National Smart Specialisation Strategy

November 2014

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List of abbreviations

BM.....Ministry of Interior
B2B .....Relations of companies and firms *inter se* (Business-to-business)
CCHOP……Competitive Central Hungary Operational Programme
CIS .....„Community Innovation Survey”
DE .....University of Debrecen
DRS .....Danube Region Strategy
EDP .....“Entrepreneurial Discovery Process”
EKD .....Individual Government Decision
EMMI.....Ministry of Human Capacities
EAFRD.....European Agricultural Fund for Rural Development
EDIOP…… Economic Development and Innovation Operational Programme
ERDF .....European Regional Development Fund
ESFRI.....“European Strategy Forum on Research Infrastructures”
ESIF.....European Structural and Investment Funds
ESF.....European Social Fund
EMFF .....European Maritime and Fisheries Fund
EU .....European Union
Eurostat...Statistical Office of the European Union
FDI .....Foreign Direct Investment
FET……. ….Future Emerging Technologies
FIEK…..…..Higher Education and Industrial Cooperation Centre
FP7…… ……Framework Programme for Research and Technological Development
FTE.....Full Time Equivalent
GDP .....Gross Domestic Product
HFOP……..Hungarian Fisheries Operational Programme
HPC.....High Performance Computing
HRDOP…..Human Resources Development Operational Programme
H2020.....Horizon 2020
MA.....Managing Authority
IKF.....“Information and Knowledge Fusion”
ICT .....Information and Communication Technology
IUS .....Innovation Union Scoreboard
JRC.....Joint Research Centre A Directorate-General of the European Commission.
R+D.....Research and Development
KET .....Key Enabling Technologies
RDI.....Research, Development and Innovation
RDP…….Rural Development Programme
RI .....Research Infrastructure
R+I .....Research and Innovation
KKM.....Ministry of Foreign Affairs and Trade
SME .....Small and Medium-sized Enterprise
KMR.....Central Hungarian region
KSH .....Central Statistical Office
KTIA .....Research and Technology Innovation Fund
ME .....Prime Minister’s Office
HAS.....Hungarian Academy of Sciences
NEKIFUT...National Research Infrastructure Survey and Roadmap
NFM.....Ministry of National Development
NGM .....Ministry for National Economy
NKFIH .....National Office for Research, Development and Innovation
NIH .....National Innovation Office
NIT.....National Level Steering Board (S3)
NUTS.....Nomenclature of Territorial Units for Statistics
NUTS-2 ....Level of statistical regions
NUTS-3 ....Level of the counties and Budapest

OECD .....Organisation for Economic Cooperation and Development
OP.....Operational Programme
OTKA .....National Scientific Research Fund
PcP.....Pre-commercial procurement
PPP .....cooperation between the public and private sectors (public-private partnership)
PPI .....Public Procurement of Innovative Solutions
PTE .....University of Pécs
RIS3 .....Regional innovation strategy based on smart specialisation (national/regional research and innovation strategy for smart specialisation)
RIA.....Regional Innovation Agency
SF.....Structural Fund
S3.....Smart Specialisation Strategy
SRI .....Strategic Research Infrastructure
SWOT .....Strengths, Weaknesses, Opportunities and Threats
TO.....Thematic Objective
TEÁOR .....Single classification system of sectoral activities
S&T.....Scientific and Technological
STI.....Science, Technology and Innovation
VM.....Ministry of Rural Development

Introduction

In order to maintain and increase the economic role of the Community and the wellbeing of the Member States, the Union treats research, development and innovation and encouraging the socio-economic exploitation of the results thereof as priorities in the 2014-2020 programming period. Therefore, the most important objectives of the seven years include i) making Europe a world-class science character; (ii) eliminating the barriers to innovation); and iii) strengthening cooperation between the public and private sectors.

It is important, therefore, that all nations and territorial units develop their own research and innovation strategy *in coordination with each other*. The strategies so developed ensure that the funds available from the Structural Fund, being a key instrument of the cohesion policy, can be used by the members in a coordinated manner and effectively, building on the EU, national and regional synergies.

The strategies would outline, in the areas of research and innovation, who wants to be the best, setting out from the existing situation, and in which area. This will avoid the duplication of development, and facilitates EU level co-ordination and increasing the competitiveness of the Community. These documents are the *smart specialisation strategies* (also known as RIS3 or S3). Similar to innovation strategies have been prepared in the past as well, but the new types of strategies differ from their predecessors:

- the local target audience and resources are widely involved in the strategy-building;
- the emphasis is moved from technological research and development to fostering the full process of innovation;
- not only the best practice is adopted, but the foundations are laid on the economic competitive advantages and future potentials while recognizing the unique strengths and values of the areas.

The preparation of the smart specialisation strategies is not only a recommendation, but has also been incorporated into the EU body of law. Regulation 1303/2013 EU provides that a Member State may be granted EU funds to strengthen research, development and innovation, as well as the development of information and communication technologies only if that country has a smart specialisation strategy and the grant is given in accordance with the objectives thereof. So, the preparation of the S3 design documents is a condition precedent to supporting *research, development and innovation* in all Member States.

The S3 is developed in the rigorous methodological framework predefined by the EU in every country. Hungary began planning in early 2013, during which a wide range of social reconciliation took place, using a variety of domestic design documents, summarising the objectives of the different territorial levels and intertwining with the design of the operational programmes.

Prepared as a result of the work, the national smart specialisation strategy sets the directions for the entire country, along which research, development and innovation are planned to be is supported in the most sustainable way, with the greatest social profit and the promise of the best financial utilisation rate.

1. Situation analysis

1.1. General situation

1.1.1. Society

According to the 2011 census, 9 million and 985 thousand people were living in Hungary. Like most of the countries of the European Union, the decline of the population in Hungary is coupled with the ageing of the society, namely, **the increase in the proportion of the elderly**, in which low fertility and the increase in life expectancy play a crucial role. There were **significant differences** in the **population movements** of the counties during the past years. Budapest and Pest and Győr-Moson-Sopron counties showed a significant positive balance for the 2001-2011 period, **while the majority of the counties which suffered the migration loss is located in the eastern part of the country**.

The **health status** of the Hungarian population is not favourable in international comparison. According to figures of the KSH, the average life expectancy at birth was 72.01 years for men and 78.78 years for women, respectively, in 2013, which is below the average of the Member States of the European Union (it was 77.5 respectively 81.83 years in 2012). The **high mortality rate among middle-aged men**, which has continuously been observed for several years, should be highlighted. The problems are aggravated by the inequalities in respect of the health status within the country, which are well characterized, for example, by that the difference in life expectancy between certain social groups can be up to 4-6 years. Another problem is the **low rate of the use of preventive health services:** this is clearly shown by that in only a little more than a quarter of the adult population participated in a chest examination in 2012.

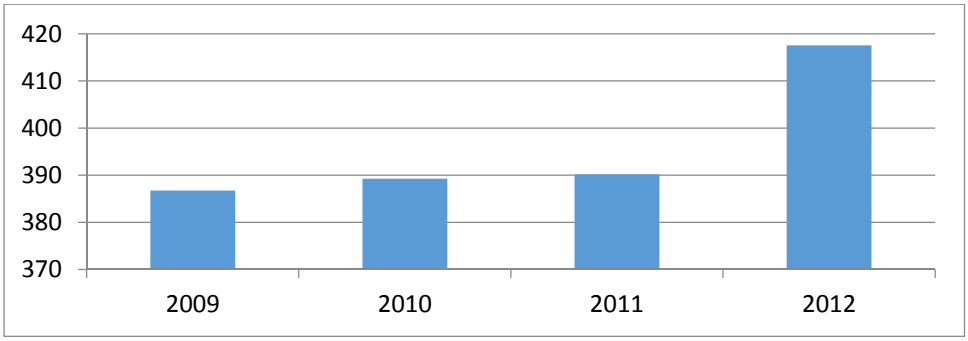
The proportion of public and private health expenditure to the GDP varied from 7.5% to 7.8% between 2009 and 2012 – this is relatively low among the OECD members, and is an average value in terms of our region. According to the OECD data, this ratio is above 10% in a part of the developed countries, while the expenditures of Hungary can be compared with Slovakia (8.1%) and the Czech Republic (7.5%). The **proportion of the resources devoted to state curative-preventive services to the GDP fluctuated around 3% in recent years.**

1.1.2. Sustainability

The preservation of the health of the society and the development of a modern economic structure are linked to the environmental issues. There has been **significant progress** in many areas, for example, the quantity of waste water, which is treated only primarily (mechanically) decreased by 93.3% (!) from 2007 to 2012, while the quantity of waste water treated through 3 cleaning stages from the purified waste water almost doubled during the same period.

The R&D expenditures for environmental purposes also increased significantly, though with large fluctuations. The environment is also a priority objective in the OECD classification system of socio-economic objectives – according to the data of the KSH, the R&D expenditure devoted to that purpose increased steadily both in absolute terms and in proportion to the GDP in recent years. It should, however, be noted that the expenditures of the national economy for environmental purposes have stagnated in recent years.

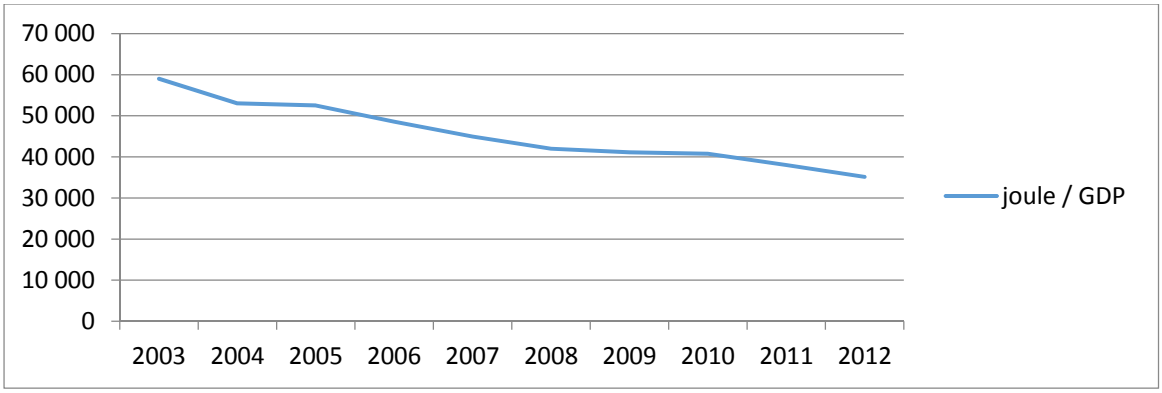
Figure1: R&D expenditure for environmental purposes per 1 million HUF of GDP (GHUF/1 million HUF of GDP)



Source: NIH RDI Observatory calculations on the basis of KSH

In the meantime, energy efficiency increased significantly in Hungary: the quantity of energy required to produce one unit of GDP steadily declined in the past decade: the 2012 value is only 59.36% of the value of 2003.

Figure2: Quantity of energy required to produce one unit of GDP (Joule/GDP)



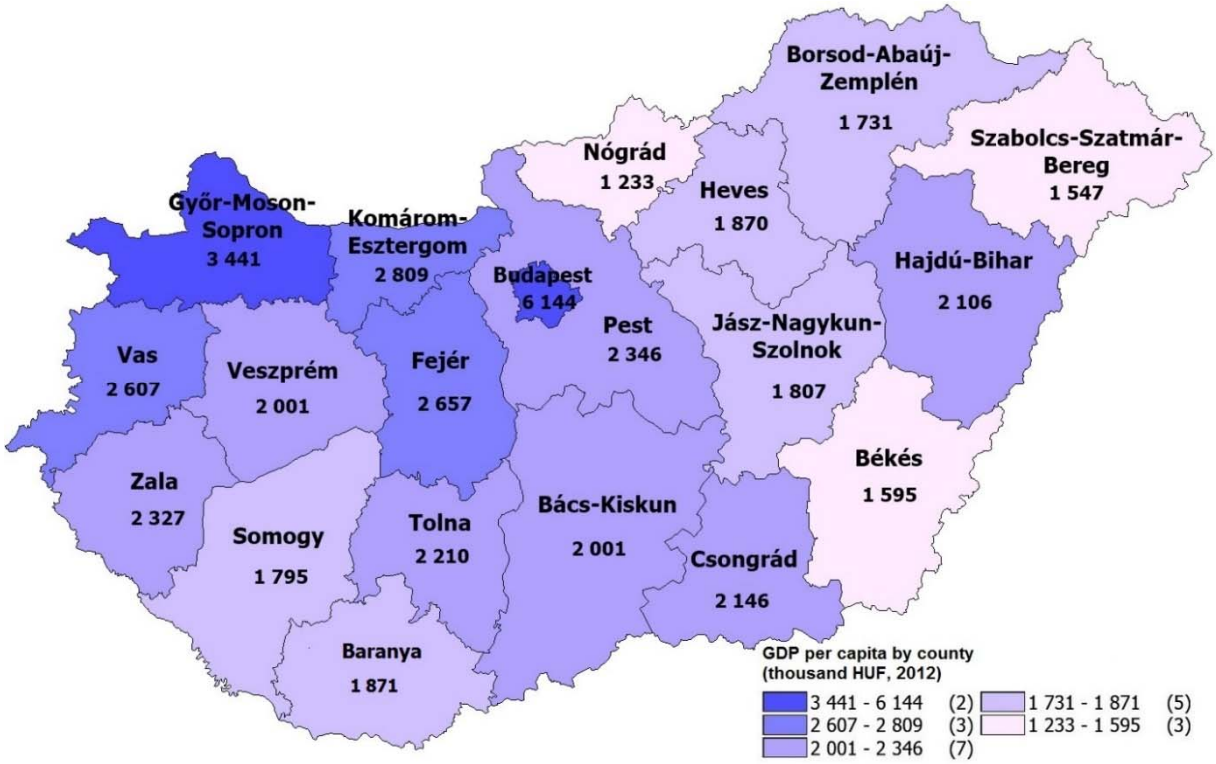
Source: Eurostat

The proportion of renewable energy sources reached 9.6% of the total energy consumption by 2012. This is below the EU average of 14.1%, but is gradually increasing. The National Energy Strategy set the target of 14.6% by 2020.

1.1.3. GDP and added value

The total GDP produced in Hungary in 2012 was HUF 28,048.1 billion, which means 2,827 thousand Forints per inhabitant. In terms of the performance of the counties, the **performance of Budapest** is outstanding (not included in the graph, value: **6,144 thousand HUF/inhabitant) and is more than twice the national average.** In addition, only the performance of Győr-Moson-Sopron (3,442 thousand HUF/person) exceeds the national average, which clearly shows that the country is capital-orientated, and the **relative prosperity of the north-western part**. The lowest per capita GDP was produced in Nógrád county in 2012, namely 1233 thousand HUF/person, which is only 43.6% of the national average.

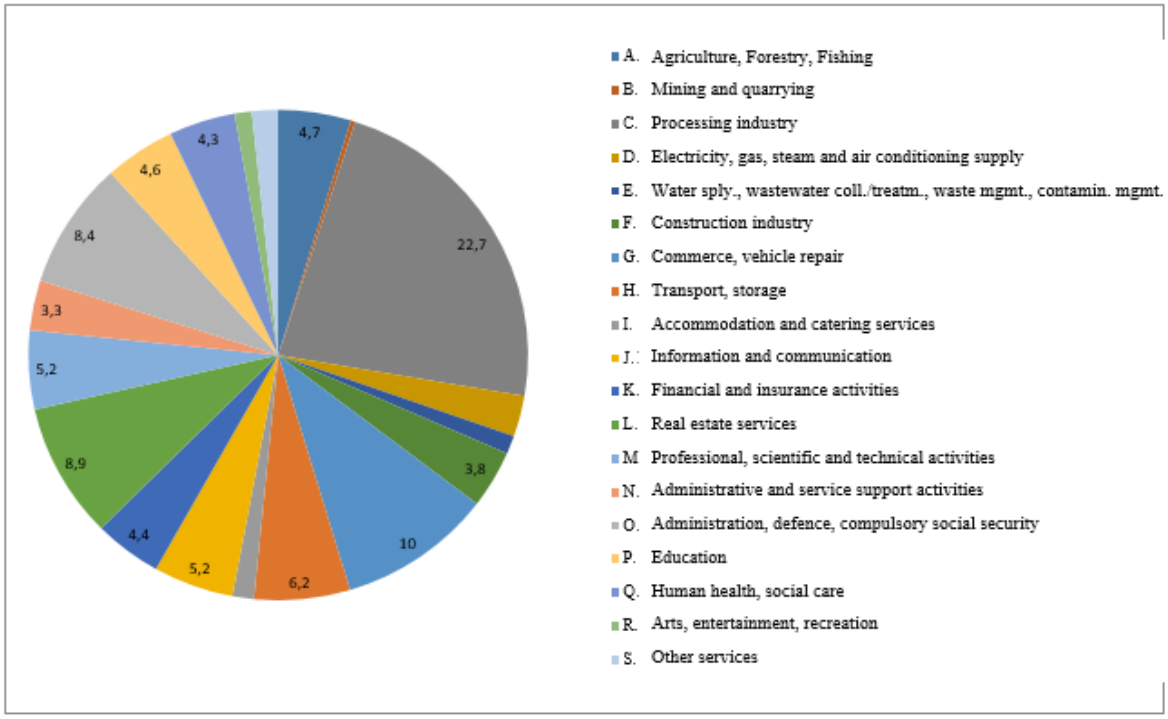
Figure3: Comparison of the economic development of the counties, measured by per capita gross domestic product, in 2012



Source: NIH RDI Observatory on the basis of KSH data

The role played the by **manufacturing industry** is outstanding in the distribution of the gross added value by the sectors of the national economy (22.7 percent). Examining the time series data, the stable defining role of the manufacturing industry is clear, while the share of the **agriculture** is descending (1995: 8.5%, 2009: 3.5%) although there was a moderate growth in the last three years (2012: 4.7%). The share of the trade is hovering at around 10%, while that of the construction industry is hovering at around 5%, but the latter has been constantly decreasing compared to the other sectors since 2005 (2012: 3.8%). The share of the **information and communication** sector is steadily increasing.

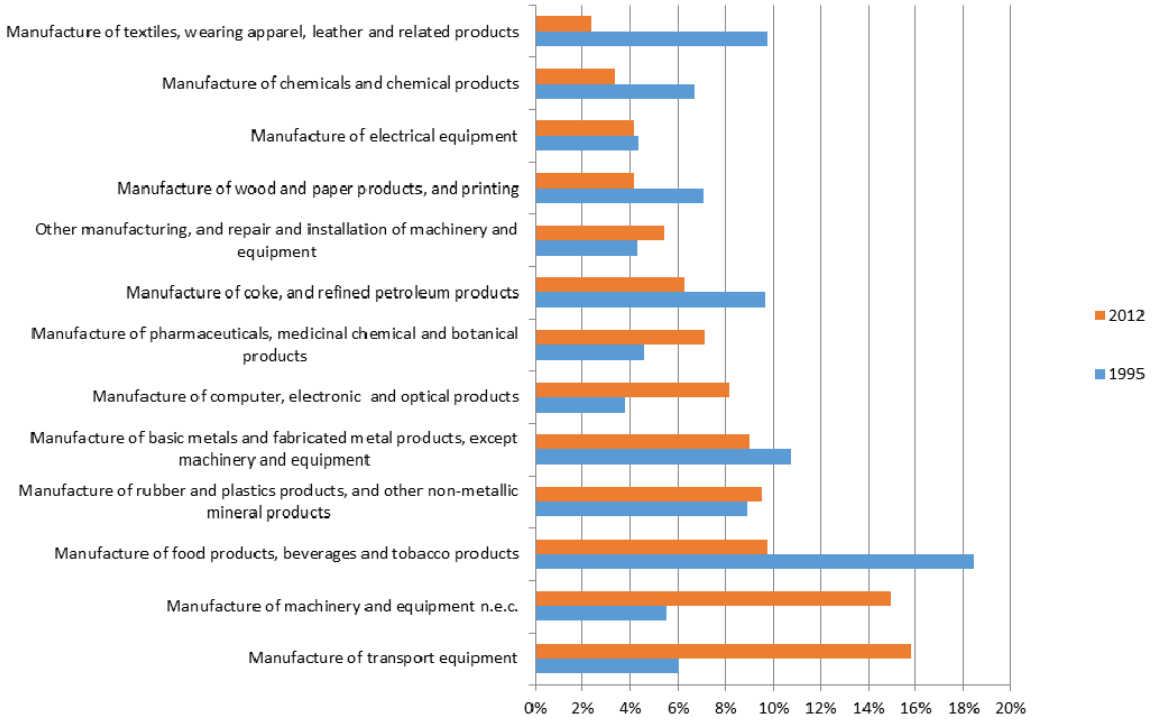
Figure4: *Distribution of the gross added value by sectors of the economy in 2012,%*



Source: KSH

The sectoral distribution of the added value of the manufacturing industry has gone through a significant change in recent years: **among other things, the weight of the automotive industry, machine building and pharmaceuticals have increased significantly.**

Figure5: Distribution of the added value of the manufacturing industry in 1995 and in 2012 (%)



Source: NIH RDI Observatory on the basis of KSH

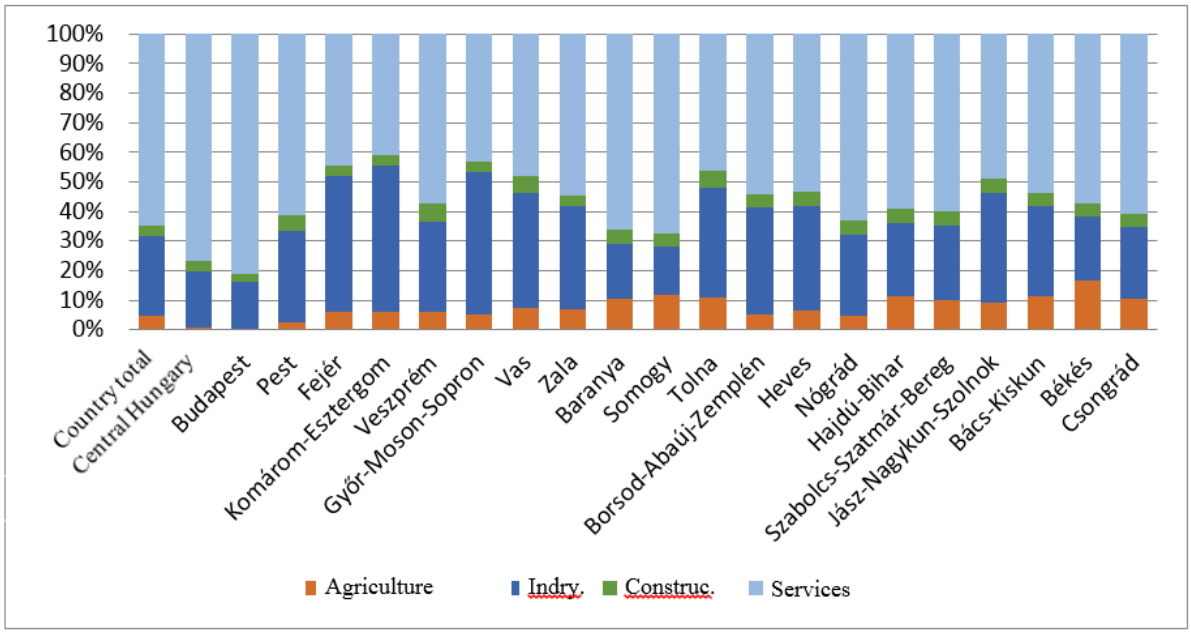
We can arrive at similar conclusions on the basis of the examination of the sectoral structure of the whole industry (sales data from 2001 and 2013): **the automotive industry and energy supply emerge** in the distribution of sale of the various sectors with **a share of nearly 20%** (the share of the automotive industry significantly increased from 2001 to 2013, while that of the energy supply increased moderately in the same period). The **food industry and the electronics industry** also had a share of around 10% in 2013. The performance of the latter was surging (both in terms of the added value and the sales). **Machine production shows a dynamically upward trend** by increasing its share to 6.4% in 2013 from the marginal value of 2.4% in 2001. **The rising position of the chemical industry** (2001: 3.8%, 2013: 4.9%) **and the pharmaceutical industry** (2001: 2.0%, 2013: 2.6%) is also outstanding. Among the sectors, the situation of the rubber and the plastics industry can be considered stable (2001: 5.7%, 2013: 5.9%) The manufacture of electrical equipment fell significantly (2001: 8.0%, 2013: 3.4%), and the weight of wood processing, the paper and printing industries (2001: 3.5%, 2013: 2.6%) as well as the textiles, clothing and leather industries (2001: 3.2%, 2013: 1.2%) decreased.

The volume index changes show that **the industries which are at an advanced technological level and require skilled labour industries have been able to show a significant improvement in recent years** (manufacture of machinery and equipment, vehicle production, manufacturing of computers, electronics and optical products) as opposed to the more labour-intensive industries which required a lower level of automation (manufacturing of textiles, clothing, leather and leather products, production of food, beverages and tobacco products).

Examining the sectoral distribution by counties, it can be concluded that **the service sector** dominates in the production of added value in a **significant part of counties and Budapest**, while the added value

produced by the **industry** is higher that produced by the services **in the north-western counties** (Fejér, Komárom-Esztergom, and Győr-Moson-Sopron).[1]

Figure 6: sectoral distribution of gross added value by counties, in 2012



Source: NIH RDI Observatory based on KSH data

1.2. RDI status

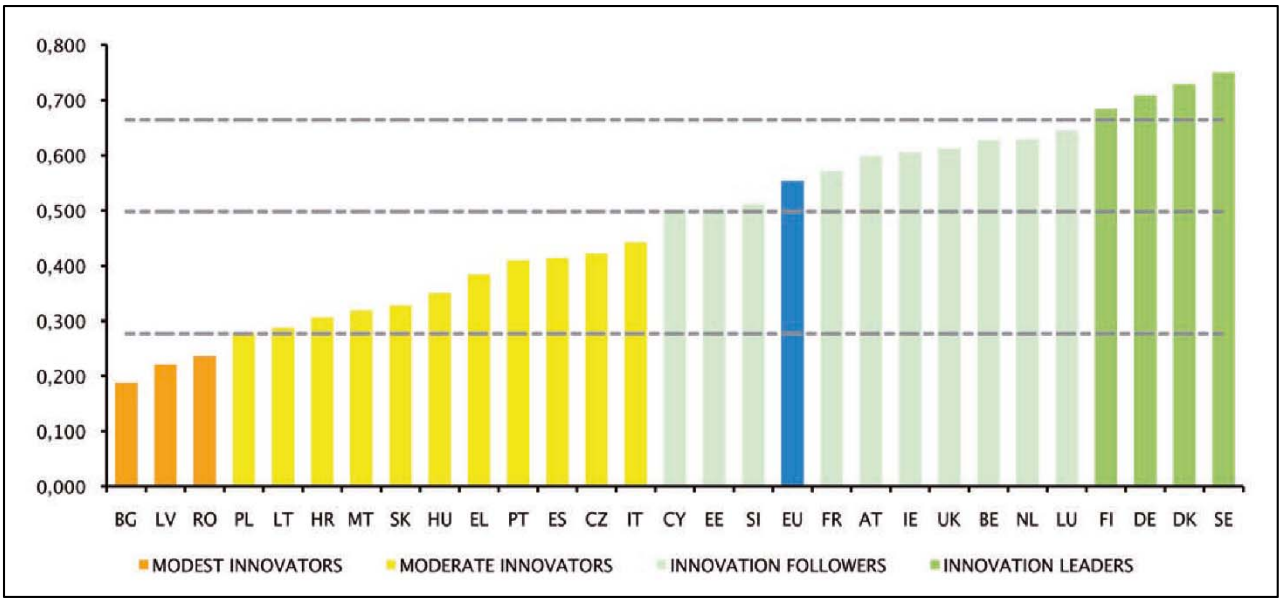
1.2.1. General RDI status

The innovation performance of the EU improved on the basis of the 2014 ranking of the Innovation Union[2]. Hungary is among the moderately innovative countries, like the majority of the countries in the region, including Slovakia and the Czech Republic.

[1] To enable easier transparency, the sectors of the national economy are shown in an aggregated manner.

[2] Issued annually, the report evaluates the innovation performance of the European states on the basis of a total of 25 aspects of 8 dimension (human resources, R&D system, finance and subsidies, corporate investments, relationships and entrepreneurship, intellectual property, innovators, economic impact). The 25 dimensions of the complex scoreboard is in the annex.

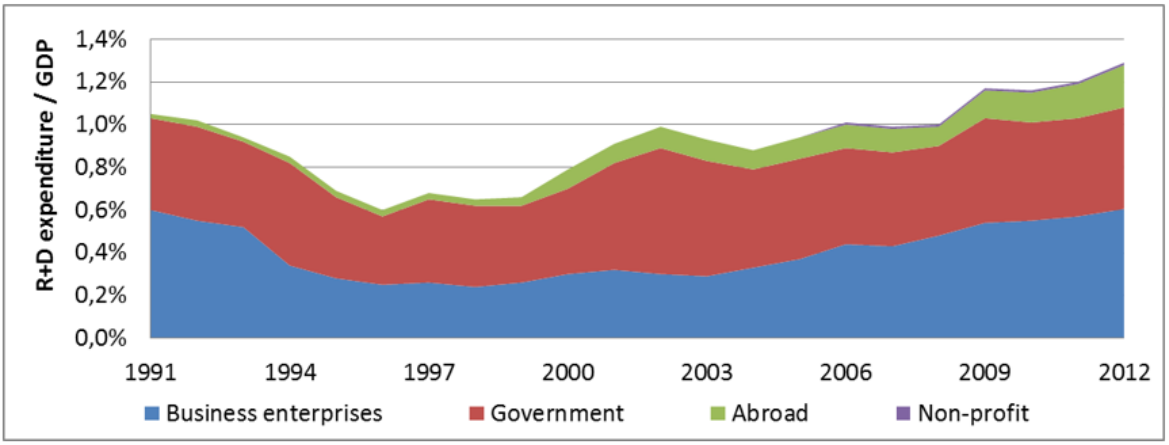
Figure7: Hungary's innovation performance in international comparison



Source: Innovation Union Scoreboard, 2014

In Hungary, the **GDP-proportionate R&D expenditures** have increased by 30% since 2008, and are expected to reach **1.44%, which is the highest level of the past twenty years.**[3] The **corporate R&D expenditures started to grow from the late 1990s, and their growth has intensified in recent years,** so they account for nearly half of the R&D expenditures. In addition to the corporate sources, the proportion and value of foreign funds are steadily increasing, and one-sixth of the expenses are today financed by foreign actors. The proportion of public resources has not changed in recent years.

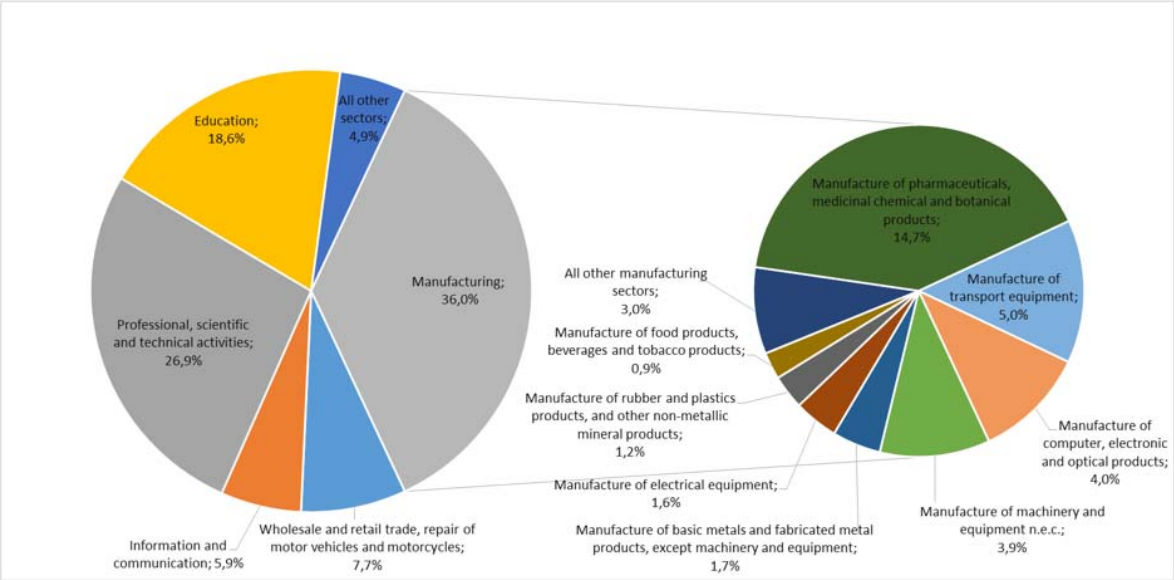
Figure8: Sources of GDP-proportionate R&D expenditure (1991-2012,%)



Source: KSH

[3] Based on the preliminary data of KSH.

Figure9: Proportion of R&D expenditures by the sectors of the national industry and the sectors of the manufacturing industry (2012; %)



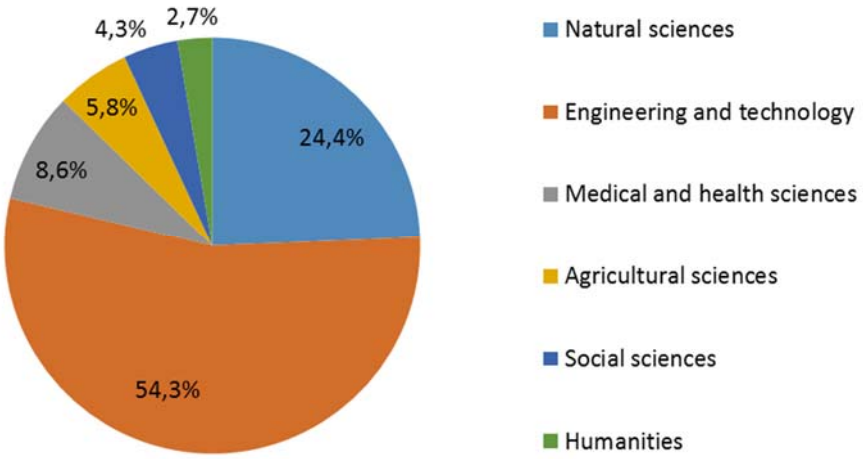
Source: NIH RDI Observatory calculations on the basis of KSH

The major part of the GDP-proportionate R&D expenditures is tied to **the manufacturing industry**, and the contribution of the professional, scientific and technical activities and the education is considerable as well. Information and communication has a share of 5.9%. Within the manufacturing industry, pharmaceuticals has the greatest weight, while **the combined R&D expenditures of vehicle construction, electronics and mechanical engineering remain below pharmaceuticals.**

The GDP-proportionate R&D expenditures show opposing dynamics in some sectors: they are increasing rapidly in the machine building, but slowly in the food industry, while no clear trend can be demonstrated in machine building and the manufacture of computers, electronic and optical products. The specific R&D expenditure of the pharmaceutical industry has fluctuated in recent years.

The R&D expenditures of the areas of science showed a very unequal picture in 2012: **within the total expenditures, the share of the technical sciences was 54.3%, while that of the natural sciences was 24.4%.** The **share of medical sciences was 8.6%**, and that of the **agricultural sciences was 5.8%**. The share of the social sciences (4.3%) and humanities (2.7%) can be considered low.

Figure10: Share of the R&D expenditures of the various areas of science (2012);



Source: KSH

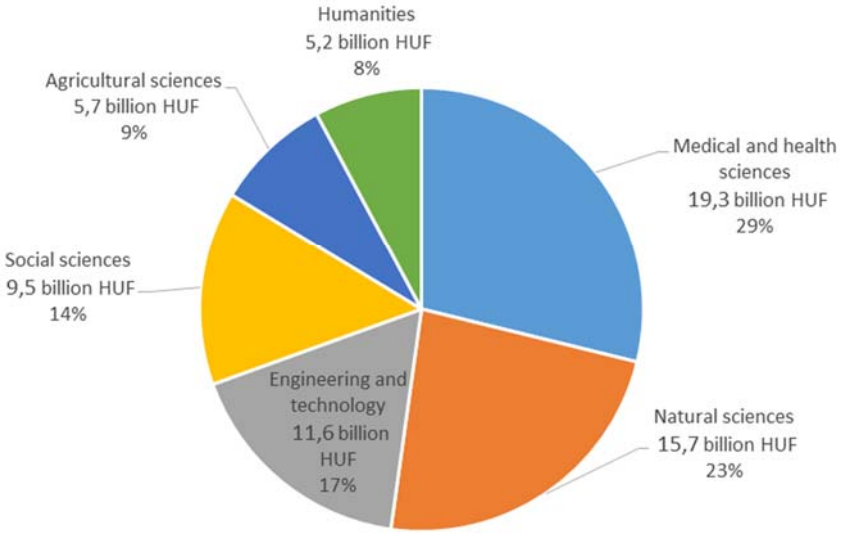
In 2012, **two-thirds** of Hungary's R&D expenditures of 358.2 billion HUF **was realized in the corporate sector. The total weight of the institutional sector in the R&D expenditures was close to 15%, while that of the higher education sector was almost 19%.**

1.2.2. Higher education research organisations

Most of the data come from the processing of the S3-related questionnaires realized in 2014 in the cooperation of EMMI and NIH RDI, and filled by the higher education institutions. We received a response from 28 higher education institutions relevant to S3. So we have a virtually complete view of the projects in the higher education sector which are significant from our perspective.

The **most important areas** of higher education research are **the health sciences, the natural sciences and the technical sciences. The proportion of social sciences and humanities in higher education is higher than in the rest of the sectors.**

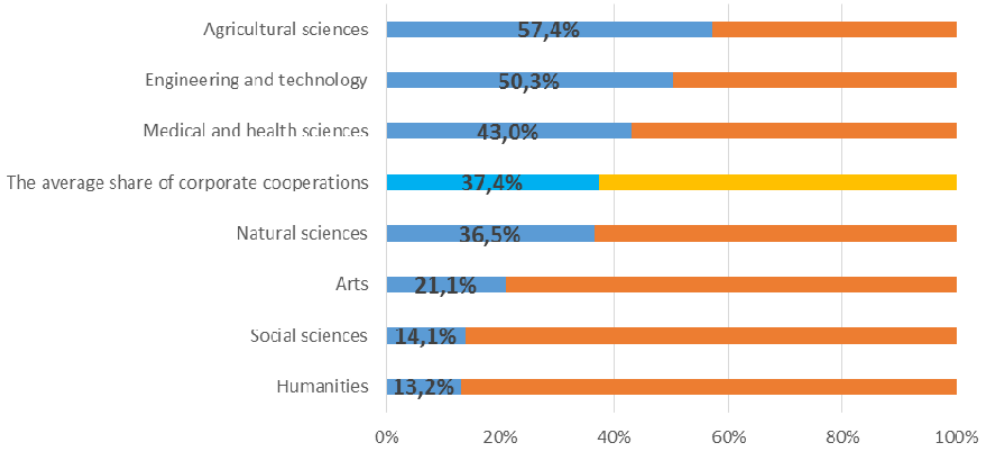
Figure11: Distribution of the R&D expenditures of higher education by areas of science (a total of 67 billion HUF in 2012)



Source: KSH

We examined also in respect of the research carried out in the higher education sector the frequency of the collaboration of higher education and the companies in research projects within each discipline. The higher education sector collaborated with the company in 37.4% of the more than 2,400 research projects, which is considered high. However, the collaboration rate significantly differs in certain disciplines: it is the **highest, over 50%, in the agricultural sciences and the technical sciences, and it is the lowest in the social sciences and the humanities**. In these areas of science, corporate-academic collaborations are present only in every 6th or 7th project.

Figure12: Corporate participation in higher education research projects



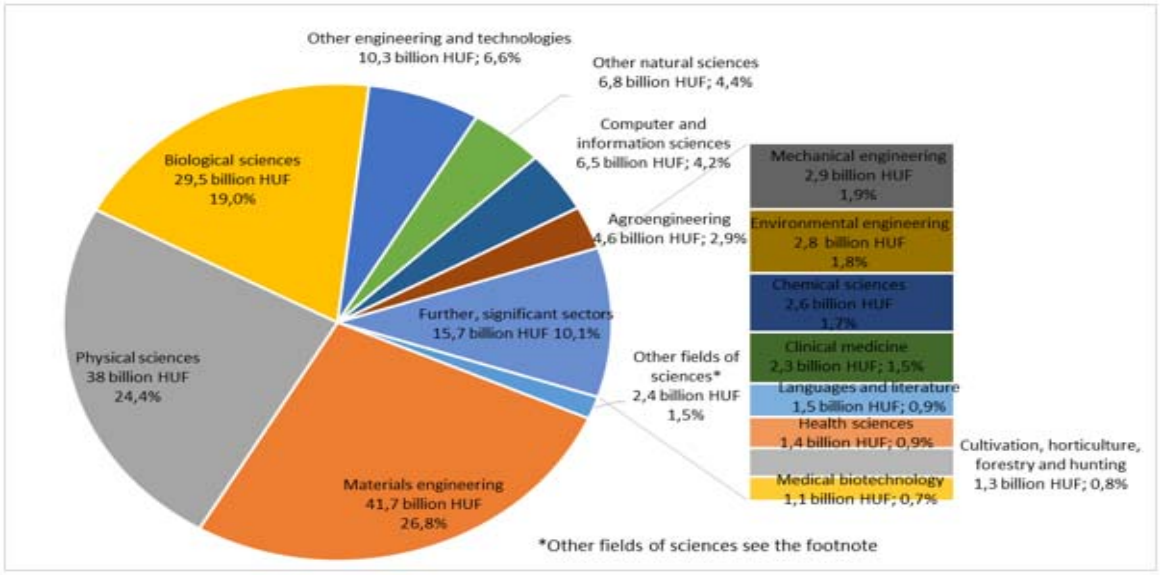
Source: Higher education S3 questionnaire, EMMI-NIH RDI Observatory, 2014

1.2.3. Research of the HAS

The Hungarian Academy of Sciences in a major player in the domestic R&D domain, so we examined the research activities of the Academy as well (in addition to higher education). The data are from the processing of the S3-relevant questionnaires filled by the institutes of the HAS: we received responses from 14 institutes out of the 10 research centres and 5 research institutes as well as from 24 university research teams sponsored by the HAS. [4] So we had an almost complete picture of the projects of the HAS research institutes carried out in collaboration with the companies.

[4] According to the information received from the HAS, it was the Humanities Research Centre from the research institutes which have not filled in the questionnaire, because it has considered its research non-relevant to the S3. The feedback and the completion rate of the research teams was much lower (25%), and there were many teams in the field of social sciences and humanities which did not fill the questionnaire, and there were teams which did not consider their research to be relevant to S3.

Figure13: Distribution of expenditures in the major research projects of the HAS by areas of science (data is available of a total of 155.4 billion HUF)

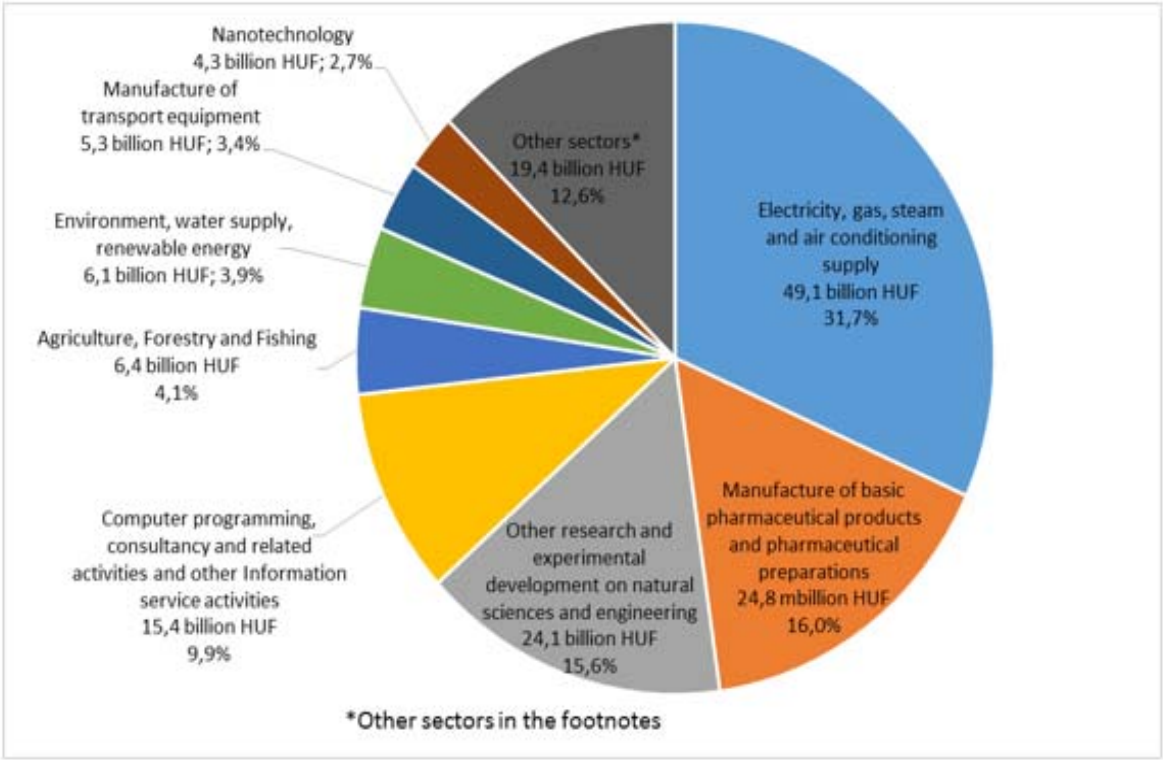


Source: NIH RDI Observatory calculations based on HAS 2014

We examined the disciplines to which the major research carried out in the above organisations is linked and the disciplines which have a relatively high R&D expenditure. **The material sciences within the technical sciences and the physical and biological sciences within the natural sciences** have outstanding shares.

Nearly one-third of the research expenditures is linked to electricity generation, while the share of pharmaceuticals and other natural science and technical research and development is nearly one-sixth. One-tenth of the sources is linked to ICT and the weight of the agriculture is 4.1%.

Figure14: Distribution of expenditures in the major research projects of the HAS by sectors
(data is available of a total of 158 billion HUF)



Source: NIH RDI Observatory calculations based on HAS 2014

Networking and the strengthening and expansion of cooperation are essential for all players of the research and development. It can be established by analysing the corporate relations of the studied institutions that there is a very large difference in the research projects of the various disciplines as regards to corporate participation in the project. Of the disciplines, **corporate partners were involved, without any exception, in all agricultural science projects** presented in the survey. **This is followed by the medical (78%), technical (72%) and natural (68%) sciences.** This share is 30% in the case of the humanities and only 6% in the case of the social sciences.

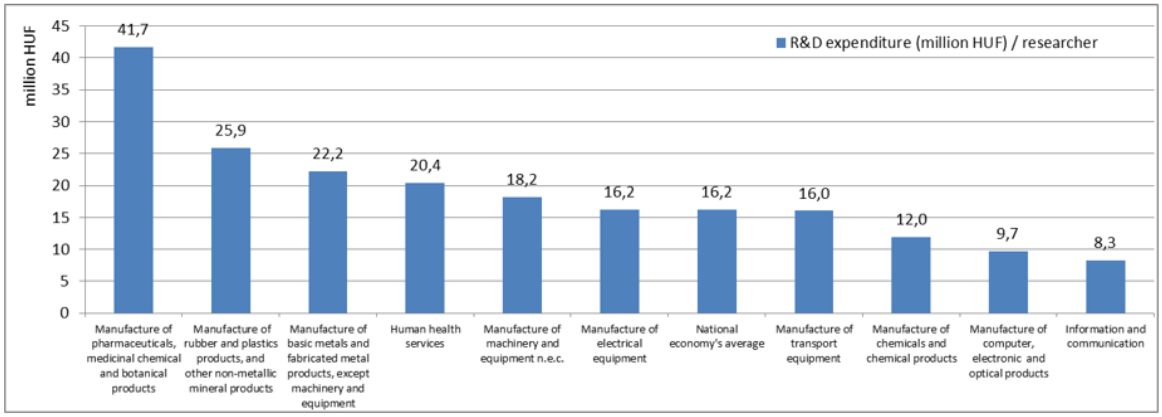
1.2.4. Corporate research organisations

In Hungary, **the large companies spend 30% more money on R&D than the micro, small and medium sized enterprises combined.** The sources of the R&D expenditures are different in the various size classes. The smaller the company, the greater the share of the state funds and the lower that of foreign funds. While only 4.1% of the R&D expenditures of large enterprises comes from public sources, the same ratio is 18% for the medium-sized companies and over 40% for the micro and small enterprises. The share of foreign funds shows an opposite trend: foreign resources exceed 20% in the case of the large enterprises, but finance only one-tenth of the expenditures of the small businesses.

The demand for expenditure of the **R&D activities of the various sectors are largely different** (mainly due to the technology, the specificities of the sector, the value of the infrastructure, the resources required by the activity carried out by the researcher and additional factors). The R&D expenditure per researcher is by far the highest in the **pharmaceutical industry**: two and a half times the national average. At the same time, the expenditure demand per researcher of other sectors having a large share of the GDP (e.g., automotive industry) is below the national average. Of particular interest is that the resource demand per researcher of the highly innovative **infocommuncation services**, which are

increasingly important from the perspective of the economy, **is only slightly above the average of the national economy.**

Figure15: R&D expenditure per researcher of the business sector in some key branches and sectors of the national economy (HUF million per researcher, 2012)



Source: Own calculations of NIH RDI Observatory on the basis of KSH data

In Hungary, one-fourth of the small businesses and nearly half of the medium-sized enterprises are innovative. However, seven out of ten large domestic companies are engaged in innovation activities. Nevertheless, the companies of the EU are even more innovative: nearly half of the small businesses, two-thirds of the medium-sized companies and four-fifths of the large corporations are innovative. The difference between the Hungarian and the EU average is the lowest in respect of the latter.

The sectors differ greatly in terms of the proportion of innovation activities carried out by their companies.

Figure16: Share of innovative companies in the manufacturing industry

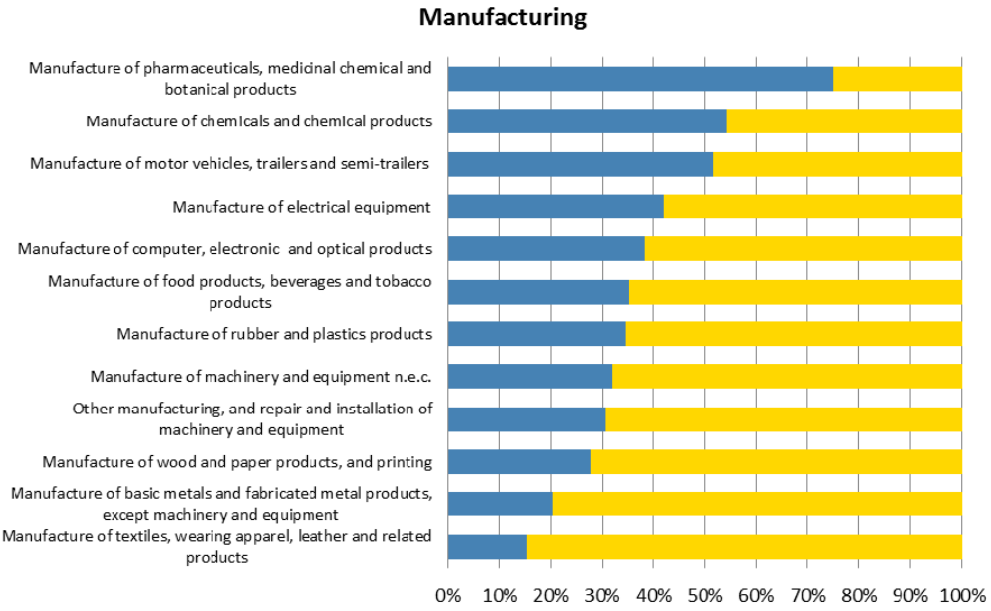
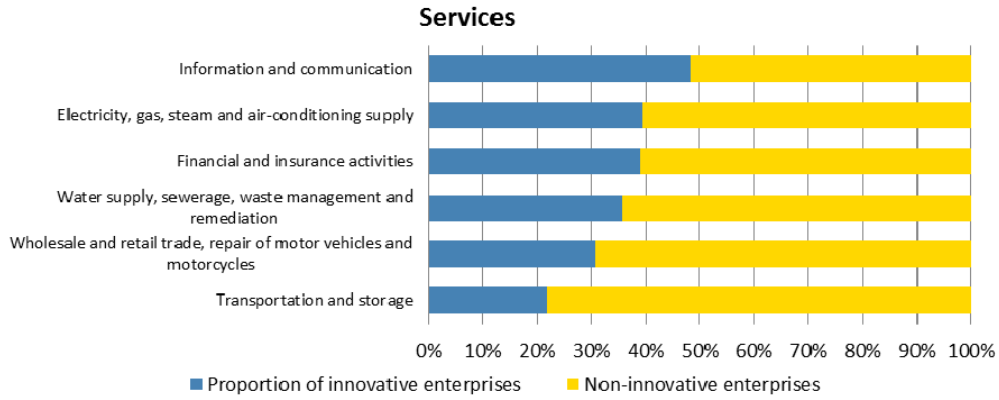


Figure17: Share of innovative companies among the services

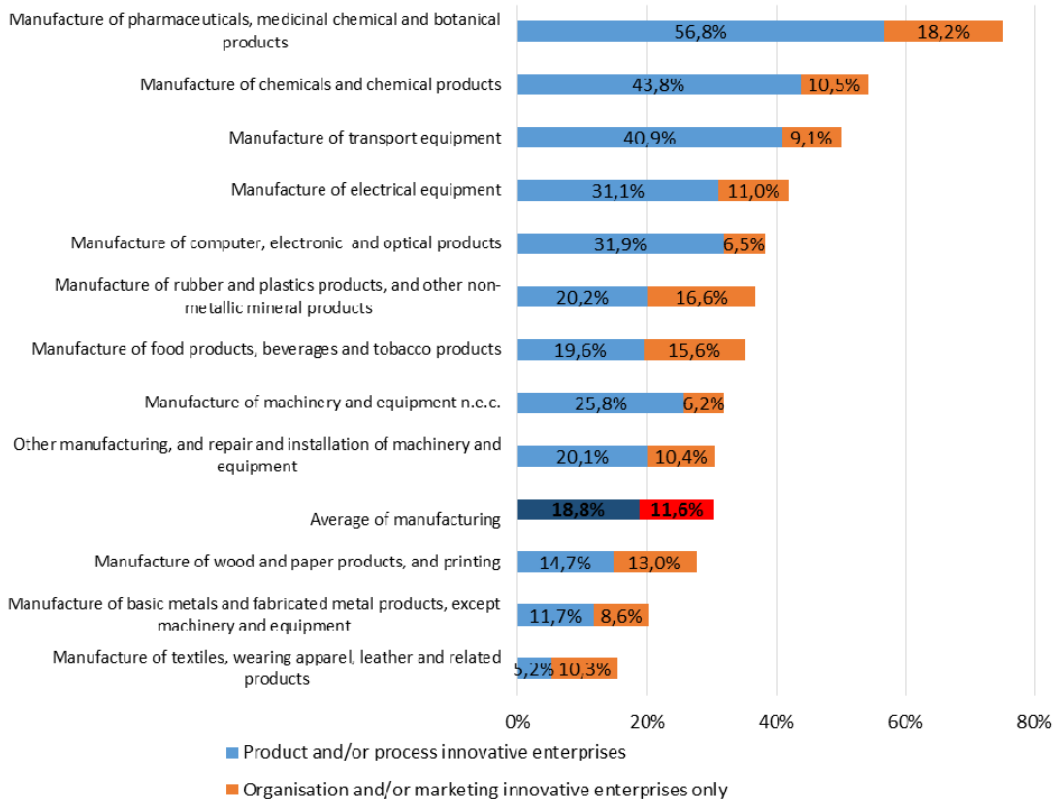


Source: Eurostat, CIS, 2010 data

Of the manufacturing industry sectors, **pharmaceuticals** achieved the best results, where 75% of the domestic companies are innovative. The pharmaceutical industry is followed by the production of **chemicals and chemical products** with 54.2% and the manufacture of **road vehicles** with 51.6%. Of the service sectors, the companies of the **information and communication** sector emerge, where 48.4% of the companies of the sector are innovative.

The proportion of companies engaged in technological innovation is 18.4% of the national economy, while the average of the manufacturing industry is somewhat higher, but both values remain below the EU average. The proportion of companies engaged in innovation is significantly different among the various sectors. It is the highest in the pharmaceuticals, the chemical and automotive industries, the manufacturing of electrical and computer equipment and electronic products.

Figure18: Share of companies engaged in innovation in the manufacturing industry



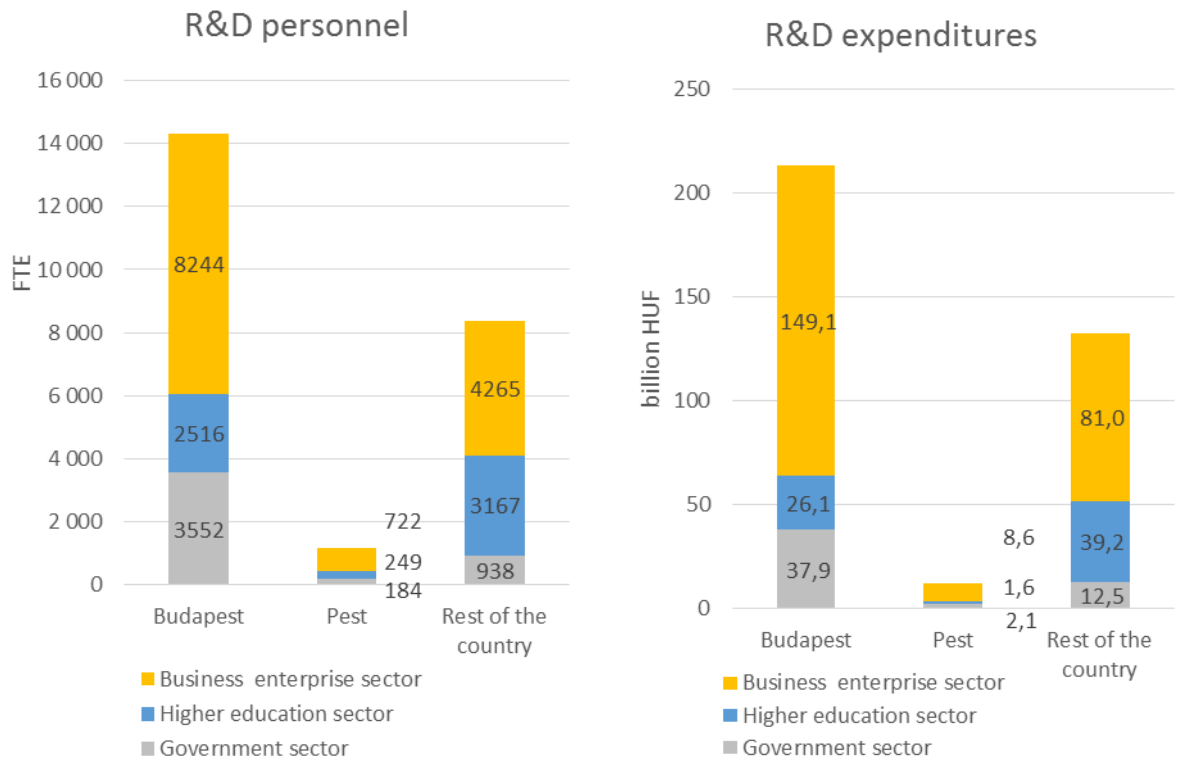
Source: NIH RDI Observatory calculations on the basis of Eurostat CIS

The ratio of companies involved in any kind of innovation co-operation is continuously growing: their proportion reached 43% in 2010.

1.2.5. Territorial characteristics of RDI

Almost two-thirds of the country's approximately 24 thousand researchers work in Budapest. Most decentralized is the higher education sector, where the majority (in FTE) works outside Budapest or the central region owing mostly to the research-intensive universities of Baranya, Csongrád and Hajdú-Bihar counties. On the other hand, the institutional sector is highly centralized: 80% of researchers work in Budapest and Pest county. The R&D expenditures develop similarly to the personnel data, and these data also show a high degree of R&D centralization in the capital.

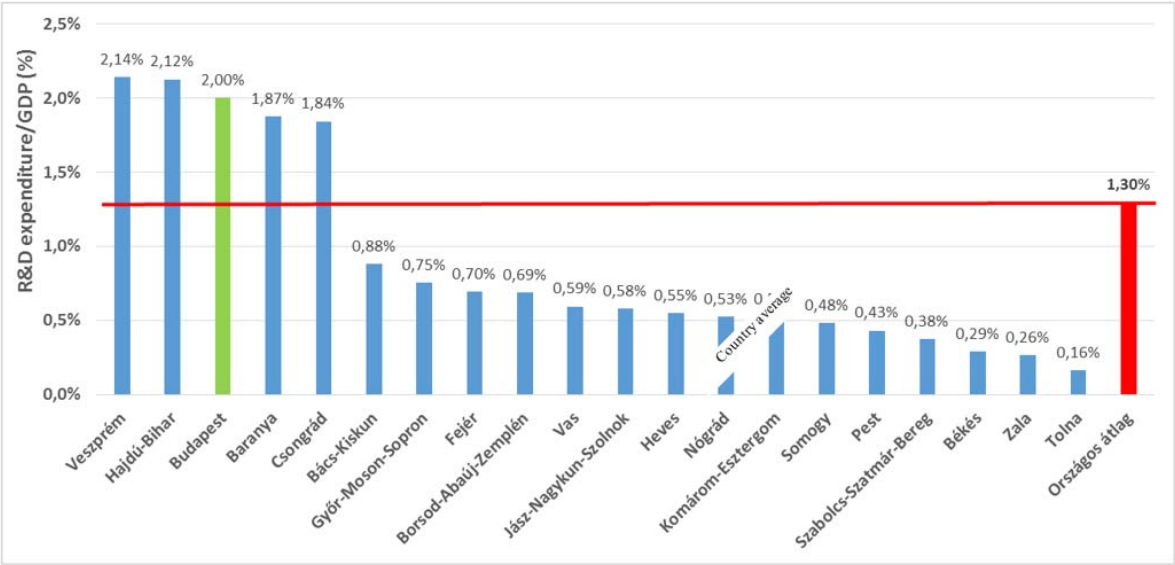
Figure19: Calculated number of researchers and developers and the disproportion of the R&D spending between Central Hungary and the rest of the regions, in a sectoral breakdown, in 2012



Source: NIH RDI Observatory calculations on the basis of KSH

The GDP-proportionate R&D expenditure shows a regionally uneven picture. The output of **Budapest and Hajdú-Bihar, Csongrád, Baranya and Veszpérm** counties exceeds the national average. The GDP-proportionate performance of the other counties is far below this.

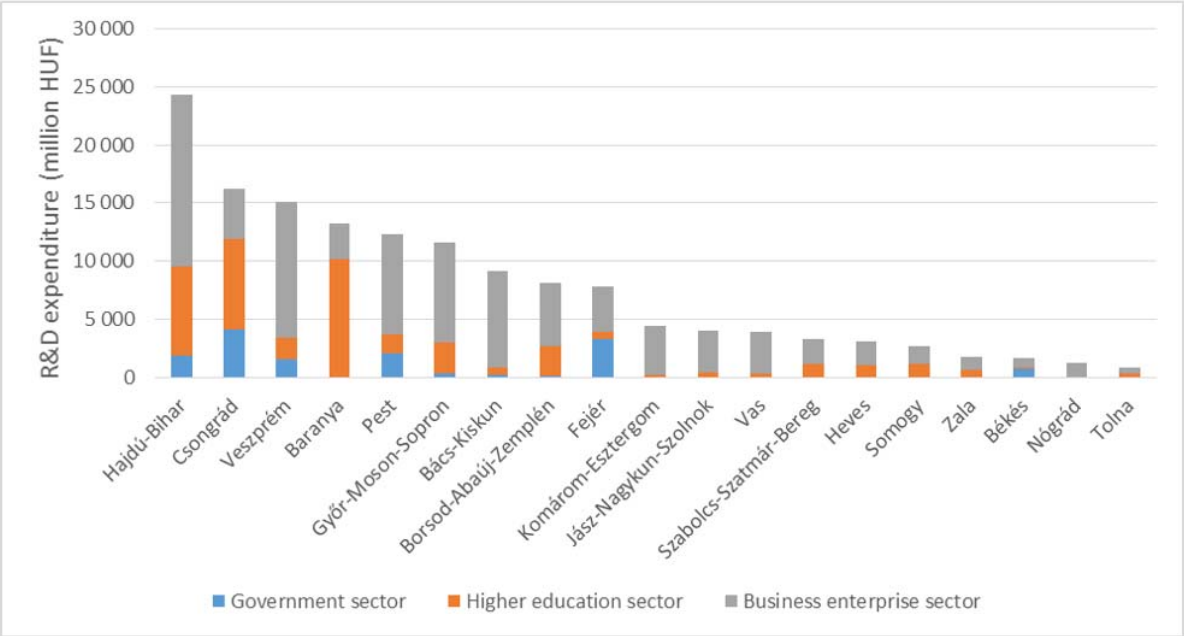
Figure20: Research and development expenditure as a proportion of the GDP by county, in 2012



Source: NIH RDI Observatory based on KSH data

The distribution of the R&D expenditure by sectors gives a diversified picture. The performance of the corporate sector dominates in most of the counties, with two significant exceptions: Csongrád and Baranya counties. Here, the R&D expenditure of the higher education institutions precedes that of the corporate sector. In the case of Csongrád and Fejér counties, the performance of the government sector is also important, and it must be noted that higher education has a very high rate in Hajdu-Bihar. This shows the strong regional role of the three major academic centres. As regards Csongrád and Fejér counties, the performance of the government/public finances (HAS) sector is also important, and this sector cannot be neglected in Hajdú-Bihar and Pest counties, either. Within the national R&D expenditure, the weight of the manufacturing industry was 36% in 2012, that of the "professional, technical and scientific" activities was 26.9%, and that of education was 18.6%. The share of ICT services was 5.9%, while that of the agriculture was only 1.2%. The rates within the manufacturing industry are shown in the figure below: the pharmaceutical industry excels, and vehicle manufacturing, the production of computers, electronics and optical products as well as mechanical engineering have a considerable weight as well.

Figure21: R&D expenditure of the counties in sectoral breakdown in 2012



Source: NIH RDI Observatory calculations based on KSH data

1.3. Summary

The average age of Hungary's population is growing, while its population is decreasing and the utilisation rate of preventive health care services is low. However, the level of health care expenditure is average compared to countries in the region. Hungary is characterized by migration to primarily Pest county and Budapest, as well as the western part of the country (mainly Győr-Moson-Sopron county).

As regards the protection of the environment, there are areas capable of demonstrating a significant improvement, with the R&D expenditures in that area growing continuously (but the spendings on the environment are stagnant). Hungary's energy efficiency and the share of renewable energy sources in the total energy consumption have increased significantly.

Hungary's economic performance shows an uneven picture: The per capita GDP of Budapest is more than twice the national average. In addition to this, only the performance of Győr-Moson-Sopron county exceeds the national average.

In terms of the distribution of the gross added value by the economic sectors, the role of the manufacturing industry is prominent, while the share of the agriculture is decreasing and the share of information and communication are increasing. The sectoral distribution of added value in the manufacturing industry has undergone significant changes in recent years: vehicle industry has increased, while the weight of the machine production and pharmaceuticals has decreased. Industries at the higher level of technology which require skilled workforce have been able to show significant improvement, compared to the more labour-intensive industries, which require less automation. The service sector dominates in the production of added value in a significant part of counties and Budapest, while the added value produced by the industry is higher that that produced by the services in the north-western counties (Fejér, Komárom-Esztergom, and Győr-Moson-Sopron).

In a European comparison, the RDI performance of Hungary is considered to be average, but improving. According to the 2014 ranking of the Innovation Union, Hungary was among the moderately

innovative countries. The GDP-proportionate R&D spending continues to grow, mainly due to the corporate and foreign sources. The majority of the R&D expenditure is linked to the manufacturing industry, with pharmaceuticals having the greatest weight, while the combined R&D expenditures of vehicle construction, electronics and mechanical engineering remain below pharmaceuticals. The share of the technical sciences is more than half of the expenditures, while that of the natural sciences is one-quarter. The share of medical sciences is 8.6%, and that of the agricultural sciences is 5.8%. Two-thirds of the R&D expenditure are realized in the business sector. The weight of the institutional sector is 15%, and that of the higher education sector is 19%.

In higher education, the collaboration rate significantly differs in certain disciplines: it is the highest, over 50%, in the agricultural sciences and the technical sciences, and it is the lowest in the social sciences and the humanities.

As regards the HAS, the material sciences within the technical sciences and the physical and biological sciences within the natural sciences have outstanding shares. Nearly one-third of the research expenditures of the HAS is linked to electricity generation, while the share of pharmaceuticals and other natural science and technical research and development is nearly one-sixth. One-tenth of the sources is linked to ICT. Examining the collaborations of the HAS, it can be established that corporate partners are involved, without any exception, in all agricultural science projects presented in the survey. This is followed by the medical (78%), technical (72%) and natural (68%) sciences. This share is 30% in the case of the humanities and only 6% in the case of the social sciences.

The R&D expenditure per researcher is by far the highest in the pharmaceutical industry, while the resource demand per researcher of other sectors with a higher share of the GDP (e.g. the automotive industry) is below the national average. In the case of the ICT services, the resource demand per researcher is just over the national average.

The sectors differ greatly in terms of the proportion their companies are engaged in R&D activities: of the manufacturing sectors, the pharmaceutical industry achieves the best results, and is followed by the manufacture of chemicals and chemical products and the manufacture of road vehicles. Of the service sectors, the companies of the information and communication sector emerge.

The R&D as a whole shows a picture of regional disproportions. In terms of the GDP-proportionate R&D expenditures, the performance of Hajdú-Bihar, Csongrád, Baranya and Veszprém counties and Budapest exceed the national average. The publication data of the major knowledge centres also show a highly focused picture with the significant weight of Budapest and the large academic centres.

International collaborations play an important role in Hungary's RDI activities and help to engage in the international circulation and the development of the RDI area.

1.4. International outlook

International trends

Lead markets - an initiative for Europe 5

The Lead Market Initiative of the European Union between 2008 and 2011 was designed to identify the market sectors with a rapid growth potential. In addition to exploring the possible directions of Community innovation, the European Commission's aim with this initiative was to examine the policy tools to be applied to support the identified sectors.

[5] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0860:FIN:HU:PDF

The following markets were appointed during the project as the potential lead markets of the European Union in the coming decades:

- *eHealth* – The ICT solutions can help improve the health care services and reduce their costs, as well as contribute to solving the major challenge for European health care systems, namely the problem of "ageing Europe".
- *Sustainable Architecture* – Buildings are responsible for the major part of EU's energy consumption (42%) and about 35% of the greenhouse gas emissions. It is necessary to develop innovative solutions to ensure that these values are reduced by 2020.
- *Technical textiles* – The most important advantage of this industry is that the products and technologies developed here are rapidly transferred to other industrial areas.
- *Products based on biological raw materials from renewable living raw materials* – Owing to its leading technological and industrial position, Europe occupies a good position in the market of innovative biotechnology products. However, the uncertainty and the weak market transparency concerning product properties prevent the rapid spread of the products.
- *Recycling* – The EU owns 30% of the world's eco-industry and 50% of the waste and recycling industry. Despite the significant market opportunities, the barriers to market development are still there. By encouraging innovation and introducing more effective processes and technologies, there are significant opportunities for improving the efficiency and the capacities.
- *Renewable energies* – Here, the initiative refers to energy sources that are extracted from regenerative energy sources, such as wind, solar, biomass, biodegradable waste or feedstock, geothermal waves, tidal and hydropower plants. The annual turnover of the European renewable energy industry is currently 20 billion EUR and employs approx. 300,000 people, while providing 8.5% of Europe's energy needs.

Single European Market[6]

Growth and job creation cannot be achieved without a stronger, deeper and expanded single market. To enable the single market to contribute to achieving the objectives of the Europe 2020 Strategy, well-functioning interconnected markets are required, where competition and consumer access stimulate growth and innovation.

Functioning as the engine of the new type of growth, the European Commission defined the following four areas:

1. Development of fully integrated networks in the single market;
2. Promoting the mobility of citizens and businesses in the Member States;
3. Support for the digital economy throughout Europe;
4. Boosting social enterprises, cohesion and consumer confidence.

Global value chains[7]

In today's globalized world, global value chains compete with each other, and the competition between the countries primarily means how each country can join and which part thereof in a structure

[6] http://ec.europa.eu/internal_market/smact/docs/single-market-act2_hu.pdf

[7] For the role of the global value chains in the international economy, and their consequences on the nation's economic policies, see e.g. OECD (2013): Interconnected Economies – Benefiting from Global Value Chains. http://s3platform.jrc.ec.europa.eu/documents/10157/46174/Interconnected_economies.pdf

created by the multinational companies. In order to better understand the value chain, it is essential for the national economy to have proper insight into the global value movements of trade. The global value chains allow the companies and the economies to carry out that part of the process, which are the best at. Since they use intermediate goods and services produced elsewhere, they do not need to build an entire industry.

To move up in the value chain, knowledge-based capital and development play a key role. Intangible assets, innovation, intellectual property and human resources are the elements in which each country must be competitive to be able to assume an increasing role within the value chain. Competitiveness needs comprehensive strategies, among other things, research and development, innovation and training in the field of the science and the economy.

Cross-border collaborations

Bilateral and international collaborations, joint international projects and programmes, as well as the programmes promoting the mobility of researchers, networking and technology transfer play a key role in Hungary's research, development and innovation activities. These programmes enable the development of the RDI sector and channelling in the international circulation through the expansion of the national relations and the international networks.

Bilateral Intergovernmental Scientific and Technological Co-operation

For Hungary, the intergovernmental scientific and technological (S&T) cooperation agreements signed with 35 countries are designed to provide the most important international scientific and technological cooperation network. The international S&T cooperation serves the utilization of the results of the Hungarian applied sciences in the global market through the instruments of international STI collaboration. The agreements serve the development of the Hungarian science and technology and strengthen the international positions of the Hungarian scientific life as well as integration in the international research centres/programs of excellence. In addition, they support the involvement of the young researchers in the international system of relations, improve the competitiveness of the innovative sectors of the Hungarian economy, and help mapping and utilizing the opportunities for Hungarian participation on RDI-related large international projects.

Participation in major international programmes and projects

- CERN
- EFDA-JET (EURATOM)
- ILL
- EMBL
- SHARE
- ECRIN
- CENTRAMO

Seventh Framework Programme for Research and Technological Development

Hungary participated in **FP7, or the Seventh Research and Development Framework Programme** (2007 - 2013). The total budget for the programme was 50 billion EUR. The amount increased significantly compared to the budget of the previous framework programme (FP6), which showed the crucial importance of research in Europe. FP7 was indeed the main instrument to meet European needs in the fields of employment and competitiveness, as well as to keep its leading role in the global knowledge-based economy. The experience and the FP7 framework programme of the 2007-2013 planning period proved that the Hungarian candidates are successful in the competition for resources

directly accessible from Brussels. During this period, every fifth application submitted from Hungary won, a success rate corresponding to the EU average.

Relations with the neighbouring countries

With the assistance of the network of foreign trade diplomats, we collected the Visegrád countries and the neighbouring countries Hungary has collaboration with in relation to RDI and the economy, and the areas thereof.

Poland

The bilateral RDI relations can be measured in both the academic and scientific fields. In this context, the Open Access Initiative and energy research should be highlighted. In the area of rural development, the emphasis is on regional cooperation and product development.

Slovakia

The Hungarian-Slovak research, development and innovation cooperation over the past seven years was characterized by cross-border RDI cooperation, the joint development of the scientific and technological infrastructures, the improvement of institutional relations, as well as the promotion of partnerships between the universities, research institutions and innovation and technology centres. The objectives of the cooperation also included the implementation of joint research projects and the dissemination of the results, as well as the development of feasibility studies, engineering designs, construction plans and environmental impact studies. It is expected that the bilateral RDI relations during the 2014-2020 period will be determined by these tasks and objectives as well.

Romania

Strengthening the social and economic cohesion of the border area is a priority in the cross-border RDI co-operation of Hungary and Romania. This includes the development of a shared research infrastructure as well as supporting the collaboration between the sectors involved in R&D activities and the development of studies and plans.

Serbia

Academic cooperation, specifically in the field of plant breeding, is typical. In addition, there has been recent progress in the cooperation of the research and development and innovation-oriented enterprises of Hungary and Vojvodina.

Slovenia

Information has been exchanged in the areas of energy sources for sustainable development and industrial technologies, and scientific and economic cooperation has been launched.

Ukraine

The bilateral RDI relations are typically for the support of scientific and economic cooperation.

Czech Republic

Cooperation involves the agriculture and energetics.

Bosnia and Herzegovina

Measurable results are coming from cross-border cooperation in the agriculture, food industry and processing industry.

Austria

Hungary has RDI cooperation with its western neighbour in terms of energy efficient solutions and the establishment of energy storage sites, primarily in order to increase energy production.

Croatia

The development of cross-border economic relationships is a priority in the bilateral cooperation. Sustainable environment and tourism are highlighted as the targets of cooperation. Strengthening the cooperation in energy policy also has a key role.

1.5. SWOT

Strengths
Education, training, research background: • We have researchers who are capable of achieving globally outstanding results in certain (limited) areas of science (e.g. mathematics or physics). • Existence of a scientific basis of established layer of elite researchers who can produce competitive scientific results of national importance, who are recognized and competitive internationally as well (sources, international citations from scientific publications, infrastructure and the use of databases). • Internationally high-standard institutions of higher education, also in the major provincial cities. **Research and innovation environment, organisations, infrastructure and services:** • R&D knowledge centres have developed with concentrated R&D capacities in some places. • The large foreign and Hungarian companies operating in the country have created cutting-edge work culture. • R&D capital concentration and the modern RDI infrastructure appeared in the vicinity of the large companies. More and more promising partnerships are established between the large companies and the universities. • Start-up companies implementing world-class development with high growth capabilities appear. Active entrepreneurial and start-up culture compared to the capacity of the country. • High level of ICT infrastructure, basic computer network infrastructure for research purposes, outstanding high-performance computing (HPC) capacity, and resulting modelling possibilities. • The higher education institutions engaged in basic research, as well as the research centres of the HAS performed well compared to rivals in the region in the European Union **Research and Technological Development Demonstration Framework Programme (FP7)**. • The health care industry is competitive internationally. • High level of readiness, adaptability and ability for changing the economic structure. • The university and college R&D potential increases, knowledge centres are created, increasing economic openness. • Many trans-European transport routes cross the region; internationally significant logistical role.

Financing:

- The fund set up to finance RDI supports development, and EU funds are available specifically in support of RDI.

Weaknesses

Education, training, research background:

- The popularity of the natural science and technical professions continues to decline, hence the low number of specialists with technical and natural science qualifications; lack of supply of researchers.
- The uncertainties in the environment for education and the falling prestige of the teaching profession hinder the supply of talents and researchers.
- Lack of knowledge map in the universities.
- Very low wages to researchers in the international comparison.
- Lack of entrepreneurship in the universities and research institutes, which can be caused by the sometimes contradictory and vague legislation and, in a sense, the over-regulated system.
- The structure of education and training can hardly adapt to the new development plans. The quality of human resource needs development and should be aligned with the needs of the economic actors.

Research and innovation environment, organisations, infrastructure and services:

- The socio-economic recovery of R&D expenditures is low.
- Despite the sporadically focused R&D capabilities, the research capacities and performances are fundamentally fragmented and not sufficiently focused. In many cases, the infrastructure is outdated and fragmented, the management of the knowledge base institutions is weak, and institutional learning is slow.
- The networking of the companies is low.
- The undertakings have a very low level of or do not have any knowledge of languages.
- The capacities and competences of the universities and the research institutes are linked to the corporate and public orders weakly compared to the possibilities.
- Strategic partnerships are rare in the SME sector.
- Low number of innovative SMEs.
- There are few internationally competitive medium-size companies.
- The determination of the faculties and the training programmes of higher education do not reflect the economic needs, so young people can hardly get employment and move away from rural towns, which has a negative effect on the sustainable society.
- The innovation policy instruments (“policy mix”) is not sufficiently harmonized.
- Most SMEs have shortcomings in their management and the level of innovation and intellectual property protection awareness is low.
- The demand for the protection of industrial property rights is extremely weak .
- There are no established forms or practice of communication between the SMEs and the research institutes (e.g., ordering services, use of infrastructure, etc.).

- The relations between the stakeholders of the R&D value chain are weak and cooperation is not efficient enough.
- The technology transfer processes are not effective, the domestic innovation processes operate with low efficiency; lack of common areas and infrastructure (e.g. laboratories) that can support the cooperation of the business and the public sectors.
- Few domestic spin-off, as their ascent is also hindered by several attitudinal and institutional factors.
- The participation rates of the companies in international research programmes are low.
- Excessive administrative burdens, both in terms of office work and the applications.
- **The** regions of the country show a picture of inequality both in terms of the R&D performance and innovation performance, and is significantly concentrated in Budapest.
- Looking at the regional presence of RDI, regional imbalance can be observed in the country.

Financing:

- Inadequate and surging funding for research, the level of institutional R&D funding is low and less tied to performance.
- The SME sector is underfunded, and the innovation and growth ambitions and abilities are weak in a global comparison.
- Low level of seed capital investment; undeveloped technology incubation processes.

Opportunities

Education, training, research background:

- The high-quality higher education, which is currently operating in the industrial and agricultural zones, moves the big cities and their surroundings towards a knowledge-based economy, if the university knowledge centres are strengthened and can put their research results effectively into practice and education, and link them to the activities of the local economy.
- Expansion of practice-oriented training (dual training), strengthening of the education of entrepreneurial innovation management.
- Adjusting the trends of higher education to the economic needs improves the situation of trained young people in the rural university towns (Csongrád, Hajdú-Bihar and Baranya counties) and strengthens the ability to keep the population.
- Development of natural science and technical education.
- Approach, which manages more areas of science at the same time and in one system; the spreading of the vision among the young people improves the application of what they learned in practice as well as in the subsequent research and economic results.
- Strengthening talent promotion.
- Promotion of the development and maintenance of relationships among the inventors and researchers through the establishment of a central database.

Research and innovation environment, organisations, infrastructure and services:

- Harmonised operation of STI diplomacy.
- The instruments prioritised by the EU ((public) procurement supporting innovation (PcP and PPI), smart specialization, etc.) are spreading.
- Optimization of the use of available research infrastructures.

- Strengthening RDI-friendly economic and regulatory environment.
- The supply and end-product manufacturing capacities of the micro, small and medium-sized enterprises improves in the major industrial areas, and Smart production systems spread.
- Increasing the economic role of innovation cooperation and clusters.
- Strengthening of new emerging R&D-intensive industries and spread of smart technologies.
- Effective institutions and systems of institutions, operating on a territorial basis, are established to promote innovation.
- Joining the major EU cooperation programmes.
- The critical innovation mass of the big towns improves through the development of new instruments for powerful incubation (e.g. open labs, tech-shops) and the spreading of incubator services.
- Closer cooperation develops between the academic and the corporate sectors.
- Balancing and catch-up of the RDI performance of the convergence regions.
- Networking, innovation and knowledge-based development are given higher value in the economic development strategies, and are highly preferred by the different levels of policies (national, EU) and support systems as well.
- Through the establishment of international-class centres of excellence, the counties with a high research potential can also take part in world-edge research projects, thus strengthening the excellence and pulling effect on the surrounding areas.
- In view of the international trends, the presence of the multinational companies will further strengthen the local economy's integration into the global economy, the introduction of advanced technologies, and the spread of modern management methods.

Financing:

- Utilisation of the global optimization of resource allocation, attracting FDI which establishes R&D.
- Further improvement of R&D tax incentives.
- The promotion of the innovation and R&D activities will remain an important development priority both on the European and the national levels: the resources to support RDI efforts will significantly increase during the 2014-2020 period.
- The promotion of venture capital investments will bring along more successful products and companies from the ideas; the entrepreneurial skills and attitudes change in a positive direction; the spread of a potentially successful entrepreneurial vision improves the ability of the society for self-provision.

Threats

Education, training, research background:

- The new generation of researchers will not be sufficient (either in number or preparedness) to maintain an internationally competitive level; innovative systemic thinking and research approach are not mastered at the national knowledge centres (campuses).
- The shortcomings of the education persist; there will not be specialists of sufficient numbers and skills to join the global networks, and their lack will grow.
- Brain drain and migration of young workforce with higher level education.

Research and innovation environment, organisations, infrastructure and services:

- The role of the SME sector in RDI will stagnate and will be unable to generate serious demand or build capacities.
- Stagnant activity in the field of international RDI cooperation and programmes.
- Increase of regional inequalities and further strengthening of the dominance of Budapest, while the counties of the convergence regions are weakening or stagnating.
- The willingness to invest declines due to the unfavourable development of the factors of the global political economy; some multinational companies withdraw from the country because of cost-cutting/restructuring, thus the industry loses its potential development (especially in the automotive and the pharmaceutical industries and the services).
- Regulatory barriers to IT procurements (particularly in the public sector).

Financing:

- Lack or insufficient level of FDI based on R&D which is properly integrated in the Hungarian economy.
- With the decline in the competitiveness, the foreign companies refuse to invest in higher-level production processes in Hungary, so the big town which currently have industrial production capacity will not be able to develop, which results in reduced labour-holding capacity, and the standard of living cannot be maintained.
- The H2020 appearance of the scientific and economic actors is not realized at the expected level.
- Due to the lack of proper means to support RDI, Central Hungary is unable to offer further pulling force to the surrounding industrial production and knowledge centres and falls back in the international competition.
- The regions in the "less developed" category which have the R&D potential cannot effectively use the resources to support RDI and, therefore, they cannot joint the international trends.

2. Governance structure

The smart specialisation, implemented both at the national and the county levels in Hungary, is based on the relevant international strategies [8] [9], the S3 guides of the EU and the OECD[10] [11] and the practical experience from the Hungarian strategy-building processes of the previous years. In the course of the design process, the local stakeholders representing the groups, that are the most important from the point of view of S3, have taken consensus-based decisions regarding the innovation of the future which bring long-term development to the region on the basis of the continued and systematic detection and analysis of the economy and the society of the region through the **eyes of the entrepreneurs** and along the interactions of the different groups, yet avoiding the dominance of enterprises. This is the only manner the national smart specialisation strategy can become qualified to encourage the society to adopt a common vision of development and modernisation, and also provide a strategic framework for the efficient and effective use of resources.

The Specialization Strategy relies on the resources available in the 2014-2020 financial period of the EU (resources of the Structural Funds, European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF) for innovation), as well as the Hungarian public resources that are essential for the development (in particular, the resources of the Research and Technology Innovation Fund (KTIA) and the National Scientific Research Fund (OTKA)). The governance structure should therefore primarily connect the EU institutional system which allocates the resources, also taking into account the resources outside the Structural Funds, the sources of which can equally be European and Hungarian, and public or private. All sources of financing have been present in the funding of the innovation processes and innovation activities. Accordingly, the governance system shall be well prepared to be able to coordinate and prioritize among the specific types of developments that require resources and the organisations that implement them.

This chapter presents the design processes which precede the S3 design, but are organically related to it; the steps of the strategy-building and the organisation which coordinates it; and the S3 monitoring system which guarantees the success of the smart specialisation processes and full implementation of the national and local **objectives and vision** formulated in the strategy and based on the specialization (and territorial) directions.

2.1. National processes before the National Smart Specialisation Strategies

The **Sectoral Strategic White Papers** were prepared in the second half of 2012. The participants of the working groups responsible for each sector involved the universities, research institutes, industrial platforms, clusters and the competent ministries. Led by outside experts, the working groups prepared strategic white papers in the following sectors: **health care industry; ICT; environmental protection; energy; agriculture; mobility, vehicle industry and logistics.**

In June 2013, the Government of Hungary adopted the **Investment in the Future – National Research and Development and Innovation Strategy (2013-2020),** whose central objective is to strengthen the knowledge-based national economy. The development of new knowledge-driven economy can be sorted into three main processes. These are the processes of production of knowledge, use of knowledge and flow of knowledge.

The implementation is supplemented by the following horizontal system-wide focuses:

[8] EU2020 - http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:Hu:PDF
[9] H2020 - http://ec.europa.eu/programmes/horizon2020/
[10] EU guide - http://s3platform.jrc.ec.europa.eu/s3pguide
[11] OECD Guide - http://www.oecd.org/sti/inno/smart-specialisation.pdf

- promotion of smart specialization;
- operation of sustainable instruments creating equal opportunities;
- provision of stable financing conditions;
- social promotion and strengthening of the recognition of knowledge and technology;
- conformity with the global social challenges;
- stable and innovation-friendly economic and regulatory environment.

The *Investing in the Future Strategy* is designed to increase the research and development expenses in Hungary to 1.8% of the GDP by the end of the decade[12], and to create an environment in which the undertakings, companies and public sector organizations engaged in research and development and implementing innovative ideas alike are able to develop and grow, this meeting the expectations of the society.

The **National Reform Programme 2014** [13] presents the structural reforms along the substantive and structural guidelines formulated by the European Commission, which are intended to make the economic growth more dynamic, expand employment and reduce the national debt to a sustainable level. In addition to presenting the progress made, the 2014 National Reform Programme provides information on the continuation of the reform measures already underway, fine-tuning and the proposed new steps. The Programme presents new measures underway or implemented since 2013, a part of which was taken in order to implement the 2013 country-specific recommendations or were actions planned for 2014-2015, while the other part is directly related to the national commitments of the Europe 2020 Strategy.

Prepared by the working groups convened for that purpose in each county, the development of the **County Development Concepts** should also be mentioned. The development of county concepts began in 2012, and the final concepts were approved after several rounds of extensive social discussion.

2.2. Introduction of the S3 stakeholders

The full spectrum of interested stakeholders has been involved in the design of the National Smart Specialisation Strategy. During the mapping of possible participant organisations, the designers set out from the so-called classical *triple helix* [14] grouping and its improved version, the *quadruple helix* [15] grouping. The four types of organizations below have been involved in the national RDI management, and the proposal for the new management system also calculates with the participation of these types of organizations:

[12] Beyond the 1.8% GDP-proportionate R&D expenditures planned by 2020, the *Investing in the Future* Strategy also forecasts 3.0% R&D expenditures by 2030.

[13] http://ec.europa.eu/europe2020/pdf/csr2014/nrp2014_hungary_hu.pdf

[14] The triple helix model distinguishes three basic types of organizations, namely, the universities as the organization training and spreading knowledge, the government research organizations which are organizations engaged in controlled strategic basic and applied research, and the innovative undertakings. The triple helix model deals with the strength and intensity of the collaboration of these three types of institutions.

[15] The role of the society in creating knowledge and innovation has come to the light through the growth of the knowledge-based economy and the perfection of the knowledge-based society. The members of the society and the communities are basically related to some scientific, technical or business area, which has called the attention to a fourth sector, namely the public and civil sector, which is also connected to the mutual relations of the universities, the industry and the government. Thus, the further development of the Triple Helix resulted in the Quadruple Helix in 2010, and, after recognizing the impact of the (natural) environment in innovation, the Quintuple Helix Model (*Carayannis–Campbell 2012*).

Table 1: Grouping of the RDI actors involved in the design

Quadruple helix elements	Groups	Organisation
Science	Higher education institutions	Universities
		Colleges
	Research institutes	Academic and sectoral (public or private) research institutes
	Knowledge centres	Regional and sectoral knowledge centres
Government	Government and local government organisations	Ministries
		National government offices
		County governments
		County government offices
		Local governments of cities of county rank
Economy	Innovative enterprises	Large enterprises
		SMEs (including micro, start-up and spin-off businesses)
		Non-profit companies
	Technology transfer organizations and accredited clusters	Innovation and technology transfer offices
		Clusters
Civil organisations		Trade associations
		Interest representation bodies (e.g. national and county chambers of commerce and industry)
		Other non-profit organisations

2.3. Planning of the National Smart Specialisation Strategy

2.3.1. The S3 planning process

The *Investment in the Future – National Research and Development Strategy (2013-2020)* considered the smart specialization strategy (S3) only **as a complementary strategy**. Accordingly, the domestic Regional Innovation Agencies (RIA's) **discussed and updated the regional innovation strategies** with the involvement of the local stakeholders in the spring of 2013. The participants of the regional S3 working groups involved the representatives of the universities, research institutes, sectoral platforms, clusters and companies of the three counties in each region. The working sessions were organised and arranged by the Ministry of National Economy (NGM), the Regional Innovation Agencies and the National Innovation Office (NIH). On the basis of the regional innovation strategies, an S3 summary

was prepared with the involvement of the NIH in the summer of 2013, which tried to shed light on the potential national priorities by comparing the development directions formulated in the different regions as a synthesis of the regional plans.

In June 2013, the S3 Platform[16] of the Seville-based Joint Research Centre held the next event of its **Peer Review Workshop** series in **Budapest**, where participating experts and the competent EU committees commented the S3 drafts of Hungary and three other countries (Malta, Lithuania and Portugal).

To assist in the planning process, the NGM compiled the smart specialisation strategy **White Paper** in the autumn of 2013. It is designed to validate the regional, innovation and structural aspects in the planning process at the collective national level, thus paving the way for the national smart specialisation strategy. The potential specialisation directions formulated in the White Paper also require bottom-up construction, based on the widespread participation of the regional stakeholders, which considers and decides on the specialisation alternatives on-site (in the region). In the first half of 2014, the Government of Hungary approved the organisational structure which will be the basis of the governance structure of the S3 process as called for by the Commission.

The management of the dedicated S3 organisational structure was taken over by the commissioner assigned with the foundation of the National Office for Research, Development and Innovation in July 2014. In accordance with the S3 methodology, the strategy development process, supplemented by consultations with EU experts, arrived at the professional finalization of the S3 strategy with the active cooperation of the counties, in six steps from processing the past experience, the available relevant national strategies and white papers, the guidelines of the EU Commission and the international best practices through the determination of the priorities and the key technologies (key enabling technologies, KET).

In the autumn of 2014, two-round S3 county workshops were held in all 19 counties with the involvement of the every local decision-maker and enterprise. The main task of the first round county events (in accordance with the criteria of KET, EDP, and Industry renewal) was to formulate the area-specific industrial/sectoral priorities on the basis of the relevant county RDI statistics and documents and to designate the sectoral specialization directions.

The methodology applied in the workshop reduced the likelihood that the local development policy efforts use the development pattern of other areas/regions as the basis, while expecting that they are taken into account in the development of the county specialisations. Imitation can easily mean the survival of fixed schemes, while the S3 is just intended to be a means to the regions to develop their own economic and development objectives tailored to their own abilities and capabilities with the involvement of the local decision-makers in a bottom-up design, by identifying the relevant priorities and RDI needs.

An S3 website [17] was created to provide information and involve those interested in the planning process. The website consists of four sections:

- it presents the relevant Hungarian planning documents and the EU methodology;

[16] http://s3platform.jrc.ec.europa.eu/home. The Joint Research Centre (JRC) is a Directorate-General of the European Commission. It has seven research institutes in five EU Member States (Belgium, Germany, Italy, Netherlands and Spain). Employing 2,700 persons, the Directorate-General JRC plays an active role in creating a safer, cleaner, healthier and more competitive Europe.

[17] http://www.s3magyarorszag.hu/

- it can contribute, through an on-line questionnaire, to the formulation of the specialisation directions of its own county through the user's proposals;
- it provides an interface to review the draft of the national S3 strategy;
- it provides up-to-date information and establishes direct connection between the designers and the local players.

Both the on-line questionnaire and the interface for reviewing the strategy complement the information provided by the county workshops.

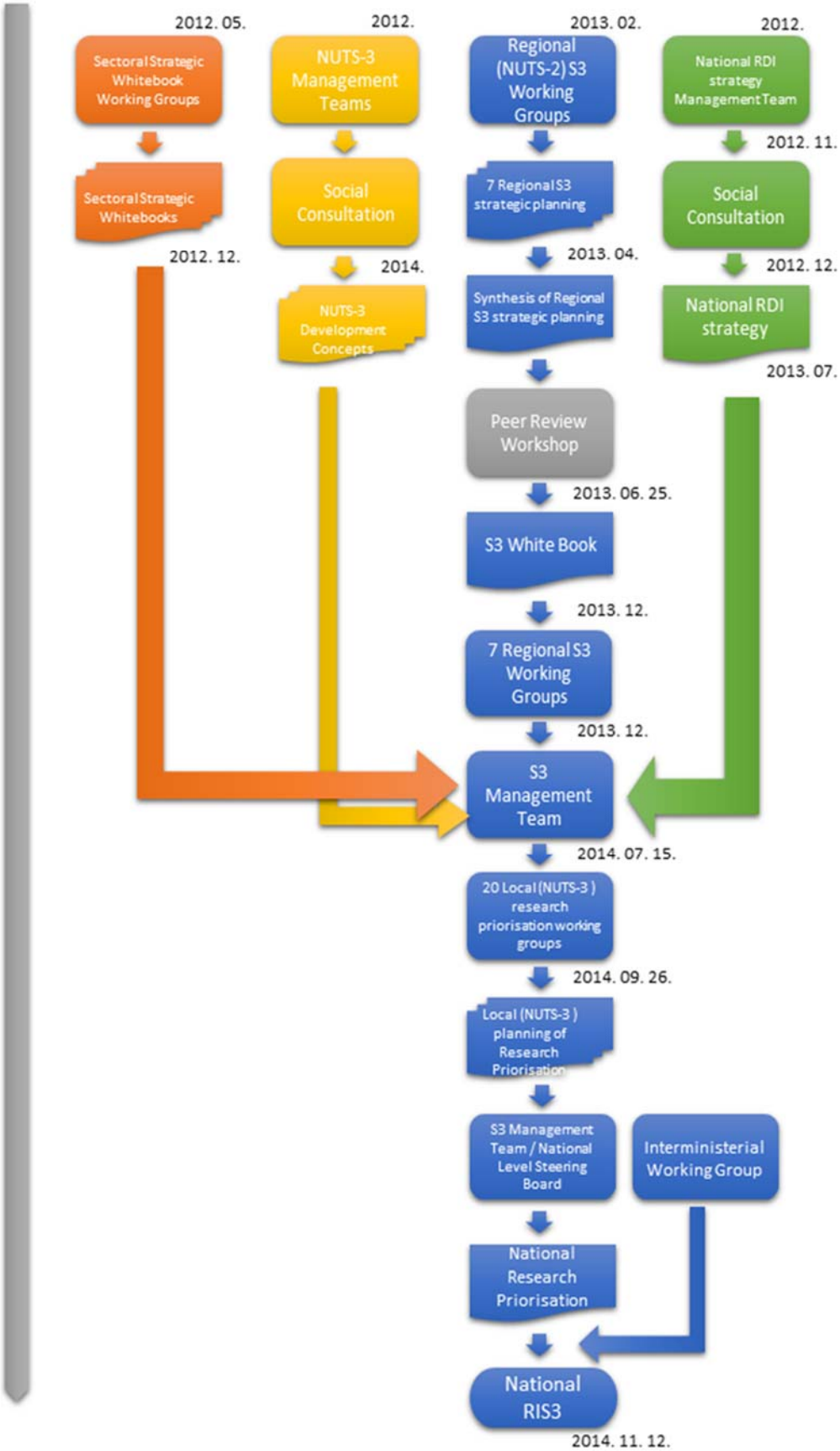
In addition to the discussions at the national and regional levels, the international outlook is also an important element of the S3 design. Therefore, the relevant strategies of the EU Member States neighbouring Hungary and of Visegrád countries, as well as the Danube Region Strategy have been processed as well. This is intended to adjust the objectives of the national S3 strategy to all regional endeavours to ensure the success of the strategy.

In the last stage of the National Smart Specialization Strategy, the feedback and commenting of the draft strategy took place as part of a national consultation, which included the second round of the county S3 workshops.

The Hungarian S3 planning will be completed at the government meeting approving the strategy in the middle of November 2014.

Figure 22: Methodology of the S3 design

Figure 23: Process of the national S3 design, including the related strategies



2.3.2. Governance structure of the S3 design

The development of the smart specialisation directions is coordinated by an organisational structure involving four bodies, each building on the other. The planning is coordinated by the S3 Management Team functioning under the control of the Prime Minister's Office.

National Level Steering Board (NIT): It functions as the professional forum embracing the S3 working group involved in the national S3 design, the professional board and the heads of the Local Research Priorisation Working Groups. The presidents of the county general meetings were also invited to the NIT meetings. **Expert panel**: means the panel of experts from the business and the academic world, civil society and regional development, which gives a technical opinion on the S3 process, especially the main directions of smart specialisation.

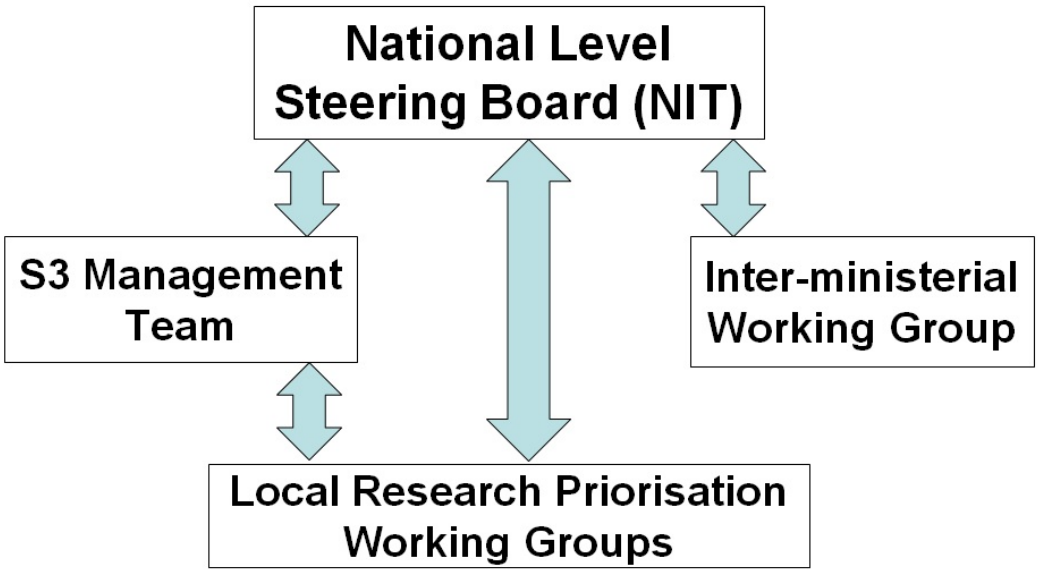
S3 Management Team: means a working group operating in the National Innovation Office and the Prime Minister's Office, which coordinates the work of the other organizations involved in the design process, directs and ensures the work of these organizations from the methodological and quality aspects, and prepares the smart specialization strategy for strategic decision-making.

Inter-ministerial Working Group: it was formed in order to ensure the monitoring of the planning process of the S3 strategy-building at the government level, ensure the feedback of the experts and the public administration, support the individual subtasks, and prepare for the implementation of the strategy. Its members are all the competent ministries, as well as the delegates of the relevant managing authorities of the 2014-20 programming period. Its priority task is to harmonise the planning of S3 and the Operational Programmes.

Local Research Priorisation Working Groups: their work is supported by the county government offices under the guide of the S3 Management Team. The county governments are also involved in the work of the Local Research Priorisation Working Groups. Under the leadership of appointed experts, the work organisations are jointly carrying out the organising work which ensures the mobilisation and involvement of the local stakeholders. The counties are responsible for establishing the specialisation directions with the involvement of all stakeholders by setting out from the local and regional experience and building on the own knowledge and information of the participants. In developing smart specialisation, the counties are required to present sectors, areas of expertise, methodologies, technologies and measures which can designate the region's sustained and successful R&I development. It may be based on the existing experience, knowledge and infrastructure, and may also contain conscious risk-taking. Participants of the Local Research Priorisation Working Groups:

- representatives of knowledge bases: universities, research institutes, platforms, clusters, technology transfer organisations and incubators
- civil organisations and chambers
- entrepreneurs: start-up and spin-off companies, innovative SMEs, large corporations with substantial research portfolio
- investors: venture capitalists, business angels, mentors
- county governments
- the government side, which primarily performs administrative (organizational, documentation) tasks.

Figure 24: Organisational chart of the governance structure of the national S3 design



2.3.3. Experience gained from the planning of the National Smart Specialisation Strategy

As a result of a wide professional and social consensus, the methodology chosen for the planning provided an appropriate basis for a national S3 strategy to serve as a guide to the smart specialisation efforts of the coming years. The quadrilateral discussions (*quadruple helix*) of the Local Research Priorisation Working Groups, on-line questionnaire available on the S3 website and the interface for commenting the strategy allowed the stakeholders to tell and share their suggestions concerning the triangle of the economy, science and innovation. The control structure and policy measures supporting the implementation of the national S3 have been created as a result of the meetings, discussions and debates of the inter-ministerial and professional working groups. All prerequisites have been fulfilled to enable the National Smart Specialisation Strategy to be an important and effective measure for using the European Union and domestic resources in an effective manner, as well as to realise a comprehensive vision and the quantified objectives formulated for the 2014-2020 period.

2.4. Governance system which maintains smart specialisation

It is an important task of the following period to develop a stable network from the perspective of the governance structure, which can fill an efficient management role in the scientific, research and development and innovation systems of the country and the counties. A key task of the management system based on the S3 is to further strengthen the social dissemination and recognition of knowledge, technology and innovation, which can be based on the research and development expenditures involved in the reforms.

The positive side of the existing management system is that the institutional structures have been recently created in Hungary, which support the above processes like in the other European countries. However, the success of implementation has been impeded in many areas by that the institutional structure was unable to firmly carry out the task owing to the occasional changes.

A key objective of this strategy is therefore to develop an RDI coordination system at the national and county levels, which operates a transparent, stable and supportive institutional structure for

the innovative companies, the research and educational institutions and the civil society, and develops the necessary framework and maintains it on the long term.

The National S3 is intended to provide a point of origin and a framework for the design processes and implementation related to the research and development and innovation activities. The strategy aims to develop the earlier innovation activities, which requires the adjustment of the governance structure. It also strengthens the specific regional conditions in order to develop a specialised RDI system which is competitive internationally and, through its resource absorption ability and resource utilisation efficiency, contributes to building an economy which is competitive in the European context.

The smart specialization process does not end with the completion of the national S3 as a strategic document. Among other things, the continued evaluation and monitoring system of S3, as well as the maintenance of the operational programmes require continuous learning, feedback and development during the seven-year planning cycle. This continuity must be ensured by the elements which build and maintain the system as well, if not by means of a permanent structure (hence rigid) institutional system, but at least a functionally conservative management structure. **The success of S3 will be guaranteed by the multiple feedback processes.**

In order to attend these functions, it should be reasonable to design the following **governance structure**, which carries forward the four groups of S3 design, thus ensuring the maintenance of good communication channels and working interfaces. In terms of the implementation, it is based on three main pillars:

1. **Professional S3 supervision and governance:** Acting as the "legal successor" of the S3 Management Team, previously introduced in the S3 planning process, the professional supervision and management level coordinates and supervises (*monitoring*) the implementation of smart specialization, supports its success, evaluates the effectiveness of the system and the results achieved, and initiates the necessary changes. It is also responsible for communication with the other regional, national and international institutions and bodies involved in the S3.

   Established on the basis and through the restructuring of the National Innovation Office (NIH), the *National Research, Development and Innovation Office (NKFIH or Office)* will be the government organ from 2015 responsible for the science and technology policy, and will supervise and manage the implementation of the national smart specialization as formulated in the present strategy (and the relevant provisions of the European Union). In addition, the NKFIH will ensure, in the framework and linked to the institutional system allocating the EU sources, the synergies in the fields of science, research and development and innovation by managing, inter alia, the domestic financial sources (*Research and Technology Innovation Fund (KTIA))* and the *National Scientific Research Fund (OTKA)*).

   An independent S3 panel of external experts will operate **closely connected to the organization of the NKFIH**, which will be involved in the implementation and the evaluation of the S3 processes.

   The panels of experts formed for the specific topics (e.g. RDI infrastructure) arising during the implementation of S3 are also linked to the work of the Office.

   It is important from that perspective smart specialization that the NKFIH liaises not only with the levels previously defined in the planning of S3. In accordance with the principle of collaborative leadership, the Office collaborates with the national scientific and RDI

institutions, the national government agencies and the national professional and social organizations in the implementation and maintenance of S3.

2. **Government level: This is the level of the *ministries concerned* as well as *the Management Authorities of the Managing Authorities (OP MA) integrated in the ministries***. The following functions are important from the perspective of S3:

   - coordination of the S3-related tasks of the ministries;
   - continuation of the EDP process, namely feedback of the experience received during the implementation of the operational programmes in the smart specialization process, and commenting the new directions of smart specialization;
   - ensuring the synergies with the relevant strategies and operational programmes.

   From January 2014, the implementation of EU development programmes was transferred to the ministries, while the use of the resources is coordinated by the Prime Minister's Office.

   The OP MAs are responsible for the effective and efficient implementation of the operational programmes within their responsibility; the professional, financial and administrative management of the programmes in accordance with the law; and the use of the resources.

   The operational programmes – which are relevant to the smart specialisation – and their responsible ministries (where the MA is located):

Table 2: Administrative bodies responsible for the operational programmes

Operational Programme	Responsible ministry
Economic Development and Innovation Operational Programme (EDIOP)	Ministry for the National Economy (NGM)
Competitive Central Hungary Operational Programme (CCHOP)	Ministry for the National Economy (NGM)
Human Resources Development Operational Programme (HRDOP)	Ministry of Human Capacities (EMMI)
Rural Development Programme (RDP)	Prime Minister's Office (ME)
Hungarian Fisheries Operational Programme (HFOP)	Prime Minister's Office (ME)

3. **Local/regional coordination:** Like in the course of planning, **the local coordinating and organization tasks of the implementation of smart specialization are carried out by the county government offices.** The government offices are responsible for ensuring the local implantation of the S3 objectives and, as a part of the EDP process, ongoing consultation with the participants involved. In addition, they also attend to the local S3 management and other relevant tasks, supply information for the regular monitoring and evaluation activities to the professional supervision and management, as a result of which the local S3 is continuously revised and updated. **The county S3 working groups,** comprising the representatives of the scientific institutions, economic players, social organizations and government agencies as well as the investors and experts, **play a key role in successful local smart specialization.**

Figure25: Organizational chart of the management structure managing the national S3

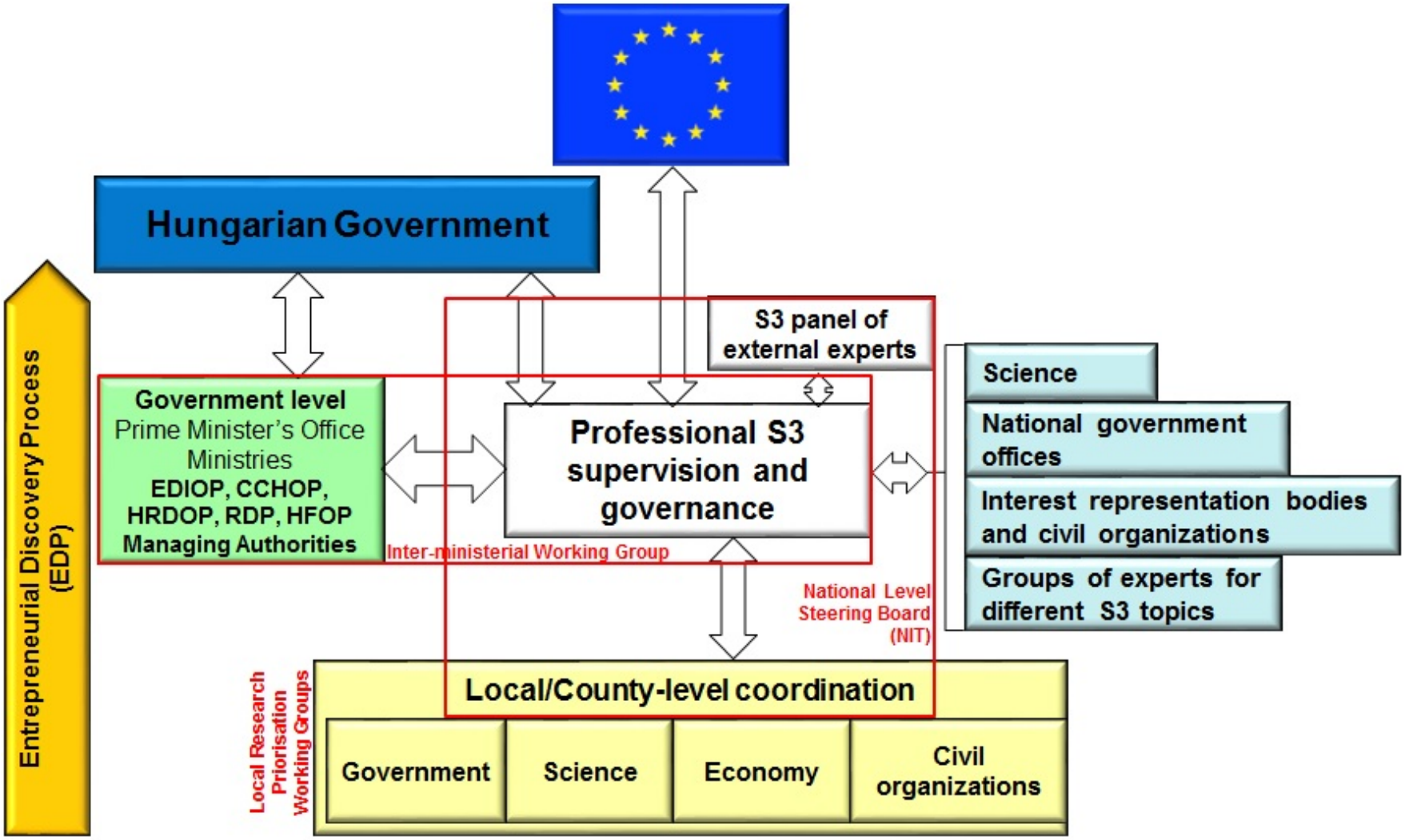


Table 1 of this chapter details the actors of EDP.

3. Vision and objectives

3.1. Vision

Smart specialization is a new type of approach of the European Union, which facilitates the targeted support of the research, development and innovation processes, thereby promoting the knowledge-based economic development of the regions, while observing the local needs and opportunities. The process is designed to enable the individual Member States and regions to further stimulate their innovation systems by 2020, so that they significantly contribute to improving the competitiveness of their economies and the Union and developing a sustainable knowledge-based economy.

By smart specialization, Hungary aims to increase the performance of all actors of the domestic scientific, technological and innovation (STI) system through the direct and indirect effects. Hungary plans to become a knowledge economy by the end of the decade, where internationally competitive knowledge bases and intensive knowledge flows are created and, thus, the use of knowledge becomes more effective. Another important consideration is that the Hungarian economy should be sustainable from the environmental, social and economic aspects alike, while the number of creative jobs and jobs with high intellectual added value as well as the innovation ability of the SME sector also grow.

Hungary's vision is to systematize and stimulate the EDP (*"Entrepreneurial Discovery Process"*) processes aligned with the territorial economic and social background, taking into account the external determinations, in order to ensure that the interventions made in favour of restructuring on the basis of the EU's objectives, the needs of the social communities and the dynamics of the economy evolve in the most favourable manner.

Another comprehensive task of the national S3 is to enable the stakeholders, namely the public administration, the economy and the civil society, to jointly manage adaptation in the rapidly changing world of technology and markets, which results in the corrective or better responsiveness of the STI policy. The effects of modernization appear in the macro and micro levels, social harmony is established and trends showing in the direction of social equilibrium come to the fore. As a result, a target is achieved, which envisions an internationally competitive specialization-learning-alignment process which works on the long term, and the strengthening of an STI ecosystem.

3.2. Classification of the Hungarian counties

In order to ensure that the domestic regions, counties and areas properly position themselves, and choose a vision and achievable goals for themselves based on a realistic analysis of the situation and competence map, they should place themselves in the appropriate segment of the innovation chain.

Prepared by the European Commission, the methodological aid supporting the development of S3 strategies (RIS3 Guide)[18] was based on the regional innovation typology method drawn up by the OECD in 2011. The typology of the regions is the first step in elaborating the region-specific development and specialisation strategies. Once the given region has been classified based on certain criteria, the development components relevant to the type of the region can be determined more effectively.

The typology methodology is based on the fact that each region is positioned in a three-dimensional space on the basis of three criteria referring to the objectives of the Europe 2020 programme (smart growth axis, sustainable growth axis and inclusive growth axis). The three criteria define each axis of the space on which the regions can take the following values:

[18] Guide to Research and Innovation Strategies for Smart Specialisation (RIS 3)

Table 3: Objectives of the Europe 2020 programme

Dimension	Values
1. Sustainable growth	• Rural • Rural, close to urban • Urban • Urban-coastal
2. Smart growth	• Low knowledge- and technology-intensity • Industrial production zone • Knowledge-intensive area
3. Inclusive growth	• Decreasing population • Growing population

After positioning in space, the RIS3 Guide defines the following types of initial basic strategy:

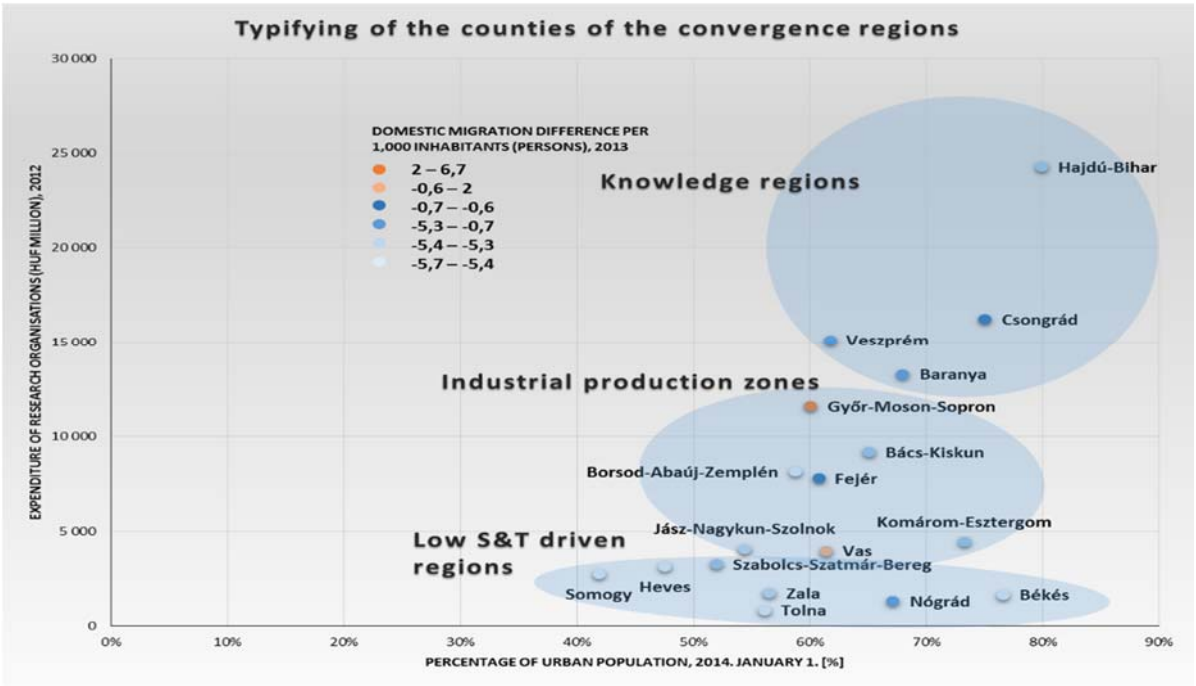
- Strategy building on existing benefits (can be science- or technology-driven, or a mixture of the two)
- Strategy promoting socio-economic transformation (conversion of existing directions, or drafting new ones)
- Convergence strategy (orientation towards knowledge-based skills)

Based on the methodology of the RIS3 Guide, the Hungarian counties are positioned in a similarly constructed innovation space. We use the same dimensions to determine the innovation space as the RIS3 Guide. The dimensions are defined by the following statistical indicators:

- Dimension 1 – Sustainable growth: Percentage of urban population, 2014. January 1. [%], percent
- Dimension 2 – Intelligent growth: Expenditure of research organisations (HUF million), 2012
- Dimension 3 – Inclusive growth: Domestic migration difference per 1,000 inhabitants (persons), 2013

Based on the above classification, the ranking of the Hungarian counties**26** evolves as shown:

Figure 26 Typifying of the counties of the convergence regions



The figure does not include the Central Hungarian region (KMR) due to the outstanding innovation performance and the special status of the region in terms of development resources (separate development operational programme).

Based on the positioning of the counties in the innovation space by using the above methodology, three types of regions can be defined in Hungary:

- Knowledge regions
- Industrial production zones
- Low S&T driven regions

The types of regions are comprised of the following counties:

Table 4: Distribution of counties by types of region

Knowledge regions	• Budapest and Pest County • Baranya County • Csongrád County • Hajdú-Bihar County • Veszprém County
Industrial production zones	• Bács-Kiskun County • Borsod-Abaúj-Zemplén County • Fejér County • Győr-Moson-Sopron County • Jász-Nagykun-Szolnok County • Komárom-Esztergom County • Vas County
Low S&T driven regions	• Békés County • Heves County • Nógrád County • Somogy County • Szabolcs-Szatmár-Bereg County • Tolna County • Zala County

It should be noted that the map drawn on the basis of the above chart does not mark strict categories, and that the method applied contains a disputable element (credibility of the image shown by the R&D expenditure, relevance of urbanisation). Therefore, this typology does not have an actual impact on the tenders affected by S3 (e.g., exclusion of certain types of counties from tenders, or advantage/disadvantage in certain invitations to tender). The typology only aims to support the definition of possible regional visions and objectives based on realistic aspects.

The typology provides a guide to the counties for the proper shading and interpretation of the priorities, surveying the number of priorities, defining the priorities, and assists in selecting the appropriate policy measures from the policy mix.

At the same time, typifying - by its nature - applies simplifications. Several counties are characterized by that the trends applicable for certain towns (primarily the county seats) are not valid in the rural areas of the county. Therefore, the vision and objectives presented in the next chapter should be interpreted more carefully during the implementation. (For example, it is possible a that certain urban

region can be considered as a knowledge region or industrial centre, but the surrounding countryside is low knowledge- and technology-intensive.)

3.3. Vision and objectives

Based on the typology of the counties, three types of geographically non-contiguous zones/regions can be determined in Hungary: Knowledge regions, Industrial production zones, and Low S&T driven regions.

The three types of regions are markedly different from each other in terms of the basic innovation features, so instead of formulating a general vision, it is necessary and appropriate to create an independent vision for all three types of regions. The three visions are shown in Table 5:

Table5: Visions outlined by the National Smart Specialisation Strategies for each type of region

Knowledge regions	The knowledge regions of Hungary will become dominant players of the macro-region and Europe in the specialization directions in the selected areas, and gain a competitive advantage through the strengthening of the knowledge centres and the involvement of the business sector which raise the knowledge and the products produced in selected specialization directions to the international level. The forward effect of smart growth at the domestic level will trigger the rise of the other regions as well.
Industrial production zones	In the zones of industrial production, the regions can connect to the innovation chain through the R&D&I activities in the fields designated in the specialisation directions, and become successful vendors through the development of products with a high added value, especially by strengthening the SME sector. By taking the path of sustainable growth, the regions will have the opportunity to set up their own knowledge centres along the specialisation directions and, thus, become a region of knowledge.
Low S&T driven regions	In the Low S&T driven regions, the traditional sectors will be renewed by means of innovative solutions in the fields designated by the specialisation directions (so-called follow-up innovation), and more vivid R&D activities will be launched. As a result of inclusive growth in the regions, the region becomes more liveable, jobs are created and migration ceases.

In order to implement the visions, all three types of region need to transform their current economic structures in an evolutionary way along the specialisation directions. To do this, the cooperation and supportive approach of the local stakeholders are essential. EDP has a key role to play in the continuing and extensive involvement of the actors involved, and that the stakeholders identify with the objectives. It is also indispensable that the four key actors (business, research and educational institutions, government, civil society and citizens, collectively, the “quadruple helix”) consciously look for and exploit the opportunities for cooperation at the local level in respect of all three visions. Thus, the local innovation ecosystems filled with contents and operating with the involvement of local actors can contribute to the implementation of the visions.

4. Priorities

4.1. Preliminary studies supporting the setting of RDI priorities

The setting of priorities has been supported by more preliminary analysing studies and strategic planning process. Based on the statistical data presented in the Situation Analysis, the pulling sectors of each (NUTS-2) region, which are capable of demonstrating apparent RDI results from the statistical point of view, can be determined in broad terms. In addition, regional founding studies were prepared in the initial process of S3 (see Chapter 2.3.1), in the course of which the main sectoral specialization directions were determined inhas also consultations with the involvement of external experts and local stakeholders. The established directions, identified breakthrough points and main RDI key sectors could be used as a basis both by the work organisations responsible for planning and coordination and responsible for the further implementation of the EDP process in the later stages of the S3 process.

4.2. Development and implementation of method determining the RDI priorities and specializations

The main sectoral specialisation directions mentioned in the previous chapter have been determined by the members of the EDP process within a series of “workshops”, through a comprehensive, bottom-up method, in line with the formulation of territorial development strategies at county (NUTS 3) level, with the aim of establishing and precisely determining them. When determining the circle of the participants of the "workshops", the coordinators of the Local Research Priorisation Working Groups especially endeavoured to ensure that the participants replicate, with sufficient precision, the economic structure of the counties (both in terms of the branches and the sectors, as described previously) as well as the human competencies and capabilities. The county coordinators/“workshop” facilitators have not been allowed to influence the setting of priorities. In order to determine the county specialisation directions, the participants of the Local Research Priorisation Working Groups have been working under the methodology described in the text box in the “workshops”.

The working method of county “workshops” determining the RDI priorities

- The 8-10-person (or smaller, in any particular case) groups have taken their seats in the “workshops ”according to the pre-determined (based on registration) composition of the group.
- The four sectors of “quadruple helix” have been represented in the composition of groups:
  - business sector: SMEs, large companies, spin-off companies, start-ups, incubators, investors, clusters, RIA's, technology transfer organizations, industrial and science parks, etc.
  - academic sector: researchers, universities, research centres, university knowledge centres, etc.
  - public administration: counties, National Innovation Office, etc.
  - civil and social sector: representative organisations, platforms, chambers, associations, private persons, etc.
- The introductory presentation of the "workshops" outlined the general economic and RDI statistical characteristics of the county, as well as the methodology of the two-round team work, as a result of which they developed their proposals for the economic, research-development and innovation directions of specialization on the basis of substantiated status analysis, entrepreneurial attitude and the consent of the representatives of entire circle of stakeholders.
- When setting the priorities, the members of the working groups have not only been thinking in terms of statistical, **TEÁOR** (NACE) sectors. Efforts have had to be made to also find and determine inter-sectoral and **technological** development opportunities at a satisfactory level. It has been important that the priorities should try to diversify the development directions.
- Maximum four priorities have had to be unanimously set within the groups, in accordance with the described conditions.
- The conversation of the participants in the group meeting has been moderated by the facilitator, with the assistance of the present S3 working group members. The moderator has kept the conversation in the right direction, has drawn attention to the importance of focused approach and the time factor, but he or she has not made any suggestions.
  - In the last part of the workshop, the priorities recommended by the groups were displayed after summarizing their content.
  - Summary: The aim of the summarisation has only been to unify the overlaps and similar objectives; the priorities unanimously set during the group work process have been included in the summarising column without any changes.
- Group Work 2: every group has reconsidered and refined their own priorities on the basis of the summarised and projected material. If their proposal has been too general in the first round, there has been a chance to specify their specialisation.

In addition to the priority proposals of the county “workshops”, the S3 work organisations have also collected proposals through an on-line, publicly available questionnaire. The respondents have had the chance to provide their priority proposals as an answer to an open question (not a closed form of questionnaire has been used), and the answers have been individually processed. During processing, each specific proposal drawn up in the county “workshops” and submitted through the on-line questionnaire had been categorised, grouped, and then the collective categories were determined on the basis of the grouping. The processing has been done in parallel, under the same methodology and categories but separated based on the origin of data (workshop / questionnaire). The analysis of the statistical underpinning of the aggregated county (workshop and questionnaire) proposals was launched, which shows if the specific proposed priority is a proven strength in the given county from the statistical point of view.

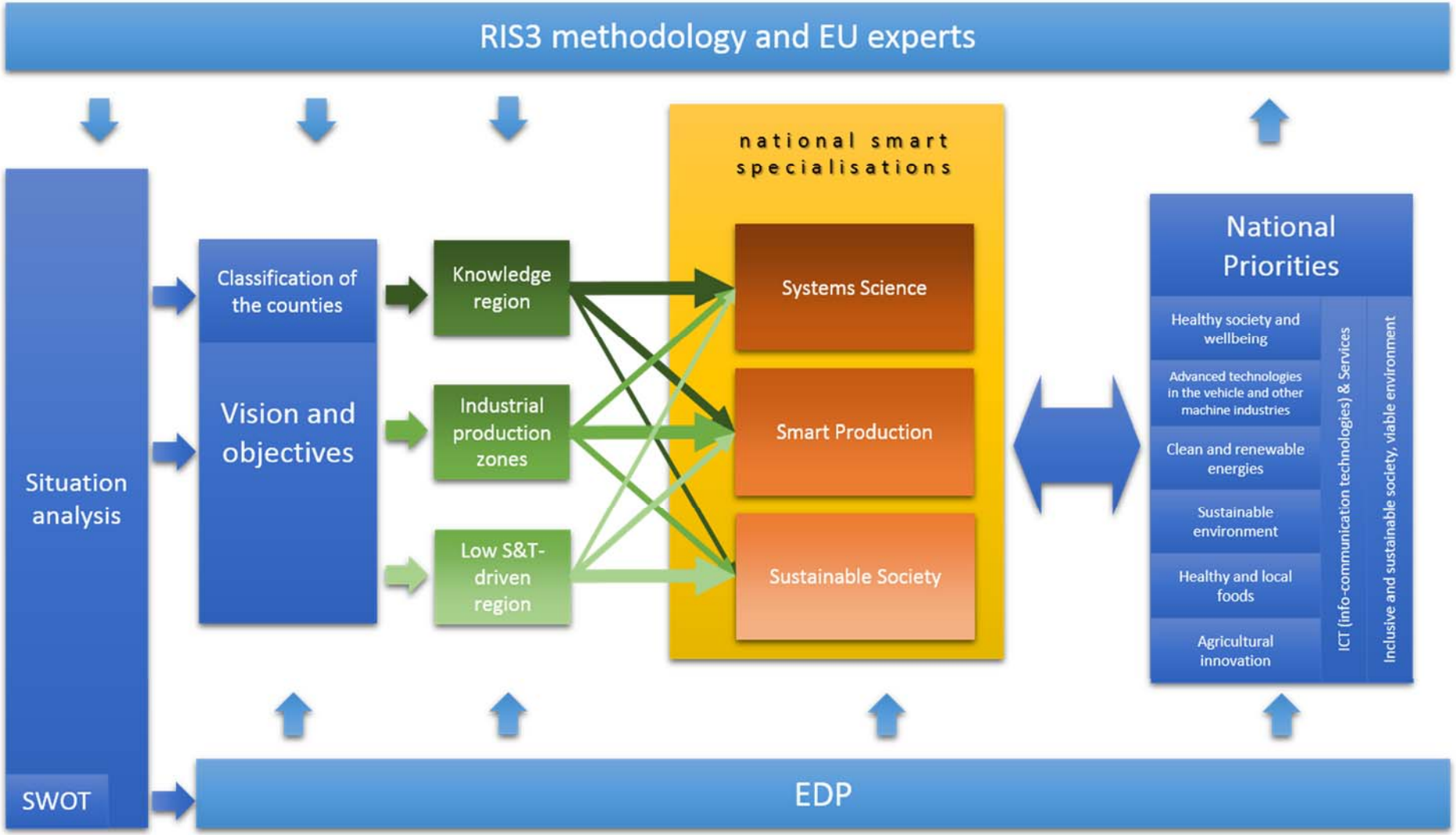
In the second round of the professional conciliation procedures, the county working teams were introduced and could comment on and supplement the draft of the National Smart Specialization Strategy for social discussion, prepared based on the proposals of the other counties as well, and could fine-tune the entire document. Expressing opinions was also possible by filling the on-line questionnaire containing open and closed questions or in the form if informal sent by e-mail. The S3 Management Team also invited other technical experts and organizations along the 'quadruple helix'. The smart specializations were developed along the materials of the county workshops and the comments received on the basis of the research priorities and county specializations, and were commented by the Inter-ministerial Working Group and the National Level Steering Board.

4.3. The National Smart Specialisation directions

As a result of the two-round EDP process detailed in the previous chapter, the participants of the county workgroups, organized along the 'quadruple helix', identified the sectors and the technologies and research directions, along which they develop their research, development and innovation strategy and specialization. In order to determine the specialization directions determined by means of the EDP process, 6+2 (six sectoral and two horizontal) national research priorities and a limited number of local specialization sectors/technologies were created in order to achieve the vision and objectives to be implemented along smart specialization. In accordance with the county typifying presented in Chapter 3, the determination of the specializations to achieve a realistic vision and objection also shows, following the two-round iteration, a triple subdivision along the three types of regions. The objective of the three directions of specialization is to formulate specializations which are independent from a specific sector or technology (or sectoral and horizontal priorities) and bridge the specific sectors and technologies (so-called "cross innovation") or enable the sectors concerned to be structurally renewed, thus making the region competitive by placing it on the orbit of sustainable growth. In the various types of regions, the participants of the EDP process formulated the nature of economic restructuring along different specialisation strategies. Each of the three types of regions has different features and challenges. It should be noted, however, that the appropriate answers to be applied in certain areas of a type of region reach their objective by applying a direction of specialization which is more typical of another region (for example, the differences of the county seat and the rural areas in some counties). For this reason, it should be stressed that certain directions of specialization have relevance in all types of regions, even if at a different level (which has the importance of the spillover effects of the innovation processes). The selection of the directions of specialization appropriate for the different types of regions followed a bidirectional process and two-round discussion. One direction was the vision of the counties, which was based on the existing characteristics in one part (see the typifying in Chapter 3), and on self-definition in the other part. The other direction was the determination of the RDI priorities. The participants of the EDP process presented the research priorities (national priorities) which are supported in details beyond what is

described in the following sections or, in many cases, by means of actual implementation steps and project plans. This enabled the formulation of the directions of specialisation which support the implementation of the so-called "cross innovation" and designate the directions of specialisation adjusted to the type of the region. In fact, the principles which have given the definition of the specializations were independent of sectors. Figure 27 gives an overview of this bidirectional building process and the series of the chapters and steps of the smart specialisation strategy discussed previously.

Figure 27: Alignment of the national smart specializations to the S3 strategy
The directions of specialization illustrated in the figure are detailed in the following chapters.



It should be stressed in the context of the national smart specialisations that they:

- **are limited:** due to the nature of the specialization, they are designed to support excellence and obtain and retain competitive advantages[19],
- can be primarily **linked a certain type of region**, but their importance is present in all types of regions, even if at a different level[20],
- are linked to the research priorities, but support **inter-sectoral relations as well**[21],
- are designed for the smart **transformation of the economy.**

4.3.1. National specializations

In accordance with the above chapters, three national smart specializations were formulated in the course of the strategy building in accordance with the types of regions outlined in Chapter 3. With regard to the findings made in the course of the specializations, the descriptions of the territorial characteristics of RDI in the Situation Analysis and the chapters presenting the different sectors serve as the reference. However, when making the classification of the counties, the specific characteristics (for example, the existence or lack of a significant corporate R&D expenditure in a knowledge region, the relatively low R&D expenditure in an industrial production zone, etc.) had to be into taken into account in all cases.

The RDI performance in the knowledge regions is determined by the academic sector (higher education institutions and HAS research institutes), therefore, the discovering research will be given greater importance. (Large) companies which are R&D-intensive can also be present, allowing the direct utilisation of knowledge:

Systems science	It places the emphasis on systematic approaches in the research. It implements new scientific results on the frontiers of the areas of sciences by using the leading research results of the neighbouring disciplines and renewing the area of research, from or on the basis of which possibilities are provided directly to the economy or the society to use significant applications.

In the industrial production zones, production, manufacturing industry and intensive company R&D presence dominate:

Smart production	It focuses on product development. It is capable of manufacturing own products or improve existing products through technological renewal in the innovation value chain, which provides a competitive advantage, in particular, by using smart technologies and/or advanced materials.

[19] „These objectives should be based on present and future competitive advantage and potential for excellence, […]

[20] as derived from the analysis of regional potential for innovation-driven differentiation" (RIS3 Guide)

[21] „In addition to technological, sectoral or cross-sectoral priority areas, horizontal priorities need to be defined." (RIS3 Guide)

The amount of the R&D expenditure is the lowest in the low knowledge- and technology-intensive regions. The counties concerned also struggle with significant migration and the presence of the academic sector is smaller or negligible:

Sustainable society	It provides innovative answers to societal challenges. It promotes the sectors with the instruments of follow-up innovation sectors, making the environment liveable and increasing the retention force of the region through the utilization of the latest research results, the use of modern technologies, equipment, and materials and social innovation.

The industries can reach renewal through (non-exclusive) structural transformation. Observing the proposals received during the EDP process, the national smart specializations aim to place certain structural transformation solution in the fore, while maintaining the possibility of laying radically new foundations:

Table 6: Relations of the main sectoral specializations and national specializations

Specialization	Main directions of the sectoral renewal
Systems science	transformation of an existing sector based on the cooperating institutions and processes
Smart production	modernisation of an existing industry with the assistance of "*Key Enabling Technologies*"[22]
Sustainable society	spreading diversification: exploitation of the synergies of a new and an old activity (focusing and the spillover effects)
laying the radically new foundations of a traditional area: R&D and innovation can make a specific low-growing socio-economic activity suddenly more attractive or more valuable than before	

Owing to the situation analysis, the smart specialization areas can prevail particular in the following areas of science and sectors of the national economy:

Table 7: Soundness of the national specializations

Specialization	Soundness	Area of science/industry
Systems science	Expenditures of HAS research (by disciplines)	material sciences, physical sciences, biological sciences, ICT and agricultural sciences
	Expenditures of HAS research (by sectors)	pharmaceuticals, energy, ICT
	R&D expenditures of higher education	technical sciences, natural sciences, medical sciences
Smart production	innovative manufacturing sectors	pharmaceutical industry, chemical industry, vehicle manufacturing, ICT
	R&D expenditures of companies	pharmaceuticals, rubber/plastic, metal processing, health care,

[22] advanced materials technology, nanotechnology, micro- and nano-electronics, industrial biotechnology and photonics

		machine industry, electrical equipment
	companies engaged in technological innovation	pharmaceuticals, chemical industry, vehicle industry, manufacture of electrical equipment, electronics, rubber/plastics manufacturing, food industry, machine industry
Sustainable society	corporate participation in higher education research	agricultural sciences, technical sciences

Specific specializations appear in all types of regions as presented in the introduction to this chapter and the introduction of the specializations, however, to varying degrees. The three specializations can be linked to the various types of regions in the following indicative table, which links the types of regions to the directions national smart specializations based on the degree of exploitation of the specializations:

Table 8: Links of the national specializations and the types of regions – an indicative table of exploitation

Specialization	Type of region	Exploitation
Systems science	Knowledge regions	about 70%
	Industrial production zones	about 20%
	Low S&T driven regions	about 10%
Smart production	Knowledge regions	about 20%
	Industrial production zones	about 60%
	Low S&T driven regions	about 20%
Sustainable society	Knowledge regions	about 10%
	Industrial production zones	about 20%
	Low S&T driven regions	about 70%

The next chapter describes the areas of research and the priorities, where the smart specialisations can prevail. The participants of the EDP process determined these priorities in the light of the situation analysis, and there were instances where conscious entrepreneurial risk assumption was applied.

4.3.2. National Priorities

Within the national research priorities, there are sectoral priorities and two horizontal priorities which are particularly important for all counties: each of the national priorities, even if they have different weights, were determined by all counties when they determined their directions of specialization. So these national priorities represent directions for specialization which can be formulated by all counties and at the national level. Therefore, the individual counties cannot be differentiated. However, proposals for specializations were received, which can be linked to a specific intelligent technology, but their soundness or relevance appears only in certain counties. So the intelligent technologies are directions of specialization which can be applied in all counties. Accordingly, the smart specialisation directions of a county include the national priorities and the intelligent technologies characteristic of the given county.

Sectoral priorities

Healthy society and wellbeing	**understanding diseases, early diagnosis, advanced medical and instrumental therapies, clinical methods, pharmaceutical research and development, innovative health industry and health tourism solutions**

This is a priority to be implemented through the wide application of advanced health care technologies, and is aimed at maintaining and improving the general health condition of the society. The priority wants to cover the entire health care industry innovation chain ranging from the better understanding of the diseases, through prevention and recognition, to curing and personalized doctoring. To this end, there will be a possibility to use advanced technologies, such as biotechnology in health industry, biomedicine and pharmaceutical industry, systems biology-based remedy, advanced diagnostic and therapeutic methods. Development of equipment and instruments linked to the above, which are necessary for healing. We have to face the health care challenges of the ageing society which, on the other hand, gives an opportunity to innovation in the health tourism. Hungary has exploitable resources in the latter area also in respect of the medicinal waters, and the RDI related thereto (e.g. balneology) can also be linked to this priority.

Advanced technologies in the vehicle and other machine industries	**machine industry RDI, advanced production technology systems, advanced materials and technologies (technical materials science, materials technology, nanotechnology, mechatronics and electronics)**

This is a priority which covers several segments of the machine industry RDI, whose priority (but non-exclusive) objective is to develop the vehicle industry from the development of vehicle components to the different branches of machine production (including, but not limited to, agricultural, food processing, precision and household machinery). To this end, product development, the development of advanced machine industry production technology systems and advanced technologies (technical materials science, materials technology, nanotechnology, mechatronics, electronics, "smart" production) can be applied and there is a chance for the research and development and innovative use of advanced materials.

Clean and renewable energies	**green energy – renewables and bio-energy, nuclear energy, energy efficiency**

This priority involving the energy sector is designed to reduce the energy dependency of Hungary by means of clean and environmentally friendly energy and promoting the related RDI activities, so that the energy produced locally is sustainable, decreases the environmental load and is cost effective, in particular for the households. In addition to using the renewable energies (solar, wind, hydro and geothermal energy) and our thermal water for energy purposes, another objective is the use of bio-energy (such as biomass, biogas, biorefinery methods or the use of various wastes and by-products for energy purposes) as well. In addition to renewable energies, it is a priority to make the other energy producing sectors of the sector clean, more efficient, environmentally friendly and more sustainable, including, particularly, the coal and nuclear energy (for example, clean coal technologies, innovative fuel and decommissioning technologies in nuclear energetics). Priority is given to energy efficiency, better and more efficient energy storage and distribution, as well as the utilization of the so-called "waste energy".

Sustainable environment	**natural resource management, advanced environmental technologies**

The priority is aimed at promoting the sustainability of the environment and natural resource management (e.g. environmental biotechnology) through the research and development of modern technologies and the implementation of the environmental industry and sectoral innovation. In addition to the advanced innovative water treatment technologies and waste water treatment and waste management, priority will be given to the non-pipe technologies (e.g. advanced production technology systems for environmental protection). The sustainability of the environment is also supported by the solutions for the innovative exploitation of the natural resources (such as drinking water, mineral resources and arable land).

Healthy local food	**food processing, locally produced and processed food of high added value**

The food sector priority aims at sustainability, both in terms of production and consumption, in particular with regard to food safety. It covers the RDI of the entire food chain. It is designed to promote the development of only short food chains, both in space and time, which preserve the biological value, helping the development of a local "brand" and, thus, establish not only the possibility of the local sales, but also the possibility of export (especially in the case of the Hungarian specialities). RDI has a special role in the Hungarian food industry in terms of the production of high-quality foods of high added value, foods supporting a healthy diet, functional foods and Hungarian specialities, as well as the shortening of food chains and in the field of food safety. These developments (may) contribute to improving the general health condition of the society; in addition to being beneficial from an environmental aspect, the regional ecological product development and local food processing also help to keep the population in the countryside by creating new jobs and thus preventing migration.

Agricultural innovation	**agriculture, forestry, hunting, aquaculture and water management, horticultural technologies, agricultural biotechnology**

The agriculture sector is traditionally present in Hungary and displays outstanding RDI activities. The aim of the priority is to advance and establish the innovations facilitating sectoral renewal from the agricultural knowledge centres through producer undertakings to individuals, with the aim of enhancing the innovation potential of the sector. Such complex agribusiness developments should be implemented that represent an opportunity to use innovative R&D solutions in crop production and protection technologies, in addition to animal production and veterinary medicine. In addition, research and development in the fisheries management and forest and wildlife management, innovative vegetables and fruit growing, viticulture and wine-making and the development of innovative irrigation systems are also featured. Special attention must be paid during the implementation of agri-innovations to the development of the proper interfaces with the food industry (see also the "healthy and local foods" national priority).

Horizontal Priorities

On the basis of county “workshops” (and the submitted questionnaires), during the setting of priorities, two horizontal priorities – one technological and one societal – have been conceived among the participants in the EDP process. It was justified by both the numbers and the importance attributed to it by the participants that the national smart specialization manages the following priorities as horizontal priorities (namely, priorities which bridge over and overlap the priorities listed above which are linked to specific sectors, or are broader in some ways).

In determining the directions of national specialization, it must be emphasized that the weight of the horizontal priorities within the national priorities is the same as that of the sectoral priorities, but their separation is justified by their nature and content detailed above.

ICT (infocommunication technologies) & Services	**infocommunication technologies in support of the sectoral priorities, infocommunication technologies and services**

Infocommunication technologies extensively encompass and support the sectoral priorities, such as bioinformatics or diagnostic imaging in the health industry, or the intelligent transport systems in the vehicle industry, or “smart city” in the energy domain.

The following solutions can be such ICT solutions that cannot be linked to sectoral priorities in an unambiguous way or can be linked to more sectors (these are just a few examples, not an exhaustive list):

- smart business, company, home
- smart city
- information security, security technology
- gamification, simulation and optimisation technology
- e-learning systems
- big data
- data mining
- software development
- remote monitoring system
- cloud computing
- intelligent transport
- development of mobile applications, location-based services
- 3D GIS
- bioinformatics
- “Internet of things”
- 3D printing
- future internet
- 5G technologies
- remote sensing
- computer-based instruments and measurement and process control improvements
- numerical modelling and simulation
- machine learning
- data centres, data transmission networks
- etc.

In addition to infocommunication technologies, services – mostly using ICT tools – without which the given complex (sectoral) RDI process could not be implemented constitute the other side of technological horizontal priority. The aim of the horizontal priority is to enable the service sector, which is a key sector of the national economy, to facilitate the implementation of complex RDI activities.

Inclusive and sustainable society, viable environment	**education and training, health-conscious education and prevention, awareness raising, promoting entrepreneurial skills, development of cooperation, networking, organization and**

	management development, social innovation[23], connection to local and regional development programmes, regional development, tourism

The societal horizontal priority sets such comprehensive objectives that have been highly emphasized by the participants in the EDP process in every sector affected by the national priorities; and they have to be realized in order to create an inclusive and sustainable social model to every citizen. The National Smart Specialisation aims to comply with the newest innovation model directions, i.e., so-called "quintuple helix" within the target system belonging to this priority. *("The quintuple helix model contributes to the alignment of ecological efficiency, knowledge and innovation, thus creating a synergy between economy, society and democracy."*[24])

4.3.3. Smart technologies

In determining the county specializations, the participants of the EDP voted for the use of several advanced technologies and the renewal of some existing traditional industries which cannot be directly adjusted to the national priorities, but the sectoral interoperability provided by the potential, conscious risk-taking or the technologies existing at the local level (e.g. materials science, nanotechnology, biotechnology, ICT) justify bringing them into the limelight.

Table 9: Presence of smart technologies in the counties

Smart technologies	Counties
photonics, laser technology	Baranya County, Budapest and Pest County, Csongrád County, Hajdú-Bihar County, Komárom-Esztergom County, Somogy County
special materials, advanced materials, modern materials technologies	Bács-Kiskun County, Baranya County, Békés County, Borsod-Abaúj-Zemplén County, Budapest and Pest County, Csongrád County, Fejér County, Győr-Moson-Sopron County, Hajdú-Bihar County County, Heves County, Komárom-Esztergom County, Nógrád County, Szabolcs-Szatmár-Bereg County, Veszprém County, Vas County, Zala County
bionics	Budapest and Pest County, Csongrád County, Fejér County
metal fabrication other than machine industry	Bács-Kiskun County, Borsod-Abaúj-Zemplén County, Budapest and Pest County, Nógrád County
electronics and semiconductor technology	Baranya County, Budapest and Pest County, Fejér County, Hajdú-Bihar County, Jász-Nagykun-Szolnok County, Tolna County, Vas County, Veszprém County

[23] The horizontal objective is linked to the Horizon 2020 objective and the strengthening of social innovation. In terms of RDI, social innovation means an advanced approach to social innovation whose broader objective is to promote adaptation to the challenges of today's society. The important elements of social innovation include, for example, initiatives which manage the social impacts of the rapid development of technology, the new types of socio-economic cooperation, including, in particular, those of the actors affected by the RDI, or the innovative measures designed to remedy the problems of employment and employability.

[24] doi:10.1186/2192-5372-1-2

modern hydrocarbon technology (crude oil / natural gas)	Borsod-Abaúj-Zemplén County, Budapest and Pest County, Csongrád County, Heves County, Veszprém County
modern packaging technologies	Bács-Kiskun County, Békés County, Budapest and Pest County, Csongrád County, Heves County, Zala County
chemical industry (e.g. rubber and plastics industry, production of intermediates, fertilizers and cosmetics)	Békés County, Bács-Kiskun County, Borsod-Abaúj-Zemplén County, Budapest and Pest County, Csongrád County, Heves County, Jász-Nagykun-Szolnok County, Szabolcs-Szatmár-Bereg County, Veszprém County, Zala County
building industry (building materials technologies)	Baranya County, Békés County, Borsod-Abaúj-Zemplén County, Budapest and Pest County, Csongrád County, Győr-Moson-Sopron County, Heves County, Tolna County, Veszprém County
textile industry	Budapest and Pest County, Győr-Moson-Sopron County, Tolna County
wood and furniture industry	Győr-Moson-Sopron County, Komárom-Esztergom County, Veszprém County, Zala County
logistics	Békés County, Bács-Kiskun County, Borsod-Abaúj-Zemplén County, Budapest and Pest County, Csongrád County, Fejér County, Győr-Moson-Sopron County, Heves County, Jász-Nagykun-Szolnok County, Szabolcs-Szatmár-Bereg County, Vas County, Zala County
cultural and creative industry	Baranya County, Budapest and Pest County, Csongrád County, Hajdú-Bihar County, Heves County, Komárom-Esztergom County, Vas County, Zala County

The above table should be revised by an independent professional community before the implementation of the smart specialisation strategy, but not later than within one year following the adoption of the strategy, in order to ensure that both integrity and conscious risk-taking prevail therein (for example, can the given smart technology be found in that county, or has the research-development-innovation community of the county taken the measures to enable the intelligent technologies to settle or create results properly matching the vision of the county).

4.3.4. The role of County Specialisations

The research priorities identified during smart specialisation can only be interpreted at a national level, but it has been particularly important during the process to justify that the national research priorities are sufficiently established by the county specialisation directions. Therefore the primary objective behind the assessment of county specialisations has been to make the sectors and technologies with sufficient critical mass/potential visible, with the involvement of local stakeholders (EDP). The proposals received from the counties are summarized in Table 10. These county specialization proposals served as the basis of, and formed, the national priorities. On the other hand, the national significance of the national priorities does not justify indicating the various counties separately in the table, since the counties cannot be differentiated in this respect – as described above.

Table 10: County specializations laying the foundations of the National Smart Specialisation Directions

National Priorities			County Specialisations
Inclusive and sustainable society, viable environment	ICT (infocommunication technologies) & Services	Healthy society and wellbeing	biomedical research
			clinical research
			diagnostics, theranostics
			production of medical instruments and devices
			medical biotechnology, systems biology-based remedy
			pharmaceutical industry
			medical and health tourism
		Advanced technologies in the vehicle and other machine industries	vehicle component and machine production
			vehicle and machine industry materials technology (metal processing, plastic processing)
			production technology development in the vehicle and other machine industries, systems for measurement, modern production systems
			machine production in other sectors than vehicle industry (agricultural machine production, production of household appliances, production of precision machines, material selection systems, space industry)
			nanotechnology in the vehicle and other machine industries
			mechatronics in the vehicle and other machine industries, hydraulics
			robotics in the vehicle and other machines industries
		Clean and renewable energies	bioenergy, biomass
			solar energy, water energy, wind energy, geothermal energy
			utilisation of thermal water
			clean coal technology
			energy-efficient and self-sustaining systems
			energy distribution systems
			energy storage
			nuclear energy (innovative fuels, decommissioning technologies)
			water treatment technologies (sewage treatment)
			waste management and utilisation
			environmental biotechnology
		Healthy local food	food processing
			functional foods
			food ingredients of high added value
			food safety
			food industry biotechnology
			regional ecological products
		Agricultural innovation	(plant and animal) variety breeding
			water management, irrigation technology, soil improvement
			horticultural technologies
			environment-friendly plant production and crop protection technologies
			animal production and veterinary medicine technologies
			viticulture and wine growing
			aquaculture

			forestry, wildlife management
			processing of pharmaceutical crops
			agricultural biotechnology
		Smart technologies	photonics, laser technology
			special materials, modern materials
			bionics
			metal fabrication other than machine industry
			electronics and semiconductor technology
			modern hydrocarbon technologies (crude oil and natural gas)
			modern packaging technologies
			chemical industry (rubber industry, plastics industry, cosmetics)
			building industry (building materials technologies)
			textile industry
			wood and furniture industry
			logistics
			creative industry

4.3.5. Examples of the implementation of national specializations along the priorities

Table 11: Examples of the implementation of national specializations along the priorities

Specialization	Priority	Industrial revival
Systematic research	Healthy society and wellbeing +ICT	use of the tools and results of molecular life sciences, ICT, mathematics and physics in the fields of healing with a systems biology approach and early pharmaceutical research
Smart production	Advanced vehicle industry and other machine industry technologies + Smart technologies	technical materials sciences, electronics, robotics, nanotechnology, mechatronics, use of advanced materials in the development of the automotive parts
Inclusive society	Healthy local food + Agricultural innovation	production and sale, not only on the local market, of local foods of high added value produced by using innovative agricultural and food technologies (e.g. Hungarian specialities)
	Sustainable environment + Clean and renewable energy + Healthy society and wellbeing	innovative natural resource management: use of thermal waters and medicinal waters in energy generation and medicine, linked the balneological research, in consideration of particularly the ageing society and the related health tourism
	ICT + inclusive and sustainable society, liveable environment	introduction of the use of computer-based instruments, developer software and measuring-control instruments in dual training

4.4. Links of the National Smart Specialisation Directions to the Horizon 2020 programme

The pillars and topics of the Horizon 2020 (H2020) programme cannot be directly matched to the directions of the national smart specialization, however, there are matches both in terms of the objectives (which are displayed in the main pillars) and the topics. You can find similarities in the objectives of the specializations, as well as the priorities are overlapping. However, the Hungarian specializations offer a different response to the major social challenges, which is typical of the domestic circumstances.

Relationship of the H2020 pillars and the national specializations

H2020	Specialization
Excellent science	Systematic research
Industrial leadership	Smart production
Societal challenges	Sustainable society

Relationship of the H2020 topics and the national priorities

H2020	Priority
Future and emerging technologies	Advanced technologies in the vehicle and other machine industries Intelligent technologies
Health care, demographic change and wellbeing	Healthy society and wellbeing
Food security, sustainable agriculture and forestry, marine research, marine and inland water research for exploitation, and bioeconomy	Healthy local food Agricultural innovation
Secure, clean and efficient energy	Clean and renewable energies
Climate change, environmental protection, resource efficiency and raw materials	Sustainable environment
Europe in a changing world – Inclusive, innovative and reflective societies	Inclusive and sustainable society, viable environment
Science in the society for the society	Inclusive and sustainable society, viable environment

Horizontal elements

H2020	Priority
ICT	ICT and services

4.5. Relationship with the Smart Specialisation Strategies of the Visegrád Countries and the Danube Region Strategy

4.5.1. The comparison of the S3 strategies of Visegrád Four,[25] the possible connections

The Visegrád Group has been the result of the effort to adopt a common stance of the countries in the Central-European region on relevant issues within the framework of the European integration. Therefore, it is an important aspect in the economic development of the Visegrád Four that they develop their visions and national priorities in a way that is consistent with each other and strengthen each other under the auspices of the European Union, in the light of their social, economic and cultural relationships.

The smart specialisation strategy of Slovakia is in the most advanced stage among the Visegrád countries (Poland, Slovakia, Czech Republic, Hungary); it is considered to be the final material both by the Slovak government and the European Commission. Poland has also prepared its own national S3 document; however, this cannot be regarded as the final document since the forthcoming regional smart specialisation strategies will form an integrated part of the strategy. The national S3 document of the Czech Republic is in the planning process; the political and social consultations are currently being held. Nevertheless, we know the Czech national S3 priorities as well on the basis of the S3 platform database operated in the JRC centre in Seville.

Owing, among other things, to its size, Poland is a single though decentralized state, where regional policy has become a separate sectoral policy since accessing the EU. While the institutional system established for managing the Structural Funds, which represents resources relevant for the development of the country are integrated into the sectoral system but it still operates in a decentralised form. This is clearly highlighted by the fact that the regional governments have decision-making competencies in the governance of decentralised operational programmes. In contrast, Slovakia or the Czech Republic, like Hungary, followed a more centralized approach in determining the S3 priorities due to their size and location, although regional smart specialisation plans were prepared in these countries as well.

Based on the review of the Polish, Slovak and Czech national priorities, four areas were found where interfaces with the Hungarian objectives can be developed.

Health care and health care development can be found in the documents of all three countries. *"Biomedicine and Biotechnology Environment"* belong to this area in the Slovak strategy. Although biotechnological development includes several agents, "biomedicine" clearly belongs to pharmaceutical industry developments, and to healthcare developments in a broader sense. Healthcare and healthcare industry are found under the buzzword *"Healthy Society"* in the Polish strategy. Similar to the Slovak strategy, the medical and healthcare biotechnologies represent the main direction when the sector is detailed and broken down in the document. In the case of the Czech Republic, the planned priorities include *"Healthcare and medical technology and devices"*, i.e. the development of health care and medical technologies and instruments.

With an outlook to the S3 programmes of other member countries of the European Union, it can be observed that healthcare developments are present in most strategies as national priorities. *"Medical Devices"* in Ireland, *"Health"* in Slovenia and Romania, *"Health Technologies and Services"* in Estonia are included as key priorities.

[25] http://www.Visegrádgroup.eu/

One of the main objectives of the Europe2020 Strategy of the European Union is to develop healthcare, which is formulated in the *"Europe2020 – for a healthier EU"* programme.

The directions of Horizon 2020 also emphasize the financing of health care developments under the programme titled "*Demographic Change, Health and Wellbeing*".

The second common set of priorities involving the Visegrád countries is **the development of the agriculture**. Both the Polish and the Slovak strategies contain priorities aimed at the development of the agricultural sector. Slovakia highlights the *"Environment and Agriculture"* sector as a national priority, similarly to Poland where *"Agri-Food, Forestry-Timber and Environmental Bioeconomy"* is included as specialisation direction.

The priorities are aligned with the Europe2020 strategy, which sets out joint agricultural development objectives,a s well as the Horizon 2020 strategy, which pays special attention to the developments in agriculture, in particular, the *"Agri-food"* and *"Sustainable Agriculture and Forestry"* topics.

The third common interface, which is also typical not only of the Visegrád Four, but generally in the EU Member States, is **Sustainable Energy**. *"Sustainable Energy"* is included in both the Slovak and Polish strategies as one of the main national priorities. In terms of sustainability, the development of buildings, industrial processes and logistical and transport solutions have been the main direction in the breakdown of the sector. The direction and purpose of the developments are the use of eco-friendly technologies (low emission of harmful substances) and renewable energy sources (establishment and dissemination of marine power plants in coastal countries), as well as a more efficient and sustainable use of raw materials.

The previous European development policies, the EU2020 and Horizon 2020 specify the developments concerning renewable and sustainable energy as a priority, which has resulted in that all countries concerned started significant improvements and programmes in order to ensure use of the targeted sources.

Fourth, the **advanced vehicle and other machine industry technologies** should be mentioned. In Slovakia, the "*Automotive and mechanical engineering industries*" (vehicle and machine industries) was indicated as the most important specialization direction. Among the priorities of the Czech Republic is the "*Transport means (automotive, aerospace, including connected ecosystem of supplying and supporting industries*", which means that industries linked to transport (automotive industry, space research, including the scientific and economic ecosystem supplying and supporting these) will be one of the pulling forces of the Czech RDI in the coming seven years.

4.5.2. The Danube Region Strategy of the European Union (DRS)[26]

The Danube Region Strategy is the macro-regional development strategy and action plan for the regions and countries located in the catchment area of the Danube river. It targets the sustainable development of the Danube macro-region as well as the protection of its natural areas, landscapes and cultural heritage. Although DRS is different from the smart specialization both in terms of its methodology and objectives, yet **there is an objective, namely "Promotion of the use of sustainable energy", which has a common interface with the relevant priorities of the S3 documents of the Visegrád Four**. The DRS countries have begun the development of a common energy sustainability strategy, and formed a joint working group for that purpose.

[26] http://www.danube-region.eu/

4.5.3. Economic development directions with a potential for cooperation of Hungary and the neighbouring countries

In addition to the possible connections presented in the case of the Visegrád Four, Hungary has the opportunity to cooperate with the neighbouring countries in several various potential RDI-related areas of expertise in the next period. These areas have been mapped and collected with the support of the network of Hungarian foreign economic diplomats. In addition to the Visegrád countries, the main cooperation partners may be such countries as Slovenia, Austria and, among others, the non-EU member state Bosnia and Herzegovina.

The cooperation may take place in line with RDI priorities, such as the developments regarding *Vehicle Industry* and *Transport Infrastructure,* in collaboration with Slovenian and Austrian partners. In this context, the cross-border cooperation can involve fields like energy efficient and eco-friendly structures, urban freight transport or sustainable transport chains.

Together with the Czech, Slovenian and Romanian potential partners, Hungary emphasizes Potential key enabling technologies (KET), e.g., nanotechnology, photonics, biotechnology and modern production and processing technologies.

Infocommunication technologies (ICT), a sector, whose special role is reflected in the EU Horizon 2020 R&D programme, also involve similar priorities. In this case, successful cooperation can be set up with the Czech Republic, Romania and Croatia is directions of specialization like cloud-based services or ICT security.

The *mining and raw material industry* offer an opportunity for international cooperation with Bosnia and Herzegovina, in particular in the field of mining machines and technologies, as well as the raw materials processing machinery and technologies.

5. Policy instruments

5.1. Consistency with the key planning documents and programmes

National Reform Programme

In the framework of the National Reform Programme, Hungary presents the steps taken on the basis of the country-specific recommendations made by the European Council, the measures to achieve headline targets concerning several areas of expertise, formulated with a view to implementing the Europe 2020 Strategy, and formulates further measures, reflecting on the priorities of the Annual Growth Survey of the European Commission. As regards the reform programme R&D, the national smart specialization strategy formulates strengthening objectives, such as he promotion of strategic RDI cooperation and initiatives through the exploitation of synergies between the undertakings and public research organizations; the development of the comprehensive system of incentives for the research and development and innovation activities; building the innovation ecosystem: credit, leasing and venture capital programmes, as well as the introduction of guarantee products.

“Investment in the future” – National research and development and innovation strategy 2013-2020

The National S3 Strategy defines the territorial-technological-sectoral projection of the "Investment in the Future, National Research & Development and Innovation Strategy 2013-2020" (hereinafter, the "RDI Strategy") adopted by Government Decree 1414/2013. (VII. 4).

In order to ensure that the state and public sources spent in the RDI sector in Hungary become investments in the future, the RDI strategy is built around three priority axes:

- internationally competitive knowledge bases, establishing economic and social development,
- knowledge and technology transfer collaborations at a national and international level, and
- innovative companies and public sector intensively utilising the modern scientific and technological (S&T) results.

The periodic comprehensive assessment and, where justified, amendment of the S3 strategy is an important instrument to systematically strengthen the RDI components. On the one hand, the comprehensive assessment may show if there is a significant component of the system, which needs energizing, on the other hand, the national RDI strategic management, which includes the above mentioned S3 planning, may be also improved.

The priorities determined in a bottom-up approach in the S3 planning process contribute to the objectives laid down in RDI and OPs by sectoral/territorial dimensions. The national smart specialisation strategy, which has a bottom-up approach and takes the regional specificities into account, is aligned with the RDI Strategy: the sectoral and territorial priorities selected in the S3 can develop along the objectives detailed in the RDI Strategy. In order to achieve these objectives, the RDI Strategy involves detailed policy instruments both in terms of the direct, indirect and capital-market instruments in order to ensure that economic development is attained through the targeted funding of research and innovation.

The alignment of S3 strategy with the Operational Programmes

The horizontal-approach measures concerning RDI, as formulated in the operational programmes, provide a framework for the implementation of the national S3 specialization directions defined by the county stakeholders in the National S3 Strategy. The financial sources of the operational programmes concerning R&D&I are used in accordance with the smart specializations specified in the S3. The specific government actions formulated in the implementation documents of the operational

programmes will cover the same sectors and specific geographical areas as they are identified in the S3 priorities. The S3 document, which details the specialization directions, and the operational programmes are therefore complementary planning materials, and the consistency between the two planning is ensured by a panel of experts set up for this purpose (the Inter-ministerial Working Group) both during the development and the implementation processes.

Presentation of the connections between the Horizon 2020 Framework Programme and the National Smart Specialisation Strategy

The Horizon 2020 Framework Programme – as the research and development and innovation programme of the European Union with the largest budget for the period between 2014-2020 – significantly alters the priorities and strategic directions of the European research and innovation map. It also plays a vital role in formulating the research and development and innovation policies of EU member states.

The important objectives during the 2014-2020 period include strengthening the Hungarian participation in the Horizon 2020 programme and achieving success beyond the results achieved in the 7th framework programme, both in terms of the number of successful project participations and the funding awarded, as well as enabling more and more Hungarian institutions to undertake attending to key professional tasks in specific projects or leading consortia. Beyond the quantifiable results of participation in the projects, we consider it particularly important to better integrate the domestic RDI institutions into the excellent leading European RDI networks, which are dominant in certain areas.

It is essential that the Framework Programme participation of Hungary should be primarily strengthened in such areas where the national RDI-system has adequate capacities and promising potential. The National Smart Specialisation Strategy has a key role in identifying these areas.

Several of the elements of the research & development and innovation application topics appearing in the 3-pillar structure of the Horizon 2020 Programme also appear among the specializations identified in relation to the national smart specialization strategy, thus facilitating the exploitation of synergies.

Achieving consistency between the national priorities and the objectives of the Horizon 2020 Framework Programme contributes in the long term to the following:

- strengthening the competitiveness of undertakings at the international level,
- enhancing the integration of the Hungarian research and higher education institutions and undertakings at Union level,
- increasing the social capital of the national institutions and exploitation of opportunities for cooperation with internationally renowned institutions.

The integration of components of the excellence-based application system into the national strategy and the development of initiatives fostering the participation in international R&D&I projects will enable the potential applicants to participate in European world class collaborations at a national level. The improvement of the infrastructural situation and human resources of the Hungarian institutions is indispensable for promoting the excellence of applications.

The consistency achieved between the tender schemes financed from the Structural Funds and the calls for proposal in the Horizon 2020 enables the implementation of long-term development plans through the coordinated use of or successive use of grants that are built on each other.

The participation in the Horizon 2020 programme is one of the priority instruments to implement the National Smart Specialisation Strategy. It is possible that a portion of the ESIF resources is used for the preparation of participation in the Horizon 2020 projects or financing the support activities dedicated for the follow-up of the successful Horizon 2020 projects, which also contribute to the exploitation of the project results in the market. When elaborating the national supporting tenders, particular

attention is given to the support of the "Widening participation" actions of Horizon 2020 with Hungarian instruments, which may be a catalyst in establishing and developing nationally, internationally renowned RDI Excellence Centres.

5.2. The components of the instrument system

5.2.1. Direct instruments

The direct instruments mean the targeted direct financial support of the RDI activities. Owing to the risk potential risk factors of the RDI activities, one of the most typical form in the context is the non-repayable grant. Due to their nature, the non-refundable grants are the most important and biggest part of the RDI funding, since they can be used for providing targeted sources to the stakeholders while reasonably balancing risk-sharing. The following are important tasks in relation to these instruments: i) development of the EU co-funded RDI support system for the 2014-2020 period, in particular, the development of the relevant priorities and implementing documents of the operational programmes (EDIOP, CCHOP, HRDOP, RDP, HFOP), ii) development of the 2015-2015 programme strategy of the domestic-funded Research and Technology Innovation Fund (KTIA), and iii) operation of a supporting institutional system aligned with the Horizon 2020 system.

These instruments are complemented with the development of the institutionalized R&D EKD (Individual Government Decision) support system which reflects the RDI strategic interests, as well as the normative support of certain budgetary institutions.

5.2.2. Indirect instruments

The indirect instruments, or fiscal (tax-side), regulatory and standardization instruments, influence the behaviour of the actors of the RDI through automatisms. In order to develop a more effective innovation ecosystem, it is necessary to apply all policy instruments in a coordinated manner.

Three types of tax incentives are known in the European Union, which encourage the companies to engage in more extensive research and development activities through different tax and contribution discounts. The first is the tax credit, i.e., postponing the tax obligation; the second is the reduction in taxable income; the third is the reduction in due tax amount. In addition, in order to increase the number of researchers, there is an opportunity to reduce the taxes and charges on employment of personnel participating in research and development activities and to adopt regulatory and standardisation measures that indirectly influence the process of research and development and innovation in a positive way.

The research contribution allowance, the tax incentives and tax refunds can indirectly stimulate the research and development activities. These instruments may be accompanied by local tax advantages, e.g., business tax advantage.

The support provided in the form of indirect tax advantages has many benefits:

- it distorts the market processes less so – as a horizontal instrument – it does not violate the EU state aid rules;
- it results in a smaller administrative burden and it is transparent;
- it is foreseeable to the taxpayer; and
- it reduces the direct R&D costs so it plays an important role in the site selection decisions of large enterprises *(National RDI Strategy).*

However, it is important to note that just because of the indirect effect mechanisms, their application requires a more complex approach and they are suitable for an immediate intervention only to a lesser extent. In addition, the benefits derived from them emerge clearly only over a longer period of time.

5.2.3. Market instruments

The market incentive instruments include the demand-side interventions of the state, the pre-commercial procurements (PCP)[27] and public procurement of innovation (PPI) [28], as well as financial instruments. Within the financial instruments, the various capital programmes are becoming increasingly important, and enable the companies engaged in research and development to obtain, among other things, seed or venture capital investments. Export guarantees, as a "semi-market" form of grant, offer collateral bank guarantees primarily to medium-sized and large corporations. The Funding for Growth Scheme, provided by the Hungarian National Bank can be mentioned as a preferential loan specifically supporting research and development activities, in the framework of which investments related to RDI are particularly supported. The capital asset investment credit for export is another type of special subsidised loan, which may be granted for an investment in order to promote increased domestic supply production that in turn generates additional export revenue for the investing entity. Targeted state support is particularly important in the capital and credit markets where there are market failures.

5.2.4. Funding principles

Application of types of intervention instruments adjusted to the target area

Compared to the period between 2007 and 2013, **the share of financial and direct instruments of financial support has increased against the non-refundable supports** within the Operation Programmes.

The consistency and links between the interests of the various stakeholders is one prerequisite of a well-functioning innovation system. In Hungary, the collaboration of the academic and the business sector is not sufficient, which leads to that the preferred research directions of the domestic research institutes and universities are not aligned with the research needs of the industry. So-called **soft innovation support instruments** should be also used in order to bring potential and demand closer to each other; as exemplified by programmes supporting the cooperation of the two sectors and the process of knowledge transfer (see pilot projects). For the same purposes, it is deemed necessary to improve the legal environment related to intellectual property protection, and to promote management skills, information flow and networking.

Taking into account the whole innovation process in the design of instruments

In supporting R&D and innovation, coordinated interventions are necessary in several sections of the innovation chain. Not only is the process of research and knowledge production, but also company start-up, product development, market introduction, marketing and the building of manufacturing capacities should be supported with the right instruments. The intervention instruments to be applied in the different stages (direct, indirect or market instruments) can differ significantly.

[27] See Chapter 5.4.3. for the details. (PcP Pilot)

[28] A PPI process means when a state authority, acting as the contracting authority, seeks tenders for innovative products and services which are not available based on a commercial basis and their purchase can be connected to certain tests and measurements. Source: http://www.innovation-procurement.org/about-ppi/
Act CVIII on 2011 on Public Procurement contains this type of procedures. For example, ***competitive dialogue*** (*Sections 101-107 PPA*) and ***design tender*** *(point 22 of Section 5 PPA) can be procedures supporting the innovation process.*

Hungary performs well in terms of basic research results, but is behind the EU in terms of the economic and social exploitation thereof[29] . Support is needed, therefore, to avoid that an idea/knowledge is halted in the different stages of the process of becoming a successful product due to the insufficiencies of the supporting-control system (depending on the features of the given disciplines and sectors), but an appropriate instrument should be provided in all stages to support future innovation. The initial research-intensive and risky stages are supported by the instruments supporting *research and development*. And as we move forward to the realization of successful innovation, interventions aimed at *supporting the undertakings* should receive an increasing role.

The following are the most important principles to be followed in relation to the early stage of product development, smooth transition between the stages and sectoral specialities:

- Because of the high risk, **ideas at an early stage** which can be hardly financed on a market basis, it is necessary to launch the **support instruments which tolerate** implementation **risks**: typically, these are non-refundable direct financial grants.
- The necessary support instruments must be provided to the **start-up and spin-off undertakings,** which play a key role in converting intellectual products into economic results. (E.g., by means of the accessible services of business incubators funded by the state in a structure compliant with the market, supported venture capital constructions and guarantee funds, and proper regulation of intellectual property rights.)
- In the later stages of the innovation chain, **other support instruments** can play an increasingly important role, for example, the services provided by trading houses, who can help in identifying the export markets and market access. The weaknesses of the financing of innovation can already be managed through financial instruments in this stage, e.g. by means of **refundable** (loans with a preferential interest rate) **and combined grants,** a demand for which was formulated also by the domestic market players.
- **Smooth transition** between the instruments of **research and development** (e.g. EDIOP priority 2) and the **support to businesses** type instruments (e.g. EDIOP priority 1) must also be provided to the beneficiaries.
- It is justified to support the **development of small businesses into medium-sized companies** which, in some less manpower-intensive sectors, does not necessarily mean reaching the medium-sized business category, but only the further development, growth and strengthening of the company.
- It is necessary to design the various policy instruments so that they cause the **least possible administration** to the users thereof (especially in the first stages of the innovation chain).
- The instruments must be **result-oriented.** When examining their configuration and use, their actual socio-economic exploitation must be analysed and kept in mind.

[29] Balázs Borsi (2004): Technological revival, innovation and research and development, as factors of competitiveness of the Hungarian economy - In: PM Research Papers No. 6.

5.3. Intervention matrix

Grouping of policy instruments by thematic objectives and types of instruments

Direct instruments				
Thematic priority	**Policy measures, investment priorities**	**Specific objective**	**Financing fund**	**Operational programme**
Strengthening research, technological development and innovation	– Improving research and innovation (R&I) excellence, and strengthening the R&I infrastructure and capacity, particularly in order to support the centres of competence of European interest; – Promotion of R&I investments of undertakings and creation of links and synergies between research and development centres and the higher education sector, particularly with regard to product and service development, technology transfer, social innovation, eco-innovation and public service applications, demand stimulation, networking, clusters and investments into open innovation through smart specialisation; and the support of technological and applied research, experimental programmes, early product verification measures, modern production capacities and pilot lines of enabling technologies, and dissemination of general-purpose technologies.	Enhancing R&I activity Increasing the number of strategic R&I networks Increasing participation in H2020 through strengthening the R&I capacities	ERDF, KTIA	EDIOP
Strengthening research, technological development and innovation in the Central Hungarian Region	– Promotion of R&I investments of undertakings and creation of links and synergies between research and development centres and the higher education sector, particularly with regard to product and service development, technology transfer, social innovation, eco-innovation and public service applications, demand stimulation, networking, clusters and investments into open innovation through smart specialisation; and the support of technological and applied research, experimental programmes, early product verification measures, modern production capacities and pilot lines of enabling technologies, and dissemination of general-purpose technologies.	Enhancing R&I activity Increasing the number of strategic R&I networks Increasing participation in H2020 through strengthening the R&I capacities	ERDF, KTIA	CCHOP
Increasing knowledge capital	– In the framework of smart specialization, specializing the profiles of the research institutes, higher education institutions, clinics, health care research institutions and research hospitals, building of the knowledge triangle, that is, supporting the interconnections of education-research-industry and supporting the collaborations of the companies and higher education and academic institutions; – Increasing the international integration of basic research in the Horizon 2020 projects and the European research networks by reaching a high level of participation in the programs and strengthening the relationships between the national and European research centres; – Increasing the number of researchers by ensuring a new generation in research; the promotion of international and inter-sectoral researcher mobility.	Increasing research, innovation and smart specialisation in human areas	ESF, KTIA	HRDOP
Infrastructural investments in order to strengthen social cooperation	– Supporting regional service providing higher education and research institutions, improving the relations and knowledge transfer between higher education and labour market and the knowledge and technology transfer services (particularly in smart specialisation).	Improving the quality, efficiency and openness of tertiary and equivalent education with a view to increasing participation and attainment levels, in particular to disadvantaged groups	ERDF, KTIA	HRDOP
Infrastructural investments	– Improving the system of conditions of discovery research along the smart specialization; supports the strengthening of the interfaces be education-research-industry (knowledge triangle) and the (public) services and higher education institutions, the basic research related to the domestic key technologies and main economic sectors as well as the expansion of young researchers, further the harmonization of the university-academic and corporate capacities.	Enhancing smart specialisation in frontier research	ERDF, KTIA	HRDOP

Infrastructural investments	– Promoting the purchase of devices and instruments in higher education, which relate to smart specialization and support interventions ensuring scientific supplies	Infrastructural development of quality higher education	ERDF, KTIA	HRDOP
Increasing the R&D activity and adaptation, and the innovation capacity of the agricultural enterprises	- Improving the efficiency of energy use of agricultural production - Keeping the rural population in place by strengthening the agricultural supplementary activities - The targeted support of young farmers to promote a generational change of farmers -Expansion and appreciation of forest usufructuary rights; the strengthening of the role of forestry in the bio-economy - Strengthening of the public welfare and tourism potential of forests		EARDF, KTIA	RDP
Strengthening of cooperation between the stakeholders in agribusiness and certain stakeholders in research and innovation, and the food chain	– Provision of development aimed at the competitiveness of food processing SMEs (product mix of higher added value) - Supporting new participation in Union and national quality systems and voluntary agricultural product verification systems - Development of short supply chains - Enhancing the use of environment-friendly technologies, the development of environmentally conscious farming – Maintenance and development of organic farming		EARDF, KTIA	RDP
Agricultural innovation	- Improving the professional preparedness of the production and service sides; the renewal of the professional system of further training - Developing water management based on water retention, adapted to climate change - Preserving soil fertility, preventing and mitigating degradation processes and promoting soil-friendly farming - Promoting the sound use of pesticides and nutrients - Developing environment-friendly technologies, promoting eco-innovation - Increasing the number of starting rural businesses, improving the efficiency and promoting the sustainable operation of the already running businesses - Promoting special economic activities based on internal resources in regions with a shortage of human resources and undertakings - Strengthening the cooperation between the stakeholders in the rural economy - Managing the problems specific to regions characterised by small villages and farm settlements		EARDF, KTIA	RDP
Agricultural innovation	- Realising the operation of demand-based consultancy system, concentrating on sectoral target groups - availability of local planning, developing and activation capacities - Promotion of the funding of small agricultural and food processing undertakings which are squeezed out of bank financing - Increasing the level of the vertical and horizontal cooperation in the agriculture, and development of product line systems - Increasing consumer awareness and environmental awareness - Increasing the competitiveness of the horticultural and animal production sectors - Mitigating the adverse effects of climate change by using complex water management interventions - Increasing the level of the vertical and horizontal cooperation in the agriculture, and development of product line systems		EARDF, KTIA	RDP
Facilitating the innovative, competitive and knowledge-based fishing and aquaculture,	- Development and market introduction of new or significantly improved products, new aquaculture species with good market prospects, as well as new or improved processes or control and management systems - Assessing the technical and economic feasibility of innovation, products and processes		EMFF, KTIA	HFOP

including also the related processing				
Capital market instruments				
Thematic priority	**Policy measures, investment priorities**	**Specific objective**	**Financing fund**	**Operational programme**
Strengthening research, technological development and innovation	– Promotion of R&I investments of undertakings and creation of links and synergies between research and development centres and the higher education sector, particularly with regard to product and service development, technology transfer, social innovation, eco-innovation and public service applications, demand stimulation, networking, clusters and investments into open innovation through smart specialisation; and the support of technological and applied research, experimental programmes, early product verification measures, modern production capacities and pilot lines of enabling technologies, and dissemination of general-purpose technologies	Improving the access of SMEs to external funding	ERDF, KTIA	EDIOP, CCHOP
Using financial instruments in order to strengthen social cooperation, and social innovation and transnational cooperation	on the one hand, it includes the financial instruments used for strengthening social cooperation, on the other hand, the actions aimed at social innovation	Supporting social inclusion by financial instruments Improving social innovation	ESF, KTIA	HRDOP
Indirect instruments				
Contribution benefit for researchers				
Tax incentive and tax refund				
Regulation of share options				

The national smart specializations appear with a different emphasis for each type of region. These differences are reflected also in the policies to be applied to the given type of region. The policies which can be assigned to each smart specialization are shown in the following table.

Assignment of policy instruments to the national smart specialization directions

Specialization	Source	Objective
Systems sciences	EDIOP, CCHOP	• Enhancing research and innovation (R&I) infrastructure and capacities to develop R&I excellence, and promoting centres of competence, in particular those of European interest; • Creating relationships and synergies between businesses, research and development centres and the higher education sector • open innovation
	HRDOP	• In the framework of smart specialization, specializing the profiles of the research institutes, higher education institutions, clinics, health care research institutions and research hospitals, building of the knowledge triangle, that is, supporting the interconnections of education-research-industry and supporting the collaborations of the companies and higher education and academic institutions • increasing the international integration of basic research in the Horizon 2020 projects and the European research networks by reaching a high level of participation in the programs and strengthening the relationships between the national and European research centres; • increasing the number of researchers by providing junior researchers, encouraging international and inter-sectoral mobility of researchers • Improving the system of conditions of discovery research along the smart specialization; supports the strengthening of the interfaces be education-research-industry (knowledge triangle) and the (public) services and higher education institutions, the basic research related to the domestic key technologies and main economic sectors as well as the expansion of young researchers, further the harmonization of the university-academic and corporate capacities. • Purchase of instruments and devices related to smart specialisation and supporting the interventions ensuring a new research generation in higher education

	RDP	• Increasing the R&D activity and adaptation, and innovation performance in agribusiness undertakings • Strengthening of cooperation between the stakeholders in agribusiness and certain stakeholders in research and innovation, and the food chain
	KTIA	
	OTKA	supporting discovery research
Smart production	EDIOP, CCHOP	• supporting technological and applied research, pilot programmes, early product validation actions, and the advanced production capacities and test production of basic technologies • promoting the R&I investments of businesses • Creating relationships and synergies between businesses, research and development centres and the higher education sector • product and service development • networking and clusters • open innovation
	HRDOP	• building the knowledge triangle, namely supporting the interfaces of education-research-industry and supporting the collaboration of the companies and the academic and higher education institutions • increasing the number of researchers by providing supplies, encouraging international and inter-sectoral mobility of researchers • promoting the interfaces of education-research-industry (knowledge triangle) and the (public) services and higher education institutions, expansion of junior researchers, coordination of the academic/university capacities and the corporate capacities • Purchase of instruments and devices related to smart specialisation and supporting the interventions ensuring a new research generation in higher education
	RDP	• Increasing the R&D activity and adaptation, and innovation performance in agribusiness undertakings • Strengthening of cooperation between the stakeholders in agribusiness and certain stakeholders in research and innovation, and the food chain
	HFOP	• Facilitating the innovative, competitive and knowledge-based fishing and aquaculture, including also the related processing
	KTIA	
Sustainable society	EDIOP, CCHOP	• product and service development • technology transfer • social innovation and eco-innovation • spreading of general-purpose technologies
	HRDOP	• building the knowledge triangle, namely supporting the interfaces of education-research-industry and supporting the collaboration of the companies and the academic and higher education institutions • Purchase of instruments and devices related to smart specialisation and supporting the interventions ensuring a new research generation in higher education
	RDP	• Increasing the R&D activity and adaptation, and innovation performance in agribusiness undertakings • Strengthening of cooperation between the stakeholders in agribusiness and certain stakeholders in research and innovation, and the food chain • Agricultural innovation
	HFOP	• Facilitating the innovative, competitive and knowledge-based fishing and aquaculture, including also the related processing
	KTIA	
	OTKA	discovery research in social sciences

5.4. Pilot projects

The launching of pilot projects is designed to induce an activity on a small sample or with the involvement of small, but constant circle of participants, which takes place in order to solve a complex problem. **A pilot project is a targeted RDI support instrument among real conditions and with a small investment of time and budget, which can effectively test the instrument which supports the given research and development.** It is implemented with the same professionalism as a similar research or development project on a larger scale. Its objectives are to establish larger-scale action and assist in their successfully integration. The experience gained in the pilot project will serve as an input or as a kind of model to implement a further larger-scale action so its know how is also part of this result.

Monitoring is particularly important for the launched pilot projects. Feedback mechanisms will be incorporated during the implementation of the project in order to receive feedback from the pilot projects.

The pilot projects proposed in the framework of the strategy will have an impact on the problems of the domestic RDI system and, in applied successfully, can significantly remedy its shortcomings.

Proposed pilot projects:

"Open lab" pilot

An "open lab" and – for the use of it – a so-called "voucher" system will be introduced in the framework of the "pilot" project to be established along the national priorities developed in the smart specialisation process. A laboratory with a research direction or technological tools specified in the national priorities can become an "open lab".

The essence of an "open lab" is that a laboratory or research infrastructure operating at a public research site[30] or a big company, and the associated research services, can be used by anyone, ranging from private individuals through private entrepreneurs to SMEs. This allows an optimized access to the equipment, where new technologies, products and services can be developed. The "pilot" would be created by opening an existing laboratory or research infrastructure.

The "open laboratory" promotes the networking and partnering between higher education institutions, academic research organisations, public non-profit research organisations, other public research organisations, research and technological centres, large enterprises and micro-, small- and medium-sized enterprises. They support the innovation activities of undertakings (mainly SMEs) that are either inadequately or not equipped with modern equipment. The introduction of "open laboratories" will significantly increase the number and success of undertakings and organisations engaged (also) in R&D and innovation. "Open laboratories" enable a local content, which is higher than the current one, and the increase in Hungarian value-added deliveries to multinational companies.

Furthermore, "open laboratories" could be an implementation site for "open innovation" efforts (they can also play the role of a so-called "living lab"). This includes in particular the cases where a company opens up a problem to be solved or a research and development task. The SMEs can carry out their research and development tasks in the innovative "open lab".

Another aim of the "open laboratories" is to support the studies and researches and contribute to the education and training of the "personnel" working in the laboratory, i.e., the talented students,

[30] Publicly financed research site: higher education institutions, academic research centres and state-owned non-profit research centres

doctoral students carrying out their research there. As a result of the research and development made in the "open lab", new undertakings, spin-offs and start-ups can be set up.

The "open labs" should operate on the basis of a public and transparent operation method and management. The operation of the "open labs" is controlled by a professional supervision. The “open laboratories” will continue to satisfy the needs of the owner/maintainer institution (e.g., research, education, etc.). In addition, external partners, in particular micro-, small- and medium-sized enterprises can use their research and development services. This could be the use of tools or causing the performance of a research project. Any micro-, small- and medium-sized enterprise can apply to use RDI services; it is the aim that this opportunity will be available to the broadest possible target group.

The small- and medium-sized enterprises could win vouchers by tendering procedure, which would serve as a means of payment in order to obtain various RDI services (order of R&D, measurements, support for the development and market introduction of a new prototype, ensuring technical/engineering background) from the “open laboratories” The resources necessary for the expansion and maintenance of the "open lab" would be covered from the operating income from the voucher system.

Open laboratories induce the following positive changes:

- the R&D infrastructures become more widely visible,
- the SMEs are given an access (in a regulated and transparent manner) to tools of adequate capacity and quality, which they could not afford so far,
- a partnership is built between the different actors of RDI, thus promoting open innovation processes.

Higher Education and Industrial cooperation Centre (hereinafter referred to as “FIEK”) pilot

In the framework of FIEK, a broad cooperation between the industry and higher education sectors will be established along the national priorities formulated in the smart specialisation strategy. The purpose of FIEK is to coordinate the given sectoral education and the R&D&I activities, transform the scientific results into practical application promising business success in order to effectively couple the applied research and the industrial experience, as well as to promote the practice-oriented education of students and doctoral students and the learning of innovative professional methods as well as to develop entrepreneurial skills. Several higher education institutions, research institutes, many large companies and small and medium-sized enterprises are involved in the collaboration along the "quadruple helix". The participants of FIEK aim to jointly develop the curricula and the teaching methods of the branches corresponding to the technological needs of the sector, coordinate their accreditation activities and develop the structure and content of the practice-oriented training. It is to be expected that the cooperation will promote the strengthening of the Hungarian industry in the field of European R&D&I. The participants in FIEK build a strong relationship with state institutions, professional organisations, in order to facilitate the development of the sector and to ensure to meet economic interests in the best way possible. It is also the aim that participants in FIEK should jointly take part in European Union tenders, reinforcing each other to have a higher chance of winning.

FIEK induces the following positive changes:

- the needs of the economy appear in the education and research directions of higher education,

- thus, the research results reach the product/service stage in a greater proportion, so their socio-economic impact occurs in the country, and
- the shortage of specialists in the fields concerned decreases.

PcP pilot

The state and the local governments are considered the largest consumers in the consumer market in Europe. According to current data, the purchases made by the public sector in the EU amount to approximately 2 billion Euros on the annual level, or 17% of the EU's GDP. Therefore, supporting public procurement in innovation (PPI), which creates the demand-side incentive of innovative economic activity[31], is an important objective of the EU.

The potential in the (public) procurement of innovative solutions (PPI) can greatly contribute to allow the new prototypes, products or services without a reference to have themselves tested and even win, thereby

- ensuring the continuity of the innovation chain;
- savings can be achieved in the budget spent in public procurement on an annual basis, so the savings can be used for supporting additional RDI;
- quality improvements can be reached in the public services through the demand-driven and tailored procurement structures;
- the micro, small and medium-sized enterprises are given new orders, which have so far proved to be inaccessible for them.

One type of procurement to support innovation is the pre-commercial procurement (PcP), which is a method and a tool for the public sector which reduces the costs, improves the efficiency and strengthens the innovation from the demand side. Through public-private partnerships, the procurement process based on shared risks and benefits facilitates the development of new technologies, products and services that provide a modern solution to the problems of public institutions.

In the course of the four-stage PcP process (design contest – feasibility study – prototyping – pre-commercial deployment testing), the institution obliged for public procurement promotes the development of solutions (at least two). The end result of PcP should be a product, which satisfies “mass demand” (and it is not only a solution to individual needs) and can be bought by anybody.

The Hungarian legal environment should not be currently amended to launch the PcP experimental programme. One of the tasks of the pilot programme will be to examine how the domestic application of PCP will require amendments to the existing regulations or introducing new legislation; furthermore, what financial incentives are needed for the domestic expansion of the PcP programme. Another important task of the pilot is the mapping of international (primarily EU) PcP (or PPI) programmes, along which the domestic public institutions and public service providers can come to know the best foreign practices.

[31] John Rigby, Patries Boekholt, Abby Semple, Jasper Deuten, Ramona Apostol, Stephan Corvers, Jakob Edler: „Summary of the Feasibility study on future EU support to public procurement of innovative solutions” http://ec.europa.eu/enterprise/policies/innovation/policy/lead-marketinitiative/files/meeting-procurement-feb2012/summary-eu-supportpublic-procurement-innovative-solutions_en.pdf

Incubator programme

The technology incubators have become an integral part of the economic policy toolkit of the developed countries of the world. Taking into account Hungary's innovation abilities, opportunities and human potential, supporting the operation of start-up companies built on technological innovation brings along significant socio-economic benefits.

Corporate incubators represent a complex service system or a kind of protected business environment provided to the technology start-ups on a temporary basis. It aims to provide resources, capital, knowledge and relationships to the companies, thereby improving their chances of survival in the initial stage of their careers.

Hungary has started a shared understanding between the government and the business operators on the promotion of the domestic business incubators and the opportunities for the development of the so-called start-up culture. This produced a number of results, including, among other things, an agreement of the government and relevant business stakeholders regarding the scope of the objectives and the agenda.

In the framework of the present pilot, a programme supporting technology incubation will be implemented, which supports the ideas and companies in the initial stage, with the responsible authorities, key actors and the target audience fully involved in their design. The full operation of the incubator programme is aligned to the business model and operation of start-ups, incubators and accelerators. The aim is that this new support instrument meets the expectations of both the special needs of the specific audiences and the requirements of the state.

The essential points of the construction must be determined as a result of the consultation process already in progress about the topic in in Hungary. Based on past experience, the following are the essential points: forms of funding to be provided to the incubators, method of accountability, ensuring the rapid response of the framework to the corporate and market developments, and the need for a high degree of administrative flexibility.

The incubator programme induces the following positive changes:

- much more ideas and developments reach the end-product stage, Hungary hosts technological innovations, the start-up firms find niche markets and specialize,
- it mobilizes private sector capital for R&D investments[32],
- a change of approach starts among the young Hungarian people about entrepreneurship, opportunities, value is given to creativity, knowledge and risk-taking,
- the domestic business opportunities are given a value, and the country's ability to attract capital increases,
- the migration of skilled workforce decreases,
- the financing problems of the start-ups are solved on a market basis,
- the ratio of business and public R&D spending improves.

[32] Most of the domestic venture capital investments between 2010 and 2013 were given by the start-ups or the so-called later-stage venture capital transactions. Seed capital investments represented a negligible share, which can be problematic in the long run in terms of the sustainability of the development of the private and venture capital markets.

The pilot projects above will have an impact on the problems of the domestic RDI system and are expected to significantly remedy its shortcomings.

5.5. Responsible Organisations

	Function	Responsible body	Managing body
1.	Professional supervision and governance	National Office for Research, Development and Innovation	Head of the National Office for Research, Development and Innovation
2.	Government level	All ministries and chapters concerned (ME, NGM, EMMI, FM, KKM MTA), including the delegates of the managing authorities concerned in the 2014-2020 programming period.	Head of the National Office for Research, Development and Innovation
3.	Local/territorial coordination	County Government Office	Government Commissioner

5.6. Resources

The resources of the Structural Fund, provided in the framework of the EU's Cohesion Policy, and the European Agricultural Fund for Rural Development has represented and will represent a significant part of the state support to the RDI sector both during the past and the coming seven-year EU budget periods. These European Structural Funds and Investment Funds provide funding through 11 thematic objectives (TC), of which first TC, namely *Strengthening research, technological development and innovation*, involves all funding which can be used for RDI.

In the framework of this 1st TC, 2,234 million EUR is available to Hungary between 2014 and 2020 (for RDI support)[33]. The amount will be disbursed through the operational programmes, respectively, their priority axes[34], which contain R&D targets in varying proportions.

The amounts included next to each priority are the amounts in the operational programmes submitted to the European Commission, which indicate the overall budget of the given priority. Since the RDI objectives often constitute only a part of each priority, the priority amounts do not equal resources that can be specifically spent on RDI in every case, but they are a part of the latter amount.

Domestic managed funds

Economic Development and Innovation Operational Programme (EDIOP) (source: ERDF, ESF, IKF; a total of 9,004.2 M EUR over 7 years)

The Operational Programmes provide access to the instruments of the Structural Fund. The Economic Development and Innovation Operational Programme is one of the most important resource available for the implementation of the strategy. The following priorities are the most important as regards financing RDI programmes among the 7 priority axes of the OP.

[33] Of this 2,149 million EUR is provided by the European Regional Development Fund, and 86 million EUR is provided by the European Agricultural Fund for Rural Development.

[34] HRDOP is an exception HRDOP, which provides R&D resources through the 10th TC, namely *Investing in education, skills and lifelong learning*.

- Priority 2: R&I, the budget of which is EUR 1687.9 M (85% funding intensity), and
- Priority 7: Financial instruments, its budget: EUR 2353.2 M (95% funding intensity).

The Operational Programme is territorially limited because it only provides funding in the six so-called "less developed" (former Convergence) regions. The of Central Hungarian region is out of the scope of EDIOP, as a separate OP, namely, the Competitive Central Hungary Operational Programme, manages the source of the Structural Funds to be allocated to the KMR.

Competitive Central Hungary Operational Programme (CCHOP) (sources: ERDF, ESF; a a total 913 M EUR over 7 years)

The OP aims to maintain and ensure the long-term economic competitive advantage of the most advanced region of Hungary over other countries, increase its economic competitiveness and reduce the differences of development within the region. Priorities of CCHOP that are relevant to R&D:

- Priority 1: Improving the competitiveness of businesses and development of knowledge economy; budget: EUR 202.2 M (50% funding intensity);
- Priority 2: Developing financial instruments and services; its budget: EUR 44.1 M (60% funding intensity).

The operational programme is restricted in territory and is primarily aimed at the regions in the "advanced" category, namely Central Hungary.

Two-thirds of the domestic research capacities are concentrated in Central Hungary (RDI strategy). Nevertheless, the Central Hungarian Region receives much less resources dedicated to R&D from the Operational Programmes than it would be able to use through its RDI potential; this limitation of Union resources is a source of serious tension in the 2014-2020 period.

Human Resources Development Operational Programme (HRDOP) (sources: ERDF, ESF; a total amount of EUR 2,999 M over 7 years)

The aim of the Human Resources Development Operational Programme is to contribute to addressing the social inclusion and demographic challenges by improving human capital and social environment. Priorities of HRDOP that are relevant to R&D:

- Priority 3: Increasing knowledge capital; EUR 898.3 M (85% funding intensity)

The aim of the priority: increasing research, innovation and smart specialisation in human areas; improving the quality, efficiency and openness of education; supporting infrastructural developments; promoting access to opportunities of life-long learning; updating the skills of employees, and matching education and training systems to labour market needs.

Rural Development Programme, RDP

The priority, which is relevant to R&D&I is the action M01 within priority 1 (Fostering knowledge transfer and innovation in agriculture, forestry and rural areas) of the

- Rural Development Programme: Knowledge transfer and innovation measures (EUR 25.3 M).

Hungarian Fisheries Operational Programme (HFOP)

The Hungarian Fisheries Operational Programme is designed to provide targeted funding to the fisheries to allow them to contribute more effectively to healthy living and conscious eating, as well as the spreading of eco-tourism and environmental protection, thus preserving the values of the rural regions and the economic stability of the local communities. Priorities of HFOP related to R&D:

- Priority 2: Supporting environmentally sustainable, resource-efficient, innovative, competitive and knowledge-based aquaculture. (No information is available on the funding budget of this strategy at the time of writing this strategy)

In addition to maintaining the use of sustainable aquaculture technologies, diversifying and fostering innovation are necessary to increase the competitiveness and viability of SMEs typical to the sector. Beyond the developments in the form of productive investments, there is a need for product development, marketing, innovative technological solutions and increase in energy efficiency.

Research and Technological Innovation Fund (KTIA)

Notified national funding scheme with an the annual income of approx. 50 billion Forints, whose main source is the innovation contribution paid by the medium and large companies. The RDI strategy lays down as regards the use of KTIA that its important purpose is to reduce the disadvantaged position of the Central Hungarian Region, but the elaboration and use of other instruments is also needed.

The Research and Technological Innovation Fund available for RDI purposes primarily provides funding in the Central Hungarian Region (KMR). The additional strategic objectives (such as the public-sector innovation, technology transfer, open pre-competitive and social innovation collaborations) can also be funded from the KTIA (National RDI Strategy).

National Scientific Research Fund (OTKA)

OTKA is such an independent national institution which supports internationally outstanding frontier researches, (in other words: basic researches) performed in Hungarian workplaces through tenders, with the involvement of Hungarian and foreign evaluators. The activities of OTKA are mainly borne by the central budget. It provides extra resources to the most excellent researchers and Hungarian research institutions through its tenders. OTKA represents the Hungarian science in the international organisations by playing an active role. It complements the international tender systems with its own resources; it participates in the cooperative research funding programmes launched in collaboration with the European research funds. The budget of the OTKA programmes is approx. 6-10 bn HUF per year (it was 5.5 bn HUF in 2011).

OTKA primarily supports basic research projects of researchers and public research institutes.

European territorial cooperation programmes

There are also international cooperation programmes and cross-border cooperation programmes (one each with our neighbouring countries), and the Intereg VC programme, within the territorial cooperation programmes. These international cooperation programmes contain proportionally less funding for R&D, but it is worth mentioning two invitations:

The *Central Europe* 2014-2020 Programme is the programme of the European Union supporting international cooperation, which aims to improve innovation capacity, competitiveness, accessibility and environmental condition of the cities and regions of the participating countries. Typically multi-actor international consortia may apply for funding in the programme. Source of funding: ERDF, project size: EUR 1-2.5 M; a total amount of EUR 300 M over 7 years)

The former South East Europe Transnational Cooperation Programme will not be launched from 2014 and funding will be provided instead to the broadly defined South-Eastern European countries by three other territorial programmes: *Adriatic-Ionian Programme, Danube Programme* and Balkan-Mediterranean Programme. Hungary can apply for funding in the first two programmes as a full partner. By the time this strategy is being drafted, the programmes are still under development so financial data are not available.

All the above programmes typically fund innovation pilot projects implemented through broad cooperation.

Short conclusion

On the whole, the majority of Hungarian state funding for R&D purposes is provided to the beneficiaries in the form of non-refundable supports. The advantage of this funding model is that it enables better targeting and the enforcement of the excellence, which is an important aspect in the field of R&D. On the other hand, the current domestic application system, which is aligned to the current method of utilising Union resources, mainly consists of mass applications, which do not always make it possible to enforce the national RDI objectives (National RDI Strategy).

The most important phenomenon of the territorial characteristics of the Hungarian RDI is the dominant performance of the Central Hungarian region compared to other areas of the country. This problem should be handled in two ways, neither of which is negligible.

The regional development and cohesion policy aims to reduce the territorial inequalities by allocating more funds to the less developed regions and counties. Supporting excellence and continuing and facilitating the promotion of the development of the best-performing areas are no less important in terms of increasing the competitiveness of the country. Considering the country as a whole, it is therefore equally important that the KMR, as a pulling force, continues to receive priority attention in addition to cohesion.

Support for the two directions is reflected in the determination of the visions and objectives, the types of regions, the national smart specialization directions, the resources, and the economic policy toolkits managing the resources.

An important condition of the preliminary (ex ante) system of conditions of the Partnership Agreement between the European Union and Hungary is that the National Smart Specialization Strategy should present the EU and domestic sources available for domestic research-development and innovation in the 2014-2020 development period. The following table summarizes this, taking into account the assignment of the policy instruments to the national smart specialization directions. The breakdown by years of the amount of each type of resource is indicative, and will be reviewed by the S3 Action Plan to be prepared based on this strategy in the first half of 2015.

The S3 Action Plan will detail how the sources which can be used for RDI will be allocated over the next seven years to the national specializations and the sectoral and horizontal priorities assigned to them, as well as the county smart technologies. It will also explain how each key RDI player will receive those sources, and how and in which manner they can contribute to the realization of smart specialization

in Hungary (example: impact of the RDI activities of large companies on small and medium-sized enterprises and the research infrastructure).

Table 12: Budgets of the main resources[35]

	2014-15	2016	2017	2018	2019	2020	Total
EDIOP	390,000	390,002	390,002	390,002	390,002	390,002	2,340,010
CCHOP	31,537	31,536	31,538	31,538	31,538	31,538	189,225
HRDOP	31,638	31,638	31,638	31,638	31,638	31,641	189,831
RDP	14,268	14,268	14,268	14,268	14,268	14,270	85,610
H2020	66,000	47,000	48,000	59,000	59,000	76,000	355,000
KTIA	305,085	244,067	244,068	244,068	244,068	244,068	1,525,424
OTKA	54,237	33,898	33,898	33,898	33,898	33,900	223,729
							1000 € (at 295 HUF/€)

5.7. Schedule

The main implementation steps of the S3 strategy	2015	2016	2017	2018	2019	2020	Responsible body[36]
Clarification of questions regarding the updating process of the strategy and the possibility of local stakeholders to participate in it	x						1
Recommended S3 rounds of review		x		x			1, 2, 3
Recommended county-level consultations		x		x			3
Recommended national S3 consultations	x	x	x	x	x	x	1, 2
Ongoing contact with the professionals of the European Commission	x	x	x	x	x	x	1
Development, operation and evaluation of the "Open Laboratory" pilot, and feedback	x	x	x	x			1
Elaboration, operation, evaluation and feedback of the PcP pilot		x	x				1
FIEK pilot	x	x	x	x	x		to be elaborated
Pilot incubator programme		x	x	x	x		1
Elaboration of further pilot projects	x			x			to be elaborated

1 - professional supervisor and controller; 2 - level of government; 3 - local/regional coordinator

[35] for the whole period of the planning cycle until 2020, the numbers still reflect the OP versions before adoption
[36] See Chapter 2.4. for the organizational chart of the structure managing the maintenance of S3

6. Evaluation and monitoring system

According to recent international experience, ***the research, development and innovation (hereinafter: "RDI") reviews*** are a dominant pillar of ***evidence-based policy making*** in the countries of the developed world as ***they have grown to become one of the most important strategic tools for information retrieval.*** The evaluation is a systematic and objective process, which analyses the relevance, efficiency, effectiveness and sustainability of a particular activity with regard to the objectives set.

The evaluations provide information in a number of areas, even at the current stage of development of the Hungarian RDI evaluation methodologies, where the economic indicators generally used to demonstrate effects are often not available. ***The social and economic effects of a single intervention in the RDI field typically show up only after a number of years or,*** if they are somewhat predictable, ***are difficult to detect due to the complex system correlations.***

Based on the above, it is essential that the experiences related to the effective and focused use of the EU resources along the objectives formulated in the National Smart Specialisation Strategy (S3) support the realisation of any modification which might become necessary in the meantime through feedback and ongoing consideration of the changes. On the other hand, it satisfies the requirement concerning the strategy, namely, that ***achieving the objectives formulated along the priorities should not be a static documentation and a momentary status, but the combination of a process with the ability to renew again and again and the assigned activities. (Ability of self-learning and internal development).***

The comprehensive assessment and monitoring of the implementation of the S3 strategy will be continuous between 2015 and 2020. If the targets prove not to be achievable time-proportionately, or we can see that the previously defined directions of intervention were inadequate, the reviews provide an opportunity for methodologically sound recommendations on how the resources can be reallocated in order to achieve that funding functions at its best again, in line with the objectives.

6.1. S3 assessment

The evaluation of the implementation of the directions included in the national smart specialisation strategy is justified by the following:

- It is necessary to survey, in an objective manner, the socio-economic impacts of every measure, intervention and programme involved in the policy in order to make the operation of the government governance system more efficient (cognitive goal).
- The players of the policy decision-makers who are willing to take risks are in need of a tool which allows the judgement of the value of each programme and the utilisation rate of the public funds allocated to the same (normative goal).
- Feedback is required to improve the effectiveness of the programmes and inform the various stakeholders about the meaning, conditions and consequences of the examined activities (instrumental goal).

It is essential for the success of the S3 strategy to implement the monitoring and evaluation of the system. The professional realisation thereof is supported by the introduction of the valuation standards.

6.2. Feedback mechanisms

It is essential that the S3 strategy is implemented adjusted to the strategic management practices that have become mature by the end of the 20th century, meaning that strategic planning/creation and implementation should not be sharply divided, but planning and implementation should constitute one whole thing as complementary parts which cooperate with each other. (Strategy building involves the definition and the assessment of the alternative pathways leading to the objectives as well as the selection and detailed development of alternative to be followed, while strategic management includes, in addition to the above, the planning, management and assessment of implementation, taking into account the changes of the environment)

The continuous assessment and monitoring of the implementation of the tasks plays an important role in smart specialisation.

6.2.1. Assessment methods

In accordance with the international standards, we apply the following methods, taking into account the time requirement of the implementation of assessment and the intentions of the assessment:

Interim assessment

Assessment relevant to a specific time (from-to) carried out during the implementation of the strategy, programme and project or the operation of the organisation.

Ongoing assessment

- The evaluation takes place continuously/periodically, rather than at a particular time;
- It monitors the process implementation and the realisation of the targets of the given programme;
- It constantly analyses the outputs and outcomes achieved.

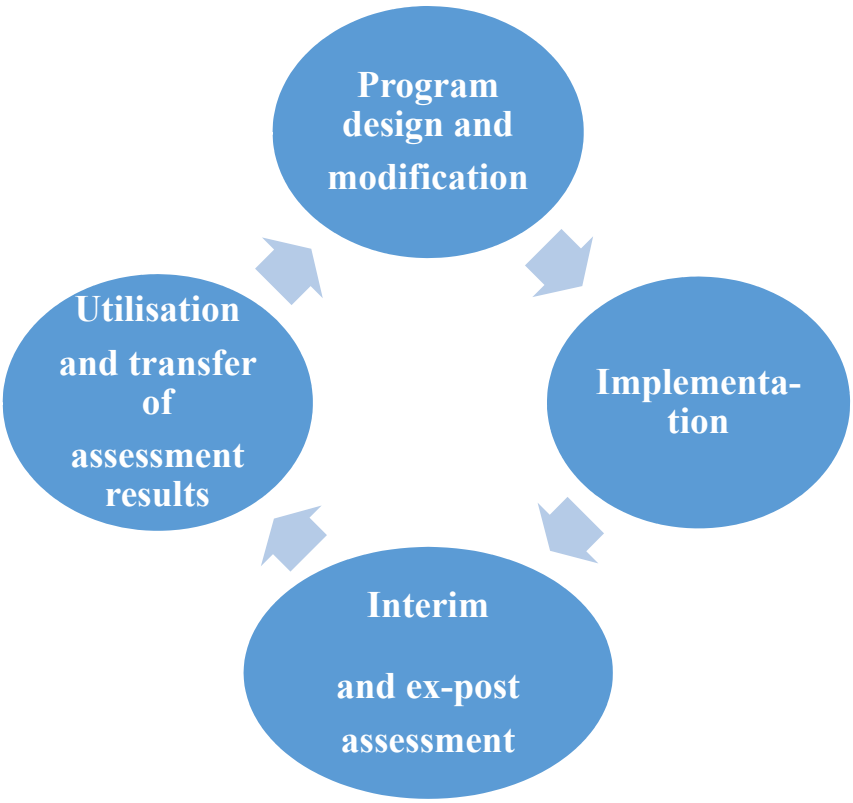
Ex-post assessment

Assessment after the completion of the strategy, programme or project.

The chart below shows the four important steps of the programming cycle:

1. Design of the intervention (e.g., development of the program's objectives and main features (directions and budget of the field))
2. Design of the programme structure (including the duration and sub-programmes of the programme, ideas for organisational implementation, other supportive measures, assumptions and conditions, and expectations regarding future evaluation)
3. Implementation (e.g., by means of tenders after clear project evaluation)
4. Assessment of the entire intervention

Figure28: Cyclicality of the assessment process



During the process, the implementation will be assessed and monitored in a formal and summary manner:

Formal assessment: Formal assessment is exploring the ways on how to improve and confirm the management and implementation of the interventions. Formal assessments are often carried out in the interests of those who manage the interventions with the aim to improve their work.

Along the well-designed indicators, monitoring and evaluation is:

Specific: because the properly defined indicators of clear content can be assigned to the feature which they actually belong to. For example, it is the function of one of the organisations in the governance structure (e.g., the **S3 Management Team**) to properly manage the implementation of the social consultation of the S3 document. Then it **integrates the feedback in the system accordingly,** to become able, once the document is prepared, to conduct social consultation which has already been carried out during the implementation.

It can be mentioned as a **suggestive example** that formative assessment can be used to clearly define the **increase and trend-like change in the number of business-researcher collaborations** in the structure managed by the S3 priorities within the RDI system.

Measurable: because the target it wants to achieve can be clearly determined, even if not numerically. By way of example: Was it possible to visualise all proposals and opinions formulated by the stakeholders in a certain form in the finished document and, subsequently, could the new development priorities, also formulated by the stakeholders, be validated in the document and its modification?

Approved and available: because the data necessary to define its value are available, meaning that all support materials are actually available, including, e.g., the priorities which must be integrated in the National Smart Specialisation Strategy or the proposals made at the NIH meetings on the basis of the existing priorities.

Relevant: because it can be objectively verified, for example, if the priorities formulated by the stakeholders in the public consultations have been integrated in the document as the fundamental and essential elements of the S3 specialisation. This may also include the growth of the number of researcher collaborations (the indicator will not only be specific, but also relevant).

Timely: because it can measure the appearance of e.g. the priorities in the specialization strategy until the completion of the S3 document and then at pre-defined intervals (on the basis of the latest stakeholder feedback).

Basically, the indicators play a significant role in the results-oriented programmes, but it is important to know that in this case they measure the management activities of the governance structure and indirect realisation, rather than direct implementation.

Summary assessment: The summary assessment examines the basic effectiveness of the programmes. The summary assessments are often made for accounting purposes, in support of the allocation decisions of budgetary resources and for external actors (i.e., to groups who do not participate directly in the management of the programmes).

Along the well-designed indicators, monitoring and assessment will measure:

- **The sum spent in the given segment Utilization rate of the direct or indirect support,** and the rate of quantitative change in the feature described by the indicator, such as: "expenditure for material consumption of the research laboratory built, decrease of the rate of research costs compared to the previous period in percentage points, or the financial resources in Forints.
- **The product created by using the given policy tool. Direct or indirect aids and tax incentives used for achieving the same.** Precise definition of the feature described by the indicator is needed, for example, the rank and quality of the research laboratory built, the exact classification of research qualifications acquired, **potentially a measurement of the decrease of the bureaucratic costs which helped the beneficiary in the given project to gain a competitive advantage,** etc.
- **Time or period change when the change occurred** in the described feature, or the evolution thereof as a function of time. Thus, the given intervention will have a specific time limit as to how long and in what form (accounts, etc.) the opportunities offered by the tender can be used. This is an indicator more of a technical nature, since the time for spending the resources depends on the nature of the project, however, is not necessarily related to the outcome or implementation quality of the project.
- **Target groups to which the sources are forwarded**. This is an extremely important factor, since forwarding the awarded aids to the corresponding target groups means not only that the S3 “process” is really implemented along the formulated priorities, but also that, in addition, the most appropriate and competent experts carry out the work, which develop the local and the national economy.
- **Place where the resources are spent.** In addition to that this typical indicator should also report on the territorial/ geographical location of the specific feature (city, area, region, etc. where the change occurred or can be interpreted), this indicator is at least as important a

feature of the implementation and success of the objectives as a target group category. In Hungary, the geographical location is of paramount importance for the project concerned as the development of the rural areas is essentially determined by the existence/presence of EU funds. From this perspective, the RDI field is particularly important for the less developed regions, since it can be a potential breakthrough point for the area's economy.

The directions and definitions of the assessment indicators extended to the monitoring system clearly show that the two inseparable components of the system create a proper combination for the operation of the system through their interdependency and cross-references. Accordingly, the monitoring section discusses the mechanisms for the development of the indicators.

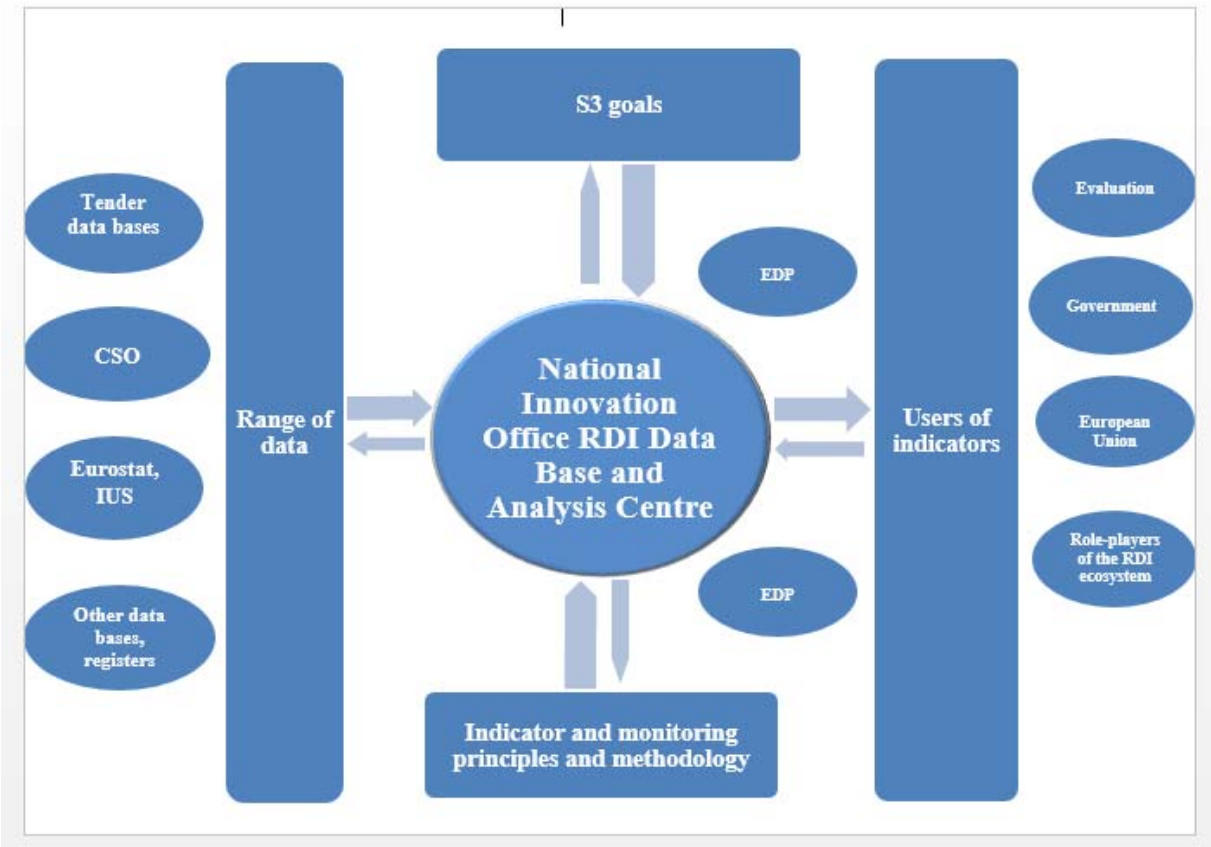
6.2.2. S3 monitoring and indicators: principles and information mechanism

Responsible and evidence-based design is impossible without monitoring, which shall be an integral part of the design process. In designing the monitoring system and determining the indicators, the logical connection between the envisaged measures, namely the intervention logic, is taken into account. The first step in the precise definition of the indicators and the targets to be achieved is the clarification of the method of intervention of the policy and the determination of the results expected of the programme and the measurability thereof. After defining the problem, the direction and the desired result of the change should be formulated, which will be the basis of the architecture of the system of indicators.

The monitoring activities should be carried out and the monitoring system and the indicators should be designed and measured by a separate department dedicated in accordance with the S3 concept, which makes the results available to the persons responsible for the implementation and elaboration of the strategy. All these tasks require a unified structure. As diverse data sets from multiple sources shall be reviewed, organized and analysed, the Database and Analysis Centre of the NIH (currently known as RDI Observatory) has, owing to its experience obtained in the field, the capacities and methodological knowledge necessary to carry out its tasks in respect of the S3-related measurement and indicator management duties. Thus, the data will be available to the users of the indicators and those engaged in assessment in the same quality and structure and in the same place.

The organisational and information mechanism proposed for that purpose is outlined in the following diagram. Measurement and indicator creation are subject to access to data of sufficient quality: the appropriate data retrieval and data supply principles and practices are being continuously developed with the data owners within the government. The figure below is the information mechanism of indicator creation:

Figure 29: Information mechanism of S3 indicator creation



Our monitoring system applies three types of indicators (context, outcome and output). Published by the European Commission, the Innovation Union Scoreboard (IUS) provides a quantified assessment about the innovation performance of each Member State on the basis of complex aspects. In addition, these data are internationally comparable, since the data are prepared by using the latest available data of the Eurostat and other internationally accepted sources. The IUS scoreboard itself can measure the progress of the entire strategy, which is why it has been chosen as the **context indicator**.

Table 13: Context indicator

	2013 basic value	2020 target value	Source	Reporting frequency
IUS Summary Innovation Index	0.351	0.406	Innovation Union Scoreboard, European Commission	annually

The **output** indicators show if the interventions are progressing properly and measure the direct outputs thereof, so they can be specially assigned to certain actions and programmes. Thus, the direct impacts of the programmes can be captured. The output indicator is the directly measurable effort of the intervention, whose indirect consequence is the change in the output indicator. Given that the output indicators are linked to specific programmes, we use only sample indicators at this stage of the

planning process (without target values). The first three indicators in the following table are indicators harmonised with the output indicators used in the EDIOP planning process, while the subsequent indicators relate to the development priorities of the research infrastructure. As regards the latter, the objectives of the intervention are to open up the infrastructure, connect to domestic and international research infrastructure networks, networking, and strengthen collaborations, including, in particular with companies.

Table 14: Output indicators

	Source	Reporting frequency
Number of new researchers at the supported entities (FTE)	Tender database	annually
Number of companies cooperating with research institutes at the supported organizations (pc)	Tender database	annually
Private investment matching the support from public funds to innovation and R&D projects (million HUF)	Tender database	annually
Ratio of external domestic researchers in the use of the research infrastructure in the past one year, calculated on FTE basis (%)	Tender database	annually
Ratio of external foreign researchers in the use of the research infrastructure in the past one year, calculated on FTE basis (%)	Tender database	annually
Share of corporate and institutional researchers in the R&D projects related to shared research infrastructures (%)	Tender database	annually
Number of companies utilizing research results	Tender database	annually

The change of the **output indicators** measures if the interventions exercise their impact properly: not only they facilitate the assessment of achieving the S3 objectives, but also greatly help in the identification and careful examination of the problems and the identification of the action mechanism (logic) along which the given instruments or actions exercise their impact as well as the relationships between the action mechanisms of the individual instruments. The change in the outcome indicator is the total of the contribution of the intervention and the contribution of other factors.

Outcome indicators can be defined also for the research infrastructure mentioned as an example in the context of the output indicators, which relate to the general development directions of the research infrastructures and the broader goals of S3. For example, such outcome indicator can be the number of scientific publications prepared through international cooperation in the research projects of the supported research infrastructures.

The following table shows the output indicators capable of measuring the specializations assigned to the specializations appearing in the three National Smart Specializations defined. Although these

indicators can properly measure the achievement of the specializations, an analysis of the specific areas of intervention and intervention logic is necessary for the evaluation.

Table 15: Outcome indicators

Specialization	indicator	unit	base year	base value	target value	Source	frequency
Systematic research	number of publications published in a foreign language	pc	2012	18,195	20,000	KSH	annually
	number of patents granted	pc	2012	3,278	3,800	KSH	annually
	R&D expenditure of institutional and higher education research centres as a percentage of GDP	%	2012	0.43	0.58	KSH	annually
Smart production	R&D expenditure of the research centres of manufacturing industry undertakings as a percentage of GDP	%	2012	0.47	0.65	KSH	annually
	calculated staff number of research centres of manufacturing industry undertakings	persons (FTE)	2013	5,901	6,800	KSH	annually
	proportion of companies engaged in technological innovation	%	2010	18.42	21.00	Eurostat	biannually
	proportion of persons employed by the high-tech and medium-high-tech manufacturing industry to the number of employees	%	2012	8.3	9.1	Eurostat	annually
Sustainable society	share of energy from renewable energy sources	%	2012	9.6	14.7	Eurostat	annually
	proportion of new undertakings to all undertakings	%	2012	15.33	17.00	KSH	annually
	activity rate in the 15-64 age-group	%	2012	64.3	70	KSH	annually
	per capita greenhouse gas emissions (CO_2 equivalent)	tons	2012	6.24	5.5	Eurostat	annually
	eco-innovation index (EU=100)	%	2013	61	75	Eurostat	annually
	total (public + private) health expenditures as a proportion of the GDP	%	2012	7.97	8.4	OECD	annually

From 2015, the NIH Database and Analysis Centre will prepare a monitoring report about the previous year by 15 December each year, which covers the whole range of the S3 indicators.

Monitoring itself should not judge the extent to which the interventions contributed to the evolution of the outcome, as it requires an appropriate assessment system. When developing the monitoring system, we have kept, and keep, in mind that it should be suitable for assessing the outcome.