SMART SPECIALISATION STRATEGY
(S3)
2021-2027

July 2021. Budapest

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On the following pages National Smart Specialisation Strategy (S3) for 2021-2027 can be read which the Government of Hungary adopted with Government Decision 1428/2021 (VII. 2.).

EXECUTIVE SUMMARY

The **Smart Specialisation Strategy** (**S3**) is a specific policy instrument focusing on the development of specific territorial and specialisation directions, which has become a common policy instrument in the European Union in the period 2014-2020. In the 2021-2027 programming period, the smart specialisation strategies aim to contribute to the Cohesion Policy's policy objective "**A smarter Europe through innovation and support for economic transformation and modernisation**". Linked to this goal, S3 design and implementation should focus on strengthening research and innovation capacities, digitisation, SME growth and developing the skills needed for S3.

For the period 2021-2027, S3 will be an **enabling condition** for Member States, with the conditions set by the European Commission for the strategy to be met throughout the cycle. So, unlike the 2014-2020 cycle, the current S3 is not just a strategy that sets out the policy directions for the period, but a framework for delivering the relevant policy objectives for the whole period.

At the same time, it is in Hungary's interest not to see S3 as just a mandatory task**. S3 is an instrument that can effectively support our strategic objectives in the field of RDI and economic development in the long term and provide a basis for the efficient use of domestic cohesion policy resources in the next financial programming period.**

The European Commission's criteria include the expectation that each Member State should have a designated body responsible for **managing the implementation of S3** throughout the implementation period. On 5 May 2020, the Minister for Innovation and Technology appointed the **National Research, Development and Innovation Office (NRDI Office)** for this task. The predecessor of the NRDI Office, the National Innovation Office, played a key role in the planning and implementation of the S3 in 2014-2020, so the required professional competences are available for the implementation of the S3 in 2021-2027, for the coordination of monitoring and evaluation tools, and for the operation of the Entrepreneurial Discovery Process (EDP). In the S3 management model, the NRDI Office will be responsible for the project management level in the implementation of the 2021-2027 strategy, linking the decision making level with sectoral stakeholders and actors in local innovation ecosystems.

In a change from the previous S3 implementation, the digitisation and enterprise development domains have been involved in the S3 planning and the EDP has been extended to include new target groups. The previous S3 was essentially an RDI-focused planning document, its design was driven by innovation policy and the EDP was mainly driven by the RDI ecosystem. However, in the new programming period, the Commission expects **stronger cooperation and coordination between policy areas** in order to make S3 more effective as a policy instrument. S3 for 2021-2027 was designed in cooperation between the RDI, enterprise development and digitisation policy areas.

All three functions have a national strategy for the implementation period of S3, namely the **National Digitisation Strategy**, the **Strategy for Strengthening Hungarian Micro, Small**

and Medium Enterprises 2019-2030, adopted by Government Decision 1627/2019 (XI. 8.), and the **National RDI Strategy 2021-2030**, also to be adopted. In addition, the implementation of S3 should also take into account the Artificial Intelligence Strategy.

While these national strategies follow specific policy area objectives, S3 can be seen as an umbrella strategy for the policy areas, building on the pillars of the strategic objectives of the three policy areas. S3 builds on the interventions and measures of the three areas to support smart specialisation to set out specialisation directions with a high development potential, where concentration of resources can contribute to increasing the competitiveness of the economy and to the EU's "Smarter Europe" policy objective.

The development of S3 started in line with the methodological guidelines of the European Commission, complemented by regular consultations with Commission experts. In the preparation of the current S3 and, prior to that, **the National RDI Strategy 2021-2030**, **we** also **drew heavily on the experience of** the **National Innovation Forum**, which took place between February and March 2019, in 25 locations and attracted more than 2,500 stakeholders.

In designing S3, we took as a starting point Dominique Foray's (2016) concept of smart specialisation and took into account the experience of the implementation of S3 in Hungary in 2014-2020.

As an initial step in the prioritisation process, we have compiled the **long list** of priorities, which identify socio-economic-technological areas that can be promising or challenging for Hungary. For this purpose, we have considered global technological, social and economic megatrends, relevant domestic policy strategies and the specialisation trends of EU member states.

One of the key elements of the S3 methodology is the use of **EDP** (entrepreneurial discovery process) in the design of specialisation directions. During the EDP, the sectors of the "quadruple helix"[1] will define in an interactive, bottom-up way what niche markets they see and what they need to exploit them. They will also identify and share potential strengths and opportunities with policy makers, with a particular focus on increasing the innovation potential, numbers and performance of SMEs

In order to achieve a bottom-up approach, the **next step in the prioritisation process was to consult with the stakeholders on the "long list" in the EDP**. As **one of the tools, a nationwide survey (S3 Online Survey)** was conducted to assess the activities, experiences, suggestions and needs of the **actors of the "quadruple helix"** in relation to smart specialisation. The survey was available on the NRDI Office's website between 12 November 2019 and 12 March 2020. During this period, a total of 2030 respondents started to fill in the survey form and ultimately **829 responses were submitted**.

Another key element of the EDP is the **creation of Territorial Innovation Platforms (TIPs)** based on local university centres, initiated by the NRDI Office and the Ministry of Innovation and Technology. **At regional level, the TIPs provide an opportunity to bring together**

[1] Representatives from business, academia, public administration, NGOs and citizens.

higher education, industry, central and local government and civil society, to disseminate the innovation process across sectors, to organise activities related to the implementation of S3 and to develop proposals to achieve the objectives.

TIPs were established in eight locations (Miskolc, Debrecen, Győr, Pécs, Szeged, Budapest, Veszprém and Gödöllő**)** by June 2020, with more than 1,100 participants attending the kick-off conferences.

In addition to **the results of the EDP**, we used the results of the macroeconomic model **(GMR model)** developed by the Regional Innovation and Entrepreneurship Research Centre of the University of Pécs in the development of the priorities. The GMR model has identified sectors with significant knowledge flows and growth potential.

The results of the two methods (EDP and the GMR model) were combined to develop the prioritisation, resulting in the **following national economic priorities**:

- **Cutting-edge technologies**
- **Health**
- **Digitisation of the economy**
- **Energy, climate**
- **Services**
- **Resource-efficient economy**
- **Agriculture, food industry**
- **Creative industry**

These priorities set out the directions for the national economy on which Hungary will focus in pursuing smart specialisation. Focusing resources on priorities can strengthen competitiveness.

In addition to the national economic priorities, two **horizontal priorities** have been selected:

- **Training, education**
- **Public sector and university innovation**

The horizontal priorities are designed to provide the skills development and business environment needed for smart specialisation in the sectors covered by the national economic priorities.

The Hungarian S3 **contains national-level priorities with a national scope**, but addresses the territorial level in order to plan the distribution of resources between specialisations, thus addressing the socio-economic development differences between counties and the effects of different RDI performance in different regions.

The counties of Hungary are classified into the following types of regions: **Knowledge regions (**Budapest capital, and Csongrád-Csanád, Győr-Moson-Sopron, Hajdú-Bihar, Pest, Veszprém, Baranya, Borsod-Abaúj-Zemplén counties), **industrial production zones (**Fejér, Heves,

Komárom-Esztergom, Vas, Zala, Bács-Kiskun counties), and **moderate knowledge and technology intensive areas (**Békés, Jász-Nagykun-Szolnok, Nógrád, Somogy, Szabolcs-Szatmár-Bereg, Tolna counties). For each **type of regions, general objectives have been set**, which are not adapted to national priorities but to the development trajectory of the counties concerned.

In order to ensure that S3 can contribute as effectively as possible to strengthening Hungary's socio-economic position in the period 2021-2027, the information collection process (i.e. the EDP) aimed at assessing the changed domestic situation after the pandemic and the regional and sectoral impacts **was finalised through a "validation survey" at the end of November 2020**. The list of priorities for this planning document was therefore established after the 10 priorities identified during the first phase of the EDP were sent by the NRDI Office to a total of 106 organisations representing all the major players in the "quadruple helix".

The survey for the professional validation of the priorities was thus also sent to the horizontal organisations in the policy area of digitisation and enterprise development, as well as to all members of the Enterprise Development Council. Respondents were given the opportunity to comment on the **objectives and content of the priorities developed in the previous EDP stage**.

The survey could be filled in between 13-24 November 2020, and the content of each priority was finalised based on the survey results.

In order to develop the priority areas defined in S3 and to implement the objectives of the strategy, we have identified the barriers to the spread of innovation and identified key interventions that provide policy responses to structural problems that are also prominent in the European Commission's country reports.

In Hungary, there are a number of factors that hinder or slow down the adaptation of the latest technologies and the strengthening of the research, development and innovation (RDI) ecosystem. These factors can be a barrier to the effective use of resources allocated to S3 priorities. In designing the strategy, we have identified bottlenecks and key challenges affecting the spread of innovation in the country *(these are the funding situation and operational efficiency of the RDI system, poor knowledge flow in the innovation ecosystem, challenges related to the training and availability of the RDI workforce, the relatively low RDI performance of companies, especially in the SME sector). Our findings are in line with the National RDI Strategy 2021-2030.*

The dual structure of the domestic corporate sector has been one of the most important structural problems of the Hungarian economy for decades: economic performance is determined mainly by a small group of foreign-owned multinationals, while the productivity and innovation potential of the large SME sector, which is also a major employer, lags behind. Therefore, it is important to **strengthen domestic small and medium-sized enterprises (SMEs)** amidst the increasingly challenging **trends of industrial transformation** *(such as digitisation and other Industry 4.0 trends, technological explosion, decarbonisation or the transformation of global*

value chains). It is therefore essential to identify the connection points between the relevant national and sectoral strategies and to present effective national, sectoral and territorial interventions to address industrial change. Ongoing or planned actions at national level to improve national and regional research and innovation systems are presented in a separate chapter.

A key objective of S3 is to build an internationally competitive RDI system based on national strengths by embracing territorial specificities. To achieve this, it is essential to increase the **international embeddedness** of local economic actors and to increase the involvement of RDI actors in international cooperation. The strategy sets out the actions and potential competitive advantages that need to be launched or sustained during implementation in the supported priority areas in order to **enhance international cooperation** between S3 stakeholders.

The smart specialisation process will start with the adoption of the S3 document by the government, and its implementation and monitoring will be managed by the NRDI Office as the responsible body with a project approach. The strategic level of management provides the sector policy representation needed for implementation, providing the means of implementation and the government powers that can support effective implementation (e.g. EU development policy planning). The operational level of the S3 management system is managed by the NRDI Office as a project management organisation, which maintains the link with the S3 network of experts and stakeholders, including the Territorial Innovation Platforms, which are continuously operating during the implementation period.

The expectations of the S3 evaluation and monitoring system, the feedback from local actors involved in implementation, but also the changed economic situation due to the current pandemic and the experience of the implementation of the operational programmes of the 2014-2020 EU programming cycle, call for continuous review, continuous improvement and regular feedback.

Compared to previous practice, the implementation of S3 for 2021-2027 **will allow for a greater possibility to review national smart specialisation priorities at regular intervals**. TIPs will help to enhance the monitoring mechanisms of the strategy with the EDP and, in addition to the activities of the coordinating body managing the implementation of S3, some processes can be decentralised during implementation and monitoring.

The implementation of S3 is primarily monitored **by priority** (sectoral, horizontal). S3 monitoring aims to assess the progress and effectiveness of the implementation of priorities in relation to themselves and to each other. The main objective of the monitoring is to assess whether the selected priorities need to be further strengthened or whether a refocusing of priorities is justified.

1. Introduction

At the beginning of the 2020s, our world is characterised by a particular duality: while we are experiencing unprecedented technological progress, our civilisation is facing challenges that will have a major impact on the performance of our economic systems and the lives of the members of our societies. Hungary's Research, Development and Innovation Strategy 2021-2030 (hereinafter: **RDI Strategy**) has analysed in detail the global social, technological and environmental megatrends that have a profound and lasting impact on Hungary. These challenges, such as the impact on society of the spread of digital technologies (artificial intelligence, big data, IoT, cyber-physical systems, autonomous systems, 5G mobile technologies), or even long-standing civilisational challenges such as the fragility of the natural environment and the risk of collapse of ecosystems, the depletion of non-renewable resources, climate change, migration, the need to develop defence industries in the face of geopolitical change, or even the risk of pandemics that could affect the entire world economy, must be addressed by Hungary as well. These **global challenges** of the 21st century have an impact on all societies, businesses and citizens to some extent. These phenomena affect modern societies and nation states in complex ways, with both opportunities and threats: digitisation is changing the needs of the labour market, the challenges of globalisation are transforming business models, decarbonisation is having a major impact on entire industrial sectors, to name but a few examples.

The **economy of the European Union** faces many challenges. The EU aims to lead the green transition and digital transformation in this decade (European Commission, 2020a), but this is hampered by its relative **competitive disadvantage** (compared to its political weight). Europe has a high level of scientific excellence in basic research, but the innovation performance of its economy is nowhere near that of its main competitors (such as the US or the more developed East Asian countries), and the problem, known as the **European paradox**, has not been solved for decades. Recognising this, the Europe 2020 Strategy has made the development of an economy based on knowledge and innovation one of its three main priorities.

Within Europe, **Hungary** currently ranks among the **moderate innovators** according to the European Innovation Scoreboard (EIS), which is compiled annually by the European Commission. The national objective is to become one of Europe's strong innovators by 2030, as this is the only way to strengthen the value-creating capacity of businesses and ultimately increase the productivity of the corporate sector. To be successful, it will require not only increased spending but also **optimal use of** EU and national **funding**. **The Smart Specialisation Strategy** (hereinafter: S3) can be a **tool for** this, which **can help to improve competitiveness by identifying regional and national strengths, defining competitive advantages and setting specialisation priorities**.

S3 is therefore a planning document to help develop a complex concept for economic development. In order for Hungary to become one of Europe's strong innovators, in addition to increasing resources and R&D expenditure on business development, it is also

necessary to plan and use EU and domestic funding in a results-oriented and more efficient way.

A key task of the S3 management system is to further strengthen the dissemination and recognition of knowledge, technology and innovation in society. In an economic environment influenced by civilisational challenges, where mitigating the economic impact of unpredictable factors such as pandemics and maintaining the competitiveness of the national economy are of utmost importance, S3 and the innovation ecosystem involved in its design and implementation can play a key role.

The aim of the European Union's Cohesion Policy in **the next seven-year programming period** is to improve the resilience of Member States' economies and populations, and to ensure that Europe is not only able to cope with these changes, but is also at the forefront of new trends. The European Union has recognised that **Cohesion Policy** needs to adapt to a rapidly changing world: it needs to be simpler, more efficient and more flexible than ever before to support the competitiveness of the EU economy more effectively, while pushing Member States more strongly towards sustainability.

In the spirit of simplification, the European Commission has replaced the previous large number of thematic objectives with **five policy objectives** that respond to the modern challenges and phenomena outlined above. These policy objectives are the following: **1. Smarter Europe - Innovative and smart economic transformation.** 2. A greener, low-carbon Europe 3. A more connected Europe - mobility and regional ICT connectivity. 4. A more social Europe - implementing the European Pillar of Social Rights. 5. A Europe closer to citizens - Sustainable and integrated development of urban, rural and coastal areas through local initiatives (European Commission, 2018a).

Strengthening the competences related to smart specialisation is key to achieving Policy Objective 1 (PO1), to develop regional economies and strengthen their structural adaptability.

By using smart specialisation strategies, the European Union also sought to make cohesion policy more effective in the 2014-2020 period, building **on the experience of** the previous programming cycle, . From 2014-2020 onwards, the European Commission has stressed that a return to the original purpose of cohesion policy requires a change of attitude at EU and regional level. The European Commission wants to move Member States towards a **results-oriented** approach as an expectation, rather than a timely use of cohesion funds and compliance with administrative requirements. The means of achieving this include a stronger emphasis on subsidiarity and territoriality, and taking into account the opinions, interests and visions of the stakeholders involved in the **Entrepreneurial Discovery Process** . It is also emphasised that the aim is not simply to make full use of the available budget, but to maximise the impact of the resources used at all levels of intervention, advancing the achievement of the European strategic objectives and national specific objectives (Marcegaglia, 2017).

In the European Commission's understanding, S3 is an instrument of results-oriented cohesion policy, which provides a framework for the efficient use of EU structural and

investment funds through long-term **priorities**, capacity building in key areas, and the **conscious design of interventions and instruments** to improve competitiveness, as well as a tool for planning and measuring the impact of investment funds after their use. The S3-based development policy fundamentally appreciates the "regional relevance" of innovation**, using regional strengths and existing competences**: *"(it aims) to spread existing knowledge and technology to where it is needed, embedding it locally through smart specialisation strategies."* (European Commission, 2018a, p.95)

In both the previous programming period and the 2021-2027 period, the European Commission has made it a **binding requirement** for Member States to **develop national/regional S3.** In the 2014-2020 cycle, Member States were not allowed to claim EU funding for costs related to their specific national objectives until the elements of ex-ante conditionality were met, and the ex-ante conditionality for innovation funds was the adoption of S3. In the 2021-2027 programming period, the adoption of S3 and compliance with the associated criteria will **be an enabling condition, i.e. the criteria must be met throughout the cycle**.

In its further development of S3, the European Commission has built on the experience of the previous programming period and has set out the conditions to encourage Member States to implement S3 in **a more results-oriented way**. These conditions also support the **monitoring of developments** linked to the priorities identified in the strategies and a **more flexible management of the specialisation directions**, with possible modifications to ensure that responses to territorial and global changes and challenges can be made with the necessary speed.

2. Management system responsible for the design and implementation of S3

The criteria set by the European Commission include, in particular, the designation of a competent national or regional organisation at Member State level responsible for the **management of S3** throughout the implementation period. By Special Ministerial Order JEF/35870/2020-ITM, the **Minister of Innovation and Technology** appointed the **National Research, Development and Innovation Office** to coordinate the planning and manage the implementation of the National Smart Specialisation Strategy on **5 May 2020** (the appointment document is attached as Annex 8).

2.1. S3 planning for the 2014-2020 EU planning period

The **National Innovation Office (NIH) - the predecessor of the National Research, Development and Innovation Office - also played a key role in the design and implementation of** the **previous national smart specialisation strategy for the 2014-2020 EU planning period**, being responsible for the policy until 2018.

Since its transformation in 2015, the NRDI Office has been overseeing and managing the implementation of the domestic smart specialisation process, as set out in the previous S3 and in line with the relevant EU requirements.

The S3 priorities were designed using the Entrepreneurial Discovery Process (EDP) methodology, designed and managed by NIH. NIH has provided opportunities for a wide range of business, public administration, research and education institutions, NGOs and citizens (in short, the "quadruple helix") to participate in the planning process, as a top-down initiative but promoting bottom-up prioritisation.

During the EDP, the counties were tasked with defining smart specialisation directions involving all local stakeholders. In this process, the county working organisations were assisted by the county government offices, and the county municipalities, led by commissioned experts, were also involved in the work process.

The **EDP Key Forum, a series of workshops** with a national coverage and targeting actors from local RDI ecosystems, was held in September 2014 **under the professional guidance and participation of NIH staff**. Businesses, institutions and government decision-makers attending the events discussed and prioritised the objectives they considered important in sector-specific groups. **In total, more than 1260 participants from 19 counties took part in the first round of the programme.** This was followed by **a synthesis of the priorities identified in the workshops**. The content of the resulting draft S3 document **was presented by NIH in another round of county consultations in each county**. The second county-wide consultation was open to those who had participated in the first event or had further suggestions for improvement. The draft strategy **was also** shared for comments **online**, on a dedicated website to ensure effective social communication. **The NIH website** provided detailed information on the background of the strategy, the need for it and how to prepare it. It served as an alternative way (in addition to workshops) for stakeholders to directly share their opinions and ideas, the **local strengths and specialisation directions** they considered to be decisive, **and the areas to be developed**. This was done through the use of an **online questionnaire** available on the website, including both open and closed questions, to **ensure a more complete Entrepreneurial Discovery Process**. **537 fully completed questionnaires and a total of nearly 700 questionnaire suggestions were received during the consultations**, which contributed to the first draft of the strategy. Stakeholders **could also send their views and preferences to NIH by email**.

The participants of the regional S3 working groups were representatives of universities, research institutes, sectoral platforms, clusters and enterprises from the counties of the regions and from the Central Hungary Region. The county S3 working groups were made up of representatives of government agencies, academic institutions and social organisations, economic actors (including investors) and invited experts.

The central S3 working group, run by NIH , also invited other experts and organisations from the quadruple helix. The smart specialisations were developed on the basis of the opinions expressed at the county event and the opinions received, in the light of the research priorities and county specialisations, and were also discussed by the National Governing Board (NIT) and the S3 Inter-ministerial Working Group, composed of delegates from all the ministries and OP managing authorities concerned. The former was a professional forum bringing together the S3 working group, the expert panel and the heads of the county working groups involved in the

national S3 planning, while the latter was responsible for the governmental monitoring of the planning process, providing expert-government feedback and preparing for implementation, in line with the current Operational Programmes.

In addition to the national consultation, there was regular communication with EU representatives and between ministries during the development of the strategy.

The S3 for the previous cycle was adopted by the Government in 2014 with the Government Decision on the adoption of the National Smart Specialisation Strategy (S3) and on Hungarian participation in major research infrastructure projects included in the Roadmap of the European Strategy Forum for Research Infrastructures (Government Decision 1640/2014 (XI. 14.)).

NIH, and as its successor the NRDI Office, has also been a key player in the implementation of S3 as the administrator of the domestic RDI funding programmes: in addition to EU funding, the most important domestic public source of funding for development is the National Research, Development and Innovation Fund (NRDI Fund) managed by the NRDI Office. **In the NRDI Office, the required professional competences are available to implement S3**, coordinate its monitoring and evaluation tools, and the Office has adequate resources to measure and provide feedback on performance in achieving the objectives of the strategy, maintain the EDP and coordinate the planning of appropriate interventions.

The **planning and management of S3 for 2021-2027** will require the incorporation of collaborative elements from the **Entrepreneurial Discovery Process** (EDP), so stakeholder engagement is crucial. There is also a need for continuous and effective cooperation between government actors, as **the objectives of** S3 **cut across several areas** within government, with coordination between economic development programmes and policy actors involved in resource coordination being of particular importance. Cooperation with the **European Commission** 's unit responsible for S3 is also essential to implement the S3 principles (S3 Platform, 2020). In addition, cooperation between **national and regional levels** is essential to achieve a good management system. The management system responsible for the design and implementation of S3 has been designed according to these principles.

2.2 The institutional framework for S3 planning

The requirements for the implementation, monitoring, ex-ante, mid-term and ex-post evaluation and review of the national strategic plan documents are set out in Government Decree 38/2012 (III. 12.).

The Hungarian **S3 is a medium-term strategic plan document, as it sets out a comprehensive, horizontal set of social, economic and environmental objectives for a seven-year implementation period**. The Minister for Innovation and Technology is responsible for coordinating the preparation of S3, which is adopted by the Government.

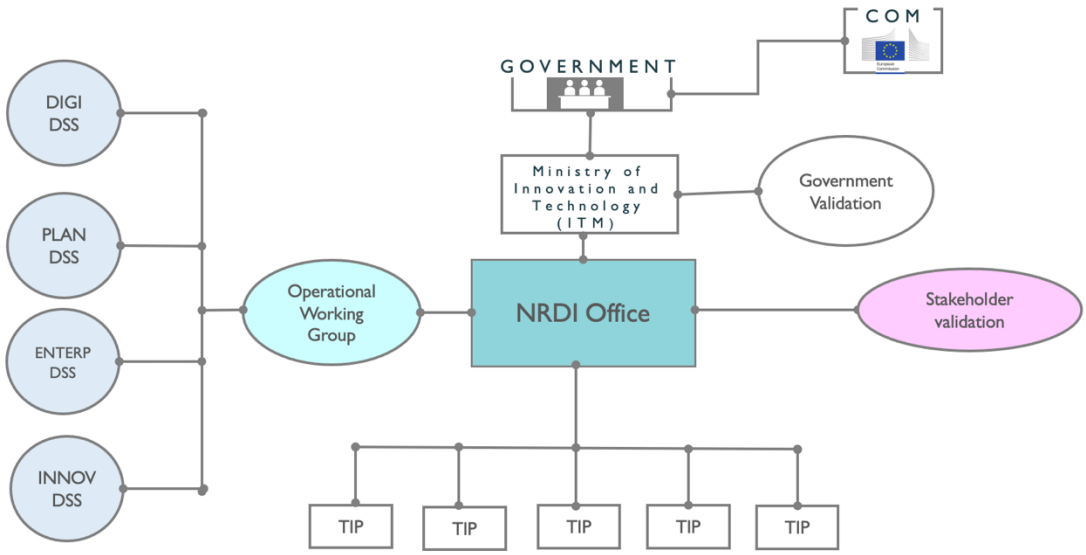
The National Research, Development and Innovation Office is responsible for planning S3 for 2021-2027. In this role, the NRDI Office coordinated the work of the organisations involved in the planning process and provided methodological and quality guidance.

The National Innovation Forum (OIF)

The institutional framework for S3 planning is based on the systematic implementation of the EDP. In addition to the experience of the S3 EDP for 2014-2020, the National Innovation Forum (OIF) held between February and March 2019 was an important precursor. **In developing the objectives of the National RDI Strategy 2021-2030 and in designing the NRDI Office's funding programmes for 2019, we drew heavily on the experiences and opinions of participants in the OIF, which took place between February and March 2019 in 25 locations and attracted more than 2,500 stakeholders.**

The national consultation, organised by the ITM and the NRDI Office, with the participation of the Hungarian Chamber of Commerce and Industry as a key professional partner, involved local and regional businesses, knowledge centres and professional organisations. The aim of the series of events, which involved all counties and was held in broad cooperation, was to lay the foundations for Hungary's new innovation ecosystem and to assess the proposals and needs arising from the renewed RDI system, the new RDI Strategy and the funding schemes. The **events were also accompanied by an online consultation, where** the stakeholders of the RDI system could express their views on the main objectives of the National RDI Strategy 2021-2030 and the planned calls for proposals.

Thus, the domestic RDI policy does not only apply the bottom-up methodology to S3 planning, the also extended the principles of EDP to other areas of policy making: the OIF with a horizontal focus can be considered as part of the EDP.



1. Figure: The institutional framework for the S3 planning process[2]

[1] Deputy State Secretariats in the fields related to Cohesion Policy Objective 1 (PO1): Deputy State Secretariat for Digitisation, Deputy State Secretariat for Development Planning and Legal Affairs,

The Territorial Innovation Platforms (TIPs)

Territorial Innovation Platforms (TIPs): TIPs are based at local university centres and their S3-related activities are coordinated by the NRDI Office. At the Territorial Innovation Platforms events from November 2019, stakeholders **identified the strengths of the region, shared their ideas on priorities to be developed and the experiences of the previous S3 cycle**.

TIPs aim to build on the university knowledge base to create regional organisations across the country that provide both an opportunity for domestic actors to learn directly about innovation policy directions, and to develop and strengthen cooperation between members of the local innovation ecosystem and create new professional foundations.

Strengthening the links between actors - policy makers, higher education and research institutions, businesses and professional organisations - at local level, following the Smart Specialisation Strategy, is key to the future performance and competitiveness of the domestic innovation ecosystem, enhancing the innovation capacity of a region. Territorial Innovation Platforms are a new approach to information flow, knowledge transfer, cooperation and networking.

Deputy State Secretariat for Economic Development, Deputy State Secretariat for Innovation. COM: European Commission.

TIP participants:

- knowledge base representatives: higher education institutions, research institutes or competence centres set up in cooperation with them;
- knowledge-dissemination organisations: platforms, clusters, technology transfer organisations, incubators;
- professional NGOs, professional interest groups;
- entrepreneurs: start-ups and spin-offs, innovative SMEs with significant research portfolios; large companies with significant research portfolios; investors: venture capitalists, business angels, mentors;
- municipalities.

The Entrepreneurship Consultation System

The EDP linked to S3 includes, in addition to the TIP network of the RDI domain, a series of consultation events and survey tools for target groups organised by the government's enterprise development and ICT policy areas, such as the Entrepreneurship Consultation System.

Entrepreneurship Consultation System: a system of consultative elements and queries to support the implementation of the Strategy for Strengthening Hungarian Micro, Small and Medium Enterprises 2019-2030 (hereinafter: SME Strategy), which regularly probes the opportunities, difficulties, ideas, needs and opinions of enterprises. The national consultation process is being carried out in cooperation with business organisations and the Hungarian Chamber of Commerce and Industry. The consultation will be accompanied by a representative survey of entrepreneurs in the form of an online questionnaire, with a complementary telephone enquiry. The consultation is repeated annually and is linked to the national consultation.

The consultation is driven by current events in the economy and policy. Accordingly, the 2020 series of consultations will focus on EU planning for 2021-2027 and the impact of the pandemic on businesses, and its results will feed into the preparation of S3.

The Enterprise Development Council (VfT) is another element of the consultation system. As a government advisory body, the activities of the VfT are regulated by Act XXXIV of 2004 on small and medium-sized enterprises and on support for their development. The VfT participates in the development of the SME development strategy, proposes technical programmes and measures for the implementation of the SME development strategy and gives its opinion on technical programmes for the development of SMEs. For details on the different elements of the EDP, see chapters 3.2 and 3.3 on prioritisation.

PO1 Working Group

PO1 Working Group: a forum for cooperation between **government policy areas** (enterprise development, digitisation, EU planning, RDI) **involved in** the implementation of cohesion policy objective 1 (PO1). The strategy document has been prepared taking into account the points raised in the regular, iterative technical and methodological discussions of the working group. The collaboration ensured that professional interfaces were explored.

S3 Stakeholder consultation

S3 Stakeholder consultation, stakeholder involvement in the professional validation of the strategy: the business sector, academia, civil society, including horizontal stakeholders' organisations, provide their professional opinions and validate the priorities identified in the EDP. During the S3 planning process, they support the steps of the EDP, proposing a review of smart specialisation directions and priorities based on the needs of the stakeholder groups they represent. As part of the professional validation process, the National Council for Telecommunications and Information Technology (NHIT) and the Enterprise Development Council will give their opinions on the strategy document.

Administrative consultation ("inter-ministerial validation")

During the planning of S3, the priorities identified as a result of the situation analysis of the smart specialisation directions and the EDP will be validated by delegates from all relevant ministries and the relevant resource coordination bodies for the 2021-2027 period, in the framework of an administrative consultation that will serve as an inter-ministerial validation.

The National Science Policy Council (NTT)

NTT is the opinion-giving body supporting the Government's RDI activities (RDI Act, 2014) and exercises supervisory rights over the operation of the NRDI Fund. The NTT is the Government's science policy advisory body, in this capacity it provides opinions on S3 documents (RDI Act, 2014, § 10/B d), and also provides opinions on reports and evaluations prepared for the Government in the course of monitoring the strategy.

2.3 Implementation of S3 and institutional arrangements for monitoring

To achieve S3 effectively, our aim is to create a stable institutional system that is transparent to all actors in the "quadruple helix" and plays an effective management role in the national and regional R&D and innovation system.

As the process of smart specialisation does not end with the adoption of S3 as a strategy document by the government, the implementation of the Strategy needs to be carried out and monitored in a project approach. The evaluation and monitoring system of S3, the local actors involved in its implementation, the changed economic situation due to the pandemic, but also the experience of the implementation of the operational programmes of the 2014-2020 EU programming cycle, require continuous review, continuous improvement and regular feedback.

To perform these functions, it is appropriate to develop a management structure that keeps the basic elements of the institutional structure of S3 planning, ensuring the maintenance of established communication channels and professional networks.

The implementation of the S3 plan document can be considered as project implementation, since the task has all the attributes a project can have. Accordingly, the implementation management system is presented with a project management approach.

The details of the implementation of the S3 project, the roles and responsibilities of the different actors will be set out in the forthcoming Project Charter (PAD).

The project implementation organisation

The bodies involved in the S3 implementation organisation ensure the implementation of S3 at three levels:

1. Strategic (professional) level
2. Operational (project management) level
3. A Stakeholder Network that ensures the continuation of the EDP and continuous feedback from stakeholders.

1. Strategic level

The strategic level of management provides the sectoral policy representation needed for implementation. The above-listed bodies provide the means of implementation and the government powers that can support effective implementation (e.g. EU development policy planning).

The **High Level Support Body (MTT)** is the supreme body of the strategic (technical) side of the management system**.** MTT takes decisions on the project at strategic level.

Within the S3 management system, the MTT functions are carried out by the National Science Policy Council as the highest level science policy advisory body to the Government. Based on Chapter II/A, Section 10/B, paragraph e) of Act LXXVI of 2014 on scientific research, development and innovation, NTT gives its opinion on proposals requiring government decisions regarding the implementation and monitoring of S3 (RDI Act, 2014).

S3 Steering Committee (IB): exercises direct control at the strategic level of the project.

Members of the IB:

- the S3 project leader,
- the Deputy State Secretaries responsible for the first policy objective (PO1),
- the Managing Authority (MA) of the Operational Programme relevant for the implementation of S3, and
- the State Secretariat for European Union Development Planning, and
- the government department responsible for monitoring and evaluating EU funds

The tasks of the IB:

- The IB delegates are responsible for coordinating S3-related tasks within the relevant state secretariats.
- The S3 Project Office prepares a progress report to the IB on the implementation of the smart specialisation logic and informs the IB of the decision points that have emerged from the stakeholder network's suggestions.
- The IB reviews the comments from the regional and professional levels of the stakeholder network, the recommendations from the professional oversight and management level - and prepares and finalises the progress report on the strategy for the MTT.
- The IB may make policy proposals to the MTT for the monitoring period and, if necessary, propose revisions and modifications to the objectives and priorities of the Strategy based on the experience gained from implementation. The MTT may, following its decision, instruct the IB to develop the details of the operational implementation of specific measures at sectoral level.
- Through its activities, the IB contributes to the maintenance of the EDP and to the feedback and integration of the lessons learnt from the implementation of the Operational Programme into the smart specialisation system. In addition, it provides support for specific steps in policy design and implementation.
- The IB will ensure that the necessary decisions are taken, the appropriate resources are available and the operational level of the project is supervised within the allocated project framework (cost, time, scope).

S3 Project Leader: the project leader responsible for the achievement of the objectives of the S3 plan document, the progress of the implementation of the strategy, and the operation of the S3 management system. It acts as a "bridge" between the strategic level and the operational level of S3, ensuring effective cooperation between the actors involved in implementation. During the implementation period, the project leader will be appointed by the NRDI Office, the body responsible for managing the implementation of S3.

2. **Operational level**

The operational level bodies carry out the practical tasks of monitoring the implementation process and running the project management of S3. The operational level of the management system liaises with the S3 network of experts and stakeholders, including

- **Territorial Innovation Platforms,**
- **the Entrepreneurial Consultation System, and**
- **external experts involved in monitoring the strategy.**

The TIP initiative strengthens the links between actors at local level - higher education institutions, research institutes, businesses, professional organisations, policy makers - and promotes information flow, knowledge transfer and cooperation in the field of research and innovation, following the logic of the "quadruple helix". Higher education is a key institution in the innovation system, so university-based platforms contribute to strengthening cooperation between actors, while increasing the competitiveness of SMEs. In implementing the strategy, TIPs represent the regional level of cooperation and support the sharing of data, information, experience and dissemination of results.

The head of the operational level is the **Head of the S3 Project Office**, who is responsible for coordinating the management processes involved in implementing the strategy. Tasks:

- is directly linked to the work of the Steering Committee at the strategic level,
- manages the work of the S3 Project Office,
- liaises with the European Commission's expert level responsible for S3,
- reports on the work of the operational level to the S3 project leader.

The S3 Project Office is responsible for the operational management of the project and for the tasks requiring project assistance for the implementation of S3. The primary operational unit and function of the S3 management system is to ensure the progress of implementation.

The tasks of the S3 Project Office, established within the National Research, Development and Innovation Office:

- Oversees and manages the implementation of the domestic smart specialisation as set out in this strategy (and as required by the European Union), as well as the full dissemination and feedback of the results to the actors as shown in Figure 10, in particular policy makers and decision makers.
- Liaises with other regional, national and international institutions involved in S3, including the European Commission and the S3 national stakeholder networks, such as the Territorial Innovation Platforms.
- Ensures that S3 documentation tasks are carried out, manages procurement, ensures consistent visibility of project status and documentation to managing and monitoring bodies and organises events related to socialisation and the EDP.
- Prepares reports for the entities ranked higher in the management system hierarchy and is responsible for the preparation of the IB meetings.

PO1 working group

The operational level of the S3 project organisation includes the PO1 working group, which provides technical input and validation to the project management and the Steering Committee.

The remit of the Task Force is linked to all priorities of S3 and provides the tools and environment to support the effective implementation of the target system.

Tasks:

- identify proposals for improving the regulatory and business environment to support the implementation of S3,
- ensure coherence with the action plans of the relevant government strategies,
- represent the operational level of government policy areas related to PO1.
- continuously monitor progress towards the S3 targets and indicators.

3. **Stakeholder network**

Stakeholders will continue to play a major role in the implementation of the S3 strategy as a continuation of the EDP.

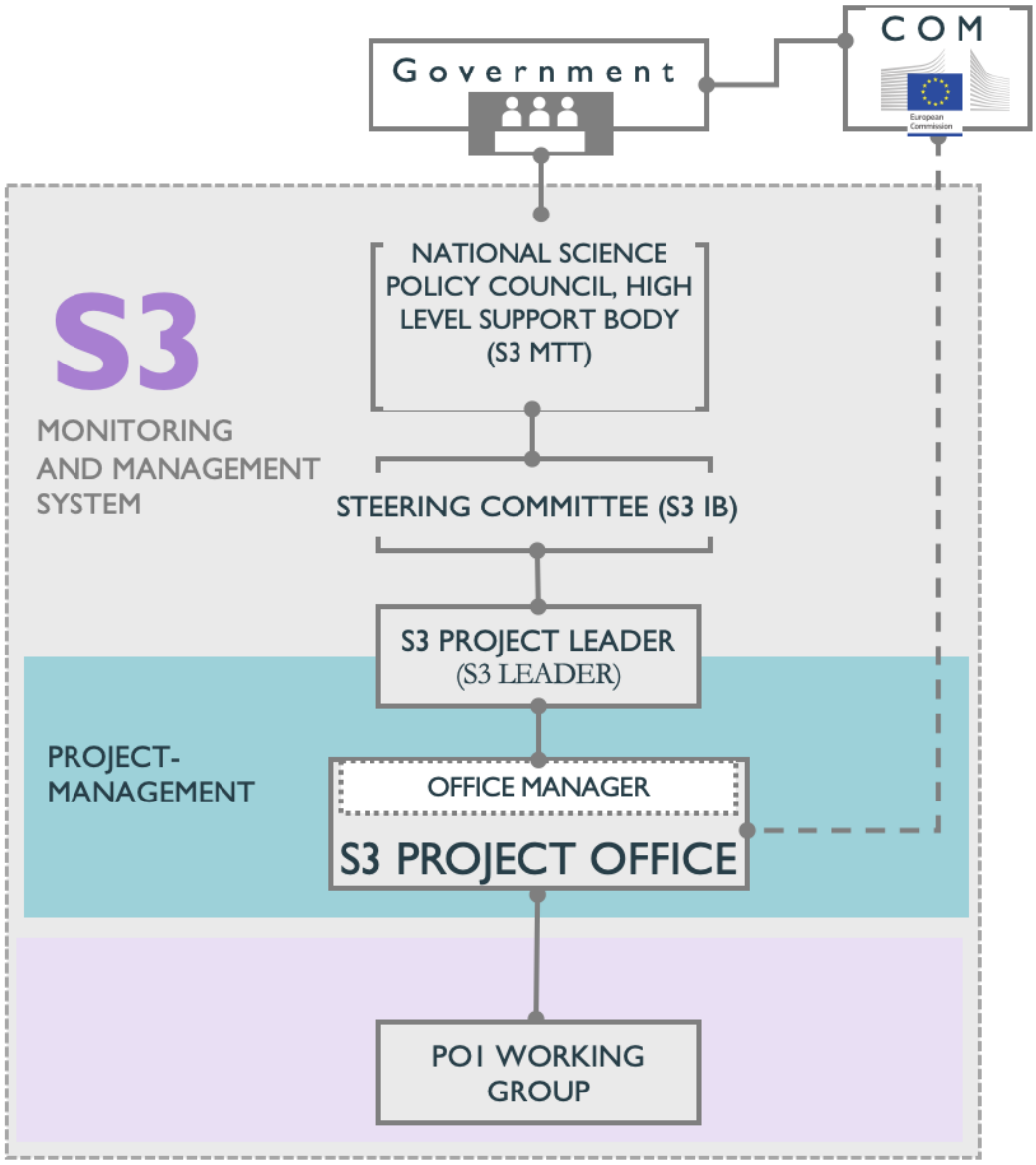
The EDP has not only been given a major role at the beginning of the S3 planning, but also has important functions during the implementation of S3.

The stakeholder network is made up of Territorial Innovation Platforms, organised on a territorial basis (at regional or county level) and operating at regional level. These platforms and expert groups will participate in the work of the S3 working groups and ensure that the principles of the EDP are continuously applied during implementation.

Territorial Innovation Platforms: The coordination and organisation of the local implementation of smart specialisation is carried out by the Territorial Innovation Platforms (TIPs), similar to planning. The TIPs are responsible for ensuring that S3 goals and tasks are embedded locally, and are regularly consulted with stakeholders as part of the EDP. They contribute to the management of S3 by providing information to the S3 institutional actors for regular monitoring and evaluation activities, which can lead to a review of the implementation of S3, update priorities and refine interventions.

In order to ensure effective communication and transparency with the stakeholder network, the NRDI Office's S3 website will be renewed (www.s3magyarorszag.hu). The aim of the website is to provide information on the planning and implementation of the strategy and related professional programmes and events, and to involve interested parties in the monitoring process. The website:

- present relevant national planning documents
- provides a platform for comments to monitor the implementation of the national S3;
- provides up-to-date information and direct contact between planners and local actors.



2. *Figure: Institutional arrangements for S3 implementation and monitoring*

3. The Entrepreneurial Discovery Process

The **Entrepreneurial Discovery Process** (EDP) is an interactive, bottom-up process involving actors from different sectors (the so-called "**quadruple helix"** model (Carayannis, et al. 2009): academia[3], industry, government and civil society) express what they see as market niches and what they would need to fill them, and identify potential strengths and opportunities for policy makers. Local businesses have an important role to play in developing technology and identifying market opportunities (Foray, 2016). A set of goals and tools, developed in consideration of the needs and challenges of the local economy, identifies **potential strengths**

and competitive advantages for the structural transformation of the economy (Mariussen, et al., 2018). An important message is not to rely primarily on the university or research institute base, however world-class, but to rely mainly on the strengths that **local businesses need**, as the main goal of S3 is to strengthen local business/industry expertise, preferably in cooperation with local knowledge bases (Lengyel, 2018).

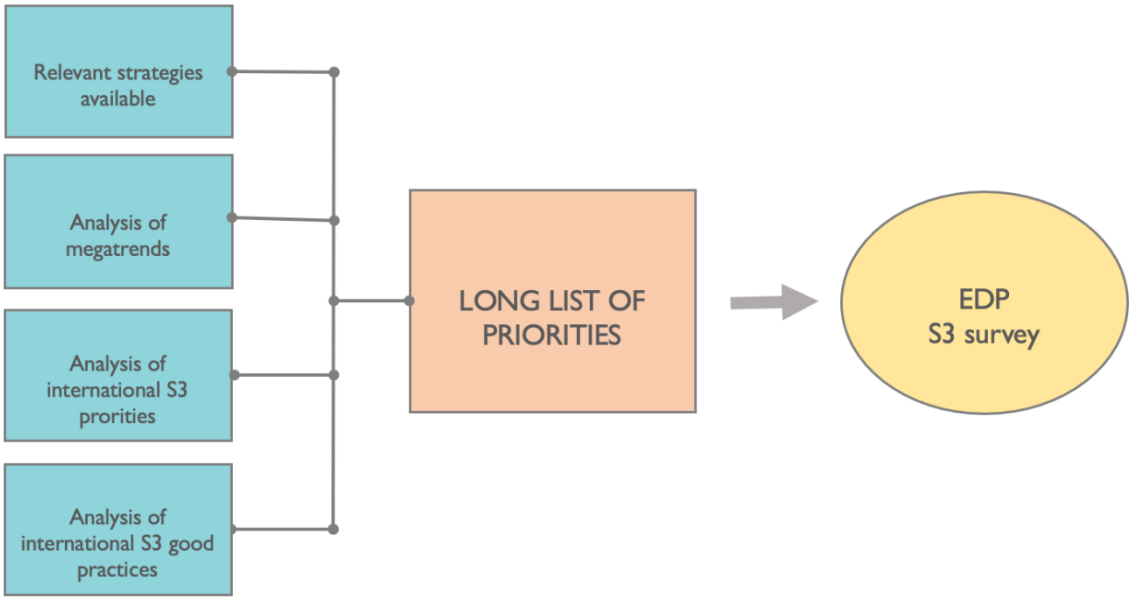
When developing S3, the existing business (entrepreneurial) knowledge base and the RDI background should be used to consider how businesses can create **commercially viable** knowledge products and innovations, especially in view of future market opportunities. Ongoing consultation is key in the EDP to ensure that stakeholders identify with the **jointly agreed objectives and** build collaborative partnerships in **a conscious, bottom-up way** (NRDI Office, 2019).

However, it is necessary to indicate that the innovation activity of SMEs, like that of enterprises as a whole, covers, from a development policy point of view, any activity (whether or not it has a scientific novelty content) that results in the renewal or significant transformation of the product/service structure or business processes of enterprises. In other words, innovation activity in the context of business process innovation includes the renewal of production processes, ICT, marketing and sales, business development, management, distribution and logistics. (Oslo Manual, 2018).

3.1 The long list of priorities

An analysis of the implementation of S3 in the 2014-2020 programming period[4] (NRDI Office, 2019) has shown that, **compared to the previous cycle, the distribution of RDI funding between priorities needs to be better targeted**. Another important finding was that **the priorities were too broad, without defining real specialisation directions**. The EDP for the planning of S3 for 2014-2020, although in all respects in line with the guidelines laid down by the European Commission, did not achieve the real goal of S3: it **did not steer development towards real specialisation**.

For this reason, **the EDP has been managed differently in the current strategic planning**. We have analysed the relevant national strategies, the main global megatrends (RDI Strategy 2020, pp. 8-10) and the priorities and good practices for S3 in different countries (Annex 2). In view of the above, we have developed a so-called **"long list" of priorities**, which **identify the potential socio-economic-technological strengths and challenges for Hungary**. The long list is not sector-based (although some sectors are included indirectly or directly), but is strongly technology-focused and **problem-oriented, reflecting potential priorities across sectors**.



3. Figure: Developing the long list of priorities

In order to achieve bottom-up consultation, the **long list of specialisations was commented by stakeholders as part of the EDP**. **Taking into account** their **local strengths and areas for improvement, and making use of a nationwide survey (S3 online survey),** we carried out the first step of the EDP in the strategy development[5]

3.2 Elements of the EDP, method for setting priorities

Territorial Innovation Platforms

The EDP in Hungary is based on the **Territorial Innovation Platforms (TIPs)**, which are established at the key higher education institutions in the region and bring together the members of the regional "quadruple helix". The principles and objectives of the Smart Specialisation Strategy were presented **at the plenary speeches** of the President and Deputy President of the NRDI Office at the **national events** of the TIPs (Miskolc, Debrecen, Győr, Szeged, Pécs, Budapest, Veszprém and Gödöllő). Afterwards, during a **professional round table** discussion, local actors shared their experiences with the implementation of the previous strategy and the results of regional cooperation, and jointly analysed the strengths, opportunities and areas for development of the region. Details of the events are given in Annex 3.

At the programme stations, participants had the opportunity to **consult with** members of the NRDI Office's S3 working group and to fill in the S3 online survey on the spot **at the** NRDI Office's S3 **stand**.

The **S3 survey** is a key element of the EDP. The survey was also available on the NRDI website **between 12 November 2019 and 12 March 2020.** In order to reach the widest possible range

5The long list is set out in detail in Annex 4.

of RDI actors, the NRDI Office also requested the support of **professional organisations** of sectoral actors, local (regional) chambers of commerce and industry, Territorial Innovation Platforms, universities, local governments of county-level cities in completing the online survey and sending the survey forms to their member organisations. **Applicants who received a grant** from the NRDI Fund received the questionnaire in a letter from the President, and the announcement was published in the **NRDI Office's newsletter and on its website**.

During the period of data collection, the Office's **events** (e.g. Conference on University & Business Cooperation in Central Europe **(CUBCCE**), 5-6 December 2019, dedicated S3 workshop) also raised awareness of the importance of smart specialisation and the opportunity to express their views. A total of **2030 respondents** started to fill in the survey, and **829 respondents answered all questions**.

The Entrepreneurship Consultation System

Part of the EDP is the **Entrepreneurial Consultation System**, which consists of two elements.

The first element is a series of consultations across the country in the form of regional events. The consultation is held annually, and its topics are determined by current events in the economy and policy. The 2020 theme is the EU planning for 2021-2027, which will be channelled into the S3 strategy from the enterprise development side. ***In view of the COVID-19 pandemic, the series of consultations was launched in June 2020.***

The other element is a representative online survey of entrepreneurs complemented with a telephone enquiry. The consultation is repeated annually and is linked to the national consultation (responses are currently being received).

The Enterprise Development Council and the National Telecommunications and Information Technology Council

The Enterprise Development Council (VfT) and the National Telecommunications and Information Technology Council (NHIT) both contribute to the consultation process.

The activities of the VfT as a government advisory body are governed by Act XXXIV of 2004 on small and medium-sized enterprises and on support for their development. The VfT participates in the development of the SME development strategy, proposes technical programmes and measures for the implementation of the SME development strategy and gives its opinion on technical programmes for the development of SMEs.

The current operation, tasks, competences and core activities of the NHIT are defined in chapter "The National Communications and Information Technology Council" of Act CLXXXV of 2010 on media services and mass communications. The NHIT is currently a five-member body, whose chair and vice-chair is appointed by the Prime Minister. Two of its members are delegated by the Media Council and one by the Hungarian Academy of Sciences.

Partnership and social consultation in the field of digitisation is also part of the process.

In the field of digitisation, a broad partnership and public consultation has been carried out on the comprehensive long-term sectoral document, the National Digitisation Strategy (NDS) 2021-2030, coordinated by the Ministry of Innovation and Technology (ITM):

- The main directions of the NDS, especially on innovation aspects, were presented at the 2020 Territorial Innovation Platform (TIP) events (in Veszprém and Gödöllő).
- The main objectives and actions of the NDS have been presented by the ITM at several digitisation or IT events (both online and offline), including in particular the Information Society Parliament in June 2020.
- On 25 June 2020, a professional consultation and forum was organised by the ITM, where representatives of the main Hungarian IT professional and civil society organisations and relevant governmental actors - with the participation of 39 participants - presented their proposals on the NDS and the digital future of the country. The ministry has amended and supplemented the Strategy in the light of what was said there.
- Subsequently, the NDS online partnership consultation took place on kormany.hu between 30 June 2020 and 13 July 2020. A total of 43 different entities (professional and interest groups, businesses, educational and civil institutions, private individuals) submitted 368 comments to this online consultation. The NDS has been amended again by processing all comments and incorporating the relevant ones.

The GMR model

In order to find out the **impact of the interventions on each sector**, the **GMR** (Geographical, Macro and Regional) **model developed by the Regional Innovation and Entrepreneurship Research Centre (RIERC) of the University of Pécs** was used. More details on the EDP are given in the chapter on priority setting.

4. Figure: Territorial Innovation Platforms (TIPs) in Hungary established in the first phase of the EDP (November 2019 - February 2020)

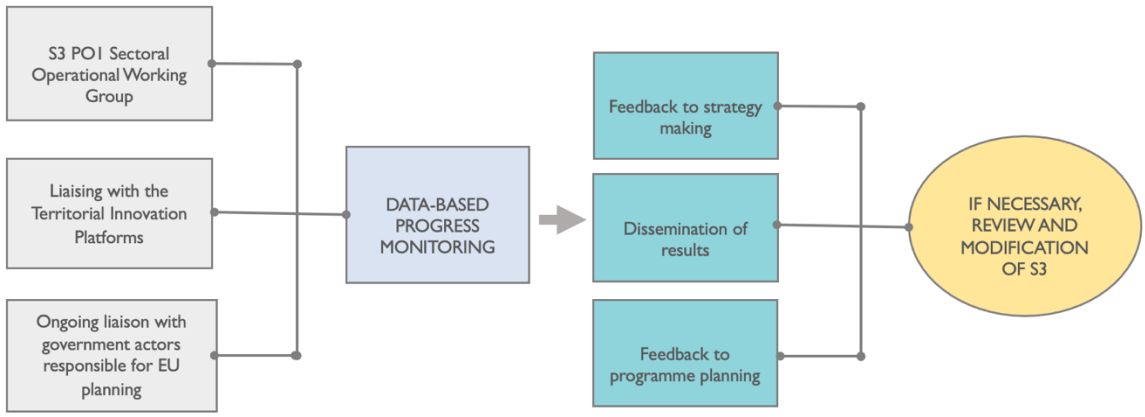
3.3. The process of validating priorities

The professional validation of the "short list" of priorities will be carried out through a **consultation with the relevant stakeholders**. During the consultation, stakeholders will comment on the document in the form of a questionnaire based on the summary of the strategy, with a focus on the conditions for the implementation of the enabling condition, in particular the established domestic priorities.

Technical validation is followed by consultation with the public administration, i.e. the **governmental validation**, where the sectoral policy planners comment on the priority list. Once the validation processes are completed, national priorities and specialisations will be fixed.

The monitoring of the implementation of smart specialisation will need to be significantly strengthened compared to the 2014-2020 cycle. **The logic of economic development requires continuous monitoring and evaluation,** which is also emphasised in the implementation criteria of **S3 as an enabling condition**.

Tracking smart specialisation with an EDP focus



5. Figure: Implementing the smart specialisation strategy

As with planning, **S3 is implemented through** an ongoing **dialogue**. Ongoing cooperation takes place at multiple levels: with the TIPs as intermediary organisations, with the governmental actors responsible for planning, with the PO1 working group and with experts from the European Commission. The data and information will be collected and channelled through the EDP stakeholders. The regular, data-driven monitoring process for S3 is described in more detail in the chapter on monitoring.

In addition to the presentation of **progress**, emphasis will **also** be placed on **providing feedback** to those responsible for strategy formulation and programme design, as well as to the actors of the "quadruple helix". If monitoring results indicate the need to revise the **strategy paper or the priority list**, it **may be amended, with a duly justified reason**.

4. Setting S3 priorities

A key objective of S3 is to select priorities that build on local strengths to stimulate knowledge creation, knowledge flows and use of knowledge in line with Hungary's RDI Strategy 2021-2030. Ultimately, S3 also contributes to the vision set out in the RDI Strategy ("A high value-added, knowledge-based, balanced, sustainable economy and society in all areas of the country") and to the overall objective of the National Digitalisation Strategy (NDS), which states that "Hungary should make coordinated efforts to promote digitalisation in the fields of economy, education, research and development, innovation and public administration, which, also by international standards, will contribute significantly to improving the country's competitiveness and the well-being of its citizens".

The SME Strategy is also an important basis for the definition of S3 priorities, which considers it important to develop an internationally successful, dynamic Hungarian entrepreneurial community and to strengthen the role of a broad range of small businesses that provide a livelihood for many people and contribute to society. These two overarching objectives are underpinned by three measurable secondary objectives: increasing the productivity of SMEs, increasing the value added they produce and increasing their export capacity.

The **choice of priorities** is mainly based on

- **the EDP (Enterprise Discovery Process)** - *(direct social feedback),*
- **the GMR model** prepared by the Regional Innovation and Entrepreneurship Research Centre of the University of Pécs (PTE–RIERC) (Varga, Szabó and Sebestyén, 2020a) - *(incorporating the expected economic and innovation spill-over effects of the priorities into the process)* and
- **S3 data** *(experience*) in relation to the 2014-20 programming cycle.

We have also incorporated information gathered through policy consultations on S3 and drawn on the European Commission's S3 planning recommendations.

4.1. The steps of setting priorities

The **national priorities were developed in the following 6 steps**:

PRIORITISATION STEPS	RESULT
Prioritisation phase 1	
1. In question 3 of the S3 survey, the priorities indicated by the respondents are aggregated and a narrower list of priorities is selected.	TOP 20 priority list (long list narrowed down).
2. Confirmation of the results of step 1, supplemented as necessary with the responses given in the open text fields in relation to the local, regional strengths identified in question 6 of the S3 survey (see Annex 4).	Confirmation of the TOP 20 priority list, no additions were justified.
3. Establishment of a sectoral priority list based on the GMR model.	Developing a TOP 15 sector list.
4. Harmonisation of the results of the survey and the GMR model at county level.	Identifying county-level matches from the two data sources - few matches were identified.
5. Choosing priorities	Based on the first phase, a first list of priorities is established. To define the content of the priorities, we have taken into account aspects of the three policy areas (RDI, enterprise development, digitisation) related to Policy Objective 1 (PO1) and the results of the EDP.
Prioritisation phase 2	
6. Social consultation and government validation of priorities	Establishing final priorities.

1. Table: The steps of prioritisation

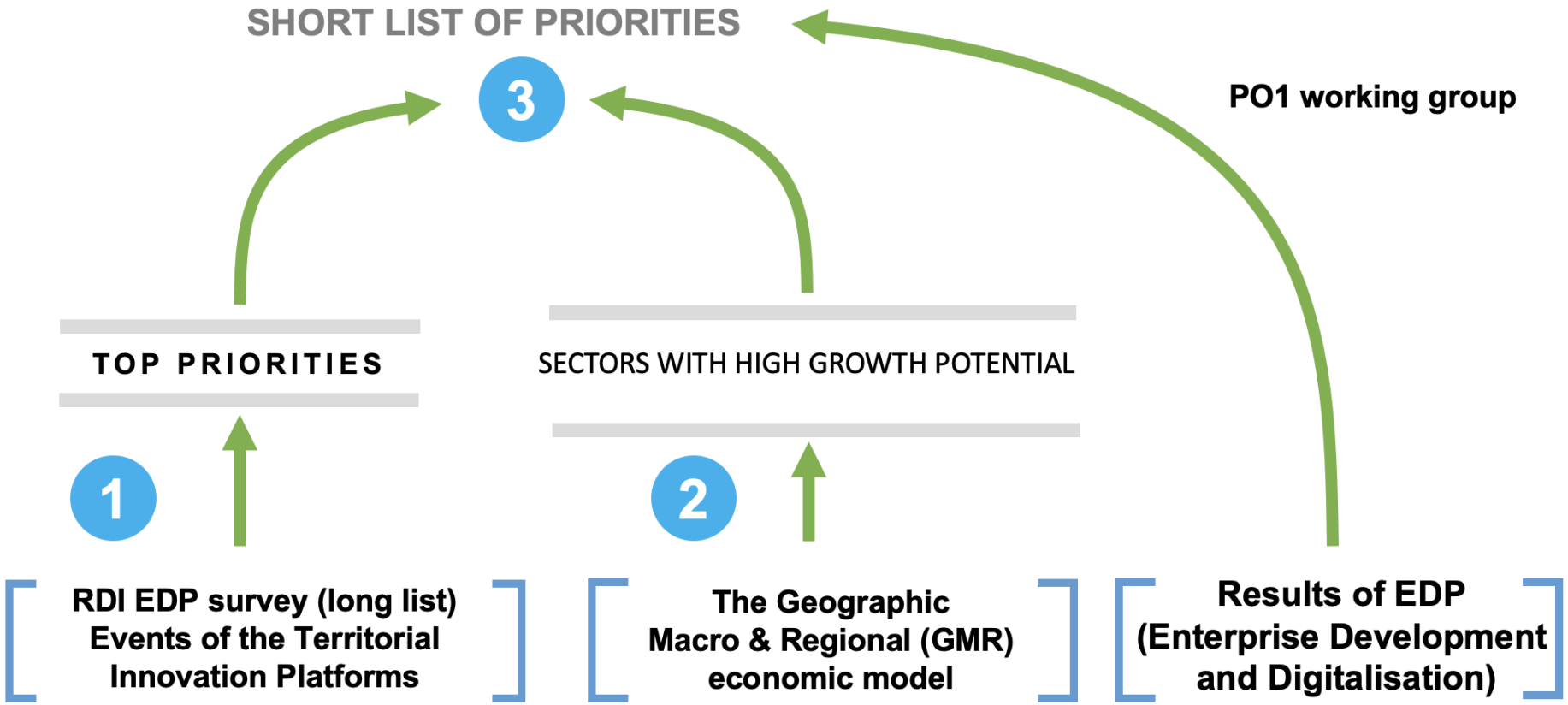
The **methodological background** for the prioritisation is provided by the concept of Smart Specialisation as a new type of policy instrument developed by **Dominique Foray** (2016) and its steps.

The guidelines suggest three steps in the prioritisation process:

a) identifying the importance of technologies,
b) economic growth, and
c) identifying the potential for knowledge diffusion.

Point (a) is implemented in steps 1 and 2 of the Hungarian S3 prioritisation process. The survey results were used to determine the national and regional importance of the priorities (i.e. the different technologies). The result is the TOP 20 list of priorities.

Points b) and c) of Foray's guidance correspond to steps 3 and 4 of the prioritisation process, whereby the industries to be supported were selected using the macro model, based on their growth effects and knowledge flow capacities. The result is the TOP 15 list of sectors.



6. *Figure: The prioritisation process*

4.2 Processing the results of the survey and the GMR model

1. **step: aggregation of the priorities identified in the S3 survey and selection of a shortlist of priorities**

The third question of the S3 survey can be directly integrated into the prioritisation process:

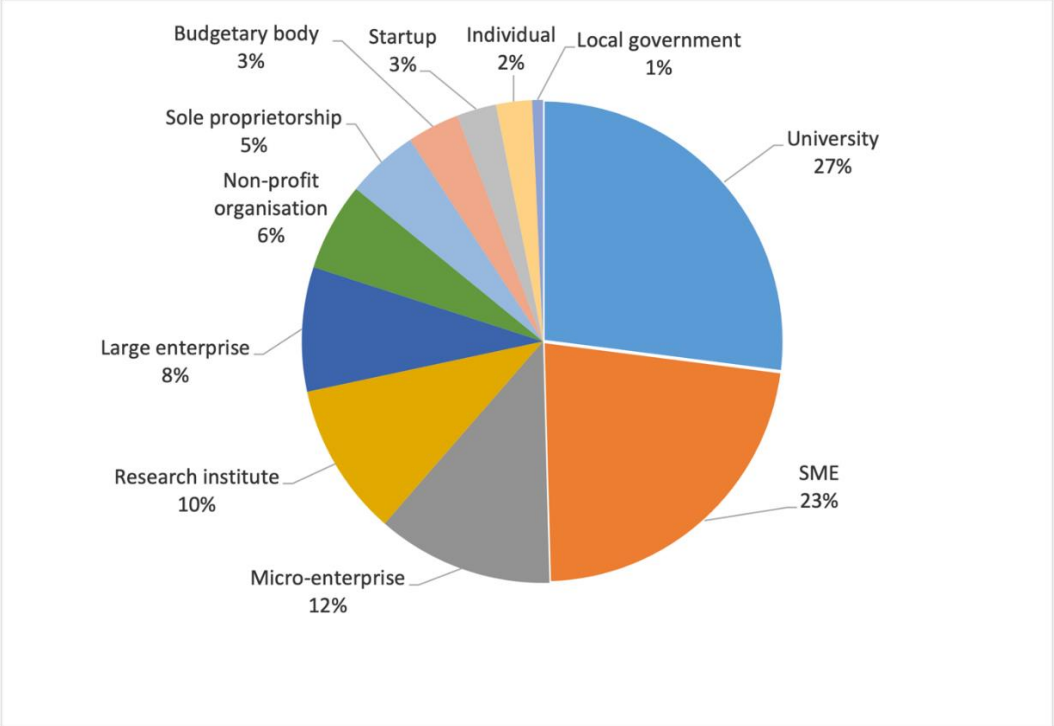
"3.: Please select the area(s) where your organisation plans to invest or develop between 2021-2027."

The aim of the question was to assess the scientific and technological areas that will characterise the domestic RDI system to the greatest extent in the next few years. On the one hand, respondents were free to choose from the pre-defined priorities, and on the other hand, they could indicate additional ones in the last field if they did not find the pre-defined list complete. The pre-defined priority list is provided in Annex 4, while the process of compiling the long list is detailed in the chapter on EDP.

A respondent could choose more than one priority in a questionnaire, these are called "nominations". The number of nominations is therefore a multiple of the number of respondents.

Main data from the database resulting from the survey:

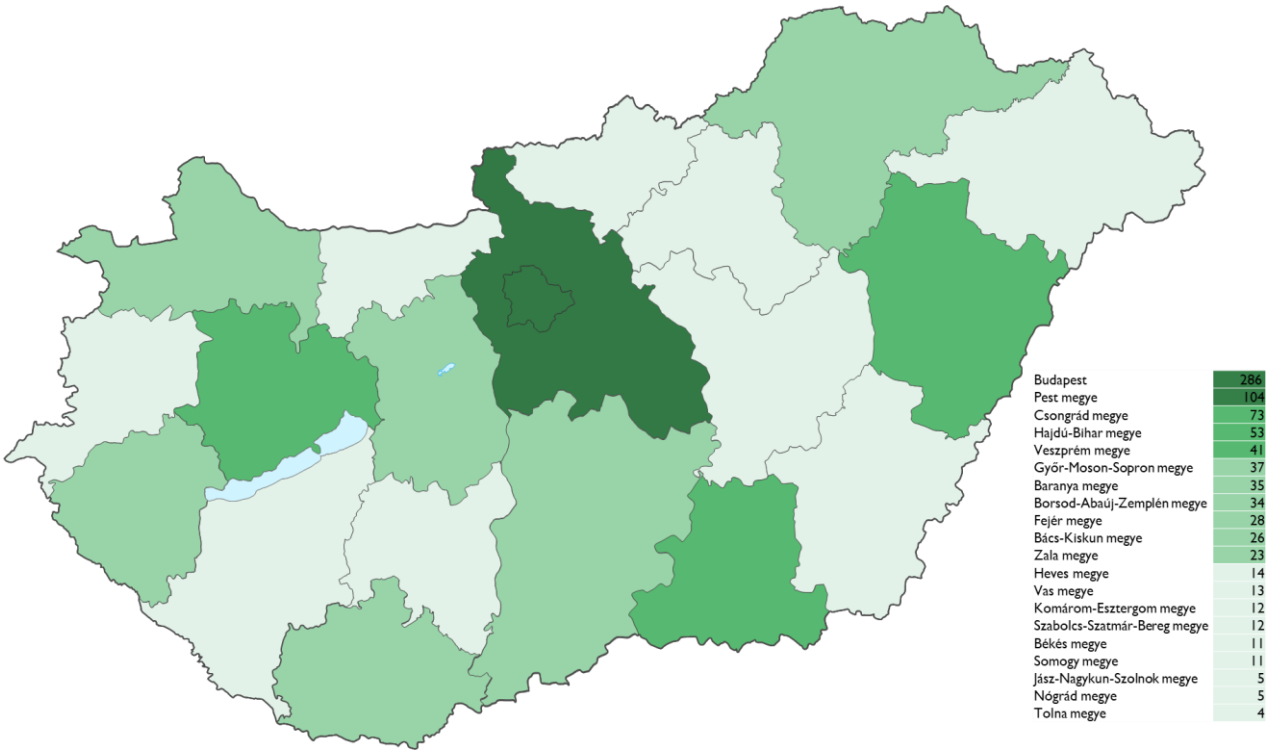
- 829 completed and processed questionnaires were used to compile the summary;
- Within 6 main priority areas, respondents could choose from 56 pre-defined priorities;
- 7245 nominations were made by respondents, i.e. 1 respondent chose on average 8-9 priorities.



7. Figure: Distribution of respondents by type of organisation

Main organisational data of respondents:

- 11 different types of organisations could be selected by the respondents
- 77% of respondents are concentrated in the business and university sector;
- 416 respondents **(50.2%) are enterprises**, 45% of which are SMEs and a further 23% are micro-enterprises;
- 69 responses were submitted by large companies, representing 16.6% of all company responses;
- 22 startups completed the survey;
- **224** responses from **universities and 85 from research institutions** were included in the results;
- 104 (12.5%) responses were submitted by other organisations, such as budgetary organisations, NGOs, municipalities or individuals.



8. Figure: Spatial distribution of respondents

- 286 (34.6%) respondents selected **Budapest** as their county;
- 104 (12.6%) of the respondents are based in **Pest** county;
- The counties of **Csongrád-Csanád, Hajdú-Bihar, Veszprém, Győr-Moson-Sopron, Baranya and Borsod-Abaúj-Zemplén** have a share of more than 4% (thanks to the larger university towns);
- The share is below **1%** in Jász-Nagykun-Szolnok, Nógrád and Tolna counties, which have low RDI intensity.

Respondents representing the **business sector**:

- **30.8% of the respondents are from Budapest**, i.e. the dominance of the capital is smaller at company level than for all respondents (34.6%);
- Pest county is also second in the business sector with 16.3%;
- The share of respondents is above 4% in Csongrád-Csanád, Baranya, Bács-Kiskun, Győr-Moson-Sopron and Fejér counties;
- The share of enterprises participating in the survey is below 1% in Jász-Nagykun-Szolnok and Tolna counties.

Universities, research institutes:

- 36% of respondents from universities, research institutes and other organisations are from Budapest;
- 5 further counties have over 5% of respondents from universities and research institutes, while the other counties have a very low response rate from this sector;
- In 10 counties, the share of enterprises is higher than that of all other operators combined;
- In 5 counties, universities and research institutions had a higher participation rate (Borsod-Abaúj-Zemplén, Budapest, Csongrád-Csanád, Hajdú-Bihar, Veszprém);
- In 5 counties the number of responses is almost the same (Győr-Moson-Sopron, Heves, Jász-Nagykun-Szolnok, Somogy and Tolna) between the business sector and other sectors.

Preliminary assessment criteria:

Based on the feedback received during the EDP, we first reviewed the sectoral coverage of the priorities set. As a result, the **priorities within the health priority were merged from the original categories**, because the results showed that the possible directions were too diverse and covered too narrow a range of sectors, making it difficult to compare the results with the other priorities. The other priorities have not been changed.

Also in a preliminary analysis, we reviewed the difference between the results reported by businesses and those reported by other respondents (mainly universities and research institutions). The aim was to assess whether aggregating the data would bring together the different characteristics between the two sectors. Preliminary results showed that several priorities were at risk of this problem (food, pharmaceuticals, energy, climate).

Sectoral analysis aspects:

Looking at the priorities in the two sectors (business and non-business) separately provides information on

- which sectors dominate among entrepreneurs but are not prominent in the university and research institution sector,
- which sectors are particularly important for public and other non-business actors, but by their nature are less relevant for the business sector,
- which sectors are important for both sectors.

This led to **further analyses, broken down by three different groups of respondents according to their type of organisation**:

A. a combined analysis of **all types of organisations**,
B. analysis of **businesses only** (from sole proprietorships to large companies, including start-ups),
C. only aggregate data from **other organisations** (universities, research institutes, budgetary organisations, non-profit organisations, municipalities, natural persons).

Territorial analysis aspects:

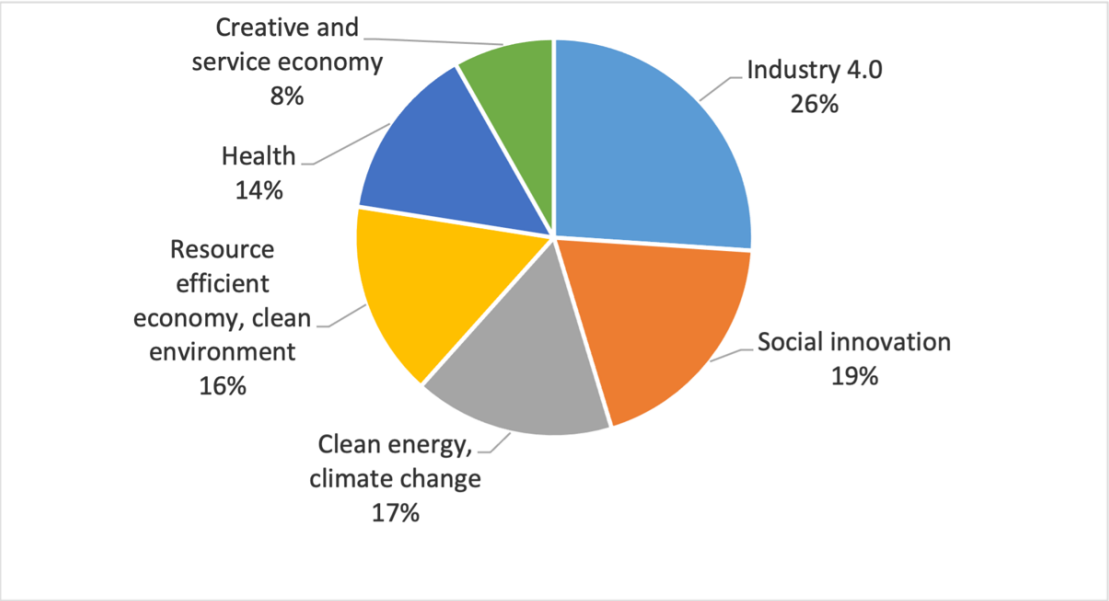
Since S3 is basically a policy instrument with a territorial focus, it was necessary to include the territorial, i.e. **county aspects** as a prominent element in the processing. We had to examine whether it was **sufficient** to set priorities **only at national level in Hungary**, or whether it was also justified to use county-level specialisations.

Data from the **three groups outlined above were** therefore **analysed separately**:

D. nationally and
E. at **county** level.

The shortlisting of priorities was essentially done along the detailed 56 priorities, but for the purposes of overview we also looked at how the nominations developed along the 6 main priority groups.

More than a quarter of the nominations (26%) cover the priorities of Industry 4.0, including **digital transformation, technological development of SMEs, cutting-edge technologies, electronics, materials technologies, metalworking**. Within the Industry 4.0 priority group, however, the distribution of priorities is already quite large, as the subsequent results show. But it is also clear that not only industrial development is important for businesses, but also the other priority groups.



9. Figure: Distribution of nominations along the 6 main priority groups

It is certainly worth highlighting that **social innovation**, which covers non-investment measures and covers a wide range of "soft" areas from education to climate awareness and healthy lifestyles, is the second priority group. This highlights the need for organisations to address societal challenges.

Clean Energy, Climate Change and **Resource Efficient Economy** are given similar weight in the nominations. **Health** is the fourth priority group with 14%. This is partly due to the fact that the sectors concerned are smaller in terms of the number of enterprises than the sectors covered by Industry 4.0.

The **Creative and Service Economy** is the sixth among the priority groups, but 8% is by no means negligible. The strengthening of services is not only seen within the service sectors, but also in productive enterprises, where competitiveness can be significantly enhanced if entrepreneurs also improve their offer by providing services.

Aggregation of the priority nominations

The example of the Industry 4.0 priority group shows the evolution of the number of nominations by the range and geographical distribution of respondents:

COUNTY	Total number of respondents	Respondents from entrepreneurs only	Respondents from other organisations
	Industry 4.0 applications, automation of production processes		
Bács-Kiskun county	11	11	
Baranya county	11	11	
Békés county	5	4	1
Borsod-Abaúj-Zemplén county	22	11	11
Budapest	82	40	42

Csongrád-Csanád county	18	10	8
Fejér county	11	9	2
Győr-Moson-Sopron county	17	10	7
Hajdú-Bihar county	14	6	8
Heves county	3	3	
Jász-Nagykun-Szolnok county	2	2	
Komárom-Esztergom county	5	4	1
Nógrád county	2	2	
Pest county	33	26	7
Somogy county	4	2	2
Szabolcs-Szatmár-Bereg county	4	3	1
Tolna county	4	3	1
Vas county	3	3	
Veszprém county	20	4	16
Zala county	5	4	1
National total	**276**	**168**	**108**

2. Table: Number of nominations by scope of respondents at county level and national aggregate for the priority group "Industry 4.0 applications, automation of production processes" - sample table

In order to narrow down the **56** priorities, we selected the **10** most highly marked priorities in each of the three analysis groups. This was named the **TOP 10 list**. At the national level, the top 10 lists of the three different groups largely overlap, **but there are also priorities that are only included in the TOP 10 list for businesses or only for other organisations**.

PRIORITY	Total number of respondents		Respondents from entrepreneurs only		Respondents from other organisations	
	Number of nominations at national level	Number of counties where the priority is in the county top 10	Number of nominations at national level	Number of counties where the priority is in the county top 10	Number of nominations at national level	Number of counties where the priority is in the county top 10
TOP 10 priorities based on national aggregate						
Clinical research, diagnostic technologies, therapeutic procedures, biomedical research, innovative and efficient care systems, personalised medicine, development of health services	**379**	8	**122**	7	**257**	12
Medical device manufacturing, development, ICT-based healthcare systems, medical IT technology, digital solutions, health "big data"; IA in healthcare, IT solutions to	**281**	8	**123**	10	**158**	8

PRIORITY	Total number of respondents		Respondents from entrepreneurs only		Respondents from other organisations	
	Number of nominations at national level	Number of counties where the priority is in the county top 10	Number of nominations at national level	Number of counties where the priority is in the county top 10	Number of nominations at national level	Number of counties where the priority is in the county top 10
improve quality of life for the elderly, bionics						
Industry 4.0 applications, automation of production processes	**277**	13	**168**	20	**109**	9
Use of renewable energy sources, renewable energy production	**260**	12	**134**	17	**126**	11
Digital economy, digital development of SMEs and micro-enterprises	**240**	11	**148**	19	**92**	9
Technological modernisation of SMEs	**227**	11	**156**	19	**71**	4
Innovative educational solutions (public education, higher education, vocational training, LLL)	**223**	10	**71**	5	**152**	14
Innovation in the services sector, expanding the range and improving the quality of services	**219**	10	**125**	15	**94**	9
Big data management and advanced algorithms	**205**	5	**99**	11	**106**	4
TOP 10 priorities based on aggregated data from companies or other organisations						
Digital society	**198**	7	**78**	8	**120**	12
Environmental change (climate awareness)	**184**	8	**54**	5	**130**	13
Pharmaceutical products (pharmaceuticals, nutritional supplements, medical biotechnology, genetics)	**175**	4	**61**	4	**114**	5
Responding to new, unresolved, inadequately addressed societal needs and challenges	**170**	5	**59**	6	**111**	9
Food safety, processing technology solutions, healthy food	**201**	10	**76**	11	**125**	10
Energy-efficient industrial solutions	**180**	10	**109**	16	**71**	3
Climate adaptation	**157**	5	**38**	3	**119**	10

3. Table: Number of nominations for the TOP 10 priorities selected at national and county level

In the table above, we have highlighted the TOP 10 priorities for each of the three analysis groups (total respondents, entrepreneurs and other organisations).

The **grey colour indicates** the data used to rank the priority in the TOP 10 lists.

The **first part of the table shows** the priorities that have been included in the **TOP 10 on the basis of a national aggregate**.

In **the second part of the table**, we have highlighted those priorities that are **not included in the national TOP 10 priorities, but are included in the TOP 10 priorities for either the business sector or other actors**. 7 such priorities have been identified. This list of 7 shows the extent to which it is appropriate to **look at the evolution of priorities from the perspective of companies and other organisations**, in addition to the national **perspective**. Of these 7 priorities, 6 are particularly relevant only for universities, research institutes, non-profit and budgetary organisations, private individuals and local authorities. It is worth mentioning that the priorities pharmaceutical industry and food safety, processing technology solutions and healthy food, as well as several research areas related to socio-economic challenges (climate awareness, climate adaptation, unresolved societal challenges, digital society) were also listed here. The latter priorities are more difficult for businesses to grasp and adapt to, but they are also in the middle of the list of priorities for businesses. Companies have added the priority of energy-efficient industrial solutions to the above list.

- **Columns 2, 4 and 6** in the table **show the** number of **nominations at national level** .
- Only three priorities are included in the table, which are in the top 10 **nationally, for businesses and for other players alike**: two **health** priorities (clinical and biomedical research, personalised medicine and medical devices, medical IT technology) and renewable energy, renewable energy production.

Not at national level, but at county level the following are key priorities:

It is not only the differences between businesses and other organisations that are mashed up in the national aggregate, but also the differences between counties. Therefore, for each priority, analyses were carried out in parallel at national and county level.

As a result of the aggregations, **we have identified priorities that were not included in the TOP 10 nationally, but in a significant number of counties (at least 10 counties) they were included in the county's own TOP 10 priority list**. To filter them out

- for each priority, we checked (both for all respondents and for companies and other organisations) how **many counties in the priority were included in the TOP 10 list for their own county**,
- then we filtered out the priorities that were **included in the TOP 10 priorities in at least 10 counties**. (In Table 2, columns 5 and 7 show the number of these counties.) For example, in the case of other organisations, agri-informatics, precision farming, agrotechnical solutions were not included in the TOP 10 in the national aggregate, but in 12 counties they appeared independently in the TOP 10 of their own county, so it is justified to include them in the shortlist of priorities.

Three such priorities have been identified and are set out in the table below. In particular, it is important to note that these priorities cover sectors (agricultural technologies, waste reduction, recycling technologies) that were completely omitted from the previous list.

PRIORITY	Total number of respondents		Respondents from entrepreneurs only		Respondents from other organisations	
	Number of nominations at national level	Number of counties where the priority is in the county top 10	Number of nominations at national level	Number of counties where the priority is in the county top 10	Number of nominations at national level	Number of counties where the priority is in the county top 10
Waste management, waste water treatment technologies, recycling technologies, waste reduction, pollution prevention	190	7	83	14	107	8
Agri-informatics, precision farming, agrotechnical solutions	155	6	57	10	98	12
Agro-biotechnology (soil replenishment, irrigation, water retention, soil protection, plant biotechnology)	129	4	35	5	94	11

4. Table: Priorities not included at national level, but included in the shortlisted priorities based on the county TOP 10 priority lists

The country-level aggregations in Table 3 have been supplemented with county-level data, resulting in the addition of **three additional priorities to the shortlist of priorities in Table 4**. With this step, we have strengthened the territorial dimension in the priority selection process. These technologies are prominent in more than half of the counties, which means that at the local, regional level, these trends are important in several areas of the country. And as S3 aims to focus on local strengths, it is certainly justified to include these technologies among the priorities.

The latter analysis by county highlights the degree of concentration of **a sector in a given area**.

- Whichever priority has been included in the TOP 10, both in terms of national results and the number of counties, it can be said that the **distribution of players in the sector is relatively even at national level**.
- If a priority is in the TOP 10 on the basis of national results but not on the basis of the number of counties concerned, it is **nationally significant** but only affects **a few** counties, so it is **quite concentrated territorially**.
- And if it is included in the 20 priorities selected on the basis of the number of counties, but not at national level, then **the sector is not the most important at national level**, but it is important at county level and **stretches over more than half the country**.

Priorities, which are defined at national level on the basis of the nominations made in the form of open texts:

In addition to the pre-defined priorities, respondents were also given the opportunity to indicate in the last open text field any sectors they felt were not included. On the basis of the information thus obtained, **two** main **areas can be highlighted which** were not closely linked to any of the priorities listed above:

- space research and
- quantum technologies.

In terms of their number, the two areas did not appear so prominently as to justify an addition to the shortlist, but they were proportionally prominent in the open text responses.

Two other factors are worth highlighting, which appear in several responses and are also included as specific objectives in the RDI Strategy. They do not set a sectoral direction, but **provide useful guidance for future RDI developments**:

- strengthening targeted marketing innovation and
- disseminate scientific results widely.

Step 2: Confirmation of the priorities identified in question 3 of the S3 survey, supplemented where necessary by the responses given in the open text fields relate to the local, regional strengths identified in question 6 of the S3 survey

In the S3 survey, in order to make the selection of priorities more methodologically sound, we collected the opinions and experiences of the respondents in the form of several questions. In the case of question 3, already presented, we prompted respondents to specify from a predefined list the area where they envisaged development activities. These responses give a direct indication of what domestic RDI actors believe will be the most dominant sectors in the coming years.

In question 6, we asked *"6. Please list three local and regional strengths that can contribute to the development of the national economy and improve its competitiveness."*

For this question, we **went beyond individual objectives** to gather the views of respondents on **specific issues at local, county level**. The **percentage of respondents filling in** the open text field **is low** compared to the total number of responses, especially at county level. Therefore, **the results cannot be used to influence the scope of the priority list developed under point 1** , i.e. to narrow or broaden it in any meaningful way.

The aggregated results **can be used to confirm or deny the prioritisation of the three priorities that were not included in the 20 priorities based on the national results but based on the county lists**. The field of **agriculture** was mentioned in many counties, which underlines the priority given to agri-biotechnology and agro-technologies.

Step 3: TOP 10 sectors based on GMR model results

The GMR model data were integrated into the S3 design based on the results of the Regional Innovation and Entrepreneurship Research Centre (Varga, Szabó and Sebestyén, 2020b). The **aim of the GMR** is to prioritise **sectors where innovative investment can help the region embark on a path of sectoral modernisation** and put the departments on a growth trajectory. "*So we want to see how the introduction of innovative ideas will impact the economic development of a region through the growth of an industrial sector*." (Varga, Szabó and Sebestyén, 2020b, p.4)

The prioritisation was carried out using the S3 methodology developed by Dominique Foray (Foray 2016). Based on this, the choice between the innovative ideas collected in the Entrepreneurial Discovery Process (EDP) requires a combination of the following three dimensions:

1. The **significance of** the **innovation** (novelty, feasibility, development costs, links to sectoral strategies, etc.). This is closely linked to the knowledge creation objectives of the RDI Strategy.
2. The **knowledge spill-over potential** of an innovative idea. The need to do so is justified by the fact that, while it is possible that point 1 is met for an intervention, it is not automatically the case for all sectors that the new innovation is adopted by newer and newer firms. Therefore, it is also necessary to examine the capacity for knowledge flow and learning. This dimension is linked to the knowledge flow objectives of the RDI Strategy.
3. The **economic impact expected** if the innovation is implemented. This is in line with the objectives of the RDI Strategy on the use of knowledge.

This theoretical framework was translated into practice by the GMR model, where the three aspects were interpreted and applied as follows:

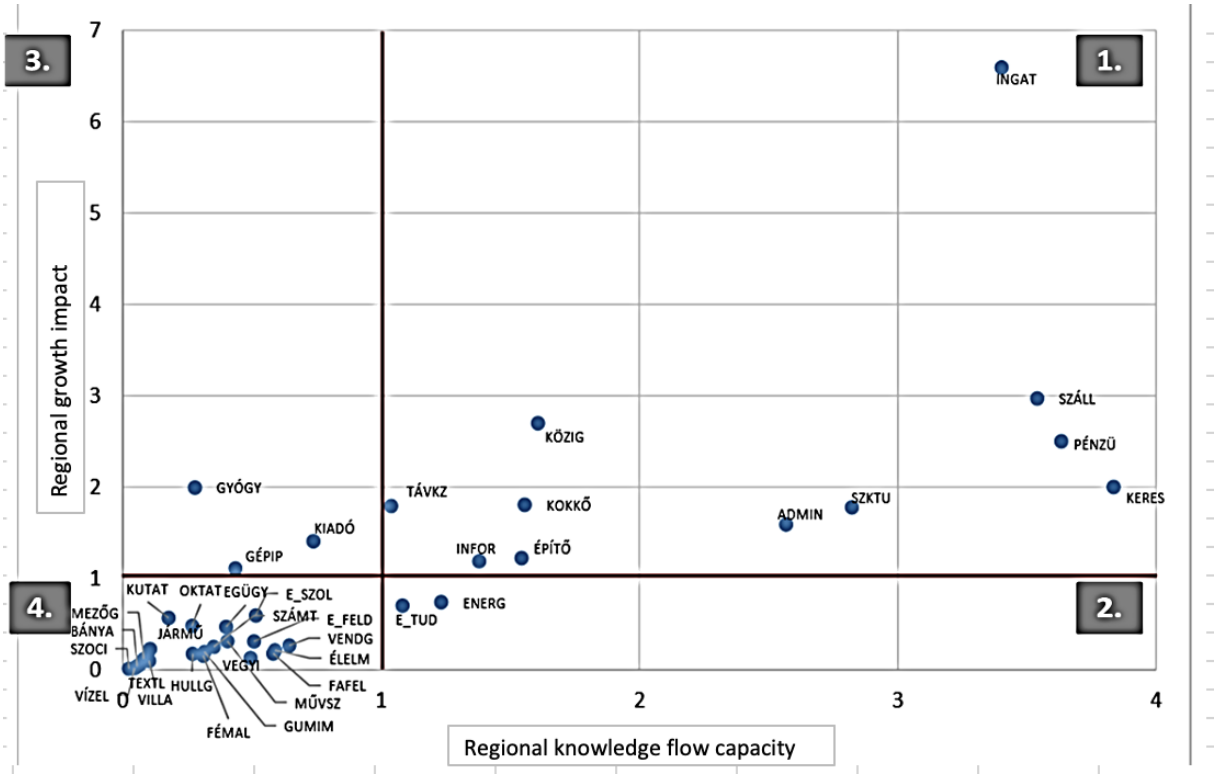
Regional knowledge flow capacity: what determines which sectoral innovation can have an impact on the region? The more actors a sector has and the more it is connected to other sectors, the greater its capacity to learn, as innovation can spread and become a source of new innovations. Thus, knowledge flow capacity evolves in line with the size of the sector and the regional embeddedness of the sector. To measure this, researchers have used the centrality index often used in network theory. In principle, the larger sectors have a better chance of driving growth in the region as a whole, simply because of their size. However, it is not necessarily true that the larger sector is better. Without extensive cross-sectoral linkages, the growth effect cannot be fully realised, so support for the sector will be less effective.

Regional growth impact: the latest version of the GMR-Hungary impact model was used to measure economic impacts (RIERC, 2020). The use of a spatial model allows not only macroeconomic but also regional impacts to be tracked, which is essential for S3 as a territorial instrument. The GMR model estimates the impact on productivity of interventions that support R&D, human capital, the level of entrepreneurship and international knowledge networks in a given sector. The productivity effect is measured by examining the demand and supply of regional input and output factors (representing buyer and supplier relationships) and the prices of these factors. This is supplemented by changes in the volume of trade between regions or in

the volume of labour and capital migration. The economic impact was compared to the average impact for each sector. Thus, the effects are interpreted as follows: 1.2 means that the sector has the potential to increase the region's GDP by 1.2 times the average impact.

The researchers placed all sectors (37 TEÁOR'08 sectors) in each county along the two dimensions in the coordinate system formed by the two factors. Based on the indicators measuring the expected growth impact and knowledge flow potential, **the sectors in each county can be grouped into** the following **four categories (the four areas divided by the two axes in the figure)**:

1. Strong knowledge diffusion potential - strong growth impact;
2. Moderate knowledge diffusion potential - strong growth impact;
3. Strong knowledge diffusion potential - moderate growth impact;
4. Moderate knowledge diffusion potential - moderate growth impact.



10. Figure: Location of sectors according to regional growth impact and knowledge flow capacity in Budapest (Varga, Szabó and Sebestyén, 2020b, p.11)

Category 1) sectors (the top right area) have **above average knowledge flow potential and above average economic impact**. They are considered to be the **most appropriate sectors** in the priority setting process (e.g.: trade, car repair, financial services or agriculture in other counties).

Category 2) (bottom right area) is also worth considering when making a decision. While these sectors generate below average economic impacts in the short term, they have a significant knowledge flow capacity. Their strong embeddedness **can lead to a longer-term return on innovative investment through innovation collaborations**. (For instance: In Budapest, electricity, gas, steam and air conditioning supply; other professional, scientific and technical activities).

Sectors in **Category 3** (top left area) should also be considered for prioritisation. These sectors have a **more modest capacity for knowledge flows**, as most of them have weak links on both the supplier and the sales side, but they still offer **great economic potential**. This is due to their **high productivity and capital intensity**. (For instance: In Budapest, publishing, sound recording and filming, broadcasting; manufacture of machinery and equipment)

Sectors in **Category 4** (bottom left area) are not recommended for prioritisation under the GMR model, as **they can generate moderate impacts in terms of both knowledge diffusion and economic impact**. (For instance: In Budapest, a significant number of sectors fall into this category, such as food, metalworking, agriculture)[6]

Results of the GMR model aggregated to the national level

One of the main advantages of the GMR model is that it ranks sectors according to, among other things, their growth potential. During the S3 planning process, however, the **economic situation has changed** significantly, GDP has fallen sharply, many sectors have suffered huge losses in the short term, almost all sectors have to adapt to the new situation (e.g. through digitisation), and certain sectors and disciplines (notably health) have received more economic policy attention. Member States have adopted or are planning to adopt budgetary measures to increase the capacity of their health systems and provide assistance to individuals and economic sectors particularly hard hit by the crisis (European Commission, 2020b). The economic downturn means that the prioritisation process for S3 should give greater weight to **economic growth potential** than before. Therefore, the GMR model results are used to **focus on sectors with strong growth potential in the national aggregation**.

1. Following the S3 survey database processing methodology, **the county level data were aggregated to the national level in Categories 1, 2 and 3**. These data are presented in

[6] It is somewhat surprising that this category includes other professional, scientific and technical activities in Budapest. This can be explained by the fact that at the moment this activity cannot contribute to economic growth and that the dissemination of the results of this activity is not sufficient. The policy objectives on knowledge exploitation, which also appear in the RDI Strategy, emphasise the need to improve this and make better use of research results. By exploiting research results at a higher level than at present, the growth impact will also be stronger.

Table 3. Each cell indicates the number of counties in which the sector is classified as Category 1, 2 or 3. For example, the trade and repair of motor vehicles sector is classified as Category 1 (strong knowledge diffusion potential, strong growth impact) in all 20 counties.

2. **We then aggregated the data for the two categories with strong growth potential**: the group with strong knowledge diffusion and strong growth potential, and the group with moderate knowledge diffusion and strong growth potential. This data is included in the **last "Total" column**.
3. Based on this aggregation, **we have selected the TOP 10 sectors**. Transport, storage; trade, repair of motor vehicles; real estate are all service sector innovation priorities on the long list, so these sectors are treated as one. **The selected TOP 10 sectors are highlighted in yellow** in the table below.

County-specific results of the GMR model

When narrowing down the list of priorities, we also took into account which priorities were not included in the TOP 10 at national level, but are important for the development of the local economy at county level. Following the same methodology, the results of the GMR model have been used to identify sectors that are not in the top 10 nationally, but which represent a significant growth potential in certain counties. These sectors are listed in the lower part of Table 5. Administrative and service support activities highlight the importance of services. Human health care reaffirms the importance of health care development, including the practical application of research results related to health care and the health industry through the spread of innovation. The Manufacture of basic metals and fabricated metal products, the Manufacture of electrical equipment and the Manufacture of computer, electronic and optical products are new sectors. In their RDI activities, these sectors can be closely linked to the technological directions that are emerging from the TOP 20 priorities. They can be important players in both Industry 4.0 and circular economy and energy developments.

SECTORS PROPOSED BY CATEGORIES 1-3 OF THE GMR MODEL (NACE2)	1: Strong knowledge diffusion potential, strong growth impact	2: Moderate knowledge diffusion potential, strong growth effect	3: Strong knowledge diffusion potential, moderate growth impact	Total 1+2
National aggregate results				
Trade, repair of motor vehicles	20	0	0	20
Public administration, defence, compulsory social security	1	19	0	20
Agriculture, forestry, fishing	19	0	0	19
Construction	15	4	0	19
Transport, storage	16	0	4	16
Real estate	16	0	4	16

SECTORS PROPOSED BY CATEGORIES 1-3 OF THE GMR MODEL (NACE2)	1: Strong knowledge diffusion potential, strong growth impact	2: Moderate knowledge diffusion potential, strong growth effect	3: Strong knowledge diffusion potential, moderate growth impact	Total 1+2
National aggregate results				
Manufacture of machinery and equipment	1	15	0	16
Automotive industry	7	6	0	13
Education	0	13	0	13
Electricity, gas, steam and air conditioning	10	0	1	10
Manufacture of food, beverages and tobacco products	9	0	9	9
Manufacture of rubber, plastic and non-metallic mineral products	6	3	4	9
County specific results				
Administrative and service support activities	7	0	7	7
Manufacture of basic metals and fabricated metal products	5	0	4	5
Computer, electronic and optical products	5	0	0	5
Manufacture of electrical equipment	1	2	0	3
Human health care	0	3	0	3

5. Table: Aggregate data at national level for the sectors covered by the GMR model in the 3 categories of the model

4. Step: Harmonisation of the results of the survey and the GMR model at county level

At the end of the prioritisation process, the results so far (answers to survey questions 3 and 6, sectors of the macroeconomic model) will be harmonised to finalise the priority list. The first attempt was made to harmonise data at county level **by comparing the GMR model county results with the EDP county TOP 10 lists**.

The **sectors** in categories 1, 2 and 3 of the GMR **model were compared at county level with the county TOP 10 priority lists developed from the EDP data**. To do this, we first matched the sectors used in the GMR model with the priorities identified in the long list.

The matching of the long list used in the EDP and the TEÁOR'08 categories used in the GMR model has sometimes been difficult. The **categories of the long list do not follow traditional sectoral classifications**, but aim to reflect socio-economic challenges and the development

directions of relevant policies. In many cases, these will be more cross-sectoral areas for development. In fact, S3 itself should, according to the planning guidelines, focus on such cross-sectoral areas.

The food industry is a positive example to compare the two approaches, as both methodologies have confirmed the importance of the food industry. However, overall, **at county level, the coincidence of the two types of prioritisation is very low**. Only **a few** sectors were identified that are included in the county TOP 10 list and in the GMR model county lists. These include the service sector, education, machinery and equipment manufacturing and food processing.

The big difference is mainly due to the very different approach taken in the two lists. The EDP data are the result of a grassroots initiative, reflecting the needs of local actors. The number of items is quite low for many counties, but they reflect direct feedback from local actors. The GMR model, on the other hand, is part of the top-down planning process and therefore covers a much broader scope than the EDP.

5. Step: Selection of S3 priorities

The prioritisation process is best supported by combining the results of both methods. To do this, **we have drawn up a set of criteria** that summarises the most important **conditions that** need to be **taken into account in S3 design**. In the first phase of the prioritisation process, S3 priorities must meet the following selection criteria:

- be included in the pre-selected TOP 20 list of the EDP survey with as many nominations as possible and/or,
- be part of the TOP 15 list of sectors filtered from the GMR model results, with strong growth potential,
- cover as much of the country as possible at county level, based on county TOP 10 and sectoral lists,
- the priorities selected should not overlap,
- all six main priority groups appear in the selected priorities,
- contribute to improving the innovation capacity of other socio-economic actors in addition to the innovation capacity of enterprises,
- to ensure clarity and feasibility, the priorities should be succinctly named and accompanied by a clear explanation of their content,
- priorities should cover a relatively similar range of development areas, i.e. they should not be overly focused or fragmented,
- a “hard” investment and a “soft” programme related to a given development direction should be included in the same priority (e.g.: investing to reduce CO_2 emissions and attitude shaping towards climate awareness).

The **next step in the selection of S3 priorities is to integrate and harmonise the results produced so far**. The TOP 20 list of sectors now includes county and national data. County data were also taken into account in the national aggregation of the GMR model data and in the selection of the TOP 15. In this final step, we will link the TOP 20 and TOP 15 lists one by one,

giving an overview of each sector and priority. Each of these priorities or sectors has been included in the list of priorities selected in the first stage of prioritisation. In line with the prioritisation criteria, some priorities and sectors have been merged where necessary. The process for this step is summarised in Annex 5.

4.3. The selected national priorities

The steps described in the previous chapter have resulted in the selection of specialisation directions from the long list of priorities to form **a short list of** national smart **priorities**. In addition to the proposals resulting from the surveys, the content of the national priorities also took into account the objectives of national interest as set out in other national strategies.

There is no justification for a different list of priorities for each county, both because (with few exceptions) the results do not differ significantly between counties, and because the process of implementing S3 would inevitably be complicated by the need to define smart specialisation directions at county level. That is why **all the priorities selected** in the strategy **have national level and scope**.

Eight **national economic priorities** have been selected for S3. These are the directions for the national economy that Hungary is focusing on in the implementation of smart specialisation. Focusing resources on priorities can strengthen competitiveness.

In addition to the national economic priorities, two **horizontal priorities have been selected**. The horizontal priorities are designed to provide the skills development and business environment needed for smart specialisation in the sectors covered by the national economic priorities.

11. Figure: Short list of priorities

The S3 document builds on the objectives of the three sectoral strategies and the EDPs conducted by the three sectors. The links between the development documents are illustrated in the figure below.

S3 PRIORITIES	Agriculture, food industry	Health	Digitisation of the economy	Creative industry
	Resource-efficient economy	Energy, Climate	Services	Cutting-edge technologies
	Public sector innovation		Training, education	
RDI STRATEGY	Knowledge production			
	Knowledge flow			
	Knowledge use			
SME STRATEGY	Strengthening the value-creating capacity of a high-growth business community			
	Providing a predictable framework for the entire SME sector			
DIGITISATION STRATEGY	Improving the digital readiness of micro, small and medium-sized enterprises in Hungary			
	Increasing the integration of digital technology in the economy			

6. Table: S3 and related policy strategies objectives

As a result of a successful decade, the Hungarian economy has entered a new era. Addressing the challenges of the digital and technological revolution and rising wages requires a comprehensive overhaul of the SME sector, improving productivity and strengthening market position.

In **the field of enterprise development**, the contribution of the schemes planned to be financed by EU funds in the 2021-2027 programming cycle to improving the productivity of micro, small and medium-sized enterprises is planned along the following three main target groups:

- strengthening companies that are moving up the value chains and have significant market and growth potential
- enabling technology change and organisational renewal for a wide range of businesses, improving the efficiency of our business processes
- implementing targeted development programmes focused on strategic sectors

Of the above three elements of the target system, the direct application of S3 is in the case of the **development of strategic sectors,** as these developments can build on the priorities defined by S3 and can make a focused contribution to the achievement of the S3 objectives. For the first two objectives, the objectives of S3 are implemented indirectly, along the intervention logic set out in the SME Strategy, which is part of the S3 mechanism.

In the field of digitalisation, EU funding for the 2021-2027 programming cycle will be used to improve the digital skills of SMEs, in line with the objectives of the National Digital Strategy.

SOCIAL INNOVATION

Horizontal aspect taken into account in the implementation of the priorities

The global civilisation challenges of the 21st century will also confront Hungary in this decade: industrial transformation and digitisation, demographic changes (e.g. ageing society), health challenges (e.g. pandemics), and the need to be at the forefront of smart specialisation in preparing for and responding to the impacts of environmental challenges.

In implementing S3, preference is given to innovative solutions that help the broadest possible section of society to adapt to these challenges and that aim to find a novel solution to a societal problem that is more efficient, effective or even sustainable than existing solutions.

Social innovation is a complex activity aimed at finding an innovative solution to a social problem: it can be a product, a technology, a service, an improvement, an intervention or some combination of these. The community and economic benefits of the value created by social innovation are not limited to individuals or companies, but are directed at society as a whole, increasing its capacity for action and resilience.

The “long list”, which was drawn up as a first step in the prioritisation process, even included social innovation as a specific priority. Based on the EDP, it is clear that participants in the domestic RDI ecosystem consider social innovation to be an important area. Several elements of the social innovation priority group of the “long list” are reflected in the content of the selected priorities (e.g. Energy, Climate; Health) based on the results of the EDP.

At the same time, the use of social innovation as an approach or method is justified in all priorities in order to maximise the contribution of smart specialisation to the resilience of society, in addition to increasing the competitiveness of the economy.

4.4. The second stage of prioritisation: professional and administrative validation

One of the main recommendations of the EU for S3 planning is that **prioritisation should go beyond simply "ranking" innovation investments**. The aim is to use prioritisation to help stimulate economic transformation in ways that can contribute to a wider range of economic, social and environmental goals. In addition to R&D and innovation, the S3 prioritisation should contribute to strengthening industrial digitisation, improving the competitiveness of SMEs, and developing a broad range of skills.

This intention was already reflected in the development of the "long list", which is the basis for the prioritisation, as among the 65 potential priorities there are several non-traditional sectors and development directions, the importance of which was also identified as a necessary development direction among the obstacles in the industrial transformation chapter or the international chapter.

Phase 2 is mainly aimed at strengthening the social consultation that accompanies the design of S3, as well as at carrying out the technical validation and the administrative consultation (inter-ministerial validation).

The technical alignment of the priorities selected in Phase 1 is a key step, in particular with those policy areas and stakeholders that are closely aligned with the S3 processes and contribute strongly to the achievement of the S3 objectives. Its organisational structure is described in chapter 3.3.

The external economic circumstances that changed during the planning of S3, triggered by the pandemic in spring 2020 and the resulting economic downturn, are particularly important issues in the technical consultation. In fact, the EDP and the S3 survey on which the prioritisation is based were completed before the outbreak. Businesses also have to react to changed circumstances, which may require them to change their previous development plans and directions. S3 design must also respond to these developments.

Once the process of professional validation has been completed and the results incorporated into the strategy, the administrative consultation (inter-ministerial validation) will be carried out. If the aspects raised by government validation so require, the list and structure of priorities may be modified or refined before government adoption.

Professional validation survey

In order to ensure that S3 can contribute as effectively as possible to strengthening Hungary's socio-economic position in the 2021-2027 period, a **short list of priorities was commented on through a "validation survey" at the end of November 2020** to understand the changed domestic situation after the pandemic and to gather information summarising regional and sectoral impacts (i.e. the EDP).

The NRDI Office sent the questionnaire to a total of 106 organisations representing all the major players in the "quadruple helix". The previous phase of the EDP was bottom-up, regardless of

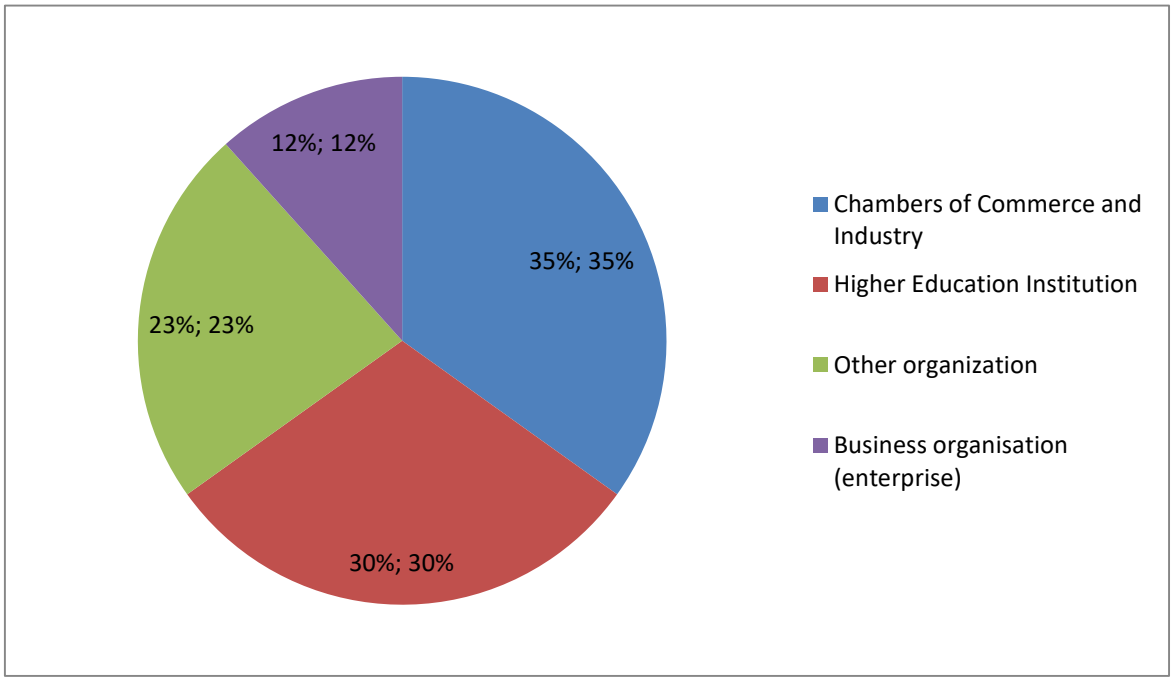
scope, and any type of organisation was able to participate in the EDP by completing the S3 survey. Professional validation was mainly requested from professional associations, umbrella organisations and sectoral horizontal advocacy organisations with a regional or national scope.

Respondents were given the opportunity to rank the priorities developed in the previous stage of the EDP, and to comment on their objectives and content.

Organisations related to Policy Objective 1 (PO1) were involved in the technical validation, the questionnaire was also sent to the horizontal organisations in the field of digitisation and enterprise development and all members of the Enterprise Development Council had the opportunity to comment.

TIPs have been key actors in the EDP and also play a key role in the implementation, monitoring and continuity of the EDP, therefore, the other major target group of the survey, besides the professional organisations, were the university TIP contacts in the professional validation framework.

The NRDI Office sent the questionnaire to 106 stakeholders.
The questionnaire, which was open for completion from 13 to 24 November 2020, was sent to a total of 88 horizontal professional associations or interest groups and 18 university TIP contacts.
A total of 147 responses were received via the LimeSurvey online interface. Out of these, 43 were finalised and suitable for processing.



12. Figure: Distribution of questionnaires completed during the professional validation by type of responding organisation (number; %)

Results of the S3 professional validation

The first question of the validation survey asked respondents to rank the priorities identified in the previous sections: *"Please rank these priorities according to how much you think they will play a key role in achieving Hungary's goal to become a major innovator by the end of the decade. (the highest priority should be placed at the top)"*

All the organisations that completed the questionnaire ranked all eight possible priorities (the horizontal priorities, as they are clearly necessary for the implementation of S3, did not need to be ranked by the respondents).

The scores indicating the ranking of the different priorities were weighted according to the number of points the respondents gave to the priority in the overall priority ranking (first ranked received 8 points, second ranked received 7 points and so on). This gives more weight to the first priority score and less to the last. This result integrates not only the top ranked priorities, but also the results of all other rankings.

Priorities	Total scores based on ranking	Percentage distribution of scores
Digitisation of the economy	281	17%
Cutting-edge technologies (such as AI, big data, space technology, quantum technology)	267	16%
Health	246	15%
Energy, climate	196	12%
Resource-efficient economy	189	12%
Agriculture, food industry	174	11%
Services	148	9%
Creative industry	119	7%

7. Table: Prioritisation and weighting of national economic priorities based on the opinions of the organisations involved in the professional validation

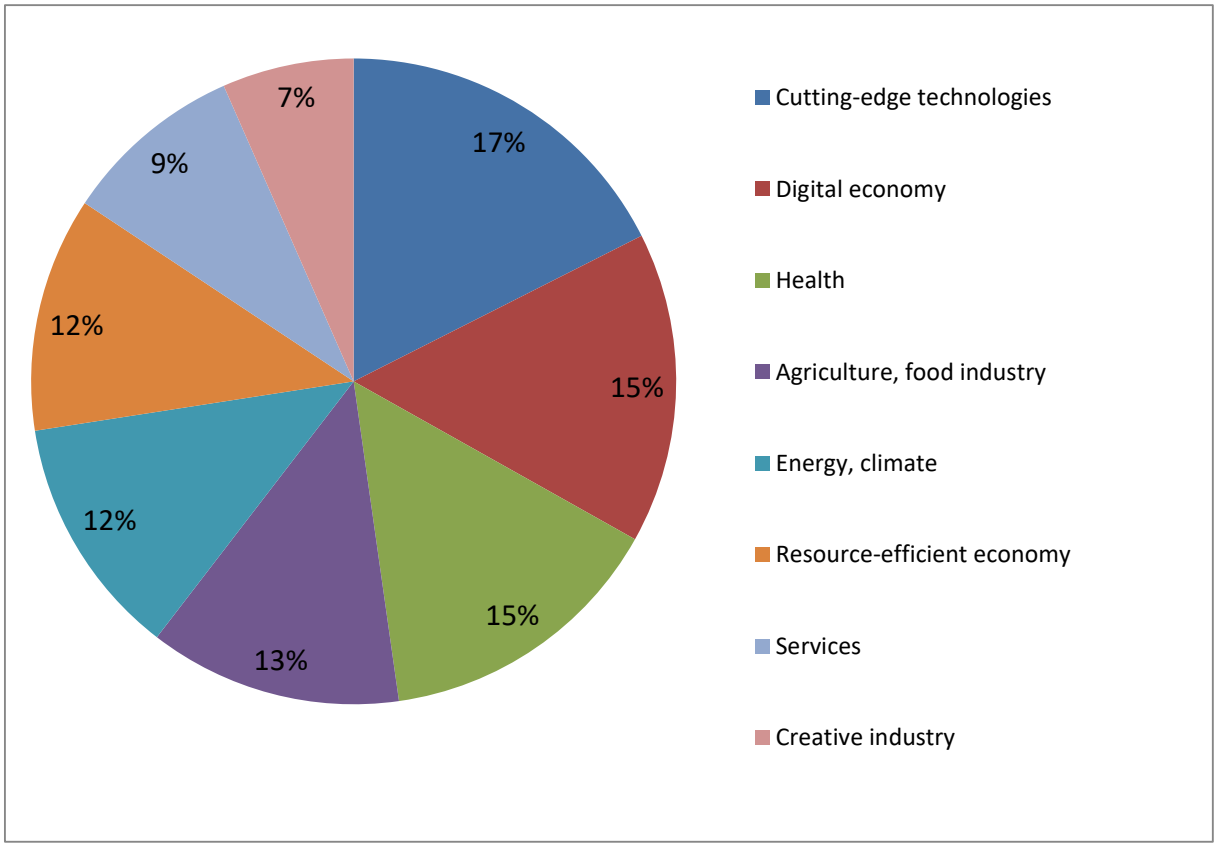
The overall result of the ranking was used to validate the S3 to assess whether the priorities are indeed appropriate to strengthen the country's capacity for innovation. If the weight of a priority is very low compared to the others, the question arises whether the areas and sectors selected are really relevant for Hungary. The answers to the first question of the professional validation suggest that there are no such glaring priorities: on the one hand, there is no very striking difference in the percentage distribution of the ranking of priorities, and on the other hand, there are no strikingly low ranked priorities.

The last question asked respondents to allocate 100% between priorities, weighting each priority. The weighting is based on how much each priority can contribute to increasing the competitiveness of the economy. The answers to this question confirmed the results of the ranking.

"When allocating your score, please consider the extent to which you think the priority can contribute to increasing the competitiveness of the economy and to achieving the goal of Hungary becoming a major innovator by the end of the decade."

When the results of the responses are aggregated, none of the priorities scored either high or low. This result means that, to varying degrees, they all contribute to strengthening Hungary's innovation capacity, and no single direction or focus area stands out as the most important development direction. When assessing the results, it is important to underline that, for example, the scores indicate that cutting-edge technologies, the digital economy and health are almost equally important areas when it comes to improving the country's capacity to innovate. But the development of the creative and service industries, which were ranked lowest, is also needed, according to the responses.

Accordingly, the list of selected priorities was not changed during validation.



13. Figure: Aggregated result of the weighting of priorities based on the answers to the professional validation survey (%) N=43

Opinion on the content of the priorities

In addition to the ranking of priorities, respondents also commented in detail on the content of national economic priorities. Once they had been informed of the content of the priorities, they were able to express their views in their own words, suggest possible additions and comment on the planned objectives of the priorities, stating to what extent they considered them relevant to the specialisation. Based on the feedback on the relevance of the objectives and the open text field responses, the content of the priorities - presented in detail in the next chapter - has been modified in the strategy.

The results of the professional validation included comments that were not related to the description of priorities and the content of the objectives, but to other measures of the S3, and that contained such meaningful insights that deserved to be incorporated in the text of the S3

document. Following professional validation, the content of the other chapters of S3 has been clarified on a number of points in response to these comments.

4.5. Content of the selected national priorities

S3 is an umbrella strategy, so the basis for its implementation is set out in the action plans of the three sectoral strategies. As an expectation, alignment with the priorities is reflected in the calls for proposals, and within them in the evaluation criteria.

In this chapter, we present the content of the national economic priorities, which have been developed taking into account the first stage of the prioritisation process and the suggestions of the stakeholders involved in the professional validation.

Each priority is presented in the chapter in the following format:

- **Priority description:** As a result of the prioritisation process, for each priority, it is possible to determine which technological development directions belong to that priority. These are summarised in the priority description section.
- **Identify priority target sectors, areas for development:** The S3 indicates the sectors that are the primary target group for the given priority (based on their TEÁOR'08 codes). In the practical application of S3, the primary target groups are not the exclusive target group, i.e. the relevant sectoral actors are not the only ones who can apply for subsequent development funds. But these are the sectors with the greatest growth potential within the priority.

- **Priority objectives:** Each priority is accompanied by one or more policy objectives. In the 2021-2027 programming cycle, proposals receiving funding should contribute to the objectives of the priorities, ensuring that the overall objectives of S3 are met.

4.5.1 National economic priorities

CUTTING-EDGE TECHNOLOGIES

Description

One strand of priority is to develop cutting-edge technologies (e.g. artificial intelligence, big data and AI-based data analysis technologies, cloud and high performance computing (HPC and quantum computing), next generation - 5G mobile networks, space technology, quantum technology, innovative materials technologies such as micro and nanotechnology; industrial biotechnology, photonics, robotics), both in the corporate and in the academic sectors, and in cooperation with these sectors.

In order to put Hungary at the forefront of European research, a strong emphasis must be placed on research into cutting-edge technologies. In an era of digitisation and industrial transformation, the global race to research leading technologies is fierce and can consume extraordinary resources. Hungary can succeed in this increasingly competitive environment and catch up with the global leaders or maintain its position if it creates a collaborative network that is internationally competitive in terms of both infrastructure and human resources by supporting knowledge transfer between sectors, focusing and connecting academic research capacities, and involving small and medium-sized enterprises.

MODIFYING THE S3 PRIORITY LIST AND THE CONTENT OF THE PRIORITIES

Based on the European Commission's expectations and the previous experience of S3, it is possible to modify the structure and objectives of the S3 priorities during the implementation period 2021-2027, if there is a justified need for this based on domestic and international economic changes or the EDP conducted during the implementation period.

Following the S3 interim evaluation, the S3 Project Office will present proposals for changes to the priority list or the content of the current priorities to the S3 Steering Committee and the National Science Policy Council, which is also the High Level Support Body for S3, taking into account the needs of the EDP participants (TIPs), the proposals of the S3 Working Group and the proposals of the relevant horizontal professional organisations.

In addition to domestic applied research (TRL 1-2), efforts should be made to ensure that experimental development and testing (TRL 3-6) for large companies also takes place in Hungary, as this can contribute to the creation of high value-added jobs. In global competition, the increased attention should also be paid to strengthening the domestic protection of intellectual property related to the research and development of cutting-edge technologies.

RDI activities for cutting-edge technologies should also include an analysis of the social, environmental impacts and risks associated with the suitability of the state-of-the-art technologies.

The other strand of the priority involves the widespread adaptation of cutting-edge technologies to make effective use of smart specialisation.

The wider application of cutting-edge technologies contributes greatly to the development and production of higher value-added products, but late reaction to global technological paradigm shifts can result in an irrecoverable disadvantage. Cross-sectoral cooperation is also key in this respect: initiatives and organisational frameworks to promote coordinated use should be encouraged, in order to increase the use of research infrastructures with cutting-edge technologies.

The *priority also covers the research, development and production of cutting-edge technologies related to the defence industry as a strategic area highlighted by the Government*. The *priority also covers the production of cutting-edge dual-use technology products, which are* part of the defence industry, *and support for innovation in the production of such products and services*.

Among the technological trends for the next 20 years, NATO (2020) has highlighted eight research areas of strategic importance for the development of defence capabilities. These areas also define the domestic focus of defence-related RDI activities in the priority:

- Data-related research *(Big Data and Advanced Analytics)*
- Research in artificial intelligence *(modelling and simulation, space, materials; virtual reality, quantum computing; autonomy)*
- Research in the field of autonomy *(Autonomous platforms and devices (such as UAVs), human-machine interaction and cooperation, countermeasures, autonomous behaviour*)
- Research in quantum technologies *(quantum computing, sensing, PNT (position, navigation, time), communications and cryptography)*
- Research in space technologies *(navigation, forecasting and threat assessment, environmental monitoring, communications, intelligence)*
- Research in biotechnology and human development *(bioinformatics and biosensors, human development, medical countermeasures, synthetic biology)*
- Research into new types of materials and manufacturing technologies *(advanced materials, nanotechnologies, 3D manufacturing)*

Primary target group

All actors in the RDI system (universities, research institutes, businesses, non-profit sector) because the range of cutting-edge technologies may vary, but in particular M: professional scientific and technical activities, P: Education, J: Information, Communication, CI: Manufacture of computer, electronic and optical products.

Objectives

- Hungary should be close to the European forefront in research on cutting-edge technologies.
- As much as possible of the experimental development of cutting-edge technology research should take place in Hungary
- Establish and operate research networks and promote cross-sectoral, knowledge transfer collaborations to research and develop cutting-edge technologies
- Research infrastructures support the commercialisation of research results related to cutting-edge technologies, with a focus on applied research
- Improve the uptake of cutting-edge technologies by small and medium-sized enterprises
- Strengthening skills development support services for the effective use of cutting-edge technologies
- Supporting initiatives to enable sharing and cross-sectoral sharing to increase access to available cutting-edge technology infrastructures

HEALTH PRIORITY

Description

The priority covers the whole field of health innovation, from better understanding of diseases, health promotion and disease detection, to cures, clinical research, clinical trials of new drugs by Hungarian pharmaceutical companies, development of services to improve physical well-being (e.g. health tourism), including a wide range of health care and research institutions engaged in RDI activities, pharmaceutical SMEs, and health industry enterprises.

The healthcare industry is becoming increasingly important, and the SME sector must be able to exploit its potential. The priority is to ensure that the health industry and health RDI activities in Hungary do not merely follow socio-economic trends.

It is a social expectation that the priority should contribute to increasing the resilience of society, in addition to increasing economic competitiveness. In addition to research into the diagnosis and treatment of diseases, the priority also gives preference to research into health preservation and disease prevention. The health priority is synergistically linked to the agriculture and food priority in the context of health promotion. It also includes RDI activities to research and assess environmental health impacts for effective prevention.

In order to increase social resilience, it is important to develop and widely deploy social innovations and technological solutions to improve access to health services.

There is an opportunity to increase the involvement of healthcare institutions in RDI projects, but the rigidity of the regulatory environment for the use of newly developed procedures and technologies in healthcare is a challenge.

The priority will focus on promoting cross-border cooperation, as it contributes to the international recognition and recognition of domestic knowledge and results, and to the enhancement of domestic health research and manufacturing capacities.

The priority projects should also fit in with the objectives of Hungary's overall Health Strategy and the 8 health sub-sectors identified in the Strategy, namely: biotechnology, e-Health background industry, herbal medicine, bionics, genomics and epigenetics background industry, health tourism, medical devices industry. In addition, health tourism projects should be in line with the National Tourism Development Strategy 2030 (NTS 2030).

Primary target group

- CF: Pharmaceuticals, 26: Manufacture of computer, electronic and optical products (266 Manufacture of electronic medical equipment, 267 Manufacture of optical instruments), 32: Other manufacturing (325 Manufacture of medical instruments), MB: Scientific research, development, P: Education, Q: Human health, social care, 46: Wholesale trade (except of motor vehicles and motorcycles), 47: Retail trade (except of motor vehicles and motorcycles), 70: Business and management consultancy activities, 10 - Manufacture of food products, 22 - Manufacture of rubber and plastic products, 1089 - Manufacture of other food products n.e.c., 2229 - Manufacture of other plastic products, 4618: Wholesale trade services on a fee or contract basis of other products, 4646 Wholesale of pharmaceutical goods, 4669: Wholesale of other machinery and equipment, 4773: Retail sale of pharmaceuticals, 4774: Retail sale of pharmaceutical goods in specialised stores, 7022: Other management consultancy activities outside these specialised branches: 128, 1089, 2110, 2120, 2229, 2660, 3250, 4618, 4646, 4669, 4773, 4774, 7022, 7490, 7211, 7219; 96:Other personal services), 9604: Physical well-being service

Objectives

- Strengthening R&D in the health sector and health industry, expanding R&D capacities: Setting up new research centres
- Increasing the involvement of healthcare institutions in R&D projects
- Strengthening RDI activities for health promotion and disease prevention
- Digital, smart care developments to increase access to health services, with a particular focus on the Silver Age (55+) and people living in depopulated settlements
- Expanding international cooperation: adapting international good practices
- To increase the sector's capacity to generate added value, in particular by encouraging large multinational companies with production capacity in the domestic market to carry out RDI activities in Hungary.

- Strengthening SMEs in the health sector, encouraging start-ups in health services, supporting collaboration between medical researchers and start-ups, SMEs and innovators
- Encourage the spread of innovative solutions for technological change (innovative diagnostic technologies, therapeutic procedures, services, medical devices e.g. individual patient specific implants PSI - Patient Specific Implants - 3D printing techniques etc., digital solutions.

DIGITISATION OF THE ECONOMY PRIORITY

Description

The priority covers the automation of production and service processes and the use of digital business solutions for enterprises (micro, SMEs and large companies).

The most important challenge for the Hungarian economy is to stimulate the innovation capacity of the SME sector, which in the era of digitisation and industrial transformation overlaps significantly with digitisation capabilities. The dissemination and everyday use of digital solutions among micro, small and medium-sized enterprises in Hungary should be given special attention, partly to enable them to be prepared and able to cooperate effectively with large companies and international partners, and partly due to the need to increase productivity. Compared to our Western competitors, the biggest gap is in the digitisation of production and service processes of micro-enterprises, and the use of digital solutions.

In Hungary, the majority of SMEs and micro-enterprises have difficulties in realising the benefits of digitisation, so one of the priorities is to achieve a paradigm shift in this area during the implementation period of the strategy.

If the domestic SME sector lags behind in this area, it could deepen the duality of the domestic economy and lead to stagnation of the SME sector: SMEs will not be able to integrate into global production chains in the short term, nor will they be able to integrate into the value chains of large multinational companies operating in Hungary.

For those SMEs that are not yet ready for full digital renewal in all respects, but are still active in production or services, job creation and retention at the local level is important, and developing digital skills to at least average levels is key to their survival in the digital age. Therefore, a key objective of the priority is to improve the overall digital readiness of micro, small and medium-sized enterprises in the domestic SME sector.

Under S3, targeted support for digitally open and capable SMEs is the main focus of the priority, which can become drivers for the effective implementation of smart specialisation in the local innovation ecosystem through a digital transformation.

By using digitisation tools and automating processes, these companies are increasing their ability to add value in their own right, while also becoming an attractive supplier base for large international companies.

The other strand of the priority is to facilitate the creation of intersectoral connectivity through digital tools, such as the move towards Food 4.0 and Packaging 4.0, building on the achievements of Hungarian agriculture.

In the era of increased digitisation and robotisation in the 21st century, cyber and other security challenges, developments related to S3 should fully enforce domestic intellectual property protection, data protection and national security requirements, as well as the uniform aspects of national resilience and dual-use (in the case of the defence industry) for stakeholders.

Primary target group

SMEs in all sectors (including agriculture) that are open and capable of digital innovation.

Objective

- Promoting the digitisation of processes and the uptake of digital solutions by micro, small and medium-sized enterprises
- Targeted support for digitally open and capable SMEs in all sectors, especially those of strategic importance but where there is a major gap (including agriculture);
- Encouraging cooperation between different sectors based on the use of digital tools
- Strengthening of national cyber defence capabilities through research and development based on domestic R&D, and development and deployment of advanced technical tools

ENERGY, CLIMATE PRIORITY

Description

The main objective of the priority is to fight climate change and promote the transition to a carbon neutral economy. Within this framework, the priority will *support the promotion of RDI activities related to energy production, storage and use, and the* dissemination of existing and new methods and technologies that *replace natural gas and oil-based energy production or reduce the use of these fossil fuels and make them more efficient. The priority includes both industrial and residential use activities, as well as support for energy efficient and environmentally friendly business operations*[7]

In Hungary, the use of nuclear energy will significantly contribute to the maintenance of energy security and - due to its low production costs - to the competitiveness of the national economy during the implementation period of S3, and nuclear power generation is also indispensable for Hungary in reducing CO_2 emissions (National Energy Strategy, 2020).

Taking into account the domestic conditions and the tasks related to the construction of new nuclear power plant units to be built by 2030, the Energy, Climate priority in the S3

[7] For sectors at risk of carbon leakage, such as steel and chemicals, more resources are needed for R&D and hydrogen research could play a greater role, including those that offer products and services to account for, reduce, eliminate and remediate negative environmental impacts and can make the greatest proportional contribution to the competitive use of hydrogen.

implementation period should cover R&D activities related to nuclear power generation capacity expansion and further nuclear innovations based on these, as well as RDI issues related to the long-term safe use of nuclear energy and the appropriate storage of radioactive waste. The priority includes reducing emissions from the largest CO_2 emitting industries by reducing energy use and increasing manufacturing efficiency, and research into technologies that enable the wider uptake of renewable and natural energy sources in energy-intensive sectors and for domestic use (such as the potential for geothermal energy from thermal water flowing out from or welling up inside spas).

In the construction and building materials industry, the production and application of modern product technologies can bring about a major change. The climate energy use of old buildings is increasing, so their early modernisation for energy efficiency is essential. The priority therefore gives preference to building energy issues.

Solutions to reduce the use of fossil fuels through the development of hydrogen industries, such as the development and enabling conditions for hydrogen fuel cell propulsion, are also eligible. Priority will be given to supporting the development of scalable and mobile energy storage capabilities and advanced battery technologies.

Increasing resilience to cyber vulnerabilities is a key national strategic priority to increase the reliability of energy services. With the digitisation of the energy network, the vulnerability of some energy distribution and storage infrastructures, including smart meters and IoT devices, is increasing, so the development of protection mechanisms following the type testing of existing infrastructures is a priority.

Primary target group

D: Electricity, gas, steam, air conditioning, CK: Manufacture of machinery and engineering products, CL: Vehicle manufacturing, CG: Manufacture of rubber, plastic and non-metallic mineral products, CH: Manufacture of basic metals and fabricated metal products, CI: Manufacture of computer, electronic and optical products, CJ: Manufacture of electrical equipment, M: Professional scientific and technical activities, F: Construction industry, P: Education

Objectives

- Support for RDI activities related to the civil use of nuclear energy and nuclear safety
- Promoting the transition to a low-carbon economy, researching and scaling up new innovative energy production, storage and use solutions that reduce environmental impact and increase energy efficiency through the widespread dissemination of existing and new methods *(through technology development, capacity building and scaling-up),* primarily (but not exclusively) in key sectors such as *mechanical engineering, automotive, construction, rubber and plastics, paper, textiles, energy-intensive metal, chemical and mineral production*
- Researching and scaling up energy efficiency solutions for the home through the widespread dissemination of existing and new methods

- Developing solutions to ensure uninterrupted energy supply to critical infrastructures and industrial supply capabilities of high national interest
- Strengthening climate awareness in society through social innovations (e.g. skills development and smart solutions)

SERVICES PRIORITY

Description

The priority approaches the sectors from two main strands.

On the one hand, it includes service sectors with high growth potential. Based on the GMR model results, these sectors include Transport, storage and warehousing; Wholesale and retail trade; Repair of motor vehicles and motorcycles; Administrative and support service activities.

These sectors are linked to many other sectors, including manufacturing, so their innovativeness can easily have an impact on other sectors.

On the other hand, this priority also covers the entire business sector, including the productive sector, with the aim of expanding their product portfolio with new services. As a result, the priority will include strengthening RDI activities in the target sectors, as well as strengthening service innovation in the whole business sector. The aim is to develop innovative services across the entire business sector that have high added value and are exportable, in particular those based on advanced IT.

At the same time, most companies do not necessarily develop the services they use, but rather buy the methods and technologies as a services that enable them to adapt their own services. Therefore, the other direction is to support the uptake of new or existing solutions that are modern, and that increase efficiency or improve customer satisfaction and "customer experience".

Primary target group

H: Transport, storage; G: Wholesale and retail trade; Repair of motor vehicles and motorcycles, N: Administrative and service support activities, M: Professional scientific and technical activities

Objectives

- strengthening R&D and innovation in service sector enterprises
- improving the competitiveness of businesses by supporting the development of innovative services and the use of new services

RESOURCE-EFFICIENT ECONOMY PRIORITY

Description

The priority covers solutions that aim to make the most efficient use of available resources, reduce environmental pressures and mitigate the effects of climate change by exploiting the

potential for resource-efficient use and optimisation of technological processes or by adapting the life cycle of products. While the energy and climate priority focuses on energy efficiency, resource efficient management focuses on reducing or optimising the use of materials, there is a synergistic relationship between the two priorities, and some improvements can build on or complement each other.

One strand of the priority covers a range of activities and sectors that can be classified as **circular economy**. The circular economy aims to minimise waste, reduce resource use, and reduce environmental pressures, primarily by transforming the life cycle of products. It encompasses corporate activities such as sustainable design, whereby companies consider the entire life cycle of a product from the design stage, through the selection of its materials and function, and strive to reduce its environmental footprint. RDI activities on the circular economy should also address more sustainable packaging and storage.

The priority covers R&D activities related to the circular economy in both the business and research institute and university sectors, mainly in the fields of mechanical engineering, automotive, rubber and plastics, energy, engineering, metalworking, electrical equipment, food and agriculture. The priority may also include RDI activities on more efficient and safer management and reuse of secondary raw materials, or the application of solutions for their management. The priority will encourage the exploration of new materials with a lower environmental impact or new applications and production possibilities for previously known materials that are not yet competitive on the market due to production costs. At the same time, cost-effective manufacturing technologies can provide a competitive but greener solution.

In the context of strengthening the circular economy, the priority not only encourages domestic RDI activities, but also covers the adaptation of solutions to minimise waste, where foreign good practice and technology can be applied more effectively and resource-efficiently than the development of domestic solutions.

The priority also covers maintenance, technical assistance, repair, refurbishment, remanufacture and recycling[8]

The priority also covers the development of water management technologies. Hungary is a leader in this area, exporting high value-added services or know-how can increase the competitiveness of the domestic economy. The priority will encourage initiatives to support the development of a bio-based economy, in synergy with the priority Agriculture and food.

Primary target group

D: Electricity, gas, steam, air conditioning, CK: Manufacture of machinery and mechanical equipment, CL: Vehicle manufacturing, CG: Manufacture of rubber and plastic products (in particular: C: 1721 and 2222: Manufacture of paper packaging and plastic packaging., CH: Manufacture of basic metals and fabricated metal products, CI: Manufacture of computer, electronic and optical products, CJ: Manufacture of electrical equipment, F: Construction

[8] PricewaterhouseCoopers Magyarország Kft: Ha a kör bezárul – a körforgásos gazdaság jelentősége és lehetőségei (Closing the circle - The importance and opportunities of a circular economy), 2018

industry, A: Agriculture, CF: Pharmaceutical manufacturing, CA: Manufacture of food, beverages and tobacco products, M: Professional scientific and technical activities, P: Education.

Objectives

- Strengthening RDI activities and the diffusion of such innovations throughout the innovation ecosystem to mitigate the effects of climate change, in particular the development of water management technologies or packaging materials and techniques or storage devices.
- Strengthening RDI activities to strengthen the circular economy, minimise waste and promote the spread of innovations and the adaptation of good practices to reduce environmental pressures.
- Developing and promoting the uptake of resource-efficient expert services in maintenance and technical support
- Developments to support the development of a bio-based economy
- Innovative solutions and skills development to raise awareness of the resource-efficient economy, to spread a conscious approach.

AGRICULTURE, FOOD PRIORITY

Description

The priority will cover the whole agri-food innovation chain, including: forestry, horticultural technologies, plant breeding, plant protection, crop production technologies; animal breeding, animal husbandry, animal feed and grassland management; agri-biotechnology (soil fertilisation, irrigation, water retention, soil protection, plant biotechnology), food safety, processing technology solutions, healthy food.

Hungary has a favourable agricultural position, with excellent production conditions, both in terms of climate, soil quality and water availability. The performance of agriculture and our food industry will remain an important pillar of the national economy during the period of the strategy.

Agriculture and the food industry are the most exposed to climate change among the sectors of the economy, therefore the priority gives preference to the development of agricultural technologies that promote adaptation to climate change and solutions that strengthen stress resilience. In synergy with the "resource-efficient economy" and "energy, climate" priorities, a key element of this priority is to reduce environmental pressures and mitigate the effects of climate change.

The priority aims to support the development of the area in two directions, building on the domestic potential:

The combination of environmental conditions and the experience of growing and rearing livestock, combined with innovative solutions, make the sector suitable for the production of premium products. Increasing the export volume of the sector by applying innovative agricultural technologies and competitive solutions *(*e.g. the use of sensors, advanced data collection and evaluation, livestock production supported by artificial intelligence and 5G mobile network access, precision technologies) can significantly contribute to the competitiveness of the national economy. To achieve this goal, the production of organic food and quality products, rather than a quantitative approach, could be a competitive advantage for domestic agri-food businesses.

The other is to ensure that agriculture and the food industry contribute to promoting sustainability while at the same time increasing the resilience of the countryside.

Ensuring that local markets are supplied with healthy, consistently high quality food in times of climate change is essential. The use of innovative, efficient technologies is also essential for local agri-food businesses to stay in the market and make their activities profitable.

As the effects of the pandemic have shown, in the 21st century, the development of short supply chains at the local economy level is of particular importance, which can also contribute to local value creation and employment. The pandemic has also shown that sustainable animal husbandry and modern animal health are also gaining in importance, due to their positive public health impact.

This priority will focus on developing the production of valuable nutritional food and medicinal products that support health promotion, and on promoting RDI and agricultural research to improve the efficiency of their production.

In both directions, the storage, transport and technological background must be improved.

Primary target group

A: Agriculture, CA: Manufacture of food, beverages and tobacco products, 28: Manufacture of machinery and equipment (283: Manufacture of agricultural and forestry machinery), M: Professional scientific and technical activities (75: Veterinary care), P: Education

Objectives

- Encourage the widespread dissemination of innovative solutions and innovative agricultural technologies for a shift towards sustainable agriculture and a bio-based economy, in particular in the areas of water and nutrient demand and solutions to reduce the environmental impact of crop protection interventions
- Experimental applications of agricultural technologies for climate change adaptation to enhance the resilience of domestic crop and livestock production
- Increasing the added value produced by agri-food businesses through the use of innovative technologies
- Supporting the internationalisation of the food industry: producing products with a higher degree of processing, promoting the presence of domestic products on international markets
- Short supply chains, short selling, shortening transport distances
- Promoting the production of healthy and therapeutic foods
- Developing agricultural storage and transport capacities

CREATIVE INDUSTRIES PRIORITY

Description

The priority covers improvements, innovations and technological investments related to the production process for products and services to be produced by the cultural and creative sectors.

Hungary's natural resources and financial potential are limited compared to the EU's core countries, so great emphasis should be placed on developing those sectors whose competitiveness and performance are fundamentally determined by the quality and availability of human resources. These are creative industries with high added value, creativity and adaptability due to their small size. Unlike mass products, it is their uniqueness and special nature that makes them attractive.

The priority covers the creative industries, which are:

Creative and design activities	Entertainment and media activities	Activities related to cultural heritage
• Design • Fashion • Advertisement • Arts and crafts • Folk arts (and crafts) • Crafts • Fine arts • Architecture • Music • Literature	• Film • Television • Radio • Online media • Press (electronic and print) • Festivals • Performing arts • Web content • Software and video game development • Game development (including board games) • Publishing activity	• Libraries and museums • Archives • Tangible and intangible cultural heritage

In addition to the above sectors, the creative industries are linked to, among others, manufacturing (light industry) activities (e.g. clothing, ceramics, furniture). An important goal is to increase the role of the creative industries in value chains.

In the design and implementation of policy measures, it is important to ensure professional coordination between the different creative sub-sectors, involving professional institutions.

The longer-term economic and social benefits of the creative industries can be manifold. For example, creative industry solutions offer answers to the challenges of an ageing society. Such is the humanisation of technology, which means both the "civilisation" of technology through the combined application of the tools of art and science, making it human-centred, leading to a higher quality of life; and the improvement of human-machine interactions, creating a kind of human character. The creative industries should also be involved in developing responses to the environmental and sustainability challenges of the near future and integrate sustainability considerations into their activities (e.g. packaging of products, materials used for fashion products, creative elements of branding).

Scientific research that investigates ergonomics, social awareness and human-machine relations can make the increasingly dynamic development of technology and the changes it brings more marketable and acceptable through appropriate forms of communication. In this respect, it is important to strengthen interdisciplinary RDI projects involving social sciences, cognitive disciplines and creative industries alongside STEM fields.

Primary target group

J: Information, communication (58: Publishing, 59: Motion picture, video and television programme production, sound recording and publishing, 60: Compilation, broadcasting), 62: Information technology services, 63: Information service) R: Arts, entertainment, leisure, 73: Advertising, market research, 74: Other professional, scientific, technical activities e.g. Fashion, design, Photography; 71: Architectural engineering; technical testing and analysis,

741, 32: Other manufacturing activities (e.g.: 321 Jewellery manufacturing, 70 Management consultancy (e.g.:7021 PR, communication),

Objectives

- the creative and cultural sectors should increase the leverage of innovation in Hungary.
- creative industries should help bridge the gap between cultural values and modern technologies in order to humanise technology. They should combine the results and skills from the creative sectors with innovation and technological developments in the productive sectors. The aim is to strengthen links between the arts and the business world.
- promote interdisciplinary RDI activities involving the creative industries to sustainably improve human health and living standards

4.5.2 Horizontal priorities

TRAINING, EDUCATION

Description

The successful domestic application of smart specialisation depends on the availability of a workforce with the right skills and in sufficient numbers to meet the objectives of national economic priorities. In implementing S3, in addition to retaining R&D staff and strengthening the supply of researchers, it is essential to ensure the availability and skills development of a workforce with the right skills to meet the needs of the local economy.

The main objective of the priority is to ensure a continuous supply of sufficient and skilled labour in line with labour market needs. The demand for skilled workers can also be significantly influenced by the manufacturing and R&D capacity of companies moving to Hungary, which places demands on both vocational and higher education.

The main objective is to implement training activities related to smart specialisation in close proximity to the sites of companies in the industry and to develop training capacities, as this will ensure more effective practical training and continuity of post-qualification employment. Cooperation between training centres and companies can also be organised more effectively. Emphasis should be placed on expanding the training portfolio both locally and nationally.

The overall aim of the priority is to reduce the quality shortage of labour and support the development of skills linked to smart specialisation. One of the priorities of S3 is to ensure that the supported investments and developments include a greater share of software activities, mainly training, which will develop the skills needed to effectively apply smart specialisation. These are the efforts that this horizontal priority aims to make.

As will be shown in chapter 5.2 of the Strategy, the effects of industrial change will affect the future of the labour market, our perceptions of work and the skills that the labour market expects. Workers who are able to adapt to the changes of an age of industrial transformation

are those who are able to adapt continuously, understand and use cutting-edge technologies, have the right transversal skills and are capable of lifelong learning.

The priority supports the development of technical skills relevant for smart industrial specialisation and digital transformation, strengthens the capacity for knowledge acquisition across professions and disciplines, based on the "T-shaped" skills model (see chapter 5.2), and promotes the development of soft skills expected in the context of industrial transformation.

To reduce the skills gap for smart specialisation, new curricula and teaching methods need to be promoted at all levels of education, from primary to tertiary.

Primary target group
All players in the local economy (universities, research institutes, vocational training centres and institutions, businesses, non-profit sector).

Objectives

- Strengthening the skills and capabilities needed to implement RDI developments in order to increase the number of enterprises carrying out RDI activities and to increase the effectiveness and efficiency of RDI projects of universities, research institutes and enterprises.
- Providing SMEs with a skilled workforce, increasing labour productivity.
- Encourage cooperation between vocational training, higher education, businesses and the public sector to train a workforce that meets the needs of the local economy and foster an attitude of innovation.
- The content of STEM training should be strengthened and developed to meet the competence needs of enterprises. Develop interdisciplinary, pathway-based training programmes that are linked to the skills needs of the labour market.

PUBLIC SECTOR AND UNIVERSITY INNOVATION PRIORITY

Description

The priority includes initiatives to strengthen the innovation capacity and innovation activities of public administrations, central government (non-profit organisations, research institutes) and local government organisations, as well as universities as educational institutions, which can be classified as service, organisational, marketing, etc. The priority will specifically support public administration innovations related to smart specialisation.

Primary target group

- Public administrations, central government (non-profit organisations, research institutes) and local government organisations and universities

Objectives

- Strengthening innovation capacities in public administrations, as innovation in this sector is also necessary to improve the efficiency and competitiveness of the national economy as a whole.

4.6 The territorial objectives of S3

The Hungarian S3 is essentially national in its priorities, but is also partly adapted to the differences between Budapest and the rest of the country. At the same time, the situation analysis and the results of the S3 monitoring report for the 2014-2020 programming period show that, in addition to Budapest, 19 other counties in the country show significant differences in both socio-economic development and RDI performance (NRDI Office, 2019)[9]

The previous S3 introduced the region type category to address these spatial differences. In the chapter on the challenges of smart specialisation, we have updated the classification of counties into different types of regions based on the latest available data: the **typology shows the relative position of counties in relation to each other**.

This justifies the use of **region types** in this S3 to **reflect the different performance of counties** and to continuously monitor changes in both their RDI and socio-economic performance.

Knowledge regions	Industrial production zones	Moderate knowledge and technology intensive areas
Budapest	Fejér	Békés
Csongrád-Csanád	Heves	Jász-Nagykun-Szolnok
Győr-Moson-Sopron	Komárom-Esztergom	Nógrád
Hajdú-Bihar	Vas	Somogy
Pest	Zala	Szabolcs-Szatmár-Bereg
Veszprém	Bács-Kiskun	Tolna
Baranya		
Borsod-Abaúj-Zemplén		

8. Table: Types of regions based on their RDI performance

For each type of region, general objectives are formulated which are not adapted to the priorities but to the development trajectory of the counties concerned.

[9] The report has taken the following KSH (Hungarian Central Statistical Office) data into account for the classification of region types: Number of enterprises per 1000 inhabitants, share of enterprises with more than 250 employees, investment per 1000 inhabitants, GDP per 1 inhabitant, industrial production per 1000 inhabitants, internet subscriptions per 1000 inhabitants, R&D expenditure per researcher, number of full-time higher education students per 1000 inhabitants.

Objectives for each type of region:

Knowledge regions

- further strengthening knowledge centres, enhancing the professional excellence of R&D, stimulating RDI activity in the business sector through ecosystem development and expanding cooperation between the two sectors to give regional players competitive advantages that will put them at the forefront of international developments.
- strengthening the university-centred innovation ecosystem by developing research infrastructure capacities, increasing the number of researchers, expanding cooperation between regional actors (universities, research institutions, businesses, non-profit organisations) in order to strengthen the weight of the local ecosystem within the country and improve the international competitiveness of regional RDI capacities.

Industrial production zones

- greater involvement of regional actors in the domestic RDI process, with the number of R&D and innovation performing enterprises increasing based on economic results. Furthermore, to strengthen the process of knowledge diffusion, both from large companies and knowledge-dissemination organisations, especially towards SMEs.

Low knowledge and technology intensive areas

- stimulating openness to R&D and innovation among regional actors, as a basis for the application of new R&D results and technological and other business innovations to a wider range of entrepreneurs.

5. Key challenges for smart specialisation

The Smart Specialisation Strategy (S3) is a specific, territorially-based and sector-oriented policy instrument, a **dynamic, medium-term umbrella strategy to** contribute **to the achievement of** Cohesion Policy **Objective 1 (Smarter Europe through innovation and support for economic transformation and modernisation)** for the 2021-2027 programming period.

In order to achieve Policy Objective 1 (PO1), the draft Regulation on the European Regional Development Fund and the Cohesion Fund also sets specific objectives, which summarise the goals of S3:

i. **enhancing research and innovation capacities and the uptake of advanced technologies;**
ii. **reaping the benefits of digitisation for citizens, companies and governments;**
iii. **enhancing growth and competitiveness of SMEs;**
iv. **developing skills for smart specialisation, industrial transition and entrepreneurship**; (European Commission, 2018b)

In Hungary, these objectives **can be** achieved **through the eight vertical and two horizontal priorities, which we have identified as "national economic priorities"** in the priorities chapter. For each priority, a target has been set to which projects receiving funding in the 2021-2027 programming cycle must contribute, ensuring that the overall objectives of S3 are met.

An important **instrument** for the implementation of S3 is the **RDI policy, of which the "National RDI Strategy 2021-2030" is an important guiding document**. What distinguishes the two documents is that **S3 is sectoral, while the RDI Strategy is horizontal in nature,** not aiming at a specific discipline or sectoral focus, but providing direction for R&D and innovation development as a whole.

Another important **tool for** achieving the S3 goals **is the enterprise development policy**. **The SME Strategy (2019) is a key document**, one of whose dedicated tasks is to establish coherence between government programmes supporting enterprises and the conditions for coordinated action.

A third important **tool for** implementing S3 **is digitisation, for which a strategy (National Digitisation Strategy) is currently being adopted**.

In order to avoid duplication, the **S3 Situation Analysis** focuses on the factors that define the S3 target system, while the RDI Strategy contains a general and broad assessment of the situation of the Hungarian RDI system.

This situation analysis therefore aims to provide a comprehensive overview of the situation along the following lines:

- **The spread of innovation and the barriers to digitisation;**
- **The dimensions of industrial transformation in Europe and Hungary.**

Chapter 6 presents the Hungarian Government's response and measures to address or mitigate the problems raised.

5.1 The spread of innovation and barriers to digitalisation

This chapter presents the findings on the Hungarian RDI system that have been highlighted in the European Commission's **country reports and country-specific recommendations**, the EU's **annual report** on small and medium-sized enterprises (SMEs) (SBA, 2019) and Hungary's RDI Strategy 2021-2030 as typical observations during the European Semesters of recent years. A comprehensive report on the domestic RDI system was produced in 2016 at the request of the European Commission, involving key domestic stakeholders and external experts, as a result of a multi-stage process (DG RTD, 2016), the findings of which are also presented in this chapter. The report is hereafter referred to as the **peer review**. All these sources provide a comprehensive picture of the **weaknesses and problems** of the Hungarian system, which RDI policy is seeking to address and to which concrete measures are being taken.

The results of **our EDP survey** (described in more detail in chapter 3) confirmed the main barriers to the spread of innovation identified in the policy documents referred to**.** The problems

most frequently reported by respondents during the EDP are identified separately in the section on the challenges.

5.1.1 Challenges in the financing of the RDI system

R&D expenditure

In the context of the Europe 2020 strategy, Hungary has made two commitments to improve the RDI system: firstly, that by **2020, the share of R&D expenditure in Hungary will reach 1.8% of GDP**, and secondly, that business R&D expenditure will reach 1.2% of GDP.

The main recurring finding of the country reports is that Hungary's R&D expenditure as a percentage of GDP (GERD[10]) is low compared to the EU average, and therefore an increase in funding is still needed. Hungary's performance is outstanding among the countries in the region, but below the EU average of 2.11% (European Commission, 2020).

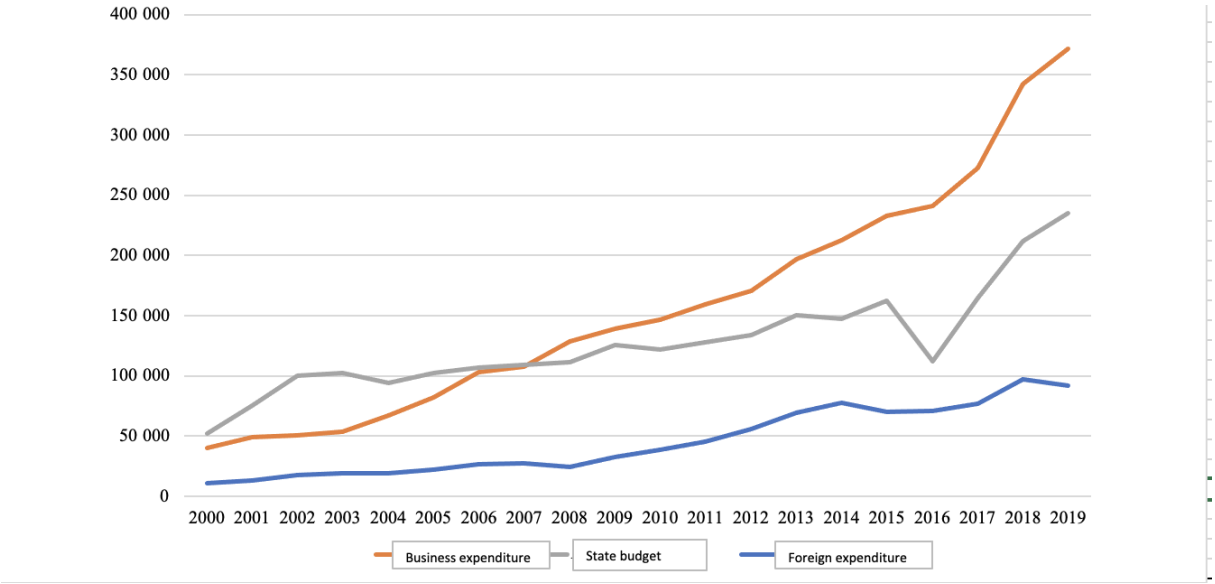
However, it should be noted that Hungarian R&D expenditure reached 1.48% in 2019 - a trend increase from 1.53% in 2018, which was probably broken by high GDP growth in 2019.

The amount spent on R&D in the Hungarian business sector as a percentage of GDP (BERD[11]) was 1.16% in 2018 (a favourable figure compared to the V4 countries: we are ahead of Slovakia (0.45%) and Poland (0.80%), and close to the Czech Republic (1.2%)). In addition, as we will show in the section on policy instruments (and as a priority in the RDI Strategy), **Hungary is taking significant steps towards a predictable and sustainable RDI funding system in the long term**.

Underfunded public R&D system

Recent country reports (European Commission 2019, 2020) emphasise that overall R&D spending in Hungary has increased in recent years, but this is typically due to an increase in R&D spending by companies. The ratio of **public budget resources** to GDP stagnated between 2004 and 2018, although the amount of expenditure from public budget resources showed an upward trend after 2016, as illustrated in the graph below.

[10] GERD: Gross Expenditure on Research and Development
[11] BERD: Business Expenditure on R&D



14. Figure: R&D expenditure by financial resources 2000-2019, (HUF million)[12] Source: Based on KSH, NRDI Office own editing

The Commission stresses that the R&D expenditure of the **publicly funded RDI system** is not yet at the EU average and that a **higher level of support than at present is justified**, as the low level of public R&D expenditure has a negative impact on research and innovation. Among the measures to strengthen the RDI system, chapter 6.2 presents the steps taken so far to make the publicly funded RDI system results-oriented and the interventions planned in the context of the restructuring of the funding system.

The Commission believes that the quality of publicly-funded science is weakened by underfunding. The lack of financial resources has had a negative impact on the career prospects of public sector researchers and their numbers fell by 1.5% between 2010 and 2018 (European Commission, 2019). However, the decline in the number of researchers may not only be due to the relative stagnation of public spending as a percentage of GDP: during the economic downturn and labour shortages of recent years, the academic sector has been under significant pressure due to the absorptive power of industry. Accordingly, in the next period, in addition to increasing public spending, the strategic objectives of the Hungarian RDI also focus on an attractive career model for researchers and more flexible mobility of researchers between sectors, as outlined in the measures.

The country reports also underline that the **level of public funding for private sector R&D in** Hungary is **among the highest in the EU**. However, business R&D support only accounts for 0.18% of domestic GDP and 16% of total business R&D expenditure in 2019, according to the Hungarian Central Statistical Office (KSH).

[12]The "Other domestic sources" funding category is not shown in the graph, as it remained at a low level compared to the other three categories over the period under review (just over HUF 3.5 billion in 2019). Removing it would have confused the visualisation of the trend.

Beyond the RDI system, the general finding of the country reports on the state of the Hungarian economy is that the ratio of public and private investment to GDP is high, but the composition of this investment is not sufficiently geared towards raising productivity. Investment in economically-useful skills, education and training is essential (European Commission, 2019). Building the right competences (creative thinking and other transversal skills, digital competences, entrepreneurial and innovative attitudes) is key for S3 for all actors in the "quadruple helix", and is therefore a key focus of this S3 plan document, the RDI strategy's target framework and the RDI pillar of the Economic Development and Innovation Operational Programme (GINOP).

5.1.2 Improving the operational efficiency of the RDI system

The regulatory and business environment is not sufficiently supportive and flexible

Typical feedback from both the Commission's country reports and expert feedback is that the regulatory and business environment in Hungary does not sufficiently support R&D activity, and this practice needs to be reviewed. The **regulatory environment**, corruption risks and weak accountability distort the allocation of resources and slow the reallocation of resources to productive enterprises, thus also holding back business dynamism (European Commission, 2019). The Commission points out that the perception of the business environment by small businesses is generally worse than for large companies, suggesting that smaller businesses operate in a less favourable business environment (European Commission, 2019).

The expert report on the review of the domestic RDI system highlights that in order to strengthen domestic RDI, existing **tax incentives** and generous RDI tax incentives need to be reviewed and evaluated to ensure that fast-growing innovative companies can make more effective use of them. The appropriateness of tax incentives for different industries and firms (start-ups, scale-ups; firms with significant RDI activity but modest sales in Hungary; export firms and traditional firms) should be examined. Conclusions should be drawn to simplify existing regulations and reduce the administrative burden for users (DG RTD, 2016). Respondents to the EDP survey also indicated a high proportion of problems related to the nature of the domestic business environment (complexity of administrative processes, bureaucracy, inadequate level of online administration) as a barrier to innovation.

The 2019 country report notes that the public procurement framework has improved in recent years, but still does not sufficiently promote competition and productivity. (European Commission, 2019). Both the 2019 and 2020 country reports encourage the promotion of greater competition and transparency in domestic public procurement.

Recognising the challenges mentioned above, Hungary's RDI Strategy 2021-2030 sets out that the business environment and, as part of it, the regulation that determines the spread of innovation, needs to be adapted to the needs of RDI actors. Part of this is to ensure as little administrative burden and as much predictability as possible, including the creation of a legislative framework for public procurement that supports the RDI system and is geared towards RDI objectives. The steps taken so far and the planned intervention points to support the business environment for the implementation of S3 are presented in the section on measures

to strengthen the RDI system. In the field of public procurement, the amendment of Act CXLIII of 2015 on Public Procurement (PP Act), in force since 19 December 2019, abolished the public procurement obligation of funded entities not classified as EU contracting authorities.

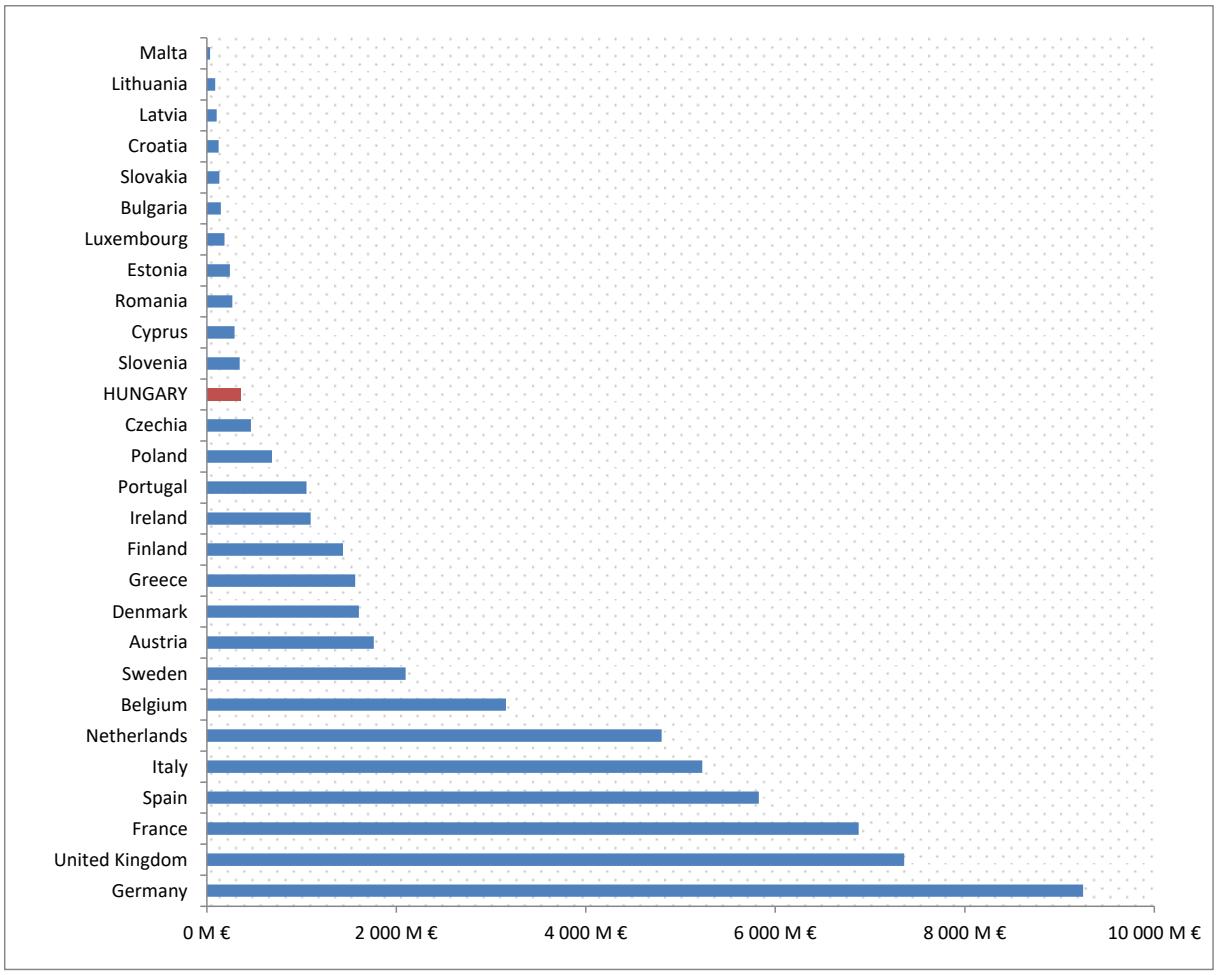
The 2017 RIO report identified the country's lack of experience in pre-commercial procurement as a problem (RIO, 2018). The Expert Panel on the domestic RDI situation also recommended the further development and use of pre-commercial procurement and public procurement for innovation to stimulate and reward research and innovation. (DG RTD, 2016). The National RDI Strategy 2021-2027 identifies "challenge- and demand-driven RDI stimulation" as a horizontal objective, whereby the sector will identify the development of a public procurement system for RDI based on innovative public procurement good practices from abroad. The Strategy states that through appropriate regulation and a change of mindset, public demand in our country should become as important a catalyst for RDI as in the leading countries. In this context, the Strategy proposes the domestic adaptation of problem-solving public procurement and pre-commercial procurement (PCP). The RDI Strategy Action Plan summarises the planned sectoral actions in these areas of intervention.

Low level of international embeddedness

Both the Commission and the independent expert report underline that the domestic RDI system is generally poorly **embedded in the international RDI ecosystem**. There is a continued need to encourage RDI actors to enter the international arena and to increase their capacity for transnational cooperation.

The EU's annual report on small and medium-sized enterprises also highlights the role of government in promoting internationalisation in the business sector, while highlighting that the percentage of total public procurement contracts awarded abroad by SMEs has declined in recent years (SBA, 2019).

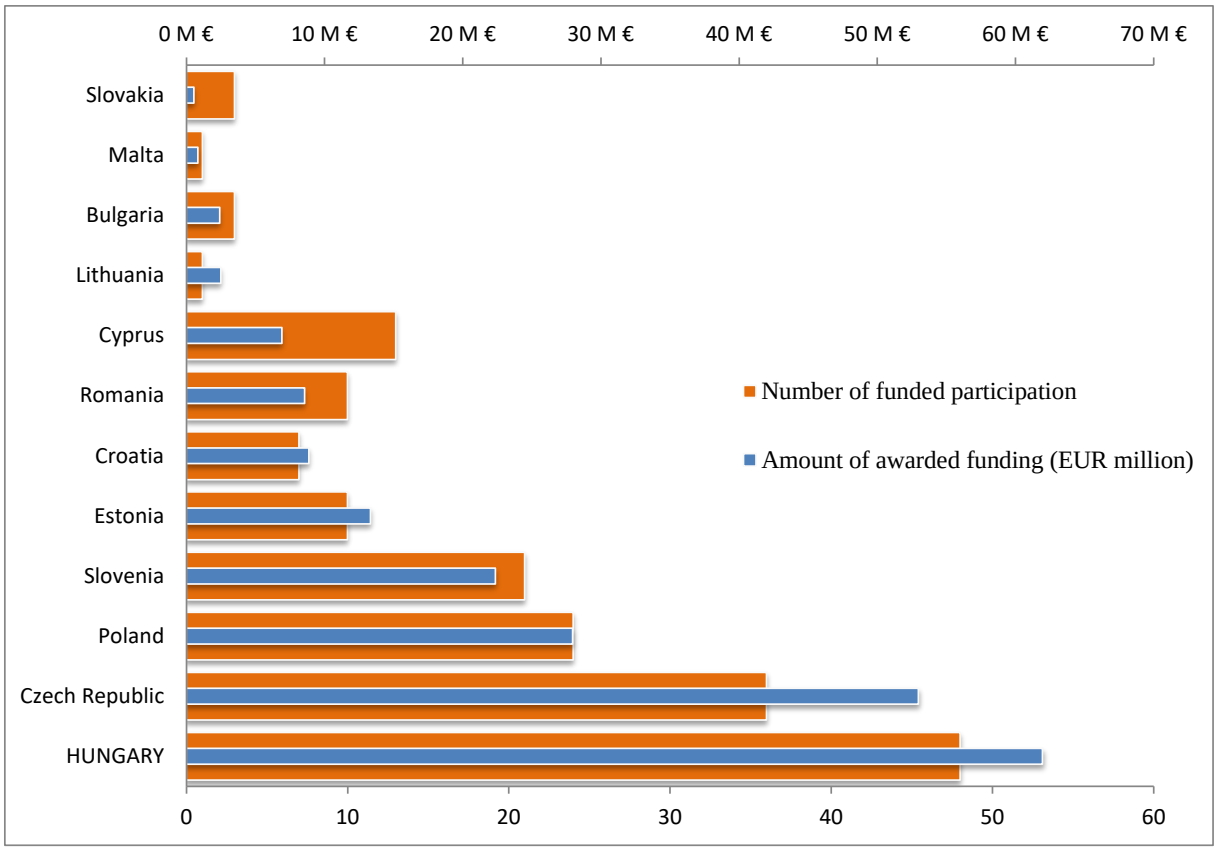
The internationalisation of the domestic RDI and SME system needs further development to enable domestic actors to act as equal partners with researchers from core countries. However, in regional comparison, domestic RDI performs well and some results show that there is a pool of researchers that can go a long way towards meeting the requirements of the European RDI system. Although the vast majority of H2020 funds have been awarded to the EU-15 (94.2% of the total), Hungary is one of the Member States that joined the EU in 2004 and performs well in the EU's framework programme for RDI. In terms of the number of projects funded (1,077 projects) and the amount of funding awarded (EUR 352 million), only Poland and the Czech Republic are ahead of Hungary among the EU-13 countries, but Hungary has set itself the target of significantly increasing this ratio.



15. Amount of funding received by EU28 Member States under the H2020 framework programme (million Euro) Source: E-Corda, December 2020 data)

At the same time, it should be pointed out that Hungary won the **largest number of ERC [13] grants** (44 funded projects[14], for a total of EUR 61.97 million) among the new Member States, representing almost 30% of the ERC grants received by the EU-13 so far.

[13]The ERC is the European Commission's funding agency for discovery research, managing proposals for excellence, with a budget provided by H2020.
[14]Number of participations: number of times national organisations have participated in ERC projects



16. Results for EU-13 countries that have received ERC funding (Source: E-Corda, December 2020 edition)

A number of good practices and initiatives have been launched recently to enhance the international role of the domestic RDI system, which are summarised in chapter 6.2. One of the main objectives of S3 is to support all actors in the "quadruple helix" to strengthen their integration into international value chains and transnational research systems, the dimensions of which, the resources to be exploited and the areas for improvement are presented in the strategy's chapter "Strengthening international cooperation to implement S3" (6.4).

5.1.3 Weaknesses of knowledge flows in the innovation ecosystem

According to the Commission's country report, **research-enterprise cooperation** in Hungary remains below the EU average due to the traditional separation of research, education and innovation organisations (European Commission, 2019). The peer review report on the domestic RDI system also recommends encouraging cooperation between actors in the RDI system, and the EDP survey confirmed that the low level of cooperation between academia and business is also perceived as a major problem by actors in the RDI system. According to the Commission's expert reports, targeted instruments should be put in place to support cooperation between universities, research institutes and industry, including at the level of individual entrepreneurs. The design of support measures to stimulate collaboration between science and industry should take into account past experience and lessons learned from existing policy measures, including the results of independent evaluations of programmes and the views of stakeholders (both beneficiaries of support measures and non-beneficiaries) (DG RTD, 2016).

In response to national and international feedback, **RDI policy has launched a number of cooperation initiatives** in recent years (e.g. Higher Education and Industry Cooperation Centres, Competence Centres, University Innovation Ecosystem). The government is giving an increasing role to university centres in strengthening "quadruple helix" networks and local innovation ecosystems, as outlined in chapter 6.2 of the strategy.

The link between higher education and the business sector should be further strengthened

As a barrier to knowledge flow and innovation, it is necessary to address the situation and problems of higher education in Hungary, which have a significant impact on the support and servicing of the needs of ecosystem businesses.

Hungarian universities are not yet strong enough in **the exploitation of academic knowledge** , despite the good practices that can be identified. The 2017 RIO country report (RIO, 2018) indicates that cooperation between academia, higher education and business needs to be strengthened.

Domestic enterprises identified as a high priority barrier to innovation activities, according to Eurostat data for 2018 (Eurostat, 2018).

However, only 10.3% of innovative businesses in Hungary collaborated with domestic higher education institutions between 2016 and 2018 (Eurostat, 2018).

The share of innovative SMEs collaborating with any other domestic company or institution between 2015 and 2017 was only 5.9%, according to the latest European Innovation Scoreboard (European Commission, 2020h). The EU-28 average was 11.8% over the same period**.**

More experience is needed in activities related to the third mission of higher education. According to the peer review, there is a lack of institutionalised contacts with SMEs, and an accurate and up-to-date portfolio of available university services is needed. Some recent policy measures, such as the **University Innovation Ecosystem** competition, focus on these problems.

Differences in approach between universities and businesses can also be a barrier. In many ways, university and business needs are "at odds". Researchers are primarily committed to scientific discovery and knowledge creation, while the socio-economic exploitation of their research results is typically less important to them. For the university, the aim is not to make a profit in the market, but to build a knowledge base, a centre of excellence (DG RTD, 2016). And it is not in the interest of companies to transfer competitive knowledge created in a joint R&D project to the university, which represents a market advantage (DG RTD, 2016).

In universities, businesses do not typically use the services of technology transfer offices (TTIs) to establish contacts, and researchers do not seek market contacts through TTIs (NRDI Office 2019). The framework for the operation of the TTIs is determined by available funding, not by long-term university concepts.

Another problem mentioned by experts is that joint research collaborations between large companies and universities have little impact on the SME sector. Knowledge generated through

joint research should also be demonstrated and made available to SMEs to strengthen knowledge building and technology transfer. This can be an important element for the sustainability of knowledge transfer projects. (NRDI Office, 2019).

Coordination is not well supported by intermediary organisations

The country reports indicate that **research, education and innovation organisations are traditionally separate**. There are a number of intermediary organisations in Hungary, but they cannot effectively provide the necessary added value in terms of the content of their services, their customer orientation, their industrial embeddedness and their ability to build a research knowledge base.

The following main problems can be identified for intermediaries in the RDI system:

- Existing domestic incubators are more focused on providing office services. They operate separately from other intermediary organisations, such as university TTIs (European Commission, 2019).
- According to the 2019 country report, the public and private sectors in Hungary do not yet have hot spots that can be compared with applied R&D organisations such as the German Fraunhofer Institutes, the Finnish VTT[15] or the Dutch TNO[16] (European Commission, 2019) - but this situation has changed fundamentally with the establishment of the Eötvös Loránd Research Network.
- Within higher education, the technology and transfer offices mentioned earlier would be the intermediary organisations. At the same time, the expert reports underline that TTIs are currently set up as general, non-scientific and non-industry-specific organisations without any live, personal contact. They are "hovering" over the different research groups in universities, not linked to specific disciplines or industries (NRDI Office 2019).

5.1.4 Training, development and availability of the RDI workforce

STEM labour shortages in quantity and quality

The **lack of quality and quantity of the STEM workforce**, which has become a feature of the whole of Europe over the past decade, has also caused significant problems in the operation and development of the domestic RDI system. The extent and long-term impact of the economic downturn caused by the COVID-19 pandemic on the labour market is yet to be seen, but it is certain that the training of professionals with the right skills for RDI activities will remain key due to the increasing industrial transformation and digitisation, and their STEM qualifications will continue to be in high demand in the market.

[15] VTT Technical Research Centre of Finland Ltd. - State Technology Research Centre (Finland)
[16] Netherlands Organisation for Applied Scientific Research - the Netherlands' most renowned "start-up incubator", set up by the city council in partnership with Delft University of Technology and the country's non-profit organisation for applied research

In recent years, country reports have also identified the lack of skilled labour as one of the main bottlenecks for the development of the Hungarian research and innovation system (European Commission, 2019). The expert feedback highlights the need to support Hungary's higher education system in order to ensure the long-term availability of a sufficient number of graduates with the right skills to carry out RDI activities, and to this end the Expert Panel recommended the continuation and enhancement of the STEM career guidance.

The 2017 report of the Research and Innovation Observatory (RIO) for Hungary highlights that the number of science and engineering graduates is low by international standards, and the participation rate in lifelong learning is low by international standards, which means that there is a significant gap between labour supply and demand. However, the report indicates that a number of actions have been launched in the field that could reverse the trend over a number of years (RIO, 2018).

According to the peer review, it is important for Hungary to increase the attractiveness of careers in science and innovation by introducing appropriate incentives to promote the mobility of researchers between the business and public sectors, and to address the significant pay gaps between the two. Hungary must tap the potential of its highly skilled RDI human resource base. It should be ensured that Hungarian universities provide adequate and up-to-date training in entrepreneurship and transferable skills, so that Hungarian students can continue to acquire skills that are useful in the future. In this respect, mentoring and exchange programmes between academia and industry, such as collaborative doctoral programmes, are the most useful tools (DG RTD, 2016). In line with the recommendation, the development of tools for more dynamic intersectoral transfer, such as **cooperative doctoral programmes**, has started. In addition, the system to support researchers at all stages of their careers has been further strengthened (e.g. the extension of the New National Excellence Programme to include Bolyai+ winners, and from 2020 onwards young researchers).

It should be noted here that the **situation of education** (including primary, secondary, higher and vocational education and training) **was overwhelmingly perceived as a barrier to innovation in Hungary by respondents to** our **EDP** survey.

The research career model is not attractive enough

A more predictable and attractive **career model for researchers** is essential to ensure that the intervention logic of S3 is effectively implemented. The lack of financial resources has had a negative impact on the career prospects of researchers and developers working in the public sector, whose numbers fell by 3.4% between 2010 and 2018 (COM 2019)**.** In addition to the national level of R&D expenditure in the system, this may be due to a number of factors, such as the absorptive power of industry, the relative unpopularity of academic research careers among younger generations, and more competitive incomes in other sectors.

Expert feedback highlights the importance of introducing appropriate incentives to increase the attractiveness of careers in science and innovation, which promote the mobility of researchers between the business and public sectors and can address the significant pay gaps between the

two (DG RTD, 2016). The steps taken to make research careers more attractive and predictable are detailed in the chapter on RDI policy measures under the RDI strategy.

Low entrepreneurial activity and lack of transversal skills in society

Hungary was ranked 33rd[17] in the Global Entrepreneurship Index (GEI) rankings published by the Global Enterprise and Development Institute (GEDI) in 2019. Our country's favourable position is mainly due to significant improvements in the skills and entrepreneurial aspirations indicator groups. In the former pillar, we have made the most progress in technology uptake, while in the latter we have made the most progress in the indicators of high growth potential enterprises, internationalisation and venture capital.

The composite indicator looks at four main sets of indicators, of which Hungary's performance is weakest in the Entrepreneurial Attitudes indicator[18] .

Statistics on entrepreneurial culture show that Hungary has made substantial progress in almost all indicators examined by the OECD, comparing the period 2004-2006 with 2014-2016.

A comparison based on data from the Global Entrepreneurship Monitor (GEM, 2016) shows that we score slightly above the OECD-EU average on a number of indicators measuring entrepreneurship - fear of failure, social status of entrepreneurs, entrepreneurial ambition. However, it also appears that the main barrier to self-employment is the lack of opportunities, with Hungary lagging furthest behind the OECD and EU averages. We are lagging behind on "Entrepreneurship as an attractive career" and on the skills needed to start a business.

The Global Entrepreneurship Monitor (GEM, 2016), which compares Hungarian data with those of Central and Eastern European countries in detail, was last published for 2015. According to the 2015 GEM report, the adult population in Hungary was the least likely to have the knowledge needed to start a business compared to other Central and Eastern European countries, the least likely to think that entrepreneurship would be a good career option, and the least likely to have a positive image of entrepreneurs in the media. Also, few people saw a business opportunity in their immediate environment and few people personally knew anyone who had been an entrepreneur in the past 2 years.

The peer review on the RDI system (NRDI Office, 2016) shows that entrepreneurship and creativity education is typically not embedded in higher education, and that doctoral schools do little to reinforce innovation-related activities. Training that strengthens entrepreneurial spirit, mindset and skills is only available in a limited number of countries in Hungary. In recent years, policy has changed direction in this respect, with a focus on strengthening the university innovation ecosystem as the medium that most influences academic innovation, while keeping subsidiarity in mind[19]

[17] The ranking includes 137 countries.

[18]Identifying opportunities, start-up skills, risk-taking, networking and promoting an entrepreneurial culture

[19] see: https://nkfih.gov.hu/palyazoknak/nkfi-alap/egyetemi-innovacios-okoszisztema-2019-121-egyetemi-oko/palyazati-felhivas-2019-121-egyetemi-oko

5.1.5 RDI performance of companies

Innovation capacity of SMEs

A regular feedback in the Commission's country reports is that, despite various forms of support, the **innovation capacity of SMEs has not improved significantly in recent years**, and the innovation propensity and activity level of enterprises is typically low. This needs to be increased to bring more innovative, higher added value domestic products and services to the market.

The 2017 RIO country report identifies the lack of R&D resources for domestic SMEs as one of the four main challenges facing domestic RDI, while the report also indicates that these companies often wait for public support to start an R&D project (RIO, 2018).

Hungarian businesses reported on the barriers to starting or implementing innovation activities in the latest Eurostat questionnaire survey for the period 2016-2018 (Eurostat, 2018). Of these, the factors rated highly by respondents were: 1.) Excessive costs (18.3%), 2.) Lack of skilled labour within the enterprise (17.0%), 3.) Difficulty in obtaining public innovation funding or grants (13.0%), 4.) Lack of own resources for innovation (12.3%), 5.) Too much competition (10.8%), 6.) Uncertain market demand for new ideas (7.1%), 7.) Lack of external financing (debt or private capital) (6.9%), 8.) Different priorities within the company (5.9%), 9.) Lack of cooperating partners (3.5%), and 10.) Lack of access to external knowledge (2.2%). According to the EU SME Report, the innovation capabilities of Hungarian SMEs lag behind the EU average because the vast majority of their innovations are still related to small-scale process innovations (SBA, 2019). **Small businesses are particularly reluctant to innovate**, which hinders their participation in the global value chain.

A general problem of the Hungarian economy is that Hungarian companies are engaged in low value-added activities in the global value chain. The OECD Trade in Value Added (TiVA) measures the value added of countries in their external trade, and thus their position in the global value chain. Based on this, the domestic value added in total Hungarian exports fluctuated between 52% and 56% between 2005 and 2016, which is lower than the Czech Republic, where the rate was above 60% in this period (the OECD average fluctuates above 90%, but the size of countries and thus their structural openness has a significant impact on the rate). All this shows that Hungary performs low value-added activities in the global value chain, with a low share of domestic value added, especially in manufacturing.

The country-specific findings for 2019 include that particularly low levels of innovation among smaller firms contribute to low levels of intellectual asset accumulation in Hungary, as shown by the number of patents, trademarks and designs (European Commission, 2019). Another problem is that businesses are not open enough to open innovation. The EU's report on the domestic business sector states that **Hungarian SMEs need to develop more innovative, higher value-added products and services** and sell them on domestic and foreign markets (SBA, 2019).

The reports stress that businesses are characterised by a lack of forward planning: they tend not to think long term and do not see innovation as a way forward in a rapidly changing technological environment, with both opportunities and threats.

In the 2014-2020 programming period, a number of funding opportunities were available to stimulate SMEs' innovation activities through the Economic Development and Innovation Operational Programme (GINOP), the Competitive Central Hungary Operational Programme (VEKOP) and the National Research, Development and Innovation Fund (NRDI Fund). Good practice programmes will continue to be available in the next financial support period under the Operational Programme for Economic Development and the NRDI Fund. In order to increase the share of RDI activities and innovation mindset among domestic SMEs, incentives other than funding scheme incentives are needed, such as encouraging knowledge flows and strengthening the service character of higher education knowledge bases.

Weaknesses in corporate and entrepreneurial culture

The European Commission's country report (2019) shows that companies often fail to adopt good corporate governance practices, as the skill levels of managers and employees are not high enough to ensure the spread of effective business practices, including digitisation. In addition, most small businesses lack the most basic elements of business planning: only three in ten have an annual business plan and only two in ten have a marketing and sales strategy. According to the Commission, employees do not innovate (in-house) or help make work organisation and processes more efficient because of a company culture that is not receptive to innovation (European Commission, 2019).

Businesses invest little in workers' skills and competences, when workers should be adopting and applying new technologies and encouraging innovation (DG RTD, 2016). One of the indicators of the Global Competitiveness Report (GCR) of the World Economic Forum (WEF) measures the importance of training and upgrading the workforce in the life of organisations. Hungary is ranked 100th out of 141 countries surveyed by the WEF (WEF, 2019. p.272).

Overall, low levels of entrepreneurial culture and weak product market competition also hold back business innovation. Weak competition also hinders the expansion of more productive businesses (European Commission, 2019).

According to the EDP survey, local innovation ecosystems also perceive weaknesses in the entrepreneurial culture. A significant number of our respondents identified the quality of financial and business models known and used by enterprises, and the weakness of organisational knowledge and marketing solutions as problems for the spread of innovative thinking. Companies also see potential for development from public and intermediary organisations, lacking real incubation activities, requiring the provision of professional advice, and seeing the low level of venture capital fund management and soft loan provision as a problem.

Digitisation of the corporate sector

Digitisation is now present in almost the entire corporate sector in Hungary, with the share of businesses with internet access close to 100%. Hungarian businesses are limited in their use of digital technology, and the smaller the business, the less it makes use of the competitive advantages of digitisation. The vast majority of Hungarian businesses are among the poorest performing, least motivated and least capitalised micro-enterprises, and preparing them for digital transformation is of paramount importance.

In recent times, strong development policy initiatives (notably the Modern Enterprise Programme) have been taken to promote e-commerce, integrated business management systems and cloud-based solutions, as well as Industry 4.0 solutions.

Despite the above, Hungary ranks among the weakest Member States in terms of indicators measuring the digital economy, according to the EU Digital Economy and Society Index (DESI) report (European Commission 2020f).

Digital technology (enterprise) integration (20%)	**DESI 2020 value Hungary**	**DESI 2020 value EU average**
DESI Digital Technologies Enterprise Integration - components and their current value		
4.a.1 Electronic exchange of information (in proportion of enterprises)	14%	34%
4.a.2 Social media usage (as a share of enterprises)	12%	25%
4.a.3 Big data use (as a share of enterprises)	6%	12%
4.a.4 Use of cloud services (as a percentage of enterprises)	11%	18%
4.b.1 Proportion of businesses selling online	12%	18%
4.b.2 Turnover from e-commerce in SMEs (% of total turnover)	11%	11%
4.b.3 Proportion of SMEs selling cross-border online	5%	8%

17. *table: Digital technology (business) integration in Hungary and the EU Source: European Commission 2020f*

In the last two EU budget periods, businesses operating in the Central Hungary region have not been able to benefit from EU funds (not only ICT funds) available in less developed regions, and they are only partially able to develop from their own resources, which is a particularly large gap in the case of digitisation investments

The EDP survey also confirmed that the level of digitisation in small and medium-sized enterprises also hampers innovation in general. A lack of digital skills, weaknesses in companies' IT infrastructure and the level of digital solutions used by companies were widely seen by respondents as factors affecting the spread of innovation.

The multiplier role of multinational companies is not properly exploited

Better harnessing the presence of multinational companies to create a favourable national RDI environment and improving the overall innovation performance of the Hungarian economy remains a key challenge (European Commission, 2016).

In the business segment, the bulk of research and development expenditure is covered by multinational companies. The domestic supplier network built around these companies can be involved in production, but less so in R&D activities.

The number of entrepreneurs who use the knowledge acquired in multinational companies to set up their own business is negligible, although this type of entrepreneurial knowledge transfer can have a significant impact on the economic processes of a region, and the interventions planned to encourage this are also summarised in chapter 6.2.

5.1.6 Other barriers to the spread of innovation

Another important finding of the **EDP survey** is that respondents also highlighted factors affecting the spread of innovation that were not highlighted or not emphasised enough in the policy documents.

These can include the following areas.

- strengthening the **culture of data management** , the use of data reporting systems, sharing data with actors in the RDI fields, in particular on the results of the use of public funds, and the presentation of the logical system of the application system;
- **non-financial support for market access**;
- operate a predictable funding system for long-term planning.

5.2 The challenges of industrial transformation in Europe and Hungary

We are living in the era of the fourth industrial revolution, a technological explosion in industry that is reshaping the field of production planning and control in a way never seen before - collectively known as the **Industry 4.0** transformation. The expected acceleration in the pace of disruptive innovation and the economy's response to these changes will complicate the design of strategic industrial development goals and government actions. It is difficult to predict to what extent, to what depth and over what time horizon Industry 4.0 and digitisation, the advance of new cutting-edge digital technologies (especially artificial intelligence, big data, 5G) will transform individual sectors and the labour market as a whole.

Similarly, the shift towards **carbon neutrality** as a government response to environmental challenges could have a significant impact on the functioning and structure of the economy.

The **technological explosion and digitisation**, which is more of a bottom-up process, and the **shift towards** a top-down accelerating **carbon-neutral economy will bring about economic and social changes** that are difficult to predict. Therefore, effective cooperation between policies, training and the availability of an appropriately skilled workforce are essential to ensure successful transformation and to tackle the problems. The question is how we can be the winners of this industrial and economic transformation.

For Hungary, which has set the **re-industrialisation of** the country as a strategic goal (Irinyi Plan, 2016), the Industry 4.0 transformation presents opportunities and challenges. The main

objective of the industrial strategy is to increase the share of industrial production in the national economy, mainly by reassessing the role of manufacturing, improving the business environment and strengthening sectors considered to be key for the national economy (Irinyi Plan, 2016).

This chapter summarises the phenomena and challenges that technological change (in particular the transformation linked to Industry 4.0 processes) and the transition to a low-carbon economy may bring.

Note that **during the EDP**, our questionnaire survey **also** gave respondents the opportunity to **indicate the socio-economic problems to which the RDI system should respond**.

The promotion of **energy efficiency solutions,** the widespread use of **renewable energy production and use solutions**, the **digitisation of industrial processes and the importance of Industry 4.0 developments** were high on the list of priorities of our respondents. The processes and effects of industrial change are of particular concern to domestic businesses and the research community.

5.2.1 Re-industrialisation and Industry 4.0

Re-industrialisation as a government solution to regain competitiveness

At the end of the 20th century, the economies of the developed countries were characterised by a process of **de-industrialisation**, i.e. the decline in the importance of industry and the rise of the service sector. However, the economic crisis that started in 2008 has led to a **paradigm shift in** developed countries and a focus on **conscious re-industrialisation**.

One reason for this was that the government sector, reflecting on the experience of the economic crisis, deliberately wanted to increase the share of high value-added production in the economy, which is needed to regain competitiveness and to ensure a higher trade surplus, to which strong industrial production with innovative potential can contribute most. This is also reflected in the Europe 2020 strategy objectives, which reflect the shock of the economic crisis, and include **improving the business environment and supporting the development of a globally competitive, strong and sustainable industrial base** as one of the key areas for recovery (Europe 2020, European Commission, 2010). The government paradigm of reindustrialisation was not a return to the previous economic structure, but was built around new buzzwords: such as increasing the efficiency of supply chains, the use of new high-tech and increasing the share of high value-added production (Nagy, Udvari and Lengyel, 2019).

Despite the development of national industrial policies, reindustrialisation is best understood in terms of restructuring the economies of sub-national territorial units (regions, counties, metropolitan areas). Firms in global industries tailor their product markets and sales to groups of countries, while their input markets and production are organised in subnational regions, usually cities and their catchment areas (Lengyel et al, 2016).

Technological paradigm shift

The reindustrialisation paradigm in government industrial strategies has thus not meant the strengthening or relocation of low-wage, low-technology, mass industry (manufacturing), but primarily the **emergence of a "knowledge economy", the stimulation of higher value-added and higher-wage industrial activities and the related business services**. In our country, this paradigm shift is marked by the shift from "Made in Hungary" to "Invented in Hungary".

The recalibration of industrial policy was driven by economic trends that continued despite the economic crisis: technological progress and the rise of information and communication technology continued the industrial restructuring, with mass-producing, low value-added industries being increasingly marginalised in many sectors (light industry, iron and steel, food) (Barta, Czirfusz and Kukely, 2008).

The fourth industrial revolution is based on a technological paradigm shift brought about by the explosion of ICT technologies. The third industrial revolution, which began in the 1970s, saw the application of computers, automation and robots to mass production. The fourth industrial revolution is moving beyond this, blurring the boundaries between physical and digital. The emphasis is on exploiting synergies between existing tools, and on complex, autonomous networking to achieve greater efficiency. Dynamically evolving technologies such as Cyber-Physical Systems (CPS), Internet of Things (IoT), cloud computing, big data, ITC (Fülep, Nick and Várgedő, 2018) enable the interconnected elements of a complex system to continuously communicate with each other, react to internal and external influences and, based on these, autonomously optimise processes. This enables faster and more flexible service to individual customer needs, with real-time continuous control of conditions. Furthermore, technological changes are increasingly shifting the focus from physical products to the production and sale of services (Cséfalvay, 2017).

One of the greatest challenges is the humanisation of technology, which means both the "civilisation" technology through the combined use of art and science, making it human-centred and leading to a higher quality of life; and improving human-machine interactions, creating a human character. This creates the social "acceptance" needed for the paradigm shift, without which the spread of new technologies (e.g. robotisation) can slow down significantly.

Industry 4.0

The "smart optimisation" of industry, exploiting the synergies of ICT and automation, and its effects, is collectively called the Industry 4.0 transformation.

In the European Commission's definition, *"**Industry 4.0*** describes the *organisation of production processes in which devices communicate autonomously with each other along the value chain: creating a 'smart' factory of the future in which computer-controlled systems monitor physical processes, create a virtual replica of physical reality and make decentralised decisions based on self-organising mechanisms"* (DG IP, 2016, p.7). However, it should be highlighted that in the public discourse, Industry 4.0 is increasingly understood as an acceleration of the digitisation of the economy and society, which has become one of the key

issues for the development and competitiveness of the European Union (Fülep, Nick and Várgedő, 2018).

The "smart optimisation" enabled by cyber-physical networks is transforming the field of production planning and control in unprecedented ways. The technological explosion is triggering economic and social changes that are difficult to predict and to which policies must respond.

5.2.2. Transition to a low-carbon economy

A parallel trend to the technological explosion is the **economy's response to environmental challenges**, which could lead to a drastic transformation of some sectors. These include the energy sector and energy-intensive industries, where the global trend is towards a low-carbon economy, taking advantage of the opportunities offered by alternative technologies. The European Union is a key player in international climate policy and has the most ambitious climate policy objective in this context. The transition to a low-carbon economy is therefore particularly crucial for the European Union and its Member States.

In 2018, the European Commission presented its long-term strategy "A Cleaner Planet for all" (European Commission, 2018c), which sets a target for its Member States to be climate neutral by 2050. Following the discussion on the strategy, the EiT set the goal of achieving climate neutrality by 2050 at EU level on 12 December 2019.

The transition to a climate-neutral economy will affect all sectors of the economy, with **some sectors being particularly affected** within the energy sector (e.g. the transformation of gas market infrastructure). One of the most important and challenging elements for Hungary will be the forced transformation of the European automotive industry, which is still overwhelmingly based on fossil fuel use, under EU legislation. The transport, freight and logistics sector also faces significant challenges, as it needs to be repositioned, while in 2018, more than 90% of EU vehicles still used fossil fuels (MTVSZ, 2018). The EU's **Just Transition Fund** (JTF), which aims to support a just transition in the most affected regions of Member States in the period 2021-2027, with the specific objective of "*enabling regions and people to manage the social, economic and environmental impacts of the transition to a climate-neutral economy*", can help in this period. The draft Regulation of the European Parliament and of the Council establishing the JTI Fund states that the Fund will mainly provide non-reimbursable grants and will focus on economic diversification in the areas concerned, as well as on the retraining of workers and their integration into the labour market, among other things. The resources of the JTF may only be used for the activities listed in Article IV of the draft.

Only eligible regions will be able to benefit from the aid. To this end, Member States should prepare Territorial Just Transition Plans (JTPs) outlining the period up to 2030 in line with their National Energy and Climate Plans, aiming at a transition to climate neutrality, and submit them to the European Commission.

Towards a carbon neutral economy in Hungary

Hungary is committed to reducing emissions. In its National Energy and Climate Plan, it has set a target of a 40% reduction in emissions at the level of the national economy by 2030, and has set a climate neutrality target for itself by 2050. **On 3 June 2020, the Parliament adopted Act XLIV of 2020 on Climate Protection, which enshrines these climate targets in law.** In addition to the transition to a low-emission economy, reducing the need for energy imports is also an important aspect for Hungary.

For the coal market, the Mátra Power Plant in Heves County and its lignite mines in Heves and Borsod-Abaúj-Zemplén Counties are highlighted. Mátra Power Plant is the second largest electricity producer in Hungary. The coal-fired power plant and the two affected regions and their workers must be prepared for changes in the operation of the electricity system. The JTF can provide support during this transitional period. Hungary therefore plans to prepare a JTP for these counties. In addition to the above, due to its significant industrial emissions, a JTP is being prepared for Baranya County, and the eligibility of other counties is under consideration.

Nuclear energy will play an important role in electricity generation and the climate-neutral transition in Hungary. Hungary's objective is to generate most of its electricity from nuclear and renewable energy (mainly solar) (National Energy Strategy 2030, with a view to 2040).

Looking at the electricity sector, the **transport sector** is expected to change at the fastest pace, as the uptake of electric cars will increase the sector's electricity consumption by orders of magnitude. In addition, in the electricity, gas and steam supply sectors, a trend reversal is expected, **energy consumption behaviour** is changing, with passive consumers increasingly being replaced by active, producer-consumer (prosumer) behaviour, in which the use of renewable energy sources (mainly solar energy) plays an important role (National Energy Strategy 2030, looking ahead to 2040).

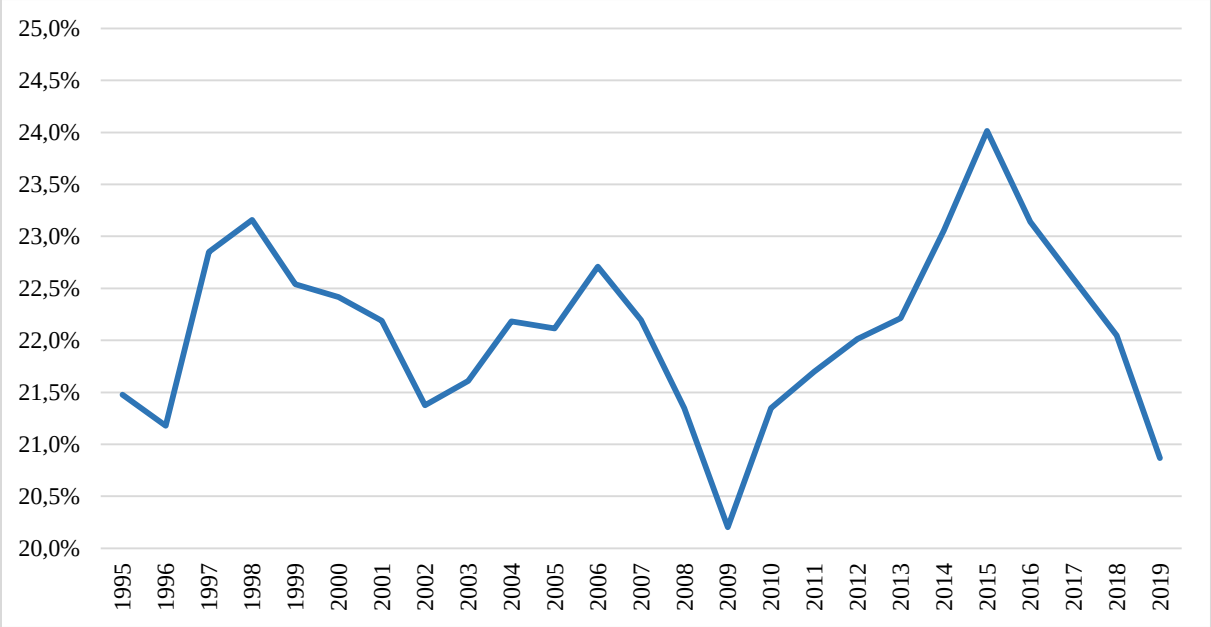
For energy-intensive industries, among which the steel, chemical and cement industries are the most prominent, the transition to climate-neutral operation is particularly challenging, as carbon is needed for reduction in technological processes. These raw materials are of strategic importance, because if their production in Europe were to cease, this would lead to excessive dependence on other countries, which the Commission also wants to avoid, as underlined in the European industrial strategy presented in March. Hydrogen seems to be the most suitable substitute for coal, and many Member States are carrying out intensive research into the development of processes using hydrogen. It is important that Hungary also participates in these programmes, given the growing role of the hydrogen economy and the research opportunities it offers.

In terms of human resources, the energy sector is experiencing a shortage of professionals and skills, and in order to improve its labour market situation, the National Energy Strategy foresees the provision of further training and retraining of the workforce (National Energy Strategy, 2020).

5.2.3 The situation of the domestic manufacturing industry

The growing role of manufacturing

Manufacturing accounted for **22.2% of gross value added (GVA) on average** in the ten years following the 2008 crisis, and its share increased in a dominant trend until 2015, when it still accounted for 24%. In 2019, the manufacturing sector accounted for only 20.9% of GVA, although its production volume increased year on year between 2009 and 2019 (KSH, 2019c).

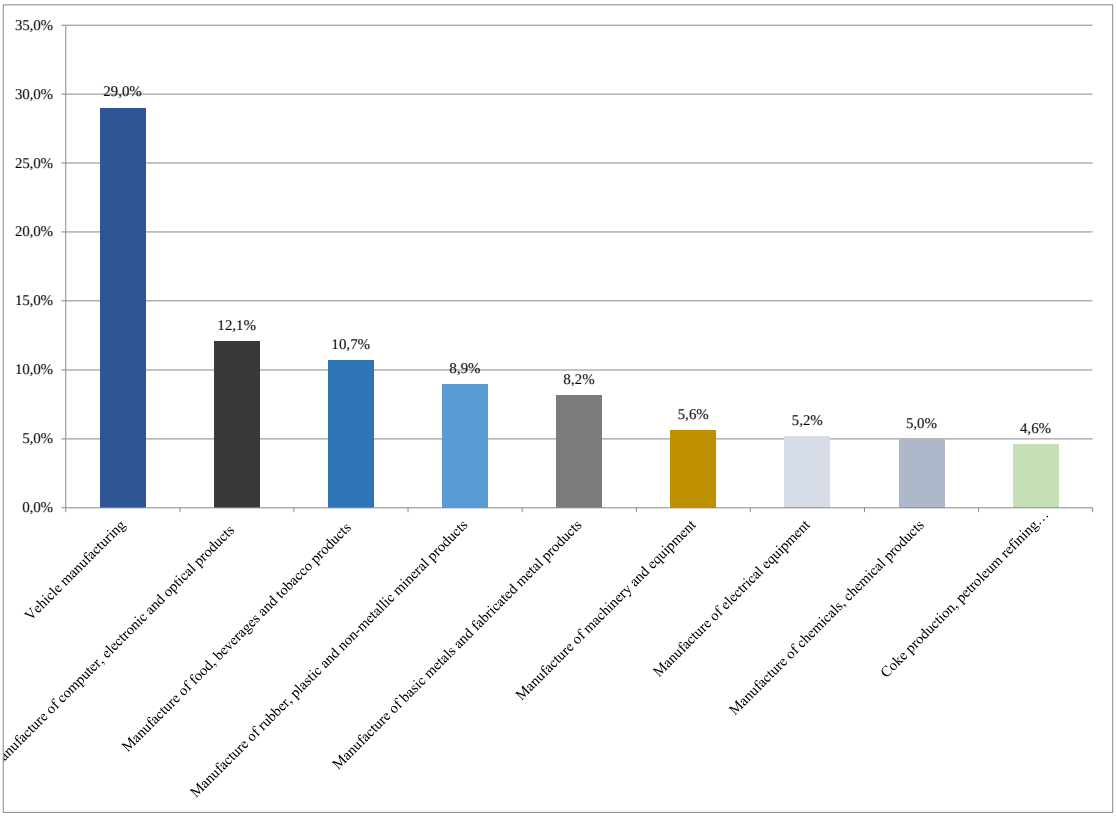


18. Figure: Share of manufacturing in GVA (current prices), 1995-2019 (preliminary data for 2019); source: KSH (NRDI Office own editing)

The manufacturing sector is also a major export earner: the share of exports in sales (at current prices) averaged 74.0% between 2015 and 2019 (KSH, 2020).

Vehicle manufacturing is a key sector within the manufacturing industry. The role of the automotive industry should also be emphasised because it can also stabilise other industries (e.g. iron and metal, electronics or other mechanical engineering), contributing to Hungary's role as a regional centre not only for vehicle assembly but also for the production of automotive components (Irinyi Plan, 2016, pp 54-55).

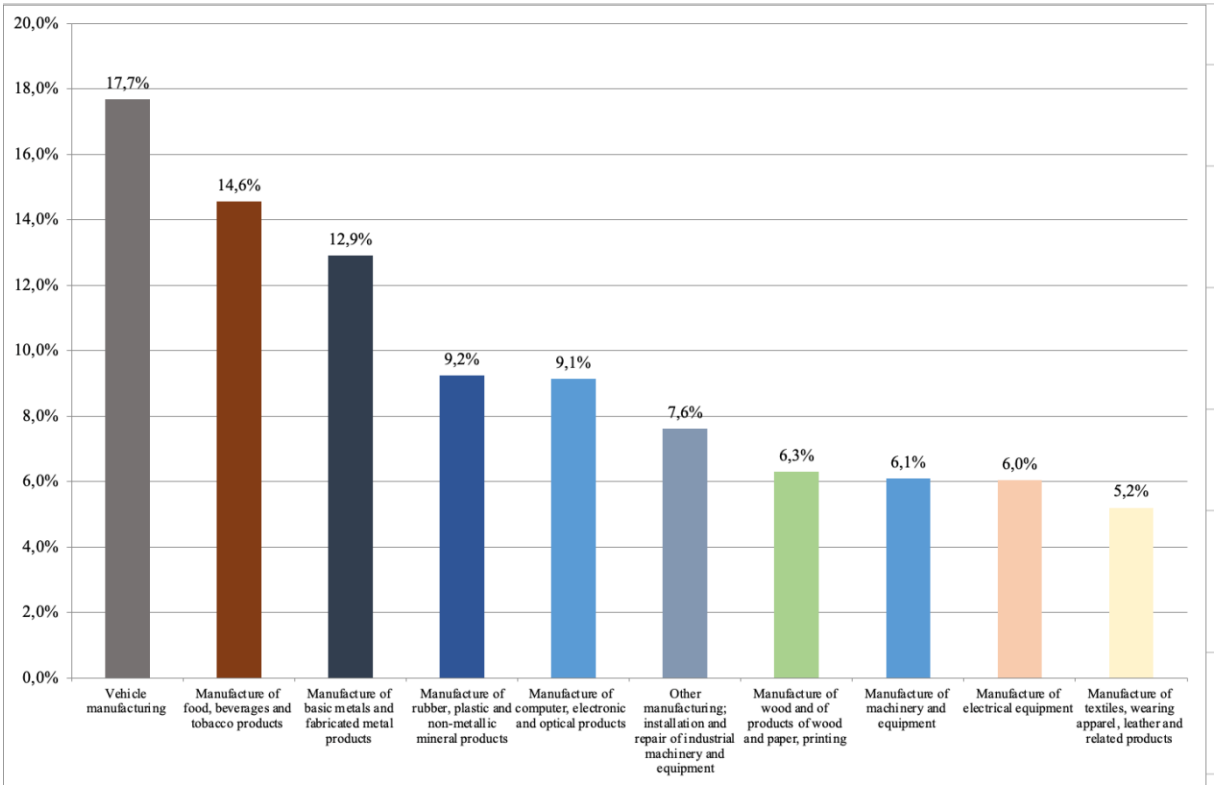
Manufacture of computer, electronic and optical products accounted for 12.1% of manufacturing output in 2019. The third largest manufacturing sector, **food, beverages and tobacco**, accounted for 10.8% of total manufacturing output in 2019 (KSH, 2019b).



19. Figure: Share of each sector in manufacturing by value of production, 2019 Source: KSH, 2019b (NRDI Office own editing)

Employment

Manufacturing employed 22.1% of all employees in Hungary **in 2019**. In the ten years since 2008, the number of people employed in the sector has increased by nearly 155,000 and in 2019, the manufacturing sector employed more than 990,000 people.



20. Figure: Number and share of persons employed in manufacturing by sector in 2019, (thousands; %) Source: Industry, KSH (NRDI Office own editing)

In terms of employment indicators, the largest employers in the manufacturing sector in 2019 were motor vehicles (176.1 thousand persons), food (145.1 thousand persons) and metal (128.5 thousand persons).

The Hungarian Industry 4.0 Platform (Industry 4.0 Platform, 2020) has revealed that half of the companies surveyed on the impact of Industry 4.0 expect **automation to reduce the number of full-time employees** (Fülep, Nick and Várgedő, 2018).

A problem in preparing for industrial transformation is that the skills of employees and managers are not high enough to ensure effective business practices (e.g. digitisation) (country report 2019). This problem was identified as a bottleneck to the spread of innovation in the design of the smart specialisation strategy.

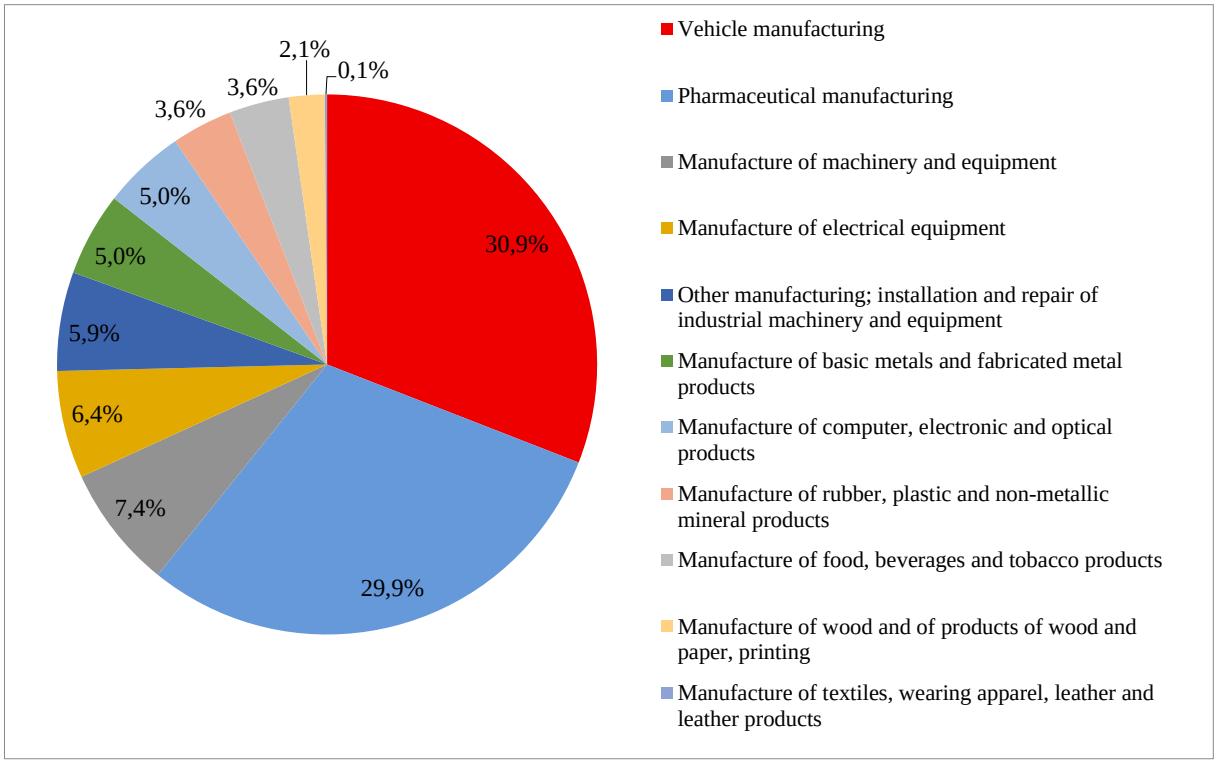
In the context of industrial renewal, it is important for Hungary to be at the forefront in the development of new digital technologies and their deployment, based on the high quality fixed and wireless (e.g. 5G) digital network infrastructure available in Hungary, which is also of high quality at EU level. It is important to highlight that Hungary is a leader in 5G readiness at EU and international level thanks to the large-scale sale of frequencies suitable for the provision of 5G services. These network access opportunities and related developments, such as the 5G test centre in Zalaegerszeg, can also contribute to the development of industry.

5.2.4 The role of industry in RDI activities

Business R&D activity increased significantly in 2018 compared to previous years (between 0.87% and 1.14% between 2013 and 2018), but is still below the EU-27 average (1.45% in 2018).

Micro, small and medium-sized enterprises accounted for 42% of business sector R&D expenditure in 2018. This was the highest in the V4, with 33% in Poland, 30% in Slovakia and 29% in the Czech Republic. This also means that, as in the EU as a whole, **large companies play a dominant role** in R&D activities.

Within the economy as a whole, the largest share of R&D expenditure is related to manufacturing, which accounted for more than HUF 240 billion in 2019. This amount **represents**34.2% of the total R&D expenditure of HUF 702 billion in the national economy and **45.4% of the total business sector**.



21. Figure: R&D expenditure of manufacturing sub-sectors in 2019, HUF billion / share (%)
Source: KSH (NRDI Office own editing)

The largest **volume of R&D expenditure** by manufacturing sub-sector in 2019 was in the **automotive** sector (HUF 72.2 billion), which accounted for 30.9% of total manufacturing R&D expenditure. The share of **pharmaceuticals** (29.9%, HUF 69.7 billion) was only slightly lower. The third largest sector, **machinery and equipment**, contributed 7.4% (HUF 17.3 billion).

The **Irinyi Plan** (2016) identifies the food, textiles and wood and construction industries **as less knowledge-intensive sectors**, while the knowledge-intensive sectors that employ more highly skilled workers are the ICT sector, chemicals and especially pharmaceuticals.

Data from Eurostat's 2018 Community Innovation Survey (CIS, 2018a) show that on average, more than half (50.3%) of businesses in the EU-27 consider themselves innovative. **In Hungary, the rate** was**28.7%**, [20] well above that of the Czech Republic (46.8%) and to a lesser extent Slovakia (30.5%) (Eurostat, 2018b).

The level of innovation in Hungary is low, especially in the SME sector. For enterprises with 10-49 employees, the rate was only 25.8%, while for large companies with 250 or more employees, the rate was much higher at 52.3%, according to the latest data (Eurostat, 2018b).

5.2.5 The impact of industrial change

In the process of industrial transformation, the OECD believes that national economic policies need to take into account the following focal points:

- Helping **workers** in regions affected by industrial transition to find jobs and supporting companies to integrate into the digital economy;
- Stimulating **productivity** growth through innovation in regions undergoing industrial transformation;
- Promoting new industrial **growth directions**;
- Managing **technological change**;
- Managing the risk of structural **unemployment** (OECD, 2019)

So far, in the EU, the deindustrialisation of the developed, centre countries has reinforced the reindustrialisation of the semi-peripheral countries, as companies in Western European countries have been interested in relocating their industrial production to these countries because of lower wages. The effects of the industrial transformation, the fourth industrial revolution, may influence this trend: **reindustrialisation in the periphery increases wages, bringing them closer to incomes in the centre countries**, and technological innovation and ICT technologies make it more profitable in the long run for companies in the centre countries to develop high-tech production units in their own countries, but with fewer employees (Nagy, Udvari and Lengyel, 2019).

In this context, it is important to underline that the structure of the Hungarian economy is still **dualistic** due to its historical development path: the corporate sector is characterised by a small number of SMEs, with a strong economic performance, a predominantly foreign-owned multinational corporation, a dominant SME layer in terms of number and employer, but weak in terms of productivity potential. Between the two dominant areas of the sector, there is a lack of a strong layer of domestically-owned medium-sized companies, which could form a bridge between the two sectors and strengthen Hungary's strategic autonomy.

[20] The share of innovative enterprises in the domestic manufacturing sector was almost the same (28.9%) in 2018. Source: KSH (Information database).

One of the engines of production in the domestic manufacturing sector is the **automotive industry**, which is influenced by the global productivity of a few (mainly German) multinationals. At the same time, this industrial sub-sector is heavily influenced by the spread of Industry 4.0 technologies (automation, the spread of cyber-physical systems, robotisation, next generation - 5G mobile networks). Cséfalvay (2019) indicates that the use of robots in industry in the EU's central and central-eastern European countries is still significantly below the world average and is mainly concentrated in the automotive industry. At the same time, the use of industrial robots is becoming increasingly diversified in the EU's core countries, including in other economic sectors, while the dominance of the automotive industry in robotisation in our region does not seem to be changing. Cséfalvay (2019) also finds that the extent of industrial robot adoption in the CEE region is largely influenced by local decisions of global companies. The sector is also particularly affected by the industrial transformation due to the transition to a low-carbon economy.

Based on expert forecasts, the government's re-industrialisation strategy, the Irinyi Plan, indicates that another major transformation of vehicle manufacturing is expected in about 10-15 years, which is expected to lead to a shrinking labour demand and increased automation, while the importance of custom-made components in supply systems will continue to grow (Irinyi Plan, 2016).

Increasing the **diversification of the** domestic economy is a key issue in preparing for industrial transformation. As underlined in the Irinyi Plan, one of the key challenges is to reduce the unilateral dependence of industry on vehicle manufacturing and related supply industries, and to strengthen other sectors to ensure balanced economic development, as well as to increase RDI spending and strengthen the innovation capacity of the domestic SME sector.

The chronic weaknesses of the Hungarian entrepreneurial system are entrepreneurs' ability to identify opportunities and product innovation. Entrepreneurial skills and the ability to think for oneself can be developed, in which school education and entrepreneurship training can play an important role. The market-oriented exploitation of research and innovation can be strengthened regionally and nationally by strengthening the innovation and incubation ecosystem built on the university base.

Impact of industrial change on the labour market

The fourth industrial revolution will have a profound impact on the future of the labour market and our ideas about work. Technological-driven industrial transformation, coupled with the rise of automation and digitisation, is leading to the replacement of human labour where possible. Based on the literature on industrial transformation, three main trends can be predicted for the impact of Industry 4.0 and digitisation:

- ***Losses of jobs and functions:*** in the coming decades, new technologies of automation, robotisation and digitisation could lead to mass job losses in the low-skilled and routine service sector in developed countries (Cséfalvay, 2017).

- ***Changing skills required in the labour market:*** *"more than one third of the knowledge and skills needed to fill current jobs will change within five years, some of the knowledge currently used will become obsolete, while the demand for new skills will increase"* (Fülep, Nick and Várgedő, 2018, 48). In the long run, the impact of the Industry 4.0 transformation will primarily assess the importance of qualitative labour shortages. Workers who are able to adapt to the processes of industrial change are those who are able to adapt continuously, understand and use modern technology, have the right transversal skills and are capable of lifelong learning.

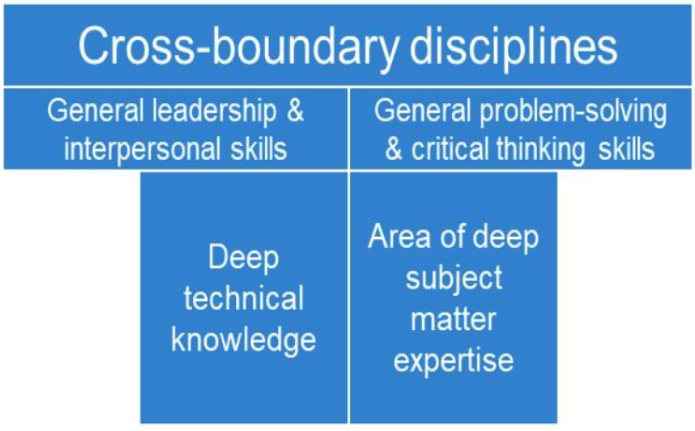
- ***Transforming employment:*** industry 4.0 and digitisation are rapidly increasing the use of more flexible, atypical forms of employment (teleworking, part-time, fixed-term contracts). *"Atypical forms are now so widespread that one could say that the atypical is slowly becoming typical"* (Artner, 2018, p352).

Skills development for smart specialisation in an era of industrial transformation

As indicated in the OECD (2013) study, developing the skills of workers to adapt to industrial change is of paramount importance, as the competitiveness of industry depends to a large extent on the knowledge, skills, competences and creativity of the workforce. Potential gaps in skills development and mismatches between labour supply and demand directly limit job creation opportunities.

The skills required by industry are not just technical. In the last decade, the concept of "T-shaped" skills has emerged, referring to the expectation that individual workers should have both general skills that span several domains and a combination of specific skills within a given domain.

The professionals of the future will be creative, innovative and entrepreneurial, able to build relationships, promote research and strengthen their organisations. The overall skills of a future professional reflect the individual's willingness and ability to work across industries, sectors and disciplines. The in-depth industry and sector skills of the future professional are also indispensable.



22. Figure: A set of 'T-shaped' skills expected in an era of industrial transformation. Source: European Commission (NRDI Office own editing)

According to a report by the European Commission (PwC, 2019), high-tech, 'T-shaped' skills are essential for the EU's competitiveness now and in the future. The concept of high-tech "T-shaped" skills focuses on programmes, projects and curricula that combine high-tech skills with specific complementary skills.

These additional capabilities are:

- Technical skills in a related technological area or system of thought;
- Skills in quality assurance, risk management and safety;
- Leadership, management and entrepreneurial skills;
- Communication skills;
- Innovation skills;
- Emotional intelligence skills; and
- The ability to consider the ethical implications.

The category of technical skills relevant for smart industrial specialisation and digital transformation covers the following technology areas, in line with recent publications on key enabling technologies and digital skills:

- Skills relevant to the research and development of production technologies (e.g. advanced manufacturing technologies, advanced materials and nanotechnologies, life sciences technologies);
- Skills related to research and development of digital technologies (e.g. micro-nanoelectronics, photonics and artificial intelligence);
- Skills related to research and development of computer technologies (e.g. digital security and connectivity);
- Basic digital technology skills (e.g. Digital User Skills, DigComp Framework7); and
- Advanced digital technology skills (e.g. skills related to the IT professions, European e-competence framework)

The above-mentioned stakeholder survey for the report commissioned by the European Commission showed that skills gaps in all these areas are expected and will require new curricula and teaching methods at all levels of education - from university programmes to primary education.

A study by the OECD (2013) classifies the skills required for industrial transformation as follows:

- ***Technical skills:*** the skills needed to solve problems, design, operate, redesign and maintain machines or technological structures, IT skills.
- ***Management skills:*** skills related to business planning, legal compliance and quality control, human resource planning and resource allocation.
- ***Entrepreneurship skills:*** skills specific to start-ups, such as risk acceptance/management, strategic thinking and confidence, the ability to build personal networks, and the ability to deal with different types of challenges and demands.
- "***Green" skills:*** specific skills to modify products, services or operations to adapt to climate change, requirements or regulations.

- ***Other skills:*** skills other than the four types described above, but required by industrial transformation.

6. Policy measures to support the implementation of S3

This chapter outlines a **policy framework**, based on national strategies, whose related measures can support the S3 objectives and interventions, along the lines of the problems identified in the situation analysis.

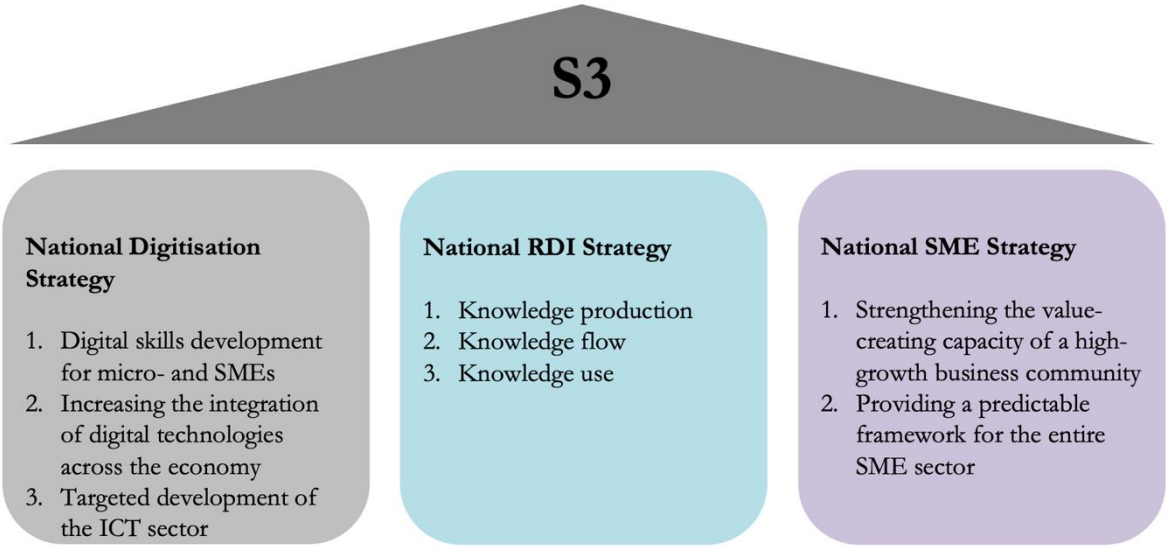
6.1. Strategic environment

6.1.1. The S3 policy pillars

S3 can also be seen as an **umbrella strategy** for the three national policy planning documents, in relation to the following strategies:

- National RDI Strategy 2021-2030,
- SME Strategy (2019-2030)
- National Digitisation Strategy (2021-2030)

These documents set out the strategic objectives for policy areas related to EU policy objective 1 and thus contribute to developing the business environment, policy framework and domestic support policies needed to successfully achieve smart specialisation. In the first part of the chapter, the objectives of these sectoral strategies are presented, followed by the planning documents for the implementation of the remaining national S3.



23. *Figure: Framework for S3 and sectoral strategies (NRDI Office own editing)*

Hungary's RDI Strategy 2021-2030

The **vision of** the **National RDI Strategy 2021-2030** (hereinafter: RDI Strategy) is to create a high value-added, knowledge-based, balanced, sustainable economy and society. In implementing the RDI strategy, it will undertake to modernise RDI institutions and funding based on international models.

The Hungarian Government's vision is that by 2030 Hungary will be among the five most competitive countries in Europe, where it is best to live, work and play. To achieve this vision, competitiveness needs to be boosted by supporting a high value-added economy open to innovation, with a business sector that uses advanced technology and is able to respond flexibly to social, economic and technological challenges. The RDI strategy sets out to achieve this government vision by the end of the decade.

Its future vision is a knowledge-based, balanced, sustainable economy and society capable of creating high added value in all areas of the country, and it will achieve this through the instruments of RDI policy by stimulating and supporting areas of key importance for Hungarian competitiveness.

The specific objectives of the RDI Strategy are pursued along three pillars (RDI Strategy 2020):

A. making **knowledge production** more efficient by increasing the transparency of the RDI system, by increasing and restructuring funding and by developing new support instruments

B. to increase **knowledge flows** by stimulating more effective cooperation between actors in the RDI ecosystem (universities-companies-research institutes network), increasing interoperability between sectors, and expanding opportunities for knowledge transfer

C . making more effective **use of knowledge** by increasing innovation in enterprises

SME Strategy (2019-2030)

In November 2019, the Government adopted **the Strategy for Strengthening Hungarian Micro, Small and Medium Enterprises** (hereinafter: SME Strategy), which will be implemented in the period **2019-2030** (SME Strategy, 2019). The strategy is specifically designed to help domestic businesses through the period of digitisation and technological revolution, and to help them through the economic restructuring process. The implementation of the SME Strategy will ensure coherence between innovation, digitisation and entrepreneurship policies, which can improve the efficiency of SMEs' operating conditions and ultimately lead to stronger businesses.

The strategy continues to set the goal of domestic participation in the global value chain. While maintaining interest as a supplier, it is important that domestically owned companies are also able to build partnerships. The development of innovation in SMEs also involves the renewal of enterprises. Considering that the share of government-funded R&D among SMEs is 88.8%, the impact of EU funds, specific grants, subsidised loans and guarantees and tax incentives on the development of companies should also be taken into account.

National Digitisation Strategy (2021-2030)

After the National Infocommunications Strategy, Hungary needs a new, defining, comprehensive, sectoral government document from 2021, the National digitisation Strategy (NDS) 2021-2030. The National digitisation Strategy's key objective is that, thanks to decisive and well-planned government measures, Hungary's digital development will exceed the EU average by the middle of the decade and be among the top ten EU economies by 2030.

The overarching goal of the Strategy is for Hungary to make concerted efforts to promote digitisation in the fields of economy, education, research and development, innovation and public administration, which - also by international standards - will contribute significantly to improving the country's competitiveness and the well-being of its people. The Strategy aims to prepare for the ever-changing trends of digitisation, and therefore the creation of a comprehensive agenda for the digital transformation of society, the economy and the public sector is a priority.

The achievement of the overall NDS objective is supported by the following specific objectives across 4 pillars:

- the availability of fixed and wireless digital infrastructure with adequate service capacity and quality *(Digital Infrastructure pillar)*;
- the continuous development of digital literacy, media literacy and digital skills of the workforce *(Digital Competence Pillar)*;
- increasing the digital readiness of businesses, the integration of digital technology and the uptake of innovative digital solutions *(Digital Economy pillar)*;
- expanding the range of available customer-friendly digital public services and increasing openness and motivation for their use among citizens and businesses, creating cross-border service provision in the areas required by the EU, and increasing the efficiency of administrative back-office processes by automating and creating a network of interoperable data connections for data-driven operations to support this *(Digital State pillar)*;

The S3 strategy is most affected by the measures under the Digital Economy pillar of the NDS.

6.1.2 International and national strategies related to the design and implementation of S3

EU industrial policy documents

As part of the European Union's industrial policy package, the European Commission presented three new documents in March 2020, the *EU Industrial Strategy*, the *SME Strategy* and the rules and enforcement". The main objectives of both the Industrial Strategy and the SME Strategy are to increase Europe's competitiveness and strengthen its strategic autonomy, two key objectives of which, according to the strategies, are to achieve climate neutrality by 2050 and to put the EU economy at the forefront of the digital transition at global level (European Commission, 2020e).

The EU's Industrial Strategy and SME Strategy also set the direction for domestic smart specialisation. At the national and sub-national level, development directions in line with the EU's key strategic objectives should be the focus of industrial policy development in order to harness the positive effects of industrial transformation.

European Agenda for Research and Innovation - Europe's chance to shape the future

The renewed European Agenda for Research and Innovation (European Commission, 2018d) sets out concrete actions to boost EU research and innovation for the period 2021-2027.

The document stresses that it is through the Smart Specialisation Strategies that the regions will be involved in the innovation economy using the European Structural and Investment Funds. The Innovation Agenda highlights the need to strengthen and modernise smart specialisation strategies to enable interregional innovation support. Synergies should be created with Horizon Europe, InvestEU, the European Social Fund, Erasmus+, Digital Europe, the Common Agricultural Policy and other programmes.

In the Innovation Agenda, the Commission proposes, among other things, that Member States take the necessary steps to maximise their investment in research and innovation to achieve an R&D expenditure of 3% of GDP, which is also the main objective of Hungary's RDI strategy for 2021-2030.

National spatial development concepts and strategies

National Development 2030 - National Development and Spatial Development Concept

Following its revision in 2013, the National Spatial Development Concept was replaced by the National Development and Spatial Development Concept (OFTK, 2014) in order to better align sectoral development policy and spatial development objectives. The PSC sets out a long-term vision, development policy objectives and principles, based on the country's social, economic, sectoral and territorial development needs.

The PIFC sets out national policy priorities for the 2014-2020 programming period, but its vision and objectives are set until 2030. *Accordingly, the PSC defines the development policy and spatial development orientations under which the objectives of the S3 priorities can be implemented*.

At territorial level, developments in the implementation of the S3 priorities should also be in line with the development orientations of the OFTK at county level.

The objectives and criteria of S3 and the OFTK are also linked at several levels:

- *The PIF includes* smart growth *as a horizontal aspect* and the mainstreaming of national development objectives and priorities as the basic principles for the use of resources, which are also the essence of S3.
- Priority S3 contributes to the objectives of the OFTK's Healthy and Renewable Society and the sustainable use of our natural resources and the protection of our environment.

- Some of the specific objectives to be pursued in the OFTK policy (competitive, innovative economy, RDI) are synergistic with the S3 objectives, while others are linked to the S3 priorities (a healing Hungary, a healthy society, a health economy, healthy food production and supply, development of the food processing industry, a creative knowledge society, marketable skills, conservation and sustainable use of strategic resources, protection of our environment).

Economic Development Zones Strategy Papers

In 2020, the government decided to create economic development zones to enable historic regions that are economically and culturally united to develop as an internationally competitive economic entity.

Four economic development zones have been created: South Transdanubian Economic Development Zone, South Great Plain Economic Development Zone, North West Hungary Economic Development Zone, *North*-East Hungary Economic Development Zone.

In implementing S3, it is necessary to take into account the strategies of the economic development zones established in 2020. In addition, the strategies of the zones should be aligned with the priorities of S3 in order to ensure that the zones play a key role in strengthening the economy while contributing to the effective implementation of smart specialisation. In this context, it is necessary to identify the skills needs generated by the development of S3 and to set corresponding objectives for skills development in the strategic plans of the economic development zones. In this respect, the principles set out in the S3 horizontal priority "Training, Education" and the specific objectives of the priority are guiding.

Policy and sectoral strategies

To develop the long list of S3 priorities, we processed the sectoral strategies in force, which were linked to the policy areas under Policy Objective 1. The application of the EDP and the GMR model has resulted in a short list of priorities. The following policy and sectoral strategic plan documents were also taken into account to develop the content and objectives of the selected S3 priorities.

Irinyi Plan, Hungary's re-industrialisation strategy (2016-2020)

In 2016, the Government adopted the Irinyi Plan (2016), a strategic document which sets the re-industrialisation of the country as the direction of domestic economic development, and for this purpose the strategy initiates the increase of added value and the expansion of research, development and innovation activities. The strategy identifies the industrial segments that need focused support for re-industrialisation. These are: automotive, specialised machinery and vehicle manufacturing; health economy, food industry; green economy development; ICT sector, in particular Shared Service Centres (SSCs) and defence industry.

National Energy Strategy 2030

According to the *National Energy Strategy* (2020) *2030, looking ahead to 2040*, Hungary has an interest in reducing its energy import needs and greenhouse gas emissions from energy production. The National Energy Strategy focuses on the consumer, strengthening security of energy supply and climate-friendly transformation of the energy sector, while exploiting the economic development potential of energy innovation. The latter will include energy innovation mapping, transport greening and the corporate greening programme (National Energy Strategy 2020).

Digital Agricultural Strategy (DAS)

The aim of the Strategy is to support the exploitation of the benefits of digital technological development in the Hungarian agricultural economy, and RDI is included in the horizontal elements of the DAS. The long list of S3 priorities has been drawn up taking into account the DAS objectives, and after the validation phases, both agriculture and digitisation are given a prominent place in the priorities (Agriculture, food industry; Digitisation of the economy).

Hungary's Artificial Intelligence Strategy (2020-2030)

The starting point of the AI Strategy adopted by Government Decision 1573/2020 (IX. 9.) is the conscious and broad preparation for the changes caused by AI. One aim of the strategy is to effectively translate artificial intelligence into knowledge-based social capability processes to maximise their contribution to economic growth. At the same time, the pillars of the strategy set out a comprehensive set of objectives to prepare society to effectively manage the inevitable changes that AI will bring. The document sets targets up to 2030 and outlines a plan of action up to 2025.

Dedicated policy measures to prepare for industrial transformation and digitisation are essential for the effective implementation of S3. In addition to the National digitisation Strategy, the Artificial Intelligence Strategy sets out the government's objectives in this area. The objectives of the S3 priority *Digitisation of the Economy* need to take into account the research, development and innovation pillar of the Artificial Intelligence Strategy.

Hungary's comprehensive Health Strategy

In August 2020, the Government adopted in its Government Resolution 1517/2020 (VIII.14.) Hungary's comprehensive Health Industry Strategy, which aims to make Hungary self-sufficient in health equipment and, in the longer term, to make the health industry one of the outstanding areas of the national economy. The objectives of the Strategy are primarily aligned with the S3 Health priority.

National Security Strategy of Hungary

The Government adopted the National Security Strategy by Government Decision 1163/2020 (IV. 21.), which aims to preserve and strengthen the current level of security in Hungary and, as a result, to ensure the further development of the country. The Strategy identifies Hungary's values and assets in the light of new types of global challenges, such as the acceleration of climate and demographic change, the closely related migration, the depletion of natural

resources, and the social shaping effects of the technological revolution. Responses to these challenges include the development of a defence industrial sector that creates high added value and requires significant innovation performance, while strengthening the overall RDI system.

The Strategy underlines that the development of revolutionary technologies is a strategic priority, which is a key objective of the S3 smart economy planning document. Among the priorities of S3, the National Security Strategy focuses on the priority of cutting-edge technologies by highlighting

- ”in key areas such as cyber defence, artificial intelligence, autonomous systems, biotechnology, R&D and its defence component need to be given special attention.”
- in order to increase our competitiveness, we need to ensure access to the most advanced technologies for domestic operators, including SMEs, as soon as possible, taking into account national security aspects.

The Strategy concludes that supporting the domestic defence industry, including R&D and innovation, is in the national security interest, as it can reduce import dependence, increase security of supply and modernise defence equipment with domestically produced products.

Defence Industrial Strategy

In 2021, the Government adopted the National Defence Industrial Strategy, which aims to strengthen the innovation capacity essential for the sustained development of the defence industry and for its pre-eminent role in our geographical proximity.

In the definition of the strategy, *“the defence industry is defined as a cross-sectoral, diversified, strategic industry, encompassing traditional defence, homeland security and emerging security industries, critical infrastructure cyber defence, counter-terrorism, disaster management, and aerospace. These sectors are interlinked, both in terms of the technologies used and the products and services, at different levels and in different forms.”*

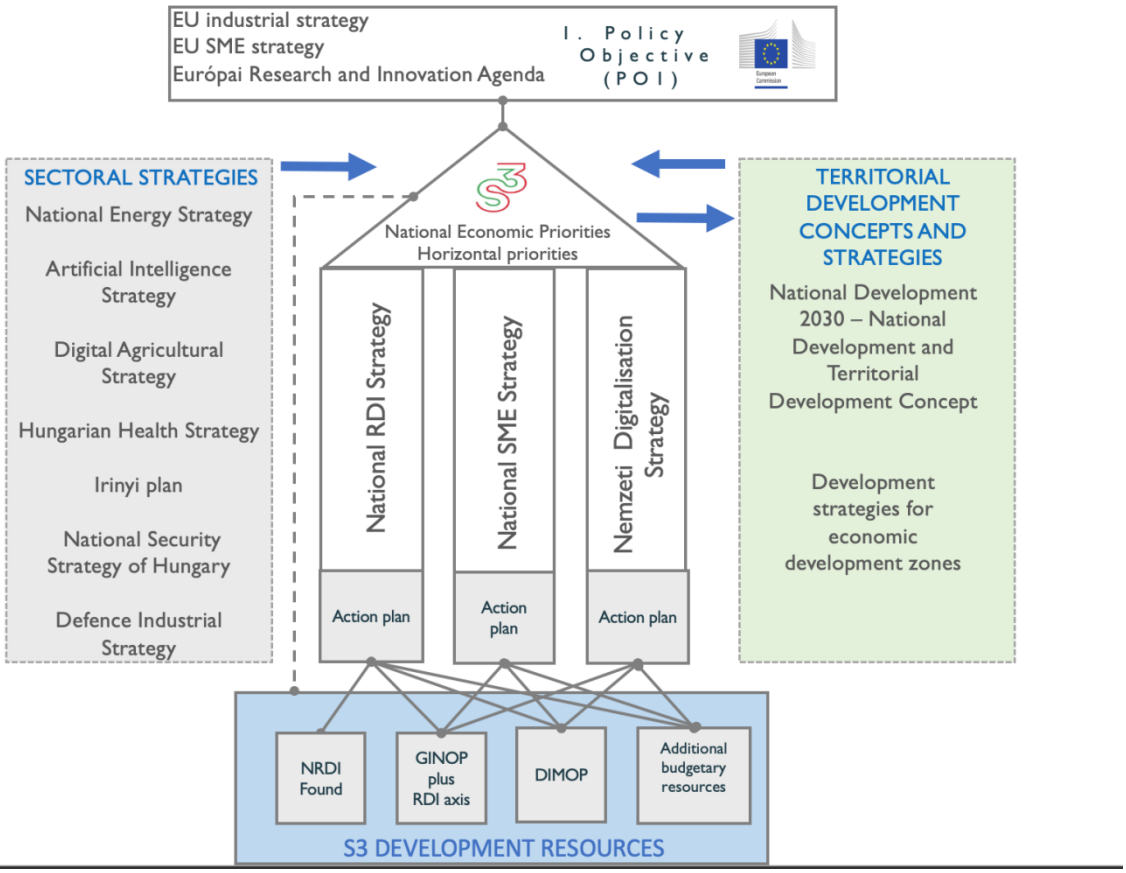
The competitiveness and sustainable operation of defence industry companies is fundamentally determined by the industry’s capacity and potential for innovation. To strengthen this, it is necessary to concentrate and focus resources, strengthen coordination between participants and stakeholders, and consciously manage dual-use research and investment.

Hungary’s aim under the Defence Industrial Strategy is dual-use. developing and strengthening its ’dual use’ capacity, optimising its resources and exploiting its synergies. Dual-use products, services and technologies can meet the needs of both defence and civil communities.

A key element in implementing the strategy is the development of a sectoral cluster system. The resulting complex defence industrial ecosystem must be able to continuously integrate the achievements of the technological “revolutions” in industry, including in particular digitisation and artificial intelligence.

In order to achieve the above objectives and to ensure economic sustainability, the defence industrial research, development and innovation capacity will be consciously strengthened, and

therefore the strategy will have a number of interfaces with the S3 umbrella strategy and the objectives of the selected priorities, as well as with the objectives of the National RDI Strategy, which can be defined as one of the pillars of S3.



24. Figure: The relationship between S3 and related strategies (NRDI Office own ed.)

In conclusion, the principles and intervention directions of S3 are in line with the expectations of the European Commission. Hungary's Smart Specialisation Strategy can be defined as an umbrella strategy for innovation, enterprise development and digitisation based on Cohesion Policy 2021-2027 Policy Objective 1 (PO1). Its economic development orientations contribute to the objectives of the EU's industrial policy agenda and innovation agenda. The implementation of S3 is defined by the objectives of the strategies of the three policy areas related to PO1 for this period and the action plans of the strategies. The resource requirements for policy measures relevant to S3 are provided by two operational programmes in the programming period: the **Digital Agenda for Europe Operational Programme (DIMOP)** and the **Operational Programme for Economic Development and Innovation Plus (GINOP Plus)** and its relevant priorities.

The measures and calls for proposals related to S3 will be implemented with the involvement of additional budgetary resources, and from the point of view of smart specialisation, the **National Research, Development and Innovation Fund (**NRDI Fund**)** proposals should be highlighted.

The national sectoral strategies shown in Figure 23 have been used in the development of the priority list and have contributed to the definition and refinement of the content and objectives of the priorities selected under the EDP.

6.2 Measures to strengthen the RDI system

In the situation analysis, we provided an overview of the barriers to the spreading of innovation and the weaknesses and problems of the Hungarian RDI system that may affect the successful implementation of the S3 objectives. RDI and relevant sectoral policies can respond to these challenges by using the right instruments.

In this chapter, we present the **policy steps** taken to mitigate or address some of the problems, or the objectives, planned actions and proposed instruments of the **national strategies** (mainly **the National RDI Strategy 2021-2030**) that are valid for the next EU financial planning period and can be considered as pillars of the S3 umbrella strategy.

6.3 RDI funding system

Restructuring R&D expenditure and gradually increasing R&D expenditure as a share of GDP

The RDI Strategy states that the Government intends to develop the governance, organisational and financing model for research, development and innovation in such a way as to strengthen the institutional capacities of the so-called 'developmental state' to achieve this goal. **Closely linked to institutional change is a reform of the overall RDI funding system**, which is an effective way to ensure a steadily increasing and sustainable increase in public R&D expenditure. A key means of achieving this is to reach 3% R&D expenditure as a share of GDP by 2030, as set out in the RDI strategy.

Restructuring the RDI funding system

The recommendation made by experts is to use international best practices in the design and evaluation of new financial instruments to maximise their potential in ensuring coherence between public finances and private investments. There is a need to attract venture capital and encourage the marketing of innovative products (DG RTD, 2016). There is also a need for strong support for marketing, commercialisation after product development and for implementing product life-cycle tracking.

The RDI funding policy system under the RDI Strategy for 2021-2030 foresees a **paradigm shift in funding** – from a two-tier system of 'non-repayable' and 'repayable' support to a spectrum-like funding logic. "*Spectrum in this case means that there are several versions of financial instruments with different policy implications for businesses, based on the basic conditions of interest and repayment. Nevertheless, simplification would also be important"* (RDI Strategy, 2020, p31).

One of the key objectives of the RDI Strategy is to create a transparent, predictable and stable funding system within the RDI funding system, which requires a paradigm shift. The

idea is to diversify the two-tier system of repayable and non-repayable funding by introducing new types of funding schemes.

The post-2021 RDI financial instruments will be developed in the framework of the action plan. International good practice will be used in the development process. Among the initiatives launched so far, young innovative SMEs with high growth potential, under the National Technology and Intellectual Property Venture Capital Programme, managed by HiVentures, is a major initiative, which, through capital support, create and launch significantly innovative products and/or services on the international market by implementing ideas and developing prototypes.

One of the key tasks of the funding system is to provide a wide range of SMEs with resources for technological development and to strengthen RDI activity. Especially in the operation of the funding schemes, particular attention should be paid to micro-enterprises, which, because of their size, are often disadvantaged in the funding policy. At the same time, their large number mean that they represent a significant slice of the domestic economy. Given their sheer numbers, the uptake of cutting-edge digital technologies could improve much faster if these developments were also strongly represented in this target group.

In the 2014-2020 period, the Smart Specialisation Venture Capital Programmes, aiming to support the expansion of companies with innovative products or services with growth potential by providing venture capital, were announced under the Economic Development and Innovation Operational Programme (GINOP) and the Competitive Central Hungary Operational Programme (VEKOP).

The main objective of **the Thematic Excellence Programme, launched in 2019**, is to establish a funding scheme to ensure the efficient and effective professional work of higher education institutions and research institutes established by the state. The goal is to ensure the targeted allocation of available financial resources based on professional excellence, to provide institutions with the framework conditions of a predictable and sustainable funding system. The **Excellence Programme for Higher Education Institutions**, which has been running since 2018, encourages the improvement of research conditions in higher education institutions, the strengthening of the focus on research, development and innovation, the improvement of conditions for academic and researcher recruitment, the operation of higher education institutions and the increase of scientific productivity. The two programmes have been launched with a budget of around HUF 32 billion in 2019 to increase the operational efficiency of the RDI system.

Related objectives of the RDI Strategy (2021-2030):

- Horizontal/4: Creating a funding system that is both stable and incentive-based
- C/4 Promoting technological and non-technological innovation

Planned government measures:

- Transforming the funding system from a two-tier to a spectrum-like logic (RDI Strategy)

- Gradual increase in public spending on RDI
- Applying a results-oriented RDI support model
- Channelling additional financing instruments into the RDI system, such as loan schemes with a different logic and more favourable repayment terms than on the market (e.g. setting up Innovation Loan, conditional or soft-loan schemes)

6.2.2 Improving the operational efficiency of the RDI system

A regulatory and business environment better adapted to the needs of the RDI ecosystem

The RDI Strategy (2020) states that the business environment determining the spreading of innovation, and as part of it the regulation, should be adapted to the needs of RDI stakeholders and should aim to ensure as little administrative burden and as much predictability as possible.

The 2021-2030 RDI Strategy highlights that the successful implementation of the strategy requires **the harmonisation and "innovation-friendly" implementation of domestic legislation,** including the revision of public procurement legislation. The Government has recently made significant progress in amending public procurement rules, which now give organisations engaged in RDI activities maximum flexibility, while respecting the relevant EU rules. The amendment of Act CXLIII of 2015 on Public Procurement (PP Act), in force since 19 December 2019, abolished the public procurement obligation of funded entities not classified as EU contracting authorities. Within the meaning of the Act, the purchase of goods and services that are directly related to RDI activities shall be exempt from the public procurement obligation up to the EU procurement threshold.

The strategy's objectives include the transformation of the practical application and a major simplification of the **public procurement rules** enabling higher education institutions to be effective innovation partners for businesses.

Another relevant objective of the strategy is to seek to procure state-of-the-art solutions from the domestic market to improve public administration, thus supporting the spread of innovation. The aim is for the state as a purchaser to be a technologically demanding customer, open to new solutions and willing to collaborate with companies on developing and testing new solutions.

An element of the Hungarian innovation system that undoubtedly needs to be improved is the practical application of theoretical knowledge, one step of which is to increase the number of patents. While the specific measures to do this are set out in the action plan of the National RDI Strategy 2021-2030; the Smart Specialisation Strategy also has a role to play, notably by concentrating resources and selecting priorities with the potential to deliver greater results. The concentration of resources along the S3 priorities in itself increases the efficiency and results of R&D activities (efficiency is also reflected in the number of patents). As priority setting (and future review) is based on the opinions of RDI stakeholders, taking into account local strengths, and resources are concentrated on areas with the potential to deliver greater results. The practical (EDP) application of the quadruple helix and the main emerging institutions outlined in S3 (such as the Science and Innovation Parks) are clearly aimed at a better use of knowledge – the results of which will also be translated into patents. In addition, the NRDI Office will also

launch its Industrial Property Rights call for project proposals in 2021, which aims to promote the national and/or international protection of intellectual properties.

Related objectives of the RDI Strategy (2021-2030):

- Horizontal/2: Creating a modern regulatory framework and business environment supportive of RDI
- Horizontal/5: Encouraging challenge- and demand-driven RDI

Planned government measures:

- Review of the adequacy of RDI tax incentives
- Simplification of existing regulations and reduction of administrative burden for users
- Reducing the tax burden on innovative start-ups, maintaining and developing existing initiatives, maintaining start-up support programmes financed from the NRDI Fund
- Strengthening domestic venture capital through tax relief instruments
- Amendments to competition law and certain requirements on calls to address the specific situation of venture capitalists and incubators that also invest
- Review and improvement of the public procurement system affecting R&D
- Procure and implement cutting-edge technology solutions to improve public administration, while providing opportunities to strengthen the market position of innovative, RDI-based SMEs and start-ups
- Support for activities to protect intellectual property rights at national and/or international level (NRDI Industrial Property call)

Support for the internationalisation of the RDI system

The peer review of the RDI sector (DG RTD, 2016) pointed out that Hungary should encourage the internationalisation of the national RDI system. The Panel proposed four specific directions in this respect:

1. Hungary should increase the use of international expertise and best international practices in the planning and implementation of RDI programmes.
2. Government departments and agencies should learn from the experience of the most relevant international programmes and transfer best practices to the domestic contexts, where feasible and with the necessary adaptation.
3. The network of the Horizon 2020 National Contact Points and Hungarian science attachés abroad should be strengthened in order to make Hungary's participation in European initiatives more effective.
4. Continuation of good practice whereby Hungary supports researchers and entrepreneurs who have been positively evaluated in international RDI competitions but ultimately not funded for budgetary reasons.

The experts would also encourage the integration of expatriate researchers into the RDI system and specifically recommend the involvement of the Hungarian diaspora in building appropriate networks of cooperation. Talented Hungarian researchers, especially young people, should be supported in pursuing international careers and returning from the diaspora to the national RDI system. The programmes should also help attract foreign talents. International best practices should be mapped to ensure a healthy circulation of intellectual capital (DG RTD, 2016).

The problems raised and several related comments of the expert panel have already been addressed in the government's RDI Strategy (2020) for the period 2021-2030.

The mandatory activity of the NRDI Office's 2019 NRDI Fund call for proposals to strengthen the University Innovation Ecosystem (NRDI Office, 2019c), whereby beneficiary higher education institutions will set up H2020 (later Horizon Europe) **Information Points** to improve participation in the EU Framework Programme for Research and Innovation, can be highlighted. The staff member employed to carry out the task will receive permanent professional support from the NRDI Office's National Contact Points (NCPs).

On the one hand, the RDI strategy sets the objective of attracting home as many internationally renowned researchers as possible, as well as a broader range of qualified early-career researchers (see *A/4. Knowledge-generating cooperation with external actors in higher education and research institutes*). In addition, the strategy considers as a target group for targeted domestic funding those applicants who are considered eligible for funding under the EU Framework Programmes' scientific calls but are placed on the reserve list due to lack of resources (e.g. H2020 Seal of Excellence, ERC) *(see: RDI Strategy: A/8 8. Strengthening scientific excellence and B/7 Encouraging international RDI cooperation).*

In line with the recommendations of experts, the objective of the strategy is to enhance the integration of international expertise and foreign good practices in the planning and implementation of RDI programmes. The strategy also sets the promotion of researcher mobility (both outward and inward) as an objective. It stresses the need to support the mobility of talented Hungarian researchers abroad and the mobility of foreign researchers and outstanding academics to Hungary at all stages of their research careers (see B/4. Encouraging international researcher mobility).

Related objectives of the RDI Strategy (2021-2030):

- A/4 Knowledge-generating cooperation between higher education and research institutes with external actors
- A/8 8. Strengthening scientific excellence
- B/4 Encouraging international researcher mobility
- B/7 Encouraging international RDI cooperation

Planned government measures:

- Strengthening the National Contact Points (NCPs)
- Establishment of H2020 Information Points in higher education institutions

- Strengthening the network of Hungarian science attachés abroad
- Developing and strengthening strategic partnerships with the most important European networks of research institutes
- Encouraging and expanding researcher mobility
- Promoting project-based bilateral cooperation

6.2.3 Strengthening knowledge flows in the innovation ecosystem

Promoting cooperation between the stakeholders of the RDI system

The RDI Strategy (2020) sets as a specific objective the **promotion of cooperation between** higher education and other stakeholders of the RDI ecosystem, such as research institutes**, primarily through the support of targeted research projects** (see *B/1 Encouraging active knowledge and technology transfer between the stakeholders in the innovation ecosystem*). Such collaborations facilitate, among others, the mobility of researchers between institutions, knowledge flows, better use of research infrastructures and helps to bring the latest research results to education.

Based on the Peer review, these instruments can include: targeted support programmes to encourage mobility of researchers to and from the corporate sector; more market-oriented research; provision of appropriate physical infrastructure (e.g. shared laboratories, incubators, accelerators, science parks, innovation clusters); the introduction of transparent and appropriate incentives for cross-sectoral mobility, including appropriate appointment and promotion criteria in the public sector to assess the exposure of researchers to companies; the involvement of private sector representatives in the governance of public sector RDI actors; and the promotion of knowledge transfer programmes at institutional and system level.

The launch of **cooperative doctoral programmes** will also serve to strengthen cooperation between the two sectors and to train new generations of researchers for companies. These programmes focus on the practical applicability of doctoral research, rather than purely scientific productivity. Doctoral programmes in cooperation with an industrial partner allow doctoral students to carry out their research partly in an academic setting and partly in a corporate environment.

The spread of technologies and synergies between sectors (e.g. the application of big data in different sectors) would be greatly facilitated by regular professional meetings between representatives of the (seemingly distant) sectors covered by S3 and those engaged in development, which would allow the different actors to be aware of each other's presence and development directions.

Strengthening the physical infrastructure of the innovation ecosystem

The RDI Strategy (2020) states that one of the most important objectives for strengthening knowledge flows is to make the most effective use of the **capacities offered by research infrastructures**. The strategy sets out the expectation that the widest possible range of RDI stakeholders should have access to publicly owned research infrastructures and the

development of a research infrastructure registry system is a prerequisite for this. It is a government objective to create a complex portfolio of knowledge-dissemination organisations that leverages the strengths and capacities of the RDI system and thus lays the foundations of mutually beneficial, long-term cooperation between the stakeholders. This provides an opportunity to address forward-looking, well-defined RDI challenges, responding to socio-economic challenges along a specific theme or research area. Collaborations result in the utilisation of research and scientific results and the creation of marketable products, services, technologies and their prototypes.

The implementation of S3 can be greatly supported by the knowledge and infrastructure network created by domestic knowledge-dissemination organisations. One type of network organisation is **created to address a specific research topic or a societal challenge**.

An example of a thematic or project-based operation is the creation of **National Laboratories**. The development of some of these will start in 2020 with support from the NRDI Fund, and the next development cycle will aim to further expand and develop them. The objective of the National Laboratories is to support large-scale, strategic research programmes and multidisciplinary projects that address global solutions or challenges.

The work of the National Laboratories will result in the creation of a critical mass of research and development capacities in research areas defined as key for society and the economy, which, through continuous development, will enable Hungarian RDI to be better integrated into European and global research networks than before. All major domestic players in the research field are involved in the work of the National Laboratories, thus the concept strengthens the cooperation potential of the RDI ecosystem towards a common goal. Developing the research competences created by the National Laboratories will enable Hungary to participate more successfully in the European research framework programmes in the relevant thematic areas and to make better use of its membership in international research infrastructures. On the other hand, funded projects can support the mitigation of the negative effects of global megatrends through the development of specific services and marketable products, while in the case of positive trends, they support contribution to economic competitiveness and social welfare.

Another type of the new knowledge-dissemination organisations is specifically designed to strengthen cooperation between local economies in a "quadruple helix" model**, by exploiting the economic and RDI potential of a given region and its priorities relevant to S3** by providing physical space and support to actors in the local economy and RDI system to maximise the synergies arising from cooperation. The planned creation of a network of **Science and Innovation Parks** will serve this purpose. The Government intends the Science and Innovation Park to be a key institution with effective networking capabilities, supporting the local innovation ecosystem and being a catalyst within the system shaping the knowledge and technology transfer spatial structure *(see C/5 Supporting new types of innovation ecosystems*).

In the first quarter of 2019, the Government debated and adopted the government proposal 1093/2019 (III.8.) on the concept for the establishment of a national Science and Innovation,

Technology and Industrial Park network, submitted by the Ministry for Innovation and Technology.

The concept aims to build a three-tier network structure by integrating the network of industrial parks currently called “Science and Technology Park” and their definition into the concept of “Science and Innovation Park”, alongside the “Industrial Park” which has been in force since 1 March 2013:

- Industrial Park;
- Technology Park;
- Science and Innovation Park.

The Science and Innovation Parks will be science-driven spaces based on a university, research institute and research infrastructure-based innovation ecosystem and research, development and innovation activities, creating an area with infrastructure at regional level where knowledge, typically built on an ecosystem in a research university environment, flows to industry and from industry to science through service centres, accelerators and incubators. Cooperation between industry, research and academia is fully integrated.

By introducing Science and Innovation Park categories, complex business activities based on applied research, organised around universities and funded by consortia of businesses, can be strengthened. In addition to the strength of the cooperation between industry, research and higher education, the different levels also define and identify the services available in the parks. The S3 priorities are effectively supported by the concept, as the investments realised in the parks established under the concept may create jobs with high added value, increase the competitiveness of the domestic SME sector and help domestic products to enter the international market.

Another example of regional-type organisations is the **Centres for Higher Education and Industry Cooperation (FIEK)** and its continuation, the **“Centres of Competence**" programme launched in 2019 under the NRDI Fund. Establishment of knowledge centres at universities functioning as matrix organisations on the basis of public/non-profit research institutes and university/corporate research facilities that can continuously satisfy the R&D demand of the business sector with a focus on the specific needs of major thematic areas or the local industry. Similar coordination can be carried out by sectoral research institutes, such as the Defence Industry Research Institute.

A further objective is to ensure that **in the international research infrastructures,** members of the RDI ecosystem make more effective use of the benefits and opportunities of their membership.

Related objectives of the RDI Strategy (2021-2030):

- A/4 Knowledge-generating cooperation between higher education and research institutes with external actors

- B/1 Encouraging active knowledge and technology transfer between the stakeholders in the innovation ecosystem
- B/3 Creating a career path for researchers that enables interoperability between the academic and business sector
- B/5 Supporting access to RDI infrastructures
- B/6 Strengthening RDI cooperation between companies
- C/5 Supporting new types of innovation ecosystems

Planned government measures:

- Improving the register of research infrastructure and assessing the usability of the university assets for companies in order to improve utilisation
- Involving professionals with market experience in education
- Establishment and operation of a Science and Innovation Park network
- Expanding and strengthening the network of FIEKs and Competence Centres
- Launching cooperative doctoral programmes
- Uniform applied research network (with the further development of Bay Zoltán Alkalmazott Kutatási Közhasznú Nonprofit Kft.)
- Increasing the use of the capacities available through membership in large international infrastructures
- Developing infrastructure and test environment to support emerging digital technologies (e.g. blockchain, drone, IoT, quantum computing) (National Digitalisation Strategy)
- In the context of the development of the defence industry, there has been a significant relocation of international capacity to our country and this way, suppliers involved in domestic production have access to international infrastructures in preparation for knowledge transfer.

6.2.4 Training and development of RDI-related workforce

Strengthening STEM training areas

In order to acquire competences that can be used in business, an objective of the University Innovation Ecosystem call for proposals under the NRDI Fund (NRDI Office, 2019c) is the development of an **entrepreneurial mindset among teachers, researchers and students** and the creation of a business-oriented link between universities and the business sector.

In the context of the Centres of Excellence under the FIEK call for proposals under No. GINOP 2.3.4, new MSc courses and cooperative doctoral programmes will be launched.

Related objectives of the RDI Strategy (2021-2030):

- A/1 Ensuring the training of a new generation of researchers
- A/2 2. Practice-oriented higher education and RDI showing openness to application areas and local needs

- A/3 Doctoral programmes that meet the actual demands, implementation of cooperative doctorates

Planned government measures:

- Expanding and developing cooperative doctoral training

An attractive career model for researchers

The RDI Strategy (2020) states that one of the areas for improvement in knowledge flows is the **development of interoperability** between sectors of the RDI system: the interoperability between industrial and academic careers needs to be made more flexible. As a solution to this, it proposes to support the involvement of researchers in solving specific industrial problems (e.g. cooperative doctoral training) and to launch an industrial sabbatical programme for higher education lecturers, aimed at enabling lecturers to engage in cutting-edge corporate RDI activities.

The other direction of the strategy in creating an attractive career path for researchers is the introduction of an incentive system/**performance appraisal system** on the academic side, which allows for performance-based promotion and support system.

In the case of support for research excellence, the strategy favours targeted support for internationally proven talent, in a "fast-track" approach (e.g. support for ERC reserve candidates). Research excellence needs to be supported at all stages of a researcher's career. A stable financial framework, available in the medium to long term, contributes to both projectable, high-quality and effective research and to the advancement of researchers. This is exactly in the focus of the research excellence grants under the NRDI Fund.

Related objectives of the RDI Strategy (2021-2030)

- A/1 Ensuring the training of a new generation of researchers
- A/3 Doctoral programmes that meet the actual demands, implementing cooperative doctoral programmes
- B/3 Creating a career path for researchers that enables interoperability between the academic and business sector
- A/4 Knowledge-generating cooperation between higher education and research institutes with external actors
- A/8 Supporting scientific excellence

Planned government measures:

- Introducing an incentive system/performance appraisal system on the academic side
- Supporting research excellence and research excellence programmes
- Attracting renown researchers living abroad through targeted programmes
- Introduction of "Industrial Sabbatical"

Strengthening transversal skills, innovation and entrepreneurship in society

In the RDI Strategy **receptiveness** and openness to **innovation**, encouragement to think creatively and create value is presented as a horizontal objective. As part of the knowledge generation pillar, the RDI Strategy sees strengthening the entrepreneurial mindset and skills of university citizens (both students and faculty) as the key to strengthening entrepreneurship in higher education, and plans to launch targeted support programmes to this end.

In order to strengthen innovation capacities in higher education, the NRDI Office (2019c) launched the "**University Innovation Ecosystem**" programme last year, which aims to support the establishment and effective operation of a results-oriented innovation ecosystem at domestic universities. The beneficiaries of the programme could also start developing services to promote and strengthen entrepreneurship among teachers, researchers and students through their projects.

Related objectives of the RDI Strategy (2021-2030):

- Horizontal/1: Receptiveness and openness to innovation, encouragement to think creatively and create value
- A/2 Practice-oriented higher education and RDI showing openness to application areas and local needs

Planned government measures:

- Encouraging receptiveness and openness to innovation, as well as creative and critical thinking and design thinking at societal level
- Creating and continuously reviewing a regulatory environment that facilitates innovation

6.2.5 RDI performance of companies

Strengthening the innovation capacity of the SME sector

In the current programming period between 2015 and 2019, over HUF 577 billion in funding was available for the development of business RDI from the Economic Development and Innovation Operational Programme (GINOP), the Competitive Central Hungary Operational Programme (VEKOP) and the National Research, Development and Innovation Fund (NRDI Fund).

In particular, the calls for proposals GINOP 2.1.1.-15, VEKOP 2.1.1-15 and the calls for proposals Vállalati KFI_16, 2018-1.1.2-KFI, 2018-1.1.1-MKI funded from the NRDI Fund, aiming to support the RDI activities of domestic enterprises, including SMEs. Businesses also benefit from the GINOP 2.1.6-16 call for innovation-driven export expansion – which was open to large companies as well as micro, small and medium-sized enterprises – and the NRDI Fund's Export_17 call. SMEs can also apply for a combined loan product under the GINOP 2.1.2-8.1.4-16 call to support their RDI activities.

GINOP-2.1.3-15 Iparjog and the Iparjog_15 call for proposals launched under the NRDI Fund aimed at supporting the protection of intellectual property rights in Hungary and abroad and

promoting the use of intellectual properties. The calls for proposals Open Innovation (2019-1.4.1-NYÍLT), aiming to involve SMEs in research and innovation issues faced by large companies and 2019-1.1.1-PIACI_KFI supporting market-oriented research, development and innovation projects to improve the competitiveness of enterprises, including SMEs, were also launched under the NRDI Fund. The 2019-1.2.1-EGYETEMI ÖKO call (NRDI Office, 2019c) aims to build a university innovation ecosystem to foster the innovation activities of SMEs.
In addition to supporting technological innovation in enterprises, it is also important to support business process innovation, including for example the promotion of innovations related to marketing, increasing administrative efficiency and other organisational development processes or, in ICT, business process innovations that are often of an adaptive nature. All of this increases the competitiveness and flexibility of companies in a rapidly changing environment.

Related objectives of the RDI Strategy (2021-2030):

- C/3 Stimulation of business innovativeness (including adaptive innovation)

Planned government measures:

- Improving the dissemination of RDI results, making them available to SMEs
- Assessing the usability of university assets by enterprises
- Supporting market-driven RDI in the business sector (NRDI Fund)
- Start SME Programme (NRDI Fund)

Better use of the potential role of multinational companies as multiplier

According to the RDI Strategy (2020), the **presence of foreign-owned large companies and the** expansion of **their research capacities** have had a dynamic impact on employment, the market share of innovative products, the relationships between the actors of the research and innovation system, and thus on the system as a whole. However, the situation of domestically-owned small and medium-sized enterprises has unfortunately been unfavourable, with their performance lagging behind the regional average. According to the RDI strategy, we need to change the image of our country as a "country of subsidiary companies". The objective of the strategy is to encourage the involvement of SMEs in solving research and innovation issues and problems faced by large companies, **with a focus on *open innovation***.

The **Open Innovation Call**, funded by the NRDI Fund, launched in 2020 encourages the involvement of SMEs in solving challenges facing large companies, building on international examples, thus strengthening cooperation and ensuring knowledge flows between them and increasing the competitiveness of domestic SMEs. The scheme will both provide opportunities for SMEs to contribute to innovation activities in large companies and increase innovation activities in large companies.

Related objectives of the RDI Strategy (2021-2030):

- B/ 2. Promotion of open innovation and open access

Planned government measures:

- Encouraging large companies to outsource RDI tasks to the SME sector
- Developing an Open Access Strategy (NRDI Office)
- Open Innovation Programme (NRDI Fund), which encourages the involvement of SMEs in solving research and innovation issues and problems faced by large companies.
- "Supporting market-driven RDI in the business sector" programme (NRDI Fund)
- Launching dedicated RDI programmes for digital economy operators based on the orientations/priorities identified in the S3 strategy (National Digitalisation Strategy)

Expanding support for innovative start-ups

In the 2014-2020 programming period, calls for proposals have been launched to **support start-ups**. In this context, the call for proposals GINOP-2.1.5-15 **Innovation Ecosystem** was launched under the Economic Development and Innovation Operational Programme (GINOP) to support the creation of an ecosystem for start-ups by encouraging the creation of new **incubators**. Incubators – and through them start-ups as final beneficiaries – are also supported from the National Research, Development and Innovation Fund (NRDI Fund) **under the ÖKO_16 Innovációs ökoszisztéma (start-up) call for proposals**. The National Technology and Intellectual Property Venture Capital Programme of No. GINOP-8.1.3/A-16 aims, among others, to foster the development of a well-functioning innovation ecosystem.

The Startup Factory Programme supported from the NRDI Fund and aiming to further develop the start-up ecosystem in Hungary also worth highlighting. Supporting successful start-up incubators in achieving even more results. The "Fast Track Programme" aims to support high growth-potential companies delivering significant added value in Hungary.

The INPUT programme (until autumn 2022) funded under the GINOP 3. ICT priority (3.1.3) and the related specific GINOP 8.2.3 venture capital programme aim to develop the Hungarian digital start-up sector.

Related objectives of the RDI Strategy (2021-2030):

- Horizontal/4 Creation of a funding system that is both stable and incentive-based
- C/2 Encouraging start-up ecosystem development and spinoff creation

Planned government measures:

- Continuing the technology incubator/ accelerator programme and good practices
- Serving marginal conditions, special business environment needs (legal environment, special tax benefits, removing administrative obstacles)
- More intensive channelling of other funding instruments into RDI (patronage, angel, community funding)
- Startup Factory Programme (NRDI Fund)
- "Fast Track Programme" (NRDI Fund)

- Digital start-up competence development (e.g. by extending the INPUT programme) (National Digitalisation Strategy)**;**
- Planned interventions to mitigate the negative impacts of industrial transformation and reap its benefits

One of the aims of S3 is to prepare the local economy and the national RDI system for the effects of the **industrial transformation** that is already underway but is set to accelerate over the next decade. This transformation is triggered by decarbonisation and the technology boom. In terms of economic policy, ensuring effective adaptation to and reaping the benefits of this industrial transformation requires the various policies to work together effectively. With its function as a bridge between territories and sectors and its horizontal approach, S3 can support this as a policy instrument beyond sectoral policy.

The effective implementation of the objectives, priorities and specialisation paths set out in S3 can only be successful at the level of the local economy if the national policy systems offer the relevant actors tools that effectively respond to the elements of industrial transformation and support, for example, the retraining of the workforce, the diversification of the economy, the promotion of entrepreneurship and the technological development of SMEs.

This chapter **presents policy objectives, initiatives and measures that can support sectors, companies and regions affected by industrial transformation** to cope with the impacts of this process in the coming years. The chapter uses policy documents and ongoing support instruments to indicate what Hungary plans to do to mitigate the impacts of industrial transformation.

6.3 Measures to cope with the effects of industrial transformation

6.3.1 Measures to respond to the effects of the technological boom

Running the Industry 4.0 National Technology Platform

Industry 4.0, as a German strategic concept for industrial development represented a platform-based approach to economic development where the operators of the economic, scientific and political sectors coordinate their activities to improve the competitiveness of a country (Fülep, 2018). This fits in with the logic of smart specialisation and is being implemented in Hungary through international good practice. The German industrial development intervention logic, which is based on stronger cooperation and coordination between sectors, has also had an increasing impact in Hungary and a cross-sectoral platform has been established in Hungary to promote the preparation for the Industry 4.0 transformation with the widest possible involvement of stakeholders. Organised by the Ministry for the National Economy and the Institute for Computer Science and Control (SZTAKI), **Industry 4.0 National Technology Platform** (2020), a legal entity currently operating under the supervision of the Ministry for Innovation and Technology, was established in the form of a federal association in May 2016 with the participation of about 40 enterprises, research institutes, professional NGOs (e.g.

Hungarian Association for Innovation, Hungarian Logistics Association) and higher education institutions domiciled in Hungary.

Policy measures to prepare for industrial transformation and digitalisation

According to the National Digitalisation Strategy, the Government plans to launch the following actions to develop the digital economy:

- Increasing digitalisation of and the use of digital infrastructure by micro, small and medium-sized enterprises
- Introducing new corporate digital financing schemes (e.g. vouchers, guarantees)
- Supporting the digital transformation of industrial SMEs, increasing their INDUSTRY 4.0 readiness
- Targeted programme to support the use of data by businesses (big data)
- Developing corporate digital experience and competence centres
- Developing infrastructure and test environment to support emerging digital technologies (e.g. blockchain, drone, IoT, quantum computing)
- Further development of an integrated business portal
- Encouraging the use of electronic transactions by citizens and businesses
- Digital Farmers Programme

Further major actions (also) affecting the industrial sector and transformation have been formulated in the Artificial Intelligence Strategy adopted in autumn 2020, already described in the previous sections.

On the business development side, the biggest challenge we see in industrial transformation and digitalisation today is in the mindset of businesses: to bring them to be open to both technological and organisational innovation. The relevant objective of the **SME Strategy** is to spread the use of technology-generated innovations among SMEs. This requires an increase in the share of intangible capital and an increase in SMEs' digital competences, and in their use of digital devices and solutions. Policy measures to prepare for industrial transformation and digitalisation are as follows:

Hungarian Multi Programme

Innovative Hungarian small and medium-sized enterprises with high growth potential play a key role in dynamizing the economy.

When supported effectively, they can make a significant contribution to improving Hungary's competitiveness and the quality of life of Hungarian families by achieving quality growth that is competitive even by international standards.

In the Hungarian Multi Programme, the identified domestic enterprises will receive, following the development of detailed diagnostic and development plans, personalised, premium business development services (training, consultancy, development plans, organisational development), along the lines of factors that significantly influence their competitiveness (efficiency, productivity, flexibility) at international level. The programme is designed to represent the

highest quality of domestic business development services with targeted, personalised, partnership-based development of the businesses that will be the backbone of the future development of the domestic economy.

Modern Demonstration Plant Programme

The programme aims to promote the renewal of the domestic entrepreneurial sector through technological change and the use of high-tech solutions; the development of strategic approach, management, organisational functioning, business processes; and the strengthening of cooperation networks of companies.

The programme targets micro, small and medium-sized enterprises open to renewal in manufacturing and all other sectors where a change or rethinking of the business model is absolutely necessary. In addition, modern, exemplary factories, plants and workshops, as well as companies providing advanced or high-tech solutions, which are able to promote the modernisation of the SME sector with their methods and tools.

The programme provides businesses with technical and financial support to renew their technology and operations. The training courses and consultations organised under the programme offer a wide range of businesses the knowledge and experience they need to run a successful business.

Joint development of supplier SMEs and integrator companies

Businesses must be able to cope with a modern technological environment that requires continuous learning. The Supplier Development Programme aims to involve domestic SMEs in the development and production of higher added-value products and to increase their productivity and efficiency through the application of modern Industry 4.0 technologies, organisational development, training, innovation and research and development activities. Integrator companies participating in the programme are expected to transfer the necessary technological and organisational knowledge, through their own supplier development programmes, to small and medium-sized enterprises, teaching them the business management methods and quality assurance procedures that will help them to become great.

Irinyi 2.0 - Industries of the future

Within the framework of the Irinyi Plan adopted in 2016, 7 sectors have been selected and developed through sub-strategies in recent years. The past period has highlighted the timeliness and need for a review of the original Irinyi Plan. Irinyi 2.0 will not only include "traditional" industries.

6.3.2. Decarbonisation-related development goals, innovation measures

The **Energy Innovation Council (EIC)**, set up in 2018, has identified areas of intervention that can help to facilitate an efficient energy transition from an innovation perspective. Emphasis was placed on promoting **the market introduction of innovative energy services**, as well as **innovative system balancing** and promoting the use of domestic natural gas assets through R&D projects. In addition, introducing “smart regulation”, promoting innovative seasonal

electricity and heat storage solutions and supporting **energy efficiency** also play a role. In the heat market, the aim is to reduce the share of natural gas in district heating production to 50% by 2030 from the current level of over 70%. The growth rate of oil consumption needs to be slowed down.

In order to make the transition to a low-carbon economy, Hungary's **National Energy Strategy** 2030 with an outlook up to 2040, published in January 2020, stated that it is in Hungary's interest to reduce the need for energy imports and to reduce greenhouse gas emissions from energy production. The National Energy Strategy focuses on the consumer, strengthening security of energy supply and climate-friendly transformation of the energy sector, while harnessing the economic development potential of energy innovation. The latter will include the mapping of potentials for energy innovation, the transport greening and the corporate greening programme (National Energy Strategy 2020)[21].

A key element of the National Energy Strategy is to increase the use of petroleum derivatives for transport by no more than 10% by 2030 (National Energy Strategy, 2020).

Another objective is **transport greening**. In transport, the aim is to reduce the rate of growth in energy use, which Hungary intends to replace with electricity and other alternative solutions. The spread of electromobility and the development of its infrastructure will be promoted by **Jedlik Ányos Plan 2.0** and the **Green Bus Programme** adopted by the Government, which will put environmentally friendly buses on the market. It also aims to promote the use and domestic production of advanced or second-generation biofuels and to increase the share of biocomponents in fuels (National Energy Strategy 2020).

Innovation for **the use of renewable energy sources** is an area of focus (National Energy Strategy 2020). In Hungary, the number of household-scale grid-connected solar systems is growing rapidly (5,000 in 2013 and 40,000 in 2018). In addition, our country has exploitable potential in the field of geothermal energy.

The most important projects (flagship projects) identified in the National Energy Strategy to achieve the energy strategy objectives include "Energy Innovation Projects", which are mainly of a pilot nature. In this context, the extent to which innovations in the field of energy contribute to improving Hungary's energy security is an important aspect.

In relation to energy innovation projects, the Government has the following priorities:

- encouraging the market introduction of innovative system balancing and energy delivery methods
- energy efficiency-related innovation
- launching R&D programmes to support the use of domestic natural gas assets

[21] With the digitalisation of the energy network, the vulnerability of certain energy distribution and storage infrastructures, including smart meters and IoT devices, is increasing, therefore, a key part of the innovation process is to develop infrastructure protection mechanisms and strengthen cyber protection.

- promoting transport greening and the use of renewable energy sources
- nuclear innovation
- promoting innovative seasonal electricity and heat storage solutions such as power-to-gas technologies (National Energy Strategy, 2020)

6.4 Strengthening international cooperation to implement S3

A key objective of the strategy is to develop an internationally competitive RDI system based on national strengths by strengthening regional specificities, but to achieve this, it is essential to increase the international embeddedness of the RDI system and the local economy.

This chapter sets out the actions that need to be launched or sustained during implementation to enhance the cooperation of S3 stakeholders with partners outside the country borders in the priority areas supported.

The smart specialisation approach requires an overview beyond national and regional borders, while the importance of the global economy and innovation networks requires a regional innovation policy that goes beyond regional and national borders. International cooperation in the field of S3 includes **sharing knowledge, launching joint projects, continuously seeking opportunities for cooperation and exploiting synergies with S3 initiatives in other countries and regions**. International cooperation is a key element of smart specialisation strategies. Working with others and developing an outward-looking mindset helps to monitor the competitive position of the country/region vis-à-vis others and to define its position in global value chains. From the perspective of policy makers, there is a need to open up the smart specialisation strategy to international cooperation for, among others, the following reasons:

- gaining access to wider business and knowledge networks
- acquiring the necessary research capacity
- accessing other markets
- expanding business opportunities
- combining complementary strengths
- joining global value chains

One of the most prominent and significant forms of transnational cooperation are projects and actions that seek to align the RDI objectives and priorities of different regions in order to develop a cross-border smart specialisation strategy.

As a result, regional and national authorities:

- make more effective use of the various funding schemes, in particular
- related to the financing of certain regional operational programmes and cross-border cooperation, and
- become more competitive in directly funded RDI excellence programmes such as Horizon 2020 / Horizon Europe.

Building on the priorities of smart specialisation, regional and national authorities also have a major role to play in the design and development of new European industrial value chains. One way to do this is to link or support the common priorities and opportunities of regional

ecosystem stakeholders and national and regional cluster organisations, and to launch pilot projects in the identified S3 priority areas.

6.4.1. Cooperation between S3 and the regions

The implementation of the smart specialisation and interregional cooperation mutually reinforce the regional RDI system.

- S3 **encourages regions to clearly identify and assess their strengths**, weaknesses and opportunities, and thus their position in comparison with other regions, thus strengthening the value chain approach.
- S3 provides insights into **market and business needs** and guidance on how to harness innovation.
- By linking the S3 priorities and interregional cooperation, the operators of the local research and innovation ecosystem **will encounter new knowledge flows** that can shed new light on the S3 priorities.

The benefits of cooperation between regions in the implementation of S3:

- Common policy experiences and good practices
- Increased regional visibility
- Better access to research expertise
- Growing critical mass in research
- Shared RDI costs and risks
- Supporting industry to exploit new markets
- Better and more integrated services for SMEs
- Supporting industry to exploit technological opportunities
- Closer links between research and industry
- Contributing to solving common socio-economic problems.

In order to ensure cooperation between regions, it is also necessary to take into account the strategies of the economic development zones created in 2020 and the territorial distribution of the defence industry clusters.

6.4.2 S3 thematic platforms, Interreg Community Initiative[22]

The cohesion policy encourages regions and Member States to build regional coalitions and support the creation of new European value chains in areas linked to strategic growth. Since 2015, **three thematic smart specialisations** (S3 Platform, 2020) led by the European Commission have been launched to support this objective. These platforms have been designed to provide an interactive environment for interregional cooperation in the context of smart specialisation areas in the fields of **agri-food industry, energy and industrial modernisation**.

On the agri-food platform, launched in 2016, the Commission has supported five partnerships as of November 2018, with between 4 and 25 participating regions. The vast majority of

[22] For drawing up this chapter, the summaries and internal working documents of the Department of Spatial Development Planning, Ministry of Finance were used

participants come from the old Member States: only 10% of the regions are located in the EU-13. The Commission supports six partnerships under the Energy Platform, each involving 10-45 partner regions. The regions of the 13 member states that joined later have a 20% share. The industrial modernisation platform, also launched in 2016, includes 21 supported partnerships with a particular focus on the application of new technologies. In January 2019, 106 European regions participated in the work of these platforms. The thematic platforms therefore offer a structure to exploit partnerships and synergies between sectors.

The thematic S3 platforms are a major contribution to building more interregional partnerships in the EU. The ultimate goal of these **cooperation networks** is to create European ecosystems for transnational and interregional cooperation in regions and countries with **similar or complementary S3 priorities**. This will enable partner regions to jointly analyse and implement the objectives set out in their smart specialisation strategies. The thematic partnerships also help regions to expand their regional knowledge base, develop new development pathways and joint innovation strategies to move up the global value chain.

The S3 thematic partnerships are based on a bottom-up approach, which means that they are initiated, developed and managed by the regions, with the active participation of all relevant "quadruple helix" actors (partners, including business organisations, research institutes, academia and NGOs). The first step for national regions to join such interregional cooperation and thematic platforms is therefore a learning phase, during which partner regions can get to know themselves and each other, as well as their regional resources, capacities, strengths and needs. The second phase is the actual joining phase, which builds on the results of the learning phase but requires a clear business case and a single directional objective for the joint projects proposed by the partner regions, thus ensuring their implementation and success. The resulting interregional projects will bring clear economic growth and added value to the domestic regions.

Established in 1990, the Interreg Community Initiative has run for three programming periods and, since 2007, it has become an instrument of the European Union's cohesion policy. The **Interreg programmes** are implemented in the framework of European territorial cooperation and are an important tool for the balanced and integrated territorial development of the EU and addressing cross-border problems involving several countries or groups of countries. Cooperation is possible through **cross-border**, **transnational** and **interregional** programmes, mainly for the exchange of experience at pan-European level. The programmes are implemented using the European Regional Development Fund (ERDF) at the EU's internal borders, the Instrument for Pre-Accession Assistance (IPA) for cooperation with candidate countries and the European Neighbourhood Instrument (ENI) for third countries.

Hungary currently participates in 13 INTERREG programmes, all of which involve 2 to 32 partner countries. The Government has transferred the implementation of cross-border programmes to the Ministry of Foreign Affairs and Trade, and the implementation of transnational and, with one exception, interregional programmes to the first local responsibility of the Ministry of Finance.

In the context of **transnational cooperation**, the institutions of a transnational region, which can be understood as a single territorial unit, work together to find solutions to the problems that affect them, which is more effective than a national solution. Of the 15 transnational programmes currently running, Hungary is involved in the **Interreg Central Europe** cooperation programme with nine Member States involved, and the geographically very large **Danube Transnational Programme** involving 14 partner countries. In the latter, the implementing institutions of the programme are hosted by our Ministry of Finance. The open, international calls for proposals published under the above programmes **were characterised by a lively Hungarian applicant activity**. Half **of the 492** projects receiving EU funding involve Hungarian consortium members and 45 are led by Hungarian partners. The programmes are co-funded at EU and national level and are implemented from the project partners' own funds.

Hungary **participates** in all **four pan-European (interregional) cooperation programmes**: ESPON 2020 researches territorial facts and processes and supports the territorial basis for policy decisions; INTERREG EUROPE promotes the exchange of experience between regions; INTERACT III supports the work of managing authorities and joint secretariats; and URBACT (is the main responsibility of the Prime Minister's Office) supports cooperation between cities. In addition to the EU Member States, these programmes also involve Switzerland and Norway, and in the case of ESPON, Iceland and Liechtenstein.

In Hungary, **cooperation along the border** has a long history, with **cross-border cooperation programmes** are currently **operating on all seven border sections of Hungary** and four of these programmes are managed by Hungary (Ministry of Foreign Affairs and Trade). For these programmes, the aim is to support cooperation between border areas in fields such as joint protection, mobility, employment development and disaster management.

From 2021 onwards, Hungary intends to ensure the maintenance of the institutional system with more than two decades of experience in the implementation of **INTERREG programmes** and the continuation of cooperation.

6.4.3. The European Institute of Innovation and Technology and S3

The community of the **European Institute of Innovation and Technology (EIT), the KICs and the S3 communities address similar RDI themes and socio-economic challenges from an EU perspective** — so, the RDI system may be fragmented and parallel research may be possibly conducted to achieve the same goals. The development of closer cooperation between the two communities would therefore be particularly justified.

Both initiatives **focus on the involvement of the knowledge triangle** and share the increase of competitiveness and seeking response to societal challenges as core objectives. Another important similarity is that the establishment of **value chains** throughout Europe is an essential mechanism for both initiatives to achieve their objectives. Although such efforts in the EIC are typically based on international cooperation between companies and organisations, closer cooperation, even at regional level, can help to align developments with business needs and bring EIC KICs closer to the innovation policies of Member States and regions. Such

cooperation could include the extension of the services provided by EIC KICs, such as financing and co-financing innovative start-ups, business development trainings and the commercial use of European sales channels for innovative solutions for SMEs. These services are currently available to businesses within reach of the KIC centres in the capital, but their transfer to the regional level would provide greater reach and would greatly assist the potential connection of domestic SMEs to European value chains.

The EIC community has a significant knowledge base in each of the long-listed themes both at European level and, through KICs, at national level. Therefore, **the organisations of the EIC community act in the EDP as a stakeholder** providing feedback on both the potentials of the domestic innovation ecosystem and on global and European developments and achievements based on the latest results in the field. The involvement of the EIC in the work of the networks responsible for the implementation of S3 and in information sharing is particularly justified because this way, the creation of parallel competing initiatives and networks in the limited domestic innovation ecosystem, which ultimately hamper the spread of innovation, can be avoided.

6.4.4. Horizon 2020 and regional relations

The directly managed Framework Programmes for Research and Innovation (FP 1-7, Horizon 2020 (2014-2020), Horizon Europe 2021-2027) have a significant impact on the Member States' research and innovation policies and strategic planning.

Horizon 2020 (2014-2020) is the EU's research, development and innovation policy programme for 2014-2020, with a budget of EUR 77 billion (in current prices). It is the financial instrument implementing the "Innovation Union", a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness.

At European level, the participation data for each Framework Programme for Research and Innovation provides a good indication of a country's or region's integration into the international scientific and innovation mainstream.

By expanding the network of relations and with an attitude that encourages the creation of innovative products and services, participation in the Framework Programme can lead to market entry, even in the short term, with important national economic benefits.

Horizon 2020 is an internationally competitive framework for excellence with funding available directly from Brussels. The project proposals are assessed against strict criteria such as excellence, highly professional and well-managed consortium and European impact.

The priorities of the Framework Programme include

- facilitating the translation of scientific breakthroughs into innovative products and services offering business opportunities, so the programme provides funding in all stages of the innovation chain from research to market entry;
- tackling societal challenges and addressing the problems of the society of the European Union (e.g. in areas such as healthcare, energy, transport);

- strengthening the small and medium-sized enterprise sector.

The EU13 currently represent 8.4% of total participation and 5.2% of total funding. The success rate is lower: 10.01%, compared to 14.65% in the EU15. A much smaller proportion of them appear as project coordinators: 5.04%, compared to 85.07% in the EU15. [23]

Based on the eCorda database managed by the European Commission (data as of 1 February 2020), Hungarian beneficiaries have received EUR 306,220,077 in funding from the Framework Programme for 908 projects with 1205 applications. In terms of funding under Horizon 2020, Hungary is the 17th largest recipient of funding among the EU Member States (EU 28), and the third largest recipient of funding among the Member States that joined the EU after 2004.

The **Smart Specialisation Areas identified by the Smart Specialisation Strategy contribute to the participation in the national framework programme by mapping capacities and identifying potential new areas**.

In addition to the areas of specialisation at national level, it is important to note the international links and identify areas of **strength and priority for development identified by** neighbouring EU and non-EU countries and regions within countries.

The analysis is based on data retrieved from the European Commission's eCorda database, using Hungary's NUTS2 regions as the territorial base units. In the case of Hungary's NUTS 2 border regions, the analysis covers joint projects and their thematic scope with NUTS 2 regions in neighbouring countries.

Given that the Horizon 2020 framework programme's funding portfolio includes programme sections supporting activities in specific scientific and technological areas, as well as programme sections without scientific disciplinary restrictions ("bottom up"), this analysis does not cover projects funded by programme sections without thematic restrictions (MSCA, ERC, Teaming, Innovation in SMEs, ERA Chairs, Twinning-type calls are not examined).

The 3 themes with the highest grant amounts per NUTS 2 region will be identified.

Budapest (HU11)

When analysing the indicators for the Budapest region, it is worth noting that one third of the national participation (1205 applications, EUR 306.2 million in funding) is in Budapest (830 applications, EUR 217 million in funding).

Beneficiaries in the Budapest region have been awarded EUR 27.5 million for Information and Communication Technologies, EUR 15.7 million for Smart, Green and Integrated Transport and EUR 14.8 million for Safe, Clean and Efficient Energy.

Pest (HU12)

[23] eCorda database (data from 01/02/2020)

Beneficiaries in the Pest region have been awarded nearly EUR 5.5 million for Health, Demographic Change and Welfare; EUR 4 million for Leadership in Enabling and Industrial Technologies (LEIT): Information and Communication Technologies (which includes ICT, Nanotechnology, Advanced Materials, Biotechnology, Advanced Manufacturing and Processing, Space) and nearly EUR 4 million for Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research, and Bioeconomy.

Joint projects identified with the neighbouring region SK02 (Západné Slovensko) can be found in the following thematic areas:

- Euratom (3 joint projects),
- Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research, and Bioeconomy (2 joint projects).

Central Transdanubia (HU21)

Beneficiaries in the Central Transdanubia region have been awarded nearly EUR 4.5 million for Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy; EUR 0.6 million for Leadership in Enabling and Industrial Technologies (LEIT) and EUR 0.4 million for Research Infrastructures.

Joint projects identified with the neighbouring region SK02 (Západné Slovensko) can be found in the following thematic areas:

- Euratom (2 joint projects),
- Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy (2 joint projects).

Western Transdanubia (HU22)

Beneficiaries in the Western Transdanubia region have been awarded nearly EUR 2 million for Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy; EUR 1.7 million for Climate Action, Environment, Resource Efficiency and Raw Materials and EUR 1.2 million for Secure, Clean and Efficient Energy.

The joint project identified with the neighbouring region AT11 (Burgenland) is in the area of Secure, Clean and Efficient Energy.

The joint projects identified with the neighbouring SK01 (Bratislavský kraj) region cover the areas of Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy, Euratom Programme and Leadership in Enabling and Industrial Technologies (LEIT).

The joint projects identified with the neighbouring HR04 (Kontinentalna Hrvatska) region cover the areas of Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy, Euratom Programme, Smart, Green and Integrated Transport and Leadership in Enabling and Industrial Technologies (LEIT).

Southern Transdanubia (HU23)

Beneficiaries in the South Transdanubia region have been awarded nearly EUR 1.8 million in the areas of Climate Action, Environment, Resource Efficiency and Raw Materials; EUR 1 million in the area of Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy and EUR 0.5 million in the area of Health, Demographic Change and Welfare.

The joint project identified with the neighbouring HR04 (Kontinentalna Hrvatska) region covers the areas of Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy.

Northern Hungary (HU31)

Beneficiaries in the Northern Hungary region have been awarded nearly EUR 1 million in the areas of Climate Action, Environment, Resource Efficiency and Raw Materials; nearly EUR 1 million in the area of Secure, Clean and Efficient Energy and EUR 0.7 million in the area of Smart, Green and Integrated Transport.

There are no links with the neighbouring regions SK03 (Stredné Slovensko) and SK04 (Stredné Slovensko).

Northern Great Plains (HU32)

Beneficiaries in the Northern Great Plains region have been awarded nearly EUR 1.1 million for Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy; EUR 0.9 million for Leadership in Enabling and Industrial Technologies (LEIT).

Under the Euratom Programme, the links with the neighbouring RO11 (Nord-Vest) region cover the areas of Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy and Secure, Clean and Efficient Energy.

Under the Euratom Programme, the links with Ukraine cover the areas of Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research, and Bioeconomy and Secure, Clean and Efficient Energy.

Southern Great Plains (HU33)

Beneficiaries in the Southern Great Plains region have been awarded nearly EUR 5.2 million in the areas of Research Infrastructures; EUR 2 million in the area of Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy and EUR 1.9 million in the area of Health, Demographic Change and Welfare.

There are links with the neighbouring RO42 (Vest) region in the area of Secure, Clean and Efficient Energy.

There are links with the neighbouring RS12 (Region Vojvodine) region in the areas of Food Security, Sustainable Agriculture and Forestry, Marine Research, Maritime and Inland Water Research and Bioeconomy.

Potential directions

The above analysis can be used to support the following objectives in line with the objectives of the RDI Strategy 2021-2030:

- in the context of Horizon Europe, the aim is to increase the participation of Hungarian institutions in projects and the amounts of funding awarded;
- in addition to increasing participation in projects and the amount of funds awarded, a qualitative change is also an important element, whereby the Hungarian consortium member(s) assume a key professional/management role in the project (technical work package leader/consortium leader);
- cooperation, in particular with neighbouring regions/countries is seen as a potential for cooperation to be exploited by the domestic research community that will increase the international visibility and regional embeddedness of domestic institutions;
- in addition to the traditional Framework Programme proposals, it is necessary to give priority to the European Partnerships, launched under Horizon Europe, which mobilise the resources of the European Commission, the Member States concerned and the main industrial players to focus on a specific technological or societal challenge. The European Partnerships' portfolio of 50 programmes provides an important link to our priorities identified in S3 and can play a key role in strengthening international relationships and cooperation between regional operators;
- the sub-programme of Horizon Europe for widening participation in the Framework Programme and strengthening the European Research Area offers the opportunity to strengthen research excellence and capacity by creating partnerships between research organisations in the less innovative 'widening' countries and institutions that are leaders in their respective fields of science and technology. Many of the actions supported under the sub-programme (e.g. Teaming, Excellence Hub, ERA Hub) are expected to be linked to the smart specialisation strategy of the Member State concerned, to attract ESIF funds, to complement Horizon Europe resources and to trigger structural changes and attitude shifts in their environment and region in order to strengthen scientific and innovation excellence;
- developing strategic partnerships with the most important European networks of research institutes, and in addition to this, it is worth considering supporting the establishment of foreign research institutes in the country, promoting their integration into the domestic ecosystem and exploiting the potential of bilateral and multilateral cooperation, in particular with neighbouring countries;
- the participation and effectiveness of regions outside the Central Region in Horizon Europe needs to be strengthened.

6.4.5. Developing international relations through cooperation between research infrastructures

Another priority area for international scientific cooperation is related to research infrastructures (RIs). Our participation **in** internationally significant **research infrastructures** provides a significant opportunity for Hungarian researchers to **improve their professional skills, to join international networks and helps to support multidisciplinary collaborations**. To encourage this, the National Research, Development and Innovation Office (NRDI Office), as outlined in the National Research Infrastructure Roadmap (NRDI Office, 2018), has **joined** several **international research infrastructures** in recent years to help connect RDI professionals to the international research community. To ensure access to such infrastructures, the NRDI Office spends around HUF 3 billion annually on joining and maintaining membership in international research infrastructures.

Research infrastructures will be an important factor in the next EU planning cycle, given **their bridging role** in RDI cooperation and economic recovery, and can play an important role in the design and implementation of S3. Their use can strengthen **cross-border regional and, through them, wider international RDI cooperation**.

The use of research infrastructures and related research services in publicly funded research organisations can create opportunities for sole proprietorships, SMEs and all industrial operators **to develop new technologies, products and services**. Research infrastructures can also serve as a tool for the implementation of "open laboratory" initiatives and can play an important role in promoting "open innovation".

The development and networking of research infrastructures has recently been supported by a number of funding schemes. These have enabled existing research infrastructures to complement regional and national research opportunities in connection with other existing major infrastructures and contributing to the creation of RDI capacities adapted to the region's industrial partners.

Research infrastructures can help **networking and cooperation** between higher education institutions, academic research centres, public non-profit research centres, other publicly funded research centres, research and technology centres, large companies and micro, small and medium-sized enterprises in the region. By increasing the number of businesses engaged in RDI in the region, these collaborations can also become internal drivers for economic growth in the region.

Cooperation opportunities related to international research infrastructure memberships

Research infrastructures can contribute to **strengthening international cooperation in the region** where an institution in the region is an active player in international RI, especially when this coincides with existing and potential thematic areas of the region's knowledge base. International cooperation between regions can also be facilitated by the fact that a given international research infrastructure also involves a country/countries neighbouring the region.

Southern Transdanubia (HU23)

In the South-Transdanubia Region, the University of Pécs –operating since 2013 with ERIC (European Research Infrastructure Consortium) status – has been an active participant of the ECRIN ERIC international RI. The RI, aiming to bring together European scientific partners and networks, encourages international collaboration in clinical research. Our active participation in RI is supported by a national research network, the HECRIN consortium, which can provide opportunities for collaboration with Croatian researchers. University of Pécs is also an active participant in the EuBI (European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences) and XFEL (European X-Ray Free-Electron Laser Facility) research infrastructures, which can also enhance international scientific cooperation in the region.

Northern Great Plains (HU32)

In the Northern Great Plain Region, the University of Debrecen is an active participant in the international research infrastructure *European Research Infrastructure for Imaging Technologies in Biological and Medical Sciences* (EuBI-ERIC) in the field of Health and Food Sciences. One of the nodes of the distributed RI is based at the University of Debrecen, with several national institutions also participating. EuBI-ERIC provides open physical access to a wide range of world-class biological and biomedical imaging technologies for researchers in life sciences. It aims to organize a network of microscopic and medical imaging laboratory services and make costly and expertise-intensive methods available in Europe. The RI could provide opportunities for collaboration with Czech and Austrian researchers who are also members. The research infrastructure E-RIHS (European Research Infrastructure for Heritage Science), coordinating research in the field of cultural heritage protection, conservation and recording, could also broaden international cooperation in the region. The Institute for Nuclear Research (ATOMKI) is institutionally linked to the research infrastructure, of which Slovenia and the Czech Republic are both parts. University of Debrecen (DE) is also a collaborating partner in the ELIXIR (European Life Sciences Infrastructure for Biological Information), EMBL, CERIC-ERIC (Central European Research Infrastructure Consortium, European Research Consortium) and CERN (European Organization for Nuclear Research) research infrastructures, and ATOMKI is a collaborating partner in the CERIC-ERIC, CERN, ESRF (European Synchrotron Radiation Facility) and ESS ERIC (European Spallation Source) infrastructures, which could create new opportunities for expanding international cooperation.

Southern Great Plains (HU33)

Hungary has been a member of the European intergovernmental life sciences research organisation, EMBL since 2017. In terms of its research performance, the institute engaged in genetics and molecular biology is ranked first in Europe. In addition to high-quality molecular and cell biology facilities, it operates strategically crucial infrastructure in the fields of bioinformatics and structural biology. In the Southern Great Plain Region, the Biological Research Centre, Szeged (SZBK) is an active participant in the research infrastructure with its outstanding results. The research infrastructure will also involve institutions from Croatia, Austria, the Czech Republic and Slovakia opening up further cooperation in the field. In

addition to SZBK, the University of Szeged (SZTE) is also involved in the cooperation between EuBI ERIC and XFEL research infrastructures, and SZTE is also exploiting the potential of the Common Language Resources and Technologies Infrastructure (CLARIN ERIC). The two main scientific players in the region have the opportunity to expand their international relations with businesses and neighbouring countries through the potential of these infrastructures.
The international cooperation opportunities of a given region with research infrastructures can be strengthened by thematic areas that are considered to be the region's knowledge base or have a high potential for development.

Opportunities to strengthen V4 RDI cooperation through research infrastructures

Among our international research collaborations, special attention is always given to the possibility of expanding our relations with the V4 countries. All V4 member states are involved in several research infrastructures (e.g. EMBL, CERN, ITER SHARE ERIC), and the cooperation established along these lines can serve as a basis for generating further research cooperation and joint applications for funding. And in the case of CERIC ERIC, ESS ERIC, XFEL, ESA, CESSDA ERIC, CLARIN ERIC, ESS ERIC (European Social Survey) and E-RIHS infrastructures, members involve at least two other V4 countries in addition to Hungary and this could further expand the possibilities for cooperation. Memberships are constantly evolving in the different research infrastructures, e.g. in the case of ECRIN, although only the Czech Republic is a full member besides Hungary, there is a strong willingness to collaborate in clinical research.

Short name of research infrastructure	Name of research infrastructure	ESFRI Landmark/ Project	Type	CZ	PL	SK
ENVIRONMENT						
EPOS	European Plate Observing System	Project	Distributed	X	X	
ECRIN-ERIC	European Clinical Research Infrastructure	landmark	Distributed	X		
ELIXIR	A distributed infrastructure for life-science information	landmark	Distributed	X		
EMBL	European Molecular Biology Laboratory	Not related to ESFRI	Distributed	X	X	X
EuBI ERIC	European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences ERIC	landmark	Distributed	X		
ICGEB	International Centre for Genetic Engineering and Biotechnology	Not related to ESFRI	Distributed			X

Short name of research infrastructure	Name of research infrastructure	ESFRI Landmark/ Project	Type	CZ	PL	SK
PHYSICAL SCIENCES & ENGINEERING						
CERIC-ERIC	Central European Research Infrastructure Consortium, European Research Consortium	Not related to ESFRI	Distributed	X	X	
CERN	The European Organization for Nuclear Research	Not related to ESFRI	Single-site	X	X	X
CERN HL-LHC (ALICE, CMS)	High-Luminosity Large Hadron Collider (CERN)	landmark	Single-site	X	X	X
ELI-ERIC	Extreme Light Infrastructure ERIC	landmark	Distributed	X		
ESRF UPGRADES	European Synchrotron Radiation Facility (ESRF) Upgrades, Phase II: Extremely Brilliant Source	landmark	Single-site			
ESS-ERIC	European Spallation Source ERIC	landmark	Single-site	X	X	
European XFEL	European X-Ray Free-Electron Laser Facility	landmark	Single-site		X	X
ITER/ EUROfusion	International Thermonuclear Experimental Reactor	Not related to ESFRI	Single-site	X	X	X
ESA	European Space Agency	Not related to ESFRI	Distributed	X	X	
SOCIAL & CULTURAL INNOVATION						
CESSDA-ERIC	Consortium of European Social Science, Data Archives	landmark	Distributed	X		X
CLARIN-ERIC	Common Language Resources and Technology	landmark	Distributed	X	X	
ESS-ERIC	European Social Survey	landmark	Distributed	X	X	
SHARE-ERIC	Survey of Health, Ageing and Retirement in Europe	landmark	Distributed	X	X	X
E-RIHS	European Research Infrastructure for Heritage Science	Project	Distributed	X	X	

9. Table: Joint participation of Hungary and the V4 countries in European research infrastructures. Source: ESFRI Roadmap 2018 (NRDI Office, 2018) and websites

Collaboration through international research infrastructures of a region

Among the existing international research infrastructures in our regions, the following must be highlighted: the **Extreme Light Infrastructure Attosecond Light Pulse Source** (ELI-ALPS) in Szeged being one of the physical and engineering research infrastructures included in the ESFRI Roadmap (European Strategy Forum for Research Infrastructures), **zalaZONE**, a unique infrastructure of its kind in the Western Transdanubia Region, the **Martonvásár Agri-Innovation Centre** in the field of agricultural science, and the **Laboratory for Heritage Science,** Debrecen that helps non-destructive dating of cultural and natural heritage artefacts.

- **ELI - three sites, three countries, one infrastructure**

The Extreme Light Infrastructure, (ELI, 2020) a high-power laser-based research infrastructure is being established in European cooperation, with the involvement of the international scientific community. The ELI is the world's first facility to enable the examination of interaction between light and matter at unprecedented intensities. The research infrastructure indicated in the ESFRI Roadmap has been commissioned continuously from the end of 2017. The laser research centre is established on three sites by Hungary, the Czech Republic and Romania at the same time, subject to joint coordination and a harmonised research strategy. The ELI-ALPS research institute in Szeged will study extremely short processes in atoms and molecules. The implementation of the research centre is considered as a flagship by the European Union because it is a notable example of how the Structural Funds, the H2020 Framework Programme and national resources can be used in a complementary way.

The ELI-ALPS equipment primarily enables basic research in physics, chemistry, materials science and biomedical sciences, but it will also be used for applied research and – as a spill over effect – for industrial application purposes. The research facility, which has been commissioned since 2017, could open up new opportunities for research cooperation with neighbouring countries in the region.

ZalaZone test track

In 2017, Hungary was quick and in the best possible time to **set up** an internationally **unique automotive test track**. ZalaZONE is a unique test track in Europe and in many respects in the world, where traditional test track functions are implemented together with elements of an R&D infrastructure focusing on future vehicles in a system where they build on each other and which allows for multi-level validation.

The rise of autonomous driving and electric vehicles is posing major technological challenges not only for vehicle manufacturers but also for developers. A key determinant of these challenges is the limited testing capacity available. Many of the traditional test tracks are only available to the car manufacturer running the track and the public tracks are usually full. In addition, European testing capacities are less prepared for the new testing needs resulting from the technological change in the automotive industry. In other words, **there is** currently a very strong **market demand for a state-of-the-art testing environment that supports the latest technologies,** as all of the few test tracks in the world were built earlier and many of them are

heavily used due to ever higher quality requirements. There are even fewer test tracks in the world that allow for the testing of complex autonomous functions where it would be feasible **to safely test complex situations and functions**.

The location of the test site provides an excellent opportunity for regional cooperation, not only in the field of research and development, but also in education and training.

The ZalaZone complex will include the construction of a part of the field test track, which could host significant defence RDI activities.

- **Martonvásár Agri-Innovation Centre**

The Agri-Innovation Centre (AIC), soon to be implemented, will be a unique research centre in Martonvásár (ATK (Centre for Agricultural Research), 2020). The AIC staff is composed of the scientific staff of the Centre for Agricultural Research and its operations will be hosted by a newly built research block. Due to the multidisciplinarity of the three interdependent disciplines located in the campus (soil science, plant protection, plant breeding / agricultural engineering), the joint work will provide more efficient responses to the comprehensive problems of agriculture. The modern instrument platforms represent a major scientific attraction and their uniqueness will facilitate participation in national and international cooperation projects. The new phenotyping platform will enable more efficient and quicker plant feeding and breeding research, allowing for a substantial growth in RDI potential. All instrument platforms have been selected in view of the current scientific trends to ensure the future-proofness of the highly valuable assets. The agri-innovation centre can contribute to the internationalisation of the Hungarian agricultural sector through its international cooperation.

- **Laboratory for Heritage Science**

The Laboratory for Heritage Science (ATOMKI, 2020), equipped with a unique set of tools in Hungary, is located at the Institute for Nuclear Research. The laboratory at the research institute in Debrecen is equipped with new imaging and dating instruments for artefacts.

Electron microscopy is an essential technique for the analysis of cultural and natural heritage objects, but sensitive samples cannot always be examined without damage, for example because the material cannot withstand the vacuum in the sample chamber. This is helped by Atomki's new AirSEM equipment, which can provide information on the morphology and composition of samples without the need for a sample chamber and by eliminating the effects of damaging agents. There are many electron microscopes in Hungary but none that do not require a sample chamber can be found elsewhere.

Looking into the future

Research infrastructures are crucial for achieving **scientific breakthroughs** and fostering innovation. In line with the EU's R&I policy ambitions for the next cycle, research infrastructures will play a greater role in **addressing new societal challenges** and create more effective synergies in the use of different funding sources at European and national level.

Research infrastructures can contribute to strengthening the role of **strategic cross-border investments** and, in addition to developing and exploiting the potential of knowledge and innovation hubs integrated in local communities and their positive regional impact, can be a basis for **increasing** European **competitiveness**. Achieving coherence between European, national and regional priorities and policies for the development and funding of research infrastructures can contribute to the long-term effective development of RDI and thus to the strengthening of regions.

The strategic plans of the EU's Horizon Europe (HE) will encourage the involvement of RIs in all three pillars of the programme and clarify their role in the work programmes in terms of missions, European partnerships and programmes to broaden participation.

Because RIs are strongly rooted in regions, they have a major impact on **regional development**. **Their role goes beyond scientific results, they have a significant impact on education systems, on the economic development of the region and contribute to solving overarching societal issues.**

On this basis, existing research infrastructures and future synchronised developments in the regions, in addition to scientific cooperation, can provide a basis for regional higher education cooperation, strengthening industrial relations and developing services and supplies.

7. Monitoring and evaluation

The enabling conditions for the 2021-2027 programming period include "monitoring and evaluation tools to measure performance against the objectives of the strategy". This is because, based on international experience, much more emphasis needs to be placed on the continuous monitoring of S3 implementation and the associated feedback process.

It is important to note that the Project Charter on the management structure and further details of implementation of S3 will contain all the detailed rules for S3 monitoring and evaluation.

7.1. S3 2014-2020 monitoring and evaluation experience

Monitoring reports

In the 2014-2020 period, Government Decision 1640/2014 (XI.14.) required the Minister of the Prime Minister's Office (the predecessor ministry supervising the NRDI Office) to **prepare a comprehensive report on the implementation of the National Smart Specialisation Strategy (S3) every two years** with the involvement of the NRDI Office.

The first report was completed in the first quarter of 2018 to ensure continuity. **In the second half of 2019**, **the second monitoring report was completed**.[24] The second document is an

[24] The 2nd report is not public. The document is available in Hungarian for the experts involved in S3.

updated version of the first report in terms of data content and methodology. Both reports examined:

- in which of the RDI calls for proposals and how the alignment with S3 has been presented,
- how the priorities, types of regions and national specialisations identified in S3 have been mainstreamed through RDI calls.

The second monitoring report looked at applications funded in 2015-2019[25].

The S3 monitoring report of 2019 (NRDI Office, 2019a) **did not yet address several aspects that will form an integral part of S3 and its planned monitoring in 2021-2027**.

These include, for example, monitoring the implementation of S3. The chapter on monitoring in this S3 document puts much more emphasis on monitoring the measures through which the operational delivery is taking place, thus helping to ensure the effectiveness of the S3 implementation. We also want to put more emphasis on the progress of indicators – especially at the priority level. The indicators in the S3 monitoring chapter were selected with this in mind. In the 2014-2020 period, S3 monitoring focused on the RDI policy, and monitoring reports did not include the assessment of measures in other relevant policy areas. A key challenge for the 2021-2027 programming period will be to extend the monitoring process to these measures.

The S3 implementation process

The task of designing the RDI funding schemes and implementing S3 was largely the responsibility of the NRDI Office as the entity responsible for the policy, which facilitated the process of S3 implementation. NRDI Office cooperated with the ministry responsible for the use of EU funds. After the institutional transformation in 2018, the RDI policy tasks were transferred to the Ministry for Innovation and Technology, similarly to the departments responsible for EU RDI funds (Government Decree 94/2018 (V.22.)). The planning task has not become more fragmented, only the decision-making powers have changed. Thanks to this organisational background, the S3 criteria have been applied not only to EU funds, but also to certain calls for proposals under the NRDI Fund. **The clear definition of tasks and the cooperation between organisations were the basis for the implementation of the S3 priorities.**

However, S3 as a coordination tool for smart specialisation can be but slowly integrated into the whole RDI policy. The purpose, approach and utility of S3 have not yet become an integral part of standard planning practice.

Progress of indicators

Monitoring mainly **measured the efficiency of the use of the financial resources deployed through output indicators**. It also looked at which **target groups the funds reached**, i.e. the number of entrepreneurs in each specialisation who were activated by public funds. Territorial characteristics were also analysed, i.e. what proportion of the **funds were used** in the different counties. In addition to the project data, statistical data were also available but, as they are too general, their use is limited.

[25] Although the EU programming cycle started before 2015, the first analysable results of the new competitive tendering system in the RDI field were only published in 2015.

The aims under the S3 monitoring and evaluation chapter include the examination of the development results, as well as a **context indicator and** a number of **result indicators** to measure the effectiveness of S3. **Their examination was not included in the monitoring.** In order to ensure coherence between S3 and the RDI strategy, S3 did not set objectives other than those included in the RDI strategy, and S3 aims to focus and optimise funds. These indicators in the S3 document are, however, commonly used, already established, nationally relevant RDI and other policy indicators, which do not reflect the S3 impact mechanism. Based on the experience with S3 monitoring collected since then, **it is** preferable to **generate indicators that are priority-oriented and that track the progress of S3 implementation**. Emphasis should be placed on a breakdown by specialisation.

We have also applied the S3 priorities outside the RDI policy as such, for example in the calls under EFOP-3.6.1-16 *Institutional development for smart specialisation*, targeting universities and managed by the Ministry of Human Capacities. However, non-RDI funding schemes were not included in the analysis.

S3 as a tool for specialisation

The deeper integration of S3 as a coordination tool into policy is made more difficult by the fact that S3 planning is a learning process for Hungary (and all other EU Member States). **Domestic RDI policy is traditionally not sector-oriented.** Even in the new funding scheme introduced in 2015, only a few particularly important – and therefore eligible – research areas (e.g. brain research, quantum technology) were highlighted. In the funding system, the main selection principle was professional excellence. **This horizontal approach is reflected in the RDI Strategy.** It is difficult to integrate into this system a policy instrument that requires a completely new approach or a specialisation based on local strengths. The policy changes in 2018 have already introduced a greater proportion of theming in the resource allocation system (e.g. the Thematic Excellence Programme), which should hopefully shift the S3 specialisation approach in a positive direction.

Specialisation in the priorities

The adaptation of S3 as a specialisation tool is also slowed down by the fact that the strategy developed in 2014 set out cross-cutting priorities that could cover **a very wide spectrum of** RDI developments. As a result, the implementation and enforcement of S3 **has not been able to result in a strong concentration of funds** in some research focus areas. This is expected from S3 in the new programming period.

EDP and policy communication

The acceptance of S3 has not been sufficiently supported by policy communication. The achievement of the 2014-2020 period is that a wide range of stakeholders have become aware of S3. However, few people know the real role and expected impact of S3. This is partly because while **entrepreneurs and universities have been involved in the S3 planning process through the EDP, they were not involved in the implementation process**. Information, feedback, media and communication programmes related to S3 were not specifically linked to S3 after the end of the planning process.

Changes in the S3 county situations

The design of the S3 targets for the previous cycle was based mainly on 2013 statistical data. The years that have passed since then justify a renewed examination of the socio-economic characteristics and research and development potential of each county. (County-level innovation data is not available and is therefore not included in the indicator group.) Indicators measuring the socio-economic situation and RDI potential of counties are grouped into two sets of indicators. In the system of coordinate axes formed by the two sets of indicators, the location of the counties is the basis for the types of regions developed in S3.

The main characteristic of **knowledge areas** is their high R&D potential, coupled with very different levels of socio-economic status.

The counties in **the industrial production zone** have in common a medium to low R&D potential and good economic performance.

Moderate knowledge and technology-intensive regions have in common lower results in terms of both R&D performance and socio-economic performance.

- **Support for the IT background**

For many schemes, the project registration system does not allow for the alignment with S3 to be managed like a database or to be queried but treats the indication of alignment with S3 as a text field. This not only complicates monitoring but also the acceptance of S3 as a policy instrument by applicants. To overcome this, the S3 monitoring processes for 2021-2027 aim to apply S3 criteria in the management system of project proposals and in the application process in an organic and consistent way for all calls for proposals. (see 'Monitoring and evaluation' for more details.)

Awareness raising and information on S3

The implementation of the previous S3 was not accompanied by active and continuous communication activities. During implementation, potential RDI actors encountered the S3 priorities mainly in the calls for proposals. In order to improve the effectiveness of S3 in the 2021-2027 programming cycle, much more emphasis needs to be placed on making the professional content of S3 widely known. This includes informing the RDI actors, all stakeholders, as well as training the experts who will carry out the professional evaluation of the proposals. The aim is to use the available means of communication to communicate the purpose and expected benefits of S3 as widely as possible.

7.1 Basics and objectives of S3 monitoring and evaluation

The process of monitoring and evaluation of S3 is influenced by a number of factors that can be attributed to the specific characteristics of S3 as a policy coordination tool. These set out the monitoring framework for the Hungarian S3 for 2021-2027, namely:

- One of the key features of monitoring is **continuity**, i.e. the implementation of regular and planned monitoring activities.
- **Partnership** also underpins the design and implementation of S3. The ambition for a broad partnership is also reflected in the monitoring process, in particular in the continuity of the EDP and inter-ministerial cooperation.

- Another key element of S3 is **focus**. Taking this into account, monitoring should also be targeted and should be designed and carried out according to the priorities identified.
- Dialogue and seeking **common understanding** permeate the design and implementation of S3 as a whole. The search for a common position is particularly important for a policy instrument that involves such a wide range of stakeholders: from public administrations, the budgetary sector, the economy and from among local and regional actors.
- The fourth key element of S3 is **territoriality**. S3 is based on local strengths and assets. Integrating territorial specificities into the process is therefore key (localisation).

The following pre-conditions were key in the development of the S3 monitoring system:

1. The **prioritisation** process and the formulation of specific objectives per priority are described in detail in the chapter on the prioritisation process and in the chapter on S3 objectives. We have built the monitoring system as a whole around the priorities identified therein.
2. **The intervention logic** shows how the steps, expected inputs, outputs and outcomes follow from each other in the S3 implementation process. It sets out, by priority, the path from policy instrument to objectives and expected results.
3. The most important element of the intervention logic for monitoring was the definition of **indicators**. A monitoring system can only be successful if it is based on a well-prepared intervention logic where objectives and expected results are genuinely linked and therefore, indicators are used that can be meaningfully influenced by the measures.
4. Another prerequisite for a successful monitoring system is the definition of the **data collection** methodology in advance. That is, we use indicators that will be available to the actors in the monitoring process. It is important that data can be produced at an annual – or at least bi-annual – frequency, broken down by area, in an internationally comparable way, with the help of an appropriate IT environment, minimising the need for manual data collection and processing. If a specific or new type of data collection is to be generated, the necessary human, financial, legal and IT resources must be provided.
5. Successful monitoring requires the **identification of** the **actors involved** and a clear definition and delimitation of roles and responsibilities. This is a particularly important aspect in such a complex, multi-actor monitoring system. The chapter on management describes in detail the structure of tasks and responsibilities for the whole S3 implementation.

Following the general methodological framework, S3 monitoring and evaluation **aims** to prepare, conduct and process the necessary data and information collection and then to provide feedback on the implementation of policy measures and the level of achievement of the

expected results (with a proposal for modifications if necessary). This is done by comparing the actual, current data with the expected results and detecting the discrepancy between the two. In this process, S3 has the monitoring task of describing "what is happening" and the **evaluation task of** "explaining the situation revealed by monitoring".

The three focus areas of S3 monitoring:

1. **Implementation:** Have the policy measures been implemented as planned in the course of S3 planning? (Have policy measures been taken with the parameters that were planned?) Have the planned outputs and results been achieved?
2. **Priorities:** Is there a need to further justify the relevance of the selected priorities or to refocus the priorities?
3. **The S3 management structure:** Has the decision-making structure and the involvement of all stakeholders in the EDP been implemented as planned?

At the same time, the aim of the evaluation is to provide answers on how the policy instruments are working and where changes and improvements are needed. To do this, it is necessary to analyse the data and results obtained by the monitoring system and, on the basis of the conclusions, to propose to decision-makers whether to continue or to modify the system.

S3 monitoring is not only about alignment with priorities but also about the achievement of S3 objectives. Learning from the experience of the previous period and building on the proposals and expectations published by the European Commission, monitoring should be extended beyond the priorities to cover other elements of implementation.

OECD monitoring methodology for enterprise development

Within the framework of the European Union's SRSP (Structural Reform Support Programme) project (European Commission. 2020g), the Ministry for Innovation and Technology submitted a project on the implementation of the SME Strategy and the development of a monitoring and evaluation system, which it intends to implement with technical assistance from OECD. One of the main elements of the project is to help set up a monitoring and evaluation system to monitor the implementation of the different elements of the SME Strategy, which will contribute to the effectiveness of the implementation through monitoring the individual programmes. A detailed agreement of the project is currently being drawn up. The relevant parts of the project will be channelled into the S3 monitoring process.

7.2 Methodological framework for the monitoring system

1. Identifying the target groups:

On the basis of the experience gained so far through calls for proposals, it is necessary to assess which economic sectors could be potential beneficiaries of the measures envisaged within the priority and which could be reached by public programmes.

The main activity of the organisations or, in the case of organisations that have already implemented a project proposal, the NACE Rev. 2 code of the project can be used to make the screening.

2. Result indicators:

With a clear understanding of the target group it is possible to select appropriately targeted results and the related indicators.

The result indicators capture the expected impact of the interventions on the beneficiaries or target group. The result indicators should be consistent with the objectives set for the priorities. Result indicators go beyond output indicators mainly because they reflect changes in the baseline situation.

3. Output indicators:

Output indicators relate to the specific activities funded. An output indicator expresses what a supported project has directly generated, expressed in terms of quantity (number of projects or enterprises funded) or financial value (amount of funding used). The value of the output indicator should be set at the level of the priority objectives.

4. The targets:

The effectiveness of S3 is based on the fact that targets are set as objectives to be achieved, which help to achieve these objectives at the policy level.

5. Source of data:

Project data: Individual data of project proposals managed in project registration systems. The content and structure of the data uploaded when submitting a proposal will have a major impact on their usability. The success of S3 monitoring is therefore strongly influenced by the quality of project registration systems and application forms.

Statistical data:

Given the sectoral focus of S3, only statistical data that are available by sector (NACE Rev. 2) are relevant for the monitoring system. Although the Hungarian S3 basically sets priorities at national level, NUTS3 (county/metropolitan) data are needed to monitor territorial differences.

Questionnaire data:

Questionnaires should be used to gather information that are not available from the project database and statistics. These can be specific and qualitative data or quantified data required for the indicators. Possible target groups for completing questionnaires:

- Target groups selected and identified by priority – based on OPTEN enterprise database.
- The actors around the TIP – signatories of the TIP charter document.
- Partners with an ongoing project.

In the case of applicants, the GDPR requires that the necessary declarations are recorded at the time of filing the project proposal so that the organisations concerned can be contacted for the purpose of collecting data through questionnaires.

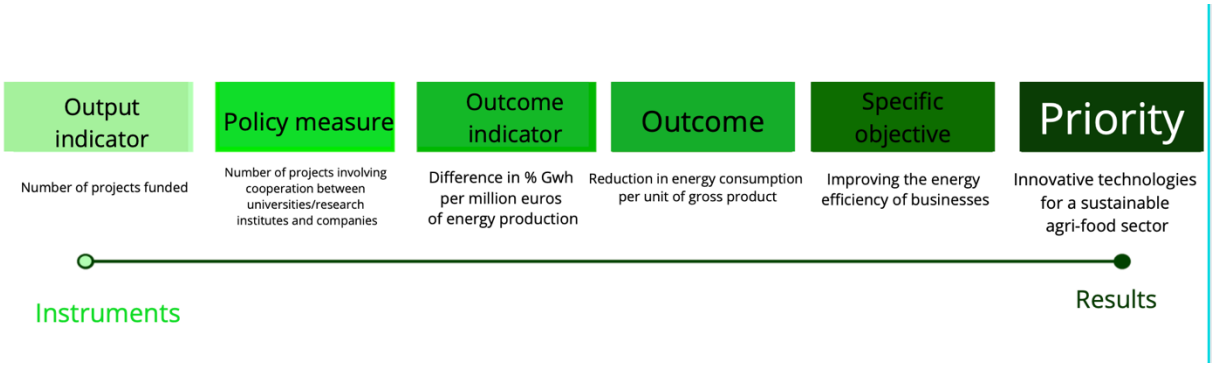
Further qualitative data:

For a given specialisation, if more in-depth qualitative data is needed, they should be collected through face-to-face and focus group interviews.

7.3. Monitoring of implementation by priority

Output and result indicators are used at this stage of monitoring to track the progress of S3. They show how the projects supported through calls for proposals have produced actual outputs and results and whether they meet the objectives set. Have policy measures been taken, calls for proposals been launched with parameters that contribute to the achievement of the objectives set out in S3? To what extent the planned outputs and results have been achieved?

To ensure methodological consistency in the monitoring process to be implemented by priorities, a model intervention logic is needed to serve as a guidance for each priority. The Joint Research Centre[26] has produced detailed technical documents to support S3 monitoring, including a model intervention logic. Below, this model will be used as a basis for further design.



25. Figure: Basic model for the intervention logic (source: JRC, 2018)

The figure above defines a specific objective, expected result, quantifying result indicator, policy measure generating all this and direct output of the measure for a specific priority.

Within the intervention logic, the starting point for defining indicators and targets for each priority is to identify the target group concerned.

Implementation is monitored by priorities. This allows us to focus on target groups during implementation to assess the success of S3. For the target groups, it should be stressed that the **sectoral focus should take into account not only the main activity of the enterprises (NACE Rev. 2 code) but also the NACE Rev. 2 code of the project activity**. Today, one of the most

[26] JRC is the European Commission's science centre providing independent, science-based advice to EU policies.

important features of RDI is interdisciplinary research, combining research areas that may be completely different from each other and research topics that overarch traditional sectors. In order to address this statistically, the NACE Rev. 2 codes listed in the definition of target groups are therefore valid for both the main activity and the project activity.

From a methodological point of view, it should also be taken into account that the NACE Rev. 2 code for **universities and research institutes** does not reflect the field of research activity (education or professional scientific and technical activities). Therefore, **for** these institutions, the **aim is to examine the projects funded on the basis of the NACE Rev. 2 code of the project activity**. For the sake of completeness, however, in projects where universities and research institutes are part of the target group, the target group includes NACE Rev. 2 codes M: Professional scientific and technical activities and P: Education.

There are priorities where the target group of the priority can be clearly identified, such as Health and Agriculture and Food. Here we can clearly identify the sub-sectors where funding should generate change. However, there are priorities where impacts are expected to be more wide-ranging. For the Digitalisation of the Economy priority, the Energy, Climate priority, and the Resource-Efficient Economy priority, R&D activities will lead to solutions that can be applied to a much wider range of businesses. The aim is to ensure that the results of these activities are applied to a broader range of domestic enterprises, for example in the form of adaptive innovation. Hence, for these priorities, R&D activities are focused on the targeted sector, while innovation activities are focused on the whole range of enterprises.

In selecting the intervention logic and indicators, the range of available statistical data should be examined. It is important that**, in view of the territorial and sectoral breakdowns, only official statistical data** that **can be provided by the Hungarian Central Statistical Office (KSH), Eurostat,** OECD or international rankings (EIS, WIPO and WEF indices) are used. For the latter data, it should also be kept in mind that if the methodology of the ranking changes, the baseline or target value may also need to be changed. A further consideration was to use a **limited number of indicators**.

The **output indicators** are also defined in a standardised way for the different priorities, and **basically** refer to the types of **organisations funded**. The selection of indicators was based on the set **of PO1 indicators provided by the European Commission** in order to ensure synergies between the operational programmes and S3.

The expected results, indicators, policy measures and interventions per priority may be refined during the validation process representing the second phase of prioritisation and the continuation of the EDP (see chapter 3.3).

The baseline and target values for the monitoring indicators are set out in the table below.

NAME OF PRIORITY	RESULT INDICATORS	Baseline	Baseline year	Target	Target year	Source of data
Health	**R&D expenditure as a percentage of GDP** in the field of medical and health sciences (including medical engineering and biological sciences)	0.41%	2018	0.60%	2027	KSH
	The share of innovative businesses in the following sectors:				2028	KSH (Eurostat)
	CF: Pharmaceutical production	CF: 67.4%		CF: 75%		
	26: Manufacture of computer, electronic and optical products (266 Manufacture of electronic medical equipment, 267 Manufacture of optical instruments)	26: 47.9%		26: 60%		
	32: Other manufacturing (32.5 Manufacture of medical devices)	32: 35.7%		32: 45%		
	10: Food production	10: 26.9%		10: 35%		
Digitalisation of the economy	Value of **the DESI Corporate Integration of Digital Technologies** indicator (sub-index) (score)	25.3	2020	40.0	2027	European Commission, Digital Scoreboard
	Percentage of enterprises that have introduced product innovation (among enterprises with more than 10 employees)	20.4%	2018	30%	2028	Eurostat
	Enterprises introducing business process innovation (among enterprises with more than 10 employees)	19.8%		30%		
Energy, climate	Share of renewable electricity generation in domestic production	10.0%	2017	20.0%	2030	National Energy Strategy
Services	Total **business R&D expenditure as a share of GDP** in the following sectors: H: Transport, storage G: Trade, repair of motor vehicles N: Administrative and service support activities M: Professional scientific and technical activities	0.56%	2018	0.75%	2027	KSH
	Percentage of enterprises that have introduced service innovation (among enterprises with more than 10 employees)	10.8%	2018	20.0%	2028	KSH

NAME OF PRIORITY	RESULT INDICATORS	Baseline	Baseline year	Target	Target year	Source of data
Resource-efficient economy	Total **R&D expenditure as a share of GDP** in the following sectors: D: Electricity, gas, steam and air conditioning CK: Manufacture of machinery and equipment CL: Automotive industry CG: Manufacture of rubber, plastic and non-metallic mineral products CH: Manufacture of basic metals and fabricated metal products CI: Computer, electronic and optical products CJ: Manufacture of electrical equipment F: Construction A: Agriculture CF: Pharmaceutical production CA: Manufacture of food, beverages and tobacco products	0.54%	2018	0.75%	2027	KSH
	Percentage of innovative enterprises (among enterprises with more than 10 employees)	28.7%	2018	35.0%	2028	KSH
Agriculture, food industry	**R&D expenditure as a share of GDP** in the field of agricultural and food sciences	0.10%	2018	0.15%	2027	KSH
	The share of innovative businesses in the following sectors:		2018		2028	KSH
	CA: Manufacture of food, beverages and tobacco products	CA: 30.0%		CA: 40.0%		
	28: Manufacture of machinery and equipment (283: Manufacture of agricultural and forestry machinery)	28: 30.9%		28: 40.0%		
Cutting edge technologies (AI, 5G, big data, space and quantum technology)	**Number of research jobs created** in the supported facilities	0	2020	depends on the type of intervention (under development)		EUPR, project indicators
Creative industry	Total **R&D expenditure as a share of GDP** in the following sectors: JA: Publishing, sound recording and film production, broadcasting (58: Publishing, 59: Motion picture, video and television programme production, sound recording and publishing, 60: Broadcasting, programming) JC: Information technology and other information services M: Professional scientific and technical activities (73: Advertising, market research, 74: Other professional, scientific and technical activities, e.g. fashion design, photography, 71: Architectural	0.18%	2018	0.25%	2027	KSH

NAME OF PRIORITY	RESULT INDICATORS	Baseline	Baseline year	Target	Target year	Source of data
	activities; Technical testing and analysis), 32: Other manufacturing, 70: Business management, management consultancy, 62: Information technology services) R: Arts, entertainment, leisure					
Training, education	Company resources for training the workforce	44,6 points, 100th place	2019	70th place	2027	WEF: The Global Competitiveness Report 2019, 6.02: Extent of staff training.)
Output indicators						
All sectoral priorities	**Enterprises funded** (micro, SME, large enterprises)	0	2021	depends on the type of intervention (under development)	2027	EUPR project details
All sectoral priorities except Services	**Universities, research institutes funded**	0	2021	depends on the type of intervention (under development)	2027	EUPR project details
All sectoral priorities except Services	**Research centres involved in joint research projects**	0	2021	depends on the type of intervention (under development)	2027	EUPR project details
Horizontal - Training, education	**Funded enterprises** (micro, SME, large enterprises) that include a training component in their project	0	2021	depends on the type of intervention (under development)	2027	EUPR project details
Horizontal - Training, education	**Funded universities, research institutes** that include a training component in their project	0	2021	depends on the type of intervention (under development)	2027	EUPR project details
Horizontal - Innovation in the public sector and universities	Number of **funded organisations** (not enterprises) implementing service, organisational, marketing, etc. innovations within the RDI project	0	2021	depends on the type of intervention (under development)	2027	EUPR project details

10. Table: The indicators defined, the corresponding baseline and target values and the source of the data

7.4 Monitoring of implementation

In the course of monitoring the implementation, we have so far examined the gap between the actual and planned status by priority. At the same time, the purpose of monitoring is also to examine the progress and effectiveness of the priorities also in relation to each other. The aim is to assess whether the selected priorities need further strengthening or refocusing. Monitoring should provide data primarily for the following evaluation questions:

- Have national and regional strengths changed?
- How much of the total RDI system is covered by the priority sectors and how has this changed?
- What is the weight of the sectors selected for the priorities in the RDI projects funded?

To what extent does each priority contribute to strengthening R&D and innovation?

7.4.1. Monitoring of territorial objectives

Territorial aspects should also be given special attention in S3 monitoring. Compared to the types of regions used in the 2014-2020 programming period, there have been changes in the relative position of the counties, with differences in both socio-economic development and RDI performance and their dynamics (NRDI Office, 2019).

The territorial objectives are designed to address these regional disparities. The key task of the monitoring process linked to the territorial objectives is to provide data to assess the answers to the following questions:

- How has the performance of the counties relative to each other changed in the short and medium term along R&D and socio-economic trends? Have there been further shifts within the types of regions?
- Has RDI support been used in line with the territorial objectives in each type of region?
- Have the different counties shifted in the right direction towards the territorial objectives as a result of the policy measures?

7.4.2. Monitoring the management structure

The operation of the management structure should also be subject to continuous monitoring, follow-up and evaluation as a result of successful implementation. The key element of S3 is partnership, the involvement of stakeholders, not only in the planning process but also throughout the implementation process. This requires a very complex management process to be developed by S3.

Monitoring linked to the management process should provide data and indicators that answer the following evaluation questions:

- How was the EDP implemented during the implementation of S3?
- Are all relevant socio-economic groups and stakeholders represented among the participants in the EDP?

- How successful was the mobilisation of stakeholders? How much stakeholder involvement was there in the EDP?
- What is the territorial dimension of the EDP? How effective has the partnership been at county level?
- What is the sectoral dimension of the EDP? Which sectors were best mobilised and which were not mobilised at all?
- Have all relevant public bodies (ministries) used S3 as planned in the call for proposals under the funding scheme?
- For each policy, in what percentage of the schemes has S3 been used?

Indicators:

- Number of organisations involved in the EDP by type of organisation (large enterprises, micro and SMEs, sole proprietorships, universities, research institutes, natural persons, budget organisations, non-profit organisations) by county and by sector per year.
- Number of stakeholders involved in the EDP (1 person per organisation) per year.
- Number of schemes by sector where S3 was enforced, by year

7.5. S3 evaluations

In the European Commission's draft Common Provisions Regulation (CPR), good governance in the 2021-2027 EU programming cycle includes the establishment of an appropriate monitoring and evaluation system linked to S3 among the enabling conditions. This emphasis on S3 monitoring and evaluation suggests that S3 evaluation should be implemented as a separate activity from OP evaluations. The same Regulation also requires that any evaluation should assess the programme's effectiveness, efficiency, relevance, coherence and EU-level added value, with the aim of improving the quality of programme design and implementation through monitoring and evaluation.

The main difference between OP and S3 monitoring and evaluation is that the process and content of OP evaluation is strictly regulated throughout the planning and implementation process. In contrast, S3 is an "untested policy innovation operating in a legislative vacuum within a self-organised management structure, which aims to mobilise all available resources (i.e. private, regional, national and international) relevant to S3 in a region (country) and introduce new measures to meet the economic transformation agenda" (Tolias, 2019).

The first step in evaluation is planning. This includes deciding why the evaluation is needed, defining the objectives, evaluation questions, timeframes, resource requirements and tasks. Planning should also consider how and who will use the evaluation results.

The most important thing when planning evaluations is to assess what needs might be driving the evaluations. Evaluations can serve a number of purposes: to set priorities and objectives, to provide information on the extent to which priorities have been achieved through evidence-

based monitoring, to demonstrate accountability, to improve decision-making, to contribute valuable knowledge to policy development, and to integrate it into future policy development.

The main purpose of the S3 evaluations is to provide information to support decisions on *whether S3 in its current form is feasible or whether changes to its content are necessary*

Within this, however, the content of each evaluation can vary greatly depending on the specific purpose it serves.

In the light of the answers to the evaluation questions outlined above, it is necessary to determine the type of evaluation we want to carry out and the methods we will use. Main types of evaluation:

- The process evaluation, which examines whether the strategy has been implemented as planned. Typically used in interim evaluations and prepared mainly for communication purposes, to support programming scheduling and for monitoring purposes.
- Impact assessments try to show, on an objective basis, what changes have occurred and to what extent they can be attributed to the strategy. Impact assessments are usually components of ex post evaluations.

The planned evaluations:

Every two years, a progress report on S3, including an assessment of priorities, the effectiveness of priorities in relation to each other, an evaluation of the management process and the extent of progress.

7.6. Requirements for databases for S3 evaluation and monitoring

The effective implementation of evaluation and monitoring requires the availability of the necessary data. The possible data types are set out in the subsection Monitoring of implementation. To ensure that data is available in a timely and accurate manner, we set out below the tasks and measures that need to be taken:

1. EUPR: (Strategic and call management task)
    a. For all RDI calls for proposals, it should be possible to query the S3 priority flags. In addition to justifying S3 alignment in their own words, the applicants must choose from the S3 priorities in the form of a multiple-choice box, indicating the proportions between the priorities where necessary.
    b. Only a maximum of two sectoral and two horizontal priorities can be selected for a single application.
2. Required information for the application form (and EUPR): (Strategic and call management task)
    a. Type of organisation of the main beneficiary, NACE Rev. 2 code
    b. Type of organisation of consortium members
    c. Other organisations receiving public funding and subcontracted to the RDI activities of the project
    d. NACE Rev. 2 code of the project activity

    e. Classification of project by fields of science
3. Required professional data for the application form: (Strategic and call management task)
    a. For all RDI calls, alignment with S3 priorities (optional or compulsory alignment) is required.
    b. It is also necessary to demonstrate the alignment with a brief textual description of how the submitted proposal contributes to the S3 priority for both sectoral and horizontal priorities.
4. In the proposal evaluation process, a peer review of S3 priorities should always be ensured. The evaluator should be given the option to reject the application if no alignment is found (in the case of a compulsory alignment) or to award no points (in the case of a possible alignment). Furthermore, the evaluators should be prepared to interpret S3 and the priorities. (Programme planning and strategic task.)
5. Result indicators: The selected result indicators are those that can be produced from the data of KSH and Eurostat without a separate data request.
6. Data requirements for evaluations: The monitoring process throughout the implementation of S3 is accompanied by evaluations at regular intervals. The evaluations should include a more detailed analysis of each priority. This may require a more detailed sectoral breakdown of innovation data. These data are not available in the data published by the KSH. On the basis of the professional cooperation agreement between the NRDI Office and KSH, it is necessary to consult with the relevant department of KSH on the further breakdown of innovation data they can provide. (Strategic task.)
7. It is also necessary to complete questionnaires allowing for the collection of specific output data and carrying out in-depth analyses. To do this, the legal conditions, by reason of the GDPR must be ensured when submitting applications or at the latest when concluding contracts. (Strategic and legal task.)
8. Outputs: Output data can be generated from EU and national RDI application data recorded in the EUPR. (Strategic task.)
9. Applicants should also be made aware of the objectives of S3 and the content of the priorities, so that they can take them into account in the planning and preparation of projects. (Strategic and communication task.)
10. The right legal basis must be in place to ensure the smooth implementation of the EDP. For data collection purposes, applicants whose applications have been rejected and those who have been successful should also be contactable with information documents. (Strategic and legal task.)
11. Running a joint S3 website where all information, planned actions and results achieved so far are published up to date. (Strategic and communication task.)

LIST OF ABBREVIATIONS

ATOMKI	Institute for Nuclear Research	Atommagkutató Intézet
BERD	Business Expenditure on R&D	üzleti szektor K+F ráfordításai
CERIC	Central European Research Infrastructure Consortium	Közép-Európai Kutatási Infrastruktúra
CERN	The European Organization for Nuclear Research	Európai Nukleáris Kutatási Szervezet
CESSDA	Consortium of European Social Science, Data Archives	Európai Társadalomtudományi Konzorcium, Adat-archívum
CIS	Community Innovation Survey	közösségi innovációs felmérés
CLARIN	European Research Infrastructure for Language Resources and Technology	Nyelvi Erőforrások és Technológia Európai Kutatási Infrastruktúrája
COM	European Commision	Európai Bizottság
COVID-19	Coronavirus disease	koronavírus-járvány
CPR	Common Provision Regulation	Európai Bizottság közös rendelkezésekre vonatkozó rendelete
CPS	Cyber-Physical Systems	kiber-fizikai rendszerek
CUBCCE	Conference on University & Business Cooperation in Central Europe	konferencia a közép-európai egyetemi és üzleti együttműködésről
DAS	Hungary's Digital Agricultural Strategy	Magyarország Digitális Agrár Stratégiája
DEFS	Digital Healthcare Development Strategy	Digitális Egészségipar-fejlesztési Stratégia
DG RTD	The Commision's Directorate-General for Research and Innovation	Európai Bizottság Kutatási és Innovációs Főigazgatósága
DJP	Digital Prosperity Program	Digitális Jólét Program
ECRIN	European Clinical Research Infrastructure Network	Európai Klinikai Kutatási Infrastruktúra Hálózat
EDP	Entrepreneurial Discovery Process	Vállalkozói Tényfeltárási Folyamat
EIS	European Innovation Scoreboard	Európai Innovációs Eredménytábla
EIT KIC	European Institute of Innovation and Technology's Knowledge and Innovation Communities	Európai Innovációs és Technológiai Intézet tudományos és innovációs munkacsoportjai
EIT	European Institute of Innovation and Technology	Európai Innovációs és Technológiai Intézet
ELIXIR	European Life Science Infrastructure for Biological Information	Európai Élettudományi Bioinformatikai Infrastruktúra
ELKH	Eötvös Lóránd Research Network	Eötvös Lóránd Kutatási Hálózat
EMBL	European Molecular Biology Laboratory	Európai Molekuláris Biológiai Laboratórium
EPOS	European Plate Observing System	Európai Lemezmegfigyelő Rendszer

ERA	European Research Area	Európai Kutatási Térség
ERC	European Research Council	Európai Kutatási Tanács
ERFA	European Regional Development Fund	Európai Regionális Fejlesztési Alap
ERIC	European Research Infrastructure Consortium	Európai Kutatási Infrastruktúra Konzorcium
E-RIHS	European Research Infrastructure for Heritage Science	Európai Örökségtudományi Kutatási Infrastruktúra
ESA	European Space Agency	Európai Űrügynökség
ESFRI	European Strategy Forum for Research Infrastructures	Kutatási Infrastruktúrák Európai Stratégiai Fóruma
ESRF	European Synchrotron Radiation Facility	Európai Szinkrotronsugárzási Intézet
ESS	European Social Survey	Európai Társadalmak Összehasonlító Vizsgálata
EU	European Union	Európai Unió
EuBI	European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences	A Biológiai és Orvosbiológiai Tudományok Képalkotó Technológiáinak Európai Kutatási Infrastruktúrája
EUPR	Programs Of European Union System	Európai Uniós Programok Rendszere
FIEK	Center for Higher Education and Industrial Cooperation	Felsőoktatási és Ipari Együttműködési Központ
GCR	Global Competitiveness Report	globális versenyképességi jelentés
GDP	Gross Domestic Product	bruttó hazai termék
GDPR	General Data Protection Regulation	általános adatvédelmi rendelet
GEDI	Global Entrepreneurship and Development Institute	Globális Vállalkozási és Fejlődési Intézet
GEI	Global Entrepreneurship Index	globális vállalkozási index
GERD	Gross Expenditure on Research and Development	nemzetgazdasági szintű bruttó K + F-ráfordítások mértéke
GINOP	Economic Development and Innovation Operational Program	Gazdaságfejlesztési és Innovációs Operatív Program
GMR modell	Geographic, Macro and Regional Model	fejlesztéspolitikai hatáselemző modellrendszer
HECRIN	Hungarian European Clinical Research Infrastructures Network	Magyar Európai Klinikai Kutatási Infrastruktúra Hálózat
HIVENT-URES	Garantiqa Creditgarantee Closed Co. Ltd, by shares	Hiventures Kockázati Tőkealap-kezelő Zrt.
ICGEB	International Centre for Genetic Engineering and Biotechnology	Nemzetközi Genetikai és Biotechnológiai Központ
IKT / ICT	*ICT Information and Communicaton Technology*	információs és kommunikációs technológiák
IOT	Internet of Things	a dolgok internete

ITER	International Thermonuclear Experimental Reactor	Nemzetközi Kísérleti Termonukleáris Reaktor
ITM	Ministry for Innovation and Technology	Innovációs és Technológiai Minisztérium
JRC	Joint Research Centre	Európai Bizottság Tudományos Központja
KFI	Research-Development and Innovation	kutatás-fejlesztés és innováció
kkv szektor	range of micro, small and medium enterprises	mikro- kis és középvállalkozások köre
KSH	Hunarian Central Statistical Office	Központi Statisztikai Hivatal
LEIT	Leadership in Enabling and Industrial Technologies	vezető szerep az alap- és az ipari technológiák területén
MKIK	Hungarian Chamber of Commerce and Industry	Magyar Kereskedelmi és Iparkamara
MSCA	Marie Skłodowska-Curie Actions – Individual Scholarship Program	Marie Skłodowska-Curie Egyéni Ösztöndíj Program
MTMI	Abbrevietid designation of mathematical, scientific, technical and IT fields	matematikai, természettudományos, műszaki és informatikai területek rövidített megjelölése
NATO	North Atlantic Treaty Organisation	Észak-atlanti Szerződés Szervezete
NCP	National Contact Points	Nemzeti Kapcsolattartó Pontok
Node	open-source, cross-platform	informatikai hálózati csomópont
NTT	National Science Policy Council	Nemzeti Tudománypolitikai Tanács
NUTS	Nomenclature of Territorial Units for Statistics	NUTS, Statisztikai Célú Területi Egységek Nómenklatúrája
OECD	Organisation for Economic Cooperation and Development	Gazdasági Együttműködési és Fejlesztési Szervezet
OIF	Hungarian Innovation Forum	Országos Innovációs Fórum
OP IH	Managing Authority for Operational Programs	Operatív Programok Irányító Hatósága
PO 1	Policy Objective 1	első szakpolitikai célkitűzés
RCO	Recovery Consistency Objective	
RCR	Responsible Conduct of Research	regionális politikai közös teljesítménymutató
RIERC	Regional Innovation and Entrepreneurship Research Center	Pécsi Tudományegyetem Regionális Innováció - és Vállalkozáskutató Központja
S3	Smart Specialization Strategy	Intelligens Szakosodási Stratégia
SBA	The small business act	európai kisvállalkozói intézkedéscsomag
SHARE	Survey of Health, Ageing and Retirement in Europe	Egészség, öregedés és nyugdíjazás felmérése Európában
SSC	Shared Service Center	Közös Szolgáltató Központ
SZBK	Biological Research Centre, Szeged	Szegedi Biológiai Kutató Központ

Teaming (pályázatok)	The mode of HORIZON 2020 applications developed for R&D cooperation	A HORIZON 2020 pályázatok K+F együttműködésre kialakított módozata
TEÁOR'08	NACE Rev. 2 - Statistical classification of economic activities	Tevékenységek Egységes Ágazati Osztályozási Rendszere
TIP	Regional Innovation Platform	Területi Innovációs Platform
TNO	Netherlands Organisation for Applied Scientific Research	Hollandia legelismertebb „startup-keltetője", amelyet a város önkormányzata a Delfti Műszaki Egyetemmel és az ország alkalmazott kutatásokra szakosodott nonprofit szervezete közösen hozott létre.
TTI /TTO	TTO / Technology Transfer Office	Technológiai Transzfer Iroda
Twinning	*European Twinning Program*	Ikerintézményi Pályázati Program
VEKOP	Competitive Central Hungary Operational Program	Versenyképes Közép-Magyarország Operatív Program
VTT	VTT Technical Research Centre of Finland Ltd.	Állami Technológiai Kutatóközpont (Finnország)
WEF	World Economic Forum	Világgazdasági Fórum
WIPO	World Intellectual Property Organization	Szellemi Tulajdon Világszervezete
XFEL	European X-Ray Free-Electron Laser Facility	Európai Röntgen-Szabadelektron Lézer Létesítmény

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Annex 1: Good practices analysed in the development of S3 priorities applicable to priorities

COUNTRY	PRIORITIES/KEY AREAS
Spain **(Andalusia)**	P1. Mobility and logistics P2. Transport-related advanced industry P3. Internal territorial resources P4. Tourism, culture and leisure P5. Health and social welfare P6. Agriculture and healthy eating P7. Renewable energies, energy efficiency and sustainable construction P8. ICT and digital economy **Dimensions**: **1. Efficient competitive industry** **2. Key technologies** **3. Innovative SMEs** **4. Overseas extension** **5. Education, talents and creative environment** **6. Social innovation** **7. Networking** **8. Infrastructures for excellence**

COUNTRY	PRIORITIES/KEY AREAS
Austria	-Information and communication technologies -Life sciences -Material sciences and smart manufacturing -Bioeconomy and sustainability -Climate change, energy use and management of scarce resources -Intellectual, social and cultural sciences (including social innovation) -Ensuring quality of life in the face of demographic change (including urbanisation, mobility and migration) -Service innovation and tourism
Bulgaria	The thematic areas identified below outline a new space of entrepreneurial opportunities and guarantee the future of the EDP process: o Information technology and ICT o Mechatronics and clean technologies o Healthy living and biotechnology o New technologies in creative and recreational industries
Cyprus	-Tourism: sustainable tourism, alternative forms of tourism, digital tourism applications, management and promotion of tourism products; -Energy: renewable energy sources, solar energy, solar energy technology, solar photovoltaic panels, solar heating and cooling technologies, energy storage and transmission; -Agriculture-food food industry: agriculture and livestock farming, food security and climate change; -Construction: Sustainable urban development, sustainable construction, existing building stock, reuse of innovative and smart materials and building materials, cultural heritage; -Transport: maritime, shipping, intelligent transport system, road freight; -Health: e-health, prognosis-prevention and disease prevention, health pharmaceuticals. The environment and ICT have been identified as important horizontal sectors. -Environment Climate change, pollution, ecosystems, eco-innovation, water resources; -ICT: ICT applications, future technologies.

COUNTRY	PRIORITIES/KEY AREAS
Czechia	-Advanced machines/technologies for a strong and globally competitive industry; Results of the 1st National "Mechanical, Energy and Metallurgical Innovation Platform" - Digital market technologies and electrical engineering, results of the 2nd National Innovation Platform – "Electronics and Electrical Engineering and ICT" - Transport in the 21st century, the results of the National Innovation Platform III "Manufacturing of Transport Equipment" - Healthcare, advanced medicine - results of the National Innovation Platform IV – "Pharmaceuticals, biotechnology, medical devices and life sciences" - Creative Czech Republic - results of the 5th National Innovation Platform "Cultural and Creative Industries" - Agriculture and environment -Social challenges
Denmark	The maritime sector - blue Denmark Creative industries and design Water, Biological and Environmental Solutions Health and Welfare Solutions Energy and Climate Tourism and Experience-based Economies Food ICT and Digital Growth

COUNTRY	PRIORITIES/KEY AREAS
Estonia	e-Health Biotechnology, including food that supports health; medicine: diagnostics, medicine; biobanking ICT: Industry 4.0, Robotics and Embedded Systems ICT: Cybersecurity ICT: e-government and data science including big data and data mining Material technologies including nano-technology in new materials science, surface treatment technologies, and oil shale in the chemical industry Development of biomass resources (mainly wood and food) and oil shale, including energy efficiency related to knowledge-based construction
Croatia	(1) Health and quality of life, (2) Energy and sustainable environment, (3) Transport and mobility, (4) Security and (5) Food and bioeconomy.

COUNTRY	PRIORITIES/KEY AREAS
Ireland	A Future networks and communications B Data analytics, management, security and data security C Digital platforms, content and applications D Connected health and independent living E Medical devices F Diagnostics G Therapies - Synthesis, processing and pharmaceutical delivery H Food for health I Sustainable food production and processing J Offshore renewable energy K Smart grids and smart cities L Producer competitiveness M Processing technologies and new materials N Innovation in services and business processes
Poland	**The 18 national smart themes (national priorities for RDI) are grouped into five thematic areas** Healthy society Agri-food, forestry wood and environmental bioeconomy Sustainable energy Natural resources and waste management Innovative technologies and industrial processes (horizontal approach)

COUNTRY	PRIORITIES/KEY AREAS
Latvia	1. Knowledge-intensive bioeconomy 2. Biomedicine, medical technologies, bio-pharmaceuticals and biotechnology 3. Smart materials, technology and engineering systems 4. Intelligent Energy 5. Information and communications technology
Lithuania	E Energy and sustainable environment S Health technologies and biotechnology M Agri-innovations and food technologies G New manufacturing processes, materials and technologies T Transport, logistics, information and communication technologies V1 Educational technologies (modern self-development technologies and processes that stimulate creativity and productive personal development) V2 Implementation of breakthrough innovations (technologies and processes for the development and implementation of breakthrough innovations)
Germany	Digital economy and society Industry 4.0, smart services, smart data, cloud computing, digital networks, digital science, digital education and digital living Smart mobility Smart transport, infrastructure, innovative mobility concepts and networks, e-mobility, automotive technologies, aviation and marine technologies Healthy living Fighting common diseases, personalised medicine, prevention and nutrition, innovative care, research of active ingredients and innovative medical technology Innovative working environment Working in a digital world, innovative services for future markets and e-skills and digital competences Sustainable economy and energy, Energy research - energy storage, electricity grids, photovoltaic construction and energy,

COUNTRY	PRIORITIES/KEY AREAS
	efficient cities, green economy, bioeconomy, sustainable agricultural production, raw materials supply, future city, future construction and sustainable consumption Civil security Research and development for civil security, cyber security, IT security and secure identity
Portugal	Energy Raw materials and materials Manufacturing technologies and processing Automotive, aeronautics and space Information and communication technologies Transport, Mobility and Logistics Agri-Food Forestry Blue Growth - Ecosystems and renewable energies Water and Environment Health Tourism Cultural and creative industries Habitat Blue Growth
Slovakia	-Materials and nanotechnology research; - Information and communication technology; -Biomedicine and biotechnology; -Sustainable energy and energetics; -Agriculture and environment; -Social issues and challenges.
Bosnia and Herzegovina	Agricultural sciences Humanities Social sciences

COUNTRY	PRIORITIES/KEY AREAS
	Medical and health sciences Natural sciences Engineering
Greece	**Food-Nutrition** **Healthcare and pharmaceuticals** **IT and telecommunications services** **Energy** Energy and its cross-cutting implications (transport, industrial production, etc.) -> Emphasis on renewables, efficiency enhancement technologies, cost-reduction of energy as a key input, outward-looking competitiveness, environmental impacts, smart grids, fuel cells, renewables-sourced energy storage, etc.). **Environment** and **Transport and logistics** **Materials and construction** **Culture, tourism and creative economy**

COUNTRY	PRIORITIES/KEY AREAS
Romania	**Safe, accessible, nutritionally optimised foodAnalysis, Management and Security of Big Data Future internet** **Increasing end-user energy efficiency** **New generation vehicles and ecological and energy efficient technologies** **Service and process innovations for public sector improving well-being** **Development of innovative space and security applications** **Education, Cultural and Creative industries** **Services**

COUNTRY	PRIORITIES/KEY AREAS
Serbia	**Information and communication technologies** **Creative industries** **Food and beverage** manufacturing and processing: **Manufacture of machinery and electronic devices** Industry 4.0
Luxemburg	Innovative materials Biotechnologies for health sciences Information and communication technologies Ecotechnologies Logistics sector
Malta	The following thematic areas were identified as a result of the analysis and consultations: a. Tourism product development b. Maritime services c. Aeronautics and space d. Health with a focus on healthy living and active ageing and e-health e. Resource efficient buildings f. High value-added manufacturing focusing on processes and design g. Aquaculture

COUNTRY	PRIORITIES/KEY AREAS
Slovenia	Smart cities and communities Smart buildings and homes Industry 4.0 - Smart factories Health/Medicine Networks for the transition to a circular economy Sustainable food production Sustainable tourism and creative cultural and heritage-based services Development of materials as products Smart mobility
Sweden	New bio-based materials, products and services Internet of Things ICT - electrical components and systems Graphene for industrial applications Innovair - aeronautics Endemic diseases Manufacturing 2030 - advanced manufacturing Metallic materials Lightweight materials and structures ICT and automation for industrial processes Mining and metal extraction
Ukraine	**Information and communication technologies** **Energy and energy efficiency** **Rational environmental management** **Life sciences new technologies for the prevention and treatment of common diseases New materials** Focus on the production, processing and combination of materials, creating a nanotechnology industry

COUNTRY	PRIORITIES/KEY AREAS
Moldova	Innovative materials, technologies and products Cultural heritage and social development Biotechnology Health and biomedicine Energy efficiency and use of renewable energy sources
Montenegro	**Renewable energy and energy efficiency Sustainable agriculture and food value chain** **New materials and sustainable technologies Sustainable health and tourism** **Information and communication technologies**

Annex 2: Series of demonstration programmes for the Territorial Innovation Platforms (TIPs)

EVENT LOCATION	DATE	VENUE	NRDI Office LINK	NUMBER OF REGISTRANTS /PERSON
Miskolc	12 November 2019	University of Miskolc, Directorate for Knowledge Management, Building C/2, Wing VI, Lecture Hall XXXIV, 3515 Miskolc, Egyetemváros	https://nkfih.gov.hu/hivatalrol/hivatal-rendezvenyei/teruleti-innovacios-platformok-miskolc-2019-11-12	**82**
Debrecen	13 November 2019	University of Debrecen, Main Building, Floor III. cloister 4032 Debrecen Egyetem tér 1.	https://nkfih.gov.hu/hivatalrol/hivatal-rendezvenyei/teruleti-innovacios-platformok-debrecen-2019-11-13	**85**
Győr	19 November 2019	Széchenyi István University, Management Campus 9026 Győr, Egyetem tér 1.	https://nkfih.gov.hu/hivatalrol/hivatal-rendezvenyei/teruleti-innovacios-platformok-gyor-2019-11-19	**72**

EVENT LOCATION	DATE	VENUE	NRDI Office LINK	NUMBER OF REGISTRANTS /PERSON
Pécs	22 November 2019	University of Pécs, Dr. József Halasy-Nagy Assembly Hall 7622 Pécs, Rákóczi út 80.	https://nkfih.gov.hu/hivatalrol/hivatal-rendezvenyei/teruleti-innovacios-platformok-pecs-2019-11-22	**110**
Szeged	26 November 2019	University of Szeged, Rector's Building, Ceremonial Hall, 2nd floor, 6720 Szeged, Dugonics tér 13.	https://nkfih.gov.hu/hivatalrol/hivatal-rendezvenyei/teruleti-innovacios-platformok-szeged-2019-11-26	**101**
Budapest	28 November 2019	New York Palace 1073 Budapest, Erzsébet krt. 9.	https://nkfih.gov.hu/hivatalrol/hivatal-rendezvenyei/teruleti-innovacios-platformok-budapest-2019-11-28	**398**

EVENT LOCATION	DATE	VENUE	NRDI Office LINK	NUMBER OF REGISTRANTS /PERSON
Veszprém	11 February 2020	University of Pannonia 8200 Veszprém, Egyetem u. 10., Building “B”, 2nd floor, Conference Centre	https://nkfih.gov.hu/hivatalrol/hivatal-rendezvenyei/teruleti-innovacios-platformok-veszprem-2020-02-11	**74**
Gödöllő	12 February 2020	Szent István University 2100 Gödöllő, Páter Károly u. 1.	https://nkfih.gov.hu/hivatalrol/hivatal-rendezvenyei/teruleti-innovacios-platformok-godollo-2020-02-12	**220**

Annex 3: The "long list" on which the S3 questionnaire is based and the S3 online questionnaire

SMART TECHNOLOGIES, ADVANCED PRODUCTION SYSTEMS	HEALTH	CLEAN ENERGY, CLIMATE CHANGE	CREATIVE AND SERVICE ECONOMY	SOCIAL INNOVATION	RESOURCE EFFICIENT ECONOMY, CLEAN ENVIRONMENT
Industry 4.0 applications, automation of production processes	Pharmaceutical products (medicines, food supplements)	Use of renewable energy sources, renewable energy production	Innovation in the services sector, expanding the range and improving the quality of services	Responding to new, unresolved, inadequately addressed societal needs and challenges	Resource efficient economy, waste minimisation, circular economy
Digital economy, digital development of SMEs and micro-enterprises	Medical biotechnology, genetics	Energy-efficient industrial solutions	Innovative and digital initiatives in architecture, fashion, crafts, design, photography, film, performing arts, music, media and advertising	Demographic changes	Water treatment technologies, sustainable water management
Nanotechnology and materials science, 3D technology	Manufacture and development of medical devices	Rational use of energy, energy mix	Computer games, virtual world, interactive technologies	Ageing society	Waste management, waste water treatment technologies, recycling technologies, waste reduction, pollution prevention

SMART TECHNOLOGIES, ADVANCED PRODUCTION SYSTEMS	HEALTH	CLEAN ENERGY, CLIMATE CHANGE	CREATIVE AND SERVICE ECONOMY	SOCIAL INNOVATION	RESOURCE EFFICIENT ECONOMY, CLEAN ENVIRONMENT
Telecommunications, 5G technology applications	ICT-based healthcare systems, medical IT technology, digital solutions, healthcare "big data"; IA in healthcare, IT solutions to improve quality of life for older people	energy system management technologies, smart devices	Innovative tourism solutions, digital solutions	The challenges of poverty and social exclusion	Sustainable forest management, afforestation and reforestation
Electronics industry, sensors, smart metering technologies	Bionics	Energy production and storage technologies	Preserving and promoting traditional cultural values in creative and innovative ways	Environmental changes (climate awareness)	Ecology, protection of natural resources
Industrial IoT, machine-to-machine (M2M) communication, advanced human-machine interfaces (HMIs), deep learning, augmented reality (AR)	Biomedical research	Adaptation to climate change (climate adaptation)		Digital society	Agro-biotechnology (soil replenishment, irrigation, water retention, soil protection, plant biotechnology)
Cybersecurity	Clinical research, diagnostic technologies, therapeutic procedures	Green fuels and vehicle technologies, integrated transport systems		Innovative educational solutions (public education, higher education, vocational training, LLL)	Animal breeding and production, animal feeding and grassland management

SMART TECHNOLOGIES, ADVANCED PRODUCTION SYSTEMS	HEALTH	CLEAN ENERGY, CLIMATE CHANGE	CREATIVE AND SERVICE ECONOMY	SOCIAL INNOVATION	RESOURCE EFFICIENT ECONOMY, CLEAN ENVIRONMENT
Technological modernisation of SMEs	Innovative, efficient care systems, personalised medicine	Energy efficient, environmentally friendly building technologies, urban development solutions, smart village, smart city solutions		Promoting entrepreneurial competences and the internationalisation of SMEs	Horticultural technologies, plant breeding, plant protection, plant production technologies
Big data management and advanced algorithms	Developing health services			Innovative public administration, eGovernment	Sustainable design
Agri-informatics, precision farming, agrotechnical solutions	Food safety, processing technology solutions			Innovative digital solutions for public culture and public collections	Chemical industry
Metalworking technologies	Healthy foods			Changing trends in health and welfare, health awareness, health education, sports	

Annex 4: Smart Specialisation Strategy (S3) - Questionnaire

1. What type of institution do you represent? Please choose one of the following.
   - university
   - large enterprise
   - small and medium-sized enterprises
   - microenterprise
   - sole proprietorship
   - start-up
   - individual
   - research institute
   - budgetary organisation
   - non-profit organisations
   - local government.

   1/a. In which county your organisation is located?

2. Which type of research or innovation activity does your organisation plan to carry out? Please choose one of the following.
   - science-based development
   - developing key technology, innovation or development to exploit market niches
   - introduction of adaptive technology
   - both.
3. Please select the area(s) where your organisation plans to invest or develop between 2021 and 2027. Below are 5 main points and further sub-points within each. Please select at least 1 main point and within that, please tick the sub-point that matches your activity. Selecting at least one sub-point is compulsory but you can also select several sub-points (even within different main points).

Industry 4.0, smart technologies and production systems

a.) industry 4.0 applications, automation of production processes
b.) digital economy, digital development of SMEs and micro-enterprises
c.) nanotechnology and materials science, 3D technology
d.) telecommunications, 5G technology applications
e.) electronics industry, sensors, smart metering technologies
f.) industrial IoT, machine-to-machine (M2M), advanced human-machine interfaces (HMIs), deep learning, augmented reality (AR), cyber security
g.) technological modernisation of SMEs
h.) big data management and advanced algorithms
i.) agri-informatics, precision farming, agrotechnical solutions
j.) metalworking technologies

Health

a) pharmaceutical products (medicines, food supplements)
b) medical biotechnology, genetics
c) manufacture and development of medical devices
d) ICT-based healthcare systems, medical IT technology, digital solutions, healthcare “big data”; IA in healthcare, IT solutions to improve quality of life for older people
e) bionics
f) biomedical research
g) clinical research, diagnostic technologies, therapeutic procedures
h) innovative, efficient care systems, personalised medicine
i) developing health services
j) food safety, processing technology solutions
k) healthy foods

Clean energy, climate change

a) use of renewable energy sources, renewable energy production
b) energy efficient industrial solutions
c) rational use of energy, energy mix
d) energy system management technologies, smart devices
e) energy production and storage technologies
f) Adapting to climate change, climate adaptation
g) green fuels and vehicle technologies, integrated transport systems
h) energy efficient, environmentally friendly building technologies, urban development solutions, smart village, smart city solutions

Creative and service economy

a) innovation in the services sector, expanding the range and improving the quality of services
b) innovative and digital initiatives in architecture, fashion, crafts, design, photography, film, performing arts, music, media and advertising
c) computer games, virtual world, interactive technologies
d) innovative tourism solutions, digital solutions
e) preserving and promoting traditional cultural values in creative and innovative ways.

Social innovation

a) responding to new, unresolved, inadequately addressed societal needs and challenges
b) demographic changes
c) ageing society
d) the challenges of poverty and social exclusion
e) environmental changes (climate awareness)
f) digital society
g) innovative educational solutions (public education, higher education, vocational training, LLL)
h) promoting entrepreneurial competences and the internationalisation of SMEs
i) innovative public administration, eGovernment
j) innovative digital solutions for public culture and public collections
k) changing trends in health and welfare, health awareness, health education, sports.

Resource-efficient economy, clean environment

a) resource-efficient economy, waste minimisation, circular economy
b) water treatment technologies, sustainable water management
c) waste management, waste water treatment technologies, recycling technologies, waste reduction, pollution prevention
d) sustainable forest management, afforestation, reforestation
e) ecology, protection of natural resources
f) agro-biotechnology (soil replenishment, irrigation, water retention, soil protection, plant biotechnology)
g) animal breeding and production, animal feeding and grassland management
h) horticultural technologies, plant breeding, plant protection, plant production technologies
i) sustainable design
j) chemical industry.

Other Please indicate the area you think is missing and give reasons for your answer. (max 500 characters)

4.When carrying out your research or innovation projects, what ...

4/1. ... DOMESTIC operators do you plan to establish cooperation with?

- micro, small- and medium-sized enterprise
- large enterprise

- higher education institution
- research institute
- government
- non-profit organisation
- you do not plan to cooperate with domestic operators
- other.

4/2. ... FOREIGN operators do you plan to establish cooperation with?

- micro, small- and medium-sized enterprise
- large enterprise
- higher education institution
- research institute
- government
- non-profit organisation
- you do not plan to cooperate with domestic operators
- other.

5. Please briefly describe your S3 experience in relation to your previous applications. (max. 500 characters)

6. Please list three local, regional strengths that can contribute to the development of the national economy and improve its competitiveness. (max 500 characters)

7. Please list three areas that need to be developed to modernise the business sector. (max. 250 characters)

Annex 5: Linking S3 questionnaire and GMR model data at county level

LIST OF 20 PRIORITIES SELECTED ON THE BASIS OF THE S3 QUESTIONNAIRE	LIST OF 15 SECTORS SELECTED ON THE BASIS OF THE GMR MODEL	SELECTED S3 PRIORITY	NOTE
Clinical research, diagnostic technologies, therapeutic procedures, biomedical research, innovative and efficient care systems, personalised medicine, development of health services	Human health services	Health	
Manufacture and development of medical devices, ICT-based healthcare systems, medical IT technology, digital solutions, healthcare “big data”; IA in healthcare, IT solutions to improve quality of life for older people, bionics	Human health services; Manufacture of computer, electronic and optical products (manufacture of medical devices)	Health	
Industry 4.0 applications, automation of production processes	Manufacture of machinery and equipment; Manufacture of transport equipment; Manufacture of rubber, plastic and non-metallic mineral products; Basic metals and fabricated metal products; Manufacture of electrical equipment; Manufacture of computer, electronic and optical products	Digitisation of the economy	

LIST OF 20 PRIORITIES SELECTED ON THE BASIS OF THE S3 QUESTIONNAIRE	LIST OF 15 SECTORS SELECTED ON THE BASIS OF THE GMR MODEL	SELECTED S3 PRIORITY	NOTE
Use of renewable energy sources, renewable energy production	Electricity, gas, steam and air conditioning supply; Manufacture of machinery and equipment; Manufacture of transport equipment; Manufacture of rubber, plastic and non-metallic mineral products; Basic metals and fabricated metal products; Manufacture of electrical equipment; Manufacture of computer, electronic and optical products; Construction	Energy, climate	
Digital economy, digital development of SMEs and micro-enterprises	All sectors	Digitisation of the economy	
Technological modernisation of SMEs	Manufacture of machinery and equipment; Manufacture of transport equipment; Manufacture of rubber, plastic and non-metallic mineral products; Basic metals and fabricated metal products;	Digitisation of the economy	

LIST OF 20 PRIORITIES SELECTED ON THE BASIS OF THE S3 QUESTIONNAIRE	LIST OF 15 SECTORS SELECTED ON THE BASIS OF THE GMR MODEL	SELECTED S3 PRIORITY	NOTE
	Manufacture of electrical equipment; Manufacture of computer, electronic and optical products		
Innovative educational solutions (public education, higher education, vocational training, LLL)	Education	Horizontal - Training, education	One of the aims of S3 is to foster innovation, not only among businesses. Another area of intervention proposed by S3 is to complement investments with training and education.
Innovation in the services sector, expanding the range and improving the quality of services	Transportation and storage; Wholesale and retail trade; Repair of motor vehicles and motorcycles; Real estate activities; Administrative and support service activities	Services	
Resource efficient economy, waste minimisation, circular economy	Manufacture of machinery and equipment; Manufacture of transport equipment; Manufacture of rubber, plastic and non-metallic mineral products; Basic metals and fabricated metal products; Manufacture of electrical equipment; Manufacture of	Resource-efficient economy	

LIST OF 20 PRIORITIES SELECTED ON THE BASIS OF THE S3 QUESTIONNAIRE	LIST OF 15 SECTORS SELECTED ON THE BASIS OF THE GMR MODEL	SELECTED S3 PRIORITY	NOTE
	computer, electronic and optical products; Construction		
Big data management and advanced algorithms	-	Cutting edge technologies (e.g. AI, 5G, big data, space and quantum technology)	This is particularly important in Budapest, especially among companies and other organisations. Similarly, the information technology and information services sector is only important in Budapest, where it is dominant in terms of both knowledge diffusion and growth. All this justifies their inclusion in the list of priorities in Budapest instead of agriculture, because none of the agri-food sectors in Budapest are included in the TOP10.
Digital society	Education	Horizontal - Training, education	Within the S3 framework, social innovation can be understood primarily through improving the digital skills of the workforce, expanding the digital knowledge of businesses and the digital solutions they use. The first is training (horizontal), the second is the digitalisation of the economy.

LIST OF 20 PRIORITIES SELECTED ON THE BASIS OF THE S3 QUESTIONNAIRE	LIST OF 15 SECTORS SELECTED ON THE BASIS OF THE GMR MODEL	SELECTED S3 PRIORITY	NOTE
Environmental changes (climate awareness)	Manufacture of machinery and equipment; Manufacture of transport equipment; Manufacture of rubber, plastic and non-metallic mineral products; Basic metals and fabricated metal products; Manufacture of electrical equipment; Manufacture of computer, electronic and optical products; Construction,	Energy, climate	Taking into account the selection criteria described in the prioritisation, the social innovation priority group should also be included in the priorities. Climate awareness was one of the sub-points marked by most respondents in the Social Innovation category. Climate change is already partly addressed (in terms of emission reductions) in the Energy priority through renewable energy and urban development. The climate area in Hungary is also strongly linked to agriculture (e.g. stress resistance); and it is included in the agriculture/food priority. And climate awareness as a way of shaping society's attitudes is included in the Energy priority. This will bring together the “hard” and “soft” instruments within the priority, as required by the criteria. This is also one of the reasons why the word climate was used in the priority name.
Pharmaceutical products (drugs, food supplements, medical biotechnology, genetics)	**Human health services**	**Health**	

LIST OF 20 PRIORITIES SELECTED ON THE BASIS OF THE S3 QUESTIONNAIRE	LIST OF 15 SECTORS SELECTED ON THE BASIS OF THE GMR MODEL	SELECTED S3 PRIORITY	NOTE
Responding to new, unresolved, inadequately addressed societal needs and challenges	-	**All priorities/horizontal**	A priority of a horizontal nature from the priority group Social Innovation, which is mainly related to socio-economic challenges. Accordingly, all the priorities serve to strengthen this area: Health (e.g. pandemics); Energy, climate (energy production, climate change); Agriculture, food (climate change, healthy food), Resource-efficient economy (pollution reduction). However, it is important to draw attention to the importance of this development direction and to emphasise its significance in the S3 implementation process. This can also be presented as a horizontal priority.
Food safety, processing technology solutions, healthy foods	**Food products, beverages and tobacco products**	**Agriculture, food industry**	
Energy-efficient industrial solutions	Electricity, gas, steam and air conditioning supply; Manufacture of machinery and equipment; Manufacture of transport equipment; Manufacture of rubber, plastic and non-metallic mineral products; Basic metals and fabricated metal products; Manufacture of electrical equipment; Manufacture of	Energy, climate	

LIST OF 20 PRIORITIES SELECTED ON THE BASIS OF THE S3 QUESTIONNAIRE	LIST OF 15 SECTORS SELECTED ON THE BASIS OF THE GMR MODEL	SELECTED S3 PRIORITY	NOTE
	computer, electronic and optical products		
Adapting to climate change, climate adaptation	-	Energy, climate	It comes under the Energy priority and therefore addresses climate change through emission reduction. Included in the Energy, climate priority.
Waste management, waste water treatment technologies, recycling technologies, waste reduction, pollution prevention	-	Will be left out	It can be classified under and forms part of the Resource-efficient economy priority. However, it is a Group 4 sector under the GMR model, which is why it was not included in the TOP 15 sectors on its own.
Agri-informatics, precision farming, agrotechnical solutions	Agriculture, forestry, fishing	Digitisation of the economy	
Agro-biotechnology (soil replenishment, irrigation, water retention, soil protection, plant biotechnology)	Agriculture, forestry, fishing	Agriculture, food industry	

LIST OF 20 PRIORITIES SELECTED ON THE BASIS OF THE S3 QUESTIONNAIRE	LIST OF 15 SECTORS SELECTED ON THE BASIS OF THE GMR MODEL	SELECTED S3 PRIORITY	NOTE
	Public administration, defence, compulsory social security	Horizontal - Innovation in the public sector	As a result of the GMR model, two sectors emerged as sectors with strong growth effect in each county, namely trade and public administration. Trade is included under the Service priority. Because of its importance, public administration cannot be excluded from the prioritisation process. While one of the main targets of S3 is the business sector, it also aims to give a broader meaning to innovation. This justifies encouraging innovation in universities, which are key players in the RDI ecosystem, as well as in local governments, which are also part of the local ecosystem and play a key role in local development. Innovation in public administration includes both the demand side of innovation and the application of innovative solutions that contribute to improving the efficiency of public administration.
		Creative industry	This is only justified as a priority in Budapest, instead of the resource-efficient economy, which did not make it into the TOP 10 in Budapest. In terms of the GMR model, the priority is justified by the fact that Budapest's sectors with strong growth potential include publishing activities, audio and film recording, broadcasting, which are part of the creative industries. And it only appears in Budapest

LIST OF 20 PRIORITIES SELECTED ON THE BASIS OF THE S3 QUESTIONNAIRE	LIST OF 15 SECTORS SELECTED ON THE BASIS OF THE GMR MODEL	SELECTED S3 PRIORITY	NOTE
			in the country. If they will not be a separate priority in Budapest, they will have to be included in the Service priority.

Annex 6: Methodology for the development of region types

The types of regions were developed along two main sets of indicators: RDI performance and socio-economic performance. The two sets of indicators include both status and change indicators:

Indicators of the set of RDI performance indicators:

- Number of research organisations - number
- Number of researchers, developers - persons
- R&D expenditure per 1 researcher - HUF million
- R&D expenditure - HUF million
- Number of full-time tertiary students per 1000 inhabitants (by place of study) - persons

Socio-economic performance

- Migration margin per 1000 inhabitants - persons
- Employment rate - %
- Number of enterprises per 1000 inhabitants - number
- Companies with more than 250 employees - rate
- Rate of foreign enterprises within active enterprises - %
- Investment per 1000 people
- GDP per capita - thousand HUF
- Value of industrial production per 1000 persons
- Internet subscriptions per 1000 inhabitants compared to national average - %

Annex 7: Special Ministerial Order designating the organisation responsible for the management of S3

MINISTRY
FOR INNOVATION AND TECHNOLOGY

PROF. DR LÁSZLÓ PALKOVICS
MINISTER

Reference No. JEF/35870/2020-ITM

SPECIAL MINISTERIAL ORDER

designating the body responsible for managing the National Smart Specialisation Strategy

Acting under the authority granted by Section 1 of Government Decree 344/2019 (XII. 23.) on the National Research, Development and Innovation Office and on the appointment of the management body of the National Research, Development and Innovation Fund, Section 4 of Act LXXVI of 2014 on scientific research, development and innovation and by Section 136 of Government Decree 94/2018 (V. 22.) on the functions and powers of the members of the government and pursuant to Section 2(1)g) of Act XLIII of 2010 on the central state administrative organs and on the legal status of Government members and state secretaries, I hereby issue the following special order:

1. I designate the National Research, Development and Innovation Office as the body responsible for managing the National Smart Specialisation Strategy.

2. This special order shall enter into force on the day of its signature and shall remain in force until revoked.

Budapest, 5 May 2020

Sgd. Prof. Dr László Palkovics

minister

Seal: Ministry for Innovation and Technology * 1* Minister

Mailing address: 1440 Budapest. Pf. 1; Phone: +36 1 795 1700; Web: www.kormany.hu

Annex 8: Alignment of the 2013-2020 RDI funding schemes with S3

Code of funding scheme	Name of funding scheme	Alignment with S3 is required or preferred under the call	Alignment with S3 is not a requirement under the call but based on to the objective of the programme it is
NVKP_16	National Competitiveness and Excellence Programme - 2016		X
2017-1.2.1-NKP	National Excellence Programme		X
2018-1.2.1-NKP	National Excellence Programme		X
KTIA_NAP_13	National Brain Research Programme, Sub programme 'A'		X
GINOP-2.3.2-15	Excellence of strategic R&D centres	X	
VEKOP-2.3.2-16	Excellence of strategic R&D centres	X	
GINOP-2.3.3-15	Reinforcing the research infrastructure – internationalisation, networking	X	
VEKOP-2.3.3-15	Reinforcing the research infrastructure – internationalisation, networking	X	
GINOP-2.3.4-15	Centre for Higher Education and Industrial Cooperation - Research infrastructure development	X	
FIEK_16	Centre for higher education and industrial cooperation – research infrastructure development		
GINOP-2.3.6-15	Implementation of the ELI laser research centre (ELI-ALPS) large project, Phase 2	X	
2017-1.3.1-VKE	Competitiveness and excellence cooperation		X
2018-1.3.1-VKE	Competitiveness and excellence cooperation	X	
GINOP-2.2.1-15	R&D competitiveness and excellence cooperation	X	
GINOP-2.2.1-18	R&D competitiveness and excellence cooperation	X	
VEKOP-2.2.1-16	Competitiveness and excellence cooperation	X	
GINOP-8.1.1-16	Funding for business RDI activities - Loan programme		
VEKOP-2.1.2-17	Smart specialisation venture capital programme	X	

Code of funding scheme	Name of funding scheme	Alignment with S3 is required or preferred under the call	Alignment with S3 is not a requirement under the call but based on to the objective of the programme it is
2017-1.4.1-EXPORT	Funding for the export-oriented R&D activities of domestic businesses	X	
GINOP-2.1.6-16	Support for the development of exportable innovative products for an innovation-driven export expansion	X	
KFI_16	Funding business R&D activities	X	
GINOP-2.1.2-8-1-4-16	Funding business RDI activities in the form of a combined credit facility	X	
2018-1.1.2-KFI	Funding the RDI activities of SMEs and large companies	X	
GINOP-2.1.1-15	Funding the RDI activity of businesses	X	
VEKOP-2.1.1-15	Funding the RDI activity of businesses	X	
GINOP-2.1.3-15	IP Protection	X	
IPARJOG_15	Support of activities fostering the domestic and international protection of intellectual property with the aim of facilitating the utilisation of such intellectual property (2015)		X
GINOP-2.1.4-15	Innovation Voucher	X	
2018-1.1.1-MKI	Support to micro and small enterprises for innovation activities		X
GINOP-2.1.7-15	Prototype, product, technology and service development	X	
VEKOP-2.1.7-15	Prototype, product, technology and service development	X	
GINOP-2.1.8-17	Enhancing the competitiveness of SMEs through adaptive technology innovation	X	
KKV_15	National support for Horizon 2020 SME Instrument applications - 2015		X
2018-2.1.4-KKV	National support for Horizon 2020 SME Instrument applications - 2018		X
EU_KP_16	Call for proposals for increased Hungarian participation in the Horizon 2020 and other EU and regional programmes		X
2018-2.1.2-EU_KP	Call for proposals for increased Hungarian participation in the Horizon 2020 and other EU and regional programmes		X

Code of funding scheme	Name of funding scheme	Alignment with S3 is required or preferred under the call	Alignment with S3 is not a requirement under the call but based on to the objective of the programme it is
EUREKA_15	Support for Hungarian participation in the EUREKA programme		X
EUREKA_16	Support for Hungarian participation in the EUREKA programme		X
2018-2.1.3-EUREKA	Support for Hungarian participation in the EUREKA programme		X
NEMZ_15	Support for participation in joint EU initiatives		X
NEMZ_16	Support for participation in joint EU initiatives		X
2018-2.1.5-NEMZ	Support for participation in joint EU initiatives		X
2018-2.1.6-NEMZ_ECSEL	Support for participation in the ECSEL Joint Undertaking		X
2017-2.3.6-TÉT-CN	Call for industrial research and development projects in Hungarian–Chinese cooperation		X
TÉT_15_IL	Call for industrial research and development projects in Hungarian–Israeli co-funding cooperation		X
2017-2.3.1-TÉT-IL	Call for industrial research and development projects in Hungarian–Israeli cooperation		X
TÉT_15_IN	Call for industrial research and development projects in Hungarian–Indian cooperation		X
2017-2.3.7-TÉT-IN	Call for industrial research and development projects in Hungarian–Indian cooperation		X
2017-2.3.4-TÉT-RU	Call for industrial research and development projects in Hungarian–Russian cooperation		X
2017-2.3.3-TÉT-VN	Call for industrial research and development projects in Hungarian–Vietnamese cooperation		X