EU International Cooperation in the Field of Research, Development and Innovation

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Abstract: - The article tries to bring a contribution to the study of the main aspects involving European Union and its Member States in the sphere of international cooperation for research, development and innovation (RDI). Having in view the importance of management of human, financial and material resources for obtaining the best results in the RDI field, the European Commission and the other EU institutions have deployed sustained efforts for achieving the best results. An effective instrument is the completion of both the material and human resources and the participation of other states (non members) in the multitude of areas and issues of general interest within the modern society. The major forces in RDI, like the US, Japan, China, South Korea, and BRICS members, were important partners for the EU for a longer or a shorter period in RDI areas like: health, environment, transport, nanotechnologies, information technologies and communications, new materials, conventional or unconventional energy, etc. The article analyzes the main EU directions of cooperation in RDI areas with major non member countries and the most current issues that regard today's world, trying to draw the more constructive and pertinent conclusions for the future of this collaboration.

Keywords: European Union, international cooperation, science, technology, innovation, partner states.

1 Introduction

There is general consensus in the world today on the major economic challenges facing humanity and how they must be solved with the help of scientific research. EU is opened to a more intensive international cooperation in RDI, because on one hand these problems are common to all countries in the world and the collaboration in scientific research is the best solution for avoiding overlaps or duplication, and on the other hand, the movement of information in Internet era is much easier and quicker, helping to tackle instantly the major challenges of the present world.

The European Union is currently one of the two major knowledge centre at global level (together with the US), carrying out almost a third of the scientific and technological production. Furthermore, while cumulating only 7% of the world population, EU achieves 24% of overall investment in research, 32% of high impact scientific publications and 32% of patent applications (EU Delegation in China, 2015).

In European Union, the program "Horizon 2020" or simply H 2020 (EC 2015-1) is the ever largest research program. It will run from 2014 to 2020, with a budget of almost 80 billion euro. The program envisages "big challenges" facing the mankind, in general, and therefore the EU. Both the precedent 7th Framework Programme (EC 2015-2), and H 2020 envisaged international cooperation activities with other countries, developed or emerging (such as the BRICS countries, those associated with or included in policy of close neighbourhood). Also, there are other programs open to international participation, in terms of joint financing and scientist participation from third countries.

The main objectives of the analysis point to the identification of contractual coordinates and the fields of interest for RDI international cooperation of EU and Member States, the situation in the last 7-8 years, the already visible or expected impact of cooperation activities already deployed and the future prospects. Romania is less integrated in RDI legal cooperation actions with other countries outside the Union, but there are some preoccupations with this situation. The author presents the conclusions and the proposals regarding the Romania's increased participation in RDI cooperation with countries like China, India or Brazil. The data used in the undertaken analysis come mainly from the European Commission (studies, analyzes, policy documents) but also from countries with which the EU carries out R&D collaboration.

The purpose of this paper is to better understand the activity of RDI sector from EU, to identify areas of interest for our country and to discern the future integration opportunities.

2 The major challenges of the contemporary world that EU international cooperation is working to meet

In the table 1 one can see the major challenges in the field of RDI that EU international cooperation is trying to approach and which are found in Horizon 2020.

Table 1 . The three priorities areas of Horizon 2020

Excellence in science	**Industrial leader status**	**Societal challenges**
European Research Council	Leadership in Key Enabling Technologies (KETs), ICT and Space	Health and wellbeing
Emerging and future technological research	Access to venture capital	Food security
Marie Curie actions	Innovation in SMEs	Transport
Research infrastructure		Energy
		Climate action
		Society
		Company security
24 billion Euro	**17 billion Euro**	**31 billion Euro**

Source: European Commission - Horizon 2020, a EU Framework Programme for Research and Innovation

In the table 2 one may find the main priority research areas from the EU and the third countries with which EU maintains close relations of cooperation, with the mention that these topics cannot be studied by all countries (such as food security or inclusive society carried out by US or safe society studied only by the EU of the four entities), but one may also find issues where collaboration could bring better results.

Table 2 . Comparison of R & D priorities in the EU, China, India and the US

	EU	**China**	**India**	**US**
MC1*	Health, demographic change and wellbeing	Biotechnology	Better prevention and health care	Initiative "The brain and saving lives at birth"
MC 2	Food Security	Food Security	Rural transformation and sustainable growth of agriculture	
MC 3	Safe and clean energy	Energy and new materials	Ensuring India's energy future	SunShot
MC 4	Inclusive societies		Effective and inclusive markets	
MC 5	Smart transport	Clean energy vehicles	Accelerated development of transport infrastructure Urbanization management	Electric Vehicles (EV) everywhere
MC 6	Climate change	Climate change, environmental conservation	Environmental Management	
MC 7	Secure societies			
MC 8	Others	New IT, advanced equipment and technology production	Strengthening the growth capacity, reinforcing the professional skills and the faster growth of employment, political decentralization, power and information, technology	Asteroids

			and innovation, improved access to education	

* **MC** = **Major Challenges**

Source: European Commission - The international dimension of research and innovation cooperation addressing the grand challenges in the global context. May 2014 (EC 2014-1)

Under the program H 2020 international cooperation generally follows the strategic collaborations lines from the Framework Programme 7 (FP 7) with EFTA countries and the countries included in the EU Neighbourhood Policy, based on a selection process having as guiding mark the professional merits. The EU provides funding to the states whose research power can fill the gaps of the Community research, with allocations coming prevalently to entities that can contribute to the EU societal changes and industry challenges.

European Research Council (ERC 2015-1), an institution founded in February 2007 by the European Commission, whose role is to manage the Specific Programme "Ideas" of the 7th Framework Programme for Research and Development, which continues in the current Program Horizon 2020. In its Activity Report for 2014 (ERC 2015- 2) it is mentioned among the latest achievements of this institution, that after the introduction of the grants system in 2011, more and more applications were received every year, some being evaluated as very interesting, this showing that ERC efforts managed to produce good results, making the EU a more attractive area both for European researchers and also for those outside EU joining them. This means a good way to attract talents from outside EU, but also to retain the existing ones in Europe.

In July 2014, the ERC researchers presented some research results, covering a wide range of technologies, to business and academia as well as to venture capital holders. According to the 2015 plan, grants were available for frontier research in three main scientific areas: life sciences, physical and technical sciences and human and social sciences. It paid more attention to researches having an impact on a large circle of citizens, institutions or companies. It should be emphasized that over 50% of these proposals came from foreign researchers or research institutions.

An example of encouraging results of the RDI cooperation with foreign researchers is the “systems and communications technology" domain that financed 130 projects for nine major global themes: (1) brain-computer interfaces, (2) communication (3) technical tools, (4) emerging and future micro- and nano-electronics (5) emerging and future opto-electronics and photonics (6) networking, (7) new generation of components and systems (8) robotics (9) methods and tools for signal processing.

Another example of fruitful cooperation is in the nuclear energy area - fission and fusion - and nuclear safety, involving numerous foreign researchers and academic institutions from US, China, Russia, India, Japan and South Korea (Euratom 2015).

3 States and areas of interest for the EU international cooperation in the RDI sector

In the 2015 edition of the Global Innovation Index (GII - 2015) with the theme "Effective policies innovation for development" there are presented some developments in recent years in the innovation capacity of 141 countries worldwide. IGI is an indicator that is useful in assessing the overall classification of the states in terms of innovation activities. It is composed of two sub-indices: a) inputs in innovation and b) innovation results (outputs) and is calculated from 79 individual indicators.

In GII ranking for the years 2014 and 2015 there are summarized all the 28 EU Member States, with their obtained place and score. Seven countries (UK, Sweden, Netherlands, Finland, Ireland, Luxembourg and Denmark) are among the first 10 countries of the world and another 6 countries (Germany, Austria, France, Estonia, Czech Republic and Belgium) are among the top 25.

Outside the EU, other countries are placed in leading or good positions in the ranking GII, the EU maintaining close cooperation links with them: Switzerland (ranked No. 1 in GII), USA (the 5th), South Korea (the 14th), Canada (16), Australia (17), Japan (19), Norway (20), Israel (22), BRICS Member States: China (29) Russia (48), Brazil (70), India (81) and South Africa.

In the 36th edition (September 30th, 2015) of the International Competitiveness Report for the year 2015-2016, World Economic Forum (WEF, 2015) shows the evolution of competitiveness of the world countries (140 countries analyzed), according to a global index - Global Competitiveness Index (GCI). GCI is grouped into three sub-indexes and 114 simple indicators. According to the respective ranking, the developed

MS from EU are placed in the top 20 countries: Germany (4th place), Netherlands (5), Finland (8) Sweden (9) United Kingdom (10) Denmark (12), Belgium (19) and Luxembourg (20), which are also presented in the top of the most innovative countries from world, presented in the GII 2015.

However competitiveness is largely determined by the degree of involvement in the global knowledge flows, and therefore by a country's ability to participate in international cooperation projects in the RDI field. Hence, a more active participation in such agreements and collaborative actions brings good results for the countries with a higher level of competitiveness, such as Germany, Sweden, Great Britain, Holland, Denmark, Belgium, Finland from the EU and to extra-EU states, such as US, Canada, Switzerland, Japan, Hong Kong, and China, India, Brazil and other emerging countries (Stănculescu, E. 2015-1).

In the "Cooperation" section of FP7 (EC 2015-3), there were mentioned EU key thematic areas for collaborative research which continue in the current program H 2020. They are:

- Health,
- Food,
- Agriculture and fisheries and biotechnology;
- Information and communication technologies;
- Nanosciences, nanotechnologies, new materials and new production technologies;
- Energy,
- Environment (including climate change);
- Transport (including aeronautics);
- Socio-economic sciences and humanities;
- Space and
- Security.
- Euratom covers researches on nuclear fusion and nuclear fission safety.

The program H2020 emphasised the importance of the "societal challenges" concept. The societal challenges identified in H 2020 are:

1. Health, demographic change and well-being;
2. Food security, sustainable agriculture and forestry;
3. Secure, clean and efficient energy;
4. Smart, green and integrated transport;
5. Climate action, environment, efficiency of resources and raw materials;
6. Europe in a changing world - inclusive, innovative and reflective capacities societies;
7. Secure societies - protecting the Europe and its citizens freedom and security.

H2020 creates a point of contact with other nations in scientific research. For example, there is some pressure from the US to cooperate directly with the EU and not with Member States in maritime field, as suggested by the "Alliance of the Transatlantic Ocean Research".

As we know, the 21st century is called "technological society", the progress of this area, occurred in the last decades, is radically changing the way of people life, through a variety of machines, tools, devices used daily, which save time and make life easier.

European Parliament Report of January 2015 (EP - 2015) acts as a barometer for detecting the interest of policy makers and general public for new trends in technological progress. The ten technologies identified in the report as having a particularly important perspective in economic and social life of EU citizens, but also around the world are: autonomous vehicles, graphene, 3D printing, virtual currencies, portable technologies, drones, acvaponic systems, new smart home-oriented technologies, electricity storage (hydrogen) and so-called key enabling technologies (KETs).European Commission identified at European level six areas of interest: nanotechnology, micro and nanoelectronics, industrial biotechnology, photonics, advanced materials and advanced manufacturing technologies (EC, 2012).

One of the increased interest forms in KETs is the proliferation of programs aimed at developing and supporting them. Without intending to give an exhaustive list we mention some examples: ARRA; Make it in America; ARPA-E in the US; National program for R&D in high-tech field in China; Assistance program for setting up innovation centres in Japan; Act to promote foreign investment in South Korea; Centres on innovative multinational R&D in Taiwan; Schemes for companies to stimulate research and technological innovation program in Singapore etc.

A goal to be reached in 2016 that would facilitate international cooperation actions in the EU RDI is the Digital Union (EC 2015- 5). The purpose of creating the digital single market is the removal of regulatory barriers separating the 28 national markets in the EU. The Commission will make a thorough analysis of the

role of online marketing platforms (search engines, social media, app stores, price comparison websites, etc.) given their impact in economic and social life (they permit to consumers to find information online and to companies to exploit the advantages of e-commerce). In the European Commission view, a fully functioning digital single market will bring significant benefits for consumers, Small and Medium Size Enterprises (SMEs), start-up companies, creative and industry sector within the EU, but also for cooperation actions in RDI sector.

The benefits of creating the digital single market will be seen in the context of international R & D collaborations, because the creative sector will dispose of:

- New business opportunities in the EU;
- An environment conducive to cultural diversity, creativity and exchanges among member countries;
- Improve the enforcement of rights and more effective action to combat piracy;
- Increasing legal access to digital data users, that would bring greater benefits for authors and would reduce piracy;
- Clarifying the rules for all actors on the EU internal market, including intermediaries that use content protected by copyright;
- Fairer remuneration of copyrights, involving all players in the value chain;
- Adapting media legislation to the digital era and ensuring the promotion of European works, especially online platforms for video on demand.

Romania has a poor participation in EU programs of international cooperation in RDI

Ranked 54 in 2015 (55 in 2014) in GII ranking, Romania faces far greater challenges than the Western Europe developed countries, in terms of research capacity development and innovation. RDI Strategy for 2007-2013 has envisaged ambitious goals focused mainly on increasing scientific production and local research human capital and also internationalization process and helped to establish a system of governance and institutional framework through which the administrative procedures involved in international cooperation could be simplified.

RDI National Strategy identifies several objectives regarding the development of international cooperation on regional and global level. Firms become key operators for innovation and excellence in RDI internationalization.

The National Plan for Research, Development and Innovation III (PNCDI III -2015), for the period 2015-2020, supports the participation of Romanian institutions in international research projects, in order to facilitate the researchers mobility and their access to programs that are not available in Romania.

4 EU partners in RDI international cooperation

4.1. USA

United States is a long-haul partner for the European Union, with official relationships starting in 1990 by the adoption of the Transatlantic Declaration. Since the 2007 US-EU Summit, the Declaration on Enhancing Transatlantic Economic and Growth Integration established a dialogue agenda for economic growth (EC 2014 - 2).

In February 2014, US entities have already participated in FP7 in 486 projects, signing agreements worth of 76.4 million euro. Top field participants of the American institutions and researchers to FP7 were at: Health - 55% of the total, ICT - 11%, KBBE (Knowledge based bio-economy) - 6%, NMP (Nano-sciences, nano-technologies, new materials and production technologies)-4%; Energy-7% Capacities (section of the Framework Programme 7) - 4%.

An underway project FP7 is BILAT EU – US (BILAT USA 2.0), whose aim is to examine areas relative to the framework cooperation conditions (ex. intellectual property, financing the US participants in common R&D programs, contractual issues, financial problems that include audit, participation rules, cooperation schemes, technology transfer and innovative knowledge, transatlantic mobility, etc.).

US was designated as important cooperative partner in the first work program of H2020 for the years 2014-2015, being encouraged to cooperate in areas such as marine and arctic research, health, transport (including aeronautics), raw materials, ICT , energy and security. Joint researches in the new bio-oriented technologies field hold also an important place. The Strategic Forum for International Cooperation (SFIC) acts for the development of synergies in the US and EU cooperation, including Member States' activities. For the future, the EU-US RDI cooperation will focus on the following activities: marine and arctic area, health, transport, raw materials, energy, e-infrastructure, nuclear fusion and fission, medicine, transport, etc (Stănculescu, E. 2015-2).

4.2. Japan

Scientific relations between Japan and the European Union have developed into a steady pace over a period of 20 years. Japan is one of the world leaders in science and technology. In 2013, the gross expenditure on R & D was 3.7% of GDP, based on a long-term target of 4% of GDP.

Having the same problems (energy security, access to raw materials, population aging) and similar approaches for other international important issues as climate change and security, Japan may be considered one of the closest collaborators of the EU on the international scene (EC 2014-2). In the first stage of the Euro-Japanese agenda one may find the negotiations on the Free Trade Agreement (FTA) and the Strategic Partnership Agreement (SPA), launched as early as April 2013, and focused on political dialogue, the cooperation to solve regional and global problems and sector cooperation (including science and technology).

By February 2014, the Japanese institutions and researchers have already recorded 108 participations in FP7; by signing financing agreements, Japan has received a total contribution of 8.9 million euro from the EU. Japanese participation in various sub-programs of FP7 is: 26% - Euratom, 22% - "Capacities" section, 16% - ICT, 10% - Health, 10% - NMP (Nanosciences, nanotechnologies, new materials and production technologies), 7% - population aging 3% - SSH (socio-economic sciences and humanities), 2% - transport, 2% - space research, 1% - security and 1% - KBBE (Knowledge-based bio-economy).

4.3. South Korea

Relations between the EU and South Korea are based on the Framework Agreement (entered into force on June, 1 st 2014). South Korea is the only country with which the EU signed a Framework Agreement (2010), a Free Trade Agreement (2011) and a Crisis Management Agreement (May 23, 2014).

In 2012, South Korea had the second national budget allocated to R & D, as a share of GDP, in the world (over 4%). EU and South Korea are important trading partners. European companies are the largest investors in South Korea. South Korea is the tenth major EU trading partner and the EU is the fourth largest export destination for South Korean goods (after China, Japan and the US).

Under FP7, the greatest share in the total value of the EU-South Korea R&D contracts is owened by the following areas: ICT - 29%, health - 24%, "Capacities" - 25%, NMP - 9% and environment - 6 % (EC 2014-2).

In the H2020 program there were included joint actions of the two parties:

- co-ordinated applications regarding the future ICT networks (5G, cloud, IoT (Internet of Things), experimental platform);
- nano-technologies: nano-safety standardization and regulation (participation in the program NANOREG);
- 5G network infrastructures for the future Internet;
- nano-materials impact assessment on the environment;
- increasing the performance capacity of nano-safety evaluation;
- micro- and nano-electronics enabling technologies;
- building international partnership and support the dialogue with countries with a high GDP;
- recycling and reproduction technologies and equipment for the product sustainable lifecycle management;
- specific cooperation between JET[1] and Kstar[2] programs in the nuclear fusion field;
- Korean participation in specific activities with broader potential approach.

4.4. China

Collaboration in research, development and innovation is an essential component of particular importance to the strategic partnership established in 2003 between the EU and China and also one of the fundamental pillars of the EU and Member States relationship with this Asiatic partner.

China is already the second largest global investor in research and development, an area in which its investments were over 2% of GDP in 2015 (Brauner, O. 2011). EU-China RDI cooperation is governed by the EU-China Science and Technology Agreement, signed in 1998, and renewed in 2004 and 2009 and other agreements and arrangements having as the main objective to reinforce various aspects of bilateral scientific cooperation (China 2015). Under FP7, 383 Chinese organizations participated in 274 cooperation projects, which summarised a total EU contribution of 35.24 million euro. In addition, Marie Sklodowska-Curie program

[1] Jet European Torus=the greatest industrial equipment for nuclear fusion
[2] Korea Superconducting Tokamak Advanced Research – Korean nuclear fusion

counted on 959 participations from China (EC 2015-3).

4.5. Other BRICS states

In recent years, other Member States of the BRICS group (Brazil, Russia, India, South Africa) have concluded cooperation agreements and participated to EU programs in the field of scientific research. The main areas of cooperation between these countries and the EU under the Framework Programme 7 and H 2020 (EC 2014-2) are:

Brazil: health, KBBE, "Capacities", ICT, energy, SSH, NMP and transport. Marine and bio-economy researches, food security and nanotechnologies are added.

Russia: transport, health, "Capacities", ICT, energy, and space research, KBBE. We may also add future demographic changes and material welfare, climate change, nanotechnologies, etc.

India is a partner of major concern for EU cooperation in RTD. Important institutions and researchers from India participated in FP7 with significant weight at sections: health (46% of total funds accessed), environment, KBBE, energy and ICT. In the future other areas of interest could be Euratom, water, bio-economy and others.

South Africa had RDI cooperation actions with the EU mainly in the areas of health, environment, KBBE, "Capacities", ICT, transport and SSH. There will be added in the future, as both parties intend, the Earth observation, research infrastructure, pole (Antarctica) research, raw materials etc.

Generally, many emerging countries are invited to participate in EU research programs, based on the principle that in the sphere of scientific research they have common interests with those of the EU and dispose of qualified staff for this sector.

5 Conclusions

Based on the analysis undertaken in this article one may draw several conclusions.

RDI international cooperation is becoming more intense every day, because, on the one hand, the problems are common to all countries worldwide and it is much more effective to collaborate in scientific research than to overlap or duplicate the research efforts, and, on the other hand, the information spreads much easier and faster today, helping to tackle fluently the major challenges of scientific progress.

Through international cooperation, one may allocate to the RDI financial and human resources existing in developed and emerging states more effectively on sub-domains of major interest to mankind. Some challenges and priorities identified by some nations are not taken into consideration by others and therefore international cooperation is an important factor for an easy access to knowledge for the states or groups of states.

The last EU Framework Program-FP7, concluded in 2013, had a special section entitled "Cooperation in R&D" and its achievements have been encouraging in terms of EU international collaboration. The current program, H 2020, supports the interest for international cooperation in RDI, especially in the following areas : health, food, agriculture and fisheries, biotechnology, information and communication technologies, nano-sciences, nano-technologies, new materials and production technologies, energy; environment (including climate change), transport (including aeronautics), socio-economic sciences and humanities, space and security. There is a wide variety of mechanisms for cooperation: joint research projects (the most common), experience exchanges, conferences, workshops, researchers'mobility. The EU can provide funding to the states with a power research that may fill the gaps in Community research, the allocations returning with priority to entities that can contribute to societal changes and industrial challenges set by the EU program. H 2020 encourages scientific research targeting both demand-side and supply-side. A tool for strengthening the links between the Member States and the EU citizens but also for RDI international cooperation activities is the Digital Union, planned to be completed by the end of 2016.

The most important EU partners in RDI cooperative activities are: USA, Japan, South Korea, BRICS Member (Brazil, Russia, India, China, South Africa), Canada, Israel, Turkey and countries from Africa, South America and Asia. These countries participate in EU programs and actions in the field of research and development: H 2020, Euratom, ITER, Marie Curie Actions, EUREKA, JET and other lesser extent programs that the EU has opened for a broad involvement of foreign institutions and persons. The importance of EU cooperation with the US, Japan, South Korea and BRICS countries (especially China and India) is shown by the large number of cooperative actions and agreements concluded with these countries. The most important areas of cooperation are health (away the first as a share of the funds received by joint actions), environment, ICT, energy (nuclear and non-nuclear), bio-technology, security, demographic changes, new materials, nano-

technologies and new production technologies.

Romania's policy in RDI is governed by the National Strategy for 2014-2020 which states that Romania's participation in the European Joint Programme Initiatives (JPI), the Joint Technology Initiatives (JTIs), the European Innovation Partnerships (EIP), the bilateral programs and those programs organized by a number of international bodies will be financed by the state. Another problem that may help to achieve this goal is the level of education and qualification of the Romanian researchers, hence the need to allocate adequate material and financial resources for ensuring their training and mobility.

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