon/statmanuals/files/OECD_Patent_Statistics_Manual.pdf)

Globalisation:

"Handbook on Economic Globalisation Indicators" (OECD 2005); (http://www.realinstitutoelcano.org/materiales/docs/OCDE_handbook.pdf)

Bibliometrics:

"Bibliometric Indicators and Analysis of Research Systems: Methods and Examples", by Yoshiko OKUBO (OECD, STI Working Paper 1997/1 (OECD 1997); (http://www.oecdilibrary.org/docserver/download/fulltext/5lgsjhvj7ng0.pdf?expires=1278920289&id=0000&accname=freeContent&checksum=5D400338493FD08BFCF7F1BD28862457)

Technology Balance of Payments:

"Proposed Standard Method of Compiling and Interpreting Technology Balance of Payments Data TBP Manual" (OECD 1990); (http://www.czso.cz/csu/redakce.nsf/i/tpb_pdf/$File/tbp_manual.pdf)

High technology:

"Revision of High-technology Sector and Product Classification" OECD, STI Working Paper 1997/2; (http://www.oecd-ilibrary.org/docserver/download/fulltext/5lgsjhvj7nkj.pdf?expires=1280853944&id=0000&accname=guest&checksum=0EE6E1D3FE16180142E21C3E63513845)

Productivity:

"Measuring Productivity Manual" (OECD 2001); (http://www.oecd.org/dataoecd/59/29/2352458.pdf)

Biotechnology:

"A Framework for Biotechnology Statistics (OECD 2005). (http://www.oecd.org/dataoecd/5/48/34935605.pdf)

2.1.2.2 The "Frascati Manual" (on the Measurement of R&D Activities)

The Frascati Manual has become the internationally recognised methodology for collecting and using R&D statistics and is an indispensable tool for statistical offices around the world[7]. It includes definitions of basic concepts, data collection guidelines, and classifications for compiling statistics[8]. The current version of the Frascati Manual (2002) is the sixth and preparations are underway for a seventh revision. All the principal directives of the manual are directly linked to internationally adopted United Nations standard classifications such as the SNA, ISCED, ISCO, ISIC, etc[9].

The Table of Contents of the 2002 Frascati Manual (6th revision) consists of eight chapters and eleven annexes (see below) dealing with:

Chapter 1:	Aim and Scope of the Manual
Chapter 2:	Basic Definitions and Conventions
Chapter 3:	Institutional Classification
Chapter 4	Functional Distribution
Chapter 5:	Measurement of R&D Personnel
Chapter 6:	Measurement of Expenditures Devoted to R&D
Chapter 7:	Survey Methodology and Procedures
Chapter 8:	Government Budget Appropriations or Outlays for R&D by Socio-Economic Objectives

[7] http://ec.europa.eu/eurostat/ramon/statmanuals/files/Frascati_Manual_2002_EN.pdf

[8] Revised Field of Science and Technology (FOS) Classification in the Frascati Manual reflects the latest changes in S&T, especially as regards emerging fields such as ICT, biotechnology and nanotechnology (http://www.oecd.org/dataoecd/36/44/38235147.pdf).

[9] The Field of Science and Technology Classification (FOS) was discussed on a number of occasions within the latest review of the Frascati Manual (FM). It was felt in particular that the time had come for the FOS Classification – the most appropriate classification for research and development in the public sector – to be reconsidered if it were to reflect the most recent changes in science and technology, especially in view of new technological areas, such as ICT, bio-technology and nanotechnology. Following those discussions in 2002, the Working Group of National Experts on Science and Technology Indicators (NESTI) decided to draw up a list of tasks that they would focus on in the review of the FOS classification. The reviewed and changed FOS was published under the responsibility of the OECD Secretary General in 2007.

Annex 1:	Brief History and Origins of the Frascati Manual
Annex 2:	Obtaining Data on R&D in the Higher Education sector"
Annex 3:	The Treatment of R&D in the United Nations' System of National Accounts
Annex 4:	R&D related to Health, Information and Communications Technology (ICT) and Biotechnology
Annex 5:	Methods of Deriving Regional R&D Data
Annex 6:	Work on S&T Indicators in Other International Organisations
Annex 7:	Other Science and Technology Indicators (Patent Statistics, The Technology Balance of Payments (TBP), Bibliometrics, High Technology Products and Industries, Innovation Statistics, Human Resources for Science and Technology (HRST);
Annex 8:	Practical Methods of Providing Up-to-date Estimates and Projections of Resources Devoted to R&D
Annex 9:	R&D Deflators and Currency Converters
Annex 10: Projects with	Supplementary Guidance on the Classification of large R&D Special Reference to the Defence and Aerospace Industries
Annex 11:	Correspondence between the Categories of R&D Personnel by Occupation in the Frascati Manual and ISCO-88 Classes

Besides being in the English and French languages, the Frascati Manual has been translated into around twenty languages. At the time of the observer status to the OECD Committee for S&T of the former Federal Republic of Yugoslavia, an early version of the manual was translated into Serbo-Croatian (published 1976 by JUND Biblioteka, Belgrade,-Jugoslovensko Udruzenje Nauka i Drustvo - Yugoslav Association Science and Society).

2.1.2.3 The "Oslo Manual" (on the Measurement of Innovation Activities)

The Oslo Manual is the foremost international source of guidelines for the collection and use of data on innovation activities in industry. The first version of the Oslo Manual (1992) focused on technological product and process innovation in the manufacturing sector, the second edition (1997) integrated technological innovation in services[10]. The third edition addresses the concepts of marketing and organisational innovations[11]. Last but not least, the fourth edition (in the pipeline) will discuss innovation activities in the public sector.

[10] http://ec.europa.eu/eurostat/ramon/statmanuals/files/Oslo_Manual_1997_EN.pdf

[11] This third edition has been updated to take into account the progress made in understanding the innovation process and its economic impact, and the experience gained from recent rounds of innovation surveys in OECD member and non-member countries. For the first time, the Manual investigates the field of non-technological innovation and the linkages between different innovation types. It also includes an annex on the implementation of innovation surveys in developing countries (http://ec.europa.eu/eurostat/ramon/statmanuals/files/9205111E.pdf)

The Table of Contents of the 2005 ”Oslo Manual” (3rd revision) is as follows:

Guidelines are given for the collection of information from respondents on amongst others product and process innovation, innovation expenditures, impacts of innovation, co-operation in innovation, public finance of innovation, and sources of inspiration for innovation.

2.1.2.4 The “Canberra Manual” (on the Measurement of S&T Personnel)

The Canberra manual, jointly written by the OECD, the European Commission services, EUROSTAT, UNESCO and the International Labour Office (ILO) is a guideline for the measurement of human resources devoted to S&T (HRST) and the analysis of such data. In this manual, highly skilled human resources are considered as essential for the development and diffusion of knowledge as well as representing the crucial link between technological progress and economic growth, and social development and environmental well-being.

HRST are defined (in terms of education and occupation) as *people who fulfil one or other of the following conditions:*

a) successfully completed education at the third level in an S&T field of study;

b) not formally qualified as above, but employed in a S&T occupation where the above qualifications are normally required.

The conditions of the above educational or occupational requirements are considered according to the internationally harmonised standards ISCED and ISCO. The conditions of the above educational requirements are considered according to the International Standard Classification of Education (ISCED).

Table of Contents of the "Canberra Manual" (1995)

Reference is frequently made in discussions to stocks and flows of S&T personnel. Personnel stocks may be seen as a snapshot of the situation at a given point of time whereas the flows relate to movements in or out of a stock (inflows, outflows) during a particular period of time. For HRST statistics, stock data refer to the employment status as well as the occupational and educational profiles of individuals in any given year.

An HRST stock can be defined as the number of people at a particular point in time who fulfil the conditions of the definition of HRST.

HRST flows can be defined as the number of people who do not fulfil any of the conditions for inclusion in HRST at the beginning of a time period but gain at least one of them during the period (inflow) as well as the number of people who fulfil one or other of the conditions of the definition of HRST at the beginning of the time period and cease to fulfil them during the period (outflow).

The domain of Human Resources in Science and Technology (HRST) presents data on stocks and flows and census data. The flows are divided into job-to-job mobility and education inflows. Stocks and flows are the core statistics for HRST.

The statistics on stocks and job-to-job mobility are obtained from the European Union Labour Force Survey (LFS). The National Statistical Offices are responsible for carrying out surveys and disseminating the results to EUROSTAT. In this context, mobility refers to the movement of an individual between one job and another from one year to the next. It excludes inflows into the labour market from a situation of unemployment or inactivity.

The statistics on education inflows are obtained from EUROSTAT's Education database (via the UNESCO/OECD/EUROSTAT questionnaire on education). The National Statistical Offices are responsible for conducting the surveys, compiling the results and disseminating the results to EUROSTAT.

2.1.2.5 The "Patent Statistics Manual"

Patents indicators are constructed on the basis of "raw data" collected by national and, increasingly, international patent offices. They help to identify trends in the structure and evolution of inventive activities by mapping changes in technology dependency, diffusion and penetration.

The Patent Statistics Manual is intended to supply persons who wish to use patent statistics to construct science and technology indicators with the key information about how to obtain and analyse such data. The latest edition (2009) takes cognisance of the most recent developments in the field. It provides the guiding principles for the use of patent data in the context of S&T measurement and includes recommendations for the compilation and interpretation of patent indicators. It aims to show what patent statistics can and cannot be used for and how to count patents in order to maximise information on S&T activities while minimising biases. Finally, it describes how patent data can be used in the analysis of a wide array of topics related to technical change and patenting activity including industry-science linkages, patenting strategies by companies, internationalisation of research, and indicators on the value of patents.

The broad contents of the Patent Statistics Manual is presented below.

Table of Contents of the OECD Patent Statistics Manual (2009)

Chapter 1. Objectives and Scope of the Manual
Chapter 2. Patents as Statistical Indicators of Science and Technology
Chapter 3. Patent Systems and Procedures
Chapter 4. Basic Criteria for Compiling Patent-Based Indicators
Chapter 5. Classifying Patents by Different Criteria
Chapter 6. The Use and Analysis of Citations in Patents
Chapter 7. Indicators of Internationalisation of Science and Technology
Chapter 8. Indicators of Patent Value - Glossary

One of the principal novelties in the Patents Manual is the introduction of the concept of “patent families” understood as a set of patents applied for in various countries to protect one single invention.

The principal OECD indicators publication **Main Science and Technology Indicators (MSTI)** has for several years issued a number of basic patents indicators (see below, still readily available from national patents offices) at the macro-level of national totals only.

- National patent applications (= the sum of resident and non-resident applications in the country);
- Resident patent applications;
- Non-resident patent applications;
- External patent applications (made abroad by residents of the country concerned);
- Dependency ratio (non-resident/resident patent applications);
- Auto-sufficiency ratio (resident/national applications);
- The inventiveness coefficient (resident patent applications per 10 000 population),
- The rate of diffusion (external/resident patent applications).

With the introduction of the patent family concept the MSTI patents indicators now refer to “triadic families”, i.e. a patent is a member of the families if, and only if, it is filed (applied for) at the European Patent Office (EPO) and the Japan Patent Office (JPO) and also granted by the United States Patent and Trademark Office (USPTO).

Recent issues of the MSTI only present the following four sets of patents indicators:

- Number of triadic patent families (priority year)
- Share of countries in triadic patent families (priority year)
- Numbers of patents in the ICT sector – applications to the EPO (priority year)
- Numbers of patents in the biotechnology sector – applications to the EPO (priority year)

2.1.2.6 Handbook on Economic Globalisation Indicators (incorporating the Technology Balance of Payments)

Globalisation has in recent years become a principal feature in all areas of the economy, and science and technology. A vast number of definitions are proposed for this concept and they all have in common that they describe processes through which regional economies and societies go beyond their traditional frameworks and become integrated at the global economic world scale through networks of trade, communication, transport, etc. The expression notably refers to economic globalisation, i.e. the integration of national markets into the world economy through trade, foreign direct investment (FDI), capital flows, migration and the circulation of science and technology. Considerable interest is devoted to the role of multinational enterprises in the world economy and their involvement in the international diffusion of technology.

The Handbook aims at measuring the magnitude of the globalisation process. Priority is given to fields that are considered the main components of globalisation: international trade, foreign direct investment, the activity of multinational firms and the production and international diffusion of technology[12].

[12] http://www.realinstitutoelcano.org/materiales/docs/OCDE_handbook.pdf

The broad Table of Contents of the Globalisation Handbook is shown in the box below (with more details for the specific issues concerning technology).

Chapter 1	The Concept of Economic Globalisation and its Measurement	
Chapter 2	Foreign Direct Investment	
Chapter 3	The Economic Activity of Multinational Enterprises	
Chapter 4	The Internationalisation of Technology	
4.1	Introduction	
4.2	The proposed indicators	
4.3	Methodological and conceptual frameworks	
4.4	The international diffusion of technology (technology balance of payments – TBP)	
4.5	Trade in high technology products	
	4.5.1	Defining high technology
	4.5.2	Measurement issues
	4.5.3	Identifying high technology sectors and products
	4.5.4	Principal limitations of the list proposed
	4.5.5	Knowledge-based sectors
Chapter 5	Aspects of Trade Globalisation	
Main Sources of Basic Data Concerning Globalisation Indicators		
Acronyms used in the Handbook		
Glossary		

Chapter 4 in the Handbook is dedicated to the internationalisation of technology, amongst others the technology balance of payments (TBP) that registers the commercial transactions related to international technology and know-how transfers. TBP consists of money paid or received for the use of patents, licences, know-how, trademarks, patterns, designs, technical services (including technical assistance) and for industrial research and development (R&D) carried out abroad. The coverage differs from country to country and the data should be considered as partial measures of international technology flows.

2.1.2.6.1 The Technology Balance of Payments (TBP)

The basic data are collected by the OECD within the framework of its regular international R&D surveys. At national level, the information is essentially drawing on Customs and National Bank statistics. With increasing liberalisation of international trade and capital transfers, some of the principal sources of the TBP data will gradually disappear and the utility of this indicator may possibly decrease.

The following broad five TBP indicators are currently issued in the OECD “Main Science and Technology Indicators” databases and publications:

- TBP Receipts (million national currency);
- TBP Payments (million national currency);
- TBP Receipts (million current dollars);
- TBP Payments (million current dollars);
- TBP Payments as a percentage of GERD.

The latter indicator (i.e TBP payments as a percentage of GERD) gives a proxy illustration of the share of imported technology to domestic R&D efforts. It should be noted that for the above international transactions, it is not possible to make use of the PPP dollars exchange rates serving for the conversion of the other R&D/S&T expenditures series (instead various central bank exchange rates are used).

The technology balance of payments provides indication on a country’s level of independence in terms of non-embedded technology, the origin of the technology used in the productive system or in exports, the links between a country’s R&D effort and its technology receipts, and about the technologies the country is able to develop itself and those that come from abroad or that have to be developed in cooperation with other countries.

The TBP transactions can be broken down according to following:

- industrial sector;
- geographical origin;
- the nature of the contracts; and
- between affiliated and non-affiliated firms.

2.1.2.6.2 The “High-technology” Industries and Products

One of the prime areas of interest in the globalisation debate is the international trade in “high-technology” products. The terminology of “high”, “medium” and “low” technologies (“tech”) is seen in discussions of industrial policy, production, employment, foreign trade, etc. In the industrialised countries, the “high-tech” sectors are presently net creators of jobs (especially in small and medium-sized enterprises) and employ more qualified and better than average paid personnel. They show higher growth rates than the economy in general, account for increasing shares of domestic and international trade, and constitute the prime industrial exporters in most countries.

Furthermore, the high-tech sectors are highly capital- and R&D-intensive and productive in creating new knowledge and technologies. They work at the development edge of R&D, as “fast inventors” with frequent introductions of new goods and services on the market. However, there are also some “high-tech” branches, in the drug industry for instance, which are involved in long-term and commercially “risky” (basic) research projects, with lengthy lead-times between the initial R&D programme and the introduction and first marketing of a new product. These industries are confronted with strong international competition but are also frequently involved in advanced international cooperative research and production programmes.

2.1.2.6.3 How May "High-tech" Be Defined?

Considerable work has been undertaken over the years at national and international level (notably OECD and EUROSTAT) to define and measure "high", "medium" and "low" technologies (industries and products). These "tech" categories were at first usually defined in terms of "R&D intensities" at broad industrial branch levels of manufacturing industry (but have then been refined in line with additional criteria). The R&D expenditures were calculated as a percentage of another economic variable, usually the production value ("output") of the same branch.

Originally, the following three R&D intensity classes were defined:

High R&D intensity ("high-tech") would broadly correspond to R&D expenditures/output = >4%;

Medium R&D intensity ("medium-tech") is R&D expenditures/output = 1-4%, and

Low R&D intensity ("low-tech") is R&D expenditures/output = <1%.

After an additional refinement the following manufacturing classification is currently suggested. The four classes (according to technological intensity) are suggested for manufacturing branches but work also continues to include the service industries that are more and more becoming "high-tech". This has introduced the concept of "knowledge-based sectors" where services are increasingly using advanced technologies.

Figure 1 Manufacturing industries classified according to their global technological intensity (ISIC revision 3)[13]:

High-technology industries		ISIC Revision 3
1.	Aerospace	353
2.	Pharmaceuticals	2423
3.	Computers, office equipment	30
4.	Electronics-communication	32
5.	Precision instruments	33
Medium-high-technology industries		
6.	**Electrical machinery**	**31**
7.	Motor vehicles	34
8.	Chemicals (except pharmaceuticals)	24-2423
9.	Other transport equipment	352+359
10.	Machinery and equipment	29
Medium-low-technology industries		
11.	**Petroleum refining**	**23**
12.	Rubber and plastics	25
13.	Non-metallic mineral products	26
14.	Shipbuilding	351
15.	Basic metals	27
16.	Fabricated metal products (except machinery and equipment	28
Low-technology industries		
17.	**Other manufacturing**	**36-37**
18.	Wood and furniture	20
19.	Paper and printing	21-22
20.	Textiles,clothing, leather	17-19

It is important to make a distinction between "high-tech industries" (sectoral approach) and "high-tech goods" (product approach). Normally, there is a direct link between the two parameters, i.e. most industrial branches classified as "high-tech" industries will also generate "high-tech" products, and "low-tech" industries will produce goods with a low-technology content. But this linkage is not

[13] EU has introduced a new classification of economic activities NACE Rev. 2 which is applied in the EU as from January 1, 2008 (EC Regulation 1893/2006). In addition, there were also the ISIC Rev. 4 classification and the comparison of these two versions of nomenclatures. The authors of this Manual are not aware of whether there has been developed a new classification of manufacturing industry by their global technological intensity on the basis of the ISIC Rev. 4 classification. This is an important issue for BIH which has already adopted a new EU standard or NACE Rev. 2 classification, as Classification of Activities of Bosnia and Herzegovina 2010 - KD BIH 2010. We would like to thank Gordana Đurić Ph.D. for this remark. It is assumed that unless there has not been developed a new classification based on ISIC Rev. 4, the data will continue to be classified according to ISIC Rev. 3 for some time in the future.

systematic. There are examples both of industries classified as "high-tech" but producing "low-tech" goods (for example, the pharmaceutical industry and headache pills…) and (medium) "low-tech" industries (the shipbuilding industry producing "high-tech" products such as satellite-navigated, nuclear-driven prototype ice-breakers…).

The list of "high-tech" products (still provisional) currently used by OECD and EUROSTAT is shown in Figure 2 below (based on SITC Revision 3, period 1988-95).

Figure 2 The OECD/EUROSTAT List of "High-tech" Products

Aerospace products

[7921+7922+7923+7924+7925+79293 + (714-71489-71499)+ 87411]

Computers- office machines

[75113+75131+75132+75134+(752-7529)+75997]

Electronics-telecommunications

[76381+76383+(764-76493-76499) +7722+77261 +77318+77625 +7763 +7764 +7768+89879]

Pharmacy products

[5413+5415+5416+5421+5422]

Scientific instruments

[774+8711+8713+8714+8719+87211+(874-87411-8742)+88111 +88121+88411 +88419+89961+89963+89967]

Electrical machinery

[77862+77863+77864+77865+7787+77844]

Chemistry (less pharmacy products)

[52222+52223+52229+52269+525+57433+591]

Non-electrical machinery

[71489+71499+71871+71877+72847+7311+73131+73135+73144 +73151+73153 + 73161+73165+73312+73314+73316 +73733+73735]

Armament products

891

2.1.3 EUROSTAT

EUROSTAT, with its headquarters in Luxembourg, is the Statistics Bureau of the European Commission and covers all areas of statistics. EUROSTAT entered STI indicators work much later than OECD and UNESCO but, thanks to solid EU political and financial support, is today at the forefront of international cooperation for data collection and methods developments. Furthermore, whereas reporting to the OECD and to UNESCO is essentially voluntary (based on a "gentlemen's agreement" basis) reporting to EUROSTAT may, in specific cases, be mandatory (EU legal basis).

The European Commission is EUROSTAT's principal customer of information from the harmonised Community statistics data bases, such as for monitoring the European Research Area (ERA) and other activities within the seventh Framework Programme for Research and Technological Development (FP7) with world-wide coverage.

EUROSTAT has been co-responsible for methodological work in most S&T indicator domains, specifically concerning the measurement of resources (stocks and flows) of S&T personnel ("the Canberra Manual"), the measurement of innovation activities, largely influenced by its Community Innovation Surveys – (CIS) – and the measurement of public budgetary expenditures (appropriations and outlays) on R&D by socio-economic objectives (GBAORD), in line with the successive versions (latest 2007) of the EU classification "Nomenclature for the Analysis and Comparisons of Scientific Programmes and Budgets – NABS).

Through its "CIS" (sixth CIS survey 2009) EUROSTAT has taken the lead in international data collection and analysis of innovation. The CIS data are currently available for about forty countries and are collected at enterprise level on a regular four-year basis with reduced surveys every two years. The results are presented in the "European Innovation Scoreboard (EIS)" covering EC, EFTA and a few candidate countries. The relatively few innovation data published by the OECD are, for reasons of statistical secrecy, much more aggregated than those of EUROSTAT which, under certain strict conditions, may even be put at the disposal of researchers at the level of the individual enterprise.

2.1.3.1 EUROSTAT Science and technology statistics: Methodology and Indicators

The following indicators on science, technology and innovation are collected by EUROSTAT:

- Research and development (R&D) - Data originate from the national R&D surveys which are based on the Frascati Manual.
- Community innovation survey (CIS) - Data originate from the national CIS surveys on innovation activity in enterprises which are based on the Oslo Manual.
- High-tech industry and knowledge-intensive services - Various origins and methodologies, statistics are compiled at EUROSTAT.
- Patents - Data originate from to the patent database PATSTAT hosted by the European Patent Office (EPO). PATSTAT gathers data on applications to the EPO and around 70 national patent offices all over the world (mainly USPTO and JPO), statistics are compiled by EUROSTAT.

- Human Resources in Science & Technology (HRST) - Data are derived at EUROSTAT from the EU Labour Force Survey (LFS) and the data collection on education systems (UOE) according to the guidelines in the Canberra Manual.

2.1.3.1.1 Research and development

EUROSTAT research and development core indicators are:

- Research and development expenditure, by sectors of performance
- Gross domestic expenditure on R&D (GERD) by source of funds
- Total researchers, by sectors of performance
- Total researchers (full-time equivalent), by sectors of performance
- Research and development personnel, by sectors of performance
- Share of women researchers, by sectors of performance
- Share of women researchers (FTE): all sectors
- Share of government budget appropriations or outlays on research and development
- Share of GBAORD allocated to defence and total civil socio-economic objectives

2.1.3.1.2 Community innovation survey

EUROSTAT Community Innovation Survey core indicators are:

- Turnover from innovation
- Effects of innovation on material and energy efficiency

2.1.3.1.3 High-tech industry and knowledge-intensive services

EUROSTAT high-tech industry and knowledge-intensive services core indicators are:

- Venture capital investments by type of investment stage
- High-tech exports
- Employment in high- and medium-high-technology manufacturing sectors
- Employment in knowledge-intensive service sectors

The classification of high and medium-high technology manufacturing sectors is based on the ratio of R&D expenditure to GDP or R&D intensity. The aggregations are made as in Figure 3.

Figure 3 NACE classification of high and medium-high technology manufacturing sectors

Classification	NACE Rev. 1.1 codes
High technology manufacturing	30 Manufacture of office machinery and computers 32 Manufacture of radio, television and communication equipment and apparatus 33 Manufacture of medical, precision and optical instruments, watches and clocks
Medium-high technology manufacturing	24 Manufacture of chemicals and chemical products 29 Manufacture of machinery and equipment n.e.c. 31 Manufacture of electrical machinery and apparatus n.e.c. 34 and 35 Manufacture of transport equipment
High and medium-high technology manufacturing	24 Manufacture of chemicals and chemical products 29 to 35 Manufacture of machinery and equipment n.e.c.; manuf. of electrical and optical equipment; manuf. of motor vehicles, trailers and semi-trailers; manuf. of other transport equipment
Low and medium-low technology manufacturing	15 to 22 Manufacture of food products, beverages and tobacco; textiles and textile products; leather and leather products; wood and wood products; pulp, paper and paper products, publishing and printing; 23 Manufacture of coke, refined petroleum products and nuclear fuel 25 to 28 Manufacture of rubber and plastic products; basic metals and fabricated metal products; other non-metallic mineral products; 36 to 37 Manufacturing n.e.c.

The knowledge intensity shows the integration with a generic or service specific science and technology base, it can be considered as a combination of knowledge embedded in new equipment, personnel, and R&D intensity. Service sectors are classified according to their knowledge-intensity. The two major groups are Knowledge-Intensive Services (KIS) and Less Knowledge-Intensive Services (LKIS). Each can be broken down into sub-groups as per Figure 4.

Figure 4 NACE classification of Knowledge Intensive Services

Classification	NACE Rev. 1.1 codes
Knowledge Intensive Services (KIS)	61 Water transport 62 Air transport 64 Post and telecommunications 65 to 67 Financial intermediation 70 to 74 Real estate, renting and business activities 80 Education 85 Health and social work 92 Recreational, cultural and sporting activities
High-technology KIS	64 Post and telecommunications; 72 Computer and related activities; 73 Research and development
Less KIS	50 to 52 Motor trade 55 Hotels and restaurants 60 Land transport; transport via pipelines 63 Supporting and auxiliary transport activities; activities of travel agencies 75 Public administration and defence; compulsory social security 90 Sewage and refuse disposal, sanitation and similar activities 91 Activities of membership organization n.e.c. 93 Other service activities 95 Activities of households as employers of domestic staff 99 Extra-territorial organizations and bodies

2.1.3.1.4 Patent statistics

EUROSTAT patent statistics core indicators are:

- Patent applications to the European Patent Office (EPO)
- Total European patent applications
- European high-technology patents
- Patents granted by the United States Patent and Trademark Office (USPTO)

2.1.3.1.5 Human Resources in Science & Technology

EUROSTAT Human Resources in Science & Technology core indicators are:

- Human resources in science and technology as a share of labour force – Total
- Doctorate students in science and technology fields - Total

2.1.4 The United Nations Educational, Scientific and Cultural Organisation – UNESCO

2.1.4.1 General

UNESCO, with its headquarters in Paris and worldwide field offices, currently brings together nearly two hundred Member countries and associated members through its five key programmes of: education, natural sciences, social and human sciences, culture, and communication/information. It sponsors literacy, technical, and teacher-training, international science programmes, the promotion of press and media freedom, cultural history projects and protection of the world's cultural and natural heritage.

UNESCO's statistical work was for many years undertaken by its Statistics Division at its headquarters in Paris, with particular emphasis given to the education and culture statistics (all data issued in the series of UNESCO Statistical Yearbooks and in regular World Science reports). Its S&T statistics work was particularly hampered by serious budget cuts in the 1980's (due to the withdrawal from the organisation by some of its principal founding member countries) and it was not until the creation in 1999 of a new UNESCO Institute for Statistics (UIS), with headquarters in Montreal, that UNESCO recovered its prominent position in international data collection, diffusion and contributions to methodological developments.

2.1.4.1.1 UNESCO Technical Guidelines and Publications

As previously mentioned, the principal UNESCO R&T/S&T guidelines are elaborated in the "Recommendation Concerning the International Standardization of Statistics on Science and Technology" (UNESCO 1978) accompanied by some practical advice to data collectors in the 1984 Guide to the Collection of Statistics on Science and Technology (Rev.1 ST/84/WS/19)14. The UNESCO Institute for Statistics fully subscribes to all the international S&T measurement guidelines indicated above. UNESCO is also the prime editor of the ISCED (education statistics) classifications.

2.1.5 Other providers

2.1.5.1 The World Bank

S&T statistics and indicators constitute just a small part of the comprehensive information available in the World Bank databases (in all some 2,000 indicators some of which are long-term). Since early 2010, the World Bank provides open and free access to its world development indicators, global development finance indicators and the global economic monitor via the address data.worldbank.org (where a data catalogue lists the data series available).

[14] Pending the update of the "Recommendation" the UNESCO Institute for Statistics fully subscribes to all the international S&T measurement guidelines. The UIS prepared the separate Annex A "Innovation Surveys in Developing Countries" of the 3rd edition of the "Oslo Manual" ("Guidelines for Collecting and Interpreting Innovation Data" - OECD/Eurostat, 2005) and is currently engaged in drafting a similar annex on the measurement of R&D activities in developing countries for the forthcoming issue of the "Frascati Manual".

2.1.5.2 International Organisation for Standardisation (ISO) standards

The International Organisation for Standardisation[15] (ISO) is the major developer of international standards for business, government and society. Among ISO's most well known and widely implemented standards are ISO 9001:2000 and ISO 14001:2004 which set the requirements for quality management and environmental management systems, respectively. These standards are used globally by industries, businesses and organisations in public and private sectors in all sectors of activity.

Existence of a certified ISO system plays an important role in developing new partnerships. The ISO certificate signals to the potential partners that an enterprise is managed according to accepted rules, which thereby considers its operation stable. Moreover, the ISO system can be seen as improving the overall management quality and also as a tool helping competitiveness and offering opportunities to join international value chains. In this respect, ISO standards can be regarded as performance indicators in terms of innovation and R&D.

The ISO undertakes regular surveys, covering the above mentioned standards. These surveys are available on the ISO website www.iso.org along with major ISO publications containing cross time and country data.

2.1.5.3 Bibliometric Indicators/Web of Science, Scopus

Bibliometrics is the general term for statistical techniques measuring the results or "outputs" of scientific (more than technological) research and the analysis of such information. Originally confined to simple publications and articles counts, with some sub-classifications by authors, institutions, countries and fields of science, bibliometrics took off as a distinct scientific discipline some thirty years ago.

Bibliometric indicators are increasingly used for science policy purposes[16]. Even if the OECD has never itself collected bibliometric statistics, a separate set of guidelines on how to use such data was issued in a separate working paper "Bibliometric Indicators and Analysis of Research Systems – Methods and Examples" (1997); the OECD experts group NESTI never gave manual status to this paper since it discusses data over which the group had no say as far as data collection is concerned.

The prime importance of bibliometrics relates to the evaluation of R&D performance and specialisation of countries, institutions, laboratories, individual scientists. Bibliometric tools are used, preferably in conjunction with other R&D/S&T indicators, to evaluate the research activities of academics whereas there are still few convenient tools to judge the quality of their teaching performance.

Thanks to the rapid advances in information and communication technologies and computer sciences, more sophisticated and multi-dimensional indicators have been developed and larger numbers of bibliometric databases have been created (frequently on a commercial basis).

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[15] www.iso.org

[16] See for instance the Science and Engineering Indicators reports of the National Science Foundation (NSF) in the United States and the European Commission's regular S&T indicators publications.

The best known and complete bibliometric databases are those of the Thomson Scientific Web of Science data (United States) with contents drawn from about ten-thousand high-impact research journals worldwide and information available, depending on disciplines, since the early 1900s; also Science Citation Index Expanded, Social Sciences Citation Index, Arts and Humanities Citation Index, Derwent Innovations/patents Index (http://isiwebofknowledge.com or http://science.thomsonreuters.com).

SCOPUS is a European actor in the bibliometrics databases area (Elsevier BV, Amsterdam, Netherlands). Its abstract and citation databases specialise in worldwide peer-reviewed scientific literature and web sources (http://info.scopus.com).

The bibliometric indicators are not exempt from criticism and should, just like the R&D input series, be used and interpreted with caution. A frequent criticism of bibliometric indicators is that they give preference to English language publications and authors, compared to other languages in general and to a large number of minority languages in particular. On the other hand, it is clear that – with a view to reaching a wider audience –researchers and inventors from non-English speaking countries now increasingly publish their results in the English language journals that are most read and cited by other scientists.

Drawing on bibliometric databases information of policy interest may be obtained on:

- numbers of scientific papers, by detailed fields of science;
- numbers of citations to scientific papers;
- co-citations (the number of times two papers are cited simultaneously) showing schematic networks;
- the number of co-signatures (co-authors) in scientific papers;
- the number of patents and citations in or to patents applications and grants;
- correlations between scientific papers (science) and patents (technology) based on citations in patent applications;
- scientific links (networks) measured by citations;
- the co-occurrence of (key-) words (“co-words”) etc.

For all these indicators, additional breakdowns may be used, such as time periods, fields of science, geographical locations of partners, institutional links (for instance between universities and enterprises), nationality and gender of authors.

Another advantage of bibliometric indicators is that they are frequently well-suited for graphical presentations. A variety of multidimensional analytical techniques have been developed to construct “maps” summarising the contents of different data series.

2.1.5.4 The OECD Guidelines on "Bio-Technology Statistics and Indicators"

Biotechnology is a recent small but important field of S&T to be understood and analysed. Initial OECD guidelines focused on the inventory of R&D performed in what could be called the "public sector", i.e. - in terms of the Frascati sectoring - the Government and the Higher education sectors combined. The OECD Group of National Experts on S&T Indicators (NESTI) organised a series of expert meetings resulting in a first report "Framework on Biotechnology Statistics" (2005) and then, in 2009, the manual "Guidelines for a Harmonised Statistical Approach to Biotechnology Research and Development in the Government and Higher Education Sectors".

The broad Table of Contents of this Biotechnology manual is as follows (note that there are also additional sub-classes for some of the reference groups):

1. Definitions
    - 1.1 Definition of "research and development"
    - 1.2 Definition of biotechnology R&D
    - 1.3 Definition of biotechnology
2. Institutional classification
3 Intramural biotechnology R&D expediture
4. Funding of intramural biotechnology R&D
5. Biotechnology R&D personnel
6. Biotechnology R&D collaboration
7. Patents and other forms of biotechnology R&D commercialisation
8. Extramural biotechnology R&D expediture
9. Measures to support biotechnology R&D or biotechnology innovation
10. Model questionnaire and appendix

The definition of R&D is consistent with that of the Frascati Manual (as previously defined in the chapter on key terminology).

The definition of biotechnology R&D is suggested as follows:

Biotechnology research and experimental development (R&D) – defined as R&D into biotechnology techniques, biotechnology products or biotechnology processes, in accordance with both the biotechnology definitions .... and the Frascati Manual for the Measurement of R&D (OECD 2002).

The definition of biotechnology to be used in the surveys and statistics on public biotechnology is that of the OECD 2005 "Framework for Biotechnology Statistics".

"The provisional single definition of biotechnology is deliberately broad. It encompasses all modern biotechnology but also many traditional and borderline activities. For this reason, the single definition should always be accompanied by the list-based definition which operationalises the definition for statistical purposes".

The "single definition" of biotechnology is as follows:

"The application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services"[17].

Broad summary of the list-based definition of biotechnology techniques (numerous subclasses) – Source OECD 2005 Framework report:

- DNA/RNA
- Proteins and other molecules
- Cell and tissue culture and engineering
- Process biotechnology techniques
- Gene and RNA vectors
- Bioinformatics
- Nanobiotechnology

2.1.6 Principal R&D/S&T Publications and Databases

The OECD, being one of the principal economic research agencies in the world, annually publishes a large number of general and specific reports. All OECD publications are available at the on-line library www.sourceOECD.org while selected publications can be found at www.oecd-ilibrary.org. As mentioned earlier, a number of the OECD methodological guidelines (manuals and working papers) can be downloaded for free (via the OECD, UNESCO and EUROSTAT websites).

A series of EUROSTAT publications (news releases, "statistics in focus" booklets, statistical publications and pocket books may be downloaded, free of charge, via the EUROSTAT homepage http://epp.eurostat.ec.europa.eu. The Directorate General for Research of the European Commission issues the monthly information magazine "Research*eu" (in English, French, German, Spanish – free of charge) at http://ec.europa.eu/research/research-eu.

[17] OECD "A framework for Biotechnology Statistics", 2005, page 9

A list of selected publications that are of relevance when analysing STI policy are presented below.

a) Regular publications:

- Main Science and Technology Indicators (MSTI): 2010/1 edition[18]
- Research and Development Statistics (RDS): 2009 Edition[19]
- OECD Science, Technology and Industry Scoreboard 2009[20]
- OECD Science, Technology and Industry Outlook 2008[21]
- Science, Technology and Innovation in Europe 2008 Edition by EUROSTAT[22]

b) Occasional publications:

- Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs[23]
- The OECD Innovation Strategy: Getting a Head Start on Tomorrow 201024 (OECD, Paris, 2010)
- UN Millennium Project, Science, Technology and Innovation, 2005[25]
- Industrial Development Report 2002/2003: Competing Through Innovation and Learning, UNIDO[26]

c) Papers:

- Hatzichronoglou, T. (1997), "Revision of the High-technology Sector and Product Classification", STI Working Paper 1997/2, OECD27
- Okubo, Y. (1997), "Bibliometric Indicators and Analysis of Research Systems: Methods and Examples", STI Working Papers, 1997/1, OECD28
- "A more research-intensive and integrated European Research Area – Science, Technology and Competitiveness key figures report 2008/200929" (EUROSTAT 2008).

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18 http://www.oecd.org/document/26/0,3343,en_2649_34451_1901082_1_1_1_1,00.html

19 http://www.oecd.org/document/52/0,3343,en_2649_34451_34537140_1_1_1_1,00.html

20 http://www.oecd.org/document/10/0,3343,en_2649_34451_39493962_1_1_1_1,00.html

21 http://www.oecd.org/document/36/0,3343,en_2649_34451_41546660_1_1_1_1,00.html

22 http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-EM-08-001/EN/KS-EM-08-001-EN.PDF

23 http://213.253.134.43/oecd/pdfs/browseit/9207121E.PDF (read-only pdf)

24 http://www.oecd.org/document/15/0,3343,en_2649_34273_45154895_1_1_1_1,00.html

25 http://www.unmillenniumproject.org/documents/Science-complete.pdf

26 http://www.unido.org/fileadmin/user_media/Publications/Pub_free/Industrial_development_report_2002_2003.pdf

27 http://www.oecdilibrary.org/docserver/download/fulltext/5lgsjhvj7nkj.pdf?expires=1280415495&id=0000&accname=guest&checksum=FCD7AA0DA2FD1654A934A49008092FDC

28 http://www.oecdilibrary.org/docserver/download/fulltext/5lgsjhvj7ng0.pdf?expires=1280415641&id=0000&accname=guest&checksum=0512D89936765ACEC6AE5BEB64EEEE35

29 http://ec.europa.eu/research/era/pdf/key-figures-report2008-2009_en.pdf

The EUROSTAT databases currently contains R&D/S&T information for around forty countries: EU Member States, Candidate Countries, potential candidates and from an increasing number of non-European OECD countries. There is also systematic exchange of data between EUROSTAT, OECD and UNESCO (with a view to avoiding duplication in data collection work). For some activities, use is made of a common EUROSTAT/OECD/UNESCO questionnaire.

Several databases provide statistics on science, technology and innovation on an aggregated and disaggregated level. The most significant are EUROSTAT's science and technology statistics[30]: OECD's STAN Database, Input-Output database, Science, Technology and R&D Statistics Online Database[31]; OECD's Analytical Business Enterprise R&D Expenditure (ANBERD) database[32]; UNESCO Institute for Statistics[33]; The World Bank[34]; and respective national statistical offices.

Time limited free access to the OECD library and database is possible by requesting a username and password through oecdilibrary@oecd.org. There is also a possibility to subscribe to these services.

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30 http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

31 http://stats.oecd.org/Index.aspx

32 http://puck.sourceoecd.org

33 http://www.uis.unesco.org/

34 http://data.worldbank.org

3. Internationally adopted classifications used in manuals in R&D/S&T data

3.1 General

As frequently stated in the present report almost all variables used for the collection of R&D/S&T data are, in one way or other, founded on generally adopted international (usually United Nations) standard statistical classifications. Revisions of these classifications are sooner or later carried forward into the various manuals. A short list of these standard classifications and their specific use for R&D/S&T statistics (notably Frascati Manual 2002) is found below.

3.2 "SNA" – The United Nations' System of National Accounts

The SNA (latest revision in 2008) serves to define the sectors of performance / finance / employment in the Frascati system though there are still some differences in their international / national treatments of R&D as an economic activity. Annex 3 of the 2002 Frascati Manual presents a thorough analysis of these links and problems[35].

Table 1 Summary of sectors in the SNA and in the Frascati Manual

SNA	**Frascati Manual**
Non-financial corporations Financial corporations	Business enterprise sector
General government	General government
Non-profit institutions serving households Households	Private non-profit sector
(Included in other SNA sectors)	Higher education sector
Rest of the world	Abroad

Source: OECD

35 "System of National Accounts 2008" (European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations and World Bank), New York, Dec. 2009. (http://unstats.un.org/unsd/nationalaccount/SNA2008.pdf)

Table 2 Sectors and producers in the SNA

Sectors	**Market producers**	**Non-market producers**
Non-financial corporate sector	Non-financial corporations or quasi-corporations Non-profit institutions (NPIs) engaging in market production1[36]	
Financial corporate sector	Financial corporations and quasi-corporations	
General government sector	[Government units engaged in market production]2[37]	Government units n.e.c. Social security funds NPIs mainly financed by government n.e.c.
Non-profit institutions serving households (NPISH)		NPISH
Households	Unincorporated enterprises engaged in market production	Households n.e.c. including unincorporated enterprises engaged in production of goods mainly or wholly for own final use

Source: OECD

[36] Supplying goods and services at an economically significant price.

[37] These are treated as quasi-corporations as long as they have a separate set of accounts.

Table 3 The SNA sectoring of units definitely and possibly included in the Frascati Manual higher education sector

	Market producers	Non-market producers
Teaching establishments **i.e. producing higher education services (PHES) as a main activity**	All non-financial corporations (or quasi-corporations) PHES1 Any unincorporated enterprises PHES1 at an economically significant price NPIs PHES at an economically significant price NPIs serving enterprises PHES[38]	
University hospitals providing healthcare services (PHSS) controlled by administered by or associated with higher education (CAAHE) and/or with a significant teaching commitment	Non-financial corporations (or quasi-corporations) PHSS2 CAAHE3 NPIs PHSS2[39] at an economically significant price CAAHE[40]	Government units PHSS2 CAAHE3 NPIs controlled and mainly financed by government PHSS2 and CAAHE3 NPIs serving households PHSS2
Research institutes or experimental stations CAAHE3 ("borderline" research institutions)	Non-financial corporations (or quasi-corporations) selling R&D but CAAHE3 NPIs selling R&D at an economically significant price CAAHE3 NPIs serving enterprises CAAHE3	Government units CAAHE3 NPIs controlled and mainly financed by government but associated with HE NPISHs which are CAAHE3
Postgraduate students supported by grants		Households benefiting from subsidies

Source OECD

[38] Providing higher education services.

[39] Providing healthcare services

[40] Controlled, administrated by or associated with higher education establishments.

Table 4 SNA classifications of government outlays and final consumption expenditure of NPI serving households

A. Government outlays1[41]
1. General public services (including basic research)
2. Defence
3. Public order and safety
4. Education (includes universities and colleges)
5. Health
6. Social security and welfare
7. Housing and community amenities
8. Recreational, cultural and religious affairs
9. Economic services
9.1. Fuel and energy
9.2. Agriculture, forestry, fishing and hunting
9.3. Mining, manufacturing and construction, except fuel and energy
9.4. Transportation and communication
9.5. Other economic affairs
10. Other functions
Total
B. Final consumption expenditure of non-profit institutions serving households
1. Research and science
2. Education
3. Medical and other health services
4. Welfare services
5. Recreational and related cultural services
6. Religious organisations
7. Professional and labour organisations serving households
8. Miscellaneous
Total

Source: OECD National Accounts, Detailed Tables, Vol. II.

41 Final consumption expenditure (of which compensation of employees and other subsidies), other current transfers and property income, gross capital formation and other capital outlays.

3.3 "ISCED" – The International Standard Classification of Education

ISCED was originally designed by UNESCO to facilitate the collection of international and national statistics at all levels of education and by fields of study. In the Frascati Manual it serves to define the categories of R&D personnel classified in terms of levels of formal qualification. The ISCED broad "fields of study" lists serve as proxies for "fields of science" and are used as institutional sub-classifications for sectors of R&D performance (notably for the higher-education and private non-profit sectors) and also for cataloguing R&D/S&T institutions and programmes, or documents, articles, citations, etc (in bibliometric databases). There are frequent references to ISCED (both to levels and fields) in the "Canberra" manual (on the measurement of total stocks and flows of S&T personnel – HRST) and also in the recent OECD/EUROSTAT/UNESCO study on careers and mobility of doctorate holders (CDH[42]).

3.4 "ISCO" – International Standard Classification of Occupations

The groups used in the Frascati Manual for the classification of R&D personnel by occupation (function) are linked to broad categories ISCO-88. There are frequent references to ISCO also in the "Canberra" manual (on the measurement of total stocks and flows of S&T personnel – HRST)[43].

3.5 "ISIC" – International Standard Industrial Classification of All Economic Activities and "NACE" – Classification of Economic Activities in the European Community

For the purpose of R&D statistics, the statistical units in the business enterprise sector have been classified into re-arranged International Standard Industrial Classification of All Economic Activities (ISIC) industry groups and sub-groups. ISIC is also used in defining, according to various criteria, "high-tech" ("R&D-intensive") industries/branches – also see SITC below)[44].

The Nomenclature générale desactivités économiques dans le communautés européennes (NACE) classification system is used in the manuals as corresponding to ISIC. NACE incorporates the activities of R&D within natural and social sciences[45].

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[42] International Standard Classification of Education, UNESCO, Paris (1997). (http://www.uis.unesco.org/TEMPLATE/pdf/isced/ISCED_A.pdf)

[43] International Labour Organisation: International Standard Classification of Occupations, ISCO-88, (Geneva 1990) (http://www.ilo.org/public/english/bureau/stat/isco/docs/resol08.pdf)

[44] United Nations (1990) Statistical Papers Series M. N° 4, Revision 3 (New York) and minirevision 3.1 (2002) (http://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1)

[45] http://ec.europa.eu/environment/emas/pdf/general/nacecodes_en.pdf

Table 5 Industrial classification proposed for surveys in the business enterprise sector based on ISIC Rev.3.1 and NACE Rev. 1.1

Title	ISIC Rev. 3.1 Division/Group/ Class	NACE Rev. 1.1 Division/Group/ Class
Mining and quarrying	10 to 14	10 to 14
Manufacturing	15 to 37	15 to 37
Food Products & Beverages	15	15
Tobacco Products	16	16
Textiles	17	17
Wearing Apparel & Fur	18	18
Leather Products & Footwear	19	19
Wood & Cork (not Furniture)	20	20
Pulp, Paper & Paper Products	21	21
Publishing, Printing & Reproduction of Recorded Media	22	22
Coke, Refined Petroleum Products & Nuclear Fuel	23	23
Chemicals & Chemical Products	24	24
Chemical Products less Pharmaceuticals	24 less 2423	24 less 2423
Pharmaceuticals	2423	2423
Rubber & Plastic Products	25	25
Non-metallic Mineral Products	26	26
Basic Metals	27	27
Basic Metals, Ferrous	271+2731	271+2731
Basic Metals, Non-ferrous	272+2732	272+2732
Fabricated Metal Products (except Machinery & Equipment)	28	28
Machinery n.e.c.	29	29
Office, Accounting & Computing Machinery	30	30
Electrical Machinery	31	31
Electronic Equipment (Radio, TV & Communications)	32	32
Electronic Components (includes Semiconductors)	321	321
Television, Radio & Communications Equipment	32 less 321	32 less 321

Title	ISIC Rev. 3.1 Division/Group/ Class	NACE Rev. 1.1 Division/Group/ Class
Medical, Precision & Optical Instruments, Watches, Clocks (Instruments)	33	33
Motor Vehicles	34	34
Other Transport Equipment	35	35
Ships	351	351
Aerospace	353	353
Other Transport n.e.c.	352+359	352+359
Furniture, Other Manufacturing n.e.c.	36	36
Furniture	361	361
Other Manufacturing n.e.c.	369	369
Recycling	37	37
Electrity, gas & water supply	40+41	40+41
Contructions	45	45
Marketed services	50 to 74	50 to 74
Sale, Retail, Maintenance & Repair of Motor Vehicles & Motorcycles	50	50
Other Wholesale Trade	51	51
Other Retail Trade	52	52
Hotels & Restaurants	55	55
Land Transport & via Pipelines	60	60
Water Transport	61	61
Air Transport	62	62
Supporting & Auxiliary Transport Activities, Travel Agencies	63	63
Post & Telecommunications	64	64
Post	641	64.1
Telecommunications	642	64.2
Financial Intermediation	65 to 67	65 to 67
Real Estate, Renting	70+71	70+71
Computer & Related Activities	72	72
Software Consultancy & Supply	722	72.2

Title	ISIC Rev. 3.1 Division/Group/ Class	NACE Rev. 1.1 Division/Group/ Class
Other Computer Services n.e.c.	72 less 722	72 less 72.2
Research & Development[46]	73	73
Other Business Activities	74	74
Architectural, Engineering & other Technical Activities	742	74.2+74.3
Other Business Activities n.e.c.	74 less 742+743	74 less 74.2+74.3
Total	01-99	01-99

Source: Frascati Manual p. 57

3.6 "SITC" – Standard International Trade Classification

This classification is used for S&T statistics on international trade in "high-tech products" (note that there is sometimes incompatibility between the ISIC high-tech "industry" and the SITC high-tech "products" data series[47]).

3.7 "NUTS" – Nomenclature des Unités Statistiques

NUTS is a hierarchical system (or three levels, NUTS1, NUTS2, NUTS3) for dividing up the economic territory of the European Union (also some candidate countries) for the collection and harmonisation of their regional statistics (including S&T statistics) for socio-economic analysis and objectives. This is a legal framework (based on negotiations between EUROSTAT and national bureaus of statistics). The divisions are made according to various criteria (in line with population, administrative frameworks and a number of geographical and other historical socio-economic considerations). The first level defines the major socio-economic regions, the second basic regions for the application of regional policies and, the third, small regions for specific diagnoses. NUTS is likely to become an essential classification for S&T policy in BiH[48].

[46] Only enterprises in the business sector should be included, following the *Frascati Manual* §§163-168. For this NACE/ISIC-group (73), data on the product field should also be collected, following the *Frascati Manual* §272.

[47] Standard International Trade Classification, Revision 3, Statistical Papers Series M N° 34, Rev.3 (New York) (http://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1)

[48] Regulation (EC) No 1059/2003 of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS) (Official Journal L 154, 21/06/2003).

3.8 Classification of fields of S&T (UNESCO/Frascati)

The Frascati Manual uses a proxy fields of science list (based on fields of study) as an institutional sub-classification for some sectors and/or activities. This list has recently been revised (2007) to take into account emerging fields (such as information and communications technologies (ICT), biotechnology, nanotechnology, etc.)[49].

Table 6 Fields of science and technology

Field of Science[50]	**Field of Science** **FOS FM 2002**	**Field of Science** **Revised FOS 2007**
1. Natural Science	1.1 Mathematics and computer sciences 1.2 Physical sciences 1.3 Chemical sciences 1.4 Earth and related environmental sciences 1.5 Biological 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 engineering, electronics 2.3 Other engineering sciences	2.1 Civil engineering 2.2 Electrical engineering, electronic engineering, 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

49 http://www.oecd.org/dataoecd/36/44/38235147.pdf

50 For further information see: www.oecd.org/dataoecd/36/44/38235147.pdf and ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm

Field of Science[50]	Field of Science FOS FM 2002	Field of Science Revised FOS 2007
		technologies 2.9 Industrijska biotehnologija 2.10 Nano-tehnologija 2.11 Ostale
3. Medical and Health	3.1 Basic medicine 3.2 Clinical medicine 3.3 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, fisheries and allied sciences 4.2 Veterinary medicine	4.1 Agriculture, forestry, and fisheries 4.2 Animal and dairy science 4.3 Veterinary science 4.4 Agricultural biotechnology 4.5 Other agricultural sciences
5. Social Science	5.1 Psychology 5.2 Economics 5.3 Educational sciences 5.4 Other 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. Human Science	6.1 History 6.2 Languages and literature 6.3 Other humanities	6.1 History and archaeology 6.2 Languages and literature 6.3 Philosophy, ethics and religion 6.4 Art (arts, history of arts, performing arts, music) 6.5 Other humanities

Source: DSTI/EAS/STP/NESTI(2006)19/FINAL, Organisation for Economic Co-operation and Development 26-Feb-2007

3.9 '"NABS" (Nomenclature for the Analysis and Comparison of scientific programmes and budgets

NABS (latest version 2007) is the EU classification (distribution) list adopted by EUROSTAT for the analysis of the R&D contents in state budgets, broken down by socio-economic objectives (SEO). OECD closely follows the NABS list at one-digit level whereas EUROSTAT also collects and publishes SEO data at more disaggregated levels[51].

3.10 Classification of statistical units by size

The other essential classification of statistical units for surveys is by size. Though different variables can be used to define the size of a statistical unit in innovation surveys, it is recommended that size should be measured on the basis of the number of employees. This recommendation is in line with all manuals in the Frascati family. Given the strata requirements in sample surveys, and given that innovation activities other than R&D are widely performed by small and medium-sized units, it is recommended that size classes include smaller firms. In order to maintain international comparability while at the same time allowing flexibility in the number of size classes, the following size classes are recommended as a minimum:

Classification of statistical units for innovation surveys by size

- Number of employees:
- 10 – 49
- 50 – 249
- 250 and above

More detailed breakdowns by size class may also be used. This also includes a size class for firms with less than ten employees. It is important that more detailed size classes are consistent with the above groups. A proposal would be:

Classification of statistical units for innovation surveys by size – detailed:

- 0
- 1 – 9
- 10 – 49
- 50 – 99
- 100–- 249
- 250 – 499
- 500 – 999
- 1 000 – 4 999
- 5 000 and above.

[51] http://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_CLS_DLD&StrNom=NABS_1992&StrLanguageCode=EN&StrLayoutCode=HIERARCHIC

3.11 Other classifications

3.11.1 Type of institution

A further useful classification of statistical units for surveys is *type of institution*. This breakdown is particularly important when the statistical unit is in general an enterprise, and when the increasing internationalisation of innovation activities is taken into account. Given these considerations and similar proposals in the Frascati Manual and the Handbook on Economic Globalisation Indicators, it is recommended that when enterprises are the statistical units in innovation surveys they should be classified as follows:

Classification of statistical units for innovation surveys by type of institution:

- Private enterprise:
  - National (no Controlled Affiliates[52] - CA - abroad).
  - Multinational, of which there may be three types:
    - Foreign-controlled[53] affiliates (CAs) (where the affiliate does not control any other affiliates abroad).
    - Foreign-controlled affiliates with CAs (parent companies under foreign control).
    - Parent companies with CAs abroad (parent company not under foreign control).
- Public enterprise[54], "resident non-financial corporations and quasi-corporations that are subject to control by government units, control over a corporation being defined as the ability to determine general corporate policy by choosing appropriate directors, if necessary."

[52] A controlled affiliate is an enterprise that is directly or indirectly controlled by a parent company. See OECD (2005), *Handbook on Economic Globalisation Indicators.*

[53] Control is defined in the *Handbook on Economic Globalisation Indicators* as having more than 50% ownership or control of more than 50% of voting shares.

[54] OECD (2002), Proposed Standard Practice for Surveys for Research and Experimental Development, *Frascati Manual 2002*, Paris, §180.

3.11.2 Other

Many other types of classifications of statistical units in innovation surveys can be used for analytical purposes. They include:

- General enterprise characteristics:
  - Form of activity, with the categories: capital intensive, labour intensive, knowledge intensive.
  - Type of goods produced, with the categories: consumer goods, intermediate goods, investment goods.
  - Export intensity, the exports of the enterprise as a ratio of sales revenue/turnover[55].
  - Geographic location.

- Innovation indicators:
  - Innovation or R&D intensity, the ratio between innovation expenditure (or R&D expenditure) and turnover.
  - Co-operation, with other enterprises / public institutions.

[55] Turnover or sales revenue is the total amount of money that the firm has earned from the sales of all its products during a given time period.

4. The measurement and sectoring of R&D expenditure and personnel

4.1 General - the Utility of Sectoring

For the measurement of R&D activities (expenditure and personnel) special significance is given to "sectoring". Four sectors of R&D performance were early defined by the OECD for R&D statistics: the Business Enterprise (BE) sector, the Government sector; the Higher Education (HE) sector, and the Private non-Profit (PNP) sector. The same sectors are used for the measurement of the sources of finance of the national R&D efforts, together with a fifth sector: "(Funds from) Abroad".

These sectors of performance, finance and employment are defined in terms of the UN/OECD/EU System of National Accounts (SNA) with the exception of the Higher Education sector which was separately identified in the earliest days of R&D statistics, due to its importance as a major performer of R&D in many countries (notably for basic research) and its responsibility for the education and training of new generations of qualified scientists and engineers.

The sectoral approach offers the most reliable way of building up national aggregates of R&D expenditure and personnel. It identifies the sources of finance to the performers of R&D and taking into account differences between activities in national economies, it facilitates the use of specific survey methods and questionnaires for each sector. Furthermore, given that the sectors are defined according to adopted standards, with their own sub-classifications, it is possible to relate R&D data to other statistical series. This facilitates analysis and understanding of the role of R&D in economic development and the formulation of S&T policies and models.

4.2 The Frascati Sectors

4.2.1 The Business Enterprise sector

The Business enterprise (BE) sector includes:

All firms, organisations and institutions whose primary activity is the market production of goods and services (other than higher education) for sale to the general public at an economically significant price, and the private non-profit institutions mainly serving them.

Public enterprises are included in the BE sector. This SNA recommendation was adopted with a view to improving the international comparability of data from countries where the status and statistical treatment of a number of important enterprises varied, such as public transport services, energy facilities, etc (public or semi-public in some countries, private in others).

The following terminology is used in relation to the Business Enterprise sector:

"BERD" = total intramural R&D expenditures of the BE sector;

"BEMP" = total R&D personnel of the sector (expressed as head-counts or full-time equivalence).

"BERSE" total R&D scientists and engineers engaged in the BE sector (idem)

4.2.2 The Government sector

The Government sector consists of:

"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".

The following terminology is used in relation to the Government sector:

"GOVERD" = total intramural R&D expenditures of the Government sector;

"GOVMP" = total R&D personnel of the sector (expressed as head-counts or full-time equivalence).

"GOVRSE" total R&D scientists and engineers engaged in the sector (idem)

4.2.3 The Higher Education (HE) sector

The Higher Education sector is composed of:

All universities, colleges of technology and other institutions of post-secondary education, whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of or administered by or associated with higher education institutions.

The experts involved in drafting the various versions of the Frascati Manual have never really managed to agree on one single and clear-cut definition of the HE sector. In the absence of a full consensus, a number of additional criteria of classification have been added over time. The last criterion – "associated with" - remains vague and flexible and presents the R&D statisticians with a range of options for classifying certain borderline institutions in the national R&D statistics. There is considerable diversity between institutions in terms of status, historical, cultural and political traditions, bearing on, for instance, national education policies and systems, levels of study, diplomas and degrees, programmes, legal frameworks, patterns of finance (sharing between Federal and State Governments, etc.). This is why the HE sector is frequently a weak point in national R&D data reporting.

The following terminology is used in relation to the Higher Education sector:

"HERD" = total intramural R&D expenditures of the sector;

"HEMP" = total R&D personnel of the sector (expressed as head-counts or full-time equivalents).

"HERSE" total R&D scientists and engineers engaged in the sector (idem)

4.2.4 The Private Non-Profit sector

The Private Non-Profit (PNP) sector covers

Non-market, private non-profit institutions serving households (i.e. the general public) and private individuals or households.

This sector is in many countries by tradition an important source of finance for the Higher education sector but it also sometimes plays an active role in the performance of R&D, for instance in medical research. Examples of units classified in the PNP sector are professional or learned societies, charities, relief or aid agencies, trade unions, consumers' associations, plus any funds contributed directly to R&D by households.

4.2.5 (Funds from...) Abroad

This sector consists of:

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 organisations (except business enterprises), including facilities and operations within the country's borders.

"Abroad" is identified as one of the sources of funds for R&D performed on national territory (in "GERD" – see below). It may also be used as a sector of destination of national R&D finance, for the calculation of the national R&D effort in terms of funding (see "GNERD" below). It is, in particular, a key variable in "innovation" statistics. With increasing globalisation more funds are transferred across borders for R&D projects performed elsewhere, in particular within multi-national enterprises.

Substantial amounts of R&D funds are provided by the European Commission (such funds have in recent years accounted for some 15-20% of some national R&D efforts - GERD).

4.3 The Calculation of National R&D Totals (GERD/GNERD, PERS)

4.3.1 General

The following terminology is used in relation to national totals (R&D expenditures and personnel):

- "GERD" = Gross Domestic Expenditure on R&D;
- "GNERD" = Gross National Expenditure on R&D
- "PERS" = total R&D personnel of the four sectors of performance (expressed as head-counts or full-time equivalents).
- "RSE" total R&D scientists and engineers engaged in the four sectors (idem)

Two separate concepts are used to calculate the total R&D expenditure efforts of a country, the first is GERD and the second is GNERD. GERD is more commonly used than GNERD, for instance when discussing the R&D efforts of a country seen as a percentage of its GDP.

The GERD and GNERD matrixes (cross-classifications of sectors of performance and sectors of finance) are shown in Table 7 and Table 8. A similar sector matrix approach is used for the calculation of the total R&D personnel resources of the country (and its component categories of PERS and RSE).

4.3.1.1 GERD – Gross Domestic Expenditure on R&D

GERD consists of the sum of all R&D performed on the national territory in a given year by the four domestic sectors described above including all domestic R&D also financed out of funds arriving from abroad (but excluding all funds from the same sectors going abroad).

4.3.1.2 GNERD – Gross National Expenditure on R&D

GNERD is the total R&D expenditures financed in the country by the same four sectors in a given year; it also includes their funding to abroad for R&D but excludes all funds they have received from abroad.

In other words, GNERD only represents the financial – not the performance - aspect of the national R&D effort. The below tables are depicting the relationship between the sectors of performance and sectors of finance.

Table 7 Gross domestic expenditure on R&D (GERD)

Sector of finance	National Sectors of R&D Performance				
	Business Enterprise sector	Government Sector	Higher Education sector	Private Non-Profit sector (PNP)	Total
Business enterprise					Total financed by the enterprise sector
Government					Total financed by the Government sector
Higher education					Total financed by the Higher Education
Public GUF					Total Public GUF
Private Non-Profit					Total financed by the PNP sector
Funds from abroad					Total financed from Abroad
TOTAL	Total performed in the Business Entreprise sector (BERD)	Total performed in the Government sector (GOVERD)	Total performed in the Higher Education sector (HERD)	Total performed in the PNP sector	**GERD**

Table 8 Gross national expenditure on R&D (GNERD)

National Sources of finance	Sectors of performance (of domestically financed R&D)					
	Business Enterprise sector	Government sector	Higher Education sector	Private Non-profit (PNP) sector	R&D Performed **Abroad**	**TOTAL Sector Finance**
Business enterprise sector						Total Enterprises
Government sector						Total Government
Higher Education sector						Total Higher Education
Public GUF						Total GUF
Private Non-profit sector						Total Private Non-profit
Total National R&D Finance	Total performed in the Business Entreprise sector	Total performed in the Government sector	Total performed in the Higher Education sector	Total performed in the PNP sector	Total performed Abroad	**GNERD**

4.4 The Measurement of R&D Expenditure and Personnel

4.4.1 General

In R&D statistics two basic components are of interest: expenditure on R&D and human resources (R&D personnel) engaged in the same efforts. Both the R&D expenditures and the personnel variables are broken down according to a series of different institutional and functional criteria that, as mentioned earlier, are closely linked to internationally adopted standard classifications (mentioned in Chapter 3).

4.4.1.1 Intramural and Extramural R&D Expenditure

The R&D expenditures of a statistical unit (the unit surveyed) may be spent either within or outside the unit (intramural vs. extramural expenditures).

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

whereas

> extramural expenditures are defined as:
>
> *... the sums a unit, organisation or sector reports having paid or committed themselves to pay to another unit, organisation of sector for the performance of R&D during a specific period. This includes acquisition of R&D performed by other units and grants given to others for performing R&D.*

4.4.1.2 R&D Expenditure

The measurement of R&D expenditures by types of costs is firstly based on a breakdown between "current costs" and "capital costs". The "current costs" are then broken down by "labour costs of the R&D personnel" and "other current costs".

Capital expenditure can be separated into three categories:

- "lands and buildings"
- "instruments and equipments"
- "computer software".

4.4.1.2.1 Labour Costs of R&D Personnel

Labour costs cover total annual wages and salaries, including all associated social security, retirement or pension scheme contributions for all staff directly engaged in R&D.

The labour costs for staff providing indirect services to R&D (such as library and computing centre personnel) – which may be calculated on a pro-rata basis – should be excluded from the above labour costs but, instead, be calculated as an element of "overheads" to be included in the category of "other current costs".

4.4.1.2.2 Other Current Costs

Other current costs include purchases of materials, supplies and small pieces of equipments to support the R&D performed by the unit surveyed. According to the Frascati Manual the following examples are mentioned as other current costs: electricity, water, fuel, books, journals, reference materials, subscriptions to libraries, laboratory animals, rent for offices and research facilities, post and telecommunications, insurance. (This category also includes administrative and other overhead costs, if necessary on a pro-rata basis).

4.4.1.3 R&D Capital Expenditure

Capital expenditure is the annual gross expenditure on fixed assets used in R&D programmes of the statistical units. It should be reported in full for the period when it took place and should not be registered as an element of depreciation. In other words, capital expenditure should be accounted for in totality in the statistics of year of acquisition. No costs for depreciation (based on country-specific fiscal rules and sometimes depending on the expected life of the capital goods) should be taken into account.

4.4.1.3.1 R&D Expenditure on Lands and Buildings

Included are expenditure for land acquired for R&D such as testing grounds and sites for laboratories, and buildings constructed or purchased, including expenditure for major improvements and repairs. In case of lands and buildings acquired for purposes other than R&D, pro-rata estimation of expenditure may be required.

4.4.1.3.2 R&D Expenditure on Instruments and Equipments

This class of expenditure covers major instruments and equipment acquired for use in R&D undertakings.

4.4.1.3.3 Computer Software

This class, introduced for the first time in the 2002 Frascati Manual, includes:

"...the acquisition of separately identifiable computer software for use in the performance of R&D, including programme descriptions and supporting materials for both systems and applications software. Annual licensing fees for the use of acquired computer software are also included".

It is recommended that software for own use, produced as part of R&D activities, should be included in the relevant cost category of the unit's intramural expenditures, i.e. in its labour costs, other current costs or capital expenditure.

4.4.2 R&D expenditure by Source of Finance

4.4.2.1 General

R&D activities involve significant transfers of money between national sectors of R&D performance (extramural expenditures) as well as cross-border transfers from and to abroad.

There are two criteria for correctly identifying the flow of funds; (i) there must be a direct transfer of resources; and (ii) the transfer must be both intended and used for the performance of R&D (contracts, grants or donations) but they may also be in kind (staff and equipment put at the disposal of the R&D performer by the contracting partner) – such transfers must necessarily be expressed in money terms.

The principal source of finance is usually the "own funds" of the performing units. Other principal sources in the national R&D efforts are various kinds of public support to enterprises and to universities.

The "Frascati Manual" discusses this public support at length, notably government incentives for R&D in enterprises, through various kinds of direct, indirect or fiscal R&D support or facilities like loans.

4.4.2.2 The Financing of Higher Education R&D

There are, in principle, three main sources for financing R&D activities in universities and other institutions of higher education.

The first consists of direct contracts and grants "ear-marked" R&D from government and other outside sources (enterprises contracting more and more money to universities). These funds can easily be accredited to their original source.

The second source consists of "own resources" such as income from the sale of non-R&D services (education services, for instance), serums, vaccines, etc. and last – but not least – tuition fees from individual students. Furthermore, many Western universities earn dividends from the stock exchange market and other property.

The third source is what the Frascati Manual calls "public general university funds – "GUF". This can lead to problems of R&D identification. Universities, in general, receive a global and annual block grant from line ministries such as a Ministry of Education and Science, Ministry of Agriculture, and Ministry of Tourism or from provincial or local authorities. These grants support overall university operations such as education, research, administration, students' welfare programmes, and sometimes also for healthcare services in university hospitals. In contrast to the other public money mentioned (from the outset, intended for R&D), the decision how the GUF and the "own funds" should be spent is, in principle, taken by the university administration itself.

Defining the R&D shares of these block grants (and their breakdowns by type of costs, between salaries and other current and capital expenditure or by fields of science), can usually not be made through a traditional R&D survey; it is by and large a "desk exercise" investigation of essentially administrative and accounting records.

For the matrixes of GERD performance/finance it is proposed that, for purposes of international comparability and for reasons of clarity, the publicly financed R&D be divided into two sub-categories: (i) direct Government funds; and (ii) “public GUF”.

4.4.3 The Measurement of the R&D (and S&T) Personnel

4.4.3.1 General

The measurement of R&D personnel is, besides R&D expenditure, the second most important variable in R&D statistics, even if it only represents a small share in the total national stocks of S&T personnel.

There are two sub-classifications used for the R&D personnel series: by occupation (broad ISCO classes) and by levels of formal qualification (according to ISCED classes).

Two approaches are used for the measurement of R&D personnel: ”head-counts” and ”full-time equivalents - FTE”. In the first case it is the “individual” (the person) who constitutes the statistical uni to be measured (as in most demographic, occupation, education etc. statistics) whereas, in the second case, the total “volume” of work produced by the R&D personnel (many of whom are engaged only part-time in R&D activities) is measured.

For many years and until quite recently the only approach used in the OECD and UNESCO R&D surveys was measurement in terms of FTE. The reason was that, using “headcounts” as a measure, in, for example, universities or in some industrial laboratories would seriously overestimate the “real” R&D effort, given that such staff are usually engaged in activities other than R&D (teaching and administration, routine testing, etc). The FTE approach was considered to result in a more realistic (“true”) picture of the R&D work actually undertaken.

With a view to considering R&D personnel in a wider S&T indicators perspective (for comparisons with other series, such as population, education, employment and unemployment and for related variables, such as age, gender, national origin/mobility, etc.) interest is now increasingly focusing on the head-count approach which is also a prerequisite for the calculation of FTE data.

Head-count data are also easier to collect because they refer to a specific unit (of employment, for instance) whereas the calculation of FTE can be subjective, depending on the survey or estimation methods used, particularly in the university sector.

4.4.3.2 Headcount vs. Full-time equivalents (FTE)

Whereas the head-count data principally refer to a given date of observation, the full-time equivalent series is more related to a given period of time, as a rule the calendar year but also the fiscal or academic year.

The Frascati Manual suggests three options for measuring head-counts:

1. the number of persons engaged in R&D on a given date (end of year, for instance);
2. the average number of persons engaged in R&D during the (calendar) year, or
3. the total number of persons engaged in R&D during the (calendar) year.

The Frascati and Canberra manuals define the FTE concept as follows:

One FTE may be thought of as one person-year. Thus, a person who normally spends 30% of his or her time on R&D and the rest on other activities (such as teaching, university administration, and student counselling) should be considered as 0.3 FTE. Similarly, if a full-time R&D worker was employed at an R&D unit for only six months, this results in an FTE of 0.5. Since the normal working day (period) may differ from sector to sector and even from institution to institution, it is impossible to express FTE in person-hours.

The Manuals insists on the fact that the personnel data should be measured and reported for the same time periods as the expenditure series.

4.4.3.3 Classification of R&D Personnel by Occupation

The classification of the R&D personnel by occupation is currently more utilised than the breakdown by level of qualification (and is recommended as priority by the Frascati Manual).

The following three categories are suggested (linked to ISCO-1988). More detailed information on the specific classes is given in the Manual.

1. "Researchers" are defined as:

"... professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and also in the management of the projects concerned".

For this category, OECD frequently uses the acronym "RSE" (Research Scientists and Engineers).

2. "Technicians and Equivalent Staff" are:

"... 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".

3. "Other supporting staff" includes:

"...skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects".

It should be noted that included under the group "other support staff" are all managers dealing mainly with financial and personnel matters, insofar as these activities provide a direct service to R&D. As a rule, in the occupation breakdown, postgraduate students should be considered as "researchers".

4.4.3.4 Classification of R&D Personnel by Level of Formal Qualification

Five classes based on the revised ISCED by level of education (regardless of the field in which the R&D personnel are qualified or working) are defined in the Frascati Manual.

The following breakdown is proposed:

1. Holders of university degrees at PhD level (ISCED level 6):

"Holders of doctorate degrees of university level or equivalent in all fields (ISCED level 6). This category includes holders of degrees earned at universities proper and also at specialised institutes of university status".

2. Holders of basic university degrees below the PhD Level (ISCED level 5A)

"Holders of tertiary-level degrees below the PhD level in all fields (ISCED level 5A). This category includes holders of degrees earned at universities proper and also at specialised institutes of university status".

3. Holders of other post-secondary diplomas (ISCED level 5B and level 4)

"Holders of other post-secondary tertiary (ISCED level 5B) or non-tertiary (ISCED –level 4) diplomas in all fields. Subject matter is typically specialised, presented at a level requiring the equivalent of full secondary level education to master it. It provides a more practically oriented/occupation-specific education than programmes at ISCED levels 5A and 6. Many such courses are offered in part-time, evening, sandwich and refresher programmes".

4. Holders of Diplomas of Secondary Education (ISCED level 3):

"Holders of diplomas at the secondary level, upper stage (ISCED level 3). This class includes not only all ISCED level 3 diplomas obtained in the secondary school system but also equivalent level 3 vocational diplomas obtained from other types of educational establishments".

5. Other Qualifications:

"This includes all those with secondary diplomas at less than ISCED level 3 or with incomplete secondary qualifications or education not falling under any of the other four classes".

4.4.3.5 Other R&D/S&T Personnel Variables of Interest

The original versions of the Frascati Manuals barely mentioned some personnel issues (gender, age, etc) and little data were collected. With increasing interest in ensuring sufficient numbers of highly qualified S&T personnel (scientists, engineers, technicians) behind the "Canberra Manual" and the recently launched OECD/EUROSTAT/UNESCO study of Careers of Doctorate Holders (CDH), data for a number of new personnel-related variables are now collected.

5. The measurement of innovation activities

It is generally accepted that innovations are the key to production and productivity growth of individual companies and thereby regional and national economies. However, despite the development of the theory of innovation it is not yet fully clear which factors affect innovation activities and innovativeness as a whole and how. Statistical surveys - the surveys of innovation activities in a country - are organised to monitor innovation activities for the purpose of creating an innovation policy, for cognitive purposes, and for international comparisons of intensity, efficiency and quality of innovation activities. This Chapter provides the basic methodological instructions for the organisation of statistical surveys/reviews of innovation activities which can be applied in BiH and which are fully based on the Oslo Manual, III ed., 2005. The practical part is based on official surveys of innovation activities which EUROSTAT lays down for the EU Member States, the so-called CIS - the Community Innovation Survey (see Annex I).

5.1 Procedure of Statistical Survey of Innovation Activities

Correct implementation of statistical methodology is the key to collection and analysis of the data on innovation activities. The appliance of the procedure will yield the results comparable to those other countries obtained through the CIS approach.

5.1.1 Targeted business enterprise group – statistical survey population

Innovation activities may take place in all economic sectors: in production activity, services, public administration, health, and even in households. For practical reasons a statistical survey does not include all possible monitoring units. The concept of innovation is not clear in all segments of the economy, and especially in activities which are not market-oriented. This is why statistical surveys of innovation activities are undertaken mainly in the business enterprise sector (BES). This includes both manufacturing and service activities. The classification of industries encompassed by the statistical survey of innovation activities is presented in Table 9 below.

Since the statistical units monitored during the survey of innovation activities may be divided under different classifications, it is recommended that this should be undertaken in accordance with the most important classification, the principal economic activity of a statistical unit ("industry" or activity)[56].

[56] Olso Manual, p. 68-70

Table 9 Industrial classification proposed for innovation surveys in the business enterprise sector based on ISIC Rev.3.1 and NACE Rev. 1.1

Title	ISIC Rev. 3.1 Division/Group/Class	NACE Rev. 1.1 Division/Group/Class
MINING AND QUARRYING	10 to 14	10 to 14
MANUFACTURING	15 to 37	15 to 37
Food Products & Beverages	15	15
Tobacco Products	16	16
Textiles	17	17
Wearing Apparel & Fur	18	18
Leather Products & Footwear	19	19
Wood & Cork (not Furniture)	20	20
Pulp, Paper & Paper Products	21	21
Publishing, Printing & Reproduction of Recorded Media	22	22
Coke, Refined Petroleum Products & Nuclear Fuel	23	23
Chemicals & Chemical Products	24	24
Chemical Products less Pharmaceuticals	24 less 2423	24 less 24.4
Pharmaceuticals	2423	24.4
Rubber & Plastic Products	25	25
Non-metallic Mineral Products	26	26
Basic Metals	27	27
Basic Metals, Ferrous	271+2731	27.1 to 27.3+27.51/52
Basic Metals, Non-ferrous	272+2732	27.4+27.53/54
Fabricated Metal Products (except Machinery & Equipment)	28	28
Machinery n.e.c.	29	29
Office, Accounting & Computing Machinery	30	30
Electrical Machinery	31	31
Electronic Equipment (Radio, TV & Communications)	32	32
Electronic Components (includes Semiconductors)	321	32.1
Television, Radio & Communications Equipment	32 less 321	32 less 32.1
Medical, Precision & Optical Instruments, Watches, Clocks (Instruments)	33	33
Motor Vehicles	34	34
Other Transport Equipment	35	35
Ships	351	35.1
Aerospace	353	35.3
Other Transport n.e.c.	352+359	35.2+35.4+35.5
Furniture, Other Manufacturing n.e.c.	36	36
Furniture	361	36.1
Other Manufacturing n.e.c.	369	36.2 to 36.6
Recycling	37	37
ELECTRICITY, GAS & WATER SUPPLY	40+41	40+41
CONSTRUCTION	45	45
MARKETED SERVICES	50 to 74	50 to 74

Title	ISIC Rev. 3.1 Division/Group/Class	NACE Rev. 1.1 Division/Group/Class
Sale, Retail, Maintenance & Repair of Motor Vehicles & Motorcycles	50	50
Other Wholesale Trade	51	51
Other Retail Trade	52	52
Hotels & Restaurants	55	55
Land Transport & via Pipelines	60	60
Water Transport	61	61
Air Transport	62	62
Supporting & Auxiliary Transport Activities, Travel Agencies	63	63
Post & Telecommunications	64	64
Post	641	64.1
Telecommunications	642	64.2
Financial Intermediation	65 to 67	65 to 67
Real Estate, Renting	70+71	70+71
Computer & Related Activities	72	72
Software Consultancy & Supply	722	72.2
Other Computer Services n.e.c.	72 less 722	72 less 72.2
Research & Development[57]	73	73
Other Business Activities	74	74
Architectural, Engineering & other Technical Activities	742	74.2+74.3
Other Business Activities n.e.c.	74 less 742+743	74 less 74.2+74.3

Innovation activities may be carried out in small, medium-sized and large enterprises. For small enterprises, the coverage is all enterprises with a minimum of 10 employees. In civil engineering and trade, the survey may include also micro enterprises with less than 10 employees. Innovation activities in such small enterprises can be particularly interesting, especially in specific sectors such as high-technology-based manufacturing, the software industry and knowledge-intensive services.

5.1.2 Business Enterprise Frame Group – Statistical Survey Population

In preparing a statistical survey of innovation activities, the business enterprise frame and targeted groups should correspond as much as possible. In practice, the group from which the enterprises are selected does often not correspond to the targeted group either because those enterprises are no longer active, while still listed in the business register, or because the frame group does not include the enterprises which are targeted by the survey.

Usually, enterprises are in the frame group created for the last year of the surveying period. Therefore, it is necessary to take into account the changes taking place during the period surveyed: changes in industrial classification, new enterprises created during that period, mergers and spin-offs, etc.

[57] Only the business enterprise sector companies can be included under the *Frascati Manual* §§163-168. The data at the level of products can also be collected for those NACE/ISIC-groups (73), under the *Frascati Manual* §272.

An ideal frame group is an updated official business register of companies, formed for statistical purposes.

If the official business register is used for a number of statistical purposes, e.g., for surveying innovation activities, science and research and research and development activities, as well as for general survey of the economic activities of enterprises, the questionnaire used for collecting the information on innovation activities should focus on questions specific for innovation activities. Other questions such as those on the number of employees, income, export and investments should be taken over directly from other statistical surveys included in the register. This is the reason why it is desirable that the official business register is formed on the basis of a number of different surveys.

5.2 Collecting Data on Innovation Activities

Suggestions and methodological observations given in the OECD Oslo Manual should be considered carefully when designing a questionnaire and preparing a statistical survey of innovation activities, particularly if the statistical survey of certain forms of innovation activities will be carried out (product innovation, process innovation, organization innovation, marketing innovation; innovative linkages of enterprises, obstacles to innovations, etc.).

5.2.1 Quantitative and qualitative data on innovation activities

A statistical survey of innovation activities gathers both quantitative and qualitative data on innovation activities. Qualitative data includes also the information whether innovation activities are undertaken in a company. Quantitative data includes questions about innovation activity costs – the so-called "innovation costs". Innovation costs are among the most important data for an innovation activity survey and when defining innovation policies. However, the questions related to innovation costs are also the most difficult and time-consuming in preparing answers to the questionnaire, especially knowing that the company's accounting office does not have the direct data; rather, the data is developed by evaluating the form and place of the innovation activity performance. If the release of the innovation activity data is not mandatory for enterprises, this needs to be taken into special consideration. In addition, data quality is important in terms of innovation costs. As the data is not directly recorded in the company's account books, only some costs may be derived from a financial report, while others have to be developed through an assessment method.

The overall costs of innovation activities include related current costs and capital expenditure. The innovation current costs include labour costs and other current expenses. Capital expenditure of innovation activities consist of the overall costs of facilities and land, costs of instruments and equipment, and computer software. Capital expenditure, which is part of research and development, is included in internal research and development activities. Capital expenditure, which is not part of research and development but refer to product and process innovations is included in the costs of procurement of equipment, machinery and other capital products. Expenditure, which is not part of research and development but refers to marketing and organisation innovations is included in the preparation for marketing innovations and organisation innovations. The remaining categories of innovation activities contain purely the elements of current costs[58].

The CIS questionnaire defines the level of detail and categories of costs for which information is sought from companies.

Of particular importance for the innovation activity survey is the way of funding innovation costs, with the aim to evaluate the role of a country's policy and the internationalisation of innovation processes.

The following classification of the sources of funding of innovation activities may be used:

- Own funds
- Funds of the companies that they are related to (affiliates or subsidiary companies)
- Funds of other (non-financial) companies
- Funds of financial companies (bank loans, venture capital, etc.)
- Government funds (loans, grants, etc.)
- Funds of international organisations (EU, etc.)
- Other sources

External sources of funds continue to be divided into national and international sources of funding innovation activities. In order to assess the government role in support of innovation processes, it is usual to know whether a company takes part in public procurement in regard to product and process innovations, which is announced by government regionally, nationally or internationally.

5.3 Methods of Statistical Survey of Innovation Activities in a Country

5.3.1 Voluntary or mandatory survey

Statistical survey of innovation activities in a country may be voluntary or mandatory. In a voluntary survey, significant response rates by the companies cannot be expected; in other words, the responding group will be smaller than expected, and thereby a higher variance, which could be compensated to some extent by higher sampling fractions. But increasing the sampling fractions does not solve the basic problem of the effect of the estimation on the target population due to high non-response rates, and thus further analysis will be less representative.

[58] This is specific for innovation activity surveys as the procurement of equipment, etc. is one of the organisation's innovation activities.

5.3.2 Comprehensive or sample-based survey

The data on innovation activities may be collected from all companies or from a sample. However, limited resources pose an obstacle to conducting a survey among all companies. The sample-based survey is the survey in which enterprises are selected randomly. In doing so, samples have to represent the basic features of the target population of the companies: type of industry, size, region. Thus, stratification of a sample is necessary.

5.3.3 Survey stratum

Special subgroups of the target population of companies may be of interest to the users of those surveys, and they are referred to as strata. In order to obtain representative results for a stratum, it has to be a subgroup of a selected sample. Potential strata can be: groups of industries, company size classes, regions, enterprises performing research and development, innovation active enterprises, etc.

5.3.4 Sampling techniques

Surveys of innovation activities are generally random sample surveys. Literature provides various sampling techniques, e.g. simple random sample technique, stratification techniques, cluster sample techniques, probability-proportional-to-size (pps) sample techniques. When stratifying a sample, it is important to ensure that a sample drawn is homogenous to innovation and non-innovation activities. It is recommended that stratification of a random sample should be based on the companies' size and principal economic activities.

5.3.5 Units

It is necessary to differentiate between a reporting unit, a monitoring unit and a statistical unit.

The reporting unit is the entity from which the requested items of data are collected. Reporting units vary from sector to sector and from country to country, depending on institutional structures, legal status, tradition, national priorities and statistical survey sources.

The monitoring unit is the unit that the received data refers to. It can correspond to the reporting unit if the data compiled in one of analytical ways (not directly from a reporting unit) for the unit is identical to the data obtained from that unit.

The statistical unit may be the monitoring unit for which the data is compiled or the reporting unit from which data is collected. The statistical unit has to be uniform for all countries conducting internationally comparable statistical surveys.

5.3.6 Classifications

The size of enterprises need to be determined on the basis of the number of their employees. The classification of statistical entities – enterprises – for statistical innovation surveys by size or the number of employees is as follows[59]:

- 10 – 49
- 50 – 249
- 250 and above.

The stratification of enterprises according to their principal activities has to be based on the ISIC Rev. 3.1 / NACE Rev. 1.1.

The classification of enterprises for statistical innovation surveys by type of institution is as follows[60]:

- Private enterprise,
- State-owned enterprise which is not controlled from abroad,
- Multinational company:
  - Affiliation controlled from abroad,
  - Daughter company, controlled from abroad,
  - Daughter company, which is not controlled from abroad.

Other classifications of enterprises for innovation surveys include:

- Form of activity, with categories of:
  - Capital intensive enterprises,
  - Labour intensive enterprises,
  - Technological, knowledge-intensive enterprises.
- Type of goods produced:
  - Consumer goods,
  - Intermediate goods,
  - Investment goods.
- Export intensity – classification by the share of the exports in the total revenue of the enterprise,
- Innovation or R&D intensity – classification by the share of innovation or R&D costs in the total revenue of the enterprise,
- Cooperation with other enterprises and state institutions.

[59] Olso Manual, p. 62

[60] Olso Manual, p. 62

5.3.7 Survey methods and suitable responses

Various methods and techniques can be used for innovation surveys, including postal surveys and interviews. In the case of postal surveys, it is necessary to follow up with enterprise managers several times, via email or phone. In order to increase response rates, it is recommended to contact company managers prior to sending questionnaires; that a letter of support from the relevant minister is sent; that the results of the past surveys are shared, while ensuring the possibility of reporting through the Internet and promising to send the results of the ongoing survey.

Many problems can be avoided through interviews, more specifically, through CATI (Computer Assisted Telephone Interview) or CAPI (Computer Assisted Personal Interview) techniques.

6. The measurement of patent activitities

6.1 Patent as protection of industrial and intellectual property

A patent is an expression of the industrial property laws of the country granting it. Patenting all or part of a new technological device or process involves its inventor in publicising the invention, which receives time-limited statutory protection from the country of filing against unlicensed copying. The product or process need not actually be made or applied to qualify for patent protection. That being so, a patent may not always be protecting some existing prototype or fully developed process. What it primarily signifies is that the applicant's invention is novel. So patenting expresses and gives legal status to a particular definition of technological invention. This sets certain limits to the ways in which patent data can be used.

6.2 Principal conventions

The "inventor's right" concept emerged during the 15th century but did not really develop until the 19th century, when today's patent systems gradually took shape as a result of growing international trade. To begin with, the patent was a national right. Every country laid down its own rules for industrial protection, rules which applied only within the borders of the country concerned. However, once national patent systems had been introduced, a need to link them up to one another was very soon felt. International conferences led to a number of agreements.

After five years of preparation the Convention for the Protection of Industrial Property was signed in Paris on 20 March 1883. The purpose of the convention, which entered into force in July 1884, was to harmonise and interlink countries' industrial property law systems and to establish some international legal institutions. Eleven countries signed the original convention. By 1 January 1993, there were 108 signatories.

Before the Union Convention came into force, an inventor filing a patent application in one country could be refused the right to patent the same invention in another country on the grounds that his invention was no longer novel. Under the Convention, an inventor filing an application in any one Union country may validly apply to patent the same invention in other Union countries within 12 months and the application cannot be refused on grounds of prior disclosure as a result of the first filing. The priority right is called the "Paris Convention priority right", "Convention priority right" or "Union priority right".

Since 1883 several conferences have been held to revise the Convention in the interests of a more efficient patenting system. In 1893 an International Bureau was established for the protection of industrial property. In 1947 an International Patent Institute was established in The Hague. Its role was to carry out novelty searches for its member countries. It was subsequently absorbed into the European Patent Organisation. A European convention was signed on 19 December 1954 under which the Council of Europe introduced the International Patent Classification (IPC). This was followed by the Strasbourg Agreement on that classification, signed on 24 March 1971; it entered into force in 1975.

In 1967 a conference held in Stockholm to revise the Union Convention established the World Intellectual Property Organisation (WIPO).

The Patent Co-operation Treaty (PCT) was signed in Washington on 19 June 1970 and came into effect on 1 June 1978. It provides for the filing of an international application to have the same effect as a national application in each of the contracting States designated in the application. International applications are centralised through WIPO. They are then examined by the European Patent Office, or an approved national office. The resulting search reports provide a basis for subsequent examination, where this is considered necessary, by the patent offices of the countries named in the application. However, patents are still granted nationally. The PCT system is superimposed upon the national and European systems. Another point is that a PCT application may designate either a national office or a regional one such as the European Patent Office (Euro-PCT), to apply for protection in one country or in a set of countries.

The Munich Convention – establishing a uniform patenting system for all countries signatory to the Convention - was signed in Munich on 5 October 1973 and entered into force on 1 June 1978. The European patent is protected under national law in each of the countries designated in the application. The Munich Convention also established the European Patent Organisation, which makes senior appointments to the European Patent Office (EPO). The Luxembourg Convention, signed on 15 December 1975, introduced a single Community patent affording protection across the entire European Community. This convention has not yet entered into force.

6.3 A glossary of patent-derived data

Application, filing: Patenting an invention involves filing an application with the patent office. For any such application we can distinguish the year of filing and the country of filing.

In interpreting patent data various classes of application can be distinguished:

- national applications (NA): all applications filed with a national patent office;
- resident applications (RA): all applications filed with a national patent office by inventors resident in the country;
- non-resident applications (NRA): all applications filed with a national patent office by persons resident abroad.

FOR ANY ONE COUNTRY: **NA = RA + NRA**

Non-resident applications (NRA) become external applications (EA) if they are considered in terms not of the recipient patent office country but of the applicant's country of residence.

AT WORLD LEVEL: **NRA = EA**

Patents granted may similarly be defined as national patents granted (NG), patents granted to resident inventors (RG), patents granted to non-residents (NRG) and external patents granted by other offices (EG).

- **Inventors, applicants:** Every patent application has to give the names and addresses of the inventor and of the person, firm or institution filing for the patent (the inventor and filer may be one and the same person). From this, the country of invention can be ascertained.

a. **Priority (priority application):** For any given invention, the priority filing is the first application. It is generally filed with the patent office of the country in which the invention was produced. Upon first filing the application receives a code number, the "priority number". Data should be available for the year of priority application (or first filing) and the country of priority application.

- **Publication:** Publication occurs when the application is made public. Patent applications are usually published 18 months after priority application. The only significant exception is the United States, where the filing is only published if a patent is granted, which may take up to five years from the first application. When an application is published it is given a publication number, the one used in subsequent searches. Each application published is also given a code (usually a letter) to show what kind of patent document it is. This shows at once whether the application has been examined, rejected or granted. Data should be available for year of publication and country of publication.
- **Search report:** The patent office examiners' search report will mention the documents against which they assessed the application. These may be the ones referred to in the application, or other documents identified by the examiners. A prior art search checks that the invention really is novel. The examiner generally bases this on the applicant's claims. The search report is generally published at the same time as the application. Search reports for applications to PCT and the European, United States and French offices are available in certain databases. Indicators can be derived from documents cited in search reports.
- **Designated countries:** These are the countries in which the applicant for a European or international patent wishes to protect his invention. The applicant will not necessarily proceed in all the designated countries, in which case those countries where he does not proceed will not grant patents.
- **Grant of patent:** This refers to the fact that a patent has effectively been granted. As mentioned above, in most systems (apart from that of the United States) applications are published 18 months after filing, whether a patent is granted or not. However, the date from which protection is provided is the date on which the application was first filed, the priority date. Data should be available for year of grant and country of grant.
- **Patent family:** The family comprises all the patent documents covering the same invention. As a rule, a patent family consists of the priority application to a national office and equivalent foreign versions of the application. The first patent publication for a family entered in a database is called the basic record. In fact the expression "patent family" is only used in those databases which collect information from more than one patent office, such as WPI(L), INPADOC and EDOC. In other words, the "basic record" corresponds to an invention which, being wholly new, is unknown to the database concerned. "Equivalents" cover the same invention as the basic record. "Basic" and "equivalents" are indicated by the same priority number.
- **Patent classification systems:** Inventions are classified by one or more symbols, so that patents belonging to a given technological field can be filed and retrieved.
- **The International Patent Classification:** As mentioned above, some system is necessary for accessing the technical information contained in published patent documents. In view of the worldwide dissemination of patent information, a single international system has proved to be necessary. This is the International Patent Classification (IPC), which is applied by

number of countries and four international organisations. Its symbols are printed on published patent documents. IPC entered into force in 1975, under the Strasbourg Agreement of 1971 which determined its principles and form of operation:

a. Principle: IPC is a retrieval system for inventions claimed in patent documents and for certain significant information only available in descriptions. IPC is designed so that each technical object to which a patent relates can be classified as a whole. A patent may contain several technical objects and therefore be allocated several classification symbols. An invention is normally classified according to its function or intrinsic nature, except when its application alone determines its technical characteristics.

b. Structure: IPC is a tiered structure in which all techniques are classified in sections, classes, subclasses, groups and subgroups. Each subgroup may be further subdivided. It contains about 64,000 entries, each represented by an alphanumeric symbol corresponding to one of the tiered divisions in the classification plan. Every patent document receives one or more classification symbols corresponding to the invention claimed in the application. So that the classification can be understood, the designations of the various IPC symbols are defined by IPC entry labels. Coding rules, applied generally or locally, have also been established. Examiners have precise instructions on how to classify a claim in accordance with the technical description. Some countries have added classification symbols for information contained only in the description, which might nevertheless be of use to the researcher. Some countries, too, classify only at subclass level (4 digits, e.g. A61K), but most allocate full classification symbols to every document (e.g. A61K 6/083) (9).

c. Updating method: The International Patents Classification is revised and if necessary amended every five not retroactively. A patent indicated by symbols have subsequently been amended is not as a rule re-indexed in accordance with the new symbols. search to be as exhaustive as possible these changes must be taken into account. In particular, versions of the classification should be used for a study covering a number of years.

IPC has been modified in a number of ways to produce other technological nomenclatures. These nomenclatures consist of a number of technology fields defined by IPC symbols. The fields as defined differ appreciably from the IPC classification pattern. They are constructed with the aim of forming homogeneous technology groups with similar volumes of documents in such a way as to reflect recent developments in a more up-to-date fashion than other conventional classifications would permit. The nomenclatures thus defined are intended to be applicable internationally and all adjustments are made with that purpose in view.

6.4 Patents as technological development indicators

Patents have many uses. As well as attesting to industrial property rights, patents form part of the technological documentation from which companies may derive information about their own industries (competition profiles, state of the art, etc.). Another related use is for assessing technological areas or subjects by means of indicators prepared from patent-derived information.

Patents Indicators (as used in the OECD ”Main Science and Technology Indicators” publications):

a. Patents indicators in earlier OECD publications:

- National patent applications (= the sum of resident and non-resident applications in the country);
- Resident patent applications;
- Non-resident patent applications;
- External patent applications (made abroad by residents of the country concerned);
- Dependency ratio (non-resident/resident patent applications);
- Auto-sufficiency ratio (resident/national applications);
- The inventiveness coefficient (resident patent applications per 10 000 population), and
- The rate of diffusion (external/resident patent applications).

b. “New” patents indicators in OECD/”MSTI” publications:

- Number of “triadic” patent families (priority year);
- Share of countries in the “triadic” patent families (idem);
- Number of patents in the ICT (information and communications technologies) applications to the European Patent Office – EPO (idem);
- Number of patents in the biotechnology sector – applications to the European Patent Office (idem)

Patents are a means of protecting inventions developed by firms, institutions or individuals, and as such may be interpreted as indicators of invention. Before an invention can become an innovation, further entrepreneurial efforts are required to develop, manufacture and market it.

Patent data have been put to profitable use by analysts and policymakers for a long time now. They provide detailed information on countries’ technological activities, covering long periods through the time series available; in addition, computerised databases make the content of patent documents easier to access and analyse, and allow more convenient data manipulation.

The main information that can be drawn from patent documents relates to the type of technology covered by the claim, the name and nationality of the inventor (individual, government agency, private corporation), links between a new patent and knowledge in earlier ones and scientific publications, the economic sector where the invention originated, and the fields and markets covered by the patents.

Overall, patent documents contain a wealth of detailed information to be found nowhere else; but successful use of that information for economic analysis needs to take account of a range of methodological problems, differences between one country or institution and another, the role of multinationals, and specific characteristics of given technologies and economic sectors. This Manual sets out guidelines for tackling these problems, while encouraging the use of patent data and giving impetus to the international harmonisation of these statistics.

Patents are just one of a number of intellectual property rights, which fall into two broad categories:

- industrial property, chiefly in technical inventions, trademarks and industrial designs; and
- copyright, chiefly in literary, musical, artistic, photographic and audiovisual works, including some software.

Industrial property rights are officially registered, whereas copyrights are not. Protection for technical inventions is offered primarily by patents, and by utility models ("petty patents") as well. The main differences are that utility models can be registered only for selected areas of technology, and some countries recognise patents but not utility models. Given these limitations, utility models will not be mentioned further below.

S&T activities comprise research and development (R&D) and other activities such as collecting S&T information, testing and standardisation, etc. The Frascati definitions explicitly exclude the latter activities from R&D. Patents are often linked to research and development and can be considered as indicators of R&D output.

At the same time, patents are a typical output of application-oriented types of R&D, formal and informal, i.e. applied research and experimental development, and sometimes basic research as well. Inventions are often generated in the context of industrial and design engineering (chiefly linked to the stock of knowledge), while some come about by accident. The legal requirement to show potential industrial applications, and the high cost of patenting, indicate a close link to industrial innovation activities, but it is not the sole link.

Patent documents contain impressive amounts of information of various kinds: about technology, markets, relations with other types of data, and so on. All this information is first processed by the producers of patent databases which, as we have seen above, sort the information into different areas according to content. This makes the information easier and quicker to access. Some questions, though, cannot be answered merely from qualitative descriptions of technologies (content of one or more patents) but will also require a more quantitative kind of processing. Such statistical processing produces indicators which provide information on patterns of technological activity at different levels of aggregation. A number of indicators of this kind have been produced, ranging from simple patent counts to more complex indicators linking technology fields, or technology and science, or technology and R&D, or - more broadly - technology and economic activity.

Patent data can be combined with several other indicators, including indicators for R&D spending (as defined in the Frascati Manual), indicators for innovation (as defined in the Oslo Manual) and indicators for technology flows, (as defined in the TBP Manual). However, patent data offer more specific indicators, at different levels of aggregation and detail, for a type of activity or a sector of technology, and it is with these that we shall be concerned here.

The reliability of patent data as an indicator of technological innovation has been illustrated by a number of surveys, showing that a large proportion of firms' inventions are patented and that a large proportion of patents become innovations with an economic use. Furthermore, patents give a good picture of invention and innovation in small firms and in the production engineering departments of large firms, something that R&D indicators alone do not properly measure.

Patent data can be aggregated and analysed in a number of ways, including:

a. patenting by type of inventor, by firms or groups of firms;

b. filings in one or more fields of technology;

c. the patenting activity of a country or a region;

d. patenting patterns over time.

Those four basic modes can be variously combined, depending on the purpose of research needs, but they call for different approaches, and caution in using and interpreting the results. In methodological terms there is a considerable difference between analysis of patenting at country level and at firm level. These two aspects will be examined separately at some length.

Patent counts

The simplest type of patent indicator is derived merely by counting the number of patents which satisfy one or more criteria. Before discussing analyses based on patent counts, however, we may usefully consider the main methodological questions. Patents do not all have the same technological and economic relevance, nationally or internationally. Whether a firm takes out a patent reflects not only the kind of business it is in, but also its own technical and marketing strategies and therefore the markets it wishes to reach.

Some fields of technology lend themselves better to patenting than others. In electronics, for example, the patenting process may not keep up with fast-moving technological advance, so a firm may prefer to keep its inventions secret rather than seek patent protection. Some types of invention, such as software, are protected under copyright rather than patent law. In other fields (chemicals and engineering, to cite just two leading areas), filing for a patent is the usual way for a firm to protect itself in the market.

This limitation also influences the interpretation of international comparisons between sectors. One country may concentrate on a field such as chemicals where patenting is the most effective means of protection, whereas another focuses on a field such as aviation in which patenting is less prevalent. The classification of patents may also be a source of problems. Classification systems are updated frequently. A leading-edge invention can be hard to classify precisely because patents in fast-evolving technological fields do not always fit into any pre-established class. Then it is best, so far as possible, to work with the most detailed and regularly updated system, such as USPOC for United States patents or ECLA for European ones, or to use keyword searches.

Certain other limitations are administrative in nature, but may have their significance. A wide swing in the patent grant statistics may be an administrative artefact, stemming from fluctuations in the administrative processes of patent review. For example, a fall in the number of patents granted in the United States in 1979 was not due to a reduction in patent filings, but simply to lack of funds for printing patents.

Bearing these methodological problems in mind, we may now consider three key questions for appropriate use of patent counts.

How can patents be counted?

Two or more inventors may make a joint application for a patent. If the inventors are of different nationalities, some analysts suggest "sharing" the patent among the various countries concerned. In measuring a country's patent output this result in fractional counting. As an example, when four inventors of different nationality file jointly for a patent, one-quarter of that patent is credited to each of the countries concerned. The same fractional count may be used for attributing patents to different fields of technology. As mentioned above, output for a field may be assessed via the number of patents bearing the relevant classification code, but some patents have more than one code. In such cases, equal fractions of the patent can be allocated to each field. When patenting by type of inventor is investigated, fractional counts can be used to assign patents to the different groups considered (firms, universities, government laboratories, individual inventors and so on). It should be noted that, especially at country level or for large aggregations of patents, the findings are much the same whatever method is used.

Which patent institution should be considered?

Patent counts lead to different results according to the patent institution where patent activity is considered. An inventor will usually file for a patent with his own country's patent office, and often with that office alone. As a result the country is over-represented in its own patent office, due to what can be called "home advantage". The extent of this home advantage can be estimated by comparing patenting activity in national and foreign institutions and matching patent indicators to other R&D and technology indicators.

One way to overcome this bias is to consider only those patents which the country's inventors and companies have filed abroad. This approach is based on the assumption, often borne out in practice, that the important patents are the international ones.

Possible courses here include the following:

- an international patent institution such as the European Patent Office can be considered, rather than a national office. It should be noted that European and especially German activity is over-represented at EPO, relative to US and Japanese patenting; the bias is lower than with national patent offices, however;
- the activity of two countries (or firms in different countries) can be compared in a third market; typically, European comparisons have been conducted on the basis of patenting in the United States;
- patent data from the major world offices (USPTO, EPO, JPO) can be combined, considering only the patents applied for (or granted) in all three institutions.

The choice of the patent institution to be considered may lead to widely different results in the description of the patenting activity of individual countries.

Patent data by country of origin and type of inventor

The specific nature of the different types of patent statistics should also be remembered. Patent applications can be classified in several ways:

- the number of resident applications (RA) can be regarded as reflecting the country's invention output;
- the number of non-resident applications (NRA) provides information on the extent to which the country is considered a worthwhile market for the introduction of foreign inventions, or a serious competitor in technological activity, prompting foreign firms to use patenting as a tool in their competitive strategy;
- the number of external applications (EA) may be regarded as an indicator of the interest of a country's firms in safeguarding the return from their inventive activity in foreign markets.

The types of inventor should also be considered. They include firms, government agencies, universities, non-profit institutions and individual inventors. In most countries, individuals and non-profit institutions have a lower interest in protecting their scientific and technological output with patents.

Filing statistics provide a broad picture of technological activity. Such statistics are often used for comparison between countries, regions, sectors and so on. The long time-series available enable us to follow technological trends over a fairly long period and to analyse the technological activity of the country, region, sector or firm concerned. As technology indicators evolve over time, they provide information about the different positions a country or a firm has taken up.

Now that some of the basic methodological questions to do with counting and interpreting patents have been clarified, we may examine the use of patent statistics as an indicator of the technological activity of countries and firms.

Technological change and innovation have become two main areas of economic analysis in the industrialised countries, as they are determining factors for the productivity and competitiveness of a nation. Science and technology (S&T) activities are crucial for fostering technical innovation, and therefore there is an increasing interest for describing the countries' S&T activities in both quantitative and qualitative terms. In this context, S&T activities are mainly measured by using indirect input, output and impact indicators. It is in the framework of output indicators that patent data are used. In particular, indicators based on patents can be very interesting for assessing the performance of application-oriented types of R&D. Although patents do not cover all kinds of innovation activity, they do cover a considerable part of it. However, patent indicators should be complemented with other S&T indicators, so as to obtain a complete view of the innovation activities of the countries and regions.

Advantages and disadvantages of using patents as an indicator of R&D output include:

Advantages

- Patents have a close link to invention and cover a broad range of fields.
- Patent data are readily available from the various national and regional patent offices.
- Patent documents contain detailed information including the year of invention, technical classification, country of applicant, country of inventor etc., with data going back many years.
- Due to the efforts and costs involved with patenting, the economic weight of the inventions for which a patent is applied for is guaranteed to a large extent.
- Being closer to the time of invention, patent statistics are more accurate than production or trade statistics, which may comprise a greater time lag between actual innovation and commercialisation.

Disadvantages

- Not all inventions are patented and not all patents have the same value.
- There are other means to reap market success from an invention, such as secrecy, rapid launching or low prices.
- There are differences in the propensity to patent across firms, sectors and countries, influenced by different national patent systems as well as the patterns of international trade and direct investment.
- In areas where developments change rapidly, patent protection may be of little value because inventions quickly become obsolete and it takes a long time to grant a patent.
- Although patents cover a wide range of fields of technology, not all inventions can apply for patent protection. This is the case, for example, of computer software under the European Patent Convention (Article 52, paragraphs 2c and 3). Nonetheless, in February 2002, the European Commission submitted a proposal for a directive on the patentability of computer implemented inventions[61]. In the context of the directive, computer software as such is excluded from patentability. In order to be patentable, the proposal requires that the invention implemented through the execution of software on a computer or similar apparatus, makes a contribution in a technical field that is not obvious to a person of normal skill in that field. Thus in Europe, unlike in the US, computer software will continue being protected by copyrights.
- The requirement of novelty for the granting of patents means that although the indicators are particularly appropriate for advanced countries, they may not adequately portray technological activity in less developed countries and regions.

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[61] Proposal for a directive of the European Parliament and of the Council on the patentability of computer-implemented inventions,
European Commission, Brussels, 20/02/2002, COM(2002) 92 final.

Criteria used to count patents used in EUROSTAT's patent domain

Different criteria can be chosen to count patents. The basic guidelines for constructing patent statistics as a measurement of scientific and technological activities are given in the OECD Patent Statistics Manual, 2009 and Compendium of Patent Statistics, OECD, 2008.

EUROSTAT's patent database contains three collections of statistical data.

- Patent applications to the EPO by priority year
- Patents granted by the USPTO by priority year
- Triadic patent families by earliest priority year

All data are available at the national level. EPO data are also available at the regional level.

Type of patents covered

EPO data refer to applications filed directly under the European Patent Convention or to applications filed under the Patent Co-operation Treaty and designating the EPO (Euro-PCT). All direct patent applications to the EPO (EPO-direct) are taken into account, but among the PCT applications made to the EPO (applications following the procedure laid down by the Patent Cooperation Treaty – PCT) only those that have entered into the regional phase are selected. Therefore, applications to national patent offices of the Member States are excluded from this data collection and also PCT applications made to the EPO that are still in the international phase are excluded.

7. The measure of other S&T data series – Government budget appropriations or outlays for R&D and careers and the mobility of doctorate holders

7.1 General

Over time, besides the basic measurements of R&D resources in terms of expenditures and personnel, new policy interests (backed up by new theoretical guidelines) have been met by a collection of additional types of information, briefly discussed below.

7.2 "GBAORD" - The Analysis of the R&D Contents in Government Budget Appropriations or Outlays

The main message in the Frascati Manual is that priority should be given to performer-declared R&D expenditure (and personnel) and not to data reported by the funders. This recommendation inevitably leads to time delays – sometimes several years – before data becomes available (the survey year must have come to an end, the accounts on which respondents base their response closed, survey data reported, collected, processed and finally issued).

These data are accordingly retrospective ("ex-post") and sometimes of limited interest only, notably to public science policy makers who need as much up-to-date figures as possible, in particular on public participation in the national S&T effort, to mirror Government's policy intentions at a given moment in time.

Another essentially ex-ante (forecast) method has therefore been developed to identify, measure and analyse the R&D content of state budgets. It consists of an examination of the "Government Budget Appropriations or Outlays for R&D (GBAORD)".

The method was initiated and refined over the years by the R&D statistics experts of the OECD, in close cooperation with UNESCO and Scandinavian countries but, for international data collection, the lead has now been taken by EUROSTAT.

This budget-based information has the advantage of being accessible much earlier than the traditional (performer-reported) R&D series but, on the other hand, the estimates are frequently less precise than the final performer-reported information. It is also subject to political and economic changes in government policies and likely to be revised during the whole budget procedures work. Its comparability is lower than the performer-reported data both between countries at a given moment in time, and in a given country over a longer time period. There is also necessarily some degree of uncertainty - sometimes subjectivity in this approach, even if the estimates are frequently backed-up by more "solid" R&D coefficients (from regular R&D surveys).

All the basic Frascati concepts and definitions of R&D are applicable to the GBAORD analysis. "Government", in principle, covers central (or federal) and provincial (or state) government (and includes all outlays to be met from taxation or other government revenue within the budget). Note that public enterprises are still excluded, contained in the Business enterprise sector, as mentioned in the sectoring section above.

The GBAORD series is classified according to a list of thirteen broad socio-economic objectives (or goals) in the Frascati Manual, though with less detail than in the corresponding EUROSTAT classification "NABS" (Nomenclature for the Analysis and Comparison of scientific programmes and budgets - (see also 3.9 above).

Two criteria are possible for the classification (or rather distribution) by socio-economic objectives – the "**purpose**" or the "**general content**" of the R&D programme or project. The Frascati Manual illustrates the differences between the two approaches by the following example:

"A research project on the effects on human body functions of various chemicals which could be used as weapons: the purpose is "defence" but the R&D content is "human health".

"A research project to develop fuel cells to provide power in remote forest locations financed by the Ministry of Agriculture: the purpose is "agriculture, forestry and fishing" but the R&D content is "energy".

From the viewpoint of government policy, the "purpose" approach is considered more important and should be given priority in the GBAORD breakdown by socio-economic objectives.

In principle, the programmes examined are allocated to their **primary objective**, but many programmes may also have very clear **secondary objectives**. For example, a government may commit R&D money to an aircraft project primarily for military reasons but also encourage exports sales by the aerospace industry and even to assist spin-offs to civil aviation.

In the countries' reports to EUROSTAT and OECD R&D should, in so far as possible, be classified according to the primary objective. Furthermore, in some cases, countries will divide large, public-financed programmes between several objectives.

The OECD list of broad socio-economic objectives (SEO) (Frascati Manual 2002) are:

1. Exploration and Exploitation of the Earth
2. Infrastructure and general planning of land use
3. Control and care of the environment
4 Protection and improvement of human health
5. Production, distribution and rational utilisation of energy
6. Agricultural production and technology
7. Industrial production and technology
8. Social structures and relationships
9. Exploration and exploitation of space
10. Research financed from general university funds
11. Non-oriented research
12. Other civil research
13. Defence

7.3 Data on the Careers and Mobility of Doctorate Holders (CDH)

7.3.1 General

The supply of qualified people to work in S&T remains an important topic of concern to all countries and international agencies. More or less as a follow-up to the Canberra Manual exercise, an international study was launched by the OECD, UIS and EUROSTAT in 2004 mapping, in quantitative and qualitative terms, the careers and the mobility of doctorate holders (CDH). The study, giving first results in 2007, was in line with concepts developed with experts from around forty countries participating in the exercise (including Croatia) which is also closely linked to public and private innovation interests (more drawing on national practice rather than on Frascati and/or Canberra parameters).

Among the multiple variables collected in this CDH survey are the numbers of doctorate holders (DH) in the population (in absolute terms and per 1,000 labour force), new doctorates per 100 university graduates, DH demographic characteristics (age, gender, etc), educational characteristics (age at graduation, duration of studies, fields of study and doctoral degree, primary sources of doctorate funding), labour force status (including unemployment rates, full-time vs. part-time positions, type of employment contract, salaries, international and national (job-to-job) mobility, and employment satisfaction. Specific attention is given to the national origins and international mobility (data collected on place of birth, citizenship(s), residential status, duration of stay in country, cross-classified with demographics (gender, age) and educational criteria, etc. Information is also collected on the outputs of doctorate holders working as researchers, such as articles, books, named in patents, patents granted, commercialised products or processes, etc.

Four types of sources have been used by countries: special CDH surveys; permanent register data (common in the Nordic countries), other permanent surveys (labour force, census) and/or a combination of the above sources..

Part Two – STI statistics in BiH: methodology, standards and current state of affairs

8. Statistics in BiH: analysis of the situation

8.1 Analysis of the situation

8.1.1 Management of Research and Development (R&D) and the Innovation System in BiH

In accordance with the Law on the Ministries and Other Administration Bodies of BiH, the Ministry of Civil Affairs (MoCA), at the state level, is responsible for coordination of activities, cooperation with the entity ministries and for defining the policy for international cooperation In accordance with the Framework Law on the Scientific and Research Activity and Coordination of Internal and International Science and Research Cooperation of BIH, MoCA plays a strong role in coordinating activities of institutions responsible for science as well as international cooperation. MoCA is the institution which represents the country at international events and signs inter-governmental agreements on cooperation in science and technology. The entities have primary responsibility in all other issues relating to science, technological development and innovation policies.

The Council for Science of BiH is a professional, advisory body of MoCA. Council activities include:

a. giving recommendations and opinions for the development of science and technology;

b. taking part in developing a Strategy for the Development of Science;

c. monitoring the implementation of the Strategy for the Development of Science in BIH and in this regard provides recommendations and opinions to MoCA necessary for the development of the implementing regulations by the Ministry (action plans, guidance, etc.);

d. preparing and recommending to MoCA instructions on the methodological frames and principles for the development of the Rulebook on Classification of Scientific Areas, Fields and Branches; the Rulebook on Minimum Requirements for the Promotion to Academic Titles; and the Rulebook on the Minimum Requirements for the Performance of Scientific and Research Activity and Pursuit of Scientific and Research Activity;

e. preparing and proposing to MoCA the adoption of the Rulebook on Rewards in Science in Bosnia and Herzegovina for International Success;

f. preparing and proposing to the relevant institutions the instruments for statistical monitoring of the situation in science and technology in Bosnia and Herzegovina, and international reporting;

g. giving recommendations for the participation of BIH in the European Union Programmes for Science and Technology;

h. giving opinion on the membership of BIH in international bodies and projects in the area of science and technology;

i. considering the situation in the area of science, and gives recommendations for the development of science and research infrastructure and training of a new generation of scientists;

j. giving recommendations for support to projects in the area of science and technology;

k. giving opinion on agreements on international cooperation in the area of science and technology;

l. giving recommendations for defining a system of science and research information in accordance with international standards.

Concerning legislation governing science and research, the Framework Law on the Scientific and Research Activity and Coordination of National and International Cooperation in Science and Research, at the BIH level, and the Framework law on Higher Education in BIH, are in place.

MoCA has developed, in cooperation with the representatives of the entity ministries, the following strategic documents on scientific and research activity:

- Strategy for the Development of Science in BIH 2010-2015
- Action Plan for the Implementation of the STI Strategy 2010-2015
- Strategic Action Plan for Development of Education in BIH 2008-2015
- Strategy for the Development of Vocational Education and Training in BIH.

In accordance with the Framework Law on the Scientific and Research Activity and Coordination of Internal and International Science and Research Cooperation of BIH, it is planned to issue instructions on methodological frames and principles for the development of the Rulebook on Classification of Scientific Areas, Fields and Branches; the Rulebook on Minimum Requirements for the Promotion to Academic Titles; and the Rulebook on the Minimum Requirements for the Performance of Scientific and Research Activity and Pursuit of Scientific and Research Activity. The relevant institutions of the entities, cantons and the Brcko District will make, under their respective authority and specific characteristics, their own rulebooks which should be harmonised to the maximum extent possible.

In the Federation of BiH, the **Federation Ministry of Education and Science** carries out administrative and other professional duties which cover development and coordination of scientific and research activity, protection of intellectual property rights, development of science and research institutions, provision of support to basic and applied research activity, development of human resources and provision of support to experimental research activity on innovations and development of new technologies. The Federation Ministry is responsible for the creation of the Council for Science of the Federation of BIH, as an advisory body in implementing R&D and innovation policy. In the Federation, cantons have primary responsibility for science and technology. Cantonal Ministries for Education, Science, Culture and Sports implement policy through their Departments for Higher Education and Science. Also, the Ministries establish their own Councils for Science with responsibilities similar to those of the state-level Council, with the main difference being that the Council proposes the budget for scientific activities and organises the evaluation of scientific projects and programmes.

The Ministry of Education and Science of the Sarajevo Canton, as well as the Ministries of Education, Science, Culture and Sports of the Tuzla and Zenica-Doboj Cantons release official data on investment in scientific and research by cantonal governments, while there is no official data available for other Cantons (the Una-Sana, the West Herzegovina and Canton 10). In the Sarajevo Canton, the members of the Council for Science are the Minister of Education, Science, Culture and Sports, and the Minister of Economy, and a representative of the economic sector.

Since Cantons have primary responsibility, cantonal assemblies pass laws, while cantonal governments are responsible for defining and managing the research and development funding through the relevant ministry, the Ministry of Education, Science, Culture and Sports.

The legal framework of the scientific and research activity of the Federation consists of the BIH Framework Law on the Scientific and Research Activity and Coordination of Internal and International Scientific and Research Cooperation, the Law on Organisation of Scientific and Research Activity in the Territory of the Canton (Official Gazette of the Sarajevo Canton, No. 10/04), the Law on Scientific Activity in the Tuzla Canton (Official Gazette of the Tuzla Canton, No. 6/99) and in the Zenica-Doboj Canton, the Law on Scientific Activity (Official Gazette of the Zenica-Doboj Canton, No. 7/99). Where there is no law on science, the old law on scientific and research activity is still in place (Official Gazette of the Socialist Republic of BIH, No. 38/90).

In Republika Srpska, the Department for Science, and the Department for Technology of the **Ministry of Science and Technology of Republika Srpska** have full responsibility for defining and managing R&D and innovation.

The RS Ministry of Science and Technology undertakes administrative and other professional duties related to scientific and research, development of national investment technologies, human resources in R&D innovations, development and improvement of technology, referral and acquisition of material rights and technologies in production, and the planning and preparation of programmes and agreements on scientific and technical cooperation. The main advisory body which assists the Ministry in strategic development is the Council for Science, appointed by the RS Government on the recommendation of the Ministry. Among other things the Council monitors and assesses the quality of scientific and research organisations and proposes the budget for scientific and research.

Regarding the legal framework for scientific and research in RS, the following legislation is in place: the BiH Framework Law on Scientific and Research Activity and Coordination of National and International Scientific and Research Cooperation (Official Gazette of BIH, No. 43/09), the Law on Scientific and Research Activity and the Law on Amendments to the Law on Scientific and Research Activity (Official Gazette of RS, Nos. 79/07, 112/07 and 13/10) as the general political framework for research organisations, institutions and financial support, as well the following rulebooks:

- Rulebook on Editing and Publication of Scientific Publications
- Rulebook on Quality Control and Efficiency of Institutes
- Criteria for Promotion to Academic Titles
- Rulebook on Criteria and Benchmarks for Implementation and Funding of Programmes (Rulebook, Amendments to the Rulebook)
- Rulebook on the Procedure and Criteria for Financial Support to the Projects for the Development of Technology, Procurement of Equipment and Participation at Academic Meetings on Technology Development
- Rulebook on the Procedure and Criteria for Financial Support to Innovativeness in Republika Srpska (Rulebook, Amendments to the Rulebook)
- Rulebook on Co-funding of Scientific and Research Projects (Rulebook, Amendments to the Rulebook)
- Rulebook on Scientific and Artistic Areas, Fields and Branches
- Rulebook on the Procedure and Criteria for Financial Support to Projects for Development of Technology, Procurement of Equipment and Participation at Academic Meetings on Technology Development
- Rulebook on Training of Young People in Research

The Ministry of Education and Culture of RS is responsible, within the area of higher education, for:

- funding, coordination and development of higher education in Republika Srpska;
- proposing a higher education policy to the Government;
- promotion of integration of teaching and research activities and stimulation of research programme in universities and high schools;
- promotion of student and teaching staff mobility and ensuring student and teaching staff mobility within Republika Srpska, Bosnia and Herzegovina, within the European Higher Education Area and in the world;
- promotion and ensuring links between higher education institutions in Republika Srpska, BiH and higher education institutions in the region and the world;

- promotion of and legal possibility for equal access to higher education, professional development and training, lifelong learning, and all other aspects of higher education in Republika Srpska;
- support for and encouragement of stronger ties among higher education sector, industry, economy and society;
- implementation of supervision over the procedure for accreditation, licensing and quality assessment of higher education institutions in Republika Srpska;
- licensing higher education institutions;
- keeping a register of higher education institutions and study programmes and other information of importance for the development of the higher education system;
- prescribing forms and content of public documents;
- keeping a register of teachers and assistants; and
- keeping a register on recognition of foreign diplomas.

In the **Brcko District**, the Department of Education does not have a position for research and development activities. Since the Brcko District is defined in the Constitution as a separate local community, and that it has the full responsibility in education system like the two entities, this virtually means that the District is formally and legally included in all processes and activities in the area of science and research in BIH.

It is planned under the Strategy for the Development of the Brcko District to establish a university and scientific institutes. In this regard, the Department for Education proposed the Higher Education Bill, which the District's Assembly passed into law (Official Gazette of the Brcko District of BiH, No. 17/08). The Department developed a draft programme for higher education which envisages the establishment of a Public University and a subdivision for higher education and science. At the same time, the Brcko District is involved in all activities related to higher education in BIH and the creation of preconditions for a smooth involvement of the Brcko District University, including the envisaged scientific and research institutes, into the higher education system of BIH.

8.1.2 Statistical system of BiH

There are three Institutes for Statistics in BIH. Under the Law on Statistics of BIH (Official Gazette of BiH, Nos. 42/2004, 46/2004), the institutions responsible for organising, compiling and distributing statistics are: the Agency for Statistics of BIH at the BIH level and for the Brcko District (BHAS); the Federation Institute for Statistics; and the Institute for Statistics of Republika Srpska. In addition to the Agency and two entity institutes for statistics, the Central Bank of BIH (CBBIH) collects monetary and financial statistics and statistics on balance of payments.

Under the Law on Statistics of Republika Srpska, the **Institute for Statistics of Republika Srpska** is responsible for defining a methodology and standards for the implementation of the programme at the level of Republika Srpska. The Law stipulates that uniform methodologies and statistics standards, harmonised with the standards of BiH and those of the European Commission, will be used in producing statistics.

The Institute for Statistics of Republika Srpska and the Federation Institute for Statistics and the Brcko District are obliged under the entity laws to submit data to the Agency for Statistics of BIH for the purpose of implementing the statistics programme of BIH and in accordance with Agency requirements.

In Republika Srpska, the Institute for Statistics produces and disseminates data for RS. The Institute defines statistical methodologies and standards for the implementation of statistics programmes which are harmonised with the statistics standards of BIH and international standards, mainly those of UN/ECE and EUROSTAT.

A statistics programme is adopted annually by the Republika Srpska National Assembly, at the proposal of the Republika Srpska Government, for a four-year period. An annual workplan is similarly adopted by the Government, following a proposal from the RS Institute for Statistics.

Under the Law on Statistics in the Federation of Bosnia and Herzegovina (Official Gazette of FBiH, No. 63/2003), the **Federation Institute for Statistics** is responsible for statistics. Under this Law the Federation Institute for Statistics organises and conducts statistical surveys for the Federation of BIH.

The Federation Institute for Statistics has its organisational units for statistics in the cantons, which collect the necessary data from the cantonal administration units and other institutions, and also from the city and municipal administration departments and all other legal entities and individuals designated by the Law and other pieces of legislation as reporting units.

In carrying out duties related to the organisation and implementation of statistical surveys, the Federation Institute for Statistics:

- Prepares proposals for the implementation of statistical surveys;
- Prepares proposal for the Programme, in cooperation with other authorised organisations for statistics;
- Establishes a uniform survey methodology in accordance with internationally recognised standards;
- Collects, controls, processes, analyses and interprets statistical data and releases the results of the survey;
- Organises and ensures the release and exchange of the statistical data with other institutions and users of the data;
- Supervises the fulfilment of the obligations of the reporting units defined in the Programme; and
- Develops data protection techniques and methods.

Cooperation between the entity institutes and the Agency for Statistics is defined in Article 18 of the Law on Statistics of BIH and the Agreement on the Application of Uniform Methodologies and Standards in developing statistics of BIH, while cooperation between the Agency and the Central Bank of BIH is regulated by the Memorandum of Understanding between the Agency and the Central Bank of Bosnia and Herzegovina.

The Agency for Statistics of BIH - a professionally independent institution reporting to the Council of Ministers of BIH - collects, processes and distributes statistical data in accordance with internationally recognised standards, on the basis of the data provided by the entity institutes for statistics and the data the Agency collects directly. The Agency coordinates the implementation of statistical activities planned in the statistical programme of BIH and the annual work plan of BIH. It is responsible also for all statistical activities of the Brcko District and for international representation and cooperation. Of particular importance for the Agency are the rules and procedures of international statistical institutions (UNECE, IMF, OECD) and the EU Commission (EUROSTAT), which define the majority of international requirements in the form of infrastructural tasks, development of strategies for the implementation of principles, best practice and the methodologies and standards.

One of the basic tasks of the Agency for Statistics is the preparation of a four-year statistical programme and annual work plans. The Agency drafts a programme following consultations with the entity-level institutes and sends it to the Council for Statistics for consideration. The statistical programme is adopted by the Council of Ministers. This is a means of coordination of statistical institutions and other producers of statistics and for harmonising statistical standards and methodologies with international requirements (e.g. EUROSTAT and the UN Economic Commission for Europe). There are also statistical programmes at the entity level. They are adopted by the entity-level legislative bodies, the RS National Assembly and the Federation Parliament.

The statistical programme of Bosnia and Herzegovina 2009-2012 is the second statistical programme of BIH. The first programme was for the period 2005-2008. During that period, a number of new international statistical methodologies, standards, practices, EU regulations and recommendations were adopted. The activities detailed in the statistical programme 2009-2012 are defined as results which constitute relevant information for various groups of users, information on periodicals and the level of dissemination. The 2009 Work Plan of the Agency for Statistics was made on the basis of the Law on Statistics of BIH, the statistical programme of BIH for 2009-2012, the Medium-term Development Strategy of BIH, the Strategy for Integration of BIH into the European Union, the Statistical Requirements Compendium and other relevant regulations and recommendations of the EU and UN. The priority tasks and activities included in the workplan are mandatory for all three statistical institutions.

Nomenclatures/classifications relevant for STI statistics

The **Nomenclature of Industrial Products of BIH, 2005** is a standard used for grouping and assorting industrial products in the area of business statistics, primarily in the industrial production statistics. The Nomenclature of Industrial Products directly relies on the relevant European Union standards regulating this area. The Nomenclature is used in regular annual and monthly surveys of industries, the basic aim of which is a quality statistical monitoring of changes in industrial production. The 2005 BIH Nomenclature was prepared in full cooperation among all three statistical institutions in BIH.

The classification of activities of BiH represents the general statistical standard which is made by the Agency for Statistics of BIH under Article 6 of the Law on the Classification of Activities in Bosnia and Herzegovina. All amendments to and modifications and reviews of the Classification are proposed by the Agency for Statistics, in cooperation with the entity institutes.

The classification is a fully transposed statistical classification of economic activities of the European Union, NACE Rev. 1.1., which is only additionally elaborated down to the level of sub-class. The sub-classes reflect the specific features of BiH, especially its two entities and the Brcko District.

With the EU introducing a new Classification of Activities, NACE Rev. 2, in 2008 and since every review of the Classification of Economic Activities in the EU entails amendments to the Classification of Activities of BIH, the Law on the Amendments to the Law on Classification of Activities enables the adoption of a Decision on New Classification of Activities, based on NACE Rev. 2., which will apply as from January 1, 2011.

The International Standard Classification of Education (ISCED 97) is followed for presenting data on education This classification enables comparison of education sector data at the international level. It has not yet been officially translated or approved at the level of BIH.

In the RS, data on primary education has been presented since 2000/2001 under the ISCED levels; on secondary education since 2001/2002, and higher education data will be presented under the ISCED subject areas of education as from the school year 2010/2011.

Publications of statistical institutions relevant for STI statistics

The Labour Force Survey (LFS) is the survey which collects the data on the basic characteristics of the economically active population, on the basis of which an estimate is made of the overall labour force of a country.

The LFS has been undertaken every year since 2006. This is a joint exercise implemented by all three statistical institutions and is part of the annual workplans of the statistical institutions. The LFS methodology is based on the recommendations and definitions of the International Labour Organisation (ILO) and EUROSTAT, which ensures the international benchmarking of data in the area of labour statistics.

The Bulletin "National Accounts – Gross Domestic Product for Bosnia and Herzegovina" is published by the Agency for Statistics of BIH, in cooperation with the entity institutes and the Brcko District. GDP is calculated based on the methodology of the United Nations System of National Accounts and the European System of National Accounts.

The entity statistical institutes issue every year education statistics bulletins, including the **Higher Education Statistics Bulletin**. The higher education bulletin contains data on enrolled students, graduates, M.Sc./MA holders, specialists and Ph.D. holders, and teachers and assistants in higher education institutions. Depending on whether particular universities are integrated or not, reliability of data on the actual number of teachers and assistants is open to question.

8.1.3 The R&D monitoring system in BiH

As mentioned above the statistical activities in BIH are coordinated at the state and entity levels. The institutions involved in statistics have different responsibilities. However, no statistical organisation implements a continued and systematic collection of data on STI activities.

The Federation Institute for Statistics established in 2005 a new system of collecting data in the area of research and experimental development in the Federation of BIH, within which methodological manuals and forms were developed in accordance with the OECD Proposed Standard Practice for Surveys on Research and Experimental Development.

The Federation Office for Statistics improved and printed in 2008[62] the following documentation:

- Methodological Manual for R&D Statistics, December 2008.;
- Questionnaire with the collected data forms / R&D report:
  - Report on R&D in business enterprise sector /R&D – 1/
  - Report on R&D in public sector (R&D – 2) and
  - Report on R&D in higher education sector (R&D – 3/.
- Addenda to the forms:
  - Addendum I. Classifications of socio-economic goals
  - Addendum II. Classifications of specially formed groups of activities
  - Addendum III. Classifications of scientific fields and branches.

The primary goal of the data collection is to consolidate and publish R&D data in the Federation of BIH on:

- R&D potential
  - Number of economic operators involved in this activity;
  - Employees;
  - Financial resources/sources of revenues and expenditures;
- Results of R&D activities:
  - Implemented activities (projects, publications),
  - Data on patents and innovations.

[62] Based on the draft document of the Federation Institute for Statistics: R&D Methodology, 2008

The reporting units are divided into three fields:

- Business sector/economy - includes all economic operators the principal activity of which is production and/or sale of products and/or services, which are at the same time involved in the R&D performance. State companies belong to this sector.
- Government sector – includes public research institutes, registered as research legal entities under the Federation and Cantonal Ministry of Science and Education, and those which are not in the register, like health and other state institutions performing R&D.
- Higher education institutions – this sector includes university schools, i.e. all legal entities established under the Law on Higher Education in the cantons of the Federation of BIH, involved in R&D performance.

With a view to ensuring international data comparability the R&D survey follows the three classifications of the Frascati Manual (OECD, 1993), namely:

- **Classification of socio-economic goals**

  The Frascati Manual presents the distribution of R&D costs by purpose – socio-economic goal/goals of anticipated funds – as developed by OECD (13 categories are used in the Tables).

- **Classification of specially formed groups of activities**

  This classification is developed in accordance with the guidelines presented in the Manual, which represent the basic methodological material for data collection in the area of research and experimental development. Classification is based on the Standard Classification of Activities in BIH, under Article 6 of the Law on the Classification of Activities in Bosnia and Herzegovina (Official Gazette of BiH, No. 76/06). The title of "specially formed" groups is appropriate as some of the parts, groups and categories are grouped together, in accordance with Frascati Manual guidance. The classification consists of three columns. The first represents the alphabetic mark of each of the specially formed groups of activities, mentioned in a questionnaire, a second column contains a narrative description, and the third contains the code of sections, groups and a class of the Standard Classification, which are united.

- **Classification of scientific fields and branches**

  The Frascati Manual recommends the use of scientific fields and branches prescribed by UNESCO. As the results of statistical analyses in the area of research and experimental development are also used for reporting purposes as part of international questionnaires which use the UNESCO classification, they are used in this survey in order for the results to be presented in an adequate way.

Organisation of R&D survey

Questionnaires, which represent the basic instrument for R&D data collection, have been prepared by the Educational Survey and Development of Social Policy, Culture, Justice and the Department for Voter Statistics.

The questionnaires are designed on the basis of the recommendations from the Frascati Manual, other country experiences and consultations with the officials from the Federation Ministry of Education and Science.

A separate address-book, which contains the addresses of legal entities/businesses, institutions and organisations in the Federation involved in R&D activities, has been developed for the purpose of questionnaire distribution. The address book has been amended in two ways:

1. In the previously established four-year intervals, respondents which met the criteria for the purpose of the R&D survey were taken from the business register, while addresses and other information were verified after the questionnaires were returned to the Federation Office for Statistics.
2. The other way of amending the register is to include legal entities, already entered in the Register of the Federation Ministry of Education and Science, and those entities which are entered in the business register, field K, part 73/Research and Development, and also to use the information from other sources.

Together with the questionnaires and instructions on how to complete, classifications used in the survey are also sent to the legal entities recorded in the register.

Processing of survey data and release of results

Statistical processing of collected data/reports consists of numerical connections and control of logical connections among individual responses contained in every questionnaire. After questionnaires are verified, they are stored on a magnetic storage device and prepared for conversion into tables and released as survey results in the form of publications, communications and bulletins, and also on the web site of the Federation Office for Statistics. There is an obligation under the RS Statistical Programme 2009-2013 to collect science and technology data.

The Republika Srpska Council for Statistics, in cooperation with the Ministry of Science and technology has plans for the implementation of a pilot survey on R&D. The scope of the activity is R&D in businesses, universities, research institutes and non-profit organisations with the goal to obtain the data on individuals engaged in R&D (presented as the number of individuals and as full-time equivalent), sources of funds, the number of research papers by field of science, published scientific and professional articles and monograph and patents in high, medium-high, medium-low and low technologies. Data collection will be based on the following reports:

a. Annual report on R&D for businesses/R&D-1 which is completed by all businesses, as well as the centres of exceptional value: centres for technology transfer, innovation centres, business and technological incubators and science and technology parks;

b. Annual report on R&D for higher education institutions/R&D-2 which is completed by all higher education institutions, scientific and research and development institutes; and

c. Annual report on R&D in the government sector and non-profit organisations/R&D-3, which is filled out by the government sector and non-profit organisations.

The Instruction for completing report forms contains the Classification of Scientific Areas and Fields, Classification of Activities, Classification of Industries by R&D Intensity, and Classification of Social and Economic Goals, in accordance with OECD methodology.

8.1.4 Innovation Monitoring System in BiH

The RS Institute for Statistics, in cooperation with the RS Ministry of Science and Technology, has so far been the only institute that has released data on innovation activities. The data, obtained through a pilot survey, refers to RS-based enterprises for the period 2006-2008. The survey provided results on product innovation and process innovation activities of enterprise, and on organisation and marketing innovations. Most of the data refers to new or significantly improved products and services and their application, the application of new or significantly improved processes, and logistics and manner of distribution. Results showed that 33% of enterprises introduced product innovation, 41% process innovation, 31% organisational innovation, and 32% of enterprises introduced marketing innovation. The highest innovation intensity was achieved in process innovation, in large enterprises (73%), medium-sized (42%) and small enterprises (29%).[63]

To date, the Federation Institute for Statistics has not conducted any survey in the area of enterprise innovation.

8.1.5 Patents in BiH

The following institutes exist within the innovation system of BIH:

- Institute for Intellectual Property of Bosnia and Herzegovina
- Institute for Standardisation of Bosnia and Herzegovina (BAS)
- Institute for Metrology of Bosnia and Herzegovina.

The Institute for Intellectual Property of BiH is a state-level institution responsible for all activities related to patent activities at the level of BIH and for cooperation with international patent organisations (WIPO, EPO, etc.), and also for patent data collection and processing.

In 2003, BIH signed a cooperation agreement with EPO, which enabled the expansion of the European patent applications and patents into BiH. The European patent applications and patents thereby become protected in BIH as patents which belong to EPO and its 30 member states."

[63] http://www.rzs.rs.ba/ObjavljenoRanije_ENG.html

As Table 10 shows the number of applications for protection of patent rights and patents granted protection has recently reduced.

Table 10 Number of patents and granted patents in a period 2005 - 2007

Overall data	2005	2006	2007
Number of patent applications	372	217	92
Number of resident patent grants	55	76	70
Number of European patent grants with extension of protection to BIH			160

The largest number of patents applied are those from the pharmaceutical and cosmetic industries, followed by the chemical industry, bio-technology and medical engineering. These related industries account for over three quarters of all patent filings. Other important technological fields are civil engineering, architecture and mining, and service users and equipment.

MoCA has been supporting innovators since 2007 under the "Support for Innovation and Technical Culture in BIH" programme. Funds are allocated through public competition. In 2009, a total of €0.07 million was allocated. RS also allocates budget funds for technological development which includes innovators, meetings and projects for the development of new technologies and the information society. The total budget for 2008 was €0.65 million, broken-down as follows: public call to innovators (€0.04 million or 6.3% of the total budget), development of new technologies (€0.60 million or 86.3% of the total budget) and development of the information society (€0.05 million or 7.4% of the total budget).

The Federation Ministry of Education and Science has also been supporting innovators, innovativeness and technical culture, and the introduction and development of new technologies over many years. Support is implemented through a public call. In the course of 2009, around €0.05 million was allocated for these purposes.

The currently available data on patents for BIH under the WPO database are as follows:

Table 11 WIPO Patent statistics for BiH, currently available

Indicators	**Country**
Patent application filings	**Available for BiH**
Total number of patent applications (1985-2007) By resident and non-resident	No! Data summary for all countries of the world TOTAL number
Patent application by patent office (1883-2008) By resident and non-resident	Yes
Patent applications by country of origin and by office (1995-2008)	Yes
Patent applications by office and filing route (1995-2008) By direct filing and PCT national phase of entry	Yes
Patent families by country of origin (1990-2006)	No
Foreign-oriented patent families by country of origin (2001-2006)	Yes
Patent application by field of technology (2002-2006) Summary data	No
Patent applications by field of technology (2002-2006 average) By leading country	No Only leading countries of the world
Patents granted	**BiH**
Total number of patent grants (1985-2007) By resident and non-resident	No Only the data collected globally
Patent grants by patent office (1883-2008) By resident and non-resident	Yes
Patent grants by country of origin and by office (1995-2008)	Yes
Patents in office	**BiH**
Patents in office by patent office (2004-2008)	Yes
Patents in office by patent office and year of filing (1998-2008)	Yes
Patent intensity	**BiH**
Resident patent filings per $billion gross domestic product (1995-2007)	Yes
Resident patent filings per million population (1995-2007)	Yes
Resident patent filings per $million research & development (R&D) expenditure (1997-2007)	No

Source: WIPO Statistical Database

8.1.6 Technology Balance of Payments in BiH

In BIH, for the time being, neither the Institutes for Statistics nor the Central Bank of BIH collects data on the technology balance of payments.

8.1.7 International quality certification in BiH

The Institute for Standardisation of Bosnia and Herzegovina (BAS) proposes a strategy for standardisation in BIH, prepares and publishes standards, represents BIH internationally, collects and disseminates information on standards and standardisation, and also grants applications and maintains databases on quality certificates. Over the last decade, the number of certificates has rapidly increased as the following tables indicate.

Table 12 ISO 9001

BIH	Dec 2001	Dec 2002	Dec 2003	Dec 2004	Dec 2005	Dec 2006	Dec 2007
	1	8	47	209	350	242	652

Source: The ISO Survey of Certifications 2007, www.iso.org

Table 13 ISO 14001

BIH	Dec 2002	Dec 2003	Dec 2004	Dec 2005	Dec 2006	Dec 2007
	1	3	10	22	17	44

Source: The ISO Survey of Certifications 2007, www.iso.org

8.1.8 Reporting to international agencies

Under Article 8 of the Law on Statistics of Bosnia and Herzegovina, the Agency for Statistics of BIH represents the country internationally and maintains cooperation with the relevant international organisations and agencies.

Under the EU Stabilisation and Association Agreement (BIH is a potential candidate for accession to the EU), cooperation established in the area of statistics with EUROSTAT needs to be primarily directed to developing an efficient and sustainable statistical system which will ensure comparable, reliable, objective and accurate data necessary for planning and monitoring of the process of transition and reform in BIH. This will include the introduction and strengthening of statistical methodologies, classification and standards.

The Agency for Statistics of BIH submits certain data from some areas to EUROSTAT. It is expected that the importance of this activity will increase over time and that BIH's international obligations will also increase. BIH can not yet report to EUROSTAT on R&D as an R&D monitoring system has yet to be established.

8.2 Comparative analysis of STI statistics in BIH: Conclusions

Comparison of international STI statistics, outlined in Part One (Chapters 2-7) with the situation in BIH, provided in Part Two, shows the following:

1. BIH accepted the international standards in STI statistics by adopting the EU CRS – Statistical Requirements Compendium.[64] The requirements for the fields of science and technology are defined in the following modules: 5.06.01 Statistics of Science and technology, and 5.06.02 Statistics of Innovations. This formal acceptance still needs to be translated into a clear sequence of actions and decisions which will help establish the EU compatible system of STI statistics.

2. In order to ensure R&D personnel data quality and international comparability of R&D data, BIH regulated through the Framework Law on Foundations of Scientific and Research Activity and Coordination of National and International Scientific and Research Cooperation of BIH the adoption of an instruction on methodological frames and principles for the development of the Rulebook on the Classification of Scientific Areas, Fields and Branches; the Rulebook on the Minimum Requirements for Promotion to Academic Titles; and the Rulebook on the Minimum Requirements for the Performance of Scientific and Technological Activity and Pursuit of Scientific and Research Activity.

   The entities, cantons and the Brcko District of Bosnia and Herzegovina are obliged, under the instructions and the methodological frames and principles, to make their own rulebooks on the classification of scientific areas, fields and branches, the rulebook on the minimum requirements for promotion to academic titles, and the rulebook on the minimum requirements for the performance of scientific and technological activity and pursuit of scientific and research activity.

3. The official business register, which the statistical institutes will create for statistical purposes, should be based primarily on data from company filed tax reports on financial operations in the previous fiscal tax year. Those enterprises which report on expenditure for science, research and development activities and the appropriate forms of non-financial investments should be selected for the STI register.

4. A pilot R&D survey was conducted in the Federation of BIH. In the RS, a pilot R&D survey is currently underway. An innovation survey has so far been conducted only in the RS.

5. In 2005, the Federation Institute for Statistics developed a new system of R&D data collection in the Federation and produced a methodological instruction and forms, harmonised with OECD's "General Guidelines for Research and Development Survey". In 2008, the Federation Institute for Statistics amended and printed a Methodological Instruction for Research and Development Statistics (December 2008), and a Questionnaire with Forms for Data Collection and R&D Reports.

   The RS Ministry of Science and Technology and the RS Institute for Statistics launched in the early 2010 a project for development of annual research and

[64] See http://www.bhas.ba/Arhiva/Compendium2009.pdf

development reports in the RS for: businesses, research and development institutes, and non-profit organisations and associations.

The Institute for Statistics, in cooperation with the Ministry of Science and Technology, disseminated data on enterprise innovation activities for the period 2006-2008. The data was obtained through the pilot survey.

6. It is necessary to harmonise the existing R&D questionnaire applicable in the Federation of BIH with the amendments to the EUROSTAT's Frascati Manual 2002, including the FOS 2007 and other relevant international statistical classifications. In the RS, a pilot project with questionnaires developed in accordance with international standards, is being implemented in 2010. At the same time, it is necessary to harmonise the questionnaire in both entities in order to ensure internationally comparable R&D data.

7. Innovation data collection should be fully harmonised with the official innovation survey which EUROSTAT defines for the EU Member States, the Community Innovation Survey (CIS). This implies: enterprise coverage to be included in the survey, the set of questions to cover all forms of innovation activities and the accompanying phenomena which are also surveyed (obstacles to innovations, sources of information on innovation, innovations in specific areas, etc.) as well as the period for which the enterprises report on completed innovation activities.

8. In July 2009, BIH adopted the Strategy for Development of the Institute for Intellectual Property 2008-2015. As part of the Strategy implementation, harmonisation with the regulation of the European Patent Office (EPO) is necessary.

9. As of now, there is no quality data on the mobility or careers of doctorate holders (CHB) in BIH. It is necessary to launch a pilot survey. The goal of the survey should be to collect statistics on the level of education, work experience and mobility of doctorate holders in order to obtain internationally comparable indicators on the basis of the joint, harmonised methodology. The survey's focus should be on persons with a Ph.D. degree obtained anywhere in the world.

10. Statistics under the Canberra Manual is not yet applied in BIH, although there is sufficient basis for the data to be collected, and to launch a pilot survey. Much of the data required is already available from existing sources.

11. It is necessary to prepare for the development of a methodology in BIH for high-tech statistics which includes: defining a "high-tech sector" on the basis of the NACE classification, of the Classification of Activities in BIH; defining "high-tech products" on the basis of SIT/ national classification of industrial products; and defining "high-tech patents" on the basis of IPO.

    These statistics can and should be prepared from the following sources which are not yet fully available:

    a. Foreign Trade Statistics
    a. R&D – Research and Development statistics
    b. CIS – Innovation Statistics
    c. LFS – Labour Force Survey
    d. HRST – Human Resources in S&T
    e. SBS – Structural Business Statistics
    f. PATENT – Patent Statistics.

12. As of now, in BIH, there are no annual reports on R&D or innovation, as a crucial element of STI policy. Such reports could be prepared when R&D and innovation data becomes available. The ISO 9001 and 14000 certificates should be included in the context of quality, and the available patents in the context of inventive activity.
13. BIH has not yet begun to collect data on budget appropriations for R&D. It is necessary to launch a GBAORD survey (GBAORD - General Budget Appropriations and Outlays for R&D) based on EUROSTAT's Frascati Manual 2002. This exercise needs to be undertaken in cooperation with national experts from the BIH Ministry of Civil Affairs, the RS Ministry of Science and Technology, the Federation Ministry of Science, Cantonal Ministries of Science, the BIH Agency for Statistics, the Federation and the Republika Srpska Institutes for Statistics and international experts. It should define the relevant standard for GBAORD statistics which would include the survey plan, methodology, classification of the fields of science/the rulebook on scientific and artistic areas, fields and branches.
14. It is necessary to develop a project for technology balance of payments statistics, which is defined on the basis of the statistical data already collected from other relevant statistics, such as import, export and production statistics.
15. It is necessary to ensure access to the sources of data relevant for bibliometric indicators available in the Web of Science and SCOPUS databases, as well as access to and analysis of COBISS publications. There is also a need for a project for the development of bibliometric indicators for BIH.

Part Three – Statistical instruments and tools

9. Methodological instructions for statistical surveys

9.1 Statistical survey

9.1.1 General

After the first years of experimental R&D/S&T data collection most countries now have well-established survey routines. Many methods are still country-specific and conditioned by the size of country, the statistical population and the volume of information requested.

Whereas "full surveys" may be possible in smaller countries, larger surveys necessarily have to use various kinds of sample approaches (not only for R&D/S&T but in general) with the sample figures grossed-up to total size. Much information is derived from desk-work and analysis of administrative records or financial accounts. This is in particularly true for the R&D data of the higher-education sector.

9.1.2 Development and adoption of questionnaires

Questionnaires for the collection of data on science and technology (S&T) and research and development (R&D) and innovation activities (IA) in BIH should be developed in accordance with the following principles and requirements:

- Questionnaires represent direct and full implementation of the OECD/EU methodological instructions, manuals and standards, which define the collection and use of the data on S&T, R&D and IA.
- Questions and other requirements for the collection of data which arise from the above requirement constitute the main part of the questionnaire;
- The specific features of S&T, R&D and IA, as a consequence of the organisation of the state, level of development of economy and society as a whole, and especially the S&T and R&D system, and thereby the national innovation system, as well as other factors, can and should be included in the questionnaires used to collect the data on S&T, R&D and IA.

- The way in which these questions are included should comply with the following:

  a) no contradiction to the main part of the questionnaire.
  b) any additional question(s) has to be based on the applicable law(s), or political decisions regulating the S&T and R&D system and the national innovation system. Thereby a pre-defined scope and form of analysis, presentations and purposes for which the indicators to be generated on the basis of the data collected will be used. The questions and other requirements for data collection arising from this requirement constitute a supplement questionnaire.

- Data collection and the completion of a questionnaire are undertaken by a number of persons from the organisations included in the survey.
- The survey has to be designed in a way which will ensure separation of some sections completed by different people who are responsible for various duties and activities in the organisation. This ensures high quality, accuracy and complete answers, leading to higher numbers and faster returns of the completed questionnaire.
- The questionnaire has to be fully supported with detailed instructions for completion.
- Due to a relatively low level of knowledge of some terms, it is necessary to include in the questionnaire all the necessary definitions, next to the term where it appears for the first time.
- The questionnaire should be written in a language(s) which is in official use and in the style which is clear to an average level of education of the employees who will complete the questionnaire.
- If necessary, the questionnaire should be prepared in a multi-language form, using the commonly used terms.

In addition to the above requirements, attention should be given also to what already exists elsewhere (e.g. Croatia and Serbia) and in the country, including:

The Federation Institute for Statistics

1. Report on Research and Development in Business Sector /R&D-1
2. Report on R&D in Public Sector /R&D-2
3. Report on R&D in Higher Education Sector /R&D-3

Republika Srpska Institute for Statistics

1. Innovation Activities in Enterprises /INOV
2. Annual Report on R&D of Businesses /R&D-1
3. Annual Report on R&D in Higher Education Institutions /R&D-2
4. Annual Report on Research and Development in the Government Public Sector and Non-Profit organisations /R&D-3

It is necessary to develop questionnaires for harmonised S&T, R&D and IA data collection in all constituent parts of BIH on the basis of the existing statistical instruments and those developed in Croatia and Serbia, in accordance with EUROSTAT standards. Prior to the launch of the surveys, the following good practice rules should be respected:

- Every questionnaire needs to be tested prior to its official use. Testing includes interviews with experts and managers to examine how they understand some questions and sending a questionnaire to a smaller group of organisations for test survey. The answers provided and findings should serve for improving the quality of the final form of the questionnaire.
- Questionnaires should be as simple and short as possible, logically structured, with clear definitions and instructions.
- Most often, the length of a questionnaire and the completion rate are in inverse proportion. This effect can be minimised if more attention is paid to the design and form of the questionnaire, if clear and sufficiently comprehensive instructions and examples are given, and if the questions are appropriately sequenced.
- Special attention should be given to qualitative statements.
- The use of the binary yes/no responses should be avoided; instead, ordinal scales ranking the factors by importance should be introduced wherever possible.
- Foreign terms should be translated in the basic part of the questionnaire; also, the design of a questionnaire should not allow any deviations from international standards.
- Translation should not lead to a situation in which it is not possible to compare the data obtained with the same category of data collected by EUROSTAT for other countries.
- Shortened versions of a questionnaire should be used for smaller reporting units, especially in the case of innovation activities.
- Small reporting units can be discouraged from completing comprehensive, long questionnaires, which is particularly true for the innovation survey. In such cases, shortened versions of a questionnaire should be used, under the EUROSTAT instructions.

As European statistics places an ever stronger emphasis on quality, the producers of official statistics have to show that high quality standards have been applied and achieved during the implementation of statistical processes.

There are two documents which national statistical institutes can use in developing quality reports:

a) ESS Standard for Quality Reports, and ESS Handbook for Quality Reports, from 2009.

The purpose is to harmonise report quality among the EU Member States and to facilitate benchmarking of processes and outputs.

9.1.3 Operation of Surveys

Working with statistical offices

- Dilemma: Web-based R&D survey and innovation survey vs. paper-based R&D survey and innovation survey
- Predefinition of analysis and indicators which should be generated by the surveys
- Coordination of activities by the Statistical Agency of BiH
- Finalisation of questionnaires
- Programming and organising IT support
- Preparing list of surveying organisations
- Preparing the surveying organisations for upcoming activities
- Training of staff in statistical units
- Organisation of dissemination of surveys' results, findings and recommendations

Working with authorities:

- Main preconditions in order to adopt R&D survey and Innovation survey (description of importance, effects, ...)
- Political will/approval
- Financial resources available

Working with respondents:

- Encouraging co-operation: The survey questionnaire must include a minimum number of basic questions on R&D activity in order to produce harmonised and comparable statistics for transmission to international organisations. Owing to the response burden, the questionnaire should be as simple and short as possible, logically structured and have clear definitions and instructions. Generally, the longer the questionnaire, the lower the unit and item response rates. For smaller units, a simplified survey questionnaire could be used. It is highly recommended to test draft questionnaires on a sample of respondents. Work has started to develop a harmonised OECD questionnaire for R&D surveys in the business enterprise sector.
- Training of responsible persons in surveying organisations: once the survey respondent has been identified, it is necessary to identify the best person to complete the questionnaire. In R&D surveys, he/she is usually in the accounting or personnel unit or in the R&D unit. Each has advantages and disadvantages. The R&D manager can better identify the R&D of the unit according to Frascati Manual norms but may not be able to supply exact figures. The accountant or personnel manager has some exact figures that may not exactly correspond to R&D as defined in the Frascati Manual. In

bigger units, the co-operation of all three types of respondents is essential. Nevertheless, one person must co-ordinate the response. It is often useful to send the questionnaire to the person who responded the previous year. If this is not known, surveys should be addressed to the managing director. In big, complex institutions like universities and large enterprises or groups of enterprises, it is useful to identify in advance the person responsible for providing information and for co-ordinating information from smaller sub-units.

- It is very important to secure the co-operation of the person in charge of responding. Respondents are asked to spend time on a task which is often of no direct benefit to them; they may even see completing a questionnaire on R&D as a waste of time and money. It is the responsibility of the surveying agency to help contributors to appreciate the potential uses of the data and to be alert to respondents' potential needs in terms of R&D statistics. It is also its responsibility to respect data confidentiality and to ensure that users are aware of respondents' concerns. In the design of surveys, it should consider the need to minimise the burden on respondents.
- The respondent is rarely a user of statistics, but it is important to show what has been done with the data in order to encourage co-operation. The respondent should receive the publication, or, if this is not feasible, a summary. Customised information which allows the respondent to compare his/her unit with corresponding national totals may also be useful.
- The statistical agency should provide the respondent with support as required. The extent to which follow-up procedures are used will depend on the level and quality of responses, the number of units surveyed and the resources available to the surveying authority. It is rarely feasible to contact personally all the units surveyed. One possibility is to plan a follow-up programme for each enquiry, aiming to visit all the main units over a given period. Another is to limit the follow-up and to thoroughly check a few respondents. Personal contacts with respondents who require guidance or who submit unsatisfactory returns should be encouraged.
- Almost all respondents will have to make some estimates. Not only is R&D a complex activity in itself, it is inextricably linked to a number of other activities. Furthermore, an institution's R&D may not be satisfactorily reflected either in its organisation or in its records and accounts.
- R&D is not only what R&D laboratories and research institutes do. It is both less and more than this, since very few of the surveyed entities have only one activity. The measurement of R&D inputs may be carried out in three stages:
  - Identification of all specialised R&D units and measurement of their total activity.
  - Estimates of the non-R&D portions of their activity and subtraction of these estimates from the total.
  - Estimates of the inputs used for R&D in other units and addition of these estimates to the total.
- In practice, minor deviations from the strict R&D definition may be overlooked in order to better utilise existing records or to otherwise ease the burden on respondents. In some cases, particularly in the higher education sector, it may be necessary to resort to very crude ratios to estimate R&D inputs.

Operational criteria:

- Operational criteria that are suitable for the sector surveyed must be developed. Thus, on questionnaires intended for the business enterprise sector, it is appropriate to give guidance for distinguishing between R&D and pre-production, whereas a government questionnaire might concentrate on the difference between R&D, on the one hand, and data collection and information, on the other. Sector-specific examples can be useful to guide respondents. Reference might be made to detailed examples in this Manual. Responding units may need criteria for distinguishing between contracts to industry for goods and services required for intramural R&D and those awarded for the performance of industrial R&D. Criteria with the same intent but different wording may be useful in business enterprise surveys. Nor should differences within a sector be overlooked. For example, operational definitions and examples appropriate for the oil and gas industry are probably not well suited to the electrical products industry. In discussions with respondents, supplementary criteria are often useful.
- During R&D surveys, respondents may find it very difficult to apply the theoretical distinctions made in earlier chapters of this Manual to the wide range of projects under way in their organisation. As surveying agencies are not always able to check responses and are usually obliged to accept them as given, it is of utmost importance that they provide the institutions surveyed with clear explanations and guidance to complement the formal definitions in order to ensure uniformity.
- Four important tools for achieving this objective are:
  - Explanatory notes.
  - Hypothetical examples.
  - Guidance to individual respondents.
  - Documentation on treatment of different cases.
- For obvious reasons, this Manual deals exclusively with the first two tools. Formal definitions and theoretical distinctions have to be complemented by the last two. To ensure that the guidance given by surveying agencies is consistent, it is essential to develop documentation on how difficult borderline cases have been solved. Such documentation can also serve as a valuable source of hypothetical examples and may help countries to develop more uniform classification practices.

9.1.4 Frequency of national surveys

Practices vary between countries as to frequency of surveys. For international data collection the principal agencies used to recommend surveys every second year (using questionnaires) but these routines are now progressively replaced by "rolling" electronic reporting whenever complete or fractional data are available. Countries may wish to decide their own intervals between, for instance, full and/or intermediate surveys (not necessarily the same for all sectors).

9.1.5 The statistical population

A small country would for its Business Enterprises survey perhaps include all firms above the size of 50 employees, plus a sample (for example, 40%) of manufacturing and business services firms with 10 to 49 employees and a 10 per cent sample for other branches. These results will then be grossed up to "full size". Other criteria may be exploited, also to include some small and/or even very small firms in recognised "high-tech" branches, for instance, for having received R&D contracts from government or national research councils, etc.(also tax reliefs, procurements, etc).

9.1.6 The surveys and the questionnaires

One or two of the smaller OECD countries manage to use one common questionnaire for all four sectors of performance (also requesting information on innovation activities). In a few Scandinavian countries two types of questionnaires are used, one for enterprises (notably in manufacturing) and the other for what is called the "institutes sector", covering units in all the four Frascati sectors of performance. Depending on the purpose of the operation, these data may then be redistributed, for instance, to fit the reporting to international agencies.

For the Government sector, more is now made of central administrative records, first to identify the R&D personnel and then to calculate the corresponding expenditure series.

There are few countries that have an identical (higher) education system and, furthermore, virtually no countries use the same methods for measuring and/or estimating its R&D activities (personnel and expenditure). Assessing these data is often a combination of surveys and desk work (estimates).

Some smaller countries use sophisticated "time-budget" surveys, addressed to all individual faculty members (registered in special files) or to a sample of faculty staff, requesting detailed information on how they spent their working time between a variety of professional activities (teaching, R&D and Administration, etc.) during a given period of time (a year, a "typical" week once or several times a year). Drawing on this information, special R&D ratios (or "coefficients") are calculated and used to estimate the full-time equivalents (FTE) for the human resources put into R&D. (A number of such methods were described in the 1989 supplement to the Frascati Manual and were subsequently either incorporated into its main text in 2002 or its current Annex 2 "Obtaining Data on R&D in the Higher Education Sector").

These "coefficients" are applied to different budget items in administrative and financial records and used to estimate a number of the variables of interest to the R&D statistics, such as categories of R&D personnel and types of costs including salaries, types of finance, with additional breakdowns by fields of science.

Other countries use more basic methods to estimate the R&D contents of total sector expenditure, frequently some "rule of thumb" approach ("fifty-fifty" R&D and education" or "one-third R&D, one-third education and one-third "other" (including administration, etc.) applied at aggregated levels of central administrative and financial data series.

9.1.7 Working with respondents

As for all kinds of statistical surveys, every effort should be made to stimulate respondents by ensuring they benefit from their participation in the exercise; if they make an effort to respond, they should also get some return back from their contribution. Besides some mandatory reporting to EUROSTAT, responding to national R&D surveys is still an informal exercise. To this end respondents should be clearly informed and participation kindly requested in a motivating cover letter, and be supplied with clear technical instructions to the uncomplicated questionnaire (including important detail on the confidentiality rules concerning treatment of their survey responses).

9.1.8 Estimates: Treatment of Non-response ("Nowcasting" and Forecasting)

For most kinds of data collection (R&D/S&T is not an exception) there is really nothing to replace a well-prepared survey, undertaken between competent statistical services and motivated respondents. Unfortunately, in the "real world" the situation is quite different and the data collectors are faced with sometimes high rates of non-response and either untimely or incomplete reporting.

Depending on the exercise, various kinds of estimation procedures are therefore needed to overcome the problems. Such estimation procedures, with particular reference to R&D/S&T, are discussed in section 7.5 of the Frascati Manual (chapter on survey methodology and procedures) and in its separate Annex 8 "Practical Methods of Providing Up-to-date Estimates and Projections of Resources Devoted to R&D".

Given the particular status of R&D measurement, due notably to the borderline issues (for both expenditures and personnel) between R&D proper and related S&T activities, even every-day reporting involves considerable elements of estimation, particularly on behalf of the respondents. This is the case for the treatment of the R&D share in total higher education sector resources that, to a large extent, is the result of complex "desk work". This is also true for the assessment of the R&D content in state budgets.

At the level of the statistical agency, there are standard estimation procedures to "gross-up" sample survey data to "total levels". The agencies equally have to "fill gaps" (due to non-response or incomplete reporting) in data received, for instance with a view to assessing (branch, sector, regional, national…) totals but also for making "nowcasts" to appraise the up-to-date status of some results of an urgent policy interest (remember that ex-post results are frequently not available until several years after the survey year ended, for R&D in enterprises' in particular).

There is also an increasing demand for "projections" of some data series for the private sector to "keep pace" with information on the public R&D trends revealed through GBAORD analysis. This is in relation to estimating future GERD and GERD/GDP data (information on the role of enterprises – BERD and BEMP - is crucial, given their weight in GERD in most OECD countries) and since this GERD/GDP indicator is important for all national and international S&T policies.

Estimation procedures vary from, on the one hand, very simple "informed guesses" ("guesstimates") based on extrapolation of previous survey results from the same respondent, copying information from similar categories of firms, exploiting various kinds of known growth-rates to very sophisticated econometric estimation methods particularly working with the OECD analytical databases for enterprises.

Several statistical agencies request information from enterprises on their projected R&D efforts (expenditures, personnel) over the next few years, in some cases limiting information requests to trends ("increasing", "unchanged", "decreasing"). Experience has shown that trends in the R&D personnel resources are easier to exploit for these projections than the corresponding, more unstable expenditure series.

It is important that the data issued should be properly annotated concerning their status (survey data, partly or fully estimated, provisional, etc.).

9.2 Calculation and/or estimation of a set of main R&D indicators for BIH in accordance with OECD and EUROSTAT standards

Estimates are a necessary supplement to surveys (respondents must often make estimates in order to provide the requested "survey" information). Using ratios derived from survey data, it is possible to provide adequate aggregate trends or totals from incomplete information without recourse to a costly survey. Indeed, the R&D inputs of the higher education sector are often partially, and in some countries wholly estimated. When statistics are released, full information on the sources and generation of the statistics should be provided.

9.2.1 Estimation procedures

In the process of compiling R&D statistics, various estimation procedures are used. Results from sample surveys have to be grossed up, using various methods, to correspond to the total target population. Especially in surveys of the business enterprise and government sectors, there are problems of unit and item non-response. In the higher education sector, statistics in most countries are based on a combination of surveys and estimation procedures.

9.2.2 Unit and item non-response

In practice, responses to R&D surveys are often incomplete, irrespective of the survey method used. Two types of missing values can be distinguished: item and unit non-responses. Unit non-response means that a reporting unit does not reply at all. The statistics agency/institute may not be able to reach the reporting unit or the reporting unit may refuse to answer. For item non-response, a unit does answer but leaves a question(s) unanswered.

Item and unit non-responses would be less of a problem if missing values were randomly distributed over all sampling units and all questions. In reality, however, both types of missing values are biased with respect to certain characteristics of the population and the questionnaire. Item non-response is more likely when the question is (or seems to be) difficult. Examples are the breakdown of R&D investments (land and buildings and equipment) or of R&D by type of R&D.

These non-responses clearly affect the comparability of the results of national and international R&D surveys. Appropriate methods to overcome this problem have to be developed. As different methods may lead to different results, some general recommendations should be followed. Otherwise, differences in results over time and/or among countries may arise from using different concepts to reduce the bias of item and unit non-responses.

For practical as well as theoretical reasons, one recommended way to overcome the problem of item non-response is a group of methods called “imputation methods” for estimating missing values on the basis of additional information. The easiest method is to use the previous answer for the same enterprise. Another possibility is to use statistical techniques such as “hot decking”, using information from the same survey, or “cold decking”, using information from previous surveys.

In the case of unit non-response, past R&D data at firm level can be used to estimate R&D expenditure for the same firm for the current period. The evolution of sales and or employment can be used to adapt the previous figures. In cases where no previous R&D data at firm level are available, as R&D is a metric variable correlated to a certain degree with sales, a recommended method is to use the relation between the sales of the total population and the sales of the realised sample for each cell in the sample. Another method is to use employment as a variable. This procedure is based on the assumption that the ratios of R&D to sales or R&D personnel to total personnel of responding and non-responding units are identical. This assumption can be tested through non-response analysis of a representative sample of non-responding units. Even if the assumption is wrong, the bias introduced can be disregarded as long as the fraction of non-responding units is fairly small.

9.2.3 Estimation procedures in the higher education sector

Often over half of the funding of R&D is given as general university funds, not earmarked for research but given for the general functioning of the university. The R&D share of these funds is often unknown to the universities themselves. To determine which part should be devoted to R&D, a variety of methods have been used:

- Central estimates not based on empirical knowledge of how time is spent on different activities.
- Time-use surveys/studies concerning the distribution of time by various categories of personnel.
- Time-use surveys/studies based on researchers’ own evaluation of their working time.

From the time-use studies, research coefficients are derived for use in calculating full-time equivalents on R&D (FTEs) and R&D labour costs. Other R&D costs should primarily be estimated on the basis of purpose. For example, the acquisition of research equipment and expenditures for a research laboratory should be put under research, while maintenance of teaching facilities should be put under teaching. For expenditures not clearly attributable to either research or teaching, an estimate can be made using the research coefficients as the basis of calculation.

9.2.4 Obtaining data on R&D in the Higher Education Sector

Obtaining data on R&D in the higher education sector presents special problems. The discussion mainly draws on methodological work from the middle of the 1980s which led to a special supplement to the fourth edition of the Frascati Manual (R&D Statistics and Output Measurement in the Higher Education Sector, OECD, 1989b).

- Time-use surveys or, if these are not possible, other methods, described below, of estimating share of R&D (R&D coefficients) in total activities in the higher education sector are a necessary basis for statistics.
- The use of coefficients based on these methods to estimate R&D expenditure and personnel based on information on total activities in universities is discussed next, along with some other measurement issues.

Time-use surveys and other methods of estimating shares of R&D in total activities in the higher education sector

OECD member countries use various kinds of time-use surveys or other methods to establish a basis for identifying the share of R&D in total university activities (i.e. for calculating R&D coefficients). R&D coefficients are fractions or proportions of the statistics covering the higher education sector's total resources. They serve as a tool for calculating/estimating the shares of personnel and expenditure data attributable to R&D.

Caution must be exercised when using time-use surveys in higher education surveys. Staff in institutions of higher education combine research with a range of other duties, such as teaching, administration and supervision. It may therefore be difficult for respondents to identify unambiguously that part of their time (working or otherwise) that is devoted exclusively to R&D. First, several survey methods that may help to minimise some of the problems raised by such estimations are outlined. Then, other ways of establishing R&D coefficients are described.

Methods for time-use surveys

When choosing the most appropriate survey method, the following factors have to be considered:

- The resources available to the producers of statistics;
- The desired level of quality of the statistics;
- The burden that can reasonably be laid on university administrations and individual respondents; and
- Special features of the country.

Two methods for time-use studies can be distinguished:

- Those based on researchers' own evaluation of the distribution of their working time; and

- Those based on estimates by the heads of university departments or institutes.

Methods based on respondents' own evaluation of the distribution of their working time

These methods can be divided according to the period covered by the survey:

- Surveys on the distribution of working time during the whole year;
- Surveys on the distribution of working time during one or several specified weeks; and
- Surveys on the distribution of working time during the whole year by means of partial "rolling" surveys of a specific sample of the population every week during the year.

Surveys on the distribution of working time during the whole year

In this type of survey, questionnaires can be sent to all individual staff members or only to a representative sample. The survey may cover the entire higher education sector or a representative institutional sample. Respondents are asked to estimate the allocation of their working time over a whole year according to various categories of work-related activities. In recent surveys undertaken by member countries, the number of activities has varied from the two categories "research" and "other" to as many as 15 categories covering all aspects of a working year. It is recognised that respondents may find it difficult to recall their pattern of work and to reply accurately to the questionnaire.

The following is an example of a use-of-time classification but, depending on the institutions examined, other activities may be suggested:

- Undergraduate time
- Postgraduate course-work time
- Postgraduate research time
- Personal research time
- Administration
- Unallocable internal time
- External professional time

Such questionnaires frequently include other questions on more general topics such as respondents' educational background, age, sex, hindrances to R&D, membership on committees, etc.

Surveys on the distribution of working time during one or several specified weeks

Questionnaires may be sent to all staff or to a representative sample of staff. The questionnaire is in the form of a diary in which the respondents mark, according to the list presented, the activity that best represents the use of each hour or half-hour of each day.

Staff members included in the survey may be asked to maintain diaries for three short periods of the academic year, such as:

- A normal teaching week.
- A vacation week that falls outside a personal holiday period.
- An examination period week.

Surveys by means of partial special surveys every week during the year

It is assumed to be very difficult for academic staff to give accurate, detailed information on how they spend their time when the questionnaire covers more than one week. A method has therefore been developed, which uses partial surveys of a "rolling" sample of respondents for one week to estimate the time allocation pattern for the whole year. Sampling consists of choosing individuals out of the total population to be surveyed and assigning one or several particular survey week(s) to each person chosen in order to cover the whole year. This information is then used to calculate/estimate the corresponding R&D personnel and expenditures series.

The method involves the following broad steps prior to sending out the questionnaires:

- Defining the survey population.
- Drawing a sample from the population if a full survey is not made.
- Assigning one (or several) survey week(s) to each person included in the survey.

Countries take various approaches to acquiring information in this type of survey. Respondents are sometimes asked to indicate the number of hours spent on various activities over the entire week; they are also sometimes asked to reply for each day of the week.

While countries offer their respondents different options, the general principle is always to list all possible work-related activities and ask respondents to identify how much time they spend on them (in absolute or relative terms).

All survey methods based on responses from individual staff members are comparatively expensive, and surveys of this kind are often undertaken at rather long intervals.

Methods based on estimates by heads of university departments/sections/institutes

It is usually not possible to gather full information on R&D activities in the higher education sector without obtaining data from specific university units. In most countries, R&D statistics for the higher education sector are based on a combination of information obtained at central administrative and institute level and information supplied by individual staff members. The questionnaires addressed to the university units often contain questions on certain types of expenditures and other total resources available and on the estimated share of R&D in these resources.

Several countries have found it convenient to include questions on time-use at a more aggregate level in a questionnaire addressed to the university units, rather than make time-use studies of individual researchers. The method is cheaper than those described above and puts a less heavy burden on respondents. In this case, the questionnaires are usually addressed to the head of the institute, who is assumed to have the knowledge of ongoing activities needed to supply sufficiently accurate estimates.

However, consultations with individual staff members are also often necessary to prepare the best possible estimates.

Treatment of borderline R&D activities

Respondents to time-use surveys need clear instructions if accurate and comparable results are to be obtained. Therefore, the surveyor must state very clearly which activities should be included in the R&D reported and which should not. Clear definitions must be given in the guidelines when respondents are asked to distribute their own activities.

Response rates

Methods based on estimates obtained from the university units place virtually no burden on the individual researcher (or other categories of respondents) but a modest one on the university itself. The diary exercise makes rather heavy demands on the academic staff but none on the university unit. The burden on the individual respondent is smaller in surveys when he/she only has to indicate the distribution of time over the whole year.

Response rates are generally comparatively low for diary exercises covering one or several weeks. They are usually higher when respondents reply for the whole year. On the other hand, response rates for surveys addressed to the university institutes are often close to 100%.

Methods based on other sources

While surveys are the most systematic and accurate way of collecting information on time-use, they are not always suited to the resources and/or needs of individual countries. They require a great deal of time and money and can make heavy demands on the resources of producers of statistics. Large countries, in particular, may find it difficult to carry out detailed time-use surveys, given their many higher education institutions and researchers.

In addition, the formulation of education and research policy in some countries may not require information at the level of detail available from time-use surveys.

Therefore, alternative data collection methods are needed to accommodate resource constraints and meet information needs.

Non-survey-based R&D coefficients are derived in a number of ways, ranging from informed guesses to sophisticated models. Whatever the method used, they may be an alternative to the more costly large-scale surveys of researchers and/or higher education institutions described above.

The accuracy of the coefficients depends on the quality of the judgement used in calculating them; the accuracy of the resulting estimates depends on the quality of the data to which they are applied and the detail available for both data and coefficients.

Coefficients should be prepared to match the level of detail available for the data and needed for the statistics. They may be derived in several ways, depending on the information available to the responsible statistical unit. It is essential that experienced and knowledgeable persons participate in the work.

A variety of relevant information will normally be available. Employment contracts may specify time allowed for some activities; the job descriptions of some categories of employee may provide useful input. Some institutions may have established full or partial coefficients for their own planning or evaluations; other countries with similar education systems may have derived relevant coefficients.

Coefficients derived for calculating overall R&D activity can sometimes be validated by comparison with the results of time-use surveys of other countries with similar higher education structures.

The use of models to derive research coefficients is a relatively new activity resulting from the increased computerisation of information on the higher education sector. Different models are developed by applying different coefficients to weighted or unweighted higher education data.

Use of coefficients to estimate R&D expenditure and R&D personnel

The aim of the time-use studies and other methods described above is to obtain a basis for distributing total university resources among research, teaching and other activities (including administration). These studies are therefore only the first step in establishing R&D statistics. The next step is to derive the universities' total resources; nowadays, this is often done on the basis of various administrative sources. The final step is to use R&D coefficients to estimate the shares of R&D in total personnel and expenditure resources and to break these down into more detailed categories.

Thus, to establish R&D statistics for the higher education sector, it is necessary to estimate:

- The sector's total available resources, both human and financial;
- The corresponding R&D expenditure by type of cost; and
- The corresponding R&D expenditure by source of funds.

Total resources

Calculations of R&D resources are based on data on total available resources by applying the R&D coefficients derived from time-use studies or other sources. Total data include General University Funds (GUF) and a variety of external sources and may be derived from:

- University accounts;
- Administrative records;
- Additional breakdowns made by universities' central administrations on the basis of general accounts and registers;
- Surveys addressed to university institutes; and
- Other statistical systems (statistics on public servants, general wage statistics).

In many cases, total data are derived from various administrative sources. The role of central administrations varies from country to country and from level to level – nationally at the Ministry of Education, regionally, locally or within the higher education institute itself. Regardless of their level, such centres usually have a vast quantity of information as a result of their administrative activities. The information held by central administrations, while not necessarily specifically related to R&D, is a useful source of overall data from which R&D data can be extracted using either estimated R&D coefficients or R&D coefficients drawn from time-use surveys. R&D information is sometimes available directly from central administrations. It is not completely certain, however, that this information conforms to the definitions of the Frascati Manual, and this limits the possibilities for using it directly.

The information held by central administrations in their files varies according to the function of the particular administration. Ministries of Education may have very broad overall information, while the finance officers of higher education institutions may have income and expenditure information associated with individual researchers and other staff.

To identify the R&D in individual disciplines/fields of science may require information at the researcher level at large institutions carrying out research in many disciplines. Information at the level of the institution is sufficient if its R&D is confined to a single field of science.

There are several advantages to collecting the data from central administrations as part of an overall R&D data collection exercise:

- The data are consistent and unambiguous.
- There is no double counting of parameters.
- The data apply to a specific period.
- The data are easily accessible.
- The data form a useful input to the iterative process of model building.
- Use of data from secondary sources lowers the response burden on survey respondents.

There are also limitations to such data, some of which, if not taken into account, could lead to inaccuracies in the final R&D statistics:

- Incomplete specific data on R&D activities in terms of coverage of costs, sources of funds and personnel.
- Problems of comparability between different universities.
- Data usually available at a very aggregate level.
- R&D component of general higher education statistics not separately identified.

Countries have access to sufficiently detailed data on total resources (e.g. broken down by field of science) in different ways. Differences among universities within a given country in terms of the level of detail available may also cause variations in countries' ability to supply sufficiently detailed data to the OECD.

The results of time-use studies are used to derive countries' full-time equivalents for R&D from data on total full-time equivalents, which in theory can be defined in at least two different ways:

- The total amount of work done on R&D by one person in one year; and
- The total number of full-time positions on R&D held by one person in one year, with salary as the criterion.

The first corresponds broadly to the definition of FTE. In practice, the second is probably more feasible for data collection. As in most cases it is not possible to have information on persons who have several positions, one person may conceivably count for more than one full-time equivalent.

Type of costs

R&D expenditure should be broken down by current and capital expenditure, which in turn consist of labour and other current costs, on the one hand, and instruments/equipment expenditure and land/buildings expenditure, on the other.

If no data are directly available for each of these R&D components for a certain unit, an estimate must be made on the basis of information on total expenditure.

Labour costs (i.e. salaries and related social costs) usually represent around half of total R&D expenditure in the higher education sector. Information on total labour costs is usually available or calculated on the basis of one or several of the following data sources:

- Point on the salary scale for each researcher, technician or other member of the staff, and the scale itself.
- Labour costs by category of personnel and institute.
- Labour costs by category of personnel, institute, field of science or department.

R&D coefficients derived from time-use studies are used directly at an appropriate level (individual, institute, department, university) to estimate the share of R&D in total labour costs; if necessary, adjustments should be made to take account of the costs of various associated social security or retirement schemes.

R&D coefficients can be expected to vary according to the teaching or research discipline, the occupational category of the personnel directly involved in R&D and the type of institution in which the activity is performed. At the most level of detail, coefficients can be applied to the financial and personnel data of individual institutions. When this is possible, coefficients may be modified to reflect the different positions of the institutions in terms of R&D, for example, whether they are small liberal arts colleges, technical universities or major teaching and research universities.

Coefficients are typically applied in stages:

- R&D coefficients applied to different categories of staff, if possible by discipline and institution, yield the FTE personnel estimates.
- These personnel estimates, converted to coefficients themselves, may be applied to financial data to provide R&D expenditure estimates.

Information on other current costs is usually available by university unit and often concerns resources at the disposal of the unit themselves for the purchase of items such as documents, minor equipment, etc. The units are usually asked to estimate the R&D share of these costs on the basis of intended use. The part that is not available at unit level (overhead costs such as water, electricity, rents, maintenance, general administration, etc.) has to be distributed among the institutional units concerned. If intended use is not feasible as a criterion, the same distribution coefficients as for labour costs may be used. The shares of R&D may also be determined on the basis of conventions or the opinion of the unit.

Information on total investment in instruments and equipment is usually available at the level of the institution. In many surveys, the shares of R&D are estimated by the institutes according to the intended use of the equipment. R&D coefficients are probably of less use for estimating the shares of R&D in instruments and equipment than for estimating various types of current expenditure. The share of R&D in investments in instruments and equipment may also be based on conventions or on opinion, as for certain types of other current costs discussed above.

Information on total investment in land and buildings is usually available only at the level of the institute or the university. R&D coefficients are seldom used to estimate the shares of R&D in these investments. Here again, the R&D data are often estimated on the basis of the intended use of the facilities.

From the above, it may be concluded that R&D coefficients offer the only way to estimate the share of R&D in labour costs, play a significant role in estimating share of R&D in other current costs, but are of minor importance in calculating shares of R&D in investments in instruments and equipment or in land and buildings.

Sources of funds

Funds for R&D in the higher education sector come from different sources. The main source in most countries is traditionally a proportion of the publicly funded block grant known as public general university funds (GUF) which higher education institutions receive to support all activities. The different activities of the staff in higher education institutions – teaching, R&D, administration, healthcare, etc. – are not specifically identified for separate payment from these grants, which, in a general way, cover the payment of all work-related activities. In addition, R&D funds are received in the form of grants or contracts from other sources such as ministries, departments and other public institutions, including research councils[65], from private non-profit institutions, and, in recent years,

[65] This is not the case for research councils in BiH.

increasingly from industry and from abroad. Some universities may also have "own funds[66]" (such as income from endowments).

Time-use studies and other methods used to identify the R&D share of universities' total activities usually only concern GUF, which account for the major part of higher education R&D (HERD). External funds are often for R&D but may be used for other purposes as well. For each project funded by external sources, therefore, the survey respondent often has to evaluate whether or not it funds research, if the information is not available from central administration registers.

Some external funds[67] (especially funds from foundations and research councils) are not always fully included in the central accounting records of the universities. Some research contracts may in fact go directly to the university institute or to individual professors. To obtain as broad coverage as possible, data on institutes' external funds have in some cases to be taken from funders' accounts (although this goes against the Manual's principle of performer-based reporting) or should, at least, be double-checked against those accounts. Funder-based data usually give only expenditures, and the problem of acquiring the corresponding R&D personnel data is therefore a tricky one.

Higher education institutions are looking increasingly to outside sources to compensate for absolute cuts or levelling off of traditional GUF resources. In particular, research links with mission-oriented ministries and industry are being intensified, and the share of total expenditure from non-GUF resources will ultimately increase. Such links with outside organisations may or may not be formally identified in the accounts of the institutions and are therefore difficult to quantify in the collection of R&D statistics. Furthermore, these transfers of resources may be in kind (in the form of equipment and materials) rather than money, thus creating additional measuring difficulties. However, estimations can be made.

Accounting procedures will, therefore, largely determine how well the sources of R&D income can be separately defined and identified. Producers of R&D statistics are dependent on the detail available in such accounts. A further complication in identifying the sources of research income is the fact that outside organisations do not always pay the "full market cost", however defined, of the R&D carried out for them in institutions of higher education. Theoretically, a part of GUF spent on administration and other extra costs for externally financed research should be counted as research in addition to the R&D estimated on the basis of the coefficients used above.

Problems of accurate coverage of R&D funding sources are common to all member countries, but the main area of lack of international comparability is that of distinguishing between GUF and other sources of public R&D income. Separation of general university funds from other funding sources

Some of the problems of identifying what part of these grants is attributable to R&D have already been discussed above. This identification process is an intrinsic part of the survey methodology employed in each country. Inconsistencies arise because different countries classify the R&D component of GUF differently.

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[66] In the RS treasury system the term "own revenues" refers to all funds which a Ministry makes/receives outside the Budget. They include donations, contract-based projects, services with industries, and also education fees, licenses etc. This should be kept in mind, knowing the difference between types of sources under OECD.

[67] In BiH these external funds do not exixst.

Options for classifying such public funds at the sectoral level are:

- General university funds.
- Sector's own funds.
- Direct government funds.

General university funds

A separate category of GUF has been defined for the higher education sector to take account of the special funding mechanisms for R&D, as compared to other sectors. Most countries are of the view that as R&D forms an intrinsic part of the activities of higher education institutions any funds allocated to a third-level institution have an inbuilt and automatic R&D component. With this interpretation, such funds are classified as GUF. In adding up national totals, these data are usually included in subtotals of public finance on the grounds that "as government is the original source and has intended at least part of the funds concerned to be devoted to R&D, the R&D content of these public general university funds should be credited to government as a source of funds", and this is the approach recommended for international comparisons.

GUF should be separately reported and adjustments to the R&D cost series should take account of real or imputed social security and pension provisions and be credited to GUF as a source of funds.

"Own" funds

In their national publications, a few countries continue to classify the higher education block grant of public origin not as GUF but as "own funds", arguing that "it is within the universities that... the decisions are taken to commit money to R&D out of a pool which contains both 'own funds'... and public general university funds; therefore, the sums concerned should be credited to higher education as a source of funds.

In this situation, the "own funds" category is a significant source of funds for R&D, which will be credited to higher education and not included in public sources when adding national totals.

Other monies produced by the sector should be considered as "own funds".

Although national accounting practices will dictate how easily they can be identified, such R&D income ("retained receipts") can, notably in the case of private universities, be a considerable source of income and should undeniably be classified as "own funds".

Direct government funds

In addition to GUF, the government sector provides money for higher education R&D in the form of earmarked research contracts or research grants. This source of research income is more readily identified and does not, in general, pose major problems for the producers of statistics, as they readily classify it as a direct source of government funds. Adjustments related to "other current costs" to account for real or imputed payments of rents should be credited to the category of direct government funds.

Recommendations

To obtain the best possible international comparability of higher education R&D statistics, it is preferable to disaggregate the sources of funds as much as possible. This largely depends on the availability of information from the central accounting records in higher education institutions.

The main problem for international comparability occurs when GUF data are not separately reported and are classified by different countries either with the higher education sector's "own funds" or with the government sector.

Therefore, GUF, insofar as possible, should be reported separately; if this is not possible, the corresponding funds should be included in "funds from the public sector" and not in the higher education sector's "own funds" or "other higher education funds".

When reporting data to the OECD, member countries are encouraged to indicate which sets of expenditure and personnel data coefficients are applied to calculate R&D data, together with the actual coefficients used.

Part Four – Recommendations for establishement of STI statistics and support for STI decision-making policy

Proposal by the Manual Working Group

1. In order to develop more qualitative STI statistics in BIH, it is necessary for the BIH Agency for Statistics, in cooperation with the entity-level Institutes for Statistics, to harmonise and use indicators at the level of the entity Institutes for Statistics.
2. The BIH Agency for Statistics should initiate and coordinate activities, with the entity-level Institutes for Statistics, in harmonising the questionnaires for annual reporting on science, technology and innovation as well as encourage the development of methodology in line with EUROSTAT requirements.
3. It is important to establish continuous implementation of statistical surveys in BIH through the Community Innovation Survey (CIS), Careers of Doctorate Holders Survey (CDH) and General Budget Appropriations and Outlays for R&D (GBAORD).
4. In addition to surveys, STI data can be obtained also from administrative sources, such as the BIH Institute for Intellectual Property and the Central Bank of BIH. Also useful for STI statistics can be data from the World Bank Country Office in Bosnia and Herzegovina, obtained through the enterprise survey.
5. It is necessary to implement all measures from the Action Plan for implementation of the Strategy for the Development of Science in BiH 2010-2015, which will contribute to the monitoring of STI statistics.

6. The BIH Agency for Statistics should develop, in cooperation with the entity-level Institutes for Statistics, a new Classification on education as well as the fields of science. Till then, the existing classification should be used. The important international standards are: the Frascati Manual, 2002 (with FOS Rev. 2007) – Proposed Standard Practice for Surveys on Research and Development (OECD, 2002), ISCED 97 – International Standard Classification of Education (UNESCO), ISCO-88 – International Classification of Occupations (ILO, 1990); Instruction Manual for Completing of Questionnaire of Careers of Doctorate Holders (OECD, UNESCO, EUROSTAT, 2006); Career of Doctorate Holders – Basic Model Questionnaire (OECD, UNESCO, EUROSTAT, 2006); Career of Doctorate Holders (CDH) Statistics – Methodological Guide (OECD, UNESCO, EUROSTAT, 2006); Indicators on the Careers of Doctorate Holders – Variables in Proposed Tables – Definitions and Sources (OECD, UNESCO, EUROSTAT, 2006).
7. It is crucial to raise public awareness on the significance of the production of STI and R&D statistics in BIH. Furthermore, it is necessary to improve interaction between the data producers and users, with the ambition of obtaining as much qualitative data as possible.

Annexes

A.1. The Community Innovation survey 2010

The Community Innovation Survey 2010
(CIS 2010)

THE HARMONISED SURVEY QUESTIONNAIRE

The Community Innovation Survey 2010	**FINAL VERSION July 9, 2010**

This survey collects information on your enterprise's innovations and innovation activities during the three years 2008 to 2010 inclusive.

An innovation is the introduction of a new or significantly improved product, process, organisational method, or marketing method by your enterprise. The innovation must be new to your enterprise, although it could have been originally developed by other enterprises.

Sections 5 to 8 only refer to product and process innovations.

Please complete **all** questions, unless otherwise instructed.

Person we should contact if there are any queries regarding the form:

Name: ________________________________
Job title: ________________________________
Organisation: ________________________________
Phone: ________________________________
Fax: ________________________________
E-mail: ________________________________

1. General information about the enterprise

Name of enterprise ____

Address[1] ____

Postal code __________ **Main activity**[2] ______________________________

1.1 In 2010, was your enterprise part of an enterprise group? (A group consists of two or more legally defined enterprises under common ownership. Each enterprise in the group can serve different markets, as with national or regional subsidiaries, or serve different product markets. The head office is also part of an enterprise group.)

Yes ☐ In which country is the head office of your group located? [3] ______________

No ☐

If your enterprise is part of an enterprise group: Please answer all further questions about your enterprise only for the enterprise for which you are responsible in [your country]. Exclude all subsidiaries or parent enterprises.

1.2 In which geographic markets did your enterprise sell goods and/or services during the three years 2008 to 2010?

	Yes	No
A. Local / regional within [your country]	☐	☐
B. National (other regions of [your country])	☐	☐
C. Other European Union (EU), EFTA, or EU candidate countries*	☐	☐
D. All other countries	☐	☐

Which of these geographic areas was your largest market in terms of turnover during the three years 2008 to 2010? (Give corresponding letter) ______

*: Include the following countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Slovakia, Switzerland, Turkey, Spain, Sweden and the United Kingdom.

[1] NUTS 2 code

[2] NACE 4 digit code

[3] Country code according to ISO standard

2. Product (good or service) innovation

A product innovation is the market introduction of a **new** or **significantly** improved **good or service** with respect to its capabilities, user friendliness, components or sub-systems.

- Product innovations (new or improved) must be new to your enterprise, but they do not need to be new to your market.
- Product innovations could have been originally developed by your enterprise or by other enterprises.

A **good** is usually a tangible object such as a smart phone, furniture, or packaged software, but downloadable software, music and film are also goods. A **service** is usually intangible, such as retailing, insurance, educational courses, air travel, consulting, etc.

2.1 During the three years 2008 to 2010, did your enterprise introduce:

	Yes	No
New or significantly improved goods (*exclude the simple resale of new goods and changes of a solely aesthetic nature*)	☐	☐
New or significantly improved services	☐	☐

If no to all options, go to section 3, otherwise:

2.2 Who developed these product innovations?

Tick all that apply

	Goods innovations	Service innovations
Your enterprise by itself	☐	☐
Your enterprise together with other enterprises or institutions*	☐	☐
Your enterprise by adapting or modifying goods or services originally developed by other enterprises or institutions*	☐	☐
Other enterprises or institutions*	☐	☐

*: *Include independent enterprises plus other parts of your enterprise group (subsidiaries, sister enterprises, head office, etc). Institutions include universities, research institutes, non-profits, etc.*

2.3 Were any of your product innovations (goods or services) during the three years 2008 to 2010:

		Yes	No
New to your market?	Your enterprise introduced a new or significantly improved product onto your market before your competitors (it may have already been available in other markets)	☐	☐
Only new to your firm?	Your enterprise introduced a new or significantly improved product that was already available from your competitors in your market	☐	☐

Using the definitions above, please give the percentage of your total turnover[4] in 2010 from:

New or significantly improved products introduced during the three years 2008 to 2010 that were **new to your market**	☐☐☐ %
New or significantly improved products introduced during the three years 2008 to 2010 that were **only new to your firm**	☐☐☐ %
Products that were **unchanged or only marginally modified** during the three years 2008 to 2010 (include the resale of new products purchased from other enterprises)	☐☐☐ %
Total turnover in 2010	1 0 0 %

2.4 Were <u>any</u> of your product innovations during the three years 2008 to 2010:

	Yes	No	Don't know
A first in [your country]	☐	☐	☐
A first in Europe	☐	☐	☐
A world first	☐	☐	☐

4 For Credit institutions: Interests receivable and similar income, for insurance services: Gross premiums written

3. Process innovation

A process innovation is the implementation of a **new** or **significantly** improved production process, distribution method, or supporting activity.

- Process innovations must be new to your enterprise, but they do not need to be new to your market.
- The innovation could have been originally developed by your enterprise or by other enterprises.
- Exclude purely organisational innovations – these are covered in section 9.

3.1 During the three years 2008 to 2010, did your enterprise introduce:

	Yes	No
New or significantly improved methods of manufacturing or producing goods or services	☐	☐
New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services	☐	☐
New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing	☐	☐

If no to all options, go to section 4, otherwise:

3.2 Who developed these process innovations?

	Tick all that apply
Your enterprise by itself	☐
Your enterprise together with other enterprises or institutions*	☐
Your enterprise by adapting or modifying processes originally developed by other enterprises or institutions*	☐
Other enterprises or institutions*	☐

**: Include independent enterprises plus other parts of your enterprise group (subsidiaries, sister enterprises, head office, etc). Institutions include universities, research institutes, non-profits, etc.*

3.3 Were any of your process innovations introduced during the three years 2008 to 2010 new to your market?

Yes	☐
No	☐
Do not know	☐

4. Ongoing or abandoned innovation activities for process and product innovations

Innovation activities include the acquisition of machinery, equipment, software, and licenses; engineering and development work, design, training, marketing and R&D when they are *specifically* undertaken to develop and/or implement a product or process innovation. Also include basic R&D as an innovation activity even when not related to a product and/or process innovation.

4.1 During the three years 2008 to 2010, did your enterprise have any innovation activities that did not result in a product or process innovation because the activities were:

	Yes	No
Abandoned or suspended before completion	☐	☐
Still ongoing at the end of the 2010	☐	☐

If your enterprise had no product or process innovations or innovation activity during the three years 2008 to 2010 (no to all options in questions 2.1, 3.1, and 4.1), go to section 8.

Otherwise, go to section 5

5. Innovation activities and expenditures for process and product innovations

5.1 During the three years 2008 to 2010, did your enterprise engage in the following innovation activities:

		Yes	No
In-house R&D	Creative work undertaken within your enterprise to increase the stock of knowledge for developing new and improved products and processes (include software development in-house that meets this requirement)	☐	☐
	If yes, did your enterprise perform R&D during the three years 2008 to 2010: Continuously (your enterprise has permanent R&D staff in-house) ☐ Occasionally (as needed only) ☐		
External R&D	Same activities as above, but performed by other enterprises (including other enterprises or subsidiaries within your group) or by public or private research organisations and purchased by your enterprise	☐	☐
Acquisition of machinery, equipment and software	Acquisition of advanced machinery, equipment (including computer hardware) or software to produce new or significantly improved products and processes	☐	☐
Acquisition of external knowledge	Purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other enterprises or organisations for the development of new or significantly improved products and processes	☐	☐
Training for innovative activities	Internal or external training for your personnel specifically for the development and/or introduction of new or significantly improved products and processes	☐	☐
Market introduction of innovations	Activities for the market introduction of your new or significantly improved goods or services, including market research and launch advertising	☐	☐
Design	Activities to design, improve or change the shape or appearance of new or significantly improved goods or services	☐	☐
Other	Other activities to implement new or significantly improved products and processes such as feasibility studies, testing, routine software development, tooling up, industrial engineering, etc.	☐	☐

5.2 Please estimate the amount of expenditure for each of the following four innovation activities in <u>2010</u> only. (Include personnel and related costs)[5]

If your enterprise had no expenditures in 2010, please fill in '0'

In-house R&D (Include capital expenditures on buildings and equipment specifically for R&D)	
Purchase of external R&D	
Acquisition of machinery, equipment, and software (Exclude expenditures on equipment for R&D)	
Acquisition of external knowledge	
Total of these four innovation expenditure categories	

[5] Give expenditure data in 000's of national currency units to eight digits.

5.3 During the three years 2008 to 2010, did your enterprise receive any public financial support for innovation activities from the following levels of government? Include financial support via tax credits or deductions, grants, subsidised loans, and loan guarantees. Exclude research and other innovation activities conducted entirely for the public sector under contract.

	Yes	No
Local or regional authorities	☐	☐
Central government (including central government agencies or ministries)	☐	☐
The European Union (EU)	☐	☐
If yes, did your enterprise participate in the EU 7th Framework Programme for Research and Technical Development?	☐	☐

6. Sources of information and co-operation for product and process innovation

6.1 During the three years 2008 to 2010, how important to your enterprise's innovation activities were each of the following information sources? Please identify information sources that provided information for new innovation projects or contributed to the completion of existing innovation projects.

		Degree of importance *Tick 'not used' if no information was obtained from a source.*			
	Information source	**High**	**Medium**	**Low**	**Not used**
Internal	Within your enterprise or enterprise group	☐	☐	☐	☐
Market sources	Suppliers of equipment, materials, components, or software	☐	☐	☐	☐
	Clients or customers	☐	☐	☐	☐
	Competitors or other enterprises in your sector	☐	☐	☐	☐
	Consultants, commercial labs, or private R&D institutes	☐	☐	☐	☐
Institutional sources	Universities or other higher education institutions	☐	☐	☐	☐
	Government or public research institutes	☐	☐	☐	☐
Other sources	Conferences, trade fairs, exhibitions	☐	☐	☐	☐
	Scientific journals and trade/technical publications	☐	☐	☐	☐
	Professional and industry associations	☐	☐	☐	☐

6.2 During the three years 2008 to 2010, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions? Innovation co-operation is active participation with other enterprises or non-commercial institutions on innovation activities. Both partners do not need to commercially benefit. Exclude pure contracting out of work with no active co-operation.

Yes ☐
No ☐ (**Please go to question 7.1)**

6.3 Please indicate the type of innovation co-operation partner by location

(Tick all that apply)

Type of co-operation partner	[Your country]	Other Europe*	United States	China or India	All other countries
A. Other enterprises within your enterprise group	☐	☐	☐	☐	☐
B. Suppliers of equipment, materials, components, or software	☐	☐	☐	☐	☐
C. Clients or customers	☐	☐	☐	☐	☐
D. Competitors or other enterprises in your sector	☐	☐	☐	☐	☐
E. Consultants, commercial labs, or private R&D institutes	☐	☐	☐	☐	☐
F. Universities or other higher education institutions	☐	☐	☐	☐	☐
G. Government or public research institutes	☐	☐	☐	☐	☐

*: Include the following European Union (EU) countries, EFTA, or EU candidate countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Slovakia, Switzerland, Turkey, Spain, Sweden and the United Kingdom.

6.4 Which type of co-operation partner did you find the most valuable for your enterprise's innovation activities? (Give corresponding letter) _______

7. Objectives for your product and process innovations during 2008 to 2010

7.1 How important were each of the following objectives for your activities to develop product or process innovations during the three years 2008 to 2010?

If your enterprise had several projects for product and process innovations, make an overall evaluation

	High	Medium	Low	Not relevant
Increase range of goods or services	☐	☐	☐	☐
Replace outdated products or processes	☐	☐	☐	☐
Enter new markets or increase market share	☐	☐	☐	☐
Improve quality of goods or services	☐	☐	☐	☐
Improve *flexibility* for producing goods or services	☐	☐	☐	☐
Increase *capacity* for producing goods or services	☐	☐	☐	☐
Reduce labour costs per unit output	☐	☐	☐	☐
Reduce material and energy costs per unit output	☐	☐	☐	☐
Reduce environmental impacts	☐	☐	☐	☐
Improve health or safety of your employees	☐	☐	☐	☐

8. Factors hampering product and process innovation activities

8.1 During the three years 2008 to 2010, how important were the following factors in preventing your enterprise from innovating or in hampering your innovation activities?

		Degree of importance: High	Medium	Low	Factor not experienced
Cost factors	Lack of funds within your enterprise or group	☐	☐	☐	☐
	Lack of finance from sources outside your enterprise	☐	☐	☐	☐
	Innovation costs too high	☐	☐	☐	☐
Knowledge factors	Lack of qualified personnel	☐	☐	☐	☐
	Lack of information on technology	☐	☐	☐	☐
	Lack of information on markets	☐	☐	☐	☐
	Difficulty in finding cooperation partners for innovation	☐	☐	☐	☐
Market factors	Market dominated by established enterprises	☐	☐	☐	☐
	Uncertain demand for innovative goods or services	☐	☐	☐	☐
Reasons not to innovate	No need due to prior innovations by your enterprise	☐	☐	☐	☐
	No need because of no demand for innovations	☐	☐	☐	☐

9. Organisational innovation

An organisational innovation is a new organisational method in your enterprise's business practices (including knowledge management), workplace organisation or external relations that has not been previously used by your enterprise.

- It must be the result of strategic decisions taken by management.
- Exclude mergers or acquisitions, even if for the first time.

9.1 During the three years 2008 to 2010, did your enterprise introduce:

	Yes	No
New **business practices** for organising procedures (i.e. supply chain management, business re-engineering, knowledge management, lean production, quality management, etc)	☐	☐
New methods of **organising work responsibilities and decision making** (i.e. first use of a new system of employee responsibilities, team work, decentralisation, integration or de-integration of departments, education/training systems, etc)	☐	☐
New methods of **organising external relations** with other firms or public institutions (i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc)	☐	☐

If no to all options, go to section 10.

Otherwise, go to question 9.2

9.2 How important were each of the following objectives for your enterprise's organisational innovations introduced during the three years 2008 to 2010 inclusive?

If your enterprise introduced several organisational innovations, make an overall evaluation

	High	Medium	Low	Not relevant
Reduce time to respond to customer or supplier needs	☐	☐	☐	☐
Improve ability to develop new products or processes	☐	☐	☐	☐
Improve quality of your goods or services	☐	☐	☐	☐
Reduce costs per unit output	☐	☐	☐	☐
Improve communication or information sharing within your enterprise or with other enterprises or institutions	☐	☐	☐	☐

10. Marketing innovation

A marketing innovation is the implementation of a new marketing concept or strategy that differs significantly from your enterprise's existing marketing methods and which has not been used before.

- It requires significant changes in product design or packaging, product placement, product promotion or pricing.
- Exclude seasonal, regular and other routine changes in marketing methods.

10.1 During the three years 2008 to 2010, did your enterprise introduce:

	Yes	No
Significant changes to the aesthetic **design** or **packaging** of a good or service (*exclude changes that alter the product's functional or user characteristics – these are product innovations*)	☐	☐
New media or techniques for **product promotion** *(i.e. the first time use of a new advertising media, a new brand image, introduction of loyalty cards, etc*)	☐	☐
New methods for **product placement** or sales channels *(i.e. first time use of franchising or distribution licenses, direct selling, exclusive retailing, new concepts for product presentation, etc)*	☐	☐
New methods of **pricing** goods or services *(i.e. first time use of variable pricing by demand, discount systems, etc)*	☐	☐

If no to all options, go to section 11.

Otherwise, go to question 10.2

10.2 How important were each of the following objectives for your enterprise's marketing innovations introduced during the three years 2008 to 2010 inclusive?

If your enterprise introduced several marketing innovations, make an overall evaluation

	High	Medium	Low	Not relevant
Increase or maintain market share	☐	☐	☐	☐
Introduce products to new customer groups	☐	☐	☐	☐
Introduce products to new geographic markets	☐	☐	☐	☐

11. Creativity and skills

11.1 During the three years 2008 to 2010, did your enterprise employ individuals in-house with the following skills, or obtain these skills from external sources?

Tick both 'Employed in-house' and 'Obtained from external sources' if relevant.

	Employed in-house	Obtained from external sources*	Skills not used / not relevant
Graphic arts / layout / advertising	☐	☐	☐
Design of objects or services	☐	☐	☐
Multimedia (combining audio, graphics, text, still pictures, animation, video etc)	☐	☐	☐
Web design	☐	☐	☐
Software development	☐	☐	☐
Market research	☐	☐	☐
Engineering / applied sciences	☐	☐	☐
Mathematics / statistics / database management	☐	☐	☐

**: Include freelancers, consultants, other independent enterprises, other parts of your enterprise group, etc.*

11.2 During the three years 2008 to 2010, did your enterprise use any of the following methods to <u>stimulate new ideas or creativity</u> among your staff? If yes, was the method successful in producing new ideas or increasing creativity?

	Method used and:			
	Successful	Not Successful	Don't know if successful	Method not used
Brainstorming sessions	☐	☐	☐	☐
Multidisciplinary or cross-functional work teams	☐	☐	☐	☐
Job rotation of staff to different departments or other parts of your enterprise group	☐	☐	☐	☐
Financial incentives for employees to develop new ideas	☐	☐	☐	☐
Non-financial incentives for employees to develop new ideas, such as free time, public recognition, more interesting work, etc	☐	☐	☐	☐
Training employees on how to develop new ideas or creativity	☐	☐	☐	☐

12. Basic economic information on your enterprise

12.1 What was your enterprise's total turnover for 2008 and 2010?[6] Turnover is defined as the market sales of goods and services (Include all taxes except VAT[7]).

2008	2010
☐☐☐☐☐☐☐☐☐	☐☐☐☐☐☐☐☐☐

12.2 What was your enterprise's average number of employees in 2008 and 2010?[8]

2008	2010
☐☐☐☐☐☐	☐☐☐☐☐☐

12.3 Approximately what percent of your enterprise's employees in 2010 had a university degree?[9]

0% ☐

1% to 4% ☐

5% to 9% ☐

10% to 24% ☐

25% to 49% ☐

50% to 74% ☐

75% to 100% ☐

[6] Give turnover in '000 of national currency units. *Leave space for up to nine digits*.

[7] For Credit institutions: Interests receivable and similar income; for Insurance services give gross premiums written

[8] If administrative data are used and the annual average is not available, give results for the end of each year. Leave space for up to six digits for question 12.2.

[9] National translation: This includes ISCED 5a and 6. If administrative data are used, use the same time period as for question 12.2.

A.2. Questionnaire on statistics of Science and Technology (S&T) - UNESCO

UNESCO INSTITUTE for STATISTICS

United Nations Educational, Scientific and Cultural Organization

UIS/ST/2010

Montreal, May 2010

Country: Bosnia and Herzegovina

QUESTIONNAIRE ON STATISTICS OF SCIENCE AND TECHNOLOGY (S&T)

Data for the year 2009 and prior

This questionnaire is designed to collect the most recent statistics on science and technology (S&T), specifically resources devoted to research and experimental development (R&D), in order to update the UIS database on S&T indicators. The data can be accessed on the UIS website and will be published in reports prepared by UNESCO, other UN agencies, and public and private institutions or individuals worldwide.

Please return **one** completed questionnaire before **31 August 2010**. The UNESCO Institute for Statistics (UIS) strongly encourages the use of the electronic form available at http://survey.uis.unesco.org. The electronic form can be submitted directly to the UIS by clicking on the **[Submit]** button at the end of the questionnaire or emailed to survey@uis.unesco.org. Questionnaires completed using the printed forms should be sent to:

UNESCO Institute for Statistics
Data Processing and Standards Unit
P.O. Box 6128, Succursale Centre-Ville
Montreal, Quebec H3C 3J7
Canada

For any queries, please contact the UIS by email: survey@uis.unesco.org, fax: (1 514) 343-5740
or telephone: (1 514) 343-6880.

Please refer to the *Instruction Manual for Completing the Questionnaire on Statistics of Science and Technology* and *Data Entry Manual* before completing the questionnaire.

Only one questionnaire per country should be completed by the institution responsible for S&T policy or S&T statistics (e.g. Ministry of Science and Technology, Ministry of Research and Higher Education, National S&T Council or a similar organization) or by the National Statistical Office.

Data reported in this questionnaire should cover all institutions carrying out R&D activities in your country. If this is not the case, please provide a detailed explanation using a comment in the electronic form or footnote in the printed form. To enter comments in the electronic form, please press on the [Shift] key and the left mouse button simultaneously.

Please do not leave any cell blank. The following codes should be used wherever figures are not available:

- a = category not applicable
- m = data missing (or not available)
- n = quantity nil
- x = data included in another category (please specify where, using a comment or footnote)

Estimated or provisional data should be marked with an asterisk (*).

The electronic form contains automatic error checks. A list of these checks is available in the *Data Entry Manual* for reference when using the printed forms. Kindly correct or explain failed checks using a comment or footnote.

RESPONDENT INFORMATION

Please provide details below of the person(s) responsible for completing this questionnaire.

Respondent 1: Person in charge of completing the questionnaire

◯ Mr
◯ Ms

Family name | First name

Job title (or position)

Department, division or sector

Organization

Address | City

Bosnia and Herzegovina
Country | Postal code

Telephone: Country code | Area code | Number | Extension

Fax: Country code | Area code | Number

Mobile: Country code | Area code | Number

danijela.dragovic@gmail.com
Email | Institutional website

Respondent 2: Head of the institution (if different from Respondent 1)

◯ Mr
◯ Ms

Family name | First name

Job title (or position)

Department, division or sector

Organization

Address | City

Country | Postal code

Telephone: Country code | Area code | Number | Extension

Fax: Country code | Area code | Number

Mobile: Country code | Area code | Number

Email | Institutional website

SECTION 1. GENERAL INFORMATION

1.1 Institutional information

1.1.1 Type of institution (select only **one** option):

- ◯ Public organization
- ◯ Higher education
- ◯ Private enterprise
- ◯ Private non-profit
- ◯ Other (describe): ....

1.1.2 Primary activities of the institution (select **all** that apply):

- ☐ Official statistics
- ☐ S&T policy
- ☐ Research & development
- ☐ Higher education
- ☐ Technology transfer
- ☐ S&T services
- ☐ Other (describe): ....

1.1.3 Does your institution publish S&T statistics or indicators periodically?
(*If yes, please attach or send by mail copies of your latest publications.*)

- ◯ Yes
- ◯ No

1.1.4 Principal responsibility regarding S&T statistics (select only **one** option):

- ◯ National coordination
- ◯ Sectorial coordination
- ◯ Data producer for this institution only, no outside responsibility whatsoever
- ◯ Other (describe): ....

If your institution is **not** responsible for the national coordination of S&T statistics, please provide the contact details of the institution which has such responsibility:

National coordinating institution: ____________________

Family name: ____________________ First name: ____________________

Job title (or position): ____________________

Department, division or sector: ____________________

Address: ____________________ City: ____________________

Country: ____________________ Postal code: ____________________

Telephone: Country code ________ Area code ________ Number ________ Extension ________

Fax: Country code ________ Area code ________ Number ________

Email: ____________________ Institutional website: ____________________

1.2 Basic methodology

1.2.1 How often does your institution collect R&D statistics? (select only **one** option):

- ◯ Never
- ◯ Annually
- ◯ Biennially
- ◯ Once every three years
- ◯ Once every four years
- ◯ Other (describe): ……………………………………………………………………

1.2.2 Please select the relevant box(es) corresponding to the methodology followed to obtain data from each sector. If the methodology for collecting data on R&D personnel and R&D expenditure differs, please indicate personnel with a "P" and expenditure with an "E".

Sector	Survey (census)	Survey (sample)	Budgetary information	Database	Estimation	Other sources (please describe in a note)
Business enterprise						
Government						
Higher education						
Private non-profit						

Notes:

1.2.3 If one of the methodologies indicated in Question 1.2.2 is "Survey" (census or sample), please provide below more details on how it is conducted (such as target population, sampling techniques, etc.). Please also attach or send by mail copies of your latest survey instruments (questionnaires, instruction manuals, etc.).

Notes:

1.2.4 If one of the methodologies indicated in Question 1.2.2 is "Budgetary information", please indicate which stage of budgetary information is used to obtain data:

- ◯ Budget proposal
- ◯ Initial budget appropriations
- ◯ Final budget appropriations
- ◯ Obligations
- ◯ Actual outlays
- ◯ Other (describe): ....

1.2.5 Scope of your response to the questionnaire (please select only **one** option for each sector).

Sector	Degree of coverage		
	Completely covered	Partially covered (please provide details below and attach documentation)	Not covered
Business enterprise	◯	◯	◯
Government	◯	◯	◯
Higher education	◯	◯	◯
Private non-profit	◯	◯	◯

Notes:

1.2.6 Has your country conducted innovation surveys in the period 2005-2009?
(*If yes, please attach or send by mail copies of your latest publications on innovation statistics. Please also indicate below the contact details of the institution responsible for innovation statistics.*)

◯ Yes
◯ No

Institution

Family name | First name

Job title (or position)

Department, division or sector

Address | City

Country | Postal code

Telephone: Country code | Area code | Number | Extension

Fax: Country code | Area code | Number

Email | Institutional website

SECTION 2. HUMAN RESOURCES IN RESEARCH AND DEVELOPMENT (R&D)

Research and experimental development (R&D): 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 term R&D covers three activities: basic research, applied research and experimental development.

2.1 R&D personnel by occupation

R&D personnel: All persons employed directly in research and experimental development (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. R&D personnel comprises researchers, technicians & equivalent staff, and other supporting staff.	**Researchers** are 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 and equivalent staff** are persons with technical knowledge and experience who participate in R&D by performing scientific and technical tasks involving the application of concepts and operational methods, normally under the supervision of researchers.	**Other supporting staff** includes skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects.

Table 2.1.1 R&D personnel by occupation - Headcounts (HC)

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

Year	TOTAL R&D personnel (A+B+C+D)	Occupation			
		Researchers (A)	Technicians and equivalent staff (B)	Other supporting staff (C)	Not specified (D)
2009					
2008					
2007					
2006					
2005					

Table 2.1.2 R&D personnel by occupation - Full-time equivalents (FTE)

Full-time equivalent (FTE) data measure the volume of human resources in R&D. 1 FTE is equal to 1 person working full-time for 1 year, or more persons working part-time or for a shorter period, corresponding to 1 person-year. Thus, a person who normally spends 30% of his/her time on R&D and the rest on other activities (such as teaching, university administration and student counselling) 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, this results in an FTE of 0.5.

Year	TOTAL R&D personnel (A+B+C+D)	Occupation			
		Researchers (A)	Technicians and equivalent staff (B)	Other supporting staff (C)	Not specified (D)
2009					
2008					
2007					
2006					
2005					

Notes:

2.2 R&D personnel by sex

Table 2.2.1 R&D personnel by sex - Headcounts (HC)

Year	Total R&D personnel				of which Researchers			
	TOTAL (A+B+C)	Female (A)	Male (B)	Not specified (C)	TOTAL (D+E+F)	Female (D)	Male (E)	Not specified (F)
2009								
2008								
2007								
2006								
2005								

Table 2.2.2 R&D personnel by sex - Full-time equivalents (FTE)

Year	Total R&D personnel				of which Researchers			
	TOTAL (A+B+C)	Female (A)	Male (B)	Not specified (C)	TOTAL (D+E+F)	Female (D)	Male (E)	Not specified (F)
2009								
2008								
2007								
2006								
2005								

Notes:

2.3 R&D personnel by sector of employment and occupation

Table 2.3.1 R&D personnel by sector of employment and occupation - Headcounts (HC)

Reference year (the latest available year in the period 2005-2009):

Sector	TOTAL R&D personnel (A+B+C+D)	Occupation			
		Researchers (A)	Technicians and equivalent staff (B)	Other supporting staff (C)	Not specified (D)
TOTAL (i+ii+iii+iv+v)					
i. Business enterprise					
ii. Government					
iii. Higher education					
iv. Private non-profit					
v. Not specified					

Table 2.3.2 R&D personnel by sector of employment and occupation - Full-time equivalents (FTE)

Reference year (the latest available year in the period 2005-2009):

Sector	TOTAL R&D personnel (A+B+C+D)	Occupation			
		Researchers (A)	Technicians and equivalent staff (B)	Other supporting staff (C)	Not specified (D)
TOTAL (i+ii+iii+iv+v)					
i. Business enterprise					
ii. Government					
iii. Higher education					
iv. Private non-profit					
v. Not specified					

Notes:

2.4 R&D personnel by sector of employment and sex

Table 2.4.1 R&D personnel by sector of employment and sex - Headcounts (HC)

Reference year (the latest available year in the period 2005-2009):

Sector	Total R&D personnel				of which Researchers			
	TOTAL (A+B+C)	Female (A)	Male (B)	Not specified (C)	TOTAL (D+E+F)	Female (D)	Male (E)	Not specified (F)
TOTAL (i+ii+iii+iv+v)								
i. Business enterprise								
ii. Government								
iii. Higher education								
iv. Private non-profit								
v. Not specified								

Table 2.4.2 R&D personnel by sector of employment and sex - Full-time equivalents (FTE)

Reference year (the latest available year in the period 2005-2009):

Sector	Total R&D personnel				of which Researchers			
	TOTAL (A+B+C)	Female (A)	Male (B)	Not specified (C)	TOTAL (D+E+F)	Female (D)	Male (E)	Not specified (F)
TOTAL (i+ii+iii+iv+v)								
i. Business enterprise								
ii. Government								
iii. Higher education								
iv. Private non-profit								
v. Not specified								

Notes:

2.5 Researchers by formal qualification and sector of employment

ISCED 6: i.e. PhD, Doctorate or similar level.	**ISCED 5A:** i.e. Bachelor or Master programmes.	**ISCED 5B:** i.e. shorter occupation-oriented programmes.	**All other qualifications:** including ISCED 4 (post-secondary non-tertiary programmes) and ISCED 3 (upper secondary programmes).

Table 2.5.1 Researchers by formal qualification and sector of employment - Headcounts (HC)

Reference year (the latest available year in the period 2005-2009):

Qualification	TOTAL researchers (A+B+C+D+E)	Sector				
		Business enterprise (A)	Government (B)	Higher education (C)	Private non-profit (D)	Not specified (E)
TOTAL (i+ii+iii+iv+v)						
i. ISCED 6						
ii. ISCED 5A						
iii. ISCED 5B						
iv. All other qualifications						
v. Not specified						

Table 2.5.2 Researchers by formal qualification and sector of employment - Full-time equivalents (FTE)

Reference year (the latest available year in the period 2005-2009):

Qualification	TOTAL researchers (A+B+C+D+E)	Sector				
		Business enterprise (A)	Government (B)	Higher education (C)	Private non-profit (D)	Not specified (E)
TOTAL (i+ii+iii+iv+v)						
i. ISCED 6						
ii. ISCED 5A						
iii. ISCED 5B						
iv. All other qualifications						
v. Not specified						

Notes:

2.6 Researchers by formal qualification and sex

ISCED 6: i.e. PhD, Doctorate or similar level.	**ISCED 5A:** i.e. Bachelor or Master programmes.	**ISCED 5B:** i.e. shorter occupation-oriented programmes.	**All other qualifications:** including ISCED 4 (post-secondary non-tertiary programmes) and ISCED 3 (upper secondary programmes).

Table 2.6.1 Researchers by formal qualification and sex - Headcounts (HC)

Reference year (the latest available year in the period 2005-2009):

Qualification	TOTAL researchers (A+B+C)	Sex		
		Female (A)	Male (B)	Not specified (C)
TOTAL (i+ii+iii+iv+v)				
i. ISCED 6				
ii. ISCED 5A				
iii. ISCED 5B				
iv. All other qualifications				
v. Not specified				

Table 2.6.2 Researchers by formal qualification and sex - Full-time equivalents (FTE)

Reference year (the latest available year in the period 2005-2009):

Qualification	TOTAL researchers (A+B+C)	Sex		
		Female (A)	Male (B)	Not specified (C)
TOTAL (i+ii+iii+iv+v)				
i. ISCED 6				
ii. ISCED 5A				
iii. ISCED 5B				
iv. All other qualifications				
v. Not specified				

Notes:

2.7 Researchers by field of science and sector of employment

Table 2.7.1 Researchers by field of science and sector of employment - Headcounts (HC)

Reference year (the latest available year in the period 2005-2009):

Field of science	TOTAL researchers (A+B+C+D+E)	Sector				
		Business enterprise (A)	Government (B)	Higher education (C)	Private non-profit (D)	Not specified (E)
TOTAL (i+ii+iii+iv+v+vi+vii)						
i. Natural sciences						
ii. Engineering & technology						
iii. Medical & health sciences						
iv. Agricultural sciences						
v. Social sciences						
vi. Humanities						
vii. Not specified						

Table 2.7.2 Researchers by field of science and sector of employment - Full-time equivalents (FTE)

Reference year (the latest available year in the period 2005-2009):

Field of science	TOTAL researchers (A+B+C+D+E)	Sector				
		Business enterprise (A)	Government (B)	Higher education (C)	Private non-profit (D)	Not specified (E)
TOTAL (i+ii+iii+iv+v+vi+vii)						
i. Natural sciences						
ii. Engineering & technology						
iii. Medical & health sciences						
iv. Agricultural sciences						
v. Social sciences						
vi. Humanities						
vii. Not specified						

Notes:

2.8 Researchers by field of science and sex

Table 2.8.1 Researchers by field of science and sex - Headcounts (HC)

Reference year (the latest available year in the period 2005-2009):

Field of science	TOTAL researchers (A+B+C)	Sex		
		Female (A)	Male (B)	Not specified (C)
TOTAL (i+ii+iii+iv+v+vi+vii)				
i. Natural sciences				
ii. Engineering & technology				
iii. Medical & health sciences				
iv. Agricultural sciences				
v. Social sciences				
vi. Humanities				
vii. Not specified				

Table 2.8.2 Researchers by field of science and sex - Full-time equivalents (FTE)

Reference year (the latest available year in the period 2005-2009):

Field of science	TOTAL researchers (A+B+C)	Sex		
		Female (A)	Male (B)	Not specified (C)
TOTAL (i+ii+iii+iv+v+vi+vii)				
i. Natural sciences				
ii. Engineering & technology				
iii. Medical & health sciences				
iv. Agricultural sciences				
v. Social sciences				
vi. Humanities				
vii. Not specified				

Notes:

SECTION 3. EXPENDITURE ON RESEARCH AND DEVELOPMENT (R&D)

R&D expenditures are all expenditures for research and experimental development performed within a country, including both current costs and capital expenditures. The data requested in Tables 3.1 to 3.5 should relate to actual expenditure on R&D. If they are not available, please provide estimated data calculated using budget allocations for R&D or other methodologies and explain as a note. R&D expenditure should be reported in **national currency**.

Example: If R&D expenditure in national currency is "1,234,500,000" you should present it as 1234.5 (in millions) or 1234500 (in thousands) or 12345000 (in hundreds) or 1234500000 (in units).

Table 3.1 Total expenditure on R&D

Year	Total expenditure on R&D	Monetary unit in which data on R&D expenditure are reported (i.e. millions, thousands, hundreds or units)	National currency
2009			
2008			
2007			
2006			
2005			

3.1.1 Type of period considered:

- Calendar year
- Fiscal year

Starting month:

Notes:

Table 3.2 Total expenditure on R&D by sector of performance

Year	TOTAL (A+B+C+D+E)	Sector of performance				
		Business enterprise (A)	Government (B)	Higher education (C)	Private non-profit (D)	Not specified (E)
2009						
2008						
2007						
2006						
2005						

Notes:

Table 3.3 Total expenditure on R&D by source of funds

Year	TOTAL (A+B+C+D+E+F)	Source of funds					
		Business enterprise (A)	Government (B)	Higher education (C)	Private non-profit (D)	Funds from abroad (E)	Not specified (F)
2009							
2008							
2007							
2006							
2005							

Notes:

Table 3.4 Total expenditure on R&D by field of science

Year	TOTAL (A+B+C+D+E +F+G)	Field of science						
		Natural sciences (A)	Engineering & technology (B)	Medical & health sciences (C)	Agricultural sciences (D)	Social sciences (E)	Humanities (F)	Not specified (G)
2009								
2008								
2007								
2006								
2005								

Notes:

Table 3.5 Total expenditure on R&D by type of R&D activity

Year	TOTAL (A+B+C+D)	Type of R&D activity			
		Basic research (A)	Applied research (B)	Experimental development (C)	Not specified (D)
2009					
2008					
2007					
2006					
2005					

3.5.1 Type of expenditure used in Table 3.5:

- ◯ Total expenditure (current costs and capital expenditures)
- ◯ Current costs only

Notes:

SECTION 4. AVAILABILITY OF ADDITIONAL DATA ON R&D

The UIS is considering the extension of its data collection to obtain statistics that better reflect the status of R&D. In order to determine the availability of data, please provide the following information:

Indicator	Available now	Planned for		Not foreseen
		2011	2013	
Researchers by age	☐	☐	☐	☐
Researchers by:				
Country of birth	☐	☐	☐	☐
Citizenship/residence status	☐	☐	☐	☐
Researchers by fields of science at **2 digit** level	☐	☐	☐	☐
R&D expenditure by type of cost (current cost, capital expenditure)	☐	☐	☐	☐
R&D expenditure by major socio-economic objective	☐	☐	☐	☐
Government budget appropriations or outlays for R&D (GBAORD) (these are budget-based data and therefore refer to provisions, not actual expenditure):				
Total	☐	☐	☐	☐
By major socio-economic objective	☐	☐	☐	☐
Business enterprise R&D expenditure by industry/branch of economic activity (at 1 digit level of ISIC)	☐	☐	☐	☐
Scientific and technological services (STS): Activities concerned with R&D and contributing to the generation, dissemination and application of scientific and technical knowledge.	☐	☐	☐	☐
S&T education and training (STET): All activities comprising specialized non-university higher education and training, higher education and training leading to a university degree, post-graduate and further training, and organized lifelong training for scientists and engineers. These activities correspond broadly to ISCED levels 5A, 5B and 6, and may include some ISCED level 4 programmes.	☐	☐	☐	☐

Please provide any explanations or clarifications which will help with the interpretation of data requested in any part of this questionnaire.

To submit data directly to the UIS, please click on the [**Submit**] button below. An email will be sent to you to confirm receipt. If you do not receive this confirmation, please verify the email address provided in the respondent information section and try again.

Submit

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