Research

Serbia has achieved good progress in recent years in the area of R&D. Even with the significant progress in the development and modernization of the R&D and innovation system, several challenges remain:

- brain drain,
- low budgetary allocation for science,
- investment in science,
- effectiveness of research and innovation activities,
- weak cooperation between the public research sector and the business sector.

The objective of research and development policies is to increase the quality and quantity of R&D, create conditions for R&D cooperation and create efficient public research infrastructure. The Strategy of Scientific and Technological Development of the Republic of Serbia for the period 2010-2015 was adopted by the Government in February, 2010 (*Official Gazette of RS*, No.13/10). The Changes and Amendments to the Law on Scientific Research Activities were adopted by the Parliament in 2010 (*Official Gazette of RS*, No. 18/10, the Law on R&D).

The two key elements of the Strategy are: **focus and partnership**. Focus signifies the definition of national priorities within the science and technology domain, and partnership reinforcement achieves a critical mass in these domains, a greater presence on the international science scene and a stronger connection with the economy and technological development.

The seven national priorities within the science and technology domain defined by the Strategy are:

1. biomedicine,
2. new materials and nanosciences,
3. environmental protection and countering climate changes,
4. energy and energy efficiency,
5. agriculture and food,
6. information and communication technologies and
7. improvement of the decision-making process and affirmation of national identity.

The Strategy proposes a timetable of increasing investments in science and technology by 0.2% GDP per year, which would mean that, in 2015, Serbia would surpass 1% of GDP investments in science. In addition to the budget investments, a 400 million Euro investment into science and technology infrastructure is planned during the realization of the Strategy and in cooperation with international financial institutions.

An Action Plan of the implementation of the Strategy has been prepared by the Ministry and approved by the National Council for Science and Technological Development. The Action Plan should be approved by the Government in the near future. The implementation of the Strategy is supervised by the Ministry of Education, Science and Technological Development

in cooperation with other ministries, the National Council for Science and Technological Development, the National Council for Higher Education, the Serbian Academy of Sciences and Arts and other advisory domestic and international authorities and experts.

The sixteen programmes of general interest for the Republic of Serbia are defined in the Law on R&D activities: **Basic Research Program; Program of research and technological development; Program of co-financing of integral and interdisciplinary research;** Program of the transfer of knowledge and technologies and the implementation of scientific research results; Program of scientific and research work of the Serbian Academy of Sciences and Arts, Program of scientific and research work of the Matica Srpska; Program of scientific and research work of centres of excellence; Program of provision and maintenance of science and research equipment and science and research facilities; Program of international scientific cooperation important for the Republic; Program of information society development; Program of further education of scientific and research work experts; Program of scholarships and encouragement of young talents for scientific research work; Program of providing scientific and professional literature from abroad and access to electronic scientific and professional data bases; Program of publishing scientific publications and the organization of scientific meetings; Program of encouraging activities of scientific and professional groups, associations and other organizations as a function of improving scientific research, promotions and popularization of science and engineering and the protection of science and technology heritage; Program of project co-financing of doctoral studies; Program of co-financing the construction of apartments for young researchers and scientists in Serbia.

The funding system is based mainly on budget funds. The selection, evaluation and financing of the following programs: the Program of basic research (BR), Program of research in the area of technological development (TD), Program of integral and interdisciplinary research (IIR) and Program of provision and maintenance of scientific research equipment, are defined by law ("The Act of selection, evaluation and financing" adopted in 2010). The other programs are also financed from the budget, which is annually adopted. The funding of many programs is defined by specific by-laws (adopted by the Ministry, published on their website).

The quality of scientific research results and the quantification of individual scientific research results, the minimum levels for promotion are defined in the Rulebook of Procedures and Methods of the Evaluation and Quantitative Expression of Scientific Research of Researchers. The main scientific production indicators are the number of published articles, the quality of scientific work measured by impact factor, and citations. The relevant data bases for scientific production monitoring are the ISI Web of Science, Scopus, Pub Med, Medline, Science Citation Index. Patenting activities are also included in technical sciences.

R&D: SITUATION ANALYSIS

Research Cycle Program 2011-2014

The scientific research system of the Republic of Serbia is composed of the following institutions:

1. Accredited scientific research organizations: institutes, faculties, integrated universities, centers of excellence and
2. Innovation centers
3. Serbian Academy of Sciences and Arts - SANU and Matica Srpska.

The vast majority of R&D activities in the country are carried out by the public sector, mainly through state universities and other public research institutions. The quality of Serbian research institutions is also highlighted in the Global Competitiveness Index (World Economic Forum, 2012). Indeed, the 'quality of scientific research institutions' is the dimension in which Serbia performs best under the Innovation Pillar, ranking 58th out of 142 countries. The number of institutions active in the **Research Cycle Program 2011-2014 are** presented in Table 2.1.5.1.

Table 2.1.5.1. The number of institutions active in the Research Cycle Program 2011-2014

Research institutions	**Number of institutions**	
	State	Private
Institutes	56	3
Integrated universities	1	2
Faculties	83	4
Centers of excellence	5	
Innovation centers	4	
Total	158	

Pure basic research, beyond bringing new knowledge into existence, contributes to the creation of the most up-to-date methodology and the international portability of Serbian science; while targeted basic research additionally contributes to technological innovation, sustainability and societal adaptation.

The Ministry of Education, Science and Technological Development is implementing the following programs to boost research careers and support researchers financially:

- Program supporting basic research for the research cycle 2011-14 (BR program);
- Program supporting research in the field of technological development for the research cycle 2011-14 (TD program);
- Program of co-funding integrated and interdisciplinary research for the research cycle 2011-14 (IIR program) to support the integration of basic, applied and development research as well as to fully utilize R&D resources, emphasizing the commercialization of R&D activities and results.

Basic research and technological development programs cover all research fields from a pure and applied research standpoint, whereas the integral and interdisciplinary research program targets large-scale research projects, which draw together several research institutions and industry representatives in priority research areas.

The programs selected by the aforementioned Act are financed on a project basis, including the financing of the scientific and research work of the researchers and the financing of direct material expenses of research. The programs are financed from the budget, which is annually adopted and planned for 4 years. The distribution of financed projects in the BR program, TD program and IIR program of the **Research Cycle 2011-2014** is presented in figures from Figure 2.1.5.1. to Figure 2.1.5.4. The budget funds granted for the projects are monitored through the annual/semi-annual financial statements, and subsequently a decision on the continuation or termination of financing is made.

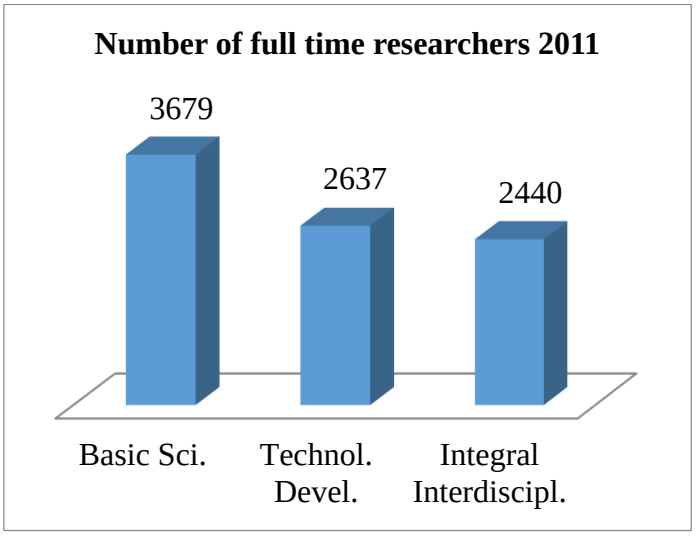

Figure 2.1.5.1. Number of full time researchers 2011

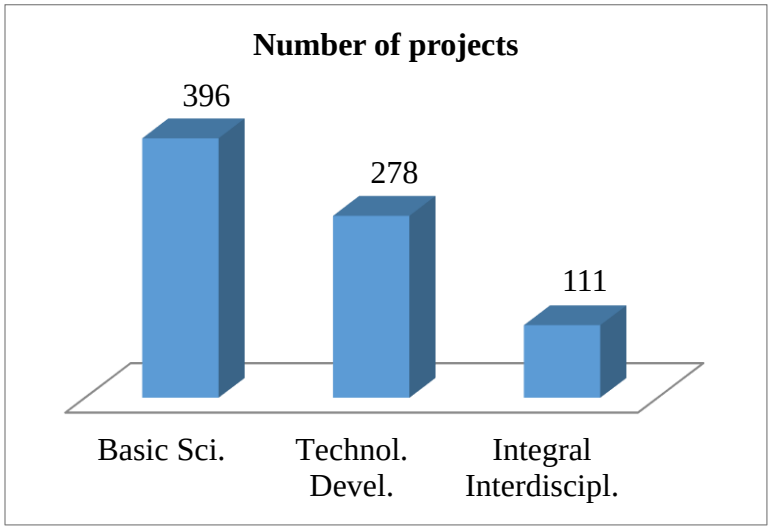

Figure 2.1.5.2. Number of projects

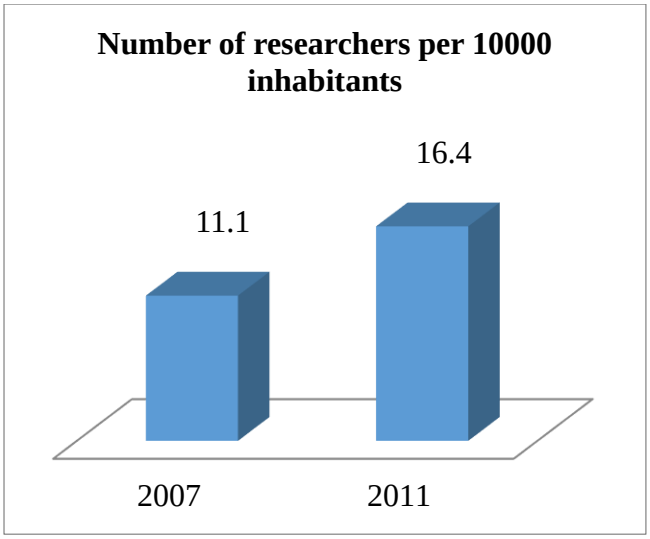

Figure 2.1.5.3. Number of researchers per 10000 inhabitants

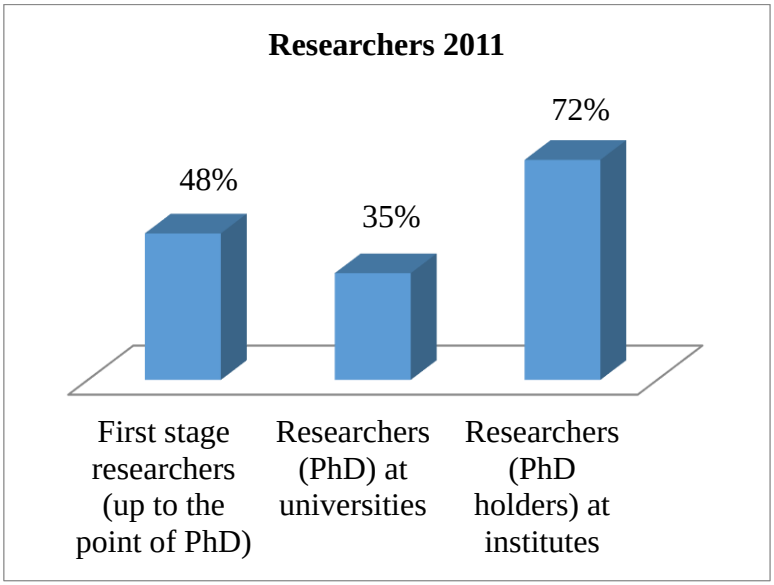

Figure 2.1.5.4. Researchers 2011

Research & development –primarily basic research – has major importance in the training of a highly qualified, creative workforce and the development of a readiness to work together. Between 2007 and 2011, the number of researchers increased from 8800 to over 11700. The number of researchers (Full Time Equivalent, FTE) in relation to the active labour force in 2012 (The total number of employed persons is 2,201,760) is 4.2, compared to 6.63 in the EU-27 (2009). The number of people employed in research & development – dependent on financial opportunities – has increased by 32% by 2011, in comparison to 2007.The number of researchers in the business sector is negligible. The majority of researchers in Serbia are trained in a traditional academic setting and are not adequately prepared for the market, to manage their intellectual property, to seek employment or set up their own company. The Strategy of Education 2020 was adopted with the goal of training enough researchers to meet national R&D targets and improve the quality of doctoral training. Universities must ensure that future

graduates are fully equipped with the skills necessary to meet modern knowledge economy challenges.

The first step in increasing the number of researchers is to ensure that enough young people study science. The distribution of PhD students among different disciplines in the academic year 2011 is presented in Figure 2.1.5.5 and Figure 2.1.5.6. The total number of PhD students studying at Serbian universities (state and private) in 2011/12 was 5026. In order to secure an adequate science base, the Serbian government and institutions have put in place measures to attract young people to PhD studies. Over 3900 PhD students were granted or engaged as young researchers in the Research Cycle Programs 2011-2014. If graduates are to go on to take doctorates, then Serbian educational institutions need to offer high-quality doctoral training. However, the picture is varied across universities and disciplines and additional efforts are needed to improve the quality of PhD studies. Enhancing the quality of doctoral training serves as a precondition for excellence and innovation. The number of new doctoral graduates increased from 330 in 2001 to around 60 in 2010.

During the first two years of the Research Cycle Programs 2011-2014, 1056 PhD students have graduated, among them 45% in basic and technical sciences.

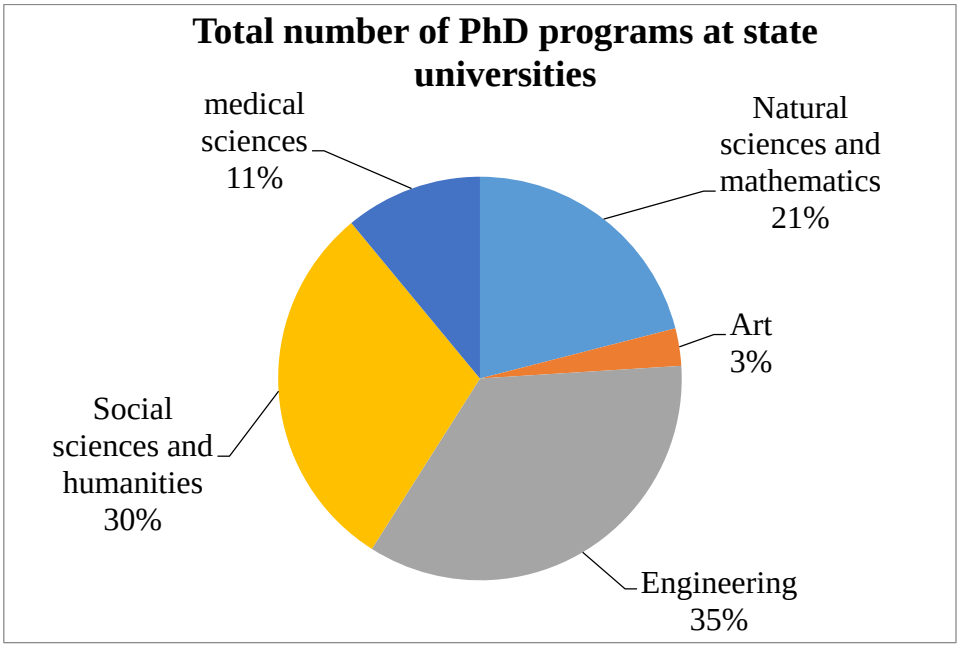

Figure 2.1.5.5. Total number of PhD programs at state universities

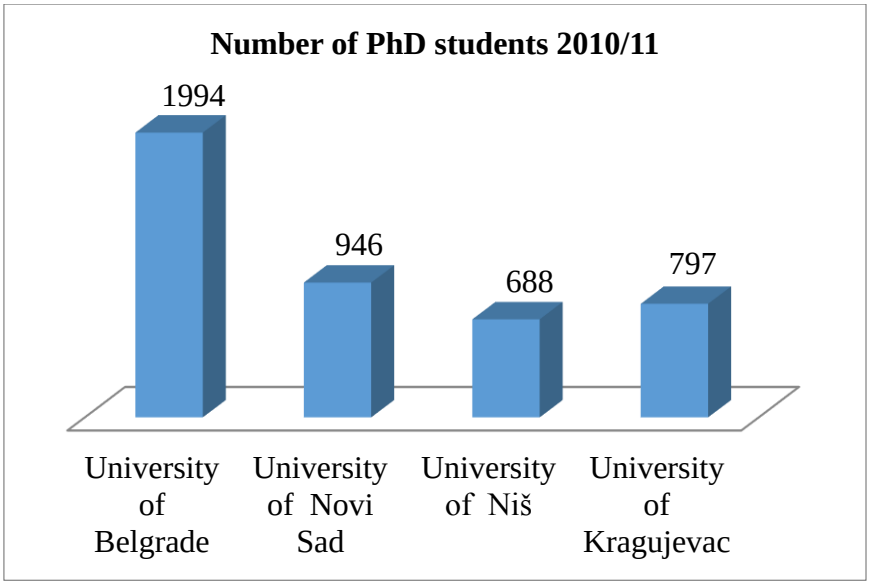

Figure 2.1.5.6. Number of PhD students 2010/11

The quality of Serbian public research is relatively high. The researchers are very productive in terms of number of scientific publications. In 2012 Serbian researchers published 5356 articles in international journals or 726 publication per million inhabitants, which is comparable with EU countries.

The number of articles (*Web of Science- Articles: SCI, SSCI, AHCI)* in different research disciplines is compared in Figure 2.1.5.7.

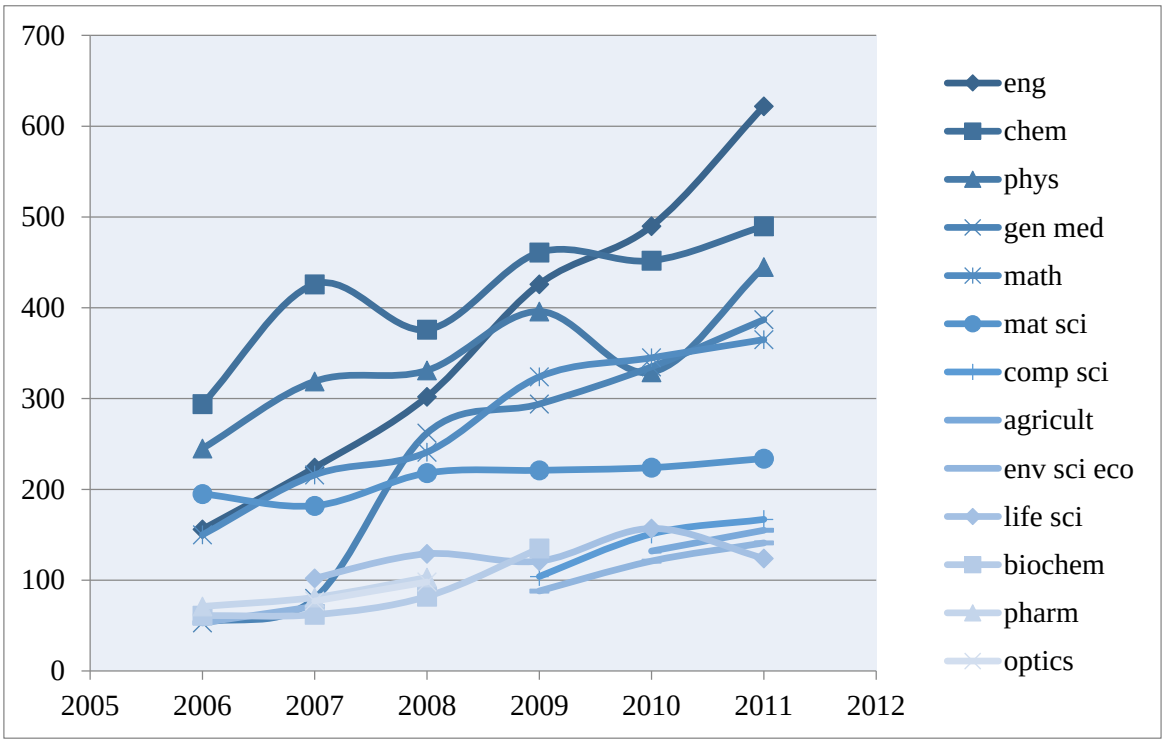

Figure 2.1.5.7. The number of articles in various research disciplines

According to assessments from 2011, the quantity of research in Serbia is relatively good. Serbia ranked 48th on the **SCImago Journal & Country Rank** among 140 countries. The achievements by Serbian science in many areas are encouraging and are an appropriate starting point for further development.

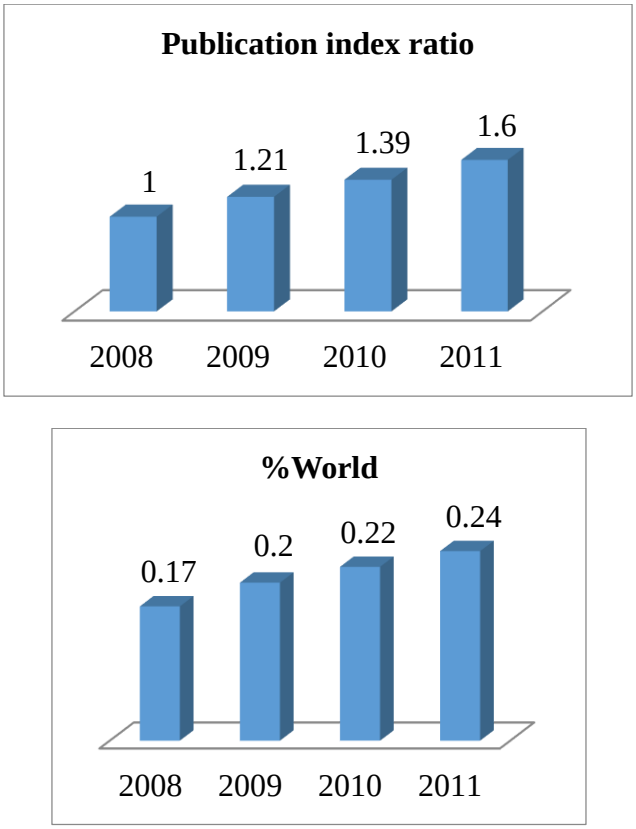

Figure 2.1.5.8. SCImago Journal & Country Rank Serbia 2011, a) increase in the number of scientific publications, b) percent of scientific publications from Serbia in the total number of global scientific publications.

International cooperation

The number of scientific co-publications provides insight into cooperation between researchers from different countries. The number of scientific publications in 2012 produced in collaboration with at least one author from another country outside of Serbia is shown in Figure 2.1.5.9. More than 200 scientific publications are a result of intensive collaborations with colleagues in the CERN programs ATLAS and CMS.

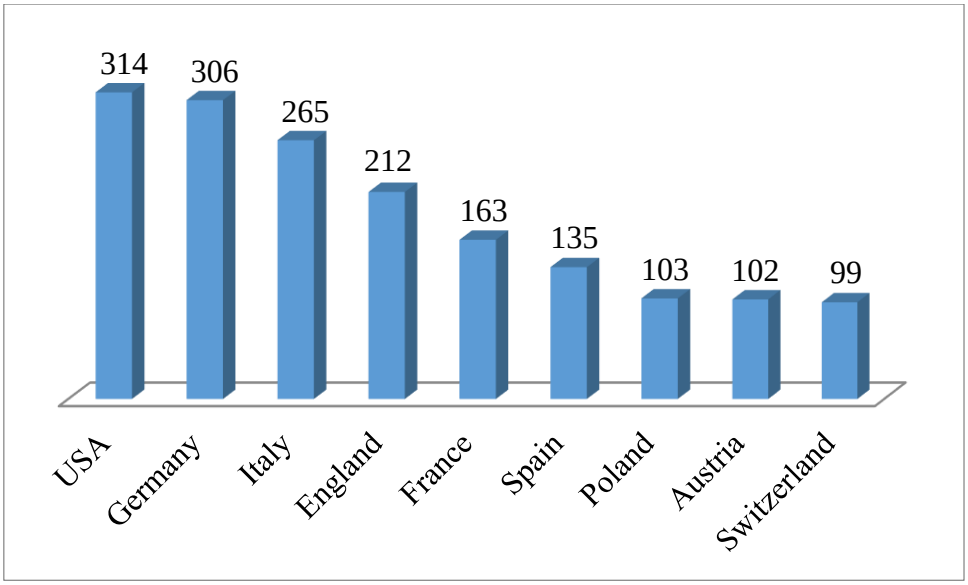

Figure 2.1.5.9. The number of scientific publications realized through international cooperation in 2012

Serbian researchers foster links with their international colleagues. In 2011 more than 5 % of publications were the result of international cooperation. Serbia is also relatively successful in drawing on the EU Framework Program funds. According to statistics from December, 2012, presented at a meeting of the Steering Platform for the Western Balkan countries, Serbian researchers participate in 187 projects of the Seventh Framework Program. They achieved a success rate of 13.32%, which is lower than the EU average, but are among the leaders in the region.

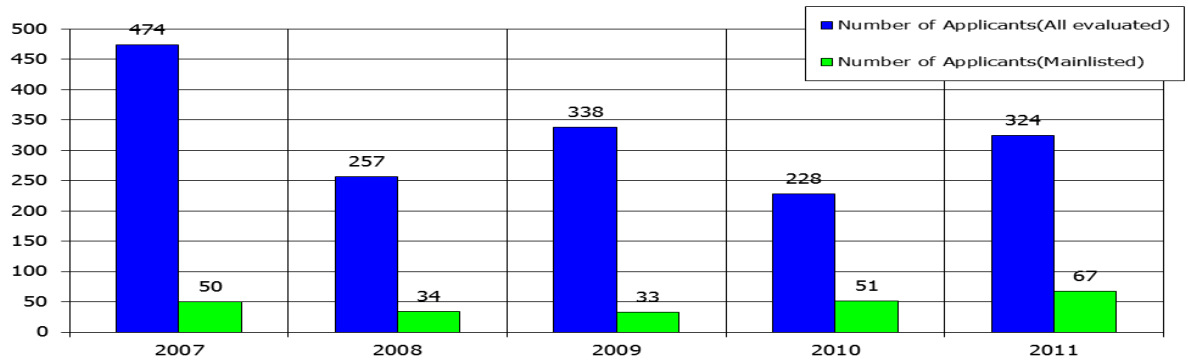

Figure 2.1.5.10. Number of applicants from Serbian for EU program funds

The "Training Workshop on Smart Specialization for South East European countries" was organized within the WBCINCO.NET project in early April, 2013 as the basis and beginning of the preparation of a Country position paper as an important document for drafting the Smart specialization strategy.

One of the results of the FP7 project EVAL-INNO is publication of the brochure *RTDI Evaluation Standards.*

Socialistic Federative Republic of Yugoslavia was one of the founders of the COST programme in 1971. Republic of Serbia joined the programme officially in 2001. At the moment, Serbia participates in over 140 COST actions of the 9 Domain plus Trans Domain, which cover a variety of professional and scientific fields. Estimates based on the number of participants in the working groups of COST in individual stocks, currently features more than 400 experienced and young researchers.

Serbia entered the Eureka program in 2002. Within the framework of the Eureka in 2013, the implementation of project activities in 16 Eureka projects is being continued, of which 14 were financed from the budget of the Republic of Serbia, on the basis of contractual obligations. So far Serbian researchers have participated in 77 Eureka projects involving 152 organizations.

The Republic of Serbia runs bilateral cooperation programs with a number of countries (Belarus, China, Croatia, France, Germany, Hungary, Slovakia, Slovenia, Switzerland, Spain, Portugal, Greece, Italy, Austria and Montenegro). This has resulted in the co-financing of R&D projects (143 projects in 2012) carried out by teams consisting of researchers from both countries. To improve R&D collaboration, bilateral cooperation has been established among all of the Western Balkan countries.

NATO Science for Peace and Security – Established in 2006 with the purpose of contributing to security, stability and solidarity among nations, by applying state of the art technical expertise, as well as with the purpose of enhancing cooperation in all the partnerships based on innovations and civil science. On July 27, 2007 the Republic of Serbia signed a Presentation document concerning the participation of the RS in the Partnership for Peace Programme committing itself to cooperation frameworks with NATO in the field of science and technology. Serbian researchers joined the programme late in 2007 and the results achieved so far have been reflected in the implementation of eight projects.

Cooperation programme with the International Atomic Energy Agency (IAEA) - Cooperation between the Republic of Serbia and the IAEA over the past several years developed primarily through technical assistance programmes involving equipment, expert knowledge and training courses, as well as through regional and interregional activities. Technical cooperation was mainly focused on programmes for decommissioning a research nuclear reactor and radioactive waste management, however it also involved nuclear and radiation security, radiation medicine and health, and nuclear and radio-chemical application of isotopes in hydrology, agriculture and industry.

Cooperation with UNESCO – is based on UNESCO's support for organizing major international conferences on topics of global interest for the international community, support for maintaining regional cooperation networks between research teams that work in a specific area of basic research and expertise in science policy issues and the creation of strategic documents.

In addition to the cooperation programmes, Serbia has actively participated in European and international scientific organisations such as CERN (European Nuclear Research Centre) where our physicists and engineers made a notable contribution despite the fact that Serbia is

not a member of that organisation. For that reason, Serbia filed an official application for membership in CERN, in March 2009. In November 2008, Serbia joined the membership of the Partnership for Advanced Computing in Europe. Serbia's membership in leading international organisations of this kind is one of the key factors in the development of its international cooperation.

Funding of research

The main source of investments in R&D is the government budget. Scientific institutes and higher education institutions generate part of the revenues through cooperation with the economy.

The Strategy foresees an increase in the allocation of budget funds for science and technological development in the next five years at the annual rate of 0.15% of the GDP. In this way, the budgetary allocation in 2015 will be 1.05%. However, the % of the GDP increased marginally during the four-year period up to 2010 from 0.31 % to 0.34 %.

Table 2.1.5.2. Percent of total budget and credit (loan) means in the GDP

	2010	**2011**	**2012**	**2013**	**2014**	**2015**
% participation of budget means in the GDP	0.31	0.35	0.36	0.34	0.33	0.32
% participation of budget and credit (loan) funds in the GDP	0.40	0.45	0.50	0.46	0.76	0.46
according to the Strategy	0.30	0.45	0.60	0.75	0.90	1.05

*The budget means are the total means allocated to the function of science. In 2010, 2011, 2012 and 2013 the means were approved, and for 2014 and 2015 they are planned – projected means. Credits (loans): for 2010, 2011 and 2012they are the drawn means and for 2013 they are the projected means. The prediction for 2014 and 2015 is based on the plan for drawing means from the loan.

Data on R&D expenditure are not available in Eurostat or in relevant EU documents. The Strategy predicts the growth of budget expenditures for science and technological development for the period 2010-2015 at an annual rate of 0.15% of the GDP. According to numerous studies, the threshold that should be reached and on which depends the support of R&D and innovation activities in a country is1% of the GDP. Only a few EU countries have not attained 1% of the GDP. Serbia, in the past ten years, is at a level of 0.3% of the GDP. Together with credit (loan) means invested in infrastructure and R&D equipment in 2012 the percent is 0.5%.

Mobility of researchers in Serbia - State of play

The collaborative nature of science requires, among other things, mobility of researchers, or more specific 'free circulation of researchers and scientific knowledge, including via digital means'. This implies not only geographical mobility, but also intersectoral (industry – academia) mobility. Even if researcher mobility contributes to excellence, still there are many obstacles that prevent mobility.

One of the most important obstacles is the lack of transparent, open and merit-based recruitment. The calls for researchers are usually answered by people who are educated or already work in the very institution that posts the call. It is rare to receive more than one application for the job. Vacancies are published in the local newspapers or web sites of the faculty or university. Only few, mainly private, universities are publishing vacancies on pan - European researcher's EURAXESS Job portal, although this portal has been operating in Serbia for years. The method of forming selection committees and their work is non-transparent.

There is no awareness of the importance of mobility. There is a misconception that outgoing mobility is identical with the brain drain, because there are no systematic mechanisms for the reintegration of researchers after their stay at a foreign institution and because there is no initiative to attract foreign researchers.

There is no cooperation with the industry in developing curriculum for doctoral studies, as well as other forms of cooperation, related to the career development of researchers, which may be a common interest.

Currently, it is not possible to transfer the national grant from one institution to another, preventing the mobility of researchers within the country. Without portability of grants it is impossible for researchers to carry out a part of their research in other academia or industry research institution.

The 'HR Excellence in Research' logo is awarded to research institutions and funding organizations that have been acknowledged by the European Commission for having made significant progress in implementing the European charter for researchers and the code of conduct for the recruitment of researchers (Charter & Code). Only four research institution from Serbia[1] signed Declarations of endorsement of Charter & Code (University of Niš, University of Novi Sad, Belgrade Metropolitan University, Institute of Field and Vegetable Crops, Novi Sad). For now, only the University of Nis is developing its "Human Resources Strategy for Researchers".

[1]http://ec.europa.eu/euraxess/index.cfm/rights/charterAndCode#S