Analysis of National Initiatives for Digitising Industry.

Hungary: IPAR 4.0

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Thanks to
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Executive Summary

General Background. Hungary with a Gross Domestic Product (GDP) of $124,343 M is the 56th economy worldwide with the US leading the ranking. In terms of Industrial Aggregated Value, the ranking of Hungarian economy is very similar but in this case China leads the overall ranking closely followed by US. According to NIH RDI Observatory on the basis of KSH, the role played the by manufacturing industry is outstanding in the distribution of the gross added value by the sectors of the national economy. 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. the automotive industry and energy supply emerge in the distribution of sale of the various sectors with a share of nearly 20%

National Strategies towards "Digitizing European Industries": The Industry 4.0 National Technology Platform has been founded by Hungarian research institutions, education institutions, companies and professional associations having premises in Hungary with the signature of the Deed of Foundation on the 06th of May, 2016. The Hungarian Industry 4.0 National Technological Platform operates several Work Groups in order to fulfil its mission defined in its Organisational and Operational Regulations.

Digitising European Industry (DEI) - Pillar 1 – Digital Industrial Platforms and R&I actions

Digital industrial Platform actions: The platform IPAR 4.0 represents a part of the national strategy seeking to fundamentally rearrange the manufacturing systems based on digital modelling. There are two primary objectives of the I4.0 NTP (1) Foster information exchange, cooperation and partnership establishment between all actors of the economy (2) Acceleration of innovation, particularly in the key areas of digitisation and production, with a specific sector focus on cybersecurity. There is a public funding model behind IPAR 4.0 comprising a mixture of different public financial instruments. As part of the wider EPIC CoE project, IPAR 4.0 is financed by the same financial sources. The Horizon2020 grant of more than €10.8 million (around HUF 3.26 billion) awarded through the Horizon 2020 framework programme represents the key financial instrument of the project. Major financial contributions were also made by the NRDI Office (€3.6 million) and GINOP. The entire budget of the EPIC CoE, including voluntary in-kind contributions from participating stakeholders accounts for €21.7 million (HUF 6.5 billion).

Research, Development and Innovation Actions: The R&I actions dealing with Strengthening research, Technological development and innovation are mainly related to the first thematic objective (TC) of the smart specialisation strategy for Hungary. The objective is to promote the development of ICT (info-communication technologies) & Services with an impact on the automotive, health and agri-food sectors. These activities are mainly funded from EDIOP, CCHOP programmes which make available 9,B€ and 913 M€ over a period of 7 years for all areas of technologies). The final objective is therefore to enhance R&I activity.

Digitising European Industry (DEI) - Pillar 2 - Standardization actions, regulation and testbeds

Standardization actions: The National Initiative has established two working groups dealing with ICT Technologies (safety, reference architectures, standards) and Legal Framework. It is also equally important the investment and strategy established to the development of open Research

infrastructure to effectively meet the societal challenges such as those proposed by Industry 4.0. One of such reference test-beds includes the test ground facility for intelligent transport systems, autonomous driving, at Zalaegerszeg, Trans-Danubian refion. In parallel, the National Research, Development and Innovation Office, through the NEKIFUT project, is in charge of maintaining and developing the national observatory and catalogue of RI, which are the basis for future test-beds and infrastructures for Industry 4.0 demonstration and open experimentation. HRDOP programme (2,999 B€ over 7 years) is covering Infrastructural investments to support interventions ensuring scientific supplies and harmonization of the university-academic and corporate capacities.

Digitising European Industry (DEI) - Pillar 3 - Digital Innovation Hubs actions.

Digital Innovation Hubs actions: The national initiative has not yet formalised a national strategy on DIH but it is actively engaged in the EU call for Smart Factories in new EU Member States". As part of the national research and innovation strategy, Hungary has already designed a number of pilots that should serve to increase the number of strategic R&I networks and as foundational elements for the effective development of DIH, e.g. "Open lab" pilots, Higher Education and Industrial cooperation Centre and the Incubator programme. The national initiative has already started an investment of 7,6M€ for development of demonstration facilities in order to boost SME developments in the field of digitalisation and automation. Complementary to that is the SZTAKI Learning Factories in Győr and Budapest.

Digitising European Industry (DEI) - Pillar 4. Skills development.

Skills development: The National Initiative considers skills as a central element of the national initiative and it is already a very active participant in the Digital Skills and Job Coalition. The overall objective of the initiative is to increasing knowledge capital and Strengthening research, technological development and innovation capacities of Hungarian industry. For this purpose different operational programmes are in place dealing with different verticals of application. RDP operational programme is targeting the needs of smart agri-food sector, whereas EDIOP (9 B€ over 7 years), CCHOP (913 M€ over 7 years) are dealing with manufacturing needs. HRDOP programme (2,999 B€ over 7 years) is horizontal in nature and addresses the needs for digital skills across all sectors of activity.

Specific national measures

Innovation promotion: According to the PwC Digital tax Index 2017 Hungary is the 3rd most attractive European country for digital business development, with a Tax Index of -6,85%. This particular tax scheme is attractive to foster foreign investment on Industry 4.0 developments for digital technologies such as cybersecurity, HPC, Big data and CPPS technologies, which are priorities for the National Initiative. Hungary RISC3 strategy has already budgeted for 2,35B€ of financial instruments to foster innovation and digital business developments in the country.

Fiche of Hungary

1. Introduction

I.1. Overall economic situation of the country

Hungary economic landscape Hungary with a Gross Domestic Product (GDP) of $124,343 M is the 56th economy worldwide with the US leading the ranking. In terms of Industrial Aggregated Value, the ranking of Hungarian economy is very similar but in this case China leads the overall ranking closely followed by US.

Industry ecosystem structure 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 (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.

Economic Motors. According to NIH RDI Observatory on the basis of KSH, 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; although there was a moderate growth in the last years (around 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. The share of the information and communication sector is steadily increasing. 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.

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.

Contribution to growth and jobs. 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%. The rising position of the chemical and the pharmaceutical industry is also outstanding. Among the sectors, the situation of the rubber and the plastics industry can be considered stable.

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 labor-intensive industries which required a lower level of automation (manufacturing of textiles, clothing, leather and leather products, production of food, beverages and tobacco products).

I.2. Overall strategy / situation concerning the digitization of manufacturing / production

Context. The industrial sector has entered a new technological era in which Internet economy fundamentally transforms the production systems. This process requires the advanced and paced deployment of the bridges between the physical and digital world, a special innovative adaptability, answers faster than ever, and bold innovative steps from each participant of the economy – with special regard to the companies involved in the key sectors targeted by the Irinyi Plan –, from the Government's economic policy as well as from the institutions of the innovation system.

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.

Timing. The Industry 4.0 National Technology Platform has been founded by Hungarian research institutions, education institutions, companies and professional associations having premises in Hungary with the signature of the Deed of Foundation on the 06th of May, 2016.

Goals. In order to support the achievement of the objectives of the Platform, the Government undertakes to

- facilitate the development of the innovation ecosystem related to the Industry 4.0 Platform, to support the creation of Industry 4.0 reference systems and model factories aimed at R+D+I and education,
- build upon the professional proposals of the Platform during the further development of the regulatory environment, and – by also shaping the boundary conditions – the successful realisation of the Industry 4.0 Program,
- catalyze domestic and international co-operations, particularly with regard to industrial R&D strategy to strengthen institutional excellence, which means first and foremost the strengthening of our position within EU research networks.
- supports both vertically and horizontally integrated supplier systems with tenders – markedly strengthening the integrative role of fast growing medium-sized companies and large

companies – the closing up of small and medium-sized enterprises and the development of the start-up ecosystem.

- supports IT and production automation projects related to the above objectives, the development of smart digital solutions, with a particular emphasis on market-based projects that directly contribute to industrial excellence and competitiveness objectives, including also the establishment of profitability on global markets,

- supports the harmonization of suggestions, standards and recommendations elaborated by the Platform with comprehensive technical regulatory and other measures,

- facilitates the high-quality R&D activities of the Platform in accordance with the above objectives, the efficiency and efficacy of education, and to raise its standard, furthermore the dissemination of professional and methodological materials aimed at improving the education's market orientation,

- facilitate the dissemination of the results and good practices of the Platform.

Strategic Action Lines. The Hungarian Industry 4.0 National Technological Platform operates several Work Groups in order to fulfil its mission defined in its Organisational and Operational Regulations. Their activity focusses on specific issues related to I4.0 and they formulate answers and recommendations to the challenges presented by the practice. The participants of the Work Groups are delegated by their own organisation, members of the Platform and they represent special expertise in the given area. They work closely together with the corresponding governmental forums and bodies thus contributing directly to the formation and implementation of the Government's strategic goals.

Currently the Platform has 7 Work Groups:

1. **Strategic Planning.** Identify lines of action required to the challenges raised by the Industry 4.0 towards Hungary, in order to adopt best practice solutions and thus the results attained so far in global competitiveness of our industry sector could be preserved and even further reinforced.
2. **Employment, Education and Training.** Cover all educational aspects of I4.0 which determine the highest priority HR preconditions and implications for its implementation in practice.
3. **Production and Logistics**. Focusses on such key goals as the digitisation of the Hungarian manufacturing industry as defined in the Irinyi Plan which will certainly play an over-important role in shaping the future of sector in Hungary.
4. **ICT Technologies (safety, reference architectures, standards).** Deals with those aspects of I4.0 that are connected to the implementation of the national strategy aiming to facilitate the digitisation of the Hungarian industry. The main topics comprise the horizontal integration of the value creation chain, the vertical intra-factory integration of the entire product life-cycle, their technological assumptions to be considered and obstacles to be overcome
5. **Industry 4.0 Cyber-Physical Pilot Systems**. Implementation perspective of one of the Platform's key topics, i.e. how can the required progress in culture, the existing paradigms of thinking as well as the related technologies be facilitated in the most efficient way. To

complete this task it is crucial to create I4.0 pilot systems for research, development, demonstration and education / further training purposes.

6. **Innovation and Business Model**. determine the major directions of R&D work at the research institutions and companies - based on their direct needs and the international trends - in the way that the innovation requirements of the national economy could be met.
7. **Legal Framework**. Addresses any issues which have a legal implication, those which are beyond the primarily technical approaches and action plans. These are e.g. related to the risks and threats in the society of the digitisation and the mandatory harmonisation with the EU directive Digital Single Market Strategy for Europe.

National Initiative Coordinates. The strategy will be followed up on an ongoing basis and the action plan will be continuously updated on the basis of the Working Groups activities

Facts on the Hungary National Platform 'IPAR 4.0'	
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Main Strategy Documents	Organisational and Operational Regulations of the Industry 4.0 National Technology Platform[2]
Related Strategy documents	National Smart Specialisation Strategy Investment in the future. National Research and Development and Innovation Strategy (2013-2020)

[1] https://www.i40platform.hu/en
[2] https://www.i40platform.hu/sites/default/files/2016-12/Ipar%204_SZMSZ_v2.2_EN.pdf

I.3. Digitization level of the country

Qualitative analysis. Hungary is among the low performing countries, like the majority of the countries in the region, including Slovakia and the Czech Republic. 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

Hungary ranks 21st in DESI 2017. Hungary performs well on Connectivity, thanks to the wide availability of fast fixed broadband (NGA) and 4G as well as to the increasing broadband take-up. Hungary improved in digital skills, but stands still slightly below the average. The key challenges remain the low use of ICTs by enterprises and the development of Digital Public Services. Hungary belongs to the cluster of low performing countries.

Quantitative analysis. In DESI 2017, Hungary has an overall score of 0.46 and ranks 21st out of the 28 EU Member States (0.52). Concerning connectivity, Hungary has a medium-high rank in fixed broadband take up (10), while it scores nr. 13 in 4G coverage and rank 28 in mobile broadband take-up. During the past year, Hungary has even improved in fast broadband subscriptions. Over half of Hungary (55%) are online and 51% of the population has basic digital skills. ICT professionals represent an increasing share of employment (3,6%; rank 13), but the number of STEM graduates must significantly improve to enable companies to recruit the ICT specialists they need. Hungary ranks high in the use of internet by citizens (15). These scores are mainly due to media consumption via the internet, they score 1st in social networks, while in online shopping / banking, Hungary scores in the lower end of the scale (20).

Hungary businesses use social media, eInvoices, cloud and eCommerce. However, the business sector is not exploiting the opportunities offered by digital technology as much as other countries do, pushing Hungary back in the ranking. They show a low adoption rate of cloud computing (8%, rank 23), and 12% (rank 20) are selling online. 8% of Swedish companies are using electronic invoicing (rank 25), and a few of them selling online cross-border (4,5%; rank 23). In 2017, the country scored somewhat lower with regard to digital public services, leaving Hungary to a 27 ranking, with a decrease in open data and a reduction in the number of users of eGovernment services.

2. National Strategy towards "Digitizing European Industries"

According to KSH, the total domestic R&D investment increased from HUF 25 bn to almost HUF 57 bn in nominal value during the period from 2004 to 2012. Intense growth had been observed in the beginning of the period (60% growth in less than 2 years; the HUF 41.7 bn value was reached already by 2006), which was followed by a significant decline and then slow growth. Statistics distinguishes three types within the R&D investments: machine and instrument investments, software investments and building investments. The corporate sector is generally regarded as the biggest "builder". It used 16% of its investments, with software investments fluctuating around 3-8% of the total amount and 61-75% being used for machines, instruments and equipment.

The public finance sector used the available R&D investment sources mainly for machinery, equipment and instruments with up to 80% of investments. A similar trend was observed in the education sector. It used the investment sources primarily for machinery, equipment and instruments in most of the period under review, while the share of construction spending generally remained below 20%. As regards the distribution between the various disciplines, Hungary roughly follows the international trends extracted from Eurostat: over 80% of the R&D investment is used in natural science and engineering science. They are followed by the agricultural and medical sciences with shares below 10%, while the share of the social sciences and humanities is 1-4%.

Following 20 months of preparations and having a vision of supporting the government decision-making processes at the very high political level, I4.0 NTP was successfully launched in the spring of 2016. For the launch, nearly 40 representatives of reputed Hungarian companies, universities and other academic circles were invited. They became the Founding Members of the platform by signing the Deed of Foundation. The Hungarian Academy of Sciences Institute for Computer Science and Control (MTA SZTAKI) was appointed as the first leader of the platform. Currently, the platform has more than 100 participants and continues to be open to new memberships. The background behind the launch of the I4.0 NTP is the realisation that Hungary, too, has entered a new technological era in which the Internet-based economy fundamentally transforms the very basics of the production and logistic systems.

The platform represents a part of the national strategy seeking to fundamentally rearrange the manufacturing systems based on digital modelling. There are two primary objectives of the I4.0 NTP:

1. Foster information exchange, cooperation and partnership establishment between all actors of the economy
2. Acceleration of innovation, particularly in the key areas of digitisation and production, with a specific sector focus on cybersecurity.

3. Digitising European Industry (DEI) Pilar 1 - Digital Industrial Platforms & Research, Development and Innovation actions.

In the area of Research and innovation environment, organisations, infrastructure and services, Hungary has already significant strengths:

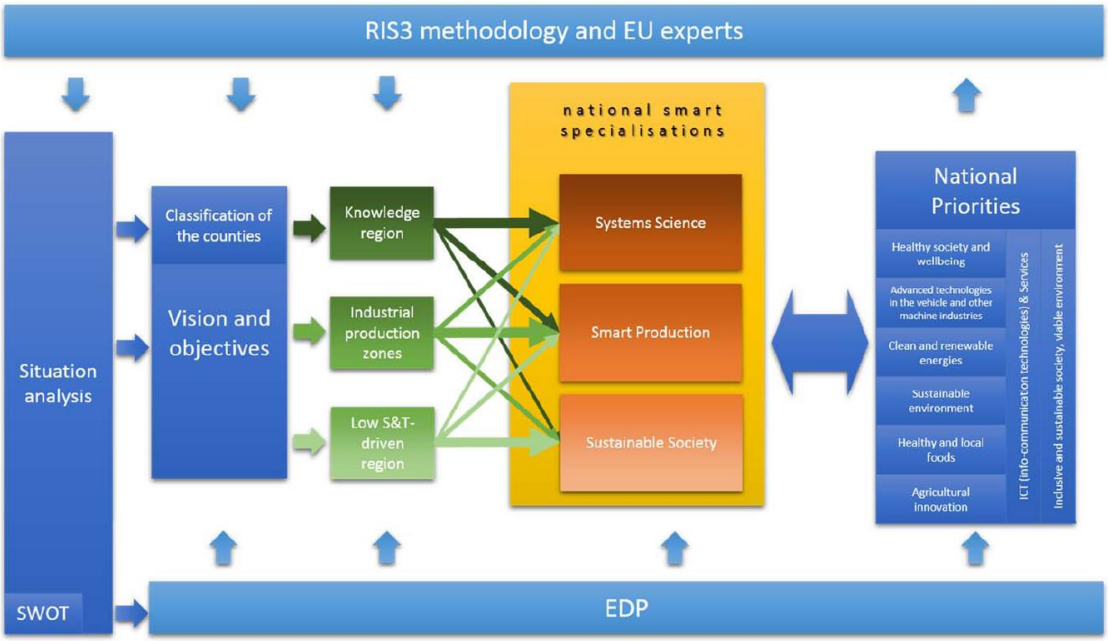
- R&D knowledge centres have developed with concentrated R&D capacities in some places.
- The large foreign and Hungarian companies operating in the country have created cutting-edge work culture.
- R&D capital concentration and the modern RDI infrastructure appeared in the vicinity of the large companies. 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.
- 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.

However, it also exhibits some weaknesses

- 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

The Industry 4.0 National Technology Platform (IPAR 4.0) was established under the leadership of the Institute for Computer Science and Control (SZTAKI), Hungarian Academy of Sciences, with the participation of research institutions, companies, universities and professional organizations and with the full support and commitment of the Government of Hungary, and specifically that of the Ministry of National Economy. The objective is for Hungary to become a winner with digitalisation, with a primary focus on the automotive sector. In order to strengthen the achievements in the global competitiveness of the industry attained by our country, the Members encourage the further deepening of the established partnership relations, as well as the creation of an intensive and action-oriented system of cooperation compliant with the best practices in Europe. Additional objectives are to act as a lobbying forum and an advisory body to the Government in shaping the digitalisation policy.



As it can be observed in the figure above, IPAR 4.0 is central to the RIS3 strategy for smart specialisation. 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.

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.

Over these 3 pillars the main strategic directions of sector renewal have been stated as follows:

- **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"
- **Sustainable society**: spreading diversification: exploitation of the synergies of a new and an old activity (focusing and the spill over effects)

In the context of the smart specialisation strategy, several priorities both vertical (sector-focused) and horizontal have been established that support directly the implementation of the industrial digital transformation policies and strategies:

- **Advanced technologies in the vehicle and other machine industries.** *Key areas: 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 nonexclusive) 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.
- **Agricultural innovation** *Key areas: 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.

From the horizontal priority perspective, both priorities (ICT and skills, networking priorities) for the smart specialisation strategy hit directly at the core of the DEI strategy. In particular:

- **ICT (info-communication technologies) & Services.** *Key areas: info-communication technologies in support of the sectoral priorities, info-communication technologies and services.* Info-communication 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 info-communication 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.** *Key areas: education and training, health-conscious education and prevention, awareness raising, promoting entrepreneurial skills, development of cooperation, networking, organization and management development, social innovation, 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.

While the IPAR 4.0 Platform objective is fostering information exchange and cooperation between Hungarian companies, research and education institutions, and professional associations, as well as accelerating innovation in the key areas of digitisation and production, i.e. those of Industry 4.0; from the above plans a number of additional interventions have been planned that are directly related to the development of advanced technological developments and platforms in the context not only but primarily of Industry 4.0 and digitisation of Hungarian industry.

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

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				

4. Digitising European Industry (DEI) Pilar 2 - Standardization actions, regulation and testbeds

Research infrastructures can be exemplary in this regard since they are all part of operating research networks or heading in this direction – establishing a real national innovation system, which supports the economy, on the basis (and through the strengthening) of this network is of critical importance to Hungary.

At the same time, it must be understood that certain changes do not leave research infrastructures unaffected; they also operate in a changing context. The traditional approach for research infrastructures focusing on possessing the own "inside fence" devices and equipment has been significantly transformed by the development of the information and communication technologies. The access to networks with fast and large data transfer capacities and huge databases expanding in a continuous and planned way in international cooperation is increasingly becoming a basic condition of modern scientific activity.

Hungary is significantly behind in this respect. If Hungary does not keep pace with the most developed countries then the scientific position reflected in the intellectual power of education and scientific community, exceeding the size and economic strength of the country may be quickly lost.

One of the most efficient method of using the significant financial resources of the European Union available between 2014 and 2020 may be the development of the research infrastructure. Without radical modernisation, it cannot be expected that the Hungarian scientific and technical development maintains its current position in the international field and it can be even less expected that the country improves its performance at an international level.

The analysis exploring the situation of the Hungarian RI is based partly on the available domestic and international statistical data, and partly on the data of the RI register created and operated by the NEKIFUT project.

In terms of developing the network of research infrastructures (RI) for impact on industry and society, the Hungarian government has stablished clear strategic principles:

- The promotion of networking and the unification of fragmented research organisations in order to build synergies. As a result, it can be expected that such RI services will be established that, due to the lack of networking, RI has not been able to provide until now; in the meantime, increase in utilisation rate is also to be expected. The technology and innovation centres, infrastructures established with the participation of entrepreneurs or undertakings are, where possible, a natural part of the networks.
- Openness, which is also a prerequisite for networking, should get a prominent role instead of the exclusive use of infrastructures. As we have seen it, this is also a premise at Union level; the use of open infrastructure is crucial to establish a research area and users shall have an equal chance to access it if they comply with the conditions laid down in the publicly available rules, except some special reason (e.g.,, national security, data protection) prevents this.

- The general principle for developing research infrastructures is that the research infrastructures that have a substantial chance for establishing connections with respect to their disciplines should get the support needed for access by developments and renewals, in the interest of striving for international excellence. Access does not only mean a "membership fee", but also that the given infrastructure should use the opportunities provided by the access as much as possible.
- It is important that a research infrastructure shall not only be taken into consideration as a "locally" available infrastructure. On the one hand, this is not appropriate because of the networking and, on the other hand, it can be problematic because of the effects described above (the outstanding infrastructure has a widespread impact, etc.). The infrastructures should be rather taken into consideration as part of a given discipline or, in a broader sense, a national or international RI-network, which answers the question how the given infrastructure or discipline should contribute to the cooperation in the scientific or business sector.
- When joining an international project, the research networks that can use the benefits stemming from the project participation through the synergistic operation of the network
- members should enjoy advantage.
- The R&D projects in the framework of which the infrastructures can be partners of the corporate sector shall be provided with a special support by all means. This can be appropriately implemented so that the research projects should only receive funding if the research infrastructure and the undertaking can cooperate for the successful implementation by creating a synergy between them.
- An important element of the RI development is in-kind contribution (which also plays a key role in the ESFRI principles), which should be strengthened from targeted Union or national funding with a view to fostering international cooperation to be realised in the field of RIs.
- The so-called in-kind contribution may significantly assist the Hungarian suppliers in developing and producing high-tech instruments so as Hungary can participate in the given infrastructure.
- Taking into account that the infrastructures of certain disciplines cannot be economically utilised in a direct way but are of significant scientific importance (which can indirectly result in economic benefits later), it is recommended not to consider these infrastructures so much as the infrastructures achieving a direct economic result; they should rather be measured and evaluated in terms of scientific excellence, through the number of researchers (users) and publications. Every major discipline is affected by these issues to a greater or lesser extent.

One of such new testbeds will be the test ground facility for intelligent transport systems, autonomous driving, smart city, and infrastructure (Zalaegerszeg, Trans-Danubian refion). It is planned the Test ground construction and 5G infrastructure to be built in Zalaegerszeg by 2018 with private involvement and regional cooperation. In this case, the target sector is the automotive industry: connected and autonomous driving, car manufacturing; ICT technologies; Transport systems; Communication Infrastructure, 5G development and test in real environment; Testing use cases. The value resides in the development of an Industrial innovation infrastructure and test bed open for the region and for European manufacturers, SME-s and startups. Major technologies involved are those related to connected and autonomous driving; intelligent transport systems; road

infrastructure; 5G; cyber security; cloud technologies; standardization with a vision on legal environment.

5. Digitising European Industry (DEI) Pillar 3 - Digital Innovation Hubs actions

In the context of the Digital Innovation Hubs, the Smart Specialisation strategy for Hungary already envisions the implementation of specific types of pilots that can be identified as the foundation for a more comprehensive and enriched approach to digital innovation and digital transformation of industry through the concept of DIH.

The RIS3 strategy defines the implementation of

- **"Open lab" pilots.** 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 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, 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.

- **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.
- **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.

In relation of DIH early actions is also worth mentioning the SZTAKI Learning Factories in Győr and Budapest, which is allows for cascading different national and European funds and the continuously expansion of complex pilot systems. The scope is on managing traditionally difficult production problems on prototype levels in constantly changing environment using various IoT devices and solutions, bringing robotic assembly tasks in collaborative workplaces. The learning factories are open development environment for some student groups and projects.

In parallel and during 2017 has started the creation of demonstration facilities in order to boost SME developments in the field of digitalisation and automation. The implementation of the programme started in April 2017, with planned ending in June 2019. Total expenditure for €7,6 million, will be financed entirely by the EU from ERDF. The programme is in line with the industrialization policy of the Hungarian Government, with policy supervision by the Ministry for National Economy. Responsible for the implementation are the IFKA non-profit Ltd responsible for the development of the industry and the ICT Association of Hungary. The target sector is manufacturing industry and the main goal of the programme is to help SME's in the digital transformation process and to improve their openness toward Industry 4.0 technological, industrial automation, guidance etc. systems, through the following tools:

1. Creating industry 4.0 demonstration applications and environments / factories, and thus demonstrating and disseminating industry 4.0 knowledge, measures and tools suitable for SME's.
2. Directly improving SME's through knowledge transfer, management training, demonstration facility visits (for practical experience).
3. Awareness-raising of SME's in the field of Industry 4.0, automated and digitized industrial processes, smart factory, Cyber-Physical Production System.

The planned industry 4.0 technological centre will be a general industry 4.0 knowledge base. It will give the possibility for SME's to acquire a broad knowledge about Industry 4.0, and also will serve as a technological demonstration facility. Digital knowledge will be spread among SME's. The programme will reach about 1 000 SME's directly and actively, 300 out of them will get a simplified development plan, 50 a full development plan.

6. Digitising European Industry (DEI) Pilar 4 - Skills development

Hungary shows significant strengths in the field of Education, training, research background:

- Hungary possess 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.

However, it also exhibits some weaknesses:

- 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.

The main interventions dealing with Digital Skills are leveraged by the HRDOP Operational programme and activities in the field of Industry 4.0 are coordinated by The IPAR 4.0 Employment, Education and Training Work Group, which has as its main task to cover all educational aspects of I4.0 which determine the highest priority HR preconditions and implications for its implementation in practice.

7. Investments for Digitising European Industry.

For the implementation of IPAR 4.0 a number of specific funds have been made available. There is a public funding model behind IPAR 4.0 comprising a mixture of different public financial instruments. As part of the wider EPIC CoE project, IPAR 4.0 is financed by the same financial sources. The Horizon2020 grant of more than €10.8 million (around HUF 3.26 billion) awarded through the Horizon 2020 framework programme represents the key financial instrument of the project. Major financial contributions were also made by the NRDI Office (€3.6 million) and GINOP. The entire budget of the EPIC CoE, including voluntary in-kind contributions from participating stakeholders accounts for €21.7 million (HUF 6.5 billion). The Centre of Excellence in Production Informatics and Control (EPIC CoE) was established with the objective to be a leading, internationally acknowledged and sustainable focus point in its field, representing excellence in research, development and innovation related to Cyber-Physical Production (CPP). The big challenges of the new technological era when information and communication technologies are fundamentally transforming and revolutionizing production will be responded by concentrating the multidisciplinary, partly overlapping, partly complementary competences of CoE partners from Hungary, Germany and Austria. The mission of EPIC CoE - as a leading-edge knowledge centre of cyber-physical production systems - is to accelerate innovation, realize industrial solutions, train new generations of highly qualified professionals and support the development of a sustainable and competitive European manufacturing ecosystem.

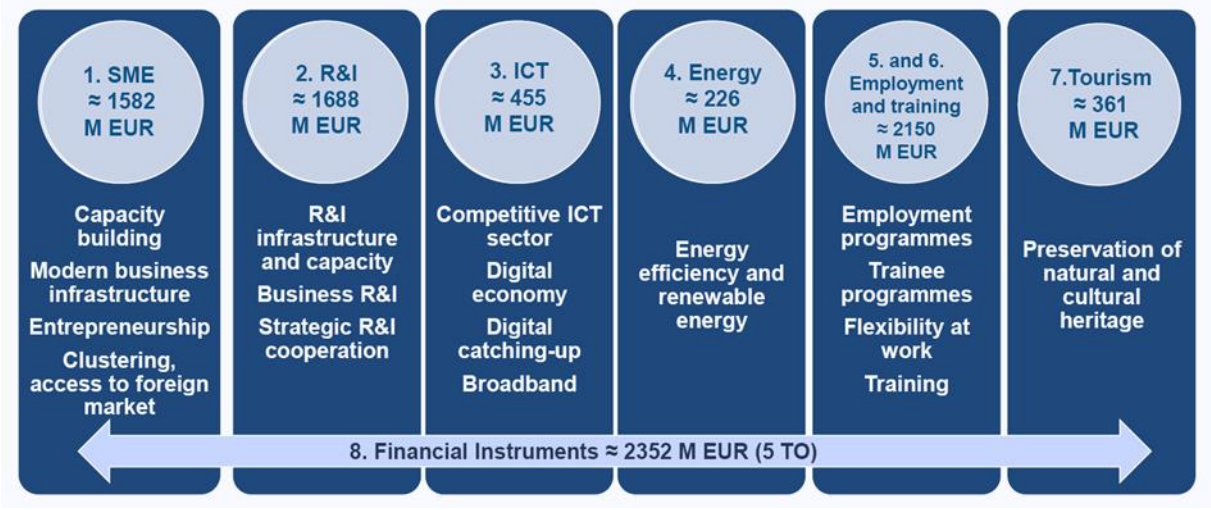
Those funds that should support the operation of the Hungarian Industry 4.0 Platform will be complemented by the resources made available through national research and innovation programmes that contribute to the strengthening of digital skills, innovation infrastructures, testbed and digital technologies.

The figure below illustrates the main EU2020 targets for Hungary

On the other hand, the Table below illustrates the funds leveraged by the operation programme 2014-2020 and the 11 Thematic Objectives of priority for the smart specialisation strategy (the ones marked in red those with a direct impact on DEI pillars)

Name of the Operational Programme	million EUR
Economic Development and Innovation Operational Programme (GINOP)	8 813
Competitive Central-Hungary Operational Programme (VEKOP)	927
Territorial Operational Programme (TOP)	3 971
Integrated Transport Development Operational Programme (IKOP)	3 920
Environment and Energy Efficiency Operational Programme (KEHOP)	3 785
Human Resources Development Operational Programme (EFOP)	3 070
Public Administration and Services Operational Programme (KÖFOP)	935
Rural Development Programme (VP)	4 174
Hungarian Fisheries Operational Programme (MAHOP)	51
OP for Supporting Socially Disadvantaged Persons (RSZTOP)	111
+ direct Single Area Payment Scheme	7 643
Total	**37 400**

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.



As shown in the figure above, in the framework of this 1st TC, 2,234 million EUR (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) is available to Hungary between 2014 and 2020 (for RDI support). The amount will be disbursed through the operational programmes, respectively, their priority axes, which contain R&D targets in varying proportions (HRDOP is an exception HRDOP,

which provides R&D resources through the 10th TC, namely Investing in education, skills and lifelong learning).

The way the resources will be made available for the implementation of the specific projects and priorities will follow the rationale below.

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:

- 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 total 913 MEUR 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).

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)

In terms of the temporal leverage of such resources the plans from the Hungarian national authorities are shown in the Table below. However, these Figures are revised yearly and should serve as an indication of the intensity of investments planned

	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/€)