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National Research and Innovation Strategy for Smart Specialisation of the Czech Republic 2021–2027

(National RIS3 Strategy)

Table of contents

Executive Summary

The National Research and Innovation Strategy for Smart Specialisation of the Czech Republic 2021–2027 (RIS3, hereinafter also the "National RIS3 Strategy") ensures that resources, primarily from European, national and local budgets are effectively targeted at supporting oriented and applied research and innovation. The National RIS3 Strategy directs support to selected **priority areas that have high potential to create a long-term competitive advantage for the Czech Republic that is based on knowledge exploitation and innovation**. Identifying and developing these promising areas, i.e., "smart specialisation", builds on the strengths of the Czech Republic and its various self-governing regions. It seeks to make targeted and "smart" use of the **unique combination of opportunities offered by our economic background and research and innovation capacity**. The strategy also identifies and addresses weaknesses in the innovation system, which ultimately represent barriers to the development of smart specialisation and the innovation environment as a whole.

These weaknesses are summarised in the analytical section of the National RIS3 Strategy, which is based on a wide range of background analyses. The analysis has identified **low value added and a focus on lower-order innovations** as an important general problem of the Czech economy, in contrast to advanced economies that focus on knowledge-intensive activities. This is largely due to the type of manufacturing activity prevailing in the Czech Republic, which is located on lower tiers of value chains. In addition, the Czech Republic has **a weak endogenous business sector** and – despite the country's industrial tradition and the technical competence and creativity of its people – it **lacks a broader base of technologically advanced companies** located on higher tiers of global value chains. Moreover, instead of diversifying the Czech Republic's product base, it is **concentrated in a few sectors**, which increases the vulnerability of the entire economy in the event of external shocks.

The economy's development towards greater innovation and value added is also hampered by **a lack of skilled people** and a lack of a stable, predictable and motivating **business environment**. A well-functioning public research and development system that produces good-quality results can significantly contribute to developing an economy that is based on knowledge, value added and responsiveness to current technological and societal trends. Despite the significant potential of some domestic research organisations and infrastructures, the overall quality and performance of public research and development in the Czech Republic still has room for improvement. Also, a key problem in terms of the National RIS3 Strategy is the inadequate **use of public research and development results for the needs of companies and society**. Although there are strong indications that the use of digital technologies has enormous potential for the Czech Republic and its economic and societal development, **digitalisation and the use of new technologies by companies and the public sector are still lagging behind**.

The purpose of the National RIS3 Strategy is to change the situation described above. Its main "motto" is: **A resilient economy based on knowledge and innovation**. In its strategic section, the National RIS3 Strategy defines two basic levels of priorities on which it focuses during implementation. Linking these two levels of priorities constitutes the operationalisation of the vision, i.e., a description of the way and the path to achieve the vision. These are, firstly, **horizontal priorities – key areas of change**, and secondly, **thematic (vertical) priorities**. The thematic priorities are represented primarily by **research and innovation specialisation domains** and also the missions that are being prepared in order to address societal challenges.

The horizontal priorities respond to the need to address the cross-cutting problems of the R&D&I system as a whole. In the **key areas of change**, the Czech Republic needs to achieve significant shifts in order to strengthen the country's basic background that is required for the well-functioning development of the country's strengths and its knowledge and innovation potential. Within the horizontal priorities, the **horizontal strategic and specific objectives** of the National RIS3 Strategy are defined, which are aimed at **improving the innovation performance of companies, the quality of public research, the availability of qualified people for R&D&I** and **the use of new technologies and digitalisation**.

Relevant instruments and model activities are defined at the level of specific objectives. The structure of strategic and specific objectives is linked to a set of indicators that measure shifts in the various key areas of change. At the level of the horizontal priorities, the **National RIS3 Strategy is closely interlinked with overarching strategies,** and it incorporates some measures that are implemented by other strategic documents (especially the National R&D&I Policy). In this way, the National RIS3 Strategy highlights aspects that are crucial to the functioning of the entire R&D&I system and thus the effectiveness of investments in smart specialisation.

The second level of the strategic section is devoted to **smart specialisation** itself. The starting points for smart specialisation are summarised in the analytical section of the updated National RIS3 Strategy. The strategic section of the RIS3 then translates these starting points into priority areas – **research and innovation specialisation domains**. The domains are basically designed so as to **interlink competitive, economically and socially important and promising sectors with research capacities and key technologies** that have been

identified based on an analysis of the Czech Republic's **technological specialisation**. Key technologies in particular represent a major **catalyst for the transformation and development** of these sectors. Creating a purposeful linkage between the principal sectors and key technologies will support added value and help create new research, technological and economic opportunities. Therefore, the National RIS3 Strategy pursues not only "specialisation", but also the necessary **diversification** (and, in turn, resilience) of the economy, because key technologies will allow the sectors within the specialisation domains to move towards newly emerging technology- and knowledge-intensive products, industries and market niches. It can be assumed that if the implementation of the strategy is successful, there will be development and growth of endogenous Czech companies that can compete in the international market with their final products and, in turn, move beyond their position of chronic subcontractors.

Some of the specialisation domains focus on sectors that form the core of the Czech Republic's industrial orientation (**Advanced materials, technologies and systems; Digitalisation and automation of manufacturing technologies; Environmentally friendly transport, Technologically advanced and safe transport**). These domains focus on products and processes with high technical demands that normally require R&D for their innovation. The domain of **Electronics and digital technologies** targets the well-established and dynamically growing ICT sector in the Czech Republic, which in the future will play a key role in ensuring the international competitiveness of companies operating in many sectors of the Czech economy. A similarly dynamic driving factor is the **Cultural and creative industries as a tool to accelerate the socio-economic development of the Czech Republic** domain. The domains of **Advanced medicine and drugs, Green technologies, bioeconomy and sustainable food resources and Smart cities and municipalities** have been chosen not only in terms of the potential competitive advantages they represent for the Czech Republic's knowledge and innovation potential, but also in terms of supporting the resilience of the Czech economy and society.

Each domain contains a list of relevant R&D&I topics within each application sector and within specific key technologies. The R&D&I topics are conceived as **topics that are strategically important for the given domain** and as such, they are an **essential element of the specialisation domains' projection into support programmes**. In practice, supported projects will therefore need to focus on these domain-specific topics. Also, these topics will be subject to modification within the entrepreneurial discovery process (EDP) and, through these topics, the domains will be refined, i.e., the smart specialisation will be narrowed down. In addition to "technical" R&D&I topics, the specialisation domains also include topics that use research results in the **social sciences and humanities**. These are mainly topics in the area of the impact of technology on people and society in a context that is relevant to the focus of the given domain.

As a specific catalyst for smart specialisation, the National RIS3 Strategy also emphasises the importance of **societal challenges**, which may take the form of societal and economic needs and threats, but at the same time, they create opportunities for innovative technological solutions. The National RIS3 Strategy defines the process for identifying specific topics in which the Czech Republic has a real capacity to find and implement solutions to the societal, environmental and economic challenges and impacts of megatrends which are currently being strongly emphasised and can be expected to continue to increase in importance in the future.

The **implementation** of the National RIS3 Strategy 2021–2027 builds on the structures and processes that were already prepared in the 2014–2020 programming period. The owner of the National RIS3 Strategy is the **Ministry of Industry and Trade**, which is responsible, among other things, for the coordination of the **RIS3 Management Committee** and the functioning of the executive units for implementing the National RIS3 Strategy, i.e., the **National RIS3 Manager** and the National **RIS3 Team**. The national-level implementation of RIS3 is accompanied by the implementation of **regional RIS3 strategies** and the development of related implementation structures (regional councils for innovation, regional innovation platforms). The purpose of the regional level of RIS3 is to identify the specificities of innovation systems in individual self-governing regions, including any existing or potential specialisation, and thus to complement the larger interventions implemented at the national level.

The existence and well-functioning implementation of the National RIS3 Strategy is an **enabling condition for implementing interventions under EU cohesion policy in the area of research, development and innovation**. This means that the continuous proper implementation of the National RIS3 Strategy is a **precondition for the use of operational programmes under EU funds** in this area. The updated National RIS3 Strategy responds to the criteria for fulfilling this condition – among other things, these criteria show a clear emphasis on the **procedural aspect of the strategy**. In line with this perspective, the emerging concept of the National RIS3 Strategy emphasises the processes that accompany its implementation, i.e., the process of **managing and monitoring** the RIS3 strategy and, in particular, the **process of entrepreneurial discovery of new opportunities** (EDP). This process is implemented at the national level through National Innovation Platforms, and it is about specifying the specialisation domains and defining the interventions needed for their development. The role of EDP at the regional level is crucial for **building functional regional-level partnerships between local businesses**

and public research. Of course, the results of the EDP process cannot be rigidly planned out. Therefore, the RIS3 strategy is and, by definition, must remain **dynamic and flexible so that the results of the processes that are tied to it can be translated into support programmes** by the state. This document thus represents a basic framework for identifying the Czech Republic's strengths and the main barriers to their development and prepares the groundwork for continuous processes that will help to create effective tools to support the Czech Republic's innovation potential.

1 Introduction

The National Research and Innovation Strategy for Smart Specialisation of the Czech Republic (RIS3, hereinafter also the "National RIS3 Strategy") is a **strategic document ensuring that resources from European, national and local budgets and related private resources are effectively targeted at supporting oriented and applied research and innovation within prioritised promising areas**. This document is an update of the original National RIS3 Strategy for the 2014–2020 programming period, the latest revision of which was approved by the Government of the Czech Republic in 2018. The new National RIS3 Strategy for the 2021–2027 programming period reflects, among other things, the latest analyses that have been prepared for the purposes of supporting R&D&I in the Czech Republic, the conclusions of the mid-term evaluation as well as new strategic documents that have been developed since 2018 both on the Czech Republic and EU levels. In addition, the shift towards searching for new innovative solutions with a view to long-term sustainability and in the light of the crisis caused by the Covid-19 pandemic has also significantly affected the orientation of the strategy. The update is also intended to answer the call for a more concise and better arranged concept of the priorities of the National RIS3 Strategy and the document as a whole.

Under the relevant proposal for a regulation[1], the existence and implementation of a smart specialisation strategy is also an **enabling condition for implementing interventions under European Union (EU) cohesion policy** in the area of research, development and innovation (R&D&I). The Ministry of Industry and Trade is the organisation responsible for (the owner of) the fulfilment of this enabling condition. The co-owners are the Office of the Government of the Czech Republic (RDIC – The Research, Development and Innovation Council) and the Ministry of Education, Youth and Sports. The EU sets out **seven fulfilment criteria for this enabling condition** against which the ongoing fulfilment of the enabling condition is assessed. These criteria state that the smart specialisation strategy must be based on:

1. An up-to-date analysis of bottlenecks for innovation diffusion, including digitalisation.
2. The existence of a competent regional/national institution or body, responsible for the management of the smart specialisation strategy.
3. Monitoring and evaluation tools to measure performance towards reaching the objectives of the strategy.
4. The functioning of cooperation with stakeholders (the "entrepreneurial discovery process").
5. Actions necessary to improve national and/or regional research and innovation systems.
6. Where relevant, actions to support industrial transition.
7. Actions to strengthen cooperation with partners outside the Member State within the priority areas supported by the smart specialisation strategy.[2]

The updated National RIS3 Strategy responds to these criteria that– among other things – show a clear emphasis on the **procedural aspect of the strategy**. In line with this perspective, the emerging concept of the National RIS3 Strategy emphasises the processes that accompany the implementation of the National RIS3 Strategy. Among other things, this means highlighting the role of RIS3 as a platform within which the interests, needs and potential of the business sector, public research, public administration as well as the regional and national levels are being systematically interlinked. In addition to the Ministry of Industry and Trade as the owner of the strategy, many other institutions and individuals from various sectors at both the national and regional levels were involved early on in the preparation of the National RIS3 Strategy. **The continuous process of cooperation** between the parties involved in implementing R&D&I, and then translating the process into R&D&I support programmes in the 2021–2027 programming period, is a key element of the National RIS3 Strategy.

The National RIS3 Strategy is structured in five main sections. The introduction is followed by the second section, which is devoted to the key **starting points** of the strategy, including its basic conceptual framework. The third – **analytical section** – presents a summary of the main conclusions of the underlying analyses for the Czech Republic's smart specialisation. In addition to these analyses, there is an overview of the challenges within different cross-cutting areas, which are the main building blocks of the innovation system. This is followed by the **strategic section**, which first outlines the strategic vision of the RIS3 and further defines the horizontal and thematic priorities of the National RIS3 Strategy. The final section of the National RIS3 Strategy is devoted to its **implementation** and describes – among other things – the structures for the management and implementation

[1] Proposal for a Regulation of the European Parliament and of the Council laying down common provisions on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, and the European Maritime and Fisheries Fund and financial rules for those and for the Asylum and Migration Fund, the Internal Security Fund and the Border Management and Visa Instrument (COM(2018)375).

[2] The wording of the enabling condition is based on the compromise text approved at COREPER II on 18 December 2019. Working translation from English into Czech.

of the National RIS3 Strategy, the system for monitoring the fulfilment of the RIS3 objectives, and it outlines its financing. The main part of the National RIS3 Strategy document is supplemented by annexes. These annexes contain cards of thematic areas and cards of regional RIS3 strategies, as well as monitoring indicators and information related to the financing of the National RIS3 Strategy.

2 Starting points of the National RIS3 Strategy 2021+

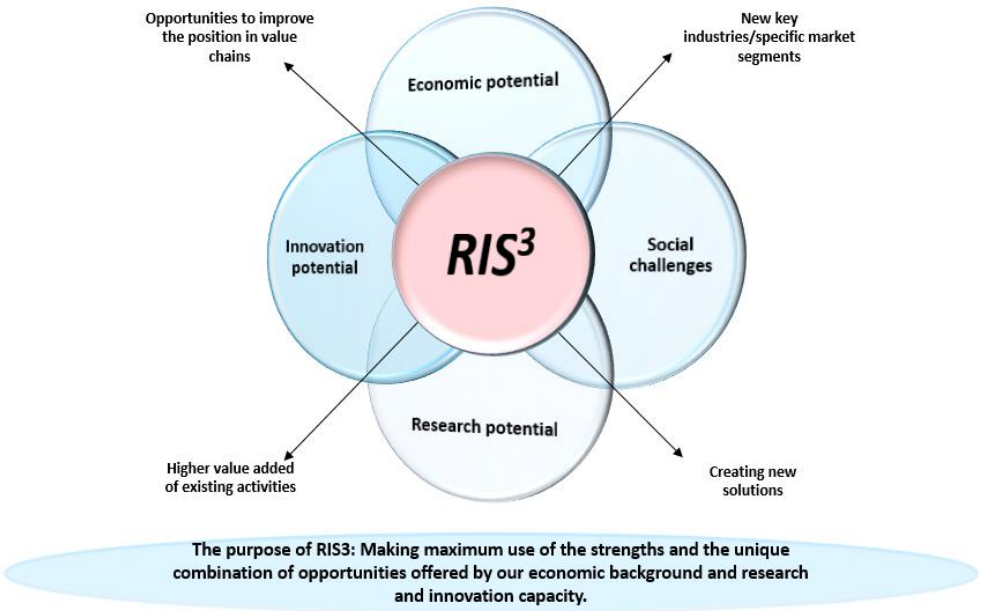
2.1 Conceptual framework of European RIS3 strategies

In recent years, smart specialisation strategies have been a widely used concept to support research and innovation, especially in EU countries. As the name suggests, the concept is oriented towards the **"smart, intelligent" exploitation and development of a country's or region's potential, aiming to create long-term competitive advantages that are based on knowledge exploitation and innovation**. The concept of smart specialisation needs to be perceived as a new approach to innovation policy, where – instead of overall support for research and innovation activities – state interventions focus on selected priority areas with a high potential for the development and application of new knowledge in economic activities.[3] The strategy builds on the strengths of a country or region and its specific capacities and resources in terms of economics, innovation and research (see the figure below).

The purpose of RIS3 is to **make the most of the unique combination of opportunities presented by the economic background and the research and innovation capacity of a country or region**. Recognising and systematically developing these opportunities then leads to higher-value-added activities, shifts within value chains and the creation of specific market niches and segments that give the country a **competitive advantage in international markets**.

Recently, the concept of RIS3 has been joined by issues of societal challenges and megatrends – these are addressed in a way that aims to not only improve the quality of life for people, but also to create opportunities for economic development. In line with this trend, EU-level research and innovation support policy increasingly focuses on a "**mission-oriented innovation policy**", i.e., a policy that channels public and private investments towards specific objectives and missions.[4] Also, a key characteristic of this approach to innovation policy is emphasis on the role that major societal challenges can play in creating new markets (both local and global) and in supporting national and/or regional competitiveness.[5]

Figure 1. The concept of smart specialisation



Source: European Commission, prepared by the authors.

[3] Foray, D.; David, P.; Hall, B. (2011). Smart specialisation: from academic idea to political instrument, the surprising career of a concept and the difficulties involved in its implementation. MTEI Working Paper, 2001-001. Lausanne: Management of Technology and Entrepreneurship Institute.

[4] Thematic missions are also planned in the new European research support programme Horizon Europe.

[5] See e.g., European Commission (2018): Towards a mission-oriented research and innovation policy in the EU, An ESIR memorandum.

At the same time, RIS3 strategies recognise the need to **address the cross-cutting problems of the R&D&I system** as a whole so that the country's outlined potential is not hindered by barriers arising from these problems. RIS3 therefore also targets cross-cutting or systemic measures that are aimed at improving the basic background necessary for facilitating the functional development of the country's strengths and its knowledge and innovation potential.

The guidelines for smart specialisation strategies are complemented by the relatively sophisticated logic of the conceptual framework of the strategies[6] and especially the **processes that are tied to this framework**. In terms of the entire RIS3 concept, these processes are at least as important as the actual strategic documents that frame RIS3. It is safe to say that the **RIS3 strategy is a process** that focuses on diffusing technology and innovation rather than a stand-alone innovation policy in the true sense of the word.[7]

The starting point of RIS3 and its basic framework consist of determining the priorities (specialisation domains), which are identified based on economic data, assessing innovation capacity and the expertise of representatives of the public and private sectors in a collaborative process involving all relevant parties. The identification of priority areas is then followed by the **identification of desirable directions for the development/transformation of these areas**. The **entrepreneurial discovery process** (EDP) plays a crucial role, especially in the area of specialisation domains. This process is about **specifying the specialisation domains and the themes or directions to be supported within them**. **The process also focuses on defining the nature, scope and purpose of the interventions needed to develop and transform these areas**.[8] To this end, the EDP process brings together representatives of business and research, as well as public administration. This process must continue throughout the implementation of the strategy, as it provides feedback and verification for the interventions implemented, but also acts as the starting point for the plan of interventions to be prepared. Last but not least, another purpose of the EDP process is to build trust and create networks for fostering collaboration between participants in the national and/or regional innovation systems.

Of course, the results of the EDP process cannot be rigidly planned out. Therefore, the RIS3 strategy is and, by definition, must remain dynamic and flexible so that the results of the processes that are tied to it can be translated into support programmes by the state. This document thus represents a **basic framework for identifying the Czech Republic's strengths and the main barriers to their development and prepares the groundwork for continuous processes that will help to create effective tools to support the Czech Republic's innovation potential**.

2.2 Strategic Framework of the National RIS3 Strategy of the Czech Republic 2021–2027

The concept of the National RIS3 Strategy of the Czech Republic 2021–2027 (hereinafter also the NRIS3) is based on the above framework, which is described in EU documents, in particular in the Guide to Research and Innovation Strategies for Smart Specialisation[9], and also in recent publications that already include experience from the implementation of RIS3 strategies in the 2014–2020 programming period.[10] The following text and figure summarise how the framework of the RIS3 strategy is approached in the Czech Republic and outlines the key building blocks of the RIS3, its pillars and the main drivers/sources of impetus for its implementation.

[6] This conceptual framework is described in the Guide to Research and Innovation Strategies for Smart Specialisation (European Commission, 2012) and in other documents that can be found mainly on the S3 platform website, which provides support for implementing RIS3 strategies in the EU. See https://s3platform.jrc.ec.europa.eu/home

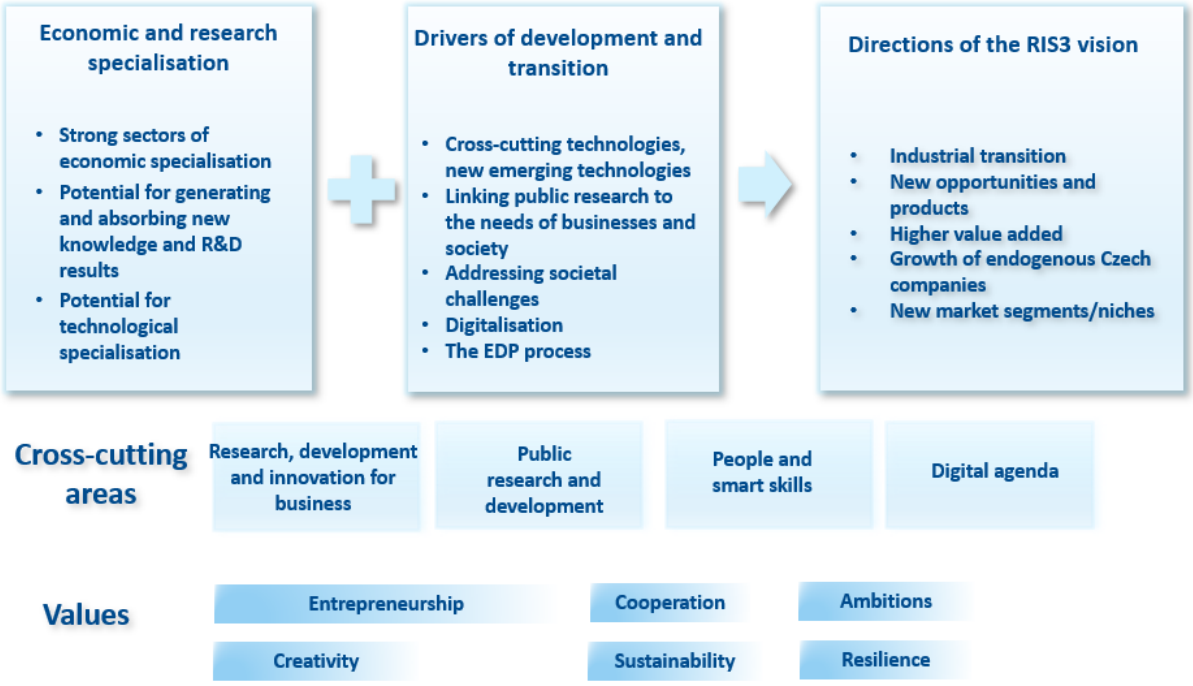
[7] Foray D., Morgan, K., Radosevic, S. (2018), The role of Smart specialisation in the EU research and innovation policy landscape, p. 4, https://ec.europa.eu/regional_policy/en/information/publications/brochures/2018/the-role-of-smart-specialisation-in-the-eu-research-innovation-policy-landscape

[8] Foray, D. (2019), In response to "Six critical questions about smart specialisations". European Planning Studies, p. 4–6.

[9] Guide to Research and Innovation Strategies for Smart Specialisation (European Commission, 2019), https://s3platform.jrc.ec.europa.eu/s3-guide

[10] See e.g. Foray, Morgan and Radosevic (2018), Foray (2019) as cited above.

Figure 2. Strategic Framework of the National RIS3 Strategy of the Czech Republic 2021–2027



Source: Prepared by the authors.

The first building block of the National RIS3 Strategy *(Economic and research specialisation)* is based on **the country's strengths, strong economic sectors and knowledge potential**. These aspects are translated into priority areas (research and innovation specialisation domains) where the Czech Republic has real potential for growth supported by a critical mass of research and business capacities and links to current or emerging technological and societal trends. The RIS3 strategy develops these strengths by bringing dynamism and change to the priority areas. To do that, it uses sources of impetus for the development and transformation of the domains *(Drivers of development and transformation)*. These sources of impetus or drivers of development and transformation are:

1. Linking key enabling technologies (KETs)[11] and other new and emerging technologies with competitive industries.
2. Linking public research to the needs of business and society.
3. Addressing societal challenges.
4. Using digitalisation and digital technologies to transform competitive industries.
5. Identifying opportunities for developing and transforming various sectors through the EDP process.

These sources of impetus/drivers are built into the core of the RIS3 strategy's implementation, supporting analytical documents[12] have been prepared for them and they are reflected in the RIS3 processes aimed at **creating and supporting projects and activities oriented towards reaching the objectives of the National RIS3 Strategy** *(The direction of the RIS3 vision).* These are sources/catalysts of change that will help transform industry, and help generate new research, technological and economic opportunities, create high added value based on research results and increase the growth of endogenous Czech companies with internationally competitive final

[11] Key enabling technologies that are knowledge intensive and associated with high R&D intensity, rapid innovation cycles, high capital expenditure and highly skilled employment. KETs enable production process, goods and service innovation throughout the economy and are of systemic relevance. (See Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, "A European strategy for Key Enabling Technologies – A path to growth and jobs", Brussels, COM(2012) 341 final.

[12] See https://www.mpo.cz/cz/podnikani/ris3-strategie/projekty-na-podporu-ris3/operacni-program-technicka-pomoc/projekt-komplexni-analyza-vychodisek-a-navrh-implementace-revidovanych-opatreni-narodni-ris3-strategie-2021--248427/.

products for the market and in newly emerging technologies- and knowledge-intensive industries or market niches.

Addressing societal challenges and the impacts of megatrends should also be highlighted as a specific driver. The RIS3 strategy views these challenges and their impacts as opportunities to **unlock the country's research and innovation potential and use it for further economic development and improving people's quality of life.** The need to better engage the country's research and innovation potential in addressing the societal, environmental and economic challenges and the impacts of megatrends is currently clearly visible, for example within the context of the impacts of climate change and the Covid-19 pandemic. This need can be expected to increase steadily in the future (for more information on megatrends, see the following chapter).

The second building block of the RIS3 strategy is represented by the *cross-cutting areas* – **horizontal interventions (horizontal cross-cutting priorities) that improve the aforementioned basic background** that is needed for the well-functioning development of the country's strengths and the opportunities they provide. The Czech Republic belongs to the group of moderate innovators according to the EIS. Both the analytical section of the RIS3 and analyses that have been performed for other purposes show that – in terms of knowledge-intensity and competitiveness based on innovation, the Czech Republic does not rank among the most developed countries. It is therefore important for the Czech Republic to implement interventions that result not only in strengthening and developing its specialisation, as is the case in the most developed countries and regions of Europe, but also to focus on interventions that develop the innovative system as a whole, improve its conditions and operation and complete it. Therefore, the National RIS3 Strategy also focuses on interventions that are not specifically oriented towards selected specialisation domains and sectors, but rather on **completing the innovation system in order to improve the conditions for making effective investments in smart specialisation** so that the development of innovation and technology does not encounter barriers that limit the country's potential. In the figure, the areas of intervention are depicted as individual pillars that support and strengthen the processes and drivers focused on developing the country's core potential. These are cross-cutting, horizontal interventions in the following areas:

- Research, development and innovation for business
- Public research and development
- People and smart skills
- Digital agenda

The various elements of the strategic framework of the National RIS3 Strategy are discussed in detail in the following chapters.

One specific element that has been introduced by the RIS3 strategy for the 2021+ programming period is to **incorporate values into the foundations of RIS3**. Values are important for the orientation of the RIS3 strategy and for understanding this orientation and its meaning. They define the needs, wishes and ideals to which we relate, and act as a link between a wide group of people who contribute in any way to the implementation of the National RIS3 Strategy, whether it be the actual RIS3 Team at the national level, regional RIS3 teams or participants in the EDP process. The values of RIS3 are reflected in its very concept and in the activities that are supported within the National RIS3 Strategy.

Entrepreneurship: Entrepreneurial people take an active approach towards life, they have a desire to put their ideas to the test in a competitive environment and take risks to do so. In this sense, more entrepreneurship can help the Czech Republic towards fulfilling the vision of the National RIS3, where emphasis is placed on supporting entrepreneurship from the education system to start-ups to well-established scale-up-oriented companies.

Cooperation: Cooperation between business and the public sector is at the heart of the EDP process. Intense cooperation between business and public research and the use of research infrastructure and research centres is one of the sources of prosperity. International cooperation, which is also emphasised in the NRIS3, moves both companies and research forward.

Ambition: RIS3 focuses on high added value, hi-tech products and companies that want to establish themselves not only at home, but also on the European or global markets. Therefore, the national RIS3 is oriented towards vertical specialisation in which endogenous Czech companies are the leaders and creators of value chains.

Creativity: Without creativity, there can be no quality research or innovation, and creative industries can move traditional industries towards higher added value. New technologies provide room for addressing problems and societal challenges in creative ways.

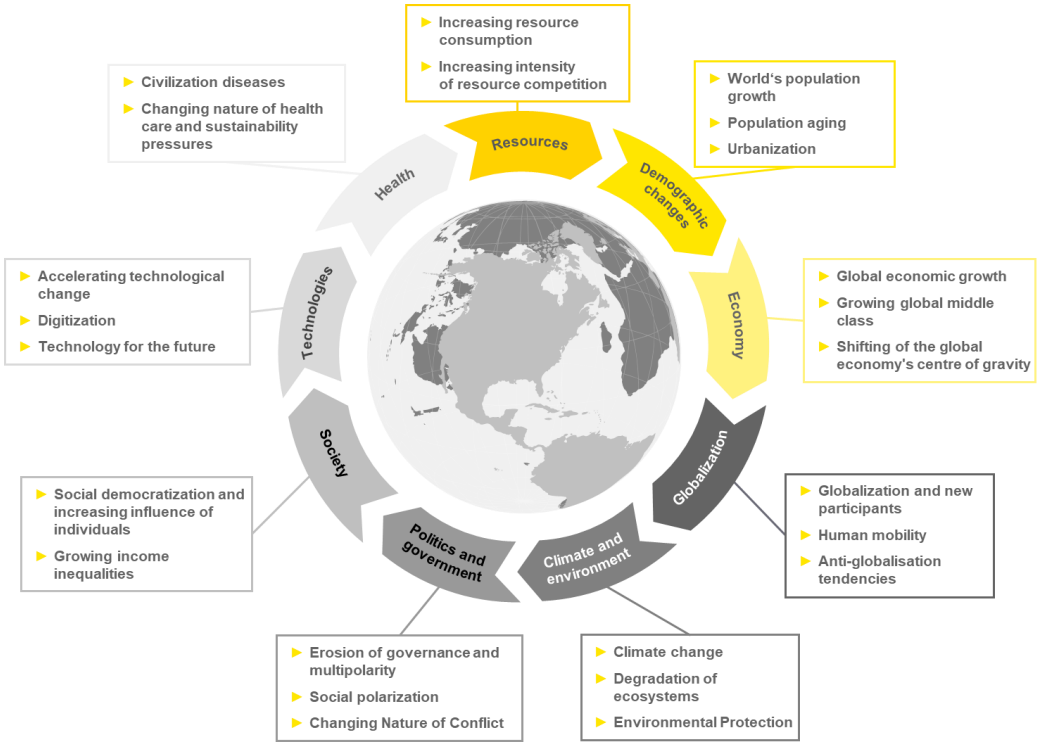
Sustainability: The NRIS3 and its priorities must take into account one of the world's main challenges – climate change, i.e., reducing its impact on people, society and nature.

Resilience: New technological solutions that result from the potential of research and technological development in the Czech Republic and in developed countries are used to reduce risks to society, improve the resilience of principal sectors and infrastructure and cyber security. The resilience of society, including its democratic institutions and structures (national, EU and supranational), is strengthened through international cooperation in coping with challenges and risks and in exploiting emerging opportunities that arise from new technologies.

2.3 Megatrends and their impact on the design of the National RIS3 Strategy

The National RIS3 Strategy must reflect the changing world in which it is set. External factors that affect or may affect the Czech Republic's competitiveness in the future include 'megatrends'. Megatrends cannot be clearly categorised as opportunities or threats because most trends include an implicit opportunity to discover new economic models of operation and to accelerate technological progress and the demand for finding more effective solutions to current problems. At the same time, however, having either no or an inadequate response to change can be a major threat to competitiveness, whether in terms of the direct impacts of the trends in question, or in terms of lagging behind relative to neighbouring countries that are more successful in new sectors and markets. Given the nature and objectives of RIS3, the predominant perspective is to identify the opportunities presented by megatrends, while not entirely ignoring the main threats. While the approach to defining megatrends, their number and the extent of their impacts varies considerably across publications, a total of 24 basic trends can be generally identified within 9 broader areas as illustrated in the figure below.

Figure 3. World megatrends



Source: Ernst & Young (2020): A complex analysis of barriers of applied and oriented research, experimental development and innovation in the Czech Republic and a proposal for implementing suggested measures in the 2021-2027 programming period for the National RIS3 Strategy 2021+, final document.

The most important key trends in terms of the National RIS3 Strategy include new technologies, climate change, the depletion of natural resources and demographic changes and urbanisation.

New technologies: The dynamics of technological change show a consistently increasing trend. In order for the state to set up reasonable support for technological trends, it is necessary to continuously monitor and evaluate the trends. **The common denominator of new technologies is mainly digitalisation** – it permeates across sectors and will continue to set the direction of development in the future. With digital innovations and other forces, the boundaries between the different areas of the economy are dissolving, essentially creating new sectors that are impossible or very hard to properly classify into traditional sectoral categories. The cost of computer and other

equipment will continue to decrease, while increased use of 'open source' development methods will provide greater opportunities for new companies, individuals and entrepreneurs to succeed in new markets. In the Czech Republic, the public sector has responded to this topic with the Digital Czechia strategy, which presents a comprehensive policy for the digitalisation of the Czech Republic in the coming years. Also, the digital agenda is one of the horizontal pillars of the National RIS3 Strategy. Key and emerging technologies are embedded in all specialisation domains of the National RIS3 Strategy as the main catalysts for transforming and increasing the future competitiveness of important sectors in the Czech Republic.

Climate change: On the one hand, climate change poses a major threat to a significant portion of the world's population; on the other hand, it brings an opportunity in that this area is strongly being focused on by the EU (most recently e.g., in the form of the Green Deal) and other major players in the global market, especially China. This emphasis is reflected in a radical increase in spending on **preventing and mitigating climate change, achieving the goal of climate neutrality** and supporting the environment in general. These funds are an opportunity for the Czech Republic to focus its research and development on sectors that will be affected by this trend, i.e., in particular the bioeconomy, circular economy, low-carbon technologies, energy, etc. Within the context of the continuing ecosystem degradation, biodiversity loss and soil degradation problems, agriculture is another key area where there will be huge room for developing and introducing innovative, environmentally friendly practices. These opportunities are also reflected in the specialisation domains of the National RIS3 Strategy (especially Advanced materials, technologies and systems, Environmentally friendly transport, Green technologies, bioeconomy and sustainable food resources).

Resources: Dwindling resources are a global issue. The support pledged by the EU for renewable energy sources is thus a crucial opportunity for the Czech Republic. The development of technologies especially for renewable-energy storage is one of the key sectors that will continue to set the trend in this area in the future. Not in the least due to the crucial role played by the automotive industry in the Czech Republic, the challenge of gradually transitioning to electric vehicles and ensuring sufficient energy for their operation (ideally from zero-carbon sources) is an opportunity to become a significant future player in this field, which is reflected in the National RIS3 Strategy's specialisation domain of Environmentally friendly transport. A more efficient use of existing resources, environmentally friendly recycling of raw materials, reduction of water use and tools to capture water are all trends that cut across sectors of the entire economy and that may appropriately support economic growth through innovation and are reflected especially in the domains of Advanced materials, technologies and systems and Green technologies, bioeconomy and sustainable food resources.

Demographic changes and urbanisation: In terms of demographic changes, the Czech Republic is mainly facing **an ageing population**. Population ageing will result in a change and increase in demand for new types of services for the elderly, especially in health care and social services. Also, the other aspect related to demographic changes is **urbanisation** which, within the Czech context, brings an opportunity for the development of towns and smaller cities based on the concept of a "smart city" or – for higher regional government units – a "smart region". These concepts make use of modern and smart technologies, including innovative solutions that make it possible to achieve significant energy savings, improve the standard of living of their inhabitants, minimise their impact on the environment, optimise transport and enable the efficient use of data for public purposes. Support for the development of smart solutions in these respects is outlined in the "Smart Czechia" strategy.[13] In the National RIS3 Strategy, these aspects are reflected, among other areas, in the Smart cities and municipalities specialisation domain.

2.4 Linkage of the National RIS3 Strategy to other strategic documents

The National RIS3 Strategy 2021–2027 operates within a strategic framework consisting of strategies that are overarching, complementary or synergistic to the National RIS3 Strategy. The following **overarching strategies** are key to the core focus of RIS3:

- **The National Research, Development and Innovation Policy** 2021+ (NP R&D&I)[14], approved by the Government in July 2020, represents the top strategic document at the national level and it sets the main strategic directions in the field of research, development and innovation and covers other related

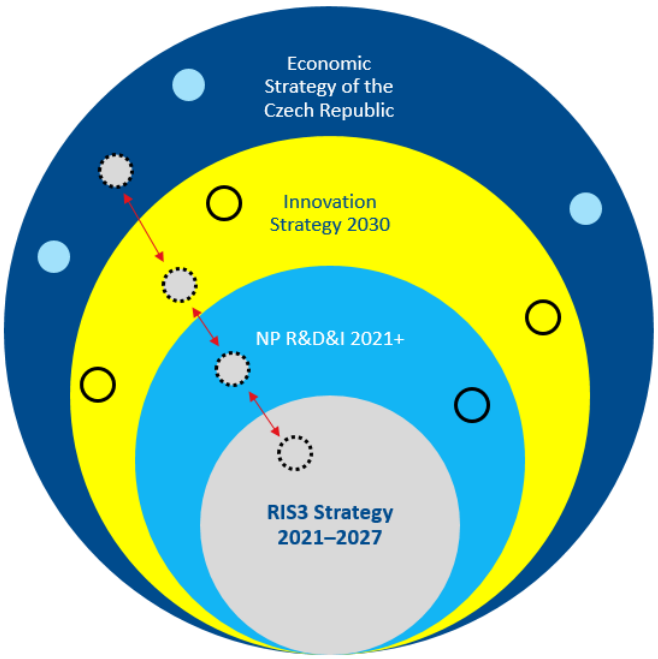
[13]Strategic framework of the Union of Towns and Municipalities in the field of Smart City: Strategic section: http://prosperujiciobecbudoucnosti.cz/wp-content/uploads/2020/03/Strategicky-ramec-Svazu-mest-a-obci-v-oblasti-Smart-City_strategicka-cast.pdf

[14] https://www.vyzkum.cz/FrontClanek.aspx?idsekce=913172

strategic documents of the Czech Republic. The basic objective of the NP R&D&I is to ensure the development of all components of R&D&I in the Czech Republic – basic research, applied research and experimental development.

- **Innovation Strategy of the Czech Republic 2019–2030** (Czech Republic: The Country for the Future).[15]It is a strategic framework plan that predetermines government policy in the field of R&D&I and is intended to help the Czech Republic to rise among the most innovative countries in Europe by 2030.
- **The Economic Strategy 2020–2030** was prepared to drive the strategic direction of the entire economy, of which R&D&I is a part.
- **The Strategy for Education Policy until 2030**[16] is linked to the National RIS3 Strategy in the "People and smart skills" key area of change, which also focuses on interventions in the education system.

Figure 4. Links of the National RIS3 Strategy 2021–2027 to the NP R&D&I, the Innovation Strategy 2030 and the Economic Strategy



Source: Prepared by the authors.

The National RIS3 Strategy 2021–2027 operates within the framework that has been set by these strategies for the areas of R&D&I and education policy and acts as an independent tool for implementing these strategies. It has its own **specific role**. This role and added value of RIS3 lies mainly in three aspects:

- Defining and developing **research and innovation specialisation domains** to ensure that funds are effectively targeted at prioritised promising areas.
- Setting up and implementing processes that are linked to the National RIS3 (the EDP process, the mission definition process, the continuous monitoring of NRIS3 priorities).
- The regional dimension of RIS3 – while the above overarching strategies are implemented at the national level, the National RIS3 Strategy has an exceptionally strong regional dimension that focuses on the development of R&D&I in the different self-governing regions.

It should be mentioned that the National RIS3 Strategy is closely linked to the overarching strategies, especially in the area of horizontal cross-cutting priorities in the field of R&D&I, and in this respect, it incorporates some measures being implemented by other strategies (especially the NP R&D&I). The NRIS3 thus highlights aspects that are crucial to the functioning of the entire R&D&I system and, by extension, the effectiveness of investments made in smart specialisation. Also, the National RIS3 Strategy offers the **possibility of shared monitoring of**

[15]https://www.vlada.cz/assets/urad-vlady/poskytovani-informaci/poskytnute-informace-na-zadost/Priloha_1_Inovacni-strategie.pdf
[16] https://www.msmt.cz/vzdelavani/skolstvi-v-cr/strategie-2030

selected indicators, as shown schematically in Figure 4 – some of the indicators that are monitored by RIS3 are also relevant for the overarching strategies (small circles in the figure represent individual indicators). In terms of the regional dimension, the NRIS3 is also linked to the **Regional Development Strategy of the Czech Republic 2021+**.[17] Within the context of gender equality, the National RIS3 Strategy is also linked to the Strategy for Equality of Women and Men 2021–2030,[18] which – among other things – focuses on innovations and proposes measures aimed at improving the institutional set-up in terms of equal opportunities and an increased number of women in R&D&I.

Within the context of the role of the National RIS3 Strategy as an enabling condition for implementing interventions under EU cohesion policy in the area of research, development and innovation, the strategy is tied to and coordinates with the Partnership Agreement of the Czech Republic for the 2021–2027 programming period – the umbrella document for the use financial resources from the EU Funds. Coordination between the two documents is ensured, among other things, through the participation of a representative of the Ministry for Regional Development, which manages the preparation and implementation of the Partnership Agreement, in the Management Committee of the National RIS3 Strategy.

Also, the National RIS3 Strategy incorporates important aspects of strategies that are complementary or synergistic to it. These include, but are not limited to, the following strategies:

- **Digital Czechia**, approved in October 2018, is a strategic document that covers the various effects of digitalisation in the Czech economy and society. The National RIS3 Strategy is closely linked to its pillar of "Digital economy and society".[19]
- **The National Artificial Intelligence Strategy of the Czech Republic 2019–2035**[20], approved in May 2019, which represents the basic strategic document for the development of artificial intelligence (AI) in the Czech Republic. The strategy covers a wide range of areas, from support for science and research to education to regulatory issues and international cooperation on AI.
- **The Strategic framework of the Union of Towns and Municipalities in the field of Smart Cities:**[21] it focuses on developing the Czech Republic in the field of Smart City/Smart Region.

2.5 Development of the National RIS3 Strategy to date

The National RIS3 Strategy 2021+ builds on the foundations that were laid down in the 2014–2020 programming period. During this period, structures were set up for the management and implementation of the NRIS3 at both the national and regional levels. The decision to establish and develop these two levels of NRIS3 implementation in the Czech Republic was made as early as 2013–2014, when the first version of the National RIS3 Strategy of the Czech Republic, including 14 regional RIS3 strategies was developed under the auspices of the Ministry of Education, Youth and Sports.

The national level of RIS3 plays a key overarching role, sets the framework for the direction of interventions under the NRIS3, and fulfils a coordinating role towards the institutions that implement support within this framework. These roles were anchored in the National RIS3 Strategy document, which was revised several times in the 2014–2020 programming period, with the latest update taking place in 2018. At the same time, processes that are tied to RIS3 were launched at the national level during that period, i.e., primarily the EDP process that is represented at the national level by National Innovation Platforms. Furthermore, a system for monitoring and evaluating the implementation of the National RIS3 Strategy and the fulfilment of its objectives was set up and continuously developed. During the 2014–2020 programming period, the institutional backing of the National RIS3 Strategy changed twice. Responsibility for implementing the National RIS3 Strategy was transferred from the Ministry of Education, Youth and Sports to the Office of the Government of the Czech Republic. After the position of Deputy Prime Minister for Science, Research and Innovation was abolished, the responsibility transferred to the Ministry of Industry and Trade in 2018.

The preparation and implementation of the NRIS3 at the national level was accompanied by setting up **implementation structures and partnerships in the self-governing regions**, often making use of existing innovation centres and agencies and in line with regional innovation strategies. The purpose of having a regional

[17] https://mmr.cz/cs/microsites/uzemni-dimenze/strategie-regionalniho-rozvoje-cr-2021

[18] The Strategy for Equality of Women and Men 2021–2030 is being prepared for approval by the Government of the Czech Republic in early 2021.

[19] https://www.mpo.cz/cz/podnikani/digitalni-spolecnost/hlavni-cile-koncepce-digitalni-ekonomika-a-spolecnost--243491/

[20] https://www.vlada.cz/assets/evropske-zalezitosti/umela-inteligence/NAIS_kveten_2019.pdf

[21] http://prosperujiciobecbudoucnosti.cz/wp-content/uploads/2020/03/Strategicky-ramec-Svazu-mest-a-obci-v-oblasti-Smart-City_strategicka-cast.pdf

RIS3 Strategy is to identify the specificities of innovation systems within individual self-governing regions, including any existing or potential specialisation, and thus to complement the larger interventions implemented at the national level. In addition, the role of regional RIS3 strategies and the related structures has been crucial for building functional regional-level partnerships between local business and public research, and for implementing the local EDP process. In this respect, national RIS3 structures can hardly replace their regional partners and their role thus remains relevant.

Since the level of development of the different self-governing regions varied in terms of regional development support, regional governments (in cooperation with regional innovation partners) were given the opportunity to obtain funds within the Smart Accelerator calls under the Operational Programme Research, Development and Education (the allocation totalled CZK 1.2 billion) to complete their regional implementation structures and support regional interventions. At the end of the 2014–2020 period, the implementation infrastructure in most self-governing regions had already been completed and the funds from the Smart Accelerator call were targeted primarily at strengthening existing links and using the outputs of the implemented interventions to further develop the regions, as well as to prepare pilot interventions and transfer successful practices from abroad.

2.5.1 Preparation of the National RIS3 Strategy 2021–2027

In connection with the preparation of the updated National RIS3 Strategy, the MIT implemented the project entitled "**A comprehensive analysis of starting points and a proposal for implementing the revised measures of the National RIS3 Strategy 2021+**" in 2019–2020. It was financed from the Operational Programme Technical Assistance. The main objective of the project was to prepare supporting analytical documents for the National RIS3 Strategy 2021–2027. The analytical work resulted in the implementation of the following studies, which were the key inputs for updating the NRIS3 strategy document and its related processes:

1. **"A complex analysis of the barriers to applied and oriented research, experimental development and innovation in the Czech Republic and a proposal for the implementation of suggested measures in the 2021-2027 programming period for the National RIS3 Strategy 2021+."** The study was prepared by Ernst & Young and resulted in an update of the supporting analytical documents for preparing the NRIS3 in the **horizontal/cross-cutting area**, for proposing horizontal objectives of the NRIS3 and related measures.
   In order to obtain feedback from stakeholders for this study, an **Expert Working Group** was set up, which included representatives of the relevant implementation structure both in the 2014–2020 and 2021–2027 programming periods, representatives of national-support providers, representatives of business and research, representatives of regional innovation centres, etc. This Expert Working Group provided continuous feedback on the outputs that had been prepared. Also, a number of meetings and focus groups were also held with members of the Expert Working Group, self-governing regions and other experts during the project. The topics discussed at these meetings included, among others, the expectations from the new NRIS3, its focus, the setting of its pillars, the weaknesses of the Czech innovation system and barriers to its development. In addition, the measures and key tools that are needed to further develop the innovation environment were also discussed.
2. **"Analysis of the interconnection between KETs[22] and the application sectors of the National RIS3 Strategy 2021+"** Prepared by the Technology Centre of the Czech Academy of Sciences, the analysis resulted in three sub-studies that created supporting documents for updating the specialisation domains of the NRIS3. Based on available data, the analyses identified promising sectors where research activities will be concentrated in the Czech Republic and where there is potential for the use of new R&D findings in the business sector and for the development of their innovation activities. At the same time, the Czech Republic's current position in R&D in technical domains (key enabling technologies) was compared and evaluated in the international context, and promising areas of KETs were identified in which it is expected that R&D results can be used in businesses operating in the various application sectors of the NRIS3. The analyses represented a key evidence-based input and framework for the EDP process that took place in autumn 2020.
3. **"Analysis of the design of the operation of National Innovation Platforms."** The analysis was prepared by the Technology Centre of the Czech Academy of Sciences with an aim of proposing a design for the functioning of the EDP process in the Czech Republic so that these standards could optimally reflect

[22] Key Enabling Technologies. These are defined e.g. in the Commission document: Re-finding Industry, Defining Innovation. Report of the independent High Level Group on industrial technologies. See also Chapter 3.1.4 Technological specialisation.

recommendations made in technical publications, the experience of countries with advanced innovation systems, and the requirements of the European Commission.

The OECD project

As part of the preparation of the National RIS3 Strategy, the MIT cooperated on an **OECD project** whose implementation started in autumn 2019. The OECD implemented this project in cooperation with the European Commission – DG REGIO. It aims was to create **A Self-assessment toolkit for regional innovation diffusion**, an online tool accessible via a web interface on the Internet which would allow each region to self-assess its strengths and weaknesses in terms of the diffusion of new ideas and innovative impulses. The tool will be mainly intended for innovation policy makers in each given region and will help them to identify the bottlenecks that hinder the free flow of ideas between public administration, academia, business and the non-profit sector. The Czech Republic and its regions participated in the pilot testing of the tool, and the results of the project were used as an input for updating the National RIS3 Strategy.

The conclusions from the OECD's analyses, interactive meetings with representatives of the Czech Republic's different self-governing regions, statistical data and questionnaires completed for the self-governing regions are in line with the above analyses that were carried out during the preparation of the National RIS3 Strategy 2021–2027. The OECD stressed the need for closer cooperation between relevant players at the national and regional levels, greater effort to address the shortage of suitably skilled labour, more intensive information transfer and good practice sharing at the national and regional levels. Also, it recommended focusing more on building communication networks and high-speed Internet infrastructure so that businesses could make more use of innovations that are linked to digitalisation and Industry 4.0, simplifying support mechanisms, removing administrative burdens, encouraging the setting up of business angels, equipping business development services with external experts and sharing them with each other, and generally simplifying the overly complex innovation support system. The OECD's final report also contains an annex in which the Czech Republic's various NUTS 2 regions were evaluated according to a number of indicators characterising the various areas of innovation diffusion. This very evaluation and comparison of each NUTS 2 region within the Czech Republic and, in some cases, against the characteristics monitored by the OECD for all regions within OECD member countries will form the basis for the future tool that is being developed by the OECD.

Updating regional RIS3 strategies

In parallel with the update to the National RIS3 Strategy, updates to regional RIS3 strategies were being prepared. In June 2019, a document entitled "Updating regional RIS3 strategies for the 2021–2027 programming period" was sent to regional RIS3 representatives that contains basic information and recommendations for updating regional RIS3 strategies according to the fulfilment criteria for the enabling condition, including a preparation schedule. The preparation of regional updates was continuously discussed at MIT meetings with regional RIS3 managers, and the MIT also provided consultations on the methodology of the document. Regional RIS3 strategies are presented in Annex 2 to this document in the form of regional cards, which contain key information on each updated regional RIS3 strategy – regional strengths, regional specialisation domains, institutional structures, etc.

Updating the smart specialisation system of the Czech Republic and defining the specialisation domains

Within the 2014–2020 programming period, a relatively complex system of specialisation of the Czech Republic was created, which was based on application sectors determined by economic specialisation, and on generally defined key enabling technologies (KETs). This has defined a relatively wide range of support options within the vertical part of NRIS3. The updated National RIS3 Strategy seeks to define the actual specialisation domains that would result from an evidence-based approach and the EDP process. Based on the above analyses made by the TC CAS, the domains of specialisation were defined as the intersection of the potential identified for the Czech Republic's technological specialisation in the areas of key enabling and emerging technologies and the potential identified for absorbing new knowledge and R&D results in the application sectors of the Czech Republic's economic specialisation. The National Innovation Platforms held an in-depth discussion on the proposed domains, which resulted in the proposed research and innovation specialisation domains.

3 Analytical section – conclusions of the analyses performed

The analytical section is a summary of the analyses that were carried out for the purposes of updating the National RIS3 Strategy. Detailed analyses are presented in the study entitled "A complex analysis of the barriers to applied and oriented research, experimental development and innovation in the Czech Republic and a proposal for the implementation of suggested measures in the 2021-2027 programming period for the National RIS3 Strategy 2021+" and in the study entitled "An analysis of the interconnection between KETs and the application sectors of the National RIS3 Strategy 2021+".[23] The above analyses are based on dozens of different data sources and existing analyses of the Czech Republic's research and innovation potential. The analyses carried out by the Technology Agency of the Czech Republic within the INKA 2 – Innovation capacity mapping project were also important inputs in the area of the innovation capacity of companies.[24]

The first part of the chapter presents the main conclusions of the analyses that are the basis for the **Czech Republic's smart specialisation**. The introduction contains a discussion of the starting points for the Czech Republic's smart specialisation, which is followed by an analysis of the Czech Republic's sectors and technological specialisation. The second part presents a summary of the analyses that are related to the **horizontal cross-cutting priorities** of the National RIS3 Strategy. This part outlines the main challenges in the fields of business and public research, development and innovation, the availability of skilled people for innovation and the digital agenda.

3.1 An analysis of the Czech Republic's specialisation

3.1.1 The starting points for the Czech Republic's smart specialisation

The structure of the economy, its competitive advantage, as well as its current position in the economic cycle, are among the main factors in defining the Czech Republic's smart specialisation and support for research and development. As a **small and very open economy**, the Czech economy depends on global and especially European demand for its goods or services. At the beginning of 2020, the share of exports of goods in Czech gross domestic product (GDP) was about 60%, which is one of the highest figures in the EU, and about 13% for services. More than 80% of total Czech exports went to and almost 63% of imports came from EU countries. In terms of the commodity structure, motor vehicles account for the largest share in exports (about 23% of total exports), followed by computers, electronic and optical equipment (17%), machinery and equipment (12%) and electrical equipment (9%). Export statistics thus prove that the main drivers of exports from the Czech Republic have long been as follows: **the automotive, electronics and electrical engineering, and mechanical engineering industries**. The territorial structure of Czech exports has also been stable over the long term, with the largest share of exports going to Germany, Slovakia, Poland, France and the United Kingdom.

The competitive advantage of a specific country can be measured using the Balassa index (hereinafter also BI).[25] Based on this index, it is possible to determine the export specialisation of a given country's specific products. Exports are normally reported according to the Standard International Trade Classification (SITC). The average BI values (Table 1. SITC 2 class with the highest share in exports from the Czech Republic) reveal that, in a global comparison, the Czech Republic is increasingly specialising in the production of road vehicles, while the importance of other sectors is significantly declining. **Instead of diversifying the product base, it is concentrated in a few sectors, which increases the vulnerability of the entire economy in the event of external shocks.**

[23] https://www.mpo.cz/cz/podnikani/ris3-strategie/projekty-na-podporu-ris3/operacni-program-technicka-pomoc/projekt-komplexni-analyza-vychodisek-a-navrh-implementace-revidovanych-opatreni-narodni-ris3-strategie-2021--248427/

[24] The key analyses that were used for the purpose of updating the National RIS3 Strategy and links to these analyses are provided at the end of the document in the list of input analyses. For the results of the INKA project, see https://inkaviz.tacr.cz/cs

[25] The Balassa index, or the Revealed Comparative Advantage (RCA) index, is expressed as the proportion of exports of a given commodity group in the country's total exports divided by the proportion of exports of that commodity group in the total exports of the reference group of countries under consideration. If the RCA value is greater than one, it can be concluded that the country specialises in the exports of the given commodity group within the group of countries under consideration.

Table 1. SITC 2 classes with the highest share in Czech exports

Export item – SITC 2		Share in Czech exports (%)			Balassa index (BI) in CR		
Code	Title	2005–2007	2014–2016	2017–2018	2005–2007	2014–2016	2017–2018
78	Road vehicles	16.61	19.97	20.55	1.98	2.56	2.59
77	Electrical machinery, apparatus and appliances, n.e.s.	9.40	9.98	9.74	1.16	1.16	1.03
75	Office machines and automatic data processing equip.	7.36	7.23	7.16	1.68	2.26	1.86
74	General industrial machinery and equipment, n.e.s.	6.90	6.85	6.94	1.88	1.79	1.83
89	Miscellaneous manufactured articles, n.e.s.	4.47	5.90	5.65	1.33	1.58	1.59
69	Manufactures of metal, n.e.s.	5.57	5.15	4.82	2.61	2.32	2.18
76	Telecommunications and sound recording apparatus	4.41	5.05	6.54	0.96	1.12	1.79
71	Power generating machinery and equipment	2.94	2.70	2.44	1.23	1.20	1.07
67	Iron and steel	4.59	2.63	2.53	1.43	1.13	1.05
72	Machinery specialized for particular industries	3.09	2.48	2.75	1.19	1.08	1.09
82	Furniture and parts thereof	2.06	2.14	2.34	2.26	2.16	2.38
62	Rubber manufactures, n.e.s.	2.25	2.11	1.91	3.10	2.70	2.54
x	Share of items 1 – 5 in Czech exports	44.74	49.93	50.05	-	-	-
x	Share of items 6 – 10 in Czech exports	20.60	18.02	19.09	-	-	-
x	Share of top 10 items in Czech exports	65.34	67.94	69.13	-	-	-

Source: Calculated by the authors based on data obtained from UNCTAD and CZSO (database of foreign trade)

If we expand this analysis to include the service sector (Table 2: The BI of the types of the Czech Republic's export services vs. the world), changes in the BI values allow us to conclude that the most significant increase in export specialisation was recorded in the categories of Computer and information services (from an average of 1.23 in 2014–2016 to 1.41 in 2017–2018) and Transport (from 1.24 to 1.39). A rough analysis of exports thus shows that the **Czech Republic is profiling itself as a major global exporter of road vehicles and ICT services**, and the importance of these two commodities in foreign trade with the world is continuing to increase over time. However, while the concentration in the export of goods is increasing in favour of road vehicles, the specialisation in the field of services is slightly diversified.

Table 2. The BI of the types of the Czech Republic's export services vs. the world

Category		Average 2005–2007		Average 2014-2016		Average 2017-2018		BI		
		CR	World	CR	World	CR	World	Average 2005–2007	Average 2014–2016	Average 2017–2018
	Services total	100.00	100.00	100.00	100.00	100.00	100.00	1.00	1.00	1.00
1	Transport	23.00	21.74	22.72	18.35	24.25	17.42	1.06	1.24	1.39
2	Tourism	36.92	25.05	26.80	24.38	25.24	24.62	1.47	1.10	1.03
3	Other services	31.60	49.82	40.52	53.94	40.20	54.41	0.63	0.75	0.74
3.I	Telecommunication services	2.71	:	1.85	:	14.17	1.62	:	:	8.74
3.II	The building industry	1.65	1.84	2.50	1.97	1.49	1.89	0.90	1.27	0.79
3.III	The insurance sector	0.50	2.59	1.10	2.53	0.99	2.46	0.19	0.43	0.40
3.IV	Financial services	2.34	9.02	1.86	8.82	:	8.46	0.26	0.21	0.03
3.V	IT and information services	8.12	7.83	12.01	9.79	11.02	7.81	1.04	1.23	1.41
3.VI	Intellectual property rights and lic. fees	0.22	6.02	1.97	6.29	1.61	6.97	0.04	0.31	0.23
3.VII	Other corporate services	17.71	19.54	20.26	21.97	19.57	21.80	0.91	0.92	0.90
3.VIII	Personal, cultural and recreational services	0.84	0.93	0.72	0.94	0.65	0.95	0.90	0.77	0.69
3.IX	Public services n.e.c.	0.22	2.05	0.09	1.47	0.12	1.30	0.11	0.06	0.09
5	Market services total	91.52	96.61	90.04	96.67	99.88	98.70	0.95	0.93	1.01

Source: Calculated by the authors based on data obtained from UNCTAD

When broken down by **technology intensity**, **high-tech services**[26] and ICT services as their subgroup are performing better in foreign trade (hereinafter also FT) than high-tech goods[27]. The trade balance of ICT services has been positive since 2011, and the surpluses have been steadily increasing over time. Within the ICT services group, computer services and software account for the highest share in exports (81.4%), while telecommunications services account for 18.6%. The growing FT surplus of ICT services is the main contributor to the positive balance of FT in the total of high-tech services, more than offsetting the deficit of trade in high-tech goods in 2018. Although the volume of trade in ICT services is not as high as the level of FT in ICT goods, its growing dynamics in the Czech Republic and the global trend of a digital transition are promising for the growing competitiveness of the Czech economy.

In addition to the openness of the Czech economy, it is also characterised by a **high orientation towards industry**. In the Czech Republic, the share of industry in gross value added (GVA) has long been around 30%, with manufacturing alone accounting for around 25%, which is the second highest share after Ireland among all EU countries. As before, the manufacture of motor vehicles, real estate activities, wholesale trade, and public administration/defence account for the largest proportion of GVA. By contrast, the proportion of services in GVA has been stable at around 60% over the long term, which places us among the countries with the lowest share of services within the EU.

Employment statistics show a similar distribution of economic activity between industry and services. However, there are some signs that change may be coming. While the share of employment in industry in total employment in the Czech Republic declined between 2010 and 2019, the **share of employment in services shows an increasing trend**. However, it should be noted that both the decline in employment in industry and the growth in employment in services are among the lowest in the EU. The data thus show that **manufacturing has historically held a strong position in the Czech Republic, but in the future, services can be expected to contribute a larger share to GVA, as is the case in other EU countries**.

The Czech economy has **significantly lower labour productivity** than most advanced EU countries, which greatly affects its long-term growth prospects. The lower productivity growth rate prevents a faster real convergence of the Czech economy with more advanced EU economies. However, there are also sectors that show a relatively smaller productivity lag compared to countries in Western Europe. Gross value added per person employed in the Czech Republic is on average **60% lower** than productivity in the 15 older EU member states. Among the selected sectors, the following show the relatively smallest productivity lag: transport equipment manufacturing (-43% in 2017), electricity, gas, heat and air conditioning production and distribution (-45%), and ICT activities (-52%). Disregarding the different wage levels in the Czech Republic and the EU and the CZK exchange rate, it is these sectors that have a relatively greater chance of success in international competition compared to other sectors of the Czech economy.

The lower labour productivity that is associated with lower wage levels is largely due to the type of manufacturing activities prevailing in the Czech Republic. **Most of the value added is concentrated in the production phase**, while a lower share of value added is concentrated in the pre-manufacturing (R&D) and post-manufacturing (services, marketing, servicing) phases where, in general, more value added is produced. The changes in the structure of the economy, in other words, increasing the share of production in the pre- and post-manufacturing phase, should aim to **shift domestic companies' production to higher tiers of value chains**.

The Czech economy is also characterised by **low domestic value added**. The share of domestic value added in exports is 55% on average for the entire Czech Republic. Per each CZK 1 of exports, it is necessary to import goods and components worth CZK 0.45. Over more than the past two decades, this indicator has increased significantly, namely by 16.2 percentage points since 1995. Apart from the manufacture of coke and refined petroleum products, the industries with the highest import intensity of exports are the manufacture of motor vehicles (58%), and some other key industries such as the manufacture of computers, electronic and optical products (57%) and the manufacture of machinery and equipment (41%).

[26] Foreign trade in high-tech services is characterised by the sale/purchase of a country's intangible technology in relation to other economies. It consists of computer services and software, architectural, engineering and other technical services, research and development services and licence fees for the right to use industrial property products. The share of high-tech services in total trade in services is around 15%.

[27] Goods with high technology intensity (hereinafter high-tech goods) are products whose production and processing require predominantly cutting-edge facilities that are very technologically advanced and intensive. The development of these products is usually associated with relatively high R&D&I costs. In FT statistics, high-tech goods are defined according to the Standard International Trade Classification. Data are available for eight main categories and are available according to the movement of goods (cross-border statistics), including an international comparison. Approximately one-fifth of the Czech Republic's FT is in high-tech goods.

Naturally, in the area of services, the dependence on foreign value added is not so high. For information technology activities, the import intensity of exports is around 15%, i.e., domestic value added accounts for as much as 85% of exports. In other service sectors, the share of imports in domestic exports does not generally exceed 20%. While the import intensity of exports is considerable in industry, which weakens economic growth in the Czech Republic, the opposite is true for services, i.e., most exports are covered by domestic value added and, in turn, the negative impact of net exports on economic growth is not so marked. In order to achieve more dynamic economic growth in terms of geographical value added, it would be more effective to promote the services sector.

The level of innovation activity also shapes the future form of the domestic economy and contributes to smart specialisation in the Czech Republic. According to the European Innovation Scoreboard[28], the **innovation performance of the Czech economy has been improving slightly since 2012, at a moderately faster pace than the EU average**. Relative to the EU average, the Czech Republic's innovation capacity was 83% in 2012, while in 2019 (relative to the EU average for 2019) it was already 84%. However, even after this improvement, the Czech Republic is still short of the EU 2012 values (only 92%). The Czech Republic thus ranks 16th out of 27 EU countries, i.e., among moderate innovators, between Slovenia and Malta and the highest among the Visegrad Four countries (Slovakia 21st, Hungary 22nd and Poland 24th). In terms of the innovation dimensions, in 2020 the Czech Republic achieved the best results compared to the EU in terms of the impact of innovation on employment, followed by the innovators dimension, partly due to a higher level of in-house innovations of products and production processes of SMEs, and the impact of innovation on sales. By contrast, the Czech Republic is performing worst in terms of intellectual assets (patent applications) and in the area of financing and support (venture capital).

The Czech Republic's innovation environment has also improved when making a global comparison. **In the Global Innovation Index (GII)[29], the Czech Republic is now among the 25 most innovative countries in the world.** Since last year, the Czech Republic's ranking has improved two places, ranking 24th out of 131 economies worldwide. It is still true that innovation outputs (ranked 17th) are stronger than innovation inputs (ranked 28th). Compared to the group of 49 high-income countries, among which the Czech Republic is ranked, it performs above average in four pillars (infrastructure, business sophistication, knowledge and technology outputs and creative outputs), while performance in the three remaining pillars (institutions, human capital and research, and market sophistication) is below average. In terms of the various sub-areas, the Czech Republic performs best in research and development financed from abroad. This is a result of the fact that the **share of research carried out in foreign-controlled businesses has been increasing over the long term**. Other areas in which the Czech Republic excels include areas related to the manufacturing industry, especially high-technology imports, exports and production.

According to cross-cutting rankings of innovation capacity, the Czech Republic generally performs on an average level within Europe, as well as within the entire developed world. **In a situation of economic recession, sustaining the pace of innovative business development will be challenging**. Companies do not have resources for conducting their operations, let alone for investing in research and development (R&D). This shortfall should be, at least in part, eliminated by public R&D spending. For future success, it will be crucial to handle change management well, both in the business and public sectors, i.e., to further improve their mutual cooperation. **The main objective of the planned changes should be to strive for a greater diversification of the Czech economy, to strengthen promising sectors of the national economy and to make economic policy counter-cyclical, i.e., to support R&D from public resources during times of economic downturn**.

[28] On 23 June 2020, the European Commission published the European Innovation Scoreboard 2020 (EIS), which provides a comparative analysis of the innovation performance of selected countries. It assesses the strengths and weaknesses of national innovation systems and, in turn, helps countries identify areas where there is room for improvement. The EIS 2020 Summary Innovation Index is composed of four main types of indicators (framework conditions, investments, innovation activities and impacts), which are further broken down into a total of ten innovation dimensions, capturing in total 27 different indicators.

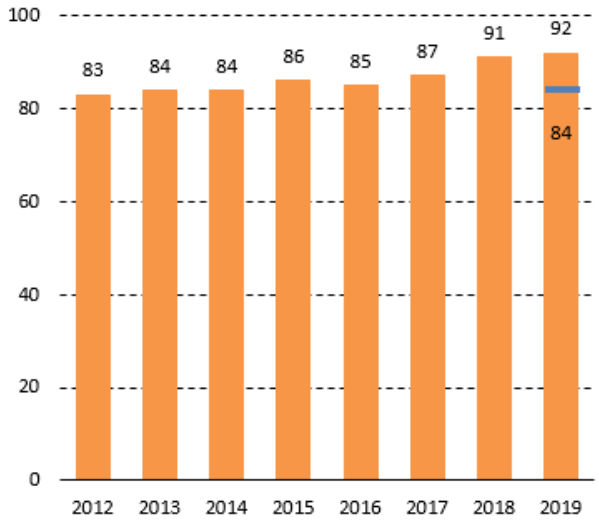
[29] The Global Innovation Index (GII) ranks the world's economies by their capacity for innovation. The multidimensional GII ranking consists of seven main pillars and nearly 80 indicators that are broken down into innovation inputs and outputs. The Global Innovation Index is published by Cornell University, INSEAD and the World Intellectual Property Organisation (WIPO), a specialised agency of the United Nations.

Table 3. Main indicators of the innovation index

Indicator	Relative to EU 2019 in 2019	Relative to EU 2012 in 2012	Relative to EU 2012 in 2019
SUMMARY INNOVATION INDEX	84.3	83.2	91.7
Human resources	73.3	78.8	84.4
Attractive research systems	73.3	55.8	83.7
Innovation-friendly environment	69.9	78.8	121.5
Finance and support	57.8	74.7	57.8
Firm investments	93.7	102.0	121.7
Innovators	97.0	90.7	86.7
Linkages	90.0	73.8	92.7
Intellectual assets	55.3	61.9	51.7
Employment impacts	137.9	123.6	148.8
Impact on sales	95.2	93.3	94.7

Source: European Commission, European Innovation Scoreboard 2020

Chart 1. Innovation performance of the Czech Republic



Source: European Innovation Scoreboard 2020

European resources should help us to achieve these goals in the coming period. To help the European economy recover from the coronavirus pandemic, the European Commission (the Commission) has introduced a programme to support economic recovery with a total allocation of EUR 750 billion (New Generation EU). The funds will mainly go to the green themes of the European Green Deal (EGD), digitalisation, ensuring self-sufficiency and promoting employment. The new operational programmes will be linked to the Commission's programme priorities in the fields of the environment, high-technology and health care, with the aim of improving the competitiveness of the European economy and the well-being of society as a whole.

3.1.2 Sectoral analysis

A sectoral analysis will be used to narrow down the specification of promising sectors and, in turn, the specialisation domains in R&D&I. The main criteria for the analysis include **R&D expenditures in the business sector, publication activity and the quality of R&D in research organisations (ROs), the level of support and**

cooperation between businesses and ROs, as well as a patent analysis. The results of an analysis by the TC CAS[30] show that business research has experienced relatively dynamic development in the post-recession period. Over the 2011–2018 period, R&D expenditures in the business sector (BERD) grew at an average annual rate of 9%. The highest relative increases in R&D expenditures occurred in the of **IT activities** (NACE 62), **electrical engineering** (NACE 27), and **electronics** (NACE 26) sectors and the **automotive** (NACE 29) industry. Large foreign-controlled businesses, which account for almost 60% of all business R&D expenditures, play a key role in the dynamic development of R&D activities in the business sector. The share of domestic SMEs in business sector research activities has been declining over time (it now stands at about 20%), in part due to the stagnation of the absolute amount of R&D expenditures in this segment.

Foreign-controlled businesses dominate most sectors with significant R&D activities. In addition to the automotive industry, where the concentration of R&D in foreign hands is almost 100%, research activities in foreign-owned companies are also more concentrated in high-tech sectors (electronics, pharmaceutical), the electrical engineering industry, as well as in IT activities and some other knowledge-intensive service sectors such as architectural and **engineering** activities, financial intermediation and telecommunications activities. In these sectors, research and development activities are also significantly concentrated in a small number of businesses, which means that the business sector is lacking a wider and more distributed research and development base.

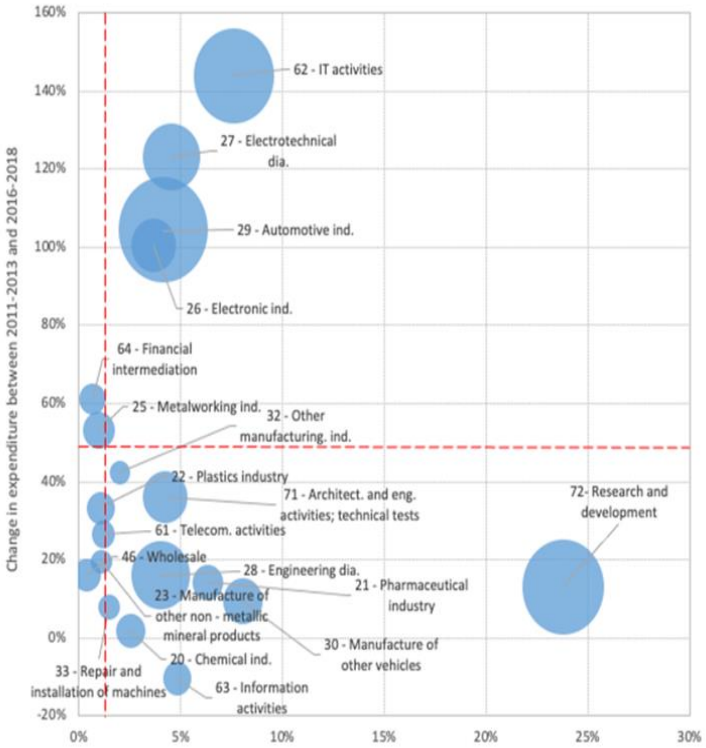
A higher **share of R&D in domestic businesses** compared to foreign-controlled businesses exists in the manufacturing of **other** transport equipment, metalworking and chemical industries, and the repair and installation of machinery and equipment, as well as in knowledge-intensive service sectors, including research and development and information activities.

As regards the knowledge base, according to the **publication activity** criterion, most publications in the Czech Republic are produced in **natural sciences (physical, chemical and biological sciences), technical sciences (especially materials engineering) and medical sciences (clinical and basic medicine)**. In some fields, the share of publications in the Czech Republic's total publication output is (significantly) higher than in the EU-15 countries. In an international comparison, the proportion of publications is especially high in the natural sciences, some technical sciences and some **agricultural sciences (agriculture, forestry and fisheries)**. When classified by economic activity, most publications are produced in the field of research and development (NACE 72). Among the sectors of the manufacturing industry, most publications can be classified under pharmacology (NACE 21), the manufacture of machinery (NACE 28), the manufacture of computer, electronic and optical products (NACE 26), the manufacture of chemicals (NACE 20) and the manufacture of rubber and plastic products (NACE 22). In the vast majority of disciplines, publication activity has been increasing. **The largest increase is in technical sciences, especially in environmental engineering, industrial biotechnology and nanotechnology**.

In most disciplines, the citation rate and, by extension, the quality of publications produced by Czech ROs is below the world average. However, the quality of publications in some disciplines is above the world average, including promising disciplines such as **computer science, physical disciplines, molecular biology and genetics, and some medical disciplines**. In most disciplines, the share of publications produced in collaboration with the business sector has been increasing, as is the share of publications produced through international collaboration. The highest proportion of co-publications with industry are being produced in the health care (NACE 86) and other manufacturing (NACE 32) sectors.

[30] CAS Technology Centre (2020): "An analysis of the linkage between KETs and the application sectors of the National RIS3 Strategy 2021+: Sectoral analysis of R&D in the Czech Republic with a focus on vertical specialisation domains", https://www.mpo.cz/assets/cz/podnikani/ris3-strategie/projekty-na-podporu-ris3/operacni-program-technicka-pomoc/2020/7/Odvetvova-analyza-VaV.pdf, April 2020.

Chart 2. R&D expenditures in the business sector as a share of GVA, by NACE sectors, and changes in expenditures between 2011–2013 and 2016–2018



Source: CZSO (VTR 5-01; National Accounts Database)

An analysis of projects in public targeted R&D&I support programmes shows that the support is concentrated mainly in knowledge-intensive service sectors, such as IT activities, R&D and architectural and engineering activities, and in medium- and high- tech industries (mechanical engineering, electronics, most of the production of other transport equipment, and the electrical engineering industry). **The sectoral structure of public support for R&D thus also generally corresponds to the structure of BERD. The biggest difference is mainly in the relatively lower amount of public support for the automotive industry** (NACE 29), which – in addition to high R&D expenditures – also has significant own resources that reduce the need for public support. While the total amount of public support for projects decreased slightly between 2015–2016 and 2017–2018, support in promising industries and technologies **such as clinical medicine, electrical and information engineering, chemical engineering and physical sciences** increased.

Table 4. Public support from national programmes of targeted support for R&D in enterprises by NACE sector (two-digit classification). The data are cumulative for the 2015–2018 period

NACE	Industry (abbreviated)	Public support (CZK thousands)		Number of projects		Companies involved					Share of companies that received a share of the total support for the sector	
		Total	Projects in cooperation with the non-corporate sphere	Total	Projects in cooperation with the non-corporate sphere	Total	Domestic companies	Companies under foreign control	Small	Medium	Large	50%	80%
62	Information technology activities	1,136,889	484,644	295	158	123	87.0%	13.0%	81.0%	17.2%	1.7%	4%	22%
28	Manufacture of machinery and equipment nec	1,128,423	765,486	291	233	134	78.4%	21.6%	33.6%	55.5%	10.9%	13%	32%
72	Research and development	1,026,518	818,042	322	275	77	84.4%	15.6%	77.5%	19.7%	2.8%	9%	28%
71	Arch and eng activities; technical testing and analysis	979,143	767,687	395	336	177	81.9%	18.1%	65.7%	32.5%	1.8%	10%	31%
26	Production of computers, el. and optical instruments and devices	784,683	552,113	170	135	64	84.4%	15.6%	50.0%	43.5%	6.5%	9%	25%
30	Manufacture of other transport facilities and equipment	586,608	385,462	74	66	30	76.7%	23.3%	15.4%	46.2%	38.5%	12%	27%
46	Wholesale trade, except of motor vehicles and motorcycles	575,084	280,358	169	143	116	84.5%	15.5%	85.3%	14.7%	0.0%	5%	24%
68	Real estate activities	515,928	68,323	50	32	33	93.9%	6.1%	93.1%	6.9%	0.0%	8%	18%
84	Public administration and defence; compulsory social security	495,055	15,121	61	5	3	100.0%	0.0%	50.0%	0.0%	50.0%	33%	67%
27	Manufacture of electrical equipment	459,326	240,938	98	72	66	72.7%	27.3%	36.8%	40.4%	22.8%	11%	32%
25	Production metal structures and metalwork. products	446,098	204,005	124	99	82	80.5%	19.5%	41.4%	47.1%	11.4%	12%	30%
33	Repair and installation of machinery and equipment	347,811	146,647	72	56	40	90.0%	10.0%	45.7%	40.0%	14.3%	6%	22%
22	Manufacture of rubber and plastic products	293,891	177,305	86	67	36	77.8%	22.2%	20.7%	62.1%	17.2%	12%	33%
20	Manufacture of chemicals and chemical products	287,812	174,599	105	83	54	81.5%	18.5%	55.6%	24.4%	20.0%	12%	34%
29	Manufacture of motor vehicles, trailers and semi-trailers	269,569	86,418	44	28	25	48.0%	52.0%	12.5%	25.0%	62.5%	16%	38%
32	Other manufacturing	254,432	209,095	72	62	31	87.1%	12.9%	65.5%	31.0%	3.4%	11%	37%
21	Basic production pharm. products and preparations	218,272	133,315	54	40	18	77.8%	22.2%	52.9%	41.2%	5.9%	21%	42%
70	Business management activities; management consulting	202,514	116,642	68	34	23	91.3%	8.7%	94.7%	0.0%	5.3%	7%	21%
23	Manufacture of other non - metallic mineral products	154,260	134,392	68	61	39	51.3%	48.7%	34.4%	46.9%	18.8%	15%	31%
39	Remediation activities and other waste management services	152,278	126,433	38	33	5	60.0%	40.0%	60.0%	40.0%	0.0%	20%	20%
43	Specialized construction activities	149,471	131,762	49	44	27	92.6%	7.4%	64.0%	36.0%	0.0%	16%	32%
10	Manufacture of food products	121,828	100,779	54	48	44	75.0%	25.0%	40.5%	54.8%	4.8%	9%	26%
41	Construction of buildings	107,468	81,303	32	29	24	95.8%	4.2%	63.2%	31.6%	5.3%	18%	32%
01	Plant and animal production, hunting	100,823	93,900	106	101	95	89.5%	10.5%	53.3%	46.7%	0.0%	15%	44%
38	Collection, collection and disposal of waste, waste treatment	94,988	32,202	25	18	16	93.8%	6.3%	78.6%	14.3%	7.1%	11%	33%
24	Basic production metals, metallurgical processing of metals; foundry	85,172	51,017	30	27	14	64.3%	35.7%	16.7%	25.0%	58.3%	17%	39%
17	Manufacture of paper and paper products	79,878	41,744	14	9	10	80.0%	20.0%	28.6%	71.4%	0.0%	30%	60%
86	Health care	70,055	62,534	45	42	28	96.4%	3.6%	32.0%	32.0%	36.0%	13%	33%
58	Publishing activity;	70,020	51,834	24	20	9	66.7%	33.3%	66.7%	33.3%	0.0%	18%	36%
63	Information activities	66,349	57,620	36	32	12	100.0%	0.0%	66.7%	33.3%	0.0%	17%	42%
74	Other professional, scientific and technical activities	62,576	35,860	58	36	35	94.3%	5.7%	94.1%	5.9%	0.0%	17%	36%
42	Civil engineering	56,704	46,749	36	33	22	63.6%	36.4%	5.6%	66.7%	27.8%	16%	32%
13	Manufacture of textiles	56,644	21,661	18	11	10	80.0%	20.0%	16.7%	50.0%	33.3%	13%	33%
47	Retail trade, except of motor vehicles and motorcycles	51,596	30,645	20	16	10	90.0%	10.0%	100.0%	0.0%	0.0%	24%	47%
02	Forestry and logging	28,299	28,299	30	30	16	93.8%	6.3%	60.0%	26.7%	13.3%	19%	44%
61	Telecommunication activities	27,887	27,887	9	9	4	75.0%	25.0%	50.0%	25.0%	25.0%	25%	50%
11	Manufacture of beverages	27,179	27,179	8	8	9	66.7%	33.3%	66.7%	22.2%	11.1%	10%	20%
95	Repair of computers and personal and household goods	25,381	20,451	12	7	6	100.0%	0.0%	83.3%	16.7%	0.0%	29%	57%
73	Advertising and market research	23,488	4,769	8	4	6	83.3%	16.7%	80.0%	20.0%	0.0%	13%	25%
85	Education	21,514	8,164	20	9	16	87.5%	12.5%	86.7%	13.3%	0.0%	16%	37%
07	Mining and processing of ores	20,266	20,266	3	3	1	100.0%	0.0%	0.0%	0.0%	100.0%	100%	100%
18	Printing and reproduction of recorded media	20,069	20,069	4	4	2	100.0%	0.0%	50.0%	50.0%	0.0%	33%	67%
35	Production and distribution of electricity, gas, heat and air conditioning	19,675	19,675	15	15	14	85.7%	14.3%	30.0%	20.0%	50.0%	6%	24%
08	Other mining and quarrying	19,038	18,782	6	4	4	100.0%	0.0%	50.0%	50.0%	0.0%	40%	40%
59	Motion picture, phone and music publishing activities	14,906	14,906	1	1	1	100.0%	0.0%	0.0%	100.0%	0.0%	50%	50%
31	Furniture production	14,852	10,107	5	3	4	100.0%	0.0%	50.0%	50.0%	0.0%	17%	33%
14	Manufacture of wearing apparel	12,133	6,529	7	5	4	75.0%	25.0%	50.0%	25.0%	25.0%	33%	50%
45	Wholesale, retail and repair of motor vehicles	12,083	4,237	4	3	4	100.0%	0.0%	100.0%	0.0%	0.0%	25%	50%
94	Activities of membership organizations to promote dispute the interests of soc	11,380	9,603	15	13	6	100.0%	0.0%	80.0%	20.0%	0.0%	29%	43%
36	Water collection, treatment and supply	10,370	10,370	19	19	10	80.0%	20.0%	10.0%	20.0%	70.0%	18%	27%
16	Wood processing, wood production. and sim. products	10,294	10,294	6	6	5	80.0%	20.0%	60.0%	40.0%	0.0%	14%	29%
75	Veterinary activities	10,278		3	0	2	100.0%	0.0%	100.0%	0.0%	0.0%	33%	67%
03	Fishing and aquaculture	9,327	9,327	8	8	8	87.5%	12.5%	62.5%	37.5%	0.0%	13%	38%
93	Sports, entertainment and recreation activities	8,856	6,337	5	4	2	100.0%	0.0%	100.0%	0.0%	0.0%	50%	100%
77	Activities in the field of renting and op. leasing	8,719	8,719	4	4	3	100.0%	0.0%	66.7%	33.3%	0.0%	40%	60%
82	Administrative, office. and support. activities for business	7,332	6,581	5	4	4	75.0%	25.0%	50.0%	50.0%	0.0%	40%	40%
56	Catering and hospitality	7,028	7,028	6	6	3	100.0%	0.0%	100.0%	0.0%	0.0%	25%	25%
52	Warehousing and support activities for transportation	6,608	6,608	6	6	4	75.0%	25.0%	0.0%	50.0%	50.0%	25%	50%
09	Mining support service activities	5,500		1	0	1	100.0%	0.0%	100.0%	0.0%	0.0%	100%	100%
55	Accommodation:	4,835	4,835	2	2	2	100.0%	0.0%	100.0%	0.0%	0.0%	50%	100%
19	Production of coke and ref. petroleum products	4,742	4,742	4	4	2	100.0%	0.0%	100.0%	0.0%	0.0%	50%	50%
80	Security and investigation activities	3,369	2,445	3	2	3	66.7%	33.3%	50.0%	50.0%	0.0%	40%	60%
49	Land and pipeline transport	3,318	3,318	6	6	4	75.0%	25.0%	33.3%	33.3%	33.3%	25%	38%
69	Legal and accounting activities	1,662	1,125	3	2	3	66.7%	33.3%	0.0%	33.3%	66.7%	33%	67%
81	Construction and landscaping activities	1,510	1,510	2	2	2	100.0%	0.0%	50.0%	50.0%	0.0%	50%	100%
51	Air transport	1,480	1,480	1	1	1	0.0%	100.0%	0.0%	100.0%	0.0%	100%	100%
15	Manufacture of leather and related products	699	699	1	1	1	100.0%	0.0%				100%	100%
64	Financial intermediation	156		1	0	1	100.0%	0.0%				100%	100%
05	Mining and processing of hard coal and lignite	0	0	1	1	1	100.0%	0.0%	0.0%	0.0%	100.0%	100%	100%
n/a	Not determined	68,864	64,166	27	24	24	41.7%	58.3%	60.0%	0.0%	40.0%	14%	31%

Source: Office of the Government (R&D&I CEP IS), CZSO (Register of Economic Entities)

When broken down by **scientific discipline**, the greatest amount of public support was given to projects in **natural sciences** (especially biological and physical sciences) and **technical sciences** (electrical engineering, electronics and computer science, materials engineering, mechanical engineering and civil and transport engineering). Projects in the field of **clinical medicine** also received high public support. In 2015–2018, the proportions of total public support for R&D were 39% for natural sciences, 34% for technical sciences and 12% for medical sciences.

Public support was mainly provided to **small enterprises** (57% of total support) and medium-sized enterprises (about 33% of support). As regards research organisations (ROs), **HEI** participated most often in the projects. Between 2015 and 2018, almost 80% of businesses' projects were implemented **in cooperation with ROs**. These projects were implemented mainly in industries and technological areas where more demanding R&D can be expected to be carried out, such as electrical engineering, electronics, information and mechanical engineering and materials. An analysis of the cooperation between businesses and ROs also showed that technically oriented HEIs, such as the Czech Technical University in Prague, The Brno University of Technology, The Technical University of Liberec, The University of Chemistry and Technology in Prague, and VSB – The Technical University of Ostrava, which represent knowledge centres for many businesses, play an important role in projects.

The last criterion for selecting promising sectors/application sectors is an **analysis of the patent activities** of ROs and businesses. An analysis by the TC CAS showed that the number of patent applications filed by businesses and ROs has stagnated in recent years. In contrast to the EU-15 countries, patent applicants are much more often

ROs (especially HEIs) in the Czech Republic. Patent applications focus mostly on the following sectors: **the chemical and pharmaceutical industry, mechanical engineering, pharmacology and instrumentation**. Between 2010–2012 and 2015–2017, the largest increase in the proportion in total patent applications occurred in **optics** (an increase of nearly 140%), **computer technology** (120%) and **medical technology** (70%). Above-average increases were also reported in the most represented technological areas – pharmacology (60%) and organic pure chemistry (45%). It has also been found that a significant proportion of patents are applied for by foreign-controlled businesses, especially in sectors that are important in terms of GVA generation, such as electrical engineering and electronics, the manufacture of transport equipment, and some areas of mechanical engineering.

3.1.3 NRIS3 application sectors

The above combination of available empirical data from sectoral analyses and macroeconomic starting points largely confirms the promising application sectors as already identified for the purposes of the National RIS3 Strategy 2014–2020 (an update was approved by the Government of the Czech Republic in 2018) on the basis of economic indicators and the EDP process. The following table lists the key application sectors and their subordinate application sectors of the National RIS3 Strategy. In these sectors, the Czech Republic shows above-average growth potential and considerable knowledge intensity.

Table 5. NRIS3 application sectors

Key application sectors/thematic areas	Application sector
Advanced machinery and technologies[31]	• Engineering, mechatronics • Industrial chemistry • Metallurgy • The energy sector
Digital technologies and electrical engineering	• Electronics and electrical engineering • Digital economy and digital content
Transport for the 21st century	• Automotive • Railway and rail vehicles • The aerospace industry
Healthcare	• Drugs, biotechnology, medical devices and life sciences
Cultural and creative industries	• New and traditional cultural and creative industries
Sustainable agriculture and environmental sectors	• Sustainable management of natural resources • Sustainable agriculture and forestry • Sustainable food production • Ensuring a healthy and quality environment, biodiversity and ecology of natural resources • Sustainable construction, human settlements and technical environmental protection

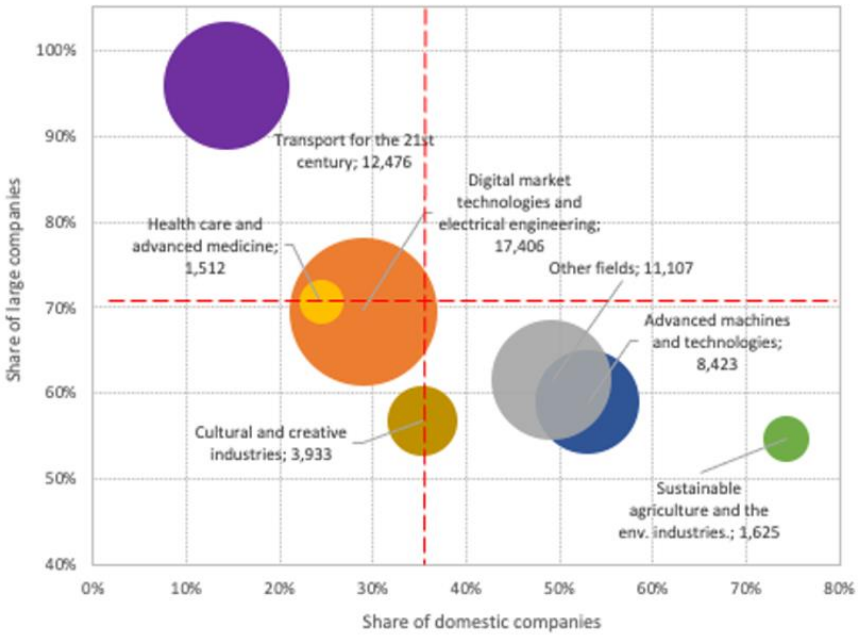
Source: Prepared by the authors

Due to the absence of quantitative data from agricultural and environmental R&D, the last application sector was identified using the EDP process. This is an area in which the Czech Republic currently has no immediate comparative advantage on an international scale, but it is reasonable to assume that the area is critical with respect to maintaining long-term competitiveness and preventing risks (sustainability of development, resource security and sufficiency) that may jeopardise the prosperity of the economy and society in the long-term.

[31] "Advanced machinery and technologies" is the name of a key application sector. In Annex 1, the title of this thematic area is modified to "Advanced machinery/technologies for globally competitive industry".

In terms of the key application sectors of the Czech Republic's economic specialisation, **business R&D activities are the most extensive** in the **Digital technologies and electrical engineering** area, which is also one of the most dynamically developing application sectors, where R&D expenditures increased by more than 160% between 2011 and 2018. Despite the significant concentration of R&D expenditures in a small number of large businesses, there are a relatively high number of businesses operating in this sector that are active in research. Together with the strong dynamics of the development of research activities, this indicates **promising potential for the absorption of R&D results** in innovation processes. This fact is further confirmed by the relatively high and still growing number of patent applications filed by businesses operating in the areas of digital technologies, electronics and electrical engineering. However, a significant number of patent applications that have a Czech originator are filed by foreign-based businesses, which indicates a certain risk of "knowledge leakage" outside the Czech Republic.

Chart 3. R&D expenditures in businesses in key application sectors in 2016–2018



Source: CZSO (VTR 5-01; National Accounts Database)

The increasing R&D potential in the area of digital technologies and electrical engineering is also evidenced by the relatively high and increasing **support for research activities from public sources**, with almost five times more support going to the Digital economy application sector than to the Electronics and electrical engineering application sector. The fact that approximately two-thirds of the supported projects are implemented as collaboration between businesses and research organisations suggests that in this area, there are relatively **well-developed links between academia and business for the transfer of new knowledge**.

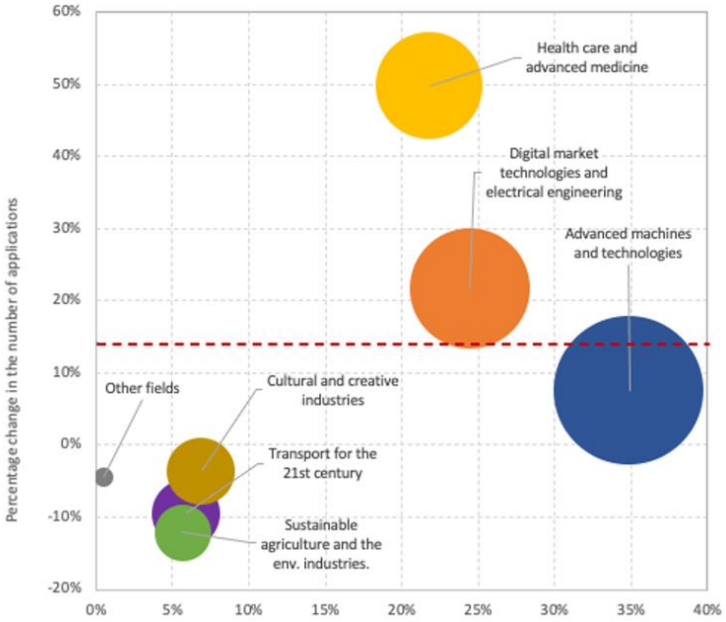
The **Advanced machinery and technologies** key application sector is characterised by a higher share of **domestic businesses** in R&D activities (approximately 55% of business R&D expenditures are implemented by domestic businesses), with a relatively high share of R&D being implemented in SMEs, except in the energy sector and metallurgy. This is also reflected in the very high number of businesses with R&D activities (the number of businesses operating in this sector is higher than in any other key application sector) and the lowest degree of concentration of R&D activities of all key application sectors in NRIS3. There is thus a **broad research base** for further development of R&D&I in this sector.

One important part of this key application sector is the energy sector, which needs to be understood as a whole, i.e., covering electricity and heat (or cold) from production through distribution to final consumption and energy storage. The energy sector comprises both a layer of individual equipment and technological parts and a layer of an interconnected energy system that is based on optimising supply security, supply at an acceptable price (for industry, services and the population) and the environmental acceptability of energy supply. Links to other

industries such as chemistry, transport and agriculture, as well as links to other areas including digitalisation are also important for the energy sector.

The Advanced machinery and technologies key application sector is characterised by strong potential for absorbing R&D results and new knowledge in innovation processes, as evidenced by the relatively high number of patent applications. Approximately one-half of the patent applications whose originators were employees from the Czech Republic are filed by foreign-controlled or foreign-based businesses. There is thus also some leakage of knowledge abroad, but its extent is not as large as in electrical engineering or the automotive industry.

Chart 4. Trends in the number of patent applications (changes in the number of applications between 2010–2012 and 2015–2017)



Source: EPO Worldwide Patent Statistical Database – Autumn 2019

The proportion of public support for R&D that goes to the area of advanced machinery and technologies is relatively high, which – given the emphasis placed on promoting cooperation between research organisations and business – is also reflected in the **intensive links between academic and business research** (approximately 80% of R&D projects that are supported from public resources are implemented in cooperation between the two sectors). These existing links create a good basis for effective knowledge transfer between research organisations and businesses, especially in the field of mechanical engineering and mechatronics.

Transport equipment for the 21st century is a key application sector with the very lowest share of expenditures by domestic businesses (only 14%). The lowest share of domestic businesses in expenditures in the Automotive application sector (7%) is a logical consequence of the ownership structure of key businesses in this sector. An exception is the application sector of Railway and rail vehicles, where the share of domestic businesses is the highest (92%). In the manufacture of transport equipment, **R&D is mainly carried out by large foreign-controlled businesses**, while the share of domestic SMEs is the lowest among all the key application sectors. This is reflected in the narrow base of business R&D and the high degree of R&D concentration in a small number of businesses.

Given the privileged position of the manufacture of transport equipment in the Czech economy, the support for businesses' research activities in this area is also relatively high. Public support is mainly provided to the Automotive and Aerospace industry sectors. On the other hand, compared to other key application sectors, patent activity in this area is low and has been showing a downward trend. This – together with the high share of R&D carried out in foreign-controlled businesses – largely reflects Czech businesses' position in production chains, where production activities in these sectors tend to focus on lower value-added activities.

In the **Healthcare and advanced medicine** key application sector, the business sector's capacity to absorb new knowledge and R&D results lags behind the public sector's research capacity. This is also indicated by businesses'

R&D expenditures, which is relatively low compared to other NRIS3 application sectors. Here, more than one-half of R&D expenditures are implemented in foreign-controlled businesses – these businesses' expenditures are increasing significantly and the share of domestic businesses in implementing R&D has been gradually decreasing. Conversely, public support especially in the field of clinical medicine has been growing over time.

The dominant position of public research in the field of healthcare and advanced medicine is also evident in patenting activity, which is mainly carried out by research institutes. Patent applicants from the business sector are mostly from domestic businesses, especially medium and large enterprises. However, between 2010–2012 and 2015–2017, the field of Healthcare and advanced medicine experienced the sharpest increase in patent applications of all the key application sectors (an increase of almost 50%). It can be generally concluded that, even though the weaker participation of businesses in R&D projects reduces the prospects of this application sector, this negative aspect is more than made up for by the dynamic increase in patent applications, the high number of publications and their citation rates, even when making an international comparison, as well as the strong public support for research organisations.

In the key application sector of **Cultural and creative industries**, which includes both traditional craft industries and industries that are associated with new activities and business models, R&D activities are not as extensive as in other sectors of the manufacturing industry and knowledge-intensive services. Nevertheless, there is a broad base of R&D activities in the business sector, as evidenced by the relatively high number of businesses reporting R&D expenditures. On the other hand, the predominant amount of R&D investments in this key application sector is implemented by a small number of large businesses. The smaller range of R&D activities in the field of cultural and creative industries is also reflected in the smaller number of newly created technical solutions with patent protection. Also, the number of patent applications focusing on cultural and creative industries has been on a downward trend in recent years.

The importance of R&D that is carried out in cultural and creative industries is evidenced by the relatively high volume of support provided to R&D projects that, by their nature, fall within this area. Compared to other key application sectors, cultural and creative industries are specific in that the dominant share of support for R&D activities goes to small domestic businesses. This shows that the endogenous sector has relatively **high potential for creating and absorbing new knowledge**. This potential is reinforced by the fact that the vast majority of supported projects are implemented in cooperation between businesses and research organisations.

Sustainable agriculture and environmental sectors is one of the key application sectors with less R&D activity, as evidenced by lower R&D expenditures in the business sector. Even though business R&D expenditures are increasing in this area, its growth rate lags behind the average growth rate of business R&D expenditures. Unlike most other key application sectors, research and development activities in sustainable agriculture and environmental sectors are mainly implemented in domestic small- and medium-sized enterprises.

The research base of business research in this sector is further strengthened by public support. Indeed, this area is characterised by the fact that business R&D is highly dependent on public support from public resources, while the share of private resources in the total cost of R&D projects is the smallest of all the key application sectors. On the other hand, more than 90% of the projects in which businesses participate are implemented in cooperation with research organisations, which shows there are well-established links between business and academia. However, the fact that the number of patent applications is low and keeps declining over time compared to other key application sectors indicates that the potential for transferring new knowledge and R&D results from the public to the private sector is rather limited.

3.1.4 Technological specialisation

In addition to the identification of key application sectors, the proposed smart specialisation is also based on analyses of the Czech Republic's technological specialisation. It serves both as a **means of identifying specialisation domains** and as a means of **identifying research directions** that have a strong position in Czech R&D and require their quality to be preferentially cultivated over the long-term. Within the new concept of the National RIS3 Strategy, these are the **drivers of the development and transformation of the Czech economy** that build on emerging technological trends and societal challenges. Based on economic analyses of market trends, the European Commission updated[32] the list of **key enabling technologies (KETs)** in 2018 to include: (i) Photonics and micro-/nano-electronics, (ii) Advanced materials and nanotechnologies, (iii) Advanced manufacturing technologies, (iv) Life sciences technologies/biotechnologies, (v) Artificial intelligence, and (vi) Digital security and connectivity. The various key enabling technologies are defined by the Commission as

[32] European Commission (2018): "RE-FINDING INDUSTRY", Report from the High-Level Strategy Group on Industrial Technologies. Conference Document, 23 February 2018, https://ec.europa.eu/research/industrial_technologies/pdf/re_finding_industry_022018.pdf.

technologies that are knowledge intensive and associated with high R&D intensity, rapid innovation cycles, high capital expenditure and a highly skilled labour force. The description of the Czech Republic's technological specialisation was made through analysing: (i) public support for R&D and cooperation between ROs and businesses in KETs, (ii) publication activities of ROs, (iii) patent activities of ROs and businesses, and (iv) an analysis of the Czech Republic's participation in EU Framework Programmes.

The results of an analysis by the CAS Technology Centre[33] shows that **public support** is mostly used in three KETs – **Advanced materials and nanotechnologies, Photonics and micro-/nano-electronics and Life sciences technologies/biotechnologies**. The largest amount of public support in projects focusing on KETs is provided to HEIs. The highest share of public support (one-half of the total amount or more) is provided to HEIs in projects focusing on Artificial intelligence, Advanced materials and nanotechnologies and Digital security and connectivity. Businesses received the largest share of public support in projects focusing on Advanced manufacturing technologies and Artificial Intelligence. Approximately 60% of the projects in KETs were implemented in cooperation between businesses and ROs. The largest share of the projects implemented in cooperation between businesses and ROs were projects in Life sciences technologies/biotechnologies and Advanced materials and nanotechnologies. Between 2015–2016 and 2017–2018, public support for projects addressing KETs increased by more than 60%, most notably in Advanced manufacturing technologies and Artificial intelligence.

Table 6. Public support and supported entities in KETs in the 2015–2018 period

Categories of entities		Photonics and micro/nanoelectronics	Advanced materials and nanotechnology	Advanced manufacturing technologies	Biotechnology	Artificial intelligence	Digital security and interconnectivity
Public support	RO - business sector	149,659	519,194	357,785	191,795	60,241	110,532
	RO - government sector	1,248,013	1,967,673	51,209	1,434,134	128,558	26,037
	RO - university sector	2,166,638	4,784,012	463,011	1,857,215	1,020,130	1,231,103
	RO - private non-profit sector	732					445,042
	Companies	**782,833**	**1,295,735**	**284,902**	**400,667**	**332,307**	**315,849**
	Others	667,297	921,848	244,269	629,200	347,051	339,026
	TOTAL	**5,015,172**	**9,488,462**	**1,401,176**	**4,513,011**	**1,888,287**	**2,467,589**
Share of public support in KETs	RO - business sector	3.0%	5.5%	25.5%	4.2%	3.2%	4.5%
	RO - government sector	24.9%	20.7%	3.7%	31.8%	6.8%	1.1%
	RO - university sector	43.2%	50.4%	33.0%	41.2%	54.0%	49.9%
	RO - private non-profit sector	0.0%	0.0%	0.0%	0.0%	0.0%	18.0%
	Companies	**15.6%**	**13.7%**	**20.3%**	**8.9%**	**17.6%**	**12.8%**
	Others	13.3%	9.7%	17.4%	13.9%	18.4%	13.7%
Supported entities	RO - business sector	49	84	61	61	21	27
	RO - government sector	42	49	13	42	10	8
	RO - university sector (university faculties)	82	103	41	72	45	29
	RO - private non-profit sector	1	0	0	0	0	1
	Companies	**166**	**258**	**94**	**127**	**89**	**92**
	Others	83	85	41	85	26	33
	TOTAL	**355**	**482**	**221**	**312**	**169**	**174**

Source: Office of the Government (R&D&I CEP IS)

An analysis of **publication activity** in KETs shows that, when making an international comparison, R&D in the Czech Republic is significantly more focused on the area of **Advanced materials and nanotechnologies**. However, the quality of publications is somewhat lower by international comparison – publications focusing on the area of **Digital security and connectivity** have the relatively highest citation rate. The share of international publications produced in this area is above-average, even when making an international comparison, which, together with the higher citation rate of the publications, indicates that the R&D that is being implemented in this area is of high-quality by international comparison. R&D results in this KET seem to have greater potential for applications compared to other KETs, as the share of publications produced in collaboration with industry is the highest among all KETs. Publications in KETs are predominantly produced by ROs operating in Prague, which is mainly due to the significant number of research-oriented HEIs and institutes of the CAS. This predominance is most evident in Advanced materials and nanotechnologies and Photonics and micro-/nano-electronics. By contrast, ROs from the South Moravian Region excel in fields related to the self-governing region's business and research specialisation (advanced mechanical engineering, IT, biotechnology), while ROs from the Moravian-Silesian Region contribute most significantly to the creation of publications in Artificial intelligence.

[33] CAS Technology Centre (2020): "An analysis of the linkage between KETs and the application sectors of the National RIS3 Strategy 2021+: Analysis of KETs and their links to NRIS3 application sectors", https://www.mpo.cz/assets/cz/podnikani/ris3-strategie/projekty-na-podporu-ris3/operacni-program-technicka-pomoc/2020/7/Analyza-KETs-a-jejich-vazeb-na-aplikacni-odvetvi-NRIS.pdf, April 2020.

Table 7. Czech Republic's publications in KETs in 2015–2018

KET	Number of publications	Change in the period 2015-2018	Share of national output (%)	Change in pp in the period 2015-2018	Industry-standardised citation rate	Representation in the Top 10%	Share of publications in international cooperation	Share of publications in cooperation with industry
Photonics and micro/nanoelectronics	2,701	16.1%	4.7%	0.2%	0.99	10.0%	67.0%	2.3%
Advanced materials and nanotechnology	5,966	9.6%	10.4%	-0.2%	0.91	9.1%	58.5%	2.0%
Advanced manufacturing technologies	311	113.0%	0.5%	0.4%	1.11	13.5%	57.2%	3.5%
Biotechnologies	1,565	-3.6%	2.7%	-0.4%	1.05	10.7%	51.7%	2.4%
Artificial intelligence	836	44.6%	1.5%	0.4%	1.03	11.7%	51.8%	2.4%
Digital security and connectedness	499	90.6%	0.9%	0.4%	1.43	14.2%	59.5%	4.2%

Source: Clarivate Analytics Web of Science

An analysis of **patent activity** shows that – in terms of using knowledge in business innovations – promising areas may include **Advanced materials and nanotechnologies and Photonics and micro-/nano-electronics**, where a higher number of patent applications are filed by entities from the Czech Republic. At the same time, it turns out that businesses are more represented among patent applicants in those technology areas that have stronger links to applications (e.g., Digital security and connectivity, Photonics and micro-/nano-electronics). By contrast, ROs predominate among applicants in technology areas where some R&D results may still be far from market application or where more intensive R&D can be expected (Life sciences technologies/biotechnologies, Advanced materials and nanotechnologies). In comparison with technologically advanced countries, the Czech Republic has a higher proportion of patent applications in Life sciences technologies/biotechnologies, Advanced manufacturing and Advanced materials and nanotechnologies. In contrast, Artificial intelligence and Digital security and connectivity account for a smaller proportion. The analysis also shows that in most KETs, applications co-created by Czech researchers are to a large extent filed by foreign businesses, meaning that there is knowledge leakage abroad (and profits are realised outside the Czech Republic).

Table 8. Patent applications in KETs with at least one applicant from the Czech Republic filed in the three-year period of 2015–2017. The change is calculated as the difference between the 2010–2012 and 2015–2017 three-year periods.

Technology	Share	Research organisation				Others			Change in the share of KET
		Total	Companies Sector	Government	University	Companies	Natural person	Foreign	
Photonics, micro/nanoelectronics	5.4%	24%	0.1%	8.4%	15.2%	57.2%	12.9%	5.7%	6.8%
Advanced materials and nanotechnology	5.3%	58%	4.7%	18.0%	35.4%	32.0%	7.0%	2.9%	-7.9%
Advanced manufacturing	4.9%	43%	3.9%	6.8%	32.3%	47.8%	6.2%	3.0%	-2.4%
Biotechnologies	4.9%	64%	3.5%	31.8%	28.4%	27.6%	4.5%	3.8%	1.2%
Artificial intelligence	1.2%	27%	0.0%	0.9%	26.1%	50.0%	18.6%	4.4%	-7.2%
Digital security and connectedness	2.9%	11%	0.4%	0.8%	7.2%	67.2%	20.1%	1.9%	41.5%
Total all Czech applications		**27%**	**2.2%**	**7.4%**	**17.0%**	**52.9%**	**15.7%**	**4.2%**	

Source: EPO Worldwide Patent Statistical Database – Autumn 2019 (PATSTAT 2019b).

The results of an analysis of **participation in EU Framework Programmes** show that to date, entities from the Czech Republic have received more than EUR 130 million for KET projects under the Horizon 2020 Framework Programme. Approximately one-half of this amount was received by HEIs, and approximately 30% by business entities. Within the H2020 Framework Programme, participants from the Czech Republic from both the public and private sectors are mostly involved in projects focusing on the KETs of **Digital security and connectivity, Photonics and micro-/nano-electronics and Advanced materials and nanotechnologies**. From the perspective of the use of R&D findings, it is positive that – in all KETs – businesses account for about one-half of the participants from the Czech Republic. In terms of the development of businesses' innovation activities, it is also positive that some businesses are involved in multiple projects within the same KET, which indicates that these businesses are more "specialised" and have potential for implementing more demanding innovations that make use of knowledge generated at the international level.

3.1.5 Research topics of large research infrastructures within the context of the National RIS3 Strategy

The Ministry of Education, Youth and Sports (MEYS) conducted a questionnaire survey of large research infrastructures (LRIs), which provided suggestions for both existing and potential research topics for the application sectors and specialisation domains of RIS3, in connection with key and cross-cutting technologies (KETs). In addition, research organisations' responses to societal challenges according to the typology of the UN Sustainable Development Goals (SDGs) 2015–2030 were also obtained.[34] The MEYS approached all 48 LRIs that are listed in the document entitled A roadmap of large research infrastructures in the Czech Republic for 2016 to 2022 (last updated and acknowledged by the Government of the Czech Republic in 2019). 46 entities responded to the questionnaire, representing a return rate of approximately 96%.[35]

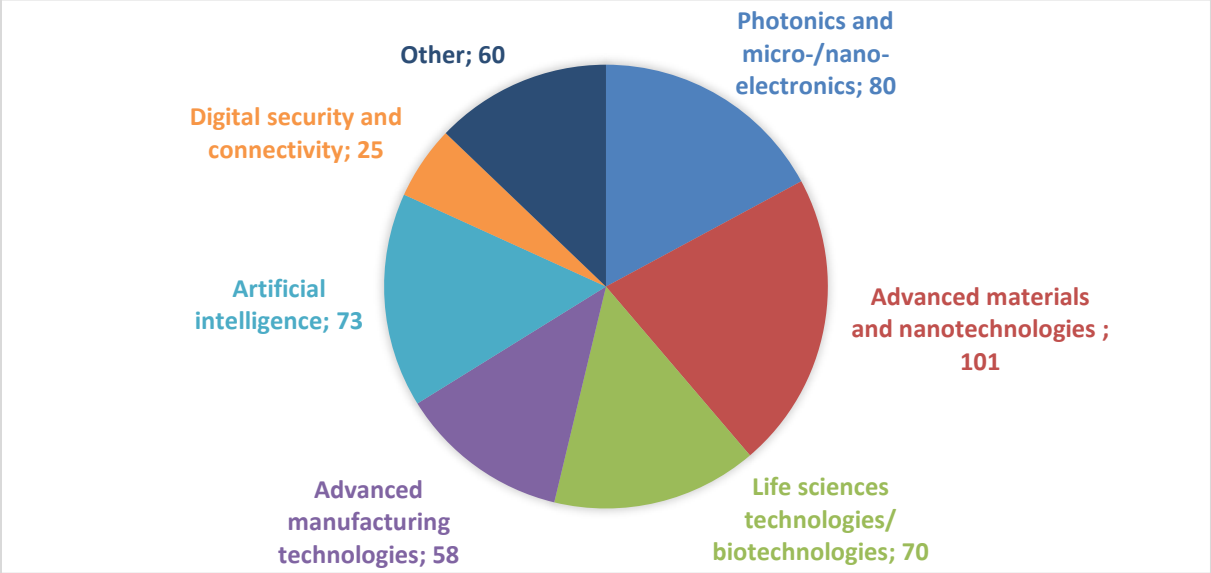
When responding to the question "In which research/technology directions and fields can you (or do you want to) offer expertise that can be used by the business/application sector?", respondents were provided with a table containing prescribed key technologies (KETs) and application sectors, including specialisation domains which are addressed by the National RIS3 Strategy 2021–2027. Respondents were asked to fill in research topics in those cells where they see a match between the fields on which the given LRI focuses and the KET indicated, and they were also supposed to distinguish between existing and potential research topics. However, the respondents could also mention other topics both outside of the field declared and outside of the KET category.

A total of 467 research topic suggestions were identified in all predefined specialisation domains that had been expanded to include additional (not explicitly stated) important application areas.

Evaluation by key technologies

Suggestions were registered for all six key enabling technologies as well as for other technologies which were considered important by respondents, yet which were outside the KET categorisation. The highest concentration of research topic suggestions was found in the key enabling technology of **Advanced materials and nanotechnologies** (101), followed by **Photonics and micro-/nano-electronics** (80). **Life sciences technologies/biotechnologies** and **Artificial intelligence** each had about 70 suggestions. For **Advanced manufacturing technologies**, 58 research topic suggestions were provided. The fewest suggestions were submitted by respondents in the **Digital security and connectivity** technology. In the "**Other**" category, 60 suggestions were collected, but these were scattered among several technologies that were identified by respondents as important, yet outside the KET categorisation. While several topics have emerged from other technologies not listed among the standard KETs, they cannot be clearly classified as technologies in the true sense of the word.

Chart 5. Numbers of research topic suggestions, by key enabling technology



[34] https://www.un.org/sustainabledevelopment/sustainable-development-goals/

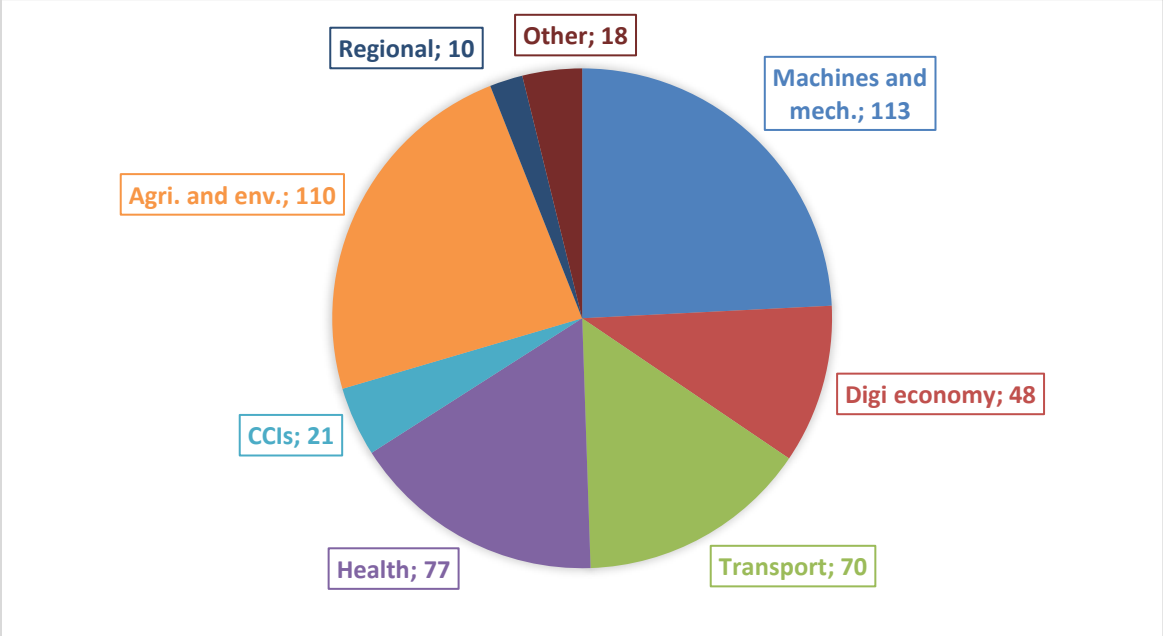
[35] The survey report is available at: https://www.mpo.cz/assets/cz/podnikani/ris3-strategie/projekty-na-podporu-ris3/operacni-program-technicka-pomoc/2020/12/Vyhodnoceni-dotazniku-pro-velke-vyzkumne-infrastruktury-.pdf

Source: Evaluation of questionnaires for large research infrastructures, Summary report, MIT/MEYS, October 2020.

Evaluation by application sector

The highest concentration of research topics (113) was found in the application sector of **Advanced machinery/technologies for globally competitive industry**. The second most numerous application area was **Agriculture and the environment** (110). The application sectors of **Transport for the 21st century** and **Healthcare, advanced medicine** had 70 and 77 research topic suggestions, respectively. The **Digital market technologies and electrical engineering** application sector received 48 research topic suggestions. The fewest research topic suggestions were submitted by LRIs in the **Cultural and creative industries** (21).

Chart 6. Numbers of research topic suggestions, by application sector



Source: Evaluation of questionnaires for large research infrastructures, Summary report, MIT/MEYS, October 2020.

For the question *"Please indicate whether your LRI can contribute to addressing some of the societal challenges of today"*, the questionnaire offered 8 specific (predefined) societal challenges of today and one free, unspecified challenge. The typology of the UN Sustainable Development Goals (SDGs) 2015–2030 was used.

The **Good health and well-being** societal challenge had the highest number of responses (32). It was followed by the societal challenges of **Affordable and clean energy** (25), **Responsible consumption and production** (20) and **Sustainable cities and communities** (20). The societal challenges of **Climate action** and **Clean water and sanitation** had 17 responses each. The societal challenges of **Zero hunger** and **Life on land** received 13 and 11 responses respectively. Of the **Other** societal challenges not listed above, the most numerous were no. 4 **Quality education** (10 cases), followed by no. 9 **Industry, innovation and infrastructure** with 6 cases. In total, the respondents thus listed **183 specific sets of research topics** which covered 16 of the 17 UN Sustainable Development Goals responding to global societal challenges.

The responses from this part of the questionnaire showed that large research infrastructures, which form the core pillar of the Czech Republic's national research and innovation system, have both considerable interest in and great potential for implementing research topics that bring results for application in practice. The research topics suggested can bring progress in areas where new technologies have not yet been used. This will help to focus the specialisation domains in the new RIS3 strategy on the national and regional levels. Proposals for addressing societal challenges will also be used to specify missions that aim to respond to new societal challenges and contribute to problem solving.

3.2 Challenges within RIS3 key areas

The second subchapter of the analytical part of the National RIS3 Strategy presents a **summary of analyses that are related to the horizontal cross-cutting priorities** of the National RIS3 Strategy. The key areas of change are as follows:

- Research, development and innovation for business
- Public research and development
- People and smart skills
- The digital agenda

The strategic objectives of the National RIS3 Strategy are broken down into the same key areas. This breakdown is partly based on the previous version of the National RIS3 Strategy for 2014–2020 and also on the European Commission's priorities for the new 2021+ programming period.

For each of the four key areas of change, the analytical part contains a summary of the main challenges and a SWOT analysis. The items in each SWOT analysis were prioritised according to the opinions of the expert working group involved in the preparation of the National RIS3 Strategy. According to this prioritisation, the individual items of the SWOT analyses are listed in order of importance, from the most important aspect to the least important. Given its scope, a detailed description of the various key areas of change is presented in the study entitled *"A complex analysis of the barriers to applied and oriented research, experimental development and innovation in the Czech Republic and a proposal for the implementation of suggested measures in the 2021-2027 programming period for the National RIS3 Strategy 2021+".*

3.2.1 Research, development and innovation for business

The characteristics of the economy in terms of value added, innovation performance and economic specialisation are presented in the previous chapter. This section summarises the main challenges concerning Czech businesses' innovation performance, which is low when making an international comparison. These challenges were identified on the basis of analyses, literature reviews and discussions with stakeholders (key players) and they also represent the main barriers to innovation diffusion:

1. **Low value added and a focus on lower-order innovations**

Despite the ongoing changes in and development of the Czech economy, the Czech Republic's economic model is still based on the use of cheap and, at the same time, skilled labour. Compared to advanced economies that are oriented towards knowledge-intensive and high value-added activities, companies in the Czech Republic achieve lower value added and lower productivity. On the one hand, the localisation of the production capacities of foreign investors and their related subcontractors has led to an increase in employment and overall economic performance, but on the other hand, these companies and their suppliers operate on lower tiers of global value (supply) chains, which has a number of consequences – including lower value added, a focus on lower-order innovation activities and lower productivity. Czech companies often do not create final products. In addition, the mapping of innovation capacities carried out by the Technology Agency of the Czech Republic has also confirmed that many companies that are among the top Czech innovation performers focus on implementing lower-order innovations, often through adopting outside innovations of a technical nature and adapting them for special markets or optimising them and using them more efficiently at lower costs.[36]

2. **An inadequate endogenous business sector**

The Czech Republic does not have a wide base of technologically advanced companies on higher-value-added tiers in global value chains.[37] The most important actors in business R&D in the Czech Republic are foreign companies, and the share of foreign-controlled businesses in R&D expenditures is growing. The Czech Republic is also specific in that research capacities are concentrated in a relatively small number of large companies, which are often foreign controlled. The lack of strength of the endogenous business sector is also illustrated by the difference in value-added between domestic businesses and foreign-controlled businesses. This situation poses a risk that business R&D will be dominated by foreign-controlled businesses while – in turn – endogenous companies, their knowledge intensity and value added will not develop as desired. The main threat is the fact that decisions concerning foreign-controlled companies' activities, orientation and business model are made by their parent companies abroad, and these may also decide to withdraw their activities from the Czech Republic.

[36] Technology Agency of the Czech Republic (2019); Analysis of macroeconomic and microeconomic data (INKA 2 – Innovation capacity mapping), page 173–174

[37] Technology Agency of the Czech Republic; Analysis of macroeconomic and microeconomic data (INKA 2 – Innovation capacity mapping), page 177-178

At the same time, however, the presence of foreign concerns, the trends of their research and development activities and their investments in activities with higher value added are an opportunity for the Czech Republic.

The factors that pose an obstacle to strengthening the endogenous business sector include insufficient market competence (e.g., a lower ability to identify new business opportunities), underdeveloped business skills and the "entrepreneurial spirit". Due to their position within multinational concerns and global supply chains (where their primary focus is on manufacturing), Czech companies have less awareness of the needs of end customers, which is a barrier having to a greater focus on higher-order innovations.[38] Another problem (and an impediment to the development of the endogenous business sector) is the not fully developed system of venture capital and start-up financing and the not always clear and generally complex rules for establishing spin-off companies.

3. An unsatisfactory business environment

A significant barrier to innovation and entrepreneurship in general is the lack of efficiency and effectiveness of public administration and also the high administrative and regulatory burdens. According to a flash Eurobarometer survey in 2018, 69% of Czech companies perceive administrative and regulatory burdens (other than costs) as a significant obstacle to investment.[39] Another related problem is the lack of a stable, predictable and motivating business environment. In the World Bank's assessment of conditions for Doing Business, the Czech Republic ranked 35th in 2019, i.e., below the OECD average.[40] There is also room for improvement in reducing the fragmentation of support for SMEs.[41] The analyses also show differences in the research and innovation performance of the self-governing regions.[42]

Another barrier to the diffusion of innovations is the lack of infrastructure that would make it possible to test research and development results for further use in final production. The openness of the existing infrastructures, their offerings and awareness in general are still insufficient. Furthermore, there is a lack of comprehensive specialised services for innovative businesses, both in terms of the above availability of testing infrastructure and in terms of expert services, e.g., in the area of digitalisation, consulting for start-ups, etc.

4. The need to respond to technological and societal trends

Czech businesses and the economy as a whole need to respond to global trends in many different aspects. The model of economic competitiveness that is based on cost differential (primarily low wages) has been exhausted. Moreover, the Czech Republic and Europe are increasingly threatened by the technologically and industrially expanding countries of Southeast Asia.[43] The further growth and development of the Czech economy is to some extent hampered by a lack of labour and production capacities. Investing in technology (especially automation and robotisation) is thus one way to compensate for the lack of labour capacity, but at the same time it is also a way to achieve the much-needed increase in productivity.

Although Czech businesses invest more in automation than the EU average, they are still lagging behind the world industry leaders (such as South Korea, Germany and Japan).[44] It is thus necessary to capture relevant technologies and technological trends (in addition to robotisation, automation and digitalisation, these include e.g., artificial intelligence, blockchain, biotechnologies, nanotechnologies and others) that have applications both in industry and in addressing current societal challenges (such as climate change, population ageing, pandemics, etc.).[45] Capturing and utilising technological trends is not only a necessity for the Czech Republic, but also a great opportunity for further development of the economy and society as such.

[38] Technology Agency of the Czech Republic; Analysis of macroeconomic and microeconomic data (INKA 2 – Innovation capacity mapping), page 167-171

[39] European Commission; Report on the Czech Republic 2019, page 39

[40] World Bank (2019): Doing business, https://www.doingbusiness.org/en/reports/global-reports/doing-business-2019

[41] World Bank; Czech Republic: Assessment of the SME Policy Mix, page 52–55

[42] European Commission, Regional Innovation Scoreboard 2019

[43] European Commission (2018); Re-finding Industry, Defining Innovation.

[44] Information Technology and Innovation Foundation; Which Nations Really Lead in Industrial Robot Adoption?, page 1–5

[45] The need to focus on new technologies, trends and breakthrough innovations is also stressed by the European Commission's 100 Radical Innovation Breakthroughs for the future, which summarises key technological trends and challenges. See https://ec.europa.eu/info/files/100-radical-innovation-breakthroughs-future_en

Table 9. SWOT analysis: Research, development and innovation for business

Strengths	Weaknesses	Opportunities	Threats
• Industrial and technical tradition combined with technical creativity supporting technical incremental innovations • Openness of the economy and strong exports • Investment in automation (5% above the EU average) • Economic/GDP growth based on investment activity • Convenient geographical location in the centre of Europe • A sound and stable banking system • Good condition of public finances	• Lower innovation performance of domestic businesses, investment in R&D&I mostly implemented by foreign companies • Inadequate efficiency and effectiveness of public administration, administrative burden • Low added value of Czech companies and their position in global supply chains, trade deficit in high-tech goods not decreasing, lack of a plan to move within global supply chains • Small proportion of higher-order technical innovations (i.e., a focus on lower-order innovations) and lower control of international markets • Concentration of business R&D in a small number of large companies, absence of a broader base of technologically advanced businesses • Incomplete transport infrastructure • Lack of a stable, predictable and motivating business environment • Difference in labour productivity and value added per worker compared to developed economies, lower productivity of domestic companies • Overall share of R&D financing by the business sector is lower than in well-established market economies • Insufficient market competence and underdeveloped business skills • A lack of modern infrastructure for testing pilot plants and R&D results in terms of their applicability to production, limited access of companies to this infrastructure and reduced availability of services for SMEs in the area of digitalisation and new technologies • Undeveloped venture capital system and start-up financing, low number of globally successful start-ups • Compared to other countries, relatively low levels of robotisation and automation, insufficient implementation of high technologies in SMEs, which reflects low labour costs – robotisation and automation do not pay off • A lack of labour and production capacities • Low internationalisation / international cooperation of SMEs • A low share of HEI and government R&D financing by businesses compared to many developed countries • Uneven economic growth in the different self-governing regions, including different intensity of R&D expenditures and different levels of development of innovation ecosystems • Fragmentation of SME support • High dependence on exports and foreign investments	• Growth in the number of globally successful domestic companies • Investing in technologies to compensate for labour shortages and to increase productivity • Using new technologies and technological trends (e.g., artificial intelligence, machine learning, blockchain, augmented and virtual reality, Internet of Things, robotisation and autonomous machines, etc.), introducing Industry 4.0 principles • Expanding the research and development activities of multinational and domestic companies • Responding to megatrends, using an interdisciplinary/multidisciplinary approach, using creative industries and using technologies to address societal challenges, using bioeconomy • Supporting SMEs in their development and increasing value added, developing support for start-ups and SME growth services • A shift from a quantitative to a qualitative phase of foreign direct investments (focus on R&D and higher value added) • Improving the position of Czech subsidiaries within multinational concerns • Greater use of the R&D tax relief system • New trends and related opportunities in the automotive industry (CO2 reduction, autonomous driving, electromobility, etc.) • Re-industrialisation – the return of production activities to traditional regions, incl. Europe • Support for multilateral cooperation between companies • Reducing “dependency” on subsidies and switching to financial instruments	• Increasing competition from East Asian countries in industries that are based not only on cheap labour, but also on knowledge and technology intensive activities • Dependence of the economy in the sense of limited entrepreneurial autonomy (many companies do not decide what to produce, for whom and for what price) • Increasing the dominance of foreign companies in R&D, increasing “leakage” abroad of knowledge/intellectual property created by workers from the Czech Republic and increasing percentage of value added that is realised outside the Czech Republic • End of the model of economic competitiveness based on cost differential compared to advanced economies (rising labour costs) and the associated risk of production relocating abroad • Stagnation or another economic crisis • A greater share of co-financing of projects financed by EU Funds, failure to adapt to the declining trend in the volume of EU Funds that will support R&D in future programming periods • Global political uncertainty, a risk of trade wars and instability of economic systems • Threats to industry, energy and agriculture from climate change • Increasing economic and social disparities between regions

3.2.2 Public research and development

The existence of a functioning public R&D system that produces high quality results is one of the main conditions for the functioning of an innovation ecosystem, which is needed to develop a knowledge-based economy, value added and the ability to respond to current technological and societal trends. At the same time, public research and development cannot work for its own sake alone, but rather it must benefit society. In addition to disseminating knowledge and information about research results, one of the necessary benefits of public research and development is the transfer of specific knowledge (know-how, technologies) into practice, including commercial exploitation. Therefore, there must be effective cooperation between research, academia and the application sector. The application sector does not only mean the commercial and business sector, but also the public sector as an important user of research and development results. On the basis of analyses, literature reviews and discussions with key actors, the following four main challenges were identified that also represent barriers to innovation diffusion:

1. **Insufficient quality of public research**

A number of positive changes can be observed in the field of public research and development, a number of excellent research teams and organisational units are developing in the Czech Republic and quality research facilities and infrastructures were built and modernised in previous programming periods. The overall performance and quality of public research is still lower compared to European countries of a similar size, such as Austria, the Netherlands, Denmark, Belgium and the EU-15 average.[46] In contrast, the quality of research is adequate compared to the EU-13 countries. The quality and performance of research, as measured by bibliometric indicators, corresponds to the absolute amount of public resources earmarked for its financing.

2. **Insufficient cooperation between the research and application sectors**

Among other things, the Commission's Country Report[47] recommends increasing the intensity of links between academia and the application or business sector to support improved knowledge and technology transfer. Based recent trends, the Czech Republic's position can be expected to improve and converge with the EU average in the coming years.[48] In terms of the degree of cooperation between the research and business sectors, which can be measured by the amount of resources used by the private sector to (co-)finance research in public research institutions and higher education institutions, relative to companies' total expenditures on research, the Czech Republic is practically on par with Germany (about 6%). This figure describing the extent of cooperation between the research and business sectors shows that there is an existing network of relationships and partnerships between R&D workers in businesses and the public sector that can be further developed.

3. **A low degree of internationalisation**

Although there has been gradual improvement, Czech public research is still weakly involved in EU programmes and – compared to developed countries – it is also less involved in international research cooperation. The number of foreign researchers in the Czech Republic is also low. The internationalisation of Czech science and international cooperation, as interpreted through bibliometric indicators, points to the fact that the best quality publications, i.e. those in the top decile or the top quartile, involve a high degree of international cooperation. It also needs to be noted that for Czech teams to join international project consortia, they must have a good professional level allowing them to succeed, which is not possible without solid backing in terms of financing from domestic sources.

4. **Inappropriate management system of the R&D system and research organisations**

Within the current R&D&I management system, responsibility for research and innovation is divided among various government bodies. The management is not yet sufficiently based on strategic intelligence, i.e. strategic information on a situation and dynamics of the development of the Czech Republic's R&D&I system and its individual components, on new trends and needs to which research should respond in terms of societal relevance, as well as on the impacts of the policies and measures implemented. The transition to the M2017+ research and development evaluation methodology is a major opportunity to promote excellence in research, quality over quantity and to counter formalism in reporting results. The same applies in the field of applied research, where there should be a shift away from formalism to better motivation for knowledge and technology transfer, the use of results in practice and cooperation between the research and application sectors. The inadequate quality of the management of research organisations themselves is also often perceived as a weakness of the entire public R&D area. Management at the level of individual research organisations is limited

[46] European Commission; European Innovation Scoreboard 2020, https://ec.europa.eu/docsroom/documents/41941
[47] European Commission, Country Report 2020.
[48] The Research, Development and Innovation Council; Analysis of the existing state of research, development and innovation in the Czech Republic and a comparison with the situation abroad in 2017, pages 20–23

by excessive targeted financing, where the randomness in obtaining grants and projects makes conceptual leadership and direction of both teams and entire institutions virtually impossible. Another problem is outdated legislation and a high amount of administrative burden across the entire R&D system.

Table 10. SWOT analysis: Public research and development

Strengths	Weaknesses	Opportunities	Threats
• Existence of high-quality research facilities and infrastructure built or modernised in recent years (in both the public and business sectors) • Existence of excellent research teams and organisational units • Dynamic development of the research sector – relatively fast growth of R&D expenditures and the number of researchers in the public sector • Well-functioning support for excellence in research through a peer review system, as demonstrated e.g. by the practice of evaluating CAS organisational units • In many cases, solid and well-established cooperation between research and business that is based on gradually built trust and a history of joint projects	• Outdated legislation, high administrative burden and a formalist approach • Room for improvement in the intensity of links between academia and the application or business sector in order to improve knowledge and technology transfer compared to many developed countries • Insufficient use of R&D results in practice, low income from the commercialisation of results and knowledge transfer, a low level of patent activity compared to many developed countries • Weak involvement in EU programmes, weak internationalisation • The complexity and fragmentation of the R&D&I management and funding system • Inadequate quality of research organisation management • Project and grant financing makes it impossible to focus more on breakthrough/disruptive topics, and forces researchers to focus on implementing research projects "on the safe side" • Considerable thematic fragmentation of Czech research due to excessive targeted financing and the resulting large number of small projects • Prevailing inadequate performance and quality of research in comparison to developed countries • A lack of experts in R&D&I and specifically in the key enabling technologies (ICT, etc.) • Unclear/complex rules for creating spin-offs • Uneven research performance between regions, underdeveloped regional innovation systems and insufficiently robust "soft infrastructure" activities to support their development compared to developed countries	• Using high-quality and well-equipped research infrastructure for economic transformation, establishing international cooperation, improving the quality and effectiveness of public research and linking research with the demand of companies and society for innovation • Developing research on megatrends, developing research on KETs, new technologies and tech trends (e.g. AI, machine learning, blockchain, augmented and virtual reality, Internet of Things, robotisation and autonomous machines, etc.) • Developing the demand for innovative solutions by public administration, and using R&D results in public administration and in the public space (including strategic planning, regional development and social innovation), developing the third role of universities • The establishment and development of technological and innovative gravity centres/hubs around research centres of (inter)national importance – the emergence/arrival of technology companies and related services • Developing the marketing/PR of R&D results and activities of research organisations • Using EU programmes' financial resources and tools • Using the Methodology for evaluating research organisations and evaluating programmes of targeted support for research and development and innovation 17+ in order to adequately evaluate basic and applied research and use R&D results in practice • Developing tools to support intellectual property protection • Using the open access/open science principle • Linking social sciences, humanities and arts with technical disciplines, promoting interdisciplinarity	• Inappropriate setting of new R&D support instruments (EU Funds and national programmes) • Insufficient coordination and cooperation in all R&D actors • The closed nature of the Czech research environment in terms of the marginalisation of international cooperation and a general shortage of researchers • The complexity of maintaining and further developing the newly built research infrastructure • Reduced contribution (relevance) of research in addressing the needs of society and the economy • A greater share of co-financing of projects by EU Funds, failure to adapt to the declining trend in the volume of EU Funds that will support R&D in future prog. periods

3.2.3 People and smart skills

The availability of an adequately skilled workforce is a prerequisite for strengthening the innovation performance of companies and improving the quality of research. Given the dynamic changes in the economy and society in terms of the digital and green transition, significant changes are also expected in the working environment, both in the labour market and in business activities. New job opportunities will arise in occupations that did not exist before, and conversely, other jobs will change or disappear. Demographic trends will require people to be able to educate themselves throughout their lives, use all their skills to adapt to these changes and to acquire skill sets that enable them to actively engage in research, development, innovation activities and entrepreneurship. An analysis of the barriers to the development of research and innovation identified the following challenges in this area:

1. **Poor results of the Czech education system**

As the international assessment shows,[49] the performance of the education system is on a downward (or at best stagnant) trend. The situation is particularly unsatisfactory in digital literacy and language skills. The number of students studying technical disciplines (STEM)[50] at HEIs is declining, which is reflected in the lack of graduates with these skills in general. The problem of Czech primary and secondary education is mainly its underfunding, which affects the quality of the educational process. In schools, traditional educational methods still prevail (e.g. frontal teaching, emphasis on memorisation of knowledge) and, on the contrary, modern methods of work (e.g. interactive group work and participatory learning) are rarely applied. Pupils and students are less motivated to be creative, entrepreneurial or to apply their knowledge in practice. While many teachers are interested in applying innovative methods in teaching, these efforts are not yet widespread. The education system places little focus on systematic work with gifted pupils, thus depriving itself of talent. Another problem is the inadequate support and motivation for girls to study STEM disciplines, which deprives the Czech Republic of their potential. The vocational education and training system in the Czech Republic has not yet been fully modernised and transformed so as to equip individuals with the skills needed for an industrial transition.

Similarly, Czech HEIs do not achieve the desired level of quality and prestige when making an international comparison.[51] The results are inferior especially in terms of the citation rates of researchers and the share of foreign employees; by contrast, the share of foreign students is higher. HEIs are less involved in international alliances and cooperation with the business sector than in most developed countries. Only a minority of higher education institutions embark on the relatively complex path of linking academia with the world of business, listen to the demands of the labour market and guide students to launch successful careers.

2. **A lack of skilled labour matching the needs of the economy and society**

The skills for successful work are already changing dynamically, both in terms of employment and in terms of doing business. The current education system does not fulfil this role sufficiently, because initial education is poorly linked to practice. In addition, demands for education are also increasing throughout a person's career and life, because both the labour market and businesses are facing changes related to new technologies. While the current selection of various forms of education is quite broad, their nature, quality and availability do not always meet the needs of those interested. The need for highly skilled workers will increase, while the demand for low- and medium-skilled workers will decrease. This will place greater demands on the up-skilling of the current workforce and re-skilling, especially in digital skills. Since the current adult education system is not yet well adapted to that, it will require changes, especially in terms of vocational education standardisation, increased permeability of the different qualification levels, recognition of qualifications, and modifications to make it possible to balance study and work. In addition, tools to facilitate a return to work, development of early childhood care and a more flexible working environment also still have room for improvement. The rather low entrepreneurial aspirations of individuals, a weak entrepreneurial and enterprising mindset and inadequate support for the development of an entrepreneurial spirit also pose a barrier.

3. **A lack of skilled people in research and development**

Even though the number of researchers has been increasing in the Czech Republic in recent years, the motivation of young people to engage in research is not very high, as is evidenced by the low completion rate of doctoral studies. Attracting foreign talented students and highly skilled staff to newly built cutting-edge research centres can be an opportunity. However, the conditions for their life in the Czech Republic will need to be improved because the salary level, the lack of a welcome office, kindergartens, etc. appear to be a significant barrier to the development of people in research and development. One negative characteristic of the Czech research environment is the low representation of women in research, which is the lowest among all EU countries. The problematic situation in this area is illustrated, among other things, by the Czech Republic's position in the Gender Equality Index (2019)[52] in the knowledge field, where the Czech Republic received a below-average score. Also, the low representation of women in research has a negative effect on the level of excellence and the innovation potential of the Czech Republic.[53] A separate challenge is the management of HEIs and research organisations, especially people management. This is reflected in inappropriately set career rules and the inability to attract and retain young researchers, foreign researchers or Czech researchers returning from abroad.

[49] http://www.oecd.org/pisa/data/

[50] STEM – Science, Technology, Engineering and Mathematics.

[51] See e.g. https://www.topuniversities.com/university-rankings/world-university-rankings/2020

[52] https://eige.europa.eu/gender-equality-index/2019/domain/knowledge/CZ

[53] See Office of the Government (2020), Strategy for Equality of Women and Men 2021–2030, which reports a positive relationship between the Summary Innovation Index, the Excellence Indicator and the Gender Equality Index.

Table 11. SWOT analysis: People and smart skills

Strengths	Weaknesses	Opportunities	Threats
● Increasing proportion of researchers in the private sector ● The number of researchers shows a long-term upward trend ● A high proportion of doctoral students studying technical or natural sciences ● A very low percentage of young people not in education, employment or training (NEETs)	● Unsystematic work of schools with gifted pupils and students ● Poor (at an average level) results of the education system at all levels of schools when making an international comparison, e.g. in the areas of digital literacy, language skills, soft skills and PISA, PIAAC results ● Poor links between the education system and practice ● The education system does not sufficiently develop competencies directly relevant to the labour market of the 21st century ● The way HEIs are managed does not support their progressive development ● A lack of motivation of young people to engage in research ● Underfunding of the Czech education system and, in turn, low attractiveness of teaching careers ● A general lack of skilled labour (good-quality and creative workers) for entrepreneurship, R&D and innovation activities, especially in the ICT sector ● Inadequate conditions for both foreign and Czech researchers (salary level, no welcome office, kindergartens, etc.) ● Low completion rates and low efficiency and in some cases quality of doctoral studies ● The entrepreneurial mindset/entrepreneurial spirit is not widespread ● Inadequate HR management at HEIs and ROs, low mobility of researchers, academic inbreeding ● Low prestige of Czech HEIs on an international level ● Flexible forms of education are not widely available or relevant to potential learners ● Significant differences in education outcomes between regions and schools ● Low representation of women in research, especially in senior positions Barriers to returning after parental leave and inadequate attention paid to this problem by research institutions and government ● A low proportion of university educated population compared to developed countries	● Greater interest of talented foreign researchers and gifted students in employment and study in the Czech Republic (brain gain) ● Utilisation of newly built cutting-edge research centres to attract talents from both the Czech Republic and abroad to work in the fields in which these centres operate ● Improving the approach in vocational education and training and the higher education system that is based on practice and that promotes links between schools and businesses ● Supporting the growth of SMEs through specific training and re-training in areas of smart specialisation and innovation management, and building administrative capacity (with a particular focus on digital skills and an industrial transition) ● Freeing up human resource capacity for more-creative work activities with higher value-added of human labour due to greater automation and robotisation ● Increasing the participation rate of the 55+ age group in economic and social life ● Harnessing the potential of changing preferences of the emerging generation Y/millennials, focusing on value-added intellectual work and innovation ● Developing an active employment policy to facilitate a return to work, developing early childcare, promoting more flexible working environments (adopting reforms aimed at increasing labour market flexibility) ● Utilising the motivation to earn the HR Excellence in Research Award to improve human resource management in ROs	● Brain drain coupled with the inability to attract foreign talent ● Implementation of ill-conceived reforms and changes to key systems – education and higher education, pension system ● Destabilisation of the labour market and the need for new competences due to technological changes. The related threat of a lack of a skilled workforce to meet the needs of (not only) the industry of the future ● Uncontrolled increase in social spending (e.g. on the pension system) at the expense of R&D investments ● The continuing decline in the number of students and HEI graduates due to demographic changes

3.2.4 The digital agenda

The development and use of digital technologies is both an opportunity and a necessary condition for a more efficient functioning of individual institutions and companies, as well as the economy and society as a whole. These mainly include technologies such as artificial intelligence, blockchain, cloud computing, big data, robotics, the Internet of Things, quantum computing, modelling and simulations, etc. which have significant disruptive potential. The situation in the Czech Republic in this area is not without problems: businesses are not yet making adequate use of the opportunities offered by new technologies and their potential; and in the area of eGovernment, the Czech Republic is lagging far behind – in 2019, the Commission ranked the Czech Republic 20th[54] in the quality of digital public services. Failure to remove the barriers identified and respond to current trends would pose a risk that businesses will not be able to maintain their competitiveness, will not improve their innovation performance and may face, for example, changes in production chains (which may affect not only companies, but also entire regions). The declining competitiveness of Czech SMEs could have fatal consequences for the entire economy. On the part of public administration, there is a risk that opportunities to reduce bureaucracy and demands on citizens and companies, as well as to reduce financial demands, will not be seized and in turn procedural efficiency will not improve. Therefore, it is necessary to achieve a higher level of digital transition in businesses, and also to eliminate reluctance by the public sector to innovate, and to support cooperation with the private sector in the development of digitalisation. Other prerequisites include strengthening cybersecurity, achieving sufficient high-speed Internet coverage and developing 5G networks. On the basis of analyses, literature reviews and discussions with key actors, the following three main challenges were identified that represent a risk to the further development of both the business and public sector:

1. **Insufficient digitalisation of public administration**

Despite the relatively good condition of basic eGovernment infrastructure (data mailboxes, basic registers), the Czech Republic is lagging far behind in other parameters. This is due to the generally low degree of digitalisation of public administration and the low use of these services within individual authorities/offices.[55] In addition, the proportion of public administration tasks that are carried out purely electronically is also very low, which is linked to a high volume of duplicated work. The poor situation in terms of the availability of eGovernment services also leads to their low use by citizens. The Act on the Right to Digital Services No. 12/2020 Sb. represents a major shift – it specifies which digital services citizens are entitled to in relation to government bodies. Equally important is the amendment to Act No. 21/1992 Sb., on banks, which makes it possible to use a bank identity for gaining access to public administration services. One of the possible reasons underlying the insufficient digitalisation of public administration is the inadequate ability to attract experts in the field of digitalisation, i.e. experts in IT services, which is also related to their unsatisfactory remuneration within public administration, which is significantly lower compared to the private sector. The need to secure an adequate number of experts is already being addressed by the Digital Czechia programme in the Information Concept of the Czech Republic.[56]

2. **Insufficient communication infrastructure**

The condition of the basic infrastructure is key to the digital agenda. In the Czech Republic, 100 % of the territory is covered by 4G networks, which ranks us third in the EU.[53] Progress has also been made in the use of mobile broadband, which at 96% is close to the EU average. However, data prices are still among the highest in Europe. In the Czech Republic, 5G readiness is 17%, ranking us 15th in the EU. In Czech households, fixed high-speed internet coverage with NGA networks (i.e. download speeds of 100 Mbit/s) is 92%, and coverage with VHCN networks (i.e. download speeds of up to 1Gbit/s) is 29%.

3. **Underutilisation of the potential of digitalisation by companies and low investments in new technologies**

In the Czech Republic, both the number of ICT companies[57] and their share in the entire business sector is growing, and there are also examples of globally successful companies. Nevertheless, companies, especially traditional manufacturing companies, are unable to exploit the potential of new technologies and their approach towards the development of digitalisation is too limited. Czech companies (with the exception of start-ups) focus mainly on "low-level" digitalisation (such as modernising user interfaces, transferring paper documentation to

[54] European Commission; Digital Economy and Society Index (DESI), Country profile – Czech Republic, 2019
[55] In the use of eGovernment services, the Czech Republic ranks 22nd. European Commission; DESI, 2019
[56] For the Information Concept of the Czech Republic, see https://www.digitalnicesko.cz/informacni-koncepce-cr/
[57] In a comparison of EU countries with similar populations, the Czech Republic ranks second. CZSO, ICT sector in the EU 2008–2016.

digital, etc.) and fail to put adequate focus on “higher-level digitalisation”, i.e. more complex digitalisation that runs deeper into the operations and overall structure of a given business. But it is only at this level that businesses and their customers benefit from noticeably higher value added, which is why this level will be of key importance to the entire economy. In addition, the level of digitalisation of business transactions and the effective use of intranets and extranets by companies is also low. In the Czech Republic, there is also a noticeable lack of systematic support in the digital field for SMEs.

Table 12. SWOT analysis: Digital agenda

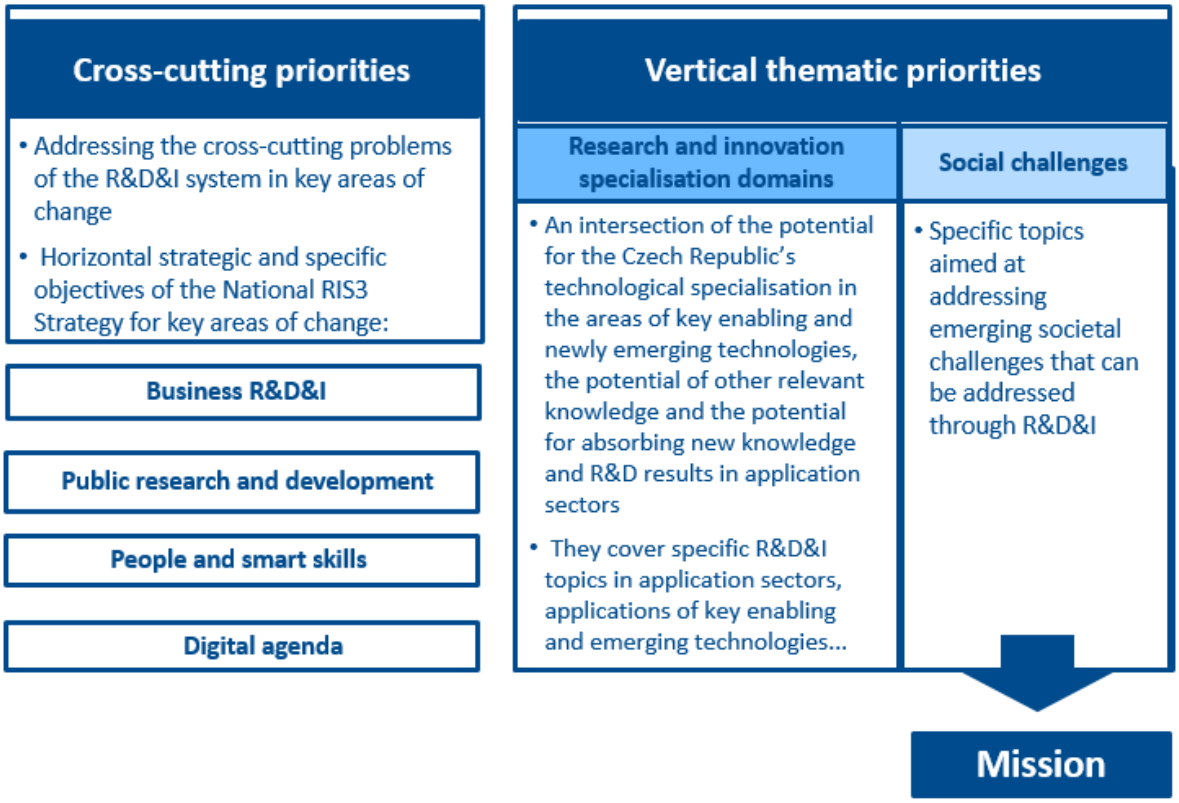
Strengths	Weaknesses	Opportunities	Threats
●The existence of successful companies active in fast-growing digital industries (cyber security, the gaming industry) ●Steadily increasing the number of ICT businesses and their share in the business sector, incl. a strong position by international comparison ●Relatively high coverage of the Czech Republic with a 4G signal ●High usage of eGovernment services by companies ●Communication infrastructure of public administration information systems, functionality of basic registers and data mailboxes	●A low degree of digitalisation of public administration and a low use of these services within individual authorities/offices ●The inability of companies to fully exploit the potential of digitalisation, low investment in artificial intelligence, machine learning, big data and blockchain ●A lack of systematic support in the digital field for SMEs ●High prices for mobile services incl. data ●Inadequate coverage of households, businesses and schools with fixed high-speed internet ●Low use of eGovernment by citizens ●Low digitalisation of business transactions	●The development of 5G networks ●Increasing demand for innovation in both the public and private sectors ●The development of digitalisation of public administration and public space (e.g. the digital map, the digitalisation of health care in connection with the Act on health care digitalisation that is currently being prepared, the concept of Smart Cities, support of open data activities, etc.) ●Support for the integration and deployment of digital technologies in SMEs, including infrastructure and services ●The establishment of endogenous companies that use digitalisation and new technologies to create new products and services (e.g. blockchain, data analytics, robot process automation, etc.) ●The advent of IT technologies for a more efficient organisation and operation of the economy and society ●Opportunities to support innovative and digital infrastructure (e.g. Digital Innovation Hubs) from European and national sources ●Prioritising the Digital Agenda through national strategies (Digital Czechia, The National Artificial Intelligence Strategy) and the possibility of obtaining financing from European-level programmes to further develop the Digital Agenda (Digital Europe) ●Public-private cooperation on digitalisation (the SONIA project) ●Adoption of the Act on the Right to Digital Services	●Increasing risks in the areas of cybersecurity/cybercrime ●A change in production chains resulting from the advent of digitalisation and automation ●A high risk of protraction and increased cost of public ICT contracts ●A risk of uncontrolled development of digital services in the public sector without ensuring interoperability ●Weak public sector demand for innovation ●Emphasis placed on increased personal data protection within the context of the adopted Commission Regulation (GDPR) with the potential to slow down the development of digital services

4 The strategic section

Similar to the underlying analyses, the strategic section of the National RIS3 Strategy is divided into two parts. The first part is the key areas of change in which the Czech Republic must achieve significant shifts in order to strengthen the knowledge-intensity of its economy to facilitate the development of the selected specialisation domains and their gradual refinement. These key areas of change correspond to the **horizontal priorities** of the National RIS3 Strategy, which are reflected in the horizontal strategic and specific objectives of the National RIS3 Strategy. The horizontal objectives respond to cross-cutting problems in R&D&I.[58]

Building on the key areas of change, the vertical part of the National RIS3 Strategy describes the **vertical thematic priorities of RIS3**, i.e. the **domains of research and innovation specialisation of the Czech Republic**, and the process of setting priorities in the area of societal challenges and missions. The following figure illustrates the combination of priorities in the National RIS3 Strategy.

Figure 5. Priorities of the National RIS3 Strategy



Source: Prepared by the authors

[58] Guide to Research and Innovation Strategies for Smart Specialisations, European Commission, 2012, p. 51.

4.1 Long-term strategic vision

The long-term strategic vision formulates the basic direction of the Czech Republic's development with emphasis on the knowledge economy and on the transformation of the economy in order to improve innovation-based competitiveness and reduce the Czech Republic's dependence on competitiveness based on low costs. The long-term strategic vision focuses on a longer period than up to 2027. Even though the National RIS3 Strategy is being prepared for the above period, the long-term strategic vision has longer validity, at least up to 2030.

RIS3 2030 vision: A resilient economy based on knowledge and innovation

Knowledge: Making full use of the Czech Republic's knowledge and technological potential, especially its long industrial and technical tradition and quality infrastructure for research and development, generating high value added in promising industries and thanks to the use of key technologies and research, highly qualified people in area of smart specialisation.
Innovation: Exploiting the potential of technology for industrial/digital transition and for generating new opportunities, a growth of endogenous Czech companies with internationally competitive final products for the market and in newly emerging technologies- and knowledge-intensive industries or market niches, the development of innovative start-ups, entrepreneurial people who are able to come up with creative solutions to problems and dynamically exploit the potential of digital technologies.
Resilience: Reducing risks to society and the efficient functioning of its institutions through new technological solutions, adapting businesses and society to new technological and societal challenges, and exploiting opportunities that arise from international cooperation in managing risks and preventing their negative impacts. Reducing these negative impacts through cutting-edge green technologies, long-term sustainable solutions and using social-science research, building a leading position in Europe in relevant specialisation areas. Strengthening the resilience of principal economic sectors and cybersecurity.

Table 13. Indicators of vision fulfilment:

No.	Indicator title	Source
1	The Global Competitiveness Index (GCI 4.0)	*World Economic Forum*
2	Gross value added by sector	*CZSO, Regional Account Database*
3	Labour productivity by sector (GVA/employee)	*CZSO, Regional Account Database*
4	The export and import of high-tech goods and services	*CZSO, Eurostat*
5	The Global Innovation Index (GII)	*World Intellectual Property Organisation*
6	The Digital Economy and Society Index (DESI)	*European Commission*
7	The European Innovation Scoreboard (EIS)	*European Commission*

Source: Prepared by the authors

4.2 Horizontal priorities: Key areas of change

Key areas of change represent interventions that are intended to help achieve the long-term strategic vision. In this sense, the key areas of change and the research and innovation specialisation domains are the "operationalisation" of the vision, i.e. they describe the methods and ways to fulfil the vision.

Horizontal priorities are structured into **strategic and specific objectives** whose achievement will contribute to achieving changes at the level of the key areas. At the beginning of the following text, the horizontal priorities are first introduced through a chart of strategic and specific objectives. For each key area of change, the strategic objective and specific objectives are then listed, including the **intervention logic** that summarises what problems need to be addressed and what the National RIS3 Strategy focuses on. For the specific objectives, the instruments and the proposed model activities to achieve the specific objectives are then proposed. The list of model activities is not exhaustive, and it is expected to be further expanded and modified during the implementation of the RIS3 strategy and in relation to the EDP process. In many cases, interventions within key areas of change will only focus on vertical thematic priorities (especially research and innovation specialisation domains).[59] The tables containing strategic and specific objectives also include indicators. These are mainly context indicators. The indicator system is then complemented by result and output indicators, which are listed in Annex 3.[60]

[59] For more information, see Chapter 5.3 Translating the priorities of the National RIS3 Strategy into operational and support programmes.
[60] Annex 3 will be updated in particular in relation to the final form of operational programmes and their indicators as well as the allocations provided.

Figure 6. Chart of the objectives of the National RIS3 Strategy

Key areas of change	Research, development and innovation for business	Public research and development	People and smart skills	Digital agenda
Strategic objectives	**A. Increasing the innovation performance of companies**	**B. Improving the quality of public research**	**C. Increasing the availability of skilled people for R&D&I**	**D. Increasing the use of new technologies and digitalisation**
Specific objectives	**A.1** Strengthening the innovation performance of existing companies and responding to industrial transition, technological and societal changes	**B.1** Improving the quality and societal relevance of public research	**C.1** Improving the education system's ability to prepare people for research, development and innovation	**D.1** Promoting digitalisation and the use of new technologies in business
	A.2 The establishment and growth of new companies and the exploitation of new opportunities	**B.2** Improving the quality of the environment for implementing public research	**C.2** Developing skills for smart specialisation, industrial transition and entrepreneurship	**D.2** Promoting digitalisation and the use of new technologies in the public sector
	A.3 Improving the functioning of innovation ecosystems at the national and regional levels		**C.3** Increasing the potential and motivation of researchers in research organisations	

Source: A complex analysis of barriers of applied and oriented research, experimental development and innovation in the Czech Republic and proposal for implementation of suggested measures in the 2021-2027 programming period for the National RIS3 Strategy 2021+

4.2.1 Research, development and innovation for business

The current model of economic competitiveness based on the cost differential compared to developed economies has been exhausted. This entails a risk of production being relocated abroad and of increasing competition e.g. from East Asian countries in industries that are based not only on cheap labour, but also on knowledge and technology intensive activities. Therefore, a response from the state is needed within its innovation policy.

In relation to the above information and the challenges defined (low value added and a focus on lower-order innovation, a weak endogenous business sector, an unsatisfactory business environment and the need to respond to technological and societal trends), the following **strategic objective** has been set in the area of Research, development and innovation for business:

A. Improving the innovation performance of companies

This strategic objective aims to increase businesses' value added and labour productivity, refocus them on higher-order innovations, improve their position within multinational concerns and global supply chains, and encourage the uptake of new opportunities and, in turn, the creation and development of new companies. At the same time, the endogenous business sector should be strengthened.

A basic prerequisite for improving the innovation performance of companies is to improve the functioning of innovation ecosystems (at the national and regional levels) and to improve the business environment in general. Similarly, it is necessary to respond to industrial transition and current technological and societal trends.

The strategic objective of Improving the innovation performance of companies will be accomplished through the implementation of three **specific objectives**:

A. 1 Strengthening the innovation performance of existing companies and responding to industrial transition, technological and societal changes

This objective is aimed at supporting the development of existing businesses in terms of **improving their innovation performance, increasing investment in research, development and innovation activities, and focusing on increasing value added.** In particular, the aim is to support businesses in developing non-manufacturing value chain activities, support the improvement of their position within global supply chains and – in the case of foreign-controlled businesses – within their multinational concerns.

Support should be primarily provided to **small- and medium-sized enterprises, under some instruments support may also target "mid-caps"** (i.e. enterprises that are not formally SMEs, yet that are not large enterprises from the perspective of global markets) and in justified cases also large enterprises.

Investments in new technologies will also be supported as part of the necessary response to the ongoing industrial transition (in particular digitalisation, automation and robotisation). At the same time, (especially small- and medium-sized) Czech businesses will be supported in their efforts to penetrate foreign markets and strengthen international cooperation.

This objective should result in **increased sales and, by extension, economic growth of the Czech Republic, an increase in the value added generated in the Czech Republic, and an improved position in value (supply) chains**.

A. 2 The establishment and growth of new companies and the exploitation of new opportunities

This objective is aimed at ensuring appropriate conditions **for the establishment and development of (not only) technology companies in areas that have high growth potential and higher value added and respond to new opportunities** related to current technological and societal trends. Starting a business, especially in technology industries, tends to be more investment-intensive and risky, and the founders of such companies need a variety of specific services and conditions to implement their business plans. Almost all developed countries in the world are trying, in different ways, to create such services and conditions.

Therefore, the objective will support the **development of a system for financing innovations** and address the need for a nationwide system to **support a well-functioning environment for the establishment and growth of new companies**, start-ups and spin-offs. Support will also be provided for the establishment and development of companies with global ambitions aiming to penetrate foreign markets.

The expected result will be an **increased level of new business activity and a higher number of new companies in technological areas**. This change is an important prerequisite for the future existence of a higher number of large Czech companies that will drive the growth of the economy.

A. 3 Improving the functioning of innovation ecosystems at the national and regional levels

Improving the functioning of national and regional innovation ecosystems is a prerequisite for increasing existing companies' value added and their response to technological trends, as well as for the establishment of new companies and the exploitation of new opportunities (i.e. the first two specific objectives).

The successful development of small- and medium-sized companies requires support services to be developed, including specific consulting in the form of coaching and mentoring, and including support for the necessary infrastructure and services that make it possible to e.g. test the results of research and development. It is also necessary to develop cooperation between businesses and between the business and research (academic) sectors and to support the transfer of technology and R&D results into practice.

On the part of the state, it is necessary to unify and simplify the SME support system, promote the use of R&D tax relief, and support demand for innovation from public administration. Last but not least, it is important to promote market competencies and other business skills.

This objective should support the accomplishment of the other two specific objectives and thus contribute to **better innovation performance of the Czech Republic** (as measured for example by the European Innovation Scoreboard).

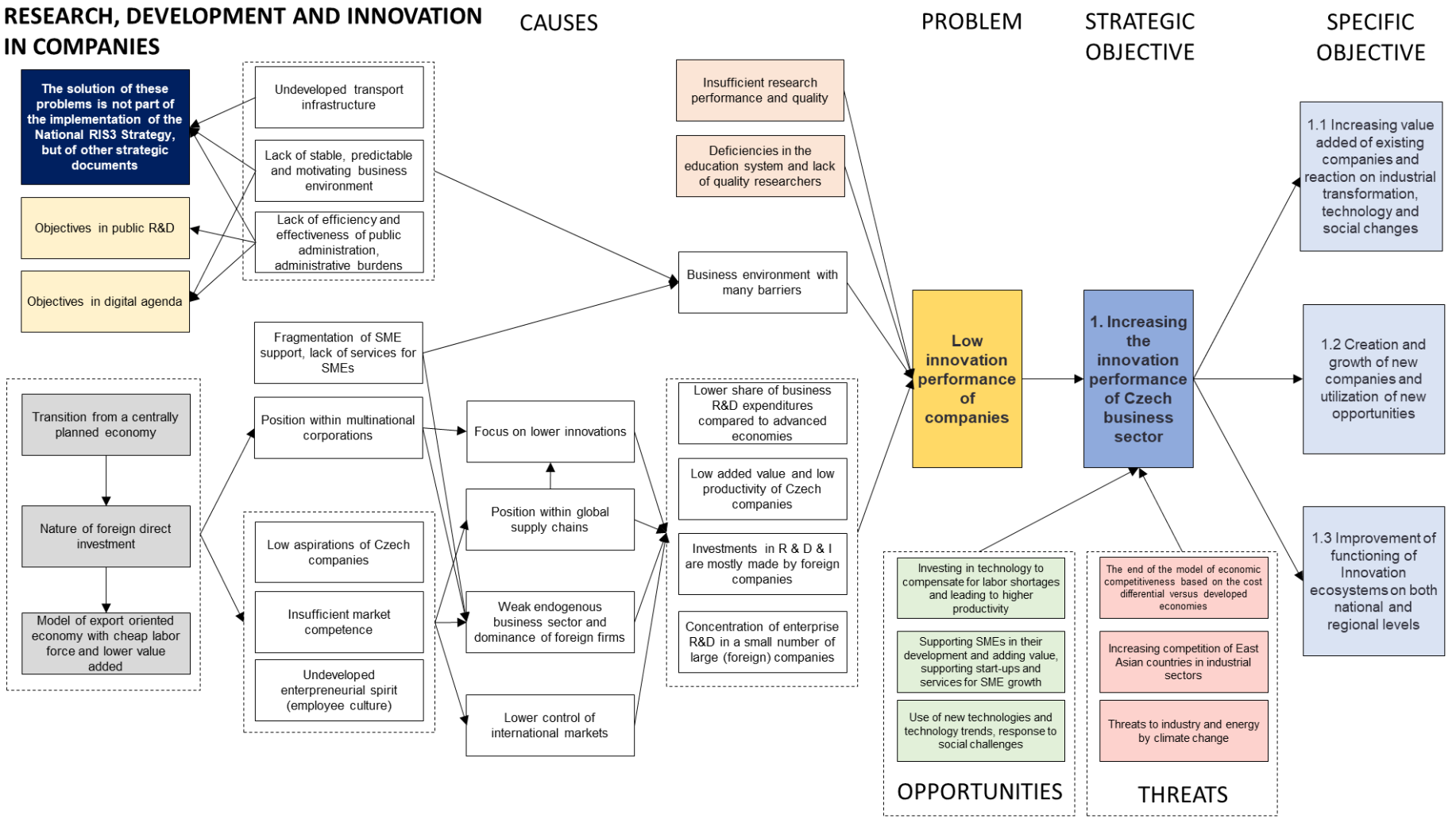
These specific objectives show that emphasis is placed on developing existing companies, increasing their value added, improving their position within global supply chains and possibly also within their parent multinational concerns. At the same time, these companies need to respond to current trends, industrial transition, technological and societal changes.

On the other hand, it is also necessary to emphasise the establishment, growth and development of new companies that will respond to new opportunities by developing new products and services, or that will possibly develop new business models and look for market gaps or niches.

Therefore, we see the future of the Czech economic model as a combination of developing the old (existing companies) and establishing the new (new companies and opportunities). For both, it is essential to develop and improve the functioning of innovation ecosystems, at both the national and regional (self-governing region, local) levels.

The table below contains context indicators for the strategic objective, and instruments and model activities for each specific objective. In some cases, the instruments and model activities are linked to NP R&D&I measures that are crucial in terms of meeting the strategic and specific objectives, especially with regard to improving the systemic conditions of R&D&I support (institutional environment, financing, etc.).

Figure 7. Intervention logic chart



Source: A complex analysis of the barriers to applied and oriented research, experimental development and innovation in the Czech Republic and a proposal for implementing suggested measures in the 2021-2027 programming period for the National RIS3 Strategy 2021+

Table 14. An overview of specific objectives, instruments and model supported activities, and indicators

Strategic objective	**A. Improving the innovation performance of companies**
Indicators	1. R&D expenditures in the business sector, BERD *(source: CZSO, VTR 5-02, R&D analysis)* 2. Early-stage venture capital investments (% of GDP) *(source: R&D analysis)* 3. The high tech sector – value added per employee *(source: CZSO)* 4. Innovation activities carried out in the business sector *(source: CZSO, Eurostat)* 5. Change in the number of newly supported businesses (first-time beneficiaries) compared to the previous period *(source: NP R&D&I)* 6. Patent applications filed in the Czech Republic *(source: CZSO, IPO CR, EUROSTAT*) 7. Revenue from the sale of patent licences (including national) in CZK millions *(source: R&D analysis)* 8. An innovation-friendly environment (EIS) *(source: European Commission)* 9. Firm investments (EIS) *(source: European Commission)* 10. Innovators (EIS) *(source: European Commission)* 11. Intellectual assets (EIS) (source: European Commission) 12. Impact on sales (EIS) (source: European Commission)
Specific objective	**A. 1 Strengthening the innovation performance of existing companies and responding to industrial transition, technological and societal changes**
Instruments and model activities	Supporting investment in technology, supporting robotisation and automation, the use of new technologies and technological trends, the implementation of Industry 4.0 principles (not only in industry, but also in other sectors – such as energy, transport, construction, agriculture, etc.) Supporting business research, development and innovation activities and increased investment in RDI by businesses Supporting improvement in the position of Czech companies in global supply chains, supporting the growth of endogenous Czech companies Supporting improvement in the position of Czech subsidiaries within multinational concerns (including e.g. support for cooperation with endogenous SMEs, cooperation between the state and multinational concerns on selected topics, etc.) Supporting the development of R&D activities, especially in SMEs Supporting exports, increased internationalisation and international cooperation especially of SMEs Supporting innovations (product, service, process and organisational innovations) Supporting the development of non-manufacturing value chain activities (i.e. activities with higher value added)

	Supporting interdisciplinary approaches, creative industries and linking social sciences and humanities with technology Supporting industrial property protection, supporting the development of businesses through the application of industrial property protection
Specific objective	**A. 2 Establishment and growth of new companies and exploitation of new opportunities**
Instruments and model activities	Developing a nationwide system to support the environment for the establishment and growth of new companies, start-ups and spin-offs (e.g. supporting quality services from entrepreneurship support to fast growing young companies; supporting the development of a system for financing innovation – venture capital and other financial instruments) Supporting industrial property protection in start-ups and spin-offs Supporting business, business development and entrepreneurship development Supporting the exploitation of new opportunities responding to societal challenges and technological trends Supporting the penetration of new markets and supporting the international presence of Czech companies Supporting interdisciplinary approaches, creative industries and linking social sciences and humanities with technology
Specific objective	**A. 3 Improving the functioning of innovation ecosystems at the national and regional level**
Instruments and model activities	Supporting the development of services for SMEs Supporting multilateral cooperation between companies (including cooperation within clusters and technology platforms) Supporting cooperation between businesses and academia, including supporting technology transfer, supporting industrial PhDs, etc. Supporting infrastructure and services for testing R&D results (e.g. technology centres, testbeds, living labs, etc.) Aligning support for companies by public administration, and supporting activities to develop the national innovation ecosystem (including supporting the Entrepreneurial Discovery Process, technology assessment and technology foresight, SMART Cities, etc.) Supporting the development of regional innovation ecosystems, including the development of SMART Cities concepts Supporting the development of market competencies and business skills Supporting the innovative demand for smart solutions by public administration Supporting wider use of the R&D tax relief system (or possibly other indirect R&D support instruments) and supporting financial instruments Supporting industrial property protection Supporting the transition of innovation from academia to the application sector, proof of concept programmes Systematic methodological support for regional RIS3 structures by the owner of the National RIS3 Strategy (e.g. in the area of the EDP process)

4.2.2 Public research and development

Improving the quality of public research is one of the main conditions for the successful development of the entire innovation ecosystem. If we want to place emphasis on improving the innovation performance of companies, we cannot do without a well-functioning and efficient research sector that produces quality results. But there is also a need for well-functioning cooperation between the two worlds (i.e. the research and application sectors). Increasing the quality of public research is not possible without improving the conditions for its implementation. In this key area of change, the following **strategic objective** has been set:

B. Improving the quality of public research

Specifically, this strategic objective should mainly lead to an increased number of publications in prestigious journals that will be frequently cited, and to increased participation in international projects. Improved cooperation between the research and business sectors should lead to an increase in the share of business spending on public research, increased revenue from the commercialisation of results and also to a greater (and more effective) use of intellectual property tools.

In terms of the quality of the environment for implementing research, the amount of administrative complexity should be reduced, the legislation should be modified, and the entire system of public R&D management should be improved, including the system for managing the implementation of the National RIS3 Strategy itself. It will be necessary to focus on new trends related to making the results of research and development available as Open Access, supporting the implementation of the EOSC European Open Science Cloud (hereinafter also the EOSC), as well as on making other information resources for R&D&I available in accordance with the principles of Open Science. At the level of research organisations, the quality of their management should be improved, with emphasis on improving people management and developing tools to support researchers.

The strategic objective of Improving the quality of public research will be accomplished through the implementation of two specific objectives:

B. 1 Improving the quality and societal relevance of public research

This objective focuses on the weaknesses and weak aspects of public research that have been identified and that need to be eliminated in order to improve the quality, output and societal relevance of research.

The instruments for accomplishing this objective mainly include **supporting an increase in the internationalisation of Czech research** (e.g. in the sense of greater involvement in international programmes and projects, as well as in the sense of increasing the number of foreign researchers in the Czech Republic) and supporting and developing **cooperation between the research and the application sectors** (with emphasis on developing long-term cooperation) and **technology transfer**.

Support will also be provided to strengthen the specialisation of research focus using already-established research infrastructures (both in terms of strengthening the thematic focus of research and reducing the large number of small research projects). It will also be important to focus not only on supporting research excellence, but also on supporting high-risk/high-gain projects.

In past programming periods, substantial investments were made in building and developing research organisations, but given the rapid developments in technology, equipment needs to be continuously added, upgraded and adapted to new trends. The Czech Republic's ambition to become one of the countries with the best scientific and research performance in Europe can only be fulfilled if the infrastructure for excellent research and cutting-edge research applicable in practice meets the demanding requirements for up-to-date technology. To the maximum extent possible, key infrastructure should then be usable across research organisations within an Open Access model. Due to efficiency and a focus on priority areas, it is necessary in the long term to maintain a completely unique knowledge and technology level of "large" research infrastructures that require continuous modernisation so that they can achieve an internationally competitive level in the long term.

This objective should lead to an **improvement in the quality of R&D results and their relevance both at an international scale and from the perspective of society**.

B. 2 Improving the quality of the environment for implementing public research

This objective is aimed at **providing appropriate conditions for developing public research and improving its quality**. Within this objective, attention will focus both on the **research, development and innovation management system** itself (at national and regional level) and on improving the quality of the **environment in actual research organisations**.

In terms of the research, development and innovation management system, it is necessary to support activities leading to its simplification and also to a reduction in the administrative burden, especially on the part of providers, hand in hand with the necessary modification of the existing legislation, including (clarification and refinement of) public support rules. Among other things, the aim is to ensure the consistent and predictable interpretation of the rules, harmonise them across providers, simplify the rules and reduce the formalism in project documentation/reporting.

As part of creating a well-functioning management system for the National RIS3 Strategy, support will be provided for the EDP process at the national and regional levels and other activities that support the development of the innovation ecosystem (e.g. analytical and evaluation activities, technology foresight, etc.).

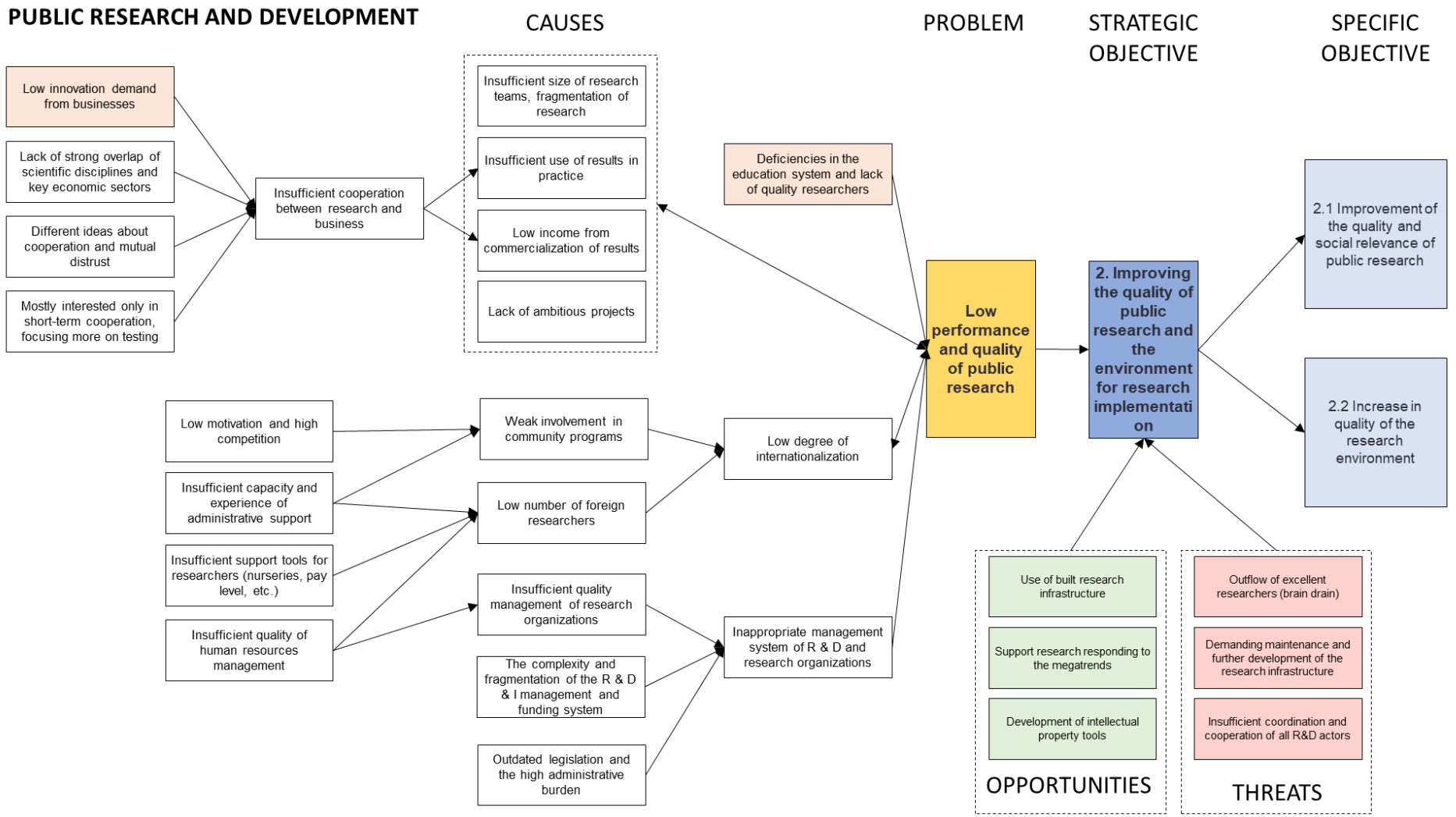
Within research organisations, support will be provided for a wide range of activities aimed for example at **improving the management quality and developing the institutional environment of higher education institutions and research organisations** (supporting, for example, knowledge transfer and cooperation with businesses, establishing spin-offs, developing a culture of working with intellectual property, etc.), supporting the **internationalisation** of the environment (e.g. in the form of a welcome office for foreign researchers) or building the necessary administrative capacity to support research teams (so that researchers can do research rather than spend their time doing paperwork more than absolutely necessary). Support will also be provided for transitioning to a new way of making the results of research and development available as Open Access, supporting the implementation of the EOSC (European Open Science Cloud) initiative, as well as making other information resources for R&D&I available in accordance with the principles of Open Science.

The expected result will be **a reduced administrative burden, an efficient and functional research, development and innovation management system supported by well-conceived legislation**. **Furthermore, the quality of management of research organisations themselves should be improved.**

Both specific objectives are interconnected, i.e. the second specific objective aimed at improving the quality of the environment for implementing public research is one of the main conditions for actually improving the quality of societal relevance of public research.

The table below contains context indicators for the strategic objective, and instruments and model activities for each specific objective. In many cases, the instruments and model activities are linked to NP R&D&I measures that are crucial in terms of meeting the strategic and specific objectives, especially with regard to improving the systemic conditions for R&D&I support (legislative and institutional environment, financing, etc.).

Figure 8. Intervention logic chart – public research and development



Source: Complex analysis of barriers of applied and oriented research, experimental development and innovation in the Czech Republic and proposal for implementation of suggested measures in the programming period 2021-2027 for the National RIS3 Strategy 2021+

Table 15. An overview of specific objectives, instruments and model supported activities, and indicators

Strategic objective	**B. Improving the quality of public research**
Indicators	1. R&D expenditure by the government and higher education sector *(source: CZSO)* 2. Share of business sector resources in R&D expenditure by the government and HEI sector *(source: CZSO; R&D analysis)* 3. Institutional state-budget expenditure on R&D&I *(source: OG CR)* 4. Share of scientific publications co-authored by domestic and foreign researchers *(source: R&D analysis)* 5. Share of highly cited publications (the share of publications in the top 10% of most cited publications in the total number) *(source: R&D analysis)* 6. Share of publications co-authored by the public and private sector in the total number of publications *(source: R&D analysis)* 7. Total number of ERC grants per thousand researchers in the government and HEI sectors *(source: R&D analysis)* 8. Number of participations in the Horizon Europe programme per thousand researchers *(source: R&D analysis)* 9. Attractive research systems (EIS) *(source: European Commission)* 10. Finance and support (EIS) *(source: European Commission)* 11. Linkages (EIS) *(source: European Commission)*
Specific objective	**B. 1 Improving the quality and societal relevance of public research**
Instruments and model activities	Promoting international cooperation, international mobility and participation in EU programmes Support for increasing the specialisation and concentration of research, and increasing the size of research teams (stronger thematic focus of research, and creation of teams of a critical size) Supporting knowledge transfer and the commercialisation of results, including supporting the establishment of spin-offs Supporting research on megatrends (societal challenges and technological trends) Supporting interdisciplinary approaches, and linking social sciences and humanities with technology Supporting demand for innovative solutions by public administration and the use of R&D results in public administration (e.g. in the SMART Cities area) Supporting the development of the third role of universities Supporting the modernisation and further development of research organisations' R&D infrastructure, including core infrastructure in the form of large research infrastructures Supporting the setting up and development of technology and innovation gravity centres/hubs around research centres Supporting cooperation between the research and application sectors, especially supporting long-term cooperation

	Supporting cooperation between the research and application sectors focusing specifically on digital technologies and digitalisation Promoting excellence in research Supporting high-risk/high-gain projects
Specific objective	**B. 2 Improving the quality of the environment for implementing public research**
Instruments and model activities	Reducing the administrative burden in research Simplifying the R&D&I management system, including the possibility of legislative modifications Building administrative capacities to support research teams Supporting an increase in the quality of research organisation management and the development of the institutional environment (including support for creating the conditions and motivation for the establishment of spin-off companies and cooperation with businesses, the conditions for supporting young people and women in research, developing a culture of working with intellectual property, etc.) Supporting the internationalisation of the environment of research organisations Creating a well-functioning system for effective management and coordination of the implementation of the National RIS3 Strategy Supporting and developing the EDP at national and regional level, strengthening cooperation between business, academia and the public sector Supporting activities to develop the national innovation ecosystem (including supporting the development of analytical and evaluation activities, technology assessment and technology foresight) Supporting the transition to a new way of making the results of research and development available as Open Access, supporting the implementation of the EOSC (European Open Science Cloud) initiative, and making other information resources for R&D&I available in accordance with the principles of Open Science Promoting research and development results in the Czech Republic and abroad

4.2.3 People and smart skills

Ensuring available skilled labour is a key condition for the successful development of the economy, an innovation ecosystem and for the development and improvement of public R&D performance. In order to have a sufficient number of skilled people, there must by a quality and well-functioning education system that responds to current trends (technological and societal) and can also respond to the needs of the labour market.

The issue of people and their skills is primarily addressed in sectoral strategies as their integral part. The objectives, instruments and measures in the field of education that are presented in this chapter are linked mainly to the Strategy for Education Policy of the Czech Republic until 2030+ and the Strategic Plan of the Ministry for Higher Education 2021+ for the period from 2021. For the education sector, the National RIS3 Strategy serves only as a recommendation and it only addresses certain aspects of education in areas that are relevant to the mission of the National RIS3 Strategy. The National RIS3 Strategy focuses only on those aspects of skills that correspond to its objective, i.e. the concentrating funding in those priority areas whose support will bring about a concrete shift towards greater competitiveness and which are continuously confronted with the needs of the economy and society through the EDP. The various strategies, especially the NP R&D&I, the Strategy for Education Policy 2030, the SME Support Strategy, the Strategic Framework for Employment Policy 2030, the Strategic Plan of the Ministry for Higher Education for the period from 2021 and others, create a broad base of conditions that must be primarily met in order for the National RIS3 to implement its objectives. In the area of the education system, support that is linked to the National RIS3 Strategy will focus e.g. on the development of STEAM fields, green and digital skills or on innovation and creativity in education.

For this key area of change, the following **strategic objective** has been set:

C. Increasing the availability of skilled people for research, development and innovation

This strategic objective should lead to the **modernisation of the education system for initial education, the development of the further education system**, especially in terms of developing skills for **smart specialisation, industrial transition and entrepreneurship**, and to an increase in the **professional potential of people in research organisations**.

The strategic objective of Increasing the availability of skilled labour for research, development and innovation will be accomplished through the implementation of three specific objectives. The first specific objective focuses mainly on improving the education system and its ability to prepare staff for research, development and innovation, while the second specific objective is rather aimed at supporting activities that link education and the needs of the labour market (such as supporting the development of flexible forms of education, supporting vocational training for employees, etc.) and the third specific objective focuses on developing staff and their skills directly in research organisations.

C. 1 Improving the education system's ability to prepare people for research, development and innovation

This objective focuses mainly on supporting the modernisation (and digitalisation) of the initial education system with emphasis on developing key competences of pupils and students that are relevant to long-term successful in the economy and society of the 21st century, both in the labour market and in independent entrepreneurship.

Support will be provided for developing STEAM skills that strengthen the priorities of smart specialisation, and for developing digital and business skills. The aim will also be to improve the management system of higher education institutions, increase their internationalisation, reduce the high drop-out rate and increase interest in pedagogical fields and subsequent careers.

Support will also be provided for linking schools and practice within the education system. The system of work with gifted pupils and students will also be developed. At the same time, it is necessary to support secondary schools and higher education institutions in their participation in lifelong learning.

This objective should lead to **an improvement in the results in the international PISA survey, an increase in the quality of higher education institutions in an international comparison, an increase in the proportion of the population with basic digital skills, an increase in the proportion of companies involved in vocational education, and stronger links between the education system and practice**.

C. 2 Developing skills for smart specialisation, industrial transition and entrepreneurship

This objective focuses on **developing flexible forms of education**, including the need to improve both their **accessibility and relevance** (i.e. so as to make education available in those areas for which there is labour market

demand). Related to this is the need to support vocational training for employees of the business and public sectors in the area of skills for the introduction of new technologies, digital and green industrial transition and smart specialisation through re-skilling and up-skilling. Support will also be provided for developing all skills needed for business, including market competencies and developing the entrepreneurial mindset in general.

The expected result will be **improved skills of people in the business sector in the areas of smart specialisation, and also improved skills needed for the introduction of new technologies, industrial transition and entrepreneurship.**

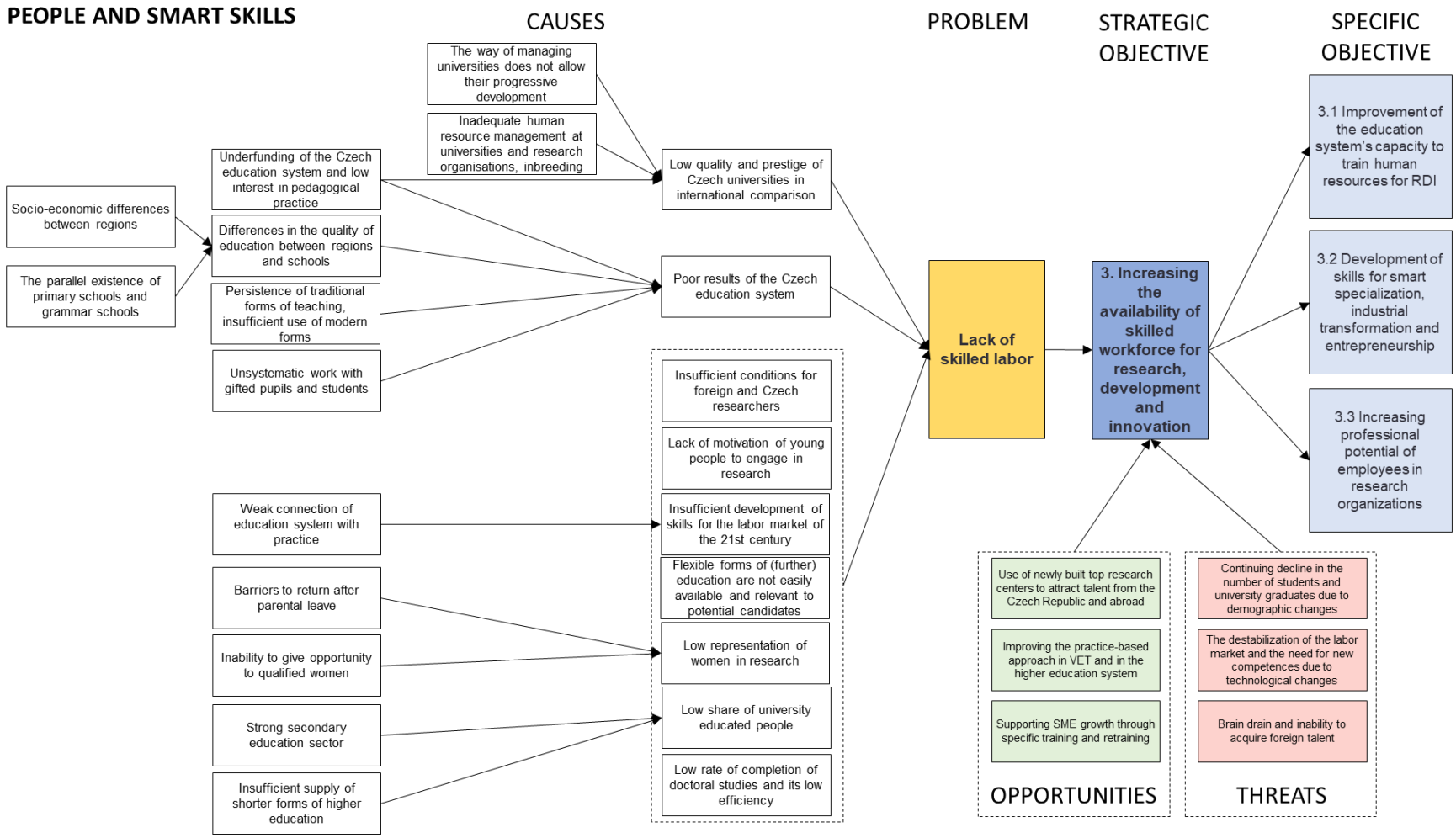
C. 3 Increasing the potential and motivation of researchers in research organisations

This objective focuses on securing and retaining quality researchers as a prerequisite for improving the quality and performance of the entire public research system. To achieve that it is necessary to **improve the institutional environment in research organisations and, in turn, to improve the working conditions of researchers**. It is also necessary to work towards increasing the internationalisation of the environment of research organisations (in terms of involvement in international cooperation and research projects, but also in terms of increasing the number of foreign researchers in the Czech Republic). To do that, it is also necessary to create appropriate conditions and environment (e.g. communication in English, the existence of a welcome office, competitive salary conditions, etc.) and also to motivate research institutions and researchers themselves to develop internationalisation.

However, the aim is not only to attract new researchers and retain existing ones, but also to **improve their expertise** – for example through supporting mobility (abroad, but also into the business/commercial sector). It is also necessary to focus on the emerging generation of researchers, support the change in the position of PhD students, and generally increase the motivation of young people to engage in research and then stay in the research sector. The expected result will be an **increase in the ability to attract and retain talent and skilled workers, an increase in the share of foreign researchers, and an increase in the share of women in research**.

The table below contains context indicators for the strategic objective, and instruments and model activities for each specific objective. In some cases, the instruments and model activities are linked to NP R&D&I measures that are crucial in terms of meeting the strategic and specific objectives, especially with regard to improving the systemic conditions for researchers.

Figure 9. Intervention logic chart – people and smart skills



Source: Complex analysis of barriers of applied and oriented research, experimental development and innovation in the Czech Republic and proposal for implementation of suggested measures in the programming period 2021-2027 for the National RIS3 Strategy 2021+

Table 16. An overview of specific objectives, instruments and model supported activities, and indicators

Strategic objective	**C. Increasing the availability of skilled people for research, development and innovation**
Indicators	1. HEI graduates by field of education according to ISCED-F classification with a focus on science, technology and ICT fields *(source: CZSO)* 2. R&D employees (3-year annual averages) *(source: CZSO)* 3. Total ICT professionals *(source: CZSO)* 4. Specialists in science and technology *(source: CZSO)* 5. Foreign PhD students as a percentage of all PhD students *(source: EUROSTAT)* 6. Employment in knowledge-intensive activities *(source: EUROSTAT)* 7. Researchers – Business enterprise sector (Eurostat) *(source: EUROSTAT)* 8. Share of foreign researchers in the total number of researchers in the government and HEI sectors *(source: R&D analysis)* 9. Number of employees newly trained in digital skills *(source: NP R&D&I)* 10. Number of employees working in AI technologies in companies *(source: NP R&D&I)* 11. Human resources (EIS) *(source: European Commission)* 12. Employment impacts (EIS) *(source: European Commission)*
Specific objective	**C. 1 Improving the education system's ability to prepare people for research, development and innovation**
Instruments and model activities	Supporting the modernisation of the education system with emphasis on the development of the key competencies of pupils, students and teachers that are relevant to the labour market of the 21st century Supporting the development of pupils' competencies in STEAM fields that strengthen the priorities of smart specialisation Supporting the development of digital literacy and computational thinking of pupils, students and teachers Strengthening the business skills and entrepreneurship of pupils and students Promoting interest in teaching careers Supporting the development of teachers' competencies Supporting the linking of schools and practice (businesses, research organisations) within the education system Supporting the mobility of pupils, students and teachers (e.g. to the private, public or research sectors, abroad) and supporting the internationalisation of the internal environment of HEIs

	Supporting the involvement of secondary schools and HEIs in lifelong learning Supporting the interconnecting of formal and non-formal education, supporting innovative forms of teaching Supporting the development of systematic work with gifted pupils and students Supporting the improvement of HEI management and developing quality assurance systems Supporting the internationalisation of schools Supporting the improvement of the quality and completion rates of doctoral studies Supporting doctoral degrees oriented towards industry and applications
Specific objective	**C. 2 Developing skills for smart specialisation, industrial transition and entrepreneurship**
Instruments and model activities	Supporting vocational training for business sector employees in the area of skills for the introduction of new technologies and industrial transition, including the issue of knowledge transfer from the public sector Supporting training for employees in the public sector and public administration in the area of innovation and the introduction of new technologies Supporting the activities of Digital Innovation Hubs (or institutions with expertise in the Digital Agenda) aimed at developing skills related to digitalisation Supporting an improvement in strategic management, acceleration of growth and management of innovations in the business sector Supporting the development of an entrepreneurial mindset, the development of market competencies and business skills Supporting the development of flexible forms of education and further education, increasing their availability and relevance Supporting the recognition of lifelong learning results by employers and the adoption of microcredentials
Specific objective	**C. 3 Increasing the potential and motivation of researchers in research organisations**
Instruments and model activities	Supporting the recruitment and retention of quality researchers, including supporting their professional development, striking a balance between professional and personal life Supporting the internationalisation of research organisations, including the environment for foreign (and Czech) researchers (a welcome office, etc.) Supporting the mobility of researchers (e.g. to the private sector or abroad) Encouraging increased representation of women in research Supporting changes in the position of PhD students and increasing the motivation of young people to engage in research

4.2.4 Digital agenda

In accordance with the document Digital Czechia (or more specifically its section of Digital economy and society), it can be stated that the digital transition is an opportunity for the Czech Republic in terms of internal modernisation, transition to an education-based economy and the emergence of domestic innovative businesses with high value added. Therefore, the National RIS3 Strategy includes the **strategic objective of**:

D. Increasing the use of new technologies and digitalisation.

In businesses, this objective should result in investments in technology, robotisation and automation and the introduction of Industry 4.0 principles. Furthermore, it should result in the development of systematic support for SMEs in this area, including the necessary infrastructure and services, and support for the establishment and development of Digital Innovation Hubs and investments complementary to the EU's Digital Europe Programme. In addition, this objective should lead to the emergence of endogenous companies that use new technologies to create new products and services.
In the area of public administration, it is expected that eGovernment will be developed and the digitalisation of public administration will be increased and, in turn, the use of electronic services by citizens, companies and authorities themselves will increase. In this respect, examples of significant shifts include the Act on the Right to Digital Services No. 12/2020 Sb., the envisaged digitalisation of the building permit procedure or the digital maps of the self-governing regions. Increasing high-speed internet coverage is also crucial, both for citizens and businesses or other entities (schools, transport corridors, etc.).
In general, the fulfilment of objectives and activities related to the Digital Czechia – Government Programme for the Digitalisation of the Czech Republic 2018+ strategy will be supported under this strategic objective, and investments that are complementary to the Digital Europe Programme will be supported. Strategic objective D. will be accomplished through the implementation of two specific objectives:

D. 1 Promoting digitalisation and the use of new technologies in business

Given that investment in new technologies remains inadequate, this specific objective is aimed at supporting the development of digitalisation (including investments in technology, the use of high-speed internet, etc.), supporting robotisation and automation, the ability to respond to new technological trends and introducing the principles of Industry 4.0 (not only in industry but also in other sectors – such as energy, transport, construction, agriculture, etc.).

In this context, it is also necessary to focus on developing support for the integration and deployment of digital technologies in SMEs, including the related infrastructure and services. At the same time, efforts will also be made to take advantage of the possibility of supporting innovation and digital infrastructure (e.g. Digital Innovation Hubs or DIHs) using both European and national resources. Given that existing state support for SMEs in the digital area is rather fragmented, the aim is to systematise this support.
In connection with dynamic technological changes and the shorter diffusion time of new technologies, support will be provided for the establishment and development of endogenous companies that use digitalisation and new technologies (possibly also open data of public administration or data of mobile operators) to create new products and services (e.g. blockchain, data analytics, robotics, automation, etc.).
The result of all the above activities will be an **increase in the number of ICT-oriented companies and an increase in their share in the business sector and, in general, an increase in the use of digital technologies in the business sector**.

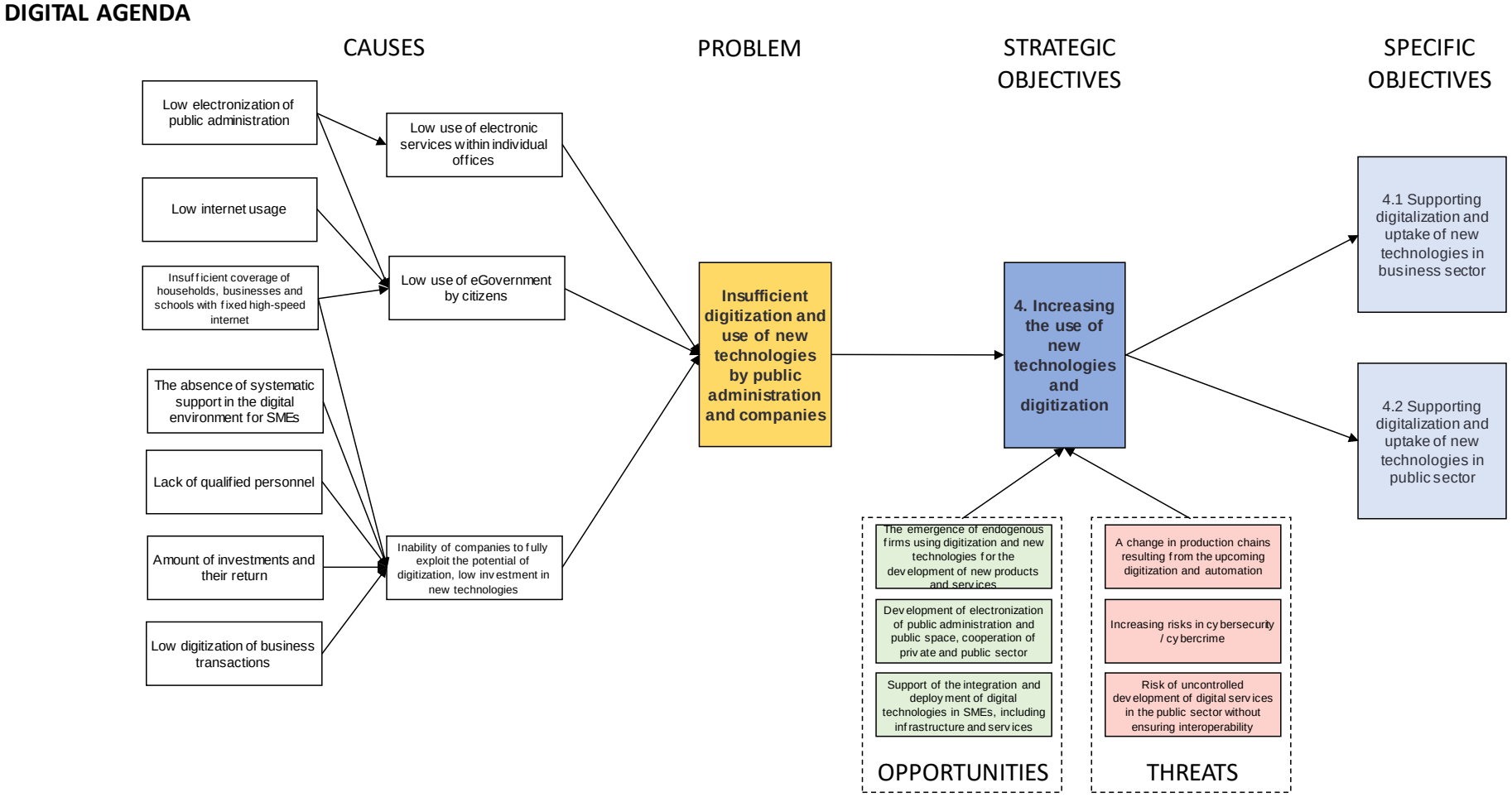
D. 2 Promoting digitalisation and the use of new technologies in the public sector

This specific objective focuses on supporting the development of digitalisation of public administration and public space in order to increase both the range of eGovernment services offered by public institutions and citizens' demand for these services. Support will be provided for activities that generally increase demand for innovative solutions and solutions that are based on digital technologies and artificial intelligence, such as Smart Cities, Open Data, etc. Also, increasing the demand for and supply of digital solutions is conditional on increasing high-speed internet coverage and availability and developing areas related to cybersecurity. It will also be crucial to simplify and modernise public administration processes (i.e. not to digitalise existing procedures, but rather to also modify and simplify them, possibly together with relevant legislation). In order to implement activities, it is also essential to support the recruitment and retention of digitalisation experts. Another important aspect is digitalisation in the energy sector.[61]

[61] See the National Action Plan for Smart Grids.

The expected result will be a **higher rate of internet usage in relation to public administration by companies, citizens and other entities, but also an increase in electronic communication and use of electronic services between the different authorities. In addition, the share of households and companies with high-speed internet connections should increase.** The two specific objectives are similar, differing mainly in their focus – the first specific objective focuses on the business (commercial) sector, while the second focuses on public administration. In addition, the first specific objective is linked to objectives in the key area of change Research, development and innovation for business.

Figure 10. Intervention logic chart – digital agenda



Source: Complex analysis of barriers of applied and oriented research, experimental development and innovation in the Czech Republic and proposal for implementation of suggested measures in the programming period 2021-2027 for the National RIS3 Strategy 2021+

Table 17. An overview of specific objectives, instruments and model supported activities, and indicators

Strategic objective	**D. Increasing the use of new technologies and digitalisation**
Indicators	1. Active fixed internet connections *(source: CZSO)* 2. Companies with a maximum internet connection speed of 30/100 Mbps and higher *(source: CZSO)* 3. Number of projects with digitalisation and artificial intelligence elements under national programmes *(source: NP R&D&I)* 4. Number of projects with digitalisation and artificial intelligence elements co-implemented by Czech business entities under international programmes *(source: NP R&D&I)* 5. An increase in the total value of services provided by DIHs to domestic and foreign business entities per year *(source: NP R&D&I)* 6. Companies using industrial robots, AI, 3D printing, cloud computing, big data analytics or web-based sales *(source: Eurostat)* 7. Number of companies using AI technologies *(source: NP R&D&I)* 8. Number of projects transferring the results of cutting-edge AI research into industrial practice *(source: NP R&D&I)* 9. Security policy aimed at managing the risk of unavailability of ICT services *(source: Eurostat)*
Specific objective	**D. 1 Promoting digitalisation and the use of new technologies in business**
Instruments and model activities	Developing systematic support for companies in the digital area, including infrastructure and services Supporting the setting up and development of a network of European Digital Innovation Hubs (e-DIHs) Supporting the establishment of new and the development of existing endogenous companies that use new technologies to create new products and services Supporting the development of digitalisation (including investment in technologies), supporting robotisation, automation and artificial intelligence, the use of new technologies and technological trends, the introduction of Industry 4.0 principles (not only in industry but also in other sectors – such as energy, transport, construction, agriculture, etc.) Supporting the development of business transaction digitalisation and digital communication both inside and outside companies Supporting the implementation of the objectives of government strategies focused on supporting the digital agenda (e.g. the Digital Czechia: Government Programme for the Digitalisation of the Czech Republic 2018+ strategy)

	Supporting activities complementary to the Digital Europe programme and other EU instruments Supporting research, development and innovation activities in the area of the digital agenda
Specific objective	**D. 2 Promoting digitalisation and the use of new technologies in the public sector**
Instruments and model activities	Supporting the development of eGovernment, digitalisation and rationalisation of public administration processes and public space (including e.g. the Smart Cities concept, Open Data, the introduction of artificial intelligence, etc.) Supporting increased use of eGovernment both by citizens and among the various authorities Supporting increased high-speed internet coverage and availability Supporting the development of cyber security Supporting the development of public-private cooperation on digitalisation Supporting research, development and innovation activities in the area of the digital agenda for the purposes of public administration Supporting the implementation of the objectives of government strategies focused on supporting the digital agenda (e.g. the Digital Czechia: Government Programme for the Digitalisation of the Czech Republic 2018+ strategy)

4.3 Thematic priorities: Smart specialisation of the Czech Republic

Smart specialisation is aimed at the "smart" exploitation and development of the Czech Republic's potential. The National RIS3 Strategy aims to create long-term competitive advantages based on the use of knowledge and innovation. The research and innovation specialisation domains, which represent the main **"vertical" thematic priorities** of the National RIS3 Strategy, are based on the Czech Republic's strengths and specific economic, innovation and research capacities and resources. Within the specialisation domains, the National RIS3 Strategy seeks to link the possibilities offered by the Czech Republic's economic background with research capacities and key enabling technologies that represent major opportunities for a shift towards activities with higher value added, a shift in value chains or for creating specific market niches and segments.

The following chapter describes the process of determining the **research and innovation specialisation domains** in the Czech Republic and summarises the focus of each domain. A more detailed definition is provided in Annex 1. Information on how the specialisation domains translate into support programmes is provided in the chapter on the implementation of the National RIS3 Strategy.

The **area of societal challenges and related missions** is also an important part of the thematic priorities of the National RIS3 Strategy. In terms of smart specialisation, societal challenges represent external stimuli that may take form of societal, economic and environmental needs and threats but, at the same time, that produce opportunities and conditions for innovative solutions, including technological and social innovations. At the same time, these solutions must be accepted by society, and they can only become well-established and successfully contribute to the desired trends if their possible negative impacts on society, the economy and the environment are assessed. In economic terms, these are also demand-based stimuli for which there is no adequate supply of solutions yet. The process for specifying the priorities in this area is described in Chapter 4.3.2.

4.3.1 Research and innovation specialisation domains

The starting point for determining the Czech Republic's research and innovation specialisation domains was the **identification and assessment of the Czech Republic's strong sectors** that form the backbone of the Czech economy and where there is potential for its further development. These sectors of economic specialisation (application sectors) were already identified in the National RIS3 Strategy in 2018, which was followed by analytical documents that were prepared for the purpose of updating the strategy for 2021–2027.

As part of the sectors of economic specialisation of the Czech Republic, the **sectoral analysis** as the second step identified areas where there is a high **potential for generating and absorbing new knowledge and R&D results**. This was done using a detailed sectoral analysis of research and innovation activities, a bibliometric analysis of publication results achieved in each sector by research organisations, a patent analysis and an analysis of cooperation between research organisations and businesses on R&D projects. Additionally, international cooperation links in R&D were monitored, which facilitate knowledge transfer and technological diffusion at the international level.[62]

In the third step, the **potential for the Czech Republic's technological specialisation in the areas of key enabling technologies (KETs)** was analysed in detail. The emphasis on analysing KETs was chosen especially due to the cross-cutting nature of these technologies, their applicability across the entire spectrum of application sectors and, last but not least, their pivotal importance for the economic transformation of the economy. This analysis focused on assessing research activities in KETs in the Czech Republic, their focus, results and existing links between research organisations and businesses. In addition, the intensity and focus of international cooperation in research and innovation was also monitored.[63] However, there are emerging technologies other than KETs and possibly other cross-cutting knowledge that are also important for the Czech Republic's smart specialisation and that are continuously identified within the EDP process.

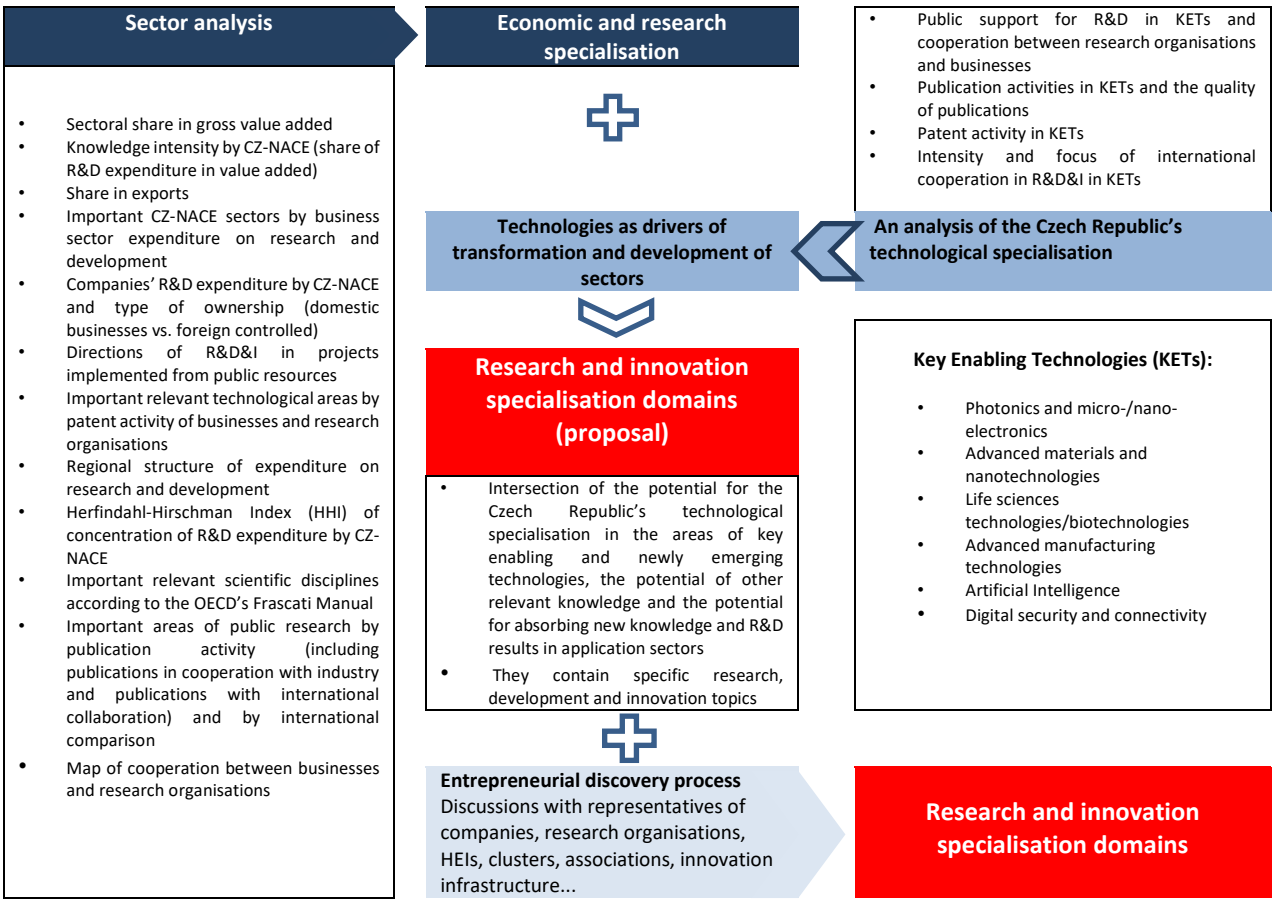
The final proposal for the **Czech Republic's research and innovation specialisation domains** was based on the intersection of the potential identified for the Czech Republic's technological specialisation in the areas of key

[62] See "Analysis of the interconnection between KETs and the application sectors of the National RIS3 Strategy 2021+ Sectoral analysis of R&D in the Czech Republic with a focus on vertical specialisation domains:" https://www.mpo.cz/assets/cz/podnikani/ris3-strategie/projekty-na-podporu-ris3/operacni-program-technicka-pomoc/2020/7/Odvetvova-analyza-VaV.pdf

[63] See "Analysis of the interconnection between KETs and the application sectors of the National RIS3 Strategy 2021+: Analysis of KETs and their links to NRIS3 application sectors:" https://www.mpo.cz/assets/cz/podnikani/ris3-strategie/projekty-na-podporu-ris3/operacni-program-technicka-pomoc/2020/7/Analyza-KETs-a-jejich-vazeb-na-aplikacni-odvetvi-NRIS.pdf

enabling and emerging technologies and the potential identified for absorbing new knowledge and R&D results in the sectors of the Czech Republic's economic specialisation. The process for defining the research and innovation specialisation domains is shown schematically in the following figure.

Figure 11. The process for defining RIS3 specialisation domains



Source: Prepared by the authors

The above empirical analyses represented the initial input to the EDP process at the national level. For the purpose of the EDP process, the Czech Republic's research and innovation specialisation domains were grouped into broader thematic units that correspond to the focus of the National Innovation Platforms. The main criterion for grouping the specialisation domains into thematic areas was their classification into application sectors that constitute the core potential for absorbing new knowledge and R&D results. An overview of the specialisation domains and the relevant National Innovation Platforms is provided in the table below.

The proposed domains were discussed within the National Innovation Platforms. The conclusions of the EDP process were reflected in the R&D&I topics (Annex 1). The topics from regional RIS3 strategies were also taken into account.

Table 18. An overview of the Czech Republic's research and innovation specialisation domains and National Innovation Platforms

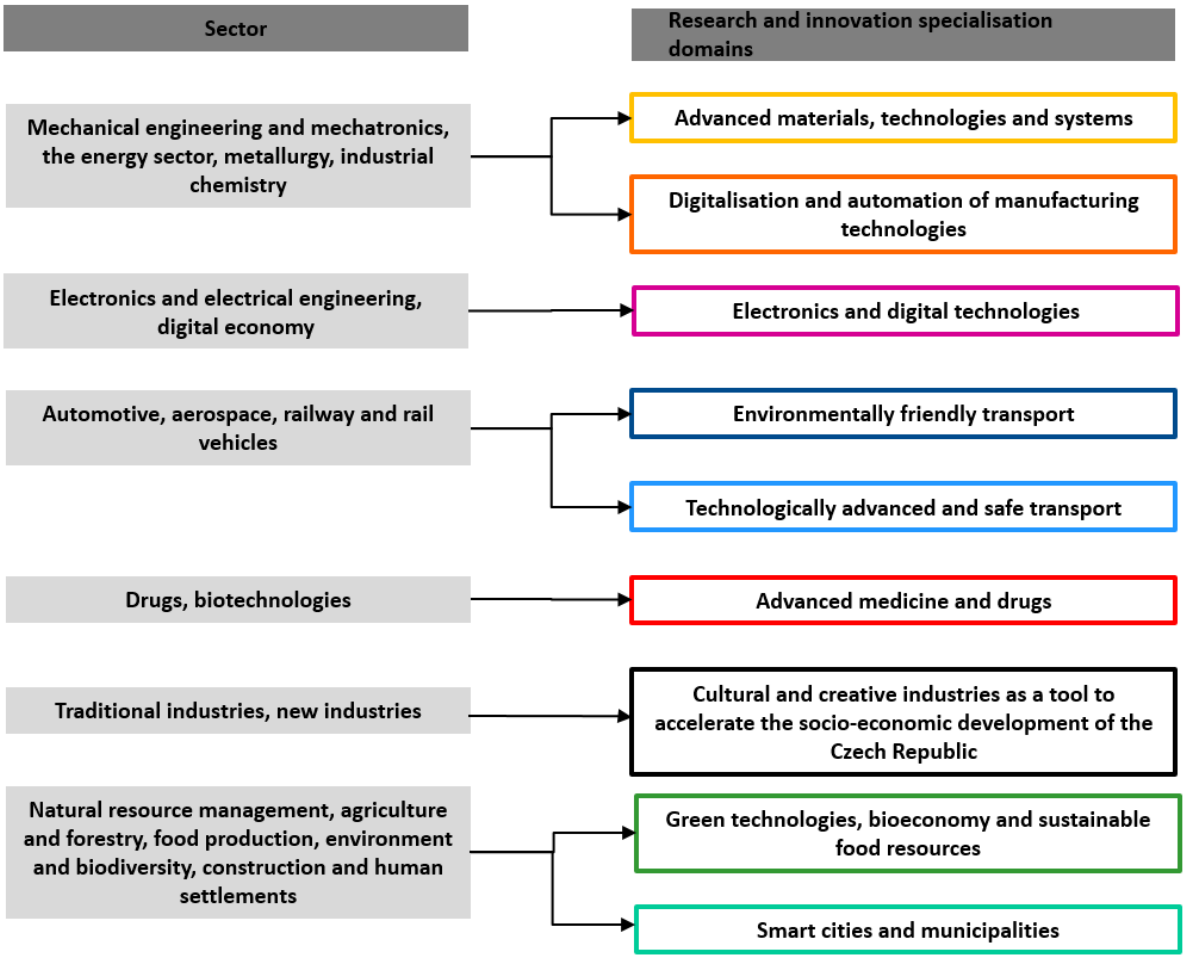
Specialisation domains	National innovation platforms
Advanced materials, technologies and systems	Advanced machinery and technologies
Digitalisation and automation of manufacturing technologies	
Electronics and digital technologies	Digital technologies and electrical engineering
Environmentally friendly transport	Transport for the 21st century
Technologically advanced and safe transport	
Advanced medicine and drugs	Healthcare, advanced medicine
Cultural and creative industries as a tool to accelerate the socio-economic development of the Czech Republic	Cultural and creative industries
Green technologies, bioeconomy and sustainable food resources	Sustainable agriculture and environmental sectors
Smart cities and municipalities	

Source: Prepared by the authors

Some of the specialisation domains focus on sectors that form the core of the Czech Republic's industrial orientation (**Advanced materials, technologies and systems; Digitalisation and automation of manufacturing technologies; Environmentally friendly transport and Technologically advanced and safe transport**). These domains focus on products and processes with high technical demands that normally require R&D for their innovation. The domain of **Electronics and digital technologies** targets the well-established and dynamically growing ICT sector in the Czech Republic, which in the future will play a key role in ensuring the international competitiveness of companies operating in many sectors of the Czech economy. A similarly dynamic domain may be **Cultural and creative industries as a tool to accelerate the socio-economic development of the Czech Republic**. The domains of **Advanced medicine and drugs, Green technologies, bioeconomy and sustainable food resources and Smart cities and municipalities** have been chosen not only in terms of the potential competitive advantages represented by the Czech Republic's knowledge and innovation potential, but also in terms of supporting the resilience of the Czech economy and society.

Regarding the internal content and structure of the specialisation domains, each specialisation domain intersects with selected application sectors (e.g. mechanical engineering, industrial chemistry), as shown schematically in the following figure. However, if it becomes apparent during the EDP process that it is necessary e.g. to include parts of other sectors, the domains concerned may be modified.

Figure 12. Links between sectors and specialisation domains



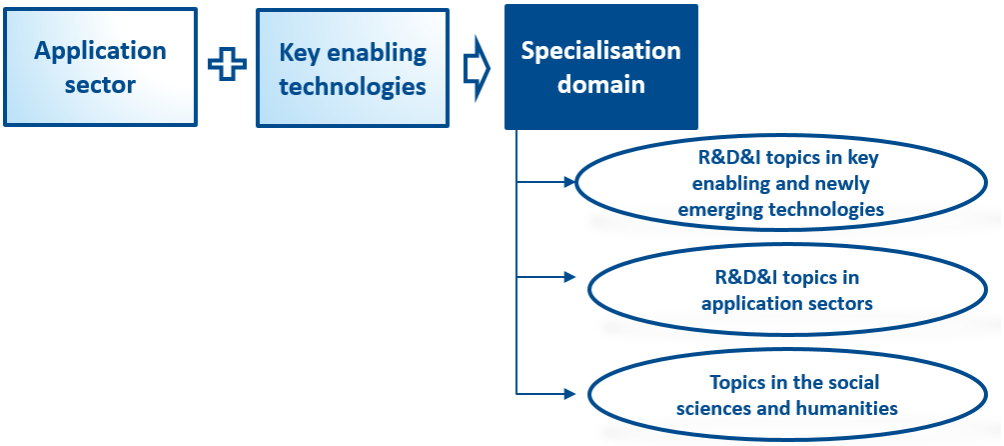
Source: Prepared by the authors

Each domain also contains selected **key enabling and newly emerging technologies as essential catalysts for the transformation and development of the respective sectors**. These technologies are domain-specific and were selected for each specialisation domain based on analyses that had indicated the potential for their use within the respective sectors. The technology directions also reflect the robust knowledge base of research organisations and research infrastructures.

In practical terms, this aspect has been reflected in each specialisation domain in the form of a list of **relevant R&D&I topics within each key enabling technology**. Each domain also contains an **overview of R&D&I topics within the different application sectors**. In the sector analysis, these R&D&I topics are underpinned by strong application potential in terms of businesses' in-house research activities and/or readiness to absorb new knowledge and proven cooperation between research organisations and businesses, which is a prerequisite for successful technology diffusion. The R&D&I topics are conceived as **topics that are of strategic importance to the given domain** and as such they are an **essential element of the specialisation domains' projection into support programmes**. Supported projects under the relevant support programmes, or under the support programmes' calls that are relevant to their activities, must be linked to the selected R&D&I topics that are listed in each domain. The list of R&D&I topics for each specialisation domain is presented in Annex 1, which is regularly updated during the implementation of the National RIS3 Strategy based on the ongoing EDP process (for additional details please see the chapter entitled Implementation of the National RIS3 Strategy).

In addition to technological and application R&D&I topics, the specialisation domains also include topics that use research results in the **social sciences and humanities (SSH)**. These are mainly topics in the area of the impact of technology on people and society in a context that is relevant to the focus of the given domain. The following figure summarises the structure of a specialisation domain.

Figure 13. Structure of a specialisation domain



Source: Prepared by the authors

The following sub-chapters provide a description of each specialisation domain, which frames the domain in terms of its sectors and knowledge base, outlines the strategic direction of the domain and summarises background information on the application of key enabling technologies within the domain. Detailed information on the specialisation domains is then provided in Annex 1, which contains cards for the different thematic areas.

Advanced materials, technologies and systems

The **Advanced materials, technologies and systems** domain focuses on R&D&I of **advanced manufacturing technologies, advanced materials and industrial biotechnologies**, including issues relating to their introduction and impact on society. The domain is aimed at the use of these technologies in sectors that form the traditional backbone of the Czech Republic's economy and contribute significantly to generating GDP. These mainly include **mechanical engineering and mechatronics**, where R&D expenditure has been increasing significantly and where there is a high number of active businesses. Approximately half of the R&D expenditure in this application sector takes place in domestic businesses, and businesses in mechanical engineering that are active in research operate in most regions of the Czech Republic. In some self-governing regions, R&D expenditure is very high and constitutes a significant portion of regional BERD. In addition to mechanical engineering and mechatronics, the domain is also oriented towards sectors that are a prerequisite for ensuring the competitiveness of the entire economy (**metallurgy** and **industrial chemistry**).

The domain also envisages the use of advanced technologies in the **energy sector**, which plays a key role in ensuring the operation of the entire national economy, the resilience of the state and the standard of living of the population.[64] The energy sector needs to be understood in its entirety, i.e. covering electricity and heat (or cold), from production through distribution to final consumption, including energy storage as a new element. The energy sector comprises a layer of individual equipment and technological parts and a layer of an interconnected energy system. The energy system is based on optimising supply security, supply at an acceptable price (for industry, services and the population) and the environmental acceptability of energy supply. In the coming years, the energy sector will undergo a fundamental transformation resulting primarily from the implementation of the European 2030 climate and energy package, the newly accelerated and expanded European Green Deal, including the target of achieving carbon neutrality by 2050. The core objectives are aimed at sharply increasing the share of renewable energy in consumption (electricity, heat and energy in transport), reducing greenhouse gas emissions and saving energy. Other objectives are aimed at reducing environmental impacts (emissions, water consumption, etc.) or improving the security of energy supply. Key trends include decarbonisation, decentralisation, increased electrification and digitalisation (with links to the domain of Digitalisation and automation of manufacturing technologies).[65] Other phenomena will include interconnecting the electricity and gas sectors and interconnecting the energy sector with other sectors and industries (chemistry,

[64] See also the State Energy Policy of the Czech Republic, https://www.mpo.cz/assets/cz/energetika/statni-energeticka-politika/2016/12/Statni-energeticka-koncepce-_2015_.pdf

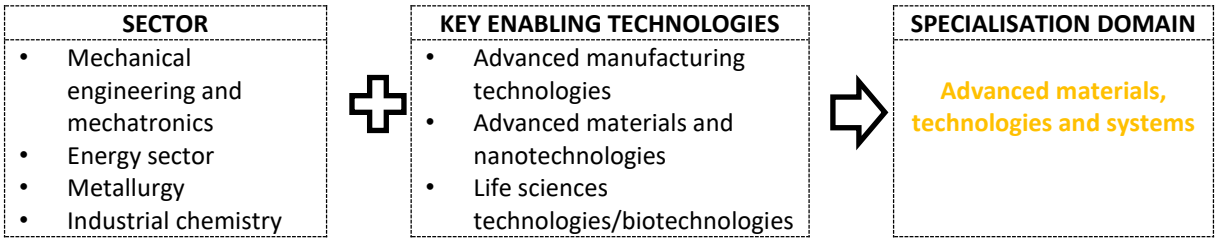
[65] In the area of digitalisation of the energy sector, the key strategic document is the National Action Plan for Smart Grids, https://www.mpo.cz/assets/cz/energetika/elektroenergetika/2016/11/Narodni-akcni-plan-pro-chytre-site.pdf

transport, agriculture or landscape management). In the European context, the key strategy in the energy sector is the European Strategic Energy Technology Plan, which defines 10 priorities in 6 areas (see https://setis.ec.europa.eu/). The energy sector has strong links to other National Innovation Platforms – Digital technologies and electrical engineering, Transport for the 21st century and Green technologies, bioeconomy and sustainable food resources.

There is a clear need for a change in societal attitudes towards energy. However, this will bring many social risks (inequality) and may have serious impacts on vulnerable populations. It is therefore necessary to use SSH knowledge and develop tools to mitigate these risks. In these areas, it turns out to be crucial to set up educational processes and knowledge transfer leading to civic responsibility in the management of energy resources. The need for a general change in people's mindsets about energy will lead to adequate awareness, stimulating society's interest in new energies and building new mechanisms for individual, corporate and state responsibility for this area.

The domain has a broad knowledge base **underpinned by strong R&D in the physical, chemical, material and computer sciences, as well as in the social sciences and humanities**, as evidenced by the high number of scientific publications. In recent years, R&D of nanomaterials and nanotechnologies has also been developing intensively. Research institutions (HEIs, ROs in the government and business sectors) carrying out R&D with the above focus operate in most of the Czech Republic's self-governing regions.[66] In the past period, EU funds were used to build research centres that have expertise and research infrastructure for implementing both basic and applied R&D with results that are usable in businesses operating in the above sectors. The high number of patent applications filed by these institutions, which are focused on mechanical engineering, chemical production and other relevant technology areas, also testifies to the potential of ROs in the field of applied R&D.

Figure 14. Sectors and key enabling technologies in the domain of Advanced materials, technologies and systems



Strategic direction of the domain:

The development of the sectors within this domain is influenced by increasing international competition, pressure to reduce costs and increasing demands on manufacturing accuracy, quality, performance and reliability. These pressures often have significant societal impacts and can lead to social instability and crises, structural unemployment or the need to find new jobs for workers in declining sectors and retrain them for jobs in new industries. In addition, the threat of climate change also has significant influence in the form of pressure to reduce negative environmental impacts.

The use of key enabling technologies will therefore aim to **improve manufacturing efficiency in mechanical engineering, increase the value added of products and the competitiveness of businesses** operating in the above sectors of this domain. Emphasis will also be placed on **reducing material and energy requirements**, wider use of waste raw materials, as well as recycling and greening of production. The domain deals with strategically important products with high technical demands that normally require research and development for their innovation. Products that are created without systematic research and development are not included.

The negative costs associated with the dynamic development of modern societies can lead to significant internal and external pressures that may result in economic or social crises and conflicts. In building tools for the adaptability and resilience of Czech society, it is possible to take advantage of SSH knowledge to prevent negative phenomena.

[66] In accordance with the standard classification, the Czech Academy of Sciences is for analytical purposes classified as a research organisation in the government sector.

The application of key enabling technologies:

The domain puts emphasis on the use of R&D&I results in **Advanced manufacturing technologies**, especially the results of R&D carried out in cooperation between ROs and businesses. The potential for use mainly exists in mechanical engineering (where R&D results can be applied in advanced technologies such as 3D printing, advanced machinery, especially in machine tools and textile machines, which form a traditional segment of machinery manufacturing) and in other manufacturing processes and procedures used in this sector.

Advanced manufacturing technologies are also used in chemical manufacturing (e.g. in the manufacture of composite materials) as well as in biotechnological processes and wastewater treatment plants. Advanced manufacturing technologies are also applied in the energy sector in nuclear and non-nuclear power facilities and metallurgy (e.g. continuous casting, heat treatment, etc.).

In addition, the results of R&D focusing on **Advanced materials and nanotechnologies** will also find applications in all these sectors. In mechanical engineering, this mainly includes the use of advanced materials in new tools to be used in mechanical engineering (cutting, grinding), surface treatment and surface finishing. Advanced materials also have applications in the energy sector (e.g. materials for membranes, filters, etc.).

By contrast, in industrial chemistry and metallurgy the emphasis is on research and development of advanced materials and technologies for their production. In the case of industrial chemistry, there is potential, for example, in the research and development of advanced polymers and composites (3D printing), advanced metallic materials, materials for energy conversion and storage, catalysts, sophisticated organic compounds, nanomaterials and industrial biotechnologies, and advanced separation processes. In metallurgy, R&D currently focuses mainly on advanced steels and alloys with specific properties.

The results of R&D focusing on **Life sciences technologies/biotechnologies**, specifically industrial biotechnologies, will be applicable above all in industrial chemistry. Currently, the results of R&D are applied in waste and wastewater treatment processes. However, biomaterials and biotechnologies also have applications in mechanical engineering and the energy sector (for example, the use of biomass in the energy sector or the use of these technologies to reduce the negative environmental impacts of machinery manufacturing).

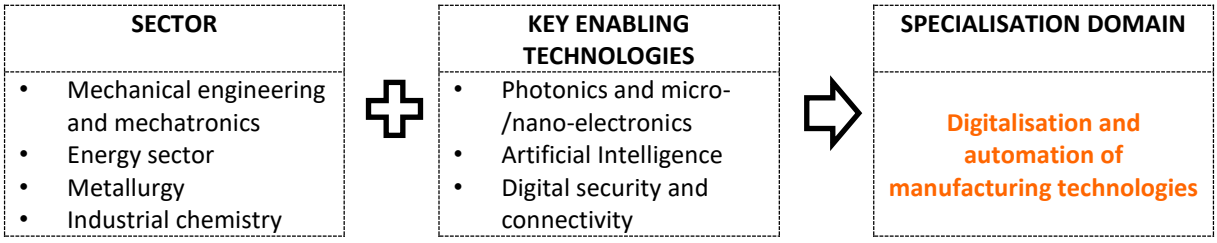
The domain also makes extensive use of SSH knowledge. Changes in technologies always have a significant impact both on society (its structure, the nature of work, interpersonal relationships) and on individuals (in terms of the psychological impacts on humans). The introduction of technological innovations is not possible without changes in many areas of social production and reproduction and must be accompanied by an evaluation of their wider impacts (sociology and psychology of work, changes in social norms, law and ethical norms). In addition, it is necessary to develop security research in the energy sector and society's core infrastructure systems. For new materials and technologies, there always are serious questions of dual use and problems concerning the assessment of the wider societal impacts of their introduction.

Digitalisation and automation of manufacturing technologies

The domain focuses on R&D&I in the promising and rapidly developing **fields of microelectronics, optics and optoelectronics, digital technologies and artificial intelligence** and their application in key sectors of the Czech economy, especially in **mechanical engineering, the energy sector and industrial chemistry**. The widespread application of digitalisation and automation will lead to a significant change in the world of work. Constant attention will have to be given to the human and societal dimensions of these processes that will result in the replacement of human labour by robotic systems, fundamentally changing both the work environment and employment opportunities.

Mechanical engineering and mechatronics can benefit from the existence of a large number of domestic businesses (including SMEs) with their own R&D activities. In the public sector (especially in HEIs), there is a broad knowledge base especially in computer science and ICT. At the same time, there is also strong R&D in the physical and technical sciences, which makes it possible to carry out R&D focused on communication equipment and software tools. Public research is strengthening its focus on digital security and connectivity, and in the Czech Republic the quality of publications in this field is the highest of all KETs. Also, digital security and connectivity has the highest proportion of publications created in collaboration with businesses, which points to relatively well-developed cooperation between the ROs and the application sector. AI-oriented R&D is also strengthening, as shown by the high increase in public support, and there is also well-developed cooperation between businesses and ROs. In the domain, emphasis is – for these reasons – placed on cooperation between businesses and ROs and the use of the results of R&D carried out in public research, because a significant number of businesses operating in application sectors do not have expertise and experience in R&D focused on these advanced technologies.

Figure 15. Sectors and key enabling technologies in the domain of Digitalisation and automation of manufacturing technologies



Strategic direction of the domain:

For the key sectors of the Czech economy, it is necessary to transition to Industry 4.0. This is also why the domain focuses on the development and implementation of digital technologies, automation of manufacturing processes and replacement of human labour (Industry 4.0). Given that labour productivity in many sectors (including mechanical engineering) remains relatively lower in the Czech Republic, the deployment of advanced technologies into production processes can be seen as a significant opportunity for restructuring the Czech economy, especially in sectors that contribute significantly to GDP.

The domain will have a significant focus on the development of artificial intelligence capabilities and on the use of artificial intelligence in machinery manufacturing, the energy sector and other sectors. The domain also aims to stimulate the development of challenging R&D that will be oriented towards disruptive innovations using promising digital technologies and artificial intelligence. In addition, the area of cyber security is also included, which is becoming increasingly important in the context of rising security threats and the greater and more-integrated inclusion of these technologies in manufacturing processes. In addition to technological and production changes, significant economic and social impacts can also be expected, which may lead to unemployment or increased social tensions. It is necessary to explore and set up tools to mitigate any potential negative impacts or develop alternative options for social cohesion. The development of artificial intelligence is a big topic on a global scale. Once it is fully integrated into society, a number of completely new ethical or legal issues will arise that will have to be addressed with emphasis on societal responsibility.

The application of key enabling technologies:

The results of R&D in **photonics and micro-/nano-electronics** have a wide range of applications, because electronic and optoelectronic systems are part of all modern manufacturing technologies. There is potential mainly in mechanical engineering, where R&D results will be applied in advanced machinery, including the traditional and strong segment of machine tools and textile machines. Sensors and electronic systems also have applications in engineering technologies (cutting, grinding, welding). The results of R&D in photonics and micro-/nano-electronics are also applied in the energy sector, both in energy generation facilities and in distribution systems. R&D results have applications in industrial chemistry (electronic control systems, sensors, etc.).

The application of R&D results focusing on **Artificial intelligence** and **Digital security and connectivity** has been increasing recently, which is related to the dynamic development of this progressive technological field. There is potential for the application of R&D results in mechanical engineering and mechatronics, where these technologies are an important prerequisite for strengthening the international competitiveness of businesses (robotisation and automation of manufacturing).

In the energy sector, the greatest potential for the application of R&D results is in the area of smart grids and smart cities, where these progressive technologies will contribute to improving energy supply reliability and security.

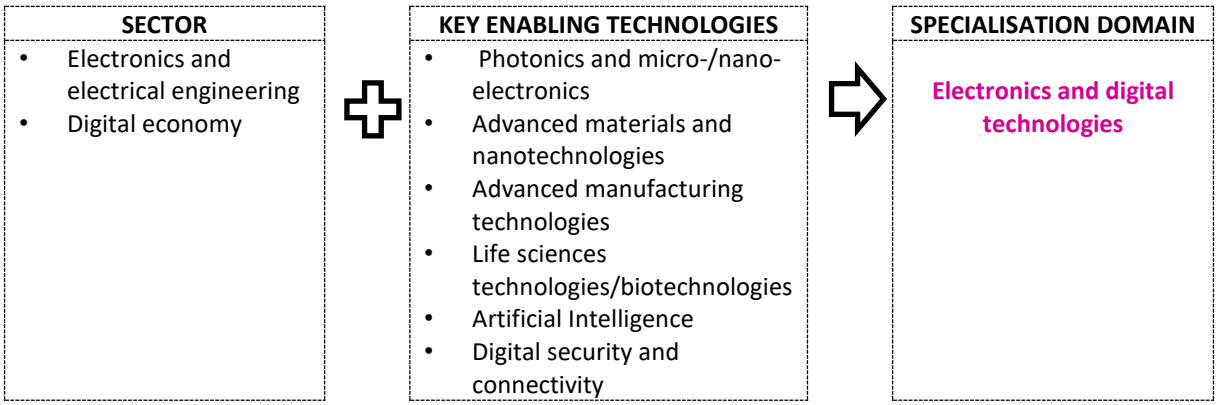
Electronics and digital technologies

The specialisation domain includes the **electronics and electrical engineering** sector and the **digital economy** area, i.e. an area that uses digital technologies to produce products and services. Business R&D expenditures in this area are very high in the Czech Republic and both areas are also among the most dynamically developing sectors in the Czech Republic. Of all the sectors, the digital economy even has the highest business R&D expenditure and the greatest increase in R&D expenditure. In both areas, businesses that are active in research operate in most self-governing regions of the Czech Republic. At the same time, businesses often cooperate with ROs in R&D&I projects – together with high patent activity, this creates the conditions for the use of public R&D

in business innovations. Digitalisation naturally also affects other segments of society, and it will have a significant impact mainly on the education system in the Czech Republic.

In public research (especially in technically oriented HEIs), there is a strong knowledge base for this domain in the areas of computer science, cybernetics, mathematics, digital humanities and physical sciences. There are also research centres operating in the Czech Republic that were built using EU funds, that carry out R&D in the field of material sciences, electrical engineering and electronics, digital technologies, ICT, cybernetics and artificial intelligence and that have high-quality research infrastructure and professional capacities.

Figure 16. Sectors and key enabling technologies in the domain of Electronics and digital technologies



Strategic direction of the domain:

The areas that are covered by the domain are currently developing dynamically and in the future will play a significant role in ensuring the international competitiveness of businesses operating in many sectors of the Czech economy. The application of electronic and optoelectronic components and systems is increasing in all sectors of the economy, and there is pressure to improve their performance, speed and reliability. Digital technologies are accelerating their development and **application in production processes and technologies, in public administration and in products and services** used in everyday life. Another influential trend is the wider spread of the **sharing economy** in society, and the increasing threats in the area of **cyber security** are also notable. Therefore, there is significant development potential within the specialisation domain, especially in R&D of new and progressive materials and manufacturing technologies and their application in electronics, optoelectronics and electrical engineering. The key driving force within the domain will be R&D focused on the promising and intensively developing area of digital, information and communication technologies and their implementation in manufacturing technologies and equipment for various industries as well as in products and services used in households and society.

The development of the digital economy has societal implications, and its impacts also carry significant risks. It is therefore necessary to address the socially sustainable development of the digital economy and develop measures to eliminate the risks of its impacts, including cyber threats. This is done by involving **research in the social sciences and humanities** (sociology, psychology, law, ethnology, political science, etc.). In this context, the **digital humanities** (e.g. the field of information extraction from textual sources and data) are becoming new areas of research.

The application of key enabling technologies:

R&D in the KETs of **Advanced materials and nanotechnologies** and **Advanced manufacturing technologies** has the potential to be implemented mainly in cooperation between businesses and ROs. In the projects implemented to date, R&D focused on materials for optics and optoelectronics (sensors, light sources, optical fibres/light guides, etc.), as well as materials for electronics and advanced metals (alloys, metals with specific properties, etc.). The results of R&D focused on Advanced manufacturing technologies will have applications in equipment for the manufacture of electronic and optoelectronic components and equipment in the areas of ICT and the treatment and processing of certain elements (cutting, grinding, surface protection of materials, etc.), including automated production processes and the use of robotic equipment. Other application areas are measurement technology, control and metrology.

In the case of R&D focused on **Life sciences technologies/biotechnologies**, the projects mostly deal more with the use of electronics and optics (i.e. optical methods) in biotechnologies and the natural sciences (especially optical and electron microscopy, devices for analysis and diagnostics, monitoring, etc.). The R&D results also have applications in biosensors.

The results of R&D focused on **photonics and micro/nano-electronics** will be applied in electronics and optoelectronics, or optical communications, and digital technologies. There is potential for application mainly in optical sensors, optical sources, light guides and optical fibres. The results of R&D in the field of photonics and electronics will also find applications in electronic, optoelectronic and optical components and devices produced by businesses operating in this application sector.

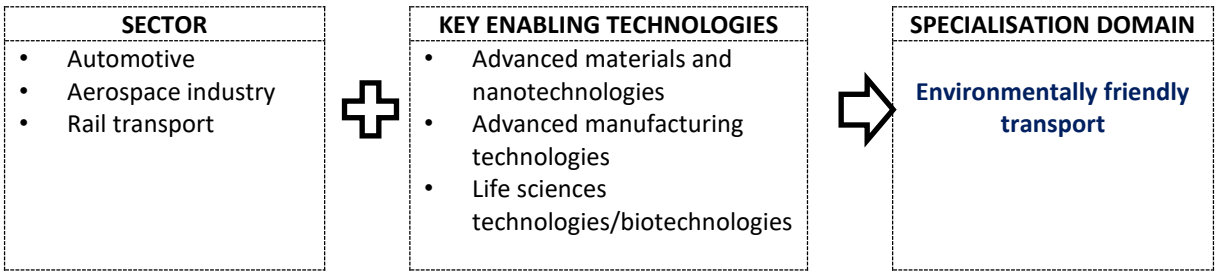
In particular, **Artificial Intelligence** and **Digital security and connectivity** have strong links to the specialisation domain, as demonstrated by the widespread use of these technologies in electronics, optoelectronics, electrical engineering and digital technologies. The potential for the application of the results of R&D focused on Artificial Intelligence exists mainly in businesses operating in the digital economy area. The projects of businesses in this sector deal with the R&D of methods and approaches in artificial intelligence (e.g. machine learning, neural networks, image recognition and cyber-physical problems) and their application in specific situations, such as in computer vision, speech and speaker recognition, person identification, big data processing and data mining, motion control, smart devices, etc. The potential for application of R&D results in the KET of Digital security and connectivity exists mainly in the area of controlling communication (including wireless) and increasing its security and defence against cyber threats (including identity protection). There is also potential for the application of R&D&I results in the field of IoT.

Environmentally friendly transport

The domain of Environmentally friendly transport focuses on the use of key enabling technologies and applications in transport in order to reduce the negative environmental impacts of transport. As with the previous domain, the domain of Environmentally friendly transport focuses on key sectors of Czech industry and construction, which have a long tradition in the Czech Republic. Space technologies and applications (technology transfer, applications for more efficient traffic management, etc.) also play an important role.

The domain is aimed at the use of the results of R&D focused on Advanced materials and nanotechnologies, Advanced manufacturing technologies and Life sciences technologies/biotechnologies. Given that R&D results from multiple KETs are applied within the sectors of the domain, support should also be provided to projects of a multidisciplinary nature, especially those involving public-sector ROs. This mainly means involving research centres that were built using EU funds and that operate in the field of advanced materials, manufacturing technologies and biotechnologies in R&D&I projects implemented in cooperation with domestic businesses. Especially in the case of materials R&D and R&D focused on nanotechnologies and biotechnologies, it will be important for businesses to cooperate with public-sector ROs that have the expertise and research infrastructure to carry out such R&D.

Figure 17. Sectors and key enabling technologies in the domain of Environmentally friendly transport



Strategic direction of the domain:

In the 21st century, transport is strongly influenced by the pressure to operate in an energetically and environmentally sustainable manner while maintaining accessibility. Due to political and public pressure to combat climate change and the general attitude of society, it can be expected that interest in modern, environmentally friendly and energy efficient transport vehicles and related equipment will increase in the future. The domain therefore focuses on supporting research and development in order to achieve a maximum reduction in emissions in transport, reduction in fossil fuel consumption, the development of new materials with

higher durability or environmentally friendly propulsion systems including e-mobility technologies. An integral part of the domain is the environmental friendliness of manufacturing in terms of using a raw material base relying on recycled materials or materials from renewable sources and research into the efficient use of transport vehicles and transport infrastructure for raw material recovery at the end of their useful life.

The area of environmentally friendly transport is also connected with the need to create infrastructure and transport systems for electromobility in a broader sense (the use of hydrogen or synthetic methane based on electrolysis), infrastructure for advanced transport – smart grids, and vehicle power management for the operation of electric buses and hybrid buses.

In the context of environmental responsibility, there is a need to build interest and understanding of the importance of the above new technologies, consider their economic and social implications, and develop a system of effective education in the transformation of key enabling technologies, including transport. This is how a stronger, adaptable and resilient society can be built.

The application of key enabling technologies:

Within the domain there is a potential for the use of the results of R&D focused on Advanced materials and nanotechnologies, Advanced manufacturing technologies and Life sciences technologies/biotechnologies, which can contribute to improving the use and properties of vehicles, improving their parameters and reducing the manufacturing complexity, as well as to reducing the negative environmental impact of transport.

A wide range of **advanced materials**, such as metallic materials and special alloys, polymeric and other organic and inorganic materials, composites, fibre and textile materials, nanomaterials and smart materials, have the potential for application in transport equipment and infrastructure. These materials can be used in many components of transport vehicles and in various technologies that are used in the manufacture of transport equipment and in the construction of transport infrastructure, such as surface treatments that improve the energy efficiency of propulsion units, technologies that improve safety and reduce negative environmental impacts, etc.

In addition, the results of R&D focused on **Advanced manufacturing technologies** and efficient material recycling also have potential for application in the manufacture of transport equipment and the building of transport infrastructure. The projects of businesses operating in the application sectors within this domain were focused, for example, on technologies for precision casting, additive manufacturing, grinding, the use of foils, the use of laser technologies (welding), vacuum technologies, surface hardening and other technologies for the manufacture of transport equipment.

The results of R&D focused on **Life sciences technologies/biotechnologies** have the potential for application in environmentally friendly technologies, technologies for the removal of pollutants and the treatment of polluted water and air, the production of biofuels, etc. The results of R&D in biotechnologies may also find applications in biomaterials that can be used in transport equipment and transport.

Technologically advanced and safe transport

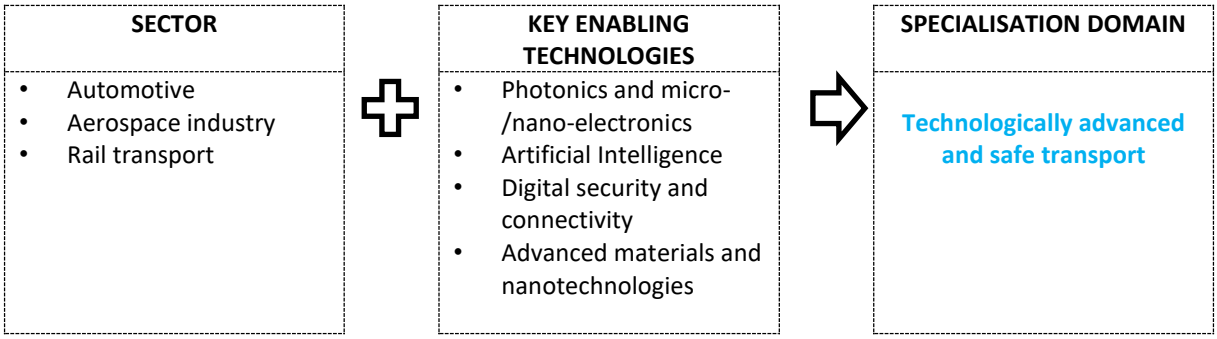
The domain focuses on the automotive and aerospace industries, rail vehicles and infrastructure, its technological equipment and the related services with parameters that will ensure the maximum level of safety. New autonomous transport systems will also have a significant impact on cities and municipalities and the settlement structure of the Czech Republic, which will be reflected in large-scale infrastructure investments. The **automotive industry** contributes significantly to the Czech Republic's overall economic performance. R&D expenditure in the business sector is very high and growing rapidly. On an international scale, the Czech Republic is an automotive power with a good background in terms of the technical knowledge and skills of employees. The **aeronautical industry** has almost a century-long tradition in the Czech Republic, the strongest aspect of which is professional continuity and internationalisation. The Czech Republic is one of a few countries in Europe that can develop and manufacture complete aircraft and their parts on its own. At the same time, the Czech aeronautical industry has become part of supply chains for major global players such as Airbus and Boeing. The Czech Republic also has a tradition of more than 60 years in the area of **space** activities. In the early days, the focus was entirely on the preparation of scientific instruments and scientific satellites, which were primarily provided by scientific institutions. As technologies developed and the Czech Republic began to cooperate with the European Space Agency (ESA), the focus has been gradually shifting to industrial activities, the preparation of application satellites and the use of their data and services. In the case of the space industry, there has been technology and knowledge transfer to the aeronautical and automotive industries. In addition, the share of space

activities in GDP is also gradually increasing, although it is still very low compared to other areas of transport. As far as the **rail industry** is concerned, Czech manufacturers are among the most sought-after suppliers of products in the markets of the EU and other countries, due to their quality and competitive prices.

The knowledge base for R&D focused on the domain's various areas mainly exists in technically oriented HEIs, certain institutes of the CAS and certain application-oriented research institutes in the government sector as well as research-oriented entities in the business sector. The Czech Republic also has research centres that were supported by EU funds and that carry out R&D in the fields of photonics and micro-/nano-electronics, digital technologies, artificial intelligence and digital security – the research centres' results have a wide range of applications in transport equipment manufacturing, transport and transport safety, where they are increasingly used along with gradual digitalisation and automation. In addition to autonomous driving systems and sensors, safe transport is also about integrated safety.

As these centres have good research infrastructure and expertise in a number of relevant fields, they should be involved in implementing projects in collaboration with businesses and other entities, especially projects that cover the entire innovation cycle and can lead to breakthrough innovations using progressive digital technologies. The complex problems that are associated with the development of autonomous systems and safe transport will need to be addressed in an interdisciplinary framework of cooperation between the technical sciences and the humanities (in particular applied ethics, legal theory, sociology and psychology).

Figure 18. Sectors and key enabling technologies in the domain of Technologically advanced and safe transport



The **Automotive** sector (often referred to as the automotive industry) can be defined as an industry within the secondary sector engaged in the development, manufacture, marketing, sale, maintenance and disposal of on- and off-road motor vehicles and their accessories. For the purposes of this strategy, this sector includes on- and off-road cars and trucks, buses, electric buses and trolleybuses.

Strategic direction of the domain:

The domain reflects trends that are gaining momentum in transport worldwide. Autonomous driving, which is one of the main trends determining the future of mobility, is a technologically complex area to which the automotive sector in particular must respond in order to remain competitive. Robotisation and automation, as knowledge-intensive technologies, will be increasingly used in manufacturing. However, technological advances must be accompanied by further development in the ethical, legal and human factor fields.

Emphasis is also placed on safety (i.e. both safety and security), including innovations in the area of active and passive vehicle safety, but also supporting measures for the safety of the entire transport system. The aim is to improve the reliability and safety of road, air and rail transport and traffic. The domain focuses on the use of modern technologies, especially advanced electronic and optoelectronic components and systems, digital technologies, satellite systems, ICT (including big data and their processing, transmission and security) and AI-enabled technologies in transport equipment, in monitoring, controlling and ensuring transport/traffic safety and other areas related to transport. In addition to autonomous driving systems and sensors, safe transport is also about integrated safety. It is also necessary to focus more on the opportunities presented by new technologies and, by extension, enable the transport sector to apply R&D results as smoothly as possible in real life – to achieve that, it is necessary e.g. to link the construction of transport infrastructure more closely with elements of intelligent transport systems (ITS) and cooperative ITS systems (C-ITS). For example, C-ITS systems

are based on communication (data exchange) regarding current traffic emergency situations, both between vehicles themselves and between vehicles and transport infrastructure equipment, and are related e.g. to the emerging concept of smart cities.

The domain also includes the human-machine and road user-machine interfaces. In addition, user acceptance of the systems and autonomous mobility as a whole, appropriate and effective user interfaces for systems used in transport vehicles, and the inclusion of ethical and legal aspects and socio-economic considerations, including the availability of new technologies and the consideration of the specific needs of their users, are also an essential part of this area.

Data and services that are based on space systems represent one of the key drivers for improving efficiency in a wide range of sectors. Therefore, there is a growing demand for both satellite systems and launch vehicles to carry satellites to space. A major trend in space technology is the emerging massive participation of the private sector, which is increasingly taking the initiative in developing its own space technologies and building its own launch vehicles and satellite systems. The Czech Republic is now able to supply complete subsystems for satellites and parts of launch vehicles. However, the focus must also be on building the capability to deliver complete systems with even higher value added. Demand is particularly high in the domains of telecommunications, earth observation and launch vehicles. Given the specificities of satellite navigation systems, the core focus is on the development of new receivers and, as with all application domains (Earth observation and satellite telecommunications), on downstream services. One of the goals is to automate the operation of satellite systems and to automate the use of their data and services. The development of space technology thus leads not only to greater efficiency in transport and other industries, but also to the expansion of scientific knowledge.

The application of key enabling technologies:

The results of R&D in the KET of **photonics and micro-/nano-electronics** have the potential for application in light sources used in transport vehicles and transport systems, sensors of various quantities and electronic units, systems and devices of vehicles. Also, the R&D results have applications in measuring equipment and energy storage (batteries). The results of such R&D can be used by companies operating in all application sectors within this thematic area, especially in the Automotive sector. In the field of space activities, this includes the use of photonics in satellite communications (information transmission using laser, optical communication within satellites and in ground-based systems) and in Earth observation. Also, the results of R&D focused on **Artificial intelligence** and **Digital security and connectivity** may find applications in multiple application sectors of this specialisation domain. There is potential for application for example in decision-making and control processes in transport vehicles and transport systems, in eliminating risk factors in transport and optimising traffic flows, etc. The R&D results from both KETs will also find applications in autonomous vehicles and aircraft (drones), i.e. in intelligent transport systems. The results of R&D in the field of cyber security and connectivity will lead, among other things, to improved security of communication in transport systems (in intelligent transport), communication between vehicles, etc.

In space activities, it mainly includes the use of artificial intelligence (and the results of R&D in this area) in the autonomous control of individual satellites (or robotic probes) and satellite systems; the processing of satellite navigation signals, signal correction in satellite telecommunications and the automated processing of satellite images from Earth observation. Artificial intelligence is also widely applied in scientific data processing. Digital security is key to the reliability of operation of and the provision of data and services by satellite systems.

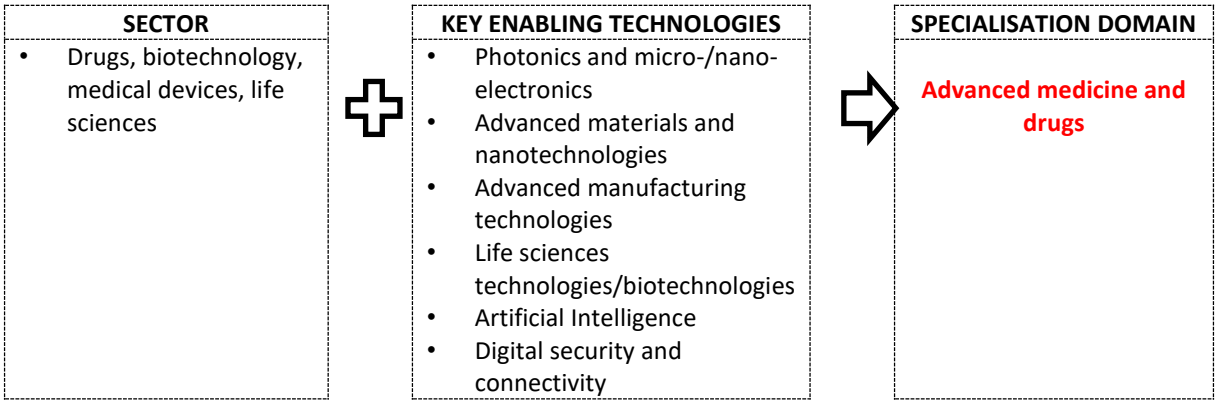
Advanced medicine and drugs

The domain of Advanced medicine and drugs focuses on R&D in medicine, diagnostic equipment and medical devices that use advanced materials, electronic and optoelectronic components and progressive digital technologies, including artificial intelligence. Another R&D&I area is R&D on innovative drugs and their use in medicine. As an integral part of progress in this domain, there is a systematic effort to eliminate the potential negative consequences of the development of new biological and medical methods and to prevent their misuse (e.g. in the field of genetic engineering). Therefore, the desired development of new therapeutic methods and procedures is accompanied by evaluation of contemporary knowledge and possible modifications to existing ethical, legal and societal norms.

Business R&D expenditure in these areas is relatively high and increasing. Business research is concentrated in several self-governing regions – Prague and the South Moravian, Moravian-Silesian and Central Bohemian Regions. The advantage of this domain is the Czech Republic's strong knowledge base in medical sciences, especially in the field of clinical medicine. By international comparison, R&D is of very high quality and both R&D focus on this area and its quality are increasing. For the implementation of instruments to support R&D&I, it is

convenient that ROs have well-established links with the application sector and at the same time have the potential to produce applied results that are usable in business innovations. This, together with the broad knowledge base in fields such as material science, biotechnology, computer science and ICT, and the high number businesses from other sectors that are active in research and that may participate in R&D&I within this specialisation domain, creates suitable conditions for the implementation of instruments to support R&D&I, the results of which will contribute to further development in the field of healthcare and medical technology as well as to improvement of medical care quality. In the Czech Republic, there are also a significant number of research centres that operate in medical and biological sciences as well as in optoelectronics, advanced materials and computing, which creates conditions for the implementation of demanding R&D, the results of which will have the potential for disruptive innovation.

Figure 19. Sectors and key enabling technologies in the domain of Advanced medicine and drugs



Strategic direction of the domain:

The main drivers that influence the direction of R&D&I in this domain are trends in societal challenges such as the increasing life expectancy, the ageing of the population and the development of civilisation diseases. In addition, this also includes enormous threats such as pandemics, biological weapons or antibiotic resistance. Another key driver is the development of technologies and their application in advanced medicine, bringing new diagnostic and therapeutic approaches (see below). When addressing the impacts of the above trends and the sustainability of health systems, the combination of advanced medicine and digital technologies plays an essential role. The development of information and communication systems in healthcare makes it possible among other things to apply more widely the principles of delivering healthcare and medical care at a distance (telemedicine) or to develop personalised medicine. In this context however, the increasing cyber threats cannot be ignored.

The application of key enabling technologies:

R&D results from all KETs can find applications in this specialisation domain. Especially the results of R&D focused on **Life sciences technologies/biotechnologies**, which have applications mainly in new advanced drugs and treatments for diseases (cancer, diabetes, etc.), have the highest potential. There is also considerable potential for the application of the results of this R&D in materials for medical purposes (e.g. surface treatments), implants, materials for additive manufacturing and medical equipment. Current R&D also focuses on stem cells, genetics, immunity, DNA, biomarkers, tissues and other areas that have significant potential in the future.

The results of R&D focusing on **Advanced materials and nanotechnologies, Advanced manufacturing technologies** and **Photonics and micro-/nano-electronics** also have a high potential for application in this domain. The result of R&D in advanced materials and nanomaterials of various nature (metallic, composite, ceramic, polymer, textile and other materials) has applications mainly in the field of medical devices such as implants, including their surface treatments and special surfaces (bone implants and dental implants), materials used in diagnostic devices (magnetic resonance imaging) or in special technologies such as additive manufacturing. The results of R&D in photonics and micro-/nano-electronics are mainly applied in products such as sensors and light sources, light guides, imaging equipment and diagnostic equipment. The results of R&D in Advanced manufacturing technologies mainly have potential for application in additive manufacturing, medical orthoses, prostheses, etc.

Progressive digital technologies such as **Artificial Intelligence** and **Digital security and connectivity** are increasingly being applied in diagnostic equipment and treatment procedures. Current R&D&I projects of

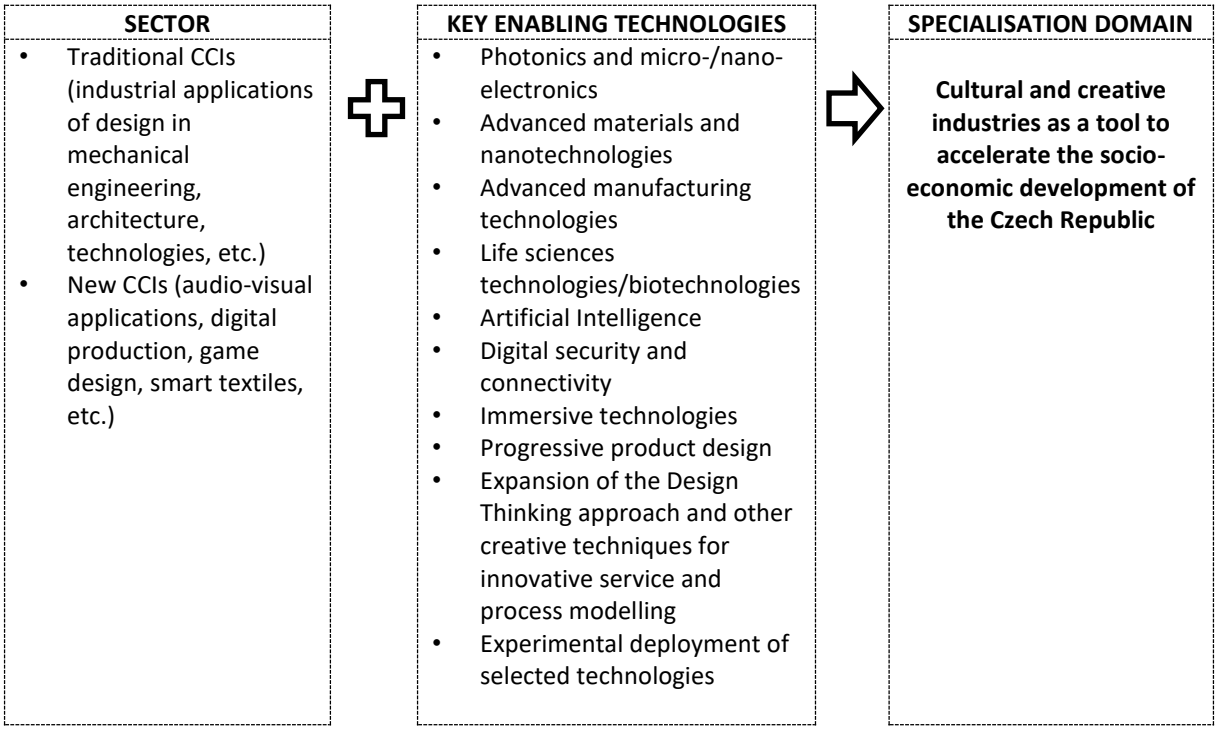
businesses in healthcare and life sciences addressing AI issues focus on machine learning, digital data (image) analysis and home care. While the number of such projects is not yet very high, the strong knowledge base in medical sciences and computer and technical sciences, together with the high number of businesses that are active in research in electronics and ICT, creates the conditions for these progressive technologies to find wider application in health equipment and medical care, for example in telemedicine, robotic and smart systems and in information and communication systems in healthcare or in the field of secure communication and biodata protection. In this context, it will also be necessary to explore and lay down the ethical basis and rules for the use of AI in medical practice, including the legal implications and their enforceability.

Cultural and creative industries as a tool to accelerate the socio-economic development of the Czech Republic

The specialisation domain focuses on the area of cultural and creative industries (CCIs), which are perceived – among other things on the basis of European good practice examples – as a tool to accelerate economic and social development, provided that selected technologies are applied. In these specialisations, business sector R&D expenditure shows an increasing trend, which is driven by opportunities in the application of advanced manufacturing technologies, nanomaterials, biotechnologies, immersive technologies and artificial intelligence combined with design. Here, design is seen as a tool to integrate the functional, distribution, emotional and social experiences of the customer or product user. The segment is generally represented by small- and medium-sized enterprises with extensive research potential, as well as start-ups and, to a lesser extent, research organisations focused on industrial and product design, digital and audiovisual production, applications of the Design Thinking approach and, last but not least, creative approaches in the social sciences, humanities and arts. Entities that do research operate in all regions of the Czech Republic – the highest R&D expenditures and the resulting outputs and results are statistically significant for Prague, the Central Bohemian and the Zlín Regions.

There is a broad knowledge and research base for the implementation of R&D, because on the one hand, the domain includes technology-based application sectors such as mechanical engineering, the glass industry or textile industry, in which a wide range of materials, technologies and manufacturing processes find application. On the other hand, there are areas such as media, cultural heritage, audiovisual production, the book market, etc., where progressive digital technologies, including artificial intelligence, are used extensively. Selected research centres operating in materials engineering and digital technologies can also participate in R&D activities and projects aimed at CCIs, which have been implemented in domestic applied research since 2007 and whose results have applications in traditional and new cultural and creative industries. The CCI area is also characterised by well-developed cooperation between businesses and ROs as well as a relatively high number of patent applications filed by businesses and ROs.

Figure 20. R&D activities and application sectors if the domain of Cultural and creative industries as a tool to accelerate the socio-economic development of the Czech Republic



Strategic direction of the domain:

In the Czech Republic, linking the CCIs with technology and traditional industry has the potential to shift the Czech economy towards generating products and services with high value added and to improve the competitiveness of this production in foreign markets. In this respect, design plays an important role – today, design creates a key comparative advantage or helps to create customised solutions in many sectors. However, the domain focuses not only on design as one of the product parameters, but also on other applications of design and the Design Thinking method in high value added services.

The domain also focuses on the application aspects of R&D in key enabling technologies in the traditional CCI sector, where it builds on the Czech Republic's strong industrial and craft tradition and also on the cultural heritage area. Above all, it is about the involvement of advanced technologies in the design and manufacturing process and in materials research. In addition to this traditional focus, the domain also emphasises CCIs related to new technologies and the digital economy. This combination often gives rise to new industries and markets, which are currently developing dynamically and where companies from the Czech Republic are able to reach world-class levels (e.g. the gaming industry). In connection with the progressive development of the sector, it is also necessary to take into account the consequences in terms of legal regulation, intellectual property, cultural policy and the transformation of business models of R&D results in the CCIs.

The focus of the CCIs is on humans and their quality of life. The domain therefore envisages that the technical sciences will be interconnected more deeply with the social sciences, humanities and arts with the aim of creating desirable synergies that improve the quality of human life and the application of innovations for well-being and regional development.

The application of key enabling technologies:

R&D results from the below preferred KETs have applications in both application sectors:

1) **Photonics and micro-/nano-electronics** – applications are mainly related to the use of optical materials in production falling under traditional CCIs, or possibly to other technological applications (e.g. glass technologies, LED and laser light sources, 3D scanning, etc.). Other applications exist in the field of sensorics. Last but not least, we find applications in visualisation technologies, which are closely linked to the use of immersive technologies (see item 7).

2) **Advanced materials and nanotechnologies** – applications are mainly related to traditional CCIs (e.g. custom manufacture of machinery, development of polymer systems), with applications e.g. in construction activities, manufacture of glass, manufacture of ceramics, manufacture of textiles. A specific area for the application of advanced materials is biotechnology (see item 4).
3) **Advanced manufacturing technologies** – applications are related to both traditional CCIs and new CCIs. These are applications in the pre-production and production phase, e.g. prototyping technologies, dynamic modelling of production processes, additive manufacturing, etc.).
4) **Life sciences technologies/biotechnologies** – applications are mainly related to new CCIs (e.g. manufacture of design packaging made of biodegradable materials) and are linked to other contemporary application sectors of the economy, such as the circular economy.
5) **Artificial intelligence** – applications are related to the use of automatic and autonomous equipment and devices in traditional CCIs (e.g. evaluation of big data and nuances of manufacturing processes) and new CCIs (e.g. scanning devices to validate the authenticity of artworks, increasing the value of cultural heritage using digital humanities tools, etc.).
6) **Digital security and connectivity** – applications are envisaged in the field of digital communication and remote forms of cooperation (e.g. remote access to databases of artworks, the remote study of collections, identification and authorisation, etc.).
7) **Immersive technologies** – at the time of preparation of the specialisation domain (12/2020), there is exponential growth in immersive technologies that use e.g. 360° video sequences, virtual reality, augmented reality and holography to enhance the customer experience of the product offered (e.g. use in architecture and construction) or the service offered (e.g. remote business models for services, mass remote communication services, etc.).

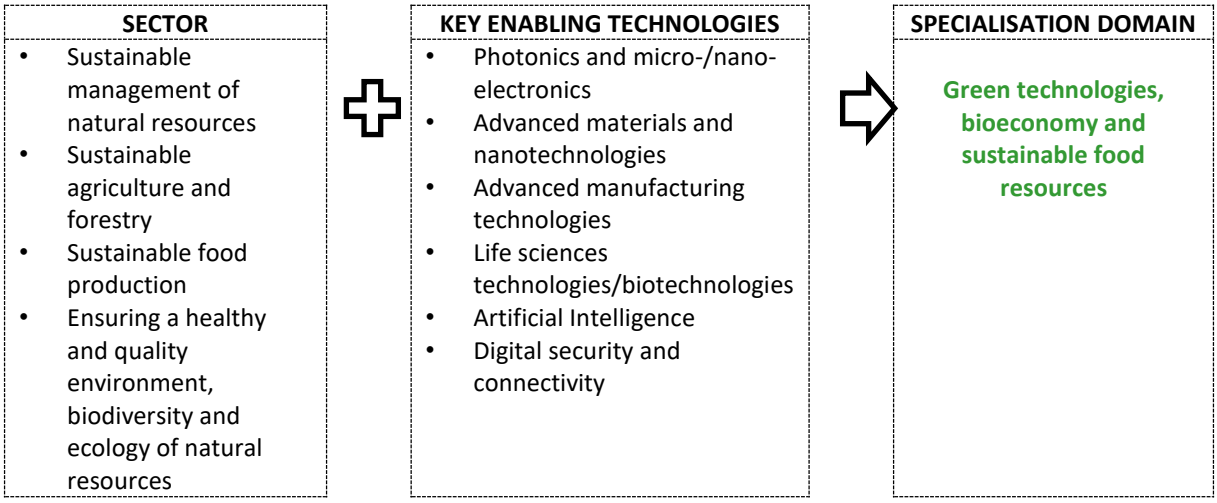
Green technologies, bioeconomy and sustainable food resources

The domain includes sectors with a focus on agriculture and the environment – sustainable management of natural resources, sustainable agriculture and forestry, sustainable food production and ensuring a healthy and quality environment, biodiversity and natural resource ecology, the impact of climate change adaptation on society.

Even though business R&D expenditure is increasing in this area, its growth rate lags behind the average growth rate of business R&D expenditure. In contrast to most sectors in other domains, R&D activities in sustainable agriculture and environmental sectors are mainly carried out by domestic businesses, and the share of domestic businesses in the implementation of R&D is relatively stable. This shows the strong position of the domestic companies segment in the research base of the business sector, and this base is largely made up of SMEs.

There is a relatively strong knowledge base for agricultural and environmentally oriented R&D in ROs under the Ministry of Agriculture and in ROs under the Ministry of the Environment as well as in some ROs in the business sector. Another conducive factor to the implementation of instruments to support R&D&I in this thematic area is the broad knowledge and research base in the public sector (especially at HEIs). Since most projects in which businesses participate are implemented in cooperation with ROs, there is potential for implementing R&D projects where businesses (even businesses with no R&D experience) will cooperate with ROs and use the results of their R&D. For R&D in the field of digital technologies and their implementation, it is possible to use the knowledge and research base in computer science and ICT in public R&D (especially at HEIs), which has the relevant expertise and also the research infrastructure for implementing R&D with that focus. The implementation of R&D projects should involve not only research centres that were built using EU funds and that operate in the field of agricultural and environmental sciences, but also centres operating in the field of digital technologies, computer equipment and artificial intelligence.

Figure 21. Sectors and key enabling technologies in the domain of Green technologies, bioeconomy and sustainable food resources



Strategic direction of the domain:

The domain reflects the need for innovation in the areas of natural resources, agriculture and food. This is an area in which the Czech Republic currently has no immediate comparative advantage on an international scale, but it is reasonable to assume that the area is critical with respect to maintaining the Czech Republic's competitiveness and resilience and preventing risks (sustainability of development, resource security and sufficiency) that may jeopardise the prosperity of the economy and society in the long-term. Within this area, too, narrower R&D&I topics have been identified that show significant dynamism in terms of the new findings produced and the applications achieved. At the same time, in this domain the strategy also aims to apply key enabling technologies in agriculture, food production and environmental protection.

The application of key enabling technologies:

Life sciences technologies/biotechnologies have the highest potential for the application of R&D results. In the case of food production, the results of such R&D have potential for application e.g. in new and progressive manufacturing processes, analyses of food composition and quality and issues relating to food safety. Also, Life sciences technologies/biotechnologies have considerable potential for application in sustainable agriculture and forestry. The results of R&D focusing on forest crops, agricultural crops, breeding and other technologies in crop and animal production will have applications in this sector. Life sciences technologies/biotechnologies will also find applications in the areas of agricultural land and waste management, ensuring a healthy and quality environment, biodiversity and natural resource ecology, where there is potential for application mainly in waste management, issues relating to air pollution and water management.

The results of R&D in **Advanced manufacturing technologies** have the potential for application in agricultural equipment and technologies used in agricultural production, forestry and ecology. These include, for example, automatic equipment for various purposes (sorting, inspection, transport), crop cultivation equipment, agricultural/forestry transport equipment and other agricultural machinery. R&D results will be applied in technologies contributing to sustainable landscape development and technologies reducing negative environmental impacts.

The results of R&D focusing on **Advanced materials and nanotechnologies** have the potential to be used both in innovative environmental technologies (e.g. in connection with the use of raw materials) and in food production (including technologies that take advantage of nanotechnology-based products). The advanced materials that may find applications in these sectors include e.g. bioactive substances, polymers, polymer carriers, polycarbonates and nanomaterials.

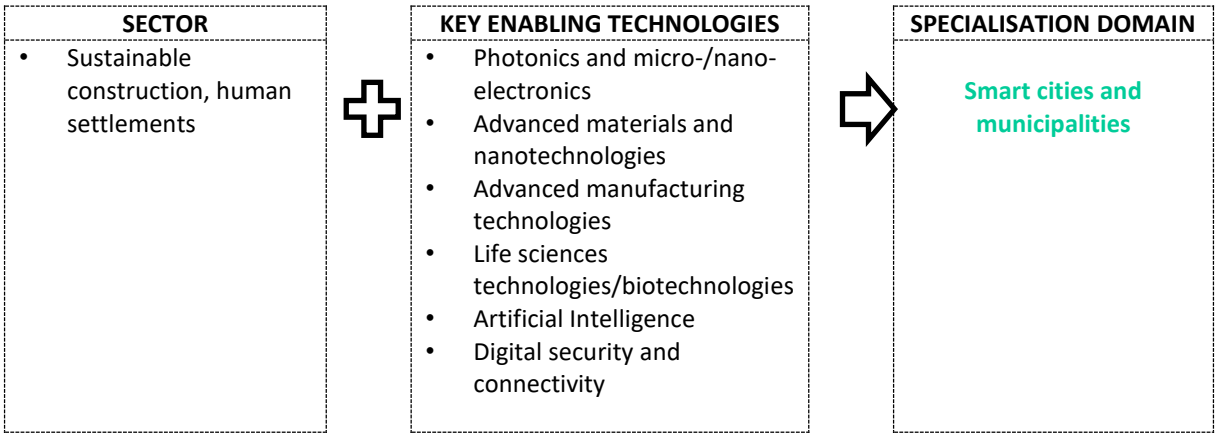
The results of R&D focusing on **Artificial intelligence** and Digital **security and connectivity** also have the potential for application. These progressive technologies can be used in technologies for Agriculture 4.0 (smart farming), in precision agriculture, control systems for mobile equipment, expert systems, etc. There are also other applications in food production.

Smart cities and municipalities

The domain focuses on R&D&I in new and advanced materials and technologies, including digital technologies, ICT and artificial intelligence, and their application in civil engineering, construction, buildings and human settlements, including the links to sustainability and environmental protection.

Business R&D expenditure in the construction and human settlements sector is high and slightly increasing. The sector has a high number of domestic businesses that are active in research. In addition, the public support received by these businesses in R&D&I projects is also relatively high and continues to increase. The R&D&I projects in which businesses participated focused on materials that can be used in construction and addressed technologies and processes in the construction sector. Another R&D&I topic is energy use in the residential and non-residential buildings sector (improving energy efficiency; using mainly passive elements within the building itself, or internal parts of the building that lead to energy savings; technologies and procedures associated with buildings that are passive or active in terms of energy; using mainly low-emission technologies for local electricity or heat production and its integration into the basic elements of buildings, etc.) Attention is also given to the issue of waste (waste water, waste air) and waste treatment. The patent activity of both businesses and ROs is high, which – together with the well-developed cooperation between ROs and businesses – creates suitable conditions for the use of R&D results in the public sector in innovations.

Figure 22. Sectors and key enabling technologies in the domain of Smart cities and municipalities



Strategic direction of the domain:

The domain focuses on the use of key enabling technologies for new (smart) solutions in the field of buildings and human settlements. Given the increasing urbanisation, it is increasingly necessary to take account of the principle of sustainable development and the impacts of climate change, i.e. the efforts to reduce its impacts on people, society and nature. Therefore, the focus of the domain includes R&D&I topics oriented towards energy efficient buildings, the use of materials from renewable sources or new advanced materials. It is essential that the domain is oriented not only towards energy, building or transport sub-solutions, but also towards complex solutions that combine multiple effects aimed at both improving the quality of life and sustainability. Given that results from all KETs are applied in the domain, the projects that are supported within the domain should also include multidisciplinary R&D (e.g. carried out in collaboration with research centres that were built using EU funds).

The application of key enabling technologies:

The results of R&D focusing on **Advanced materials and nanotechnologies** have significant potential for application in this domain. These materials can be used in various areas of the construction sector, where they will improve the performance of buildings, including interior spaces, make construction more efficient and reduce negative environmental impact (e.g. concrete with specific properties, durable materials, special polymers and composites and recyclates).

The results of R&D in **Advanced manufacturing technologies** will also be used in the domain. These technologies can contribute both to increasing the productivity and quality of construction processes (e.g. additive manufacturing, manufacturing technologies for special building materials, energy-efficient technologies in buildings, etc.) and to reducing the negative environmental impacts of technologies and increasing environmental safety.

The results of R&D focused on **Life sciences technologies/biotechnologies** also have applications. There is potential in particular in protecting the environment (treatment of waste water, polluted air, etc.) and reducing the negative impacts of construction (e.g. waste management), in environmentally friendly technologies, and in ensuring sustainable landscape development, etc. Even though businesses operating in the field of construction have little experience with R&D with this focus, in the Czech Republic there is a strong knowledge base for biotechnologies in public research (especially at HEIs and research institutes in the government sector).

The results of R&D in **Photonics and micro-/nano-electronics** also have potential for application in the domain. The results of R&D with this focus will be used mainly in lighting technology, sensors, photovoltaic cells and energy systems in buildings.

The results of R&D focused on **Artificial intelligence** and **Digital security and connectivity** will also find applications in the domain. There is potential e.g. in intelligent systems in buildings (monitoring and security of buildings) or in image analysis (identification of persons, recognition of human activity). There are also applications in energy consumption management and concepts such as Smart Cities and Smart Grids, or in communications and cyber security.

4.3.2 Societal challenges and missions

At present, the need to respond to complex social, environmental and economic challenges keeps increasing. Profound geopolitical changes, rising economic tensions, the CoV-19 pandemic, lifestyle diseases and ageing populations, as well as climate issues and the rapid development of technologies that are affecting people's privacy, among other things, and changing the way people work and communicate, all point to the need for systematic research on these processes, including their human and societal dimensions, in order to provide the conditions for an adequate and effective response. Debates and activities are underway (not only) at the EU level to make research and innovation more focused on addressing these threats. Within this context, debates about the benefits of research for society and for improving the quality of people's lives are becoming more and more frequent. Social sciences and humanities can make a significant contribution in this regard, as their mission is primarily to explore the systemic preconditions, resources and tools for increasing societal resilience to challenges or crises of a various nature. At the core is the need for a comprehensive understanding of the relationships and processes that strengthen society as a whole (and thus act preventively) in its ability to deal with crisis, sudden or threatening situations. It is therefore necessary to understand what patterns of individual and collective behaviour are applied in society and how they influence the different policies and shape the various protection or transformation mechanisms. The challenges and processes that are affecting and will affect the life of society in the 21st century must also be understood in terms of their psychological impacts on humans and their impacts on social cohesion and interpersonal relationships. It is action in these areas that strongly translates into the nature of governance and the formulation of specific policies and thus significantly affects the possibility of implementing any development strategies and the success of their operation.

EU-level research and innovation support policy increasingly focuses on a "**mission-oriented innovation policy**", i.e. a policy that channels public and private investments towards specific objectives and missions.[67] Also, a key characteristic of this approach to innovation policy is emphasis placed on the role that major societal challenges can play in creating new markets (both local and global) and in supporting national or regional competitiveness.[68] Societal challenges can therefore be **seen not only as threats to people's quality of life, but also as opportunities to improve it**.

A mission-oriented innovation policy fits very well with the RIS3 concept.[69] Responding to key societal challenges and megatrends is also part of the priorities of the National RIS3 Strategy 2021–2027. Topics within this area are part of the sectoral and technological topics that the National RIS3 Strategy identifies as priorities.

Within the pillar of the National RIS3 Strategy oriented towards societal challenges and megatrends (see the following figure), investments will be given a clear direction – they will be oriented towards addressing selected societal challenges. The main objective of the pillar is to **generate solutions to the specific needs of the Czech**

[67] Thematic missions are also planned in the new European R&D programme Horizon Europe.

[68] See e.g. European Commission (2018): Towards a mission-oriented research and innovation policy in the EU, An ESIR memorandum.

[69] For example, one of the founding fathers of the RIS3 concept, Dominic Foray, sees the alignment between the RIS3 concept and mission-oriented innovation policy. See Foray, D. (2018), Smart specialization strategies as a case of mission-oriented policy—a case study on the emergence of new policy practices, *Industrial and Corporate Change*, Volume 27, Issue 5, October 2018, Pages 817–832, https://doi.org/10.1093/icc/dty030

Republic and the EU arising from societal challenges and megatrends. The pillar is also based on a forward looking perspective, seeking to use existing and future opportunities related to societal challenges and technological trends for the sustainable development of society, further economic development and for improving the quality of people's lives, ensuring internal and external security and overcoming potential conflicts and crises within the context of the entire European Union and its resilience.

For example, the following challenges and trends, which ultimately affect all areas of life of society and are highly relevant to the economic development and competitiveness of EU Member States, including the Czech Republic, are particularly relevant at present and for the future:

- Security risks and threats arising e.g. from geopolitical changes, terrorism, organised crime, rising crime rates, migration processes[70], etc.
- The digitalisation of the world and the impacts of the development of new IT technologies on the economy, society and human psychology, threats to the stability of society (associated with threats of cyber attacks, data theft, collapse of information infrastructure, misuse of technological forms of political communication, social networks, information wars, disinformation, etc.).
- Digitalisation and automation and their impact on the economy and the labour market, including its organisational management, changes in the distribution of workforce, its qualifications, the question of workers' self-fulfilment in relation to work, individual identity and social integrity defined by work and the possible socio-pathological phenomena resulting from that.
- Environmental risks: the prevention of environmental disasters caused by human actors, the elimination of negative human interventions in the development of the environment (climate change, a loss of biodiversity), and also the ability of society to cope with natural disasters (floods, earthquakes).
- The development of the Czech Republic's new energy sector and climate protection under the conditions existing in the Czech Republic.
- Societal risks and challenges: the food crisis, the massive spread of infectious diseases, the ageing population, the transformation of education and the education system, quality of life, sustainable environmentally friendly transport and the human factor in transport, and human acceptance of new technologies.
- Technological risks: dual-use, misuse of technologies and their unintended risks.

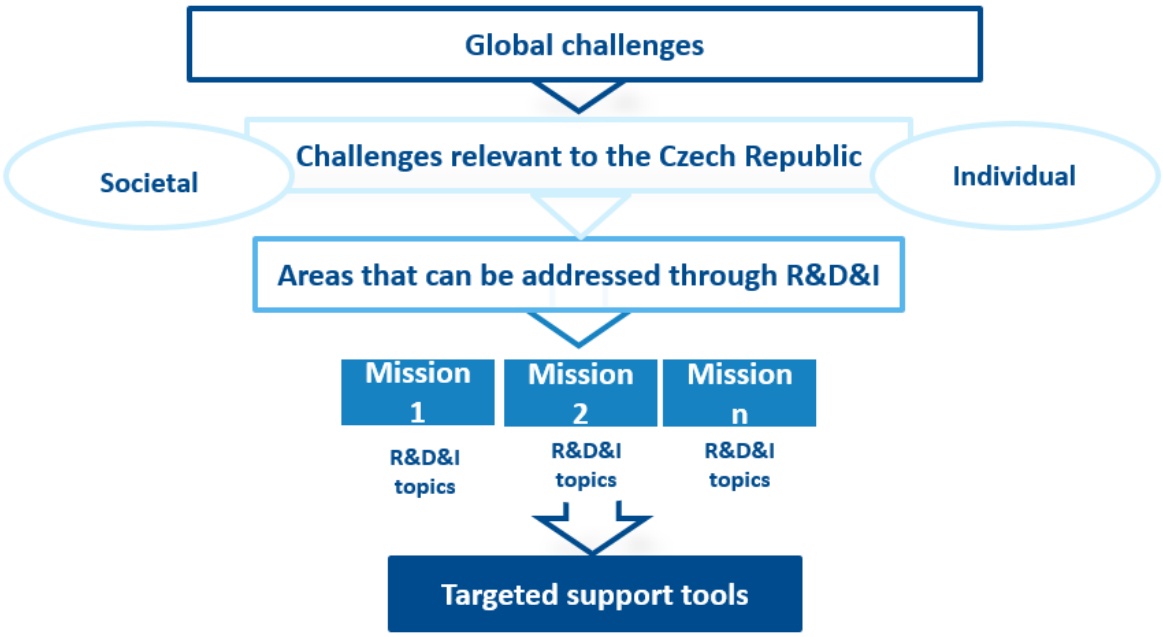
SSH can make an important contribution to both identifying societal challenges and addressing them, and preventing negative societal phenomena, which is desirable.

4.3.2.1 The process of defining and supporting missions within the National RIS3 Strategy

The activities under the National RIS3 Strategy's pillar of "Societal challenges and megatrends" represent a logically interconnected process, as shown in the figure below in a simplified way.

[70] It should be added that migration does not have to be perceived only negatively as a source of security risks. Migration is a potential source of skilled labour (brain gain) not only for R&D&I. Increasing the number of foreign workers may be the answer to the problem of an ageing population, which is discussed below. This perception of migration is associated with challenges such as integrating foreigners and creating an attractive environment for skilled foreign workers, including public services available in English and efficient immigration procedures.

Figure 23. The process under the RIS3 pillar of Societal challenges and megatrends



Source: Prepared by the authors

1. Identifying and defining societal challenges relevant in the context of the Czech Republic and NRIS3

The first part of the process is to identify the trends and challenges that are most relevant to the Czech Republic and within the context of the entire EU and its resilience. At the same time, the areas of these challenges that can be addressed through research, development and innovations will be defined. The identification process will be based on the underlying analyses[71] and the input generated in the EDP process.

Based on these underlying analyses and inputs, the process of selecting relevant societal challenges will be carried out by a panel of experts/an expert working group established for this purpose.

2. Defining missions linked to selected societal challenges

The second part of the process will lead to the definition of thematic missions that respond to current societal challenges and technological trends. The missions are focused more specifically than the actual societal challenges, and they aim to address specific problems arising from the societal challenge in question through research, development and innovation.

The missions will take the form of thematic priorities of the National RIS3 Strategy, i.e. the status of specialisation domains, and as with the specialisation domains, R&D&I topics will be defined for them. The missions will be proposed by an expert panel/an expert working group and through the EDP process. Proposals for missions and their subordinate R&D&I topics will be discussed within the relevant National Innovation Platforms or possibly other platforms established for these purposes. The proposals for missions will then be discussed and approved by the RIS3 Management Committee and passed on to the providers of support, who will regularly inform the Management Committee on how the missions and their related topics are reflected in the relevant support programmes. At the national level, the RIS3 Team will act as a strategic mission developer, i.e. it will prepare a more detailed description of the mission and its work plan consisting of supported topics and possible sources of funding (see below).

[71] The inputs used may include, but are not limited to, the results of the Horizon Scanning project of the Technology Centre of the Academy of Sciences, analyses prepared for the purposes of revising the National RIS3 Strategy (see the links above) and the project entitled "Research to identify priorities in the field of societal challenges (social sciences, SSH) – FUTURE-PRO" financed by the TA CR Beta programme.

The missions also aim to stimulate investment and innovation in various sectors and cooperation between various actors (public research, businesses, public administration, ...)[72] It can be assumed that the implementation of missions often requires interdisciplinary research and development[73] and involves both technical disciplines and disciplines in the social sciences and humanities.

3. Concentrating funding on selected missions and the identified priority topics within them

The missions will be accomplished by implementing research, development and innovation projects, the results of which should be subsequently used in practice. This use can be both commercial (i.e. by businesses, for example, in the form of new products or services) and non-commercial (i.e. for example, by public administration).

The aim of the National RIS3 Strategy is to concentrate funding on the identified priority topics of research, development and innovation. The topics within the missions will be reflected in support programmes (operational programmes financed from EU funds, national support programmes – TA CR, departmental programmes, possibly also GA CR, and it can also be assumed that, in some cases, new instruments such as the Just Transition Fund and the Modernisation Fund can also be used to finance them) especially through:

- Calls announced for R&D&I topics within the specialisation domains and missions (see Chapter 5.3, option 2: Alignment with the specialisation domain)
- Bonuses for specified topics within programmes or calls aimed at supporting research and innovation activities.
- The announcement of specific targeted calls for the identified priority topics/missions.

Through the process described above, which is linked to the EDP process, the National RIS3 Strategy will set the thematic framework for supporting societal challenges and missions. This framework will support the generation of specific solutions to societal challenges, or a part of them – these solutions will be generated bottom-up by the research sector, both business and public. This part of the National RIS3 Strategy is expected to be closely linked to Action 27 of the National Research, Development and Innovation Policy of the Czech Republic 2021+[74] *"Redefining the National Priorities of Oriented Research, Experimental Development and Innovation (NPOR), with a view to making Czech society more resilient – supporting specific research programmes relevant to the defined threats with a pan-societal impact"*, which aims to increase the resilience of Czech society so that providers of support in the field of R&D&I, and in particular providers of targeted support, are motivated to support specifically oriented research programmes that are relevant to areas of defined threats with a society-wide impact.

[72] An example often given in the context of mission-oriented innovation policy is the Apollo mission. This mission required innovations across many different high-tech (aerospace) but also low-tech (textiles) industries. The vision relating to the mission came from the top – it was a top-down decision. But these were tasks that were solved bottom up and their solution involved various types of partnerships that stimulated the subsequent growth of many industries.

[73] The European Commission, Towards a Mission-Oriented Research and Innovation Policy in the European Union, An ESIR Memorandum: Executive summary (December 2017), p. 6.

[74] http://vyzkum.cz/FrontClanek.aspx?idsekce=913172

5 Implementation of the National RIS3 Strategy

The implementation of the National RIS3 Strategy 2021+ builds on structures and processes whose foundations were already laid in the 2014–2020 programming period. During that period, structures were set up for the management and implementation of the RIS3 Strategy at both the national and regional levels. At the same time, processes that are linked to RIS3 were launched during the period, i.e. mainly the EDP process and the monitoring and evaluation system of the National RIS3 Strategy.

This chapter describes the two levels of RIS3 implementation – national and regional, namely the institutional arrangements for RIS3 management and implementation and the design of the EDP process at both levels. It also outlines the system for translating the priorities of the National RIS3 Strategy into operational programmes and other support programmes. Also, attention is given to the system for monitoring the implementation of the National RIS3 Strategy. The final section provides information on the financing of the strategy.

The aim of this chapter is to describe the RIS3 management system in the Czech Republic and the principles underlying the processes that will ensure the effective implementation of the strategy. This system and the processes linked to it may also be further detailed in the relevant procedural documents.

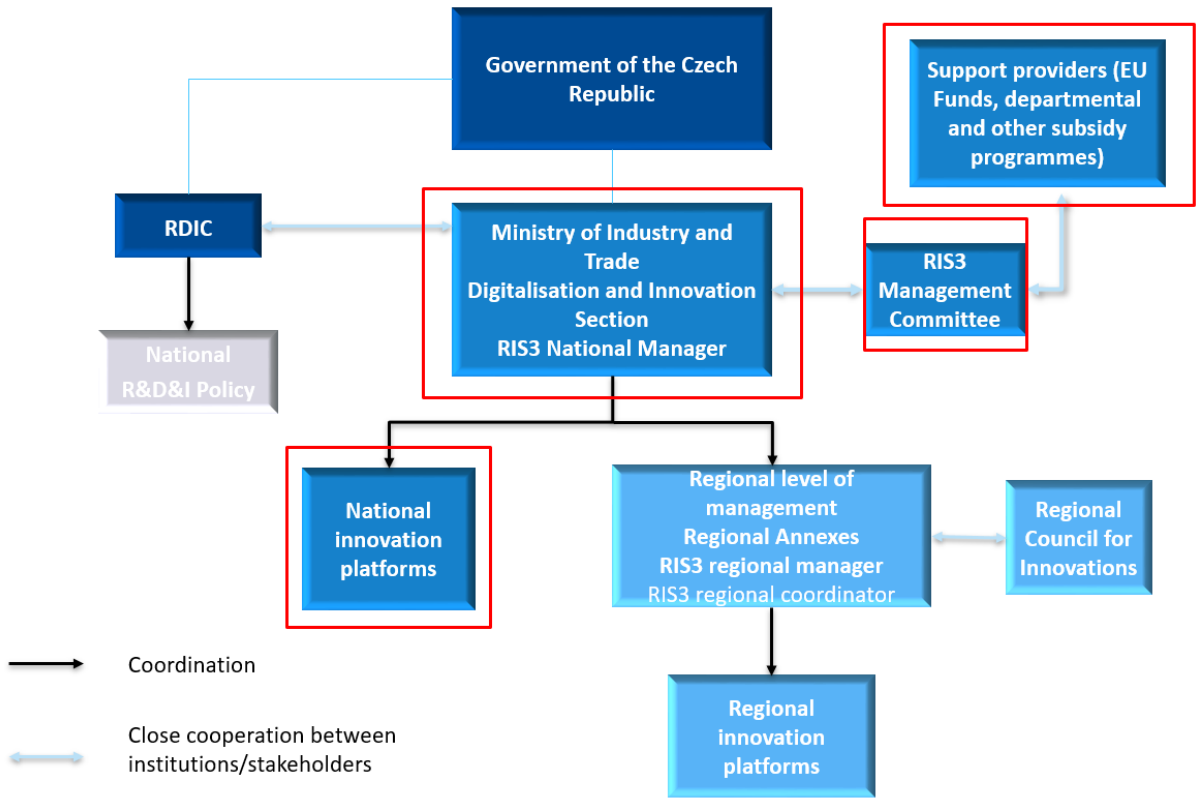
5.1 Management and implementation structures of the National RIS3 Strategy and regional RIS3 strategies

5.1.1 National level of RIS3 strategy

The national level of RIS3 has a key overarching role, sets the framework for the direction of interventions under the RIS3, and fulfils a coordinating role towards the institutions that implement support within this framework.

The following chart shows the implementation system of the National RIS3 Strategy and the institutions involved in it.

Figure 24. National RIS3 Strategy implementation system



Source: Prepared by the authors

At the top level, the National RIS3 Strategy is sponsored by the **Government of the Czech Republic**, which approves the strategy. A fundamental role in coordinating the entire R&D&I system in the Czech Republic is played by the **Research, Development and Innovation Council** (RDIC), which is an advisory body to the Government in this area.[75] One of the important tasks of the RDIC is to prepare and implement the National Research, Development and Innovation Policy (NP R&D&I),[76] which is closely interlinked with the National RIS3 Strategy in that, among other things, it includes Action 21 aimed at implementing the National RIS3 Strategy.

The owner of the National RIS3 Strategy is the **Ministry of Industry and Trade**, Digitalisation and Innovation Section. In its role as the owner of the National RIS3 Strategy, the MIT is responsible, among other things, for the coordination of the **RIS3 Management Committee** and the functioning of the executive units for implementing the National RIS3 Strategy, i.e. the **National RIS3 Manager** and the **RIS3 Team**. The MIT is also responsible for making the EDP process work at the national level, which is implemented through the **National Innovation Platforms**. The role of these structures is described in more detail in the following text.

The RIS3 Management Committee

The RIS3 Management Committee (RIS3 MC) is the main national-level body for coordinating and monitoring the interventions planned in the National RIS3 Strategy. The RIS3 Management Committee is composed of representatives of ministries and other institutions to which the activities implemented in the RIS3 are relevant, i.e. especially the MIT, MEYS, MRD, TA CR and RDIC. The Chair of the RIS3 Management Committee is the Deputy Minister in charge of the MIT Digitalisation and Innovation Section, the Secretary of the RIS3 Management Committee is the National RIS3 Manager. The RIS3 MC discusses policy and strategic issues relating to the setting and management of the National RIS3 Strategy. It also deals with reports and documents on the progress of implementation of the National RIS3 Strategy and other relevant supporting materials. The roles, composition and activities of the RIS3 Management Committee are described in more detail in the RIS3 MC Statute.

The RIS3 National Manager

The RIS3 National Manager is a senior representative of the executive unit for managing and coordinating the National RIS3 Strategy. The National RIS3 Manager is the Director of the MIT Department of Digital Economy and Smart Specialisation, Digitalisation and Innovation Section, who coordinates the implementation of the National RIS3 Strategy, the activities of the RIS3 Team and cooperates with RIS3 teams in the self-governing regions.

The National RIS3 Team

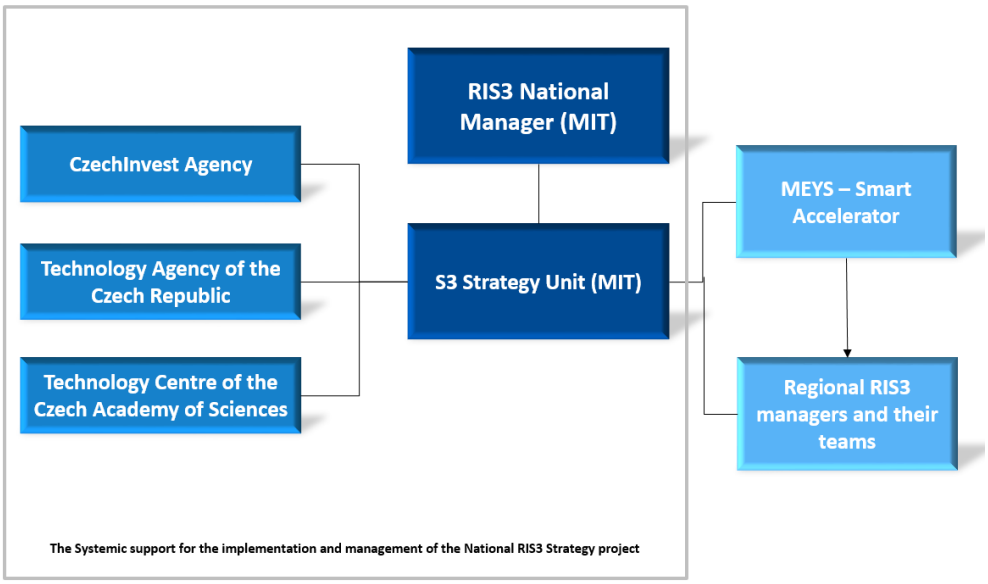
The executive unit for managing and coordinating the National RIS3 Strategy is the National RIS3 Team – the core of team is the S3 Strategy Unit, Digitalisation and Innovation Section of the MIT. The S3 Strategy Unit analyses information and supporting documents on the implementation of interventions that contribute to accomplishing the objectives of the National RIS3 Strategy, monitors the implementation of the National RIS3 Strategy and prepares monitoring reports using supporting documents from operational programmes and other sources. Also, it processes and evaluates input from the EDP process and prepares proposals for updating the National RIS3 Strategy and related documents. In this context, it also collects information on the development of the R&D&I system in the Czech Republic. The S3 Strategy Unit also organises meetings of the RIS3 MC, National Innovation Platforms and other meetings relating to the implementation of the RIS3 and the EDP process, including the preparation of supporting documents for these meetings.

The wider National RIS3 Team may also include regional RIS3 managers and regional RIS3 coordinators, who provide the national level with information from the regional level of RIS3 implementation. The wider National RIS3 Team also includes employees of the MIT's partners participating in the system project financed by the OP RDE (CzechInvest, TA CR, TC CAS – see below) for the duration of this system project (i.e. until the end of 2022). After the completion of this project, it is expected that partners to the system project will continue to be involved depending on the capacities available. The wider National RIS3 Team also includes employees who are involved in implementing the Smart Accelerator calls at the MEYS.

[75] The activities of the RDIC are regulated by Act No. 130/2002 Sb. on support for research, experimental development and innovation.

[76] The scope of the National Research, Development and Innovation Policy is also regulated by Act No. 130/2002 Sb. on support for research, experimental development and innovation.

Figure 25. Structure of the wider RIS3 Team and links of the Systemic support for the implementation and management of the National RIS3 Strategy project to the National RIS3 Team



Source: Prepared by the authors

National innovation platforms

National Innovation Platforms (NIPs) are consulting groups that are set up by the RIS3 Management Committee through the National RIS3 Manager in order to identify needs, refine/specify strategic priorities, identify business opportunities and discuss the targeting of proposed measures (i.e. the interventions intended to support the priorities of the National RIS3 Strategy[77]). NIPs are established for individual areas of smart specialisation as a forum that provides impulses and recommendations. The current setup of the National Innovation Platforms is presented in Annex 1 to this document, and it may be modified during the programming period depending on the results of the EDP process.

NIPs mainly include representatives of important actors in the application sector (especially businesses with research activities and cluster organisations), representatives of leading research organisations (representatives of the Czech Academy of Sciences, higher education institutions, research organisations), representatives of public administration and representatives of the regional level. The composition of National Innovation Platforms and a precise description of their role is set out in the NIP statute.

The "Systemic support for the implementation and management of the National RIS3 Strategy" project

The MIT has received significant support for improving the management and implementation of the National RIS3 Strategy through the systemic project entitled "Systemic support for the implementation and management of the National RIS3 Strategy" financed by the Operational Programme Research, Development and Education under the MEYS. The project was launched on 1 March 2020 and will be implemented until the end of 2022. The project activities will focus on the **processes** that are crucial for the proper and effective implementation of the National RIS3 Strategy – National RIS3 management, monitoring, the EDP process and cooperation between the national and regional levels of RIS3 in the Czech Republic. The project envisages that a new web portal will be built that will improve the effectiveness of the monitoring of the RIS3 strategy, presentation of relevant data and communication within the EDP process.

The systemic project makes it possible for **additional partners to participate intensively in the management and implementation of the National RIS3 Strategy – the Technology Agency of the Czech Republic, the CzechInvest Agency and the Technology Centre of the Czech Academy of Sciences**, who will bring other necessary national

[77] Examples may include issues relating to the skills for smart specialisation, industrial transition and entrepreneurship, which will be part of the agenda of the National Innovation Platforms.

and regional perspectives on R&D and national programmes to support R&D&I. Thanks to the system project it was also possible to strengthen the professional capacity of the internal team of the S3 Strategy Unit at the MIT.

The system project also includes an activity under the responsibility of the CzechInvest agency aimed at **developing the competencies of the team of the National and Regional RIS3 Managers**, which will provide support mainly to self-governing regions where the implementation of the regional RIS3 strategy is slower or weaker. Emphasis will also be on sharing experience with the implementation of the RIS3 Strategy both between the self-governing regions and between the regional and national levels of RIS3 implementation.

5.1.2 Regional level of RIS3 strategy

The highest level of management is constituted by **Regional Councils for Innovation/Competitiveness** / regional Research, Development and Innovation Councils (the Council), which include representatives of local governments (regional, municipal), innovative businesses, research organisations or clusters. The main role of the Council is to coordinate and approve supporting documents from the RIS3 executive unit regarding the implementation of regional RIS3 interventions, projects under the RIS3 Action Plan, updates to the RIS3 and regional specialisation domains. Usually the regional RIS3 manager is the secretary of the Council. Since most regional interventions are financed by the regional level, the approved documents and projects are passed to regional self-government bodies (Council, Assembly) for approval and financing.

The executive unit in the self-governing regions usually consists of **the regional RI3 manager and their RIS3 team** (RIS3 developers, analyst, marketing manager), who mostly work in innovation centres/agencies. The main task of the executive unit is to identify new innovation opportunities based on regional potential, select suitable partners, prepare new interventions and submit them to the management level.

The self-governing regions implementing a **Smart Accelerator**[78] project finance the executive unit, including the regional coordinator (under the Regional Development Department) and relevant administrative positions, from this project. The project owner is always the regional self-government, and the relevant regional innovation centre/agency is the potential expert partner.

The regional EDP process is delivered through **Regional Innovation Platforms**. These platforms were either linked to existing working groups or new ones were created according to the region's specialisation domains or based on the specified horizontal priorities. The regional innovation platforms for the different self-governing regions are listed in Annex 2. As before, the platforms include representatives of self-governments (regional, municipal), innovative businesses and research organisations, and they constitute an advisory and consultative body to the management and executive unit in the area of generating proposals for new interventions based on defined needs and provide feedback.

The national level (the MIT as the owner of the National RIS3 Strategy) has a coordinating and methodological role in relation to the regional level. The owner of the National RIS3 Strategy provides methodological support to regional RIS3 structures in the area of the EDP process, monitoring and other processes linked to the RIS3. This methodological and coordinating role of the national owner is essential in ensuring fulfilment of the enabling condition. The role of the owner is also important in linking the outputs of the EDP process at the regional and national level, as described below. Equally crucial is to link the different regional RIS3 strategies with each other and to use synergies in the potential of the different self-governing regions.

Regional RIS3 strategies

Regional RIS3 strategies were prepared using the same principle as for the National RIS3 Strategy. Each of them defines key areas of change (based on regional horizontal priorities) and, in addition, research and innovation specialisation domains in the region. Since the economy and public research are closely interlinked both within the self-governing regions and with the national level, most of the regional areas of change and domains overlap with the National RIS3 Strategy. It is expected that the implementation of regional RIS3 strategies will include not only support programmes at the national level, but programmes to support innovations at the level of self-governing regions (e.g. innovation vouchers and more recently also creative vouchers have been provided at this level in many self-governing regions in the long term). The priorities of the different self-governing regions are described in **"regional cards"** (Annex 2 Cards of regional RIS3 strategies),[79] which represent an extract of key data from the approved regional RIS3 strategies.

[78] These are Smart Accelerator projects supported by a MEYS intervention using resources from the ESI Funds.

[79] Annex 2 will be regularly updated (in a manner analogous to Annexes 1 and 3) depending on the processes in the self-governing regions and the modifications to the regional RIS3 strategies.

Most regional RIS3 strategies also emphasise **support for industrial transition** through the implementation of RIS3. The three most structurally affected regions (the Ústí nad Labem, Moravian-Silesian and Karlovy Vary Regions) are already supported by specific interventions under the RE:START programme. From 2021, their support should also continue with the help of the "**Just Transition Fund (JTF)**", which was created by the EU under the "Just Transition Mechanism".[80] It aims to deliver the European Green Deal by 2050 – Europe as the first climate-neutral and economically sustainable continent. The JTF is specifically targeting the three regions mentioned above, where the need to cope with structural change and implement industrial transition measures will be the most extensive. Other regions see industrial transition mainly in supporting the digitalisation of the region, where the key tools are digital innovation hubs and the **European Digital Innovation Hubs**.

In their regional RIS3 strategies, some regions also define areas that have great potential for the region in the future, be it emerging technologies or solutions to specific societal challenges. In the regional cards, this area is described in the "Emerging areas" section. These areas will be taken into account in designing solutions to societal challenges and missions at the national level and in continuously setting the thematic priorities.

In order to fulfil the basic idea of the RIS3 Strategy – developing the country's potential and competitive advantage – it is necessary to gain inspiration and work with more experienced regions and partners. The fulfilment of this criterion is best achieved at the regional level, where the different participants in the "triple helix principle" cooperate with specific counterparts in another country. Partnerships are established with the help of innovation networks operating in the region under innovation infrastructures, through membership in thematic S3 platforms, through international activities of clusters, through twinning (supported by Smart Accelerator projects) or on an individual basis. Again, specific regional international activities are described in the regional cards (Annex 2).

5.2 The EDP process

The Entrepreneurial Discovery Process (EDP) is a key tool to identify priority areas of the National RIS3 Strategy. It is a functional bottom-up process based on open, transparent and structured discussions between the different actors in the innovation system. Given the dynamic development of the innovation environment, where new challenges and opportunities for research and innovation are constantly emerging, it is essential to see the EDP as a core element of the National RIS3 Strategy throughout the cycle of its preparation and implementation. This process must continue throughout the implementation of the strategy, as it provides feedback and verification for the interventions implemented, but also the starting points for the plan of interventions to be prepared.

The key purpose of the EDP includes:

- Identifying *desirable directions for the development and transformation* of sectors that fall within the research and innovation specialisation domains.
- *Refining the research and innovation specialisation domains – refining the R&D&I priority topics and smart specialisation areas.* Based on an assessment and substantiation of existing R&D&I capacities, new identified opportunities and the capacities for using these opportunities, the NIPs define and refine the focus of R&D&I topics that should be supported within the implementation of the RIS3. R&D&I topics that fulfil the objectives of the National RIS3 Strategy must have a significant potential to transform one or more sectors of the Czech Republic' economic specialisation (application sectors) and, in turn, fulfil the requirement of smart specialisation.
- *Providing input for interventions in the horizontal priorities* of the National RIS3 Strategy. The EDP process also generates proposals and recommendations concerning specific measures and interventions through which the horizontal objectives of the National RIS3 (e.g. in the area of skills) are accomplished. In this context, the EDP platforms comment e.g. on the focus of R&D&I support programmes (operational programmes and national programmes) through which the objectives of the National RIS3 Strategy are accomplished. At the same time, the EDP may develop its own proposals for interventions contributing to the objectives of the National RIS3 Strategy.
- *Identifying emerging opportunities and fields* – proposals for new specialisation topics and ways to support them. Gathering input in order to anticipate industrial and technological trends, their national impacts and desired responses.
- *Proposing and discussing missions* and their subordinate R&D&I topics. These missions will be linked to major societal challenges (see Chapter 4.3.2). Detailing them and identifying R&D&I topics to address

[80] The Just Transition Mechanism consists of three pillars, one of which is the Just Transition Fund. The other pillars are Invest EU and the EIB loan facility.

them will be an important part of the EDP process and the implementation of the National RIS3 Strategy, which will thus incorporate – as part of the EDP process – the "public discovery process" that leads to public sector-driven innovations.

- *Building a circle of people who are actively involved in developing the innovation system,* creating new and strengthening existing partnerships and strengthening trust between the different actors of the innovation system.
- Building on the previous items, effectively targeting public and private resources intended for research and innovation.
- The EDP process will also contribute to coordinating the activities of *large research infrastructures* so as to use the potential of large research infrastructures for implementing RIS3 and developing the Czech Republic's innovative economy and society.

The main instrument of the EDP is the system of EDP Innovation Platforms, which consists mainly of National Innovation Platforms (NIPs) and Regional Innovation Platforms (see above). Specific working groups may be set up within innovation platforms in response to current needs, topics and suggestions from the various actors in the innovation system. The task of these groups is to detail relevant suggestions and prepare proposals for measures in response to these suggestions.[81] In addition, expert groups may be formed to monitor and work on topics that cut across the specialisation domains. An example of such a group would be the "Expert group for identifying priorities in the social sciences and humanities and societal challenges".

In the context of the specific approach to developing and implementing RIS3 in the Czech Republic, where it is divided into the national RIS3 dimension and the regional RIS3 dimension, the EDP needs to be seen as a single process that is implemented by mechanisms at the national and regional levels. Suggestions from the regional EDP level are mainly translated to the national level through the National Innovation Platforms, where the suggestions from the regional EDP are discussed. The transfer of suggestions that are relevant to the implementation of the National RIS3 Strategy from the regional levels to the national level is mainly done by regional RIS3 managers, whose representatives are always part of the different NIPs.

An important new element that should help improve the effectiveness of collecting suggestions and transferring them to the national level is the **EDP portal** that is being implemented within the above project "Systemic support for the implementation and management of the National RIS3 Strategy" financed by the Operational Programme Research, Development and Education.

5.3 Translating the priorities of the National RIS3 Strategy into operational and support programmes

This chapter build on the strategic section of the National RIS3 Strategy, which defines the priorities of the National RIS3 Strategy. At a general level, there are two types of priorities: 1. horizontal/cross-cutting and 2. thematic, i.e. mainly the research and innovation specialisation domains and the topics within each domain. The different thematic priorities are then detailed in Annex 1 to the National RIS3 Strategy, where the R&D&I topics falling under the given domains are defined and where the topics of societal challenges and missions are expected to be incorporated. Through modifications to this annex, it will be ensured that **the EDP process is continuously reflected in support programmes** throughout the programming period. Suggestions from the EDP process will be included in Annex 1 and will be discussed regularly by the RIS3 Management Committee. An update to Annex 1 will be subsequently approved through a Regulation of the Minister of Industry and Trade and passed on to the relevant Managing Authorities of operational programmes and to the owners of support programmes. The RIS3 Management Committee will receive regular reports from these Managing Authorities and owners of support programmes on how the conclusions of the EDP process have been incorporated into the implementation of the programmes in question. The links between the National RIS3 Team and the operational programmes will be also ensured by including the National RIS3 Team (an employee of the MIT Digitalisation and Innovation Section) as a member of the Monitoring Committee of the operational programmes concerned.

[81] A detailed proposal for the system of the operation of NIPs and other EDP platforms for RIS3 2021+ is presented in the study by the Technology Centre of the CAS entitled *"Analysis of the setup of the operation of National Innovation Platforms"* within the project financed by the Operational Programme Technical Assistance: *"A comprehensive analysis of starting points and a proposal for implementing the revised measures of the National RIS3 Strategy 2021+" See https://www.mpo.cz/assets/cz/podnikani/ris3-strategie/projekty-na-podporu-ris3/operacni-program-technicka-pomoc/2020/12/Analyza-nastaveni-fungovani-Narodnich-inovacnich-platforem.pdf*

The Managing Authorities of operational programmes and owners of support programmes in the area of R&D&I can link their programmes to the priorities of the National RIS3 Strategy using several methods, which are described in this subchapter. These methods – options 1 to 5 described below – form a **gradual system** to translate the priorities of the National RIS3 Strategy into support programmes. This means that the possibility of alignment of a programme or call with the priorities of the National RIS3 Strategy starts with the broadest option of alignment with a horizontal priority and it gradually progresses to options of RIS3 priorities that are thematically increasingly narrowed down.

Managing Authorities and owners of national support programmes may approach the alignment options as an exclusion criterion or use the possibility to award bonuses to projects that are aligned with a specialisation domain. Other combinations of or modifications to the methods to translate RIS3 priorities into support programmes are also possible.

The options for translating the priorities of the National RIS3 Strategy into operational and support programmes:

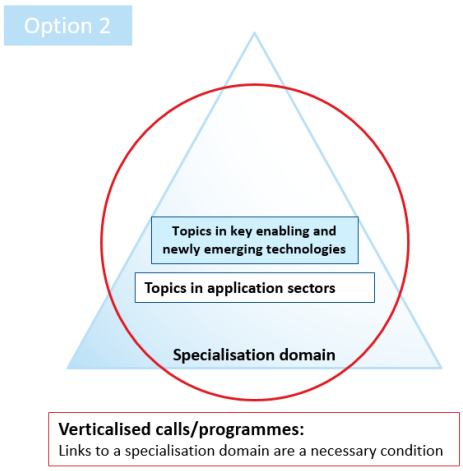
Option 1: Alignment with a specific objective of the RIS3 (horizontal calls)

The most general option represents the alignment of a call or support programme with the specific objective(s) within the key areas of change of the National RIS3 Strategy, i.e. within its horizontal/cross-cutting priorities. These are mainly interventions aimed at addressing the cross-cutting problems of the R&D&I system as a whole and barriers to the diffusion of innovations. Such interventions target cross-cutting or systemic measures that are aimed at improving the basic background necessary for the functional development of the country's strengths and its knowledge and innovation potential.

Examples of interventions: Developing a nationwide system to support an environment for the establishment and growth of new companies, start-ups and spin-offs; supporting the development of regional innovation systems, supporting the implementation of the EOSC initiative (making research data available in Open Access mode), supporting the development of the institutional environment and the internationalisation of research organisations (e.g. winning the HR Award, supporting the setting up/development of a welcome office/grant office/CTT office, international mobility of researchers, etc.)

Option 2: Alignment with a specialisation domain

Figure 26. Alignment with a specialisation domain

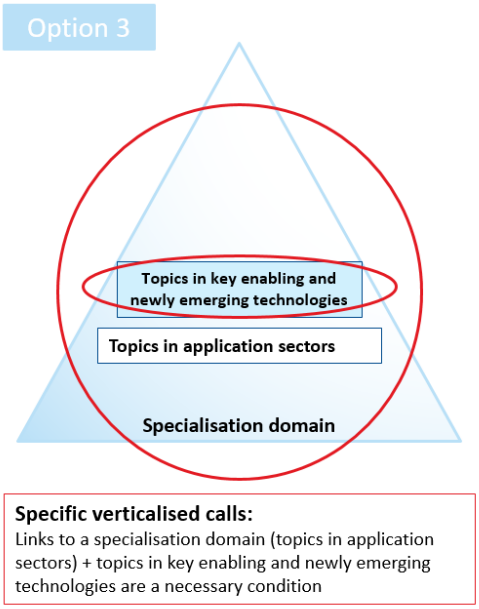


This option is the first possibility for a verticalised or thematically focused call or support programme. Verticalised calls are always aligned with a specific objective of the RIS3, but at the same time, supported projects must focus on the research and innovation specialisation domains of the National RIS3 Strategy or the missions defined within societal challenges. To assess alignment with a specialisation domain, it is important for the project to focus on at least one of the R&D&I topics defined for the various specialisation domains and/or missions within the societal challenges, based on specialisation analyses and the EDP process (see Annex 1).

Examples of interventions: Supporting knowledge transfer and commercialisation of R&D results, supporting the involvement of junior researchers in R&D projects, supporting innovations (product, service, process and organisational innovations).

Option 3: Alignment with a topic in the area of key enabling and newly emerging technologies within a specialisation domain

Figure 27. Alignment with a topic in key enabling and newly emerging technologies within a specialisation domain



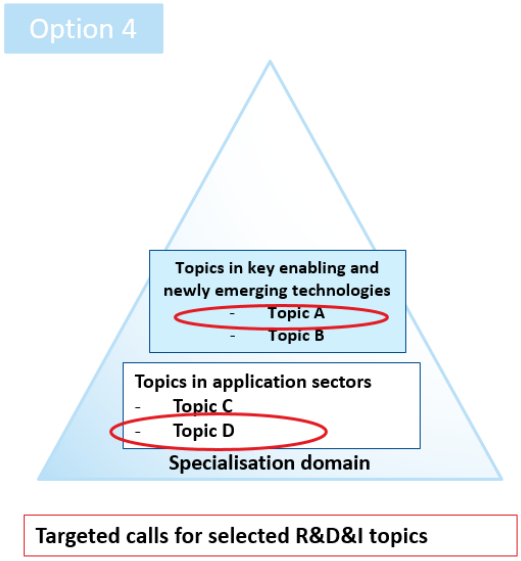
This option also assesses alignment with a research and innovation specialisation domain. However, in this option, projects must both focus on one of the R&D&I application topics and be aligned with one of the topics defined for the given domain under the topics in the area of key enabling and newly emerging technologies. This option reflects the fundamental orientation of the National RIS3 Strategy towards linking R&D&I applications and key enabling technologies that have the potential to transform and diversify industries and sectors.

An alternative under this option is to award bonuses to projects focused on topics in key enabling and newly emerging technologies.

Examples of interventions: Supporting excellence in research and developing the application potential of HEIs (supporting intersectoral cooperation between the research and application sectors), supporting business research, development and innovation activities.

Option 4: Targeted call for R&D&I topics within a specialisation domain

Figure 28. Targeted call for R&D&I topics within a specialisation domain



This option foresees the announcement of a targeted call for selected R&D&I topics within the specialisation domains. These will be mainly topics that will be evaluated – in the EDP process – as key to the development of one of the specialisation domains. An alternative is to take these topics into account through awarding bonuses in standard calls (options 1–3).

Examples of interventions: Supporting business research, development and innovation activities – e.g. the topic "R&D of nanomaterials and their use in mechanical engineering, industrial chemistry and other sectors", supporting excellence in research and developing the application potential of ROs (supporting intersectoral cooperation between the research and application sectors) – e.g. the topic "R&D of biomaterials and their use in electronics and electrical engineering".

Option 5: Targeted call for missions

A specific subset of targeted calls are calls for thematic missions. These missions will be defined during the programming period (see Chapter 4.3.2) and – in line with the concept of mission-oriented innovation policy – their substance will be their orientation towards solving specific problems arising from the selected societal challenge through research, development and innovation. Targeted calls will be oriented towards specific research, development and innovation topics, similar to option 4. However, it will be a selection of topics relevant to the given mission. Alternatively, topics that fall under the missions can be taken into account through awarding bonuses in standard calls (options 1–3).

Examples of interventions: Supporting excellence in research and developing the application potential of ROs (supporting intersectoral cooperation between the research and application sectors) – e.g. the topic "The use of artificial intelligence in the development of personalised medicine"; supporting business research, development and innovation activities – e.g. the topic "R&D of biotechnologies that contribute to reducing the negative environmental impacts of transport and environmental burdens".

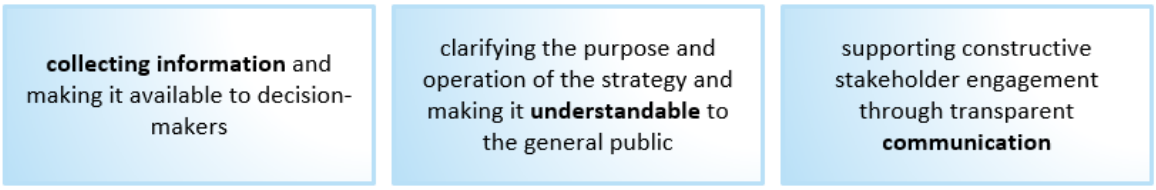
5.4 Monitoring and evaluation of the National RIS3 Strategy

5.4.1 Monitoring of the RIS3 Strategy

In general, the monitoring of RIS3 strategies focuses on tracking trends and developments related to policy interventions within specific priority areas that are identified in RIS3 strategies. Using an appropriate selection of indicators, the monitoring mechanism records the relevant expected changes that are foreseen in each RIS3 priority.

Figure 29. Three main purposes of the monitoring system of RIS3 strategies

Figure 30. Three key functions of the monitoring system



For the monitoring of specific elements of RIS3 strategies, the European Commission (the Commission) recommends the **PXL methodology**[82] (Peer Exchange & Learning), which focuses mainly on addressing issues related to the implementation of RIS3 strategies in the EU Member States. It is an important tool that creates an open and trusted learning environment where practical and conceptual issues can be discussed and explored through the experience of the various stakeholders.

In 2018, the Commission presented the challenges and options for setting up RIS3 monitoring.[83] The basic steps for **setting up the monitoring of RIS3 strategies** include the following five items:

1. *Design – governance and content; stakeholder engagement; objectives; all relevant domains;*

[82] Link: https://s3platform.jrc.ec.europa.eu/monitoring

[83] Challenges and Options for RIS3 Monitoring Systems; Claire Nauwelaers, STI Policy Expert; Vilnius, 23 October 2018.

2. *Data collection – reliability; feasibility and cost-effectiveness;*
3. *Data harmonisation – basic data structure;*
4. *Data analysis – context; stakeholder engagement – feedback;*
5. *Translation into strategies/policies – works when the system and data (indicators) are relevant to the given policy.*

A well set-up monitoring system can reveal inconsistencies (imbalances) in the objectives specified, poor synergies between interventions; effectiveness of the resources spent (financial resources; people), etc.

5.4.2 Monitoring of the National RIS3 Strategy in the Czech Republic

The basic **monitoring system of the National RIS3 Strategy in the Czech Republic** has been built continuously since 2017 and is in line with the Commission's requirements for the design of monitoring systems for RIS3 strategies. The bottom-up design of monitoring (at the level of individual projects) meets the basic requirement for reliability and efficiency of the given system. It focuses in particular on the use of funds for the interventions implemented, broken down by objective and by specialisation of the RIS3 strategy, and at the substantive level, it focuses on the fulfilment of the output and result indicators of the strategy. A separate database of the National RIS3 Strategy in the Czech Republic is gradually being created. The annual progress and implementation plan of the National RIS3 Strategy are published[84] in **RIS3 Implementation Reports** and **RIS3 Implementation Plans**.

In the new 2021–2027 programming period, the set-up of the monitoring system for RIS3 strategies will be assessed by the Commission as one of the **fulfilment criteria for the enabling condition**[85] for releasing resources from the EU funds. It will be assessed whether the monitoring set-up is an appropriate and adequate tool to measure and evaluate the performance of the RIS3 strategy in the Czech Republic.

The new structure of the horizontal key areas of change and thematic priorities and specialisation domains in the National RIS3 Strategy for the 2021–2027 programming period also required making modifications to and improving the effectiveness of its monitoring process. Within the "Systemic Support for the implementation and management of the National RIS3 Strategy" project, the MIT is implementing a key activity entitled: "Support tools of the National RIS3 Strategy", which is aimed at strengthening information and data resources in order to improve the effectiveness of the necessary analytical work and improve the quality of monitoring through developing data subsystems and aggregating disintegrated statistical data systems into a new **web and communication portal of the National RIS3 Strategy**. Also, it is expected that the effectiveness of the monitoring of the National RIS3 Strategy will be significantly improved thanks to the fact that key functionalities that are essential for this monitoring will be included into the monitoring system for the EU funds that is being prepared by the MRD for the 2021–2027 programming period. In this respect, the MIT works with the MRD in order to ensure that the new monitoring system reflects the basic needs of both the National RIS3 Strategy and regional RIS3 strategies.

The implementation of the monitoring of the National RIS3 Strategy will not be possible without mutual **cooperation** between the national and regional RIS3 strategy teams and representatives of the providers of subsidy programmes that fall under the substantive focus of the National RIS3 Strategy in the Czech Republic. This mainly includes setting up the following **basic monitoring areas**:

- ***Adjusting the electronic templates** for calls and applications in the monitoring system for subsidy programmes 2021–2027 to the needs of monitoring the implementation of the RIS3 strategy in the Czech Republic (in accordance with the Commission's requirements);*
- *Setting an appropriate **monitoring period** for RIS3 monitoring purposes;*
- *Determining the **project status** in which projects will be monitored for RIS3 monitoring purposes;*
- *The method of **monitoring expenditure** (sources, structure, usage status, etc.);*
- *Setting up **code lists** for specific RIS3 objectives, specialisation domains and research directions;*
- *Setting up monitoring **indicator sets** (contextual indicators, project indicators – output, result);*
- *Setting the **target values** for indicators.*

In cooperation with the managing authorities of operational and national programmes, the details relating to monitoring are gradually elaborated and updated in the accompanying background and methodological materials that are necessary for implementing the monitoring of the National RIS3 Strategy in the Czech Republic. The indicator set of outputs and results is presented in Table 3.1 in Annex 3.

[84] Link: https://www.mpo.cz/cz/podnikani/ris3-strategie/dokumenty/

[85] The enabling condition related to the implementation of RIS3 strategies of the EU Member States in the 2021–2027 programming period – criterion 3 (see page 4).

In addition to the national indicator system, each self-governing region also monitors its **regional indicators**, which are linked to the interventions in the self-governing region and summarise (mainly for the purposes of regional self-government) the use of funds and their impact in the region (see the chapter entitled Monitoring and evaluation of strategy objectives in Annex 2 Cards of regional RIS3 strategies).

5.4.3 Evaluation of the National RIS3 Strategy

In relation to the National RIS3 Strategy, **evaluation** means continuous monitoring and evaluating the implementation of the strategy and the degree of progress in fulfilling the set objectives. The **global objective** of evaluation is to help effectively target interventions into areas with high potential for change and to subsequently evaluate whether the impacts of the interventions made are sufficient to bring about the expected change.

To achieve the global objective, several **types of evaluations** will be carried out:

- *Ex-ante evaluation* – made at the beginning of the programming period or during the development of the strategy. Its aim is to help to appropriately target interventions and set transparent rules for implementing the strategy.
- *Mid-term evaluation* – it will be carried out in the middle of the programming period, and it will be a process evaluation. It will focus on evaluating the current progress in accomplishing the objectives and the method of implementation and propose adequate recommendations for implementing the strategy in the following years.
- *Ex-post evaluation* – this is the final evaluation, which will focus on evaluating the extent to which the objectives of the strategy have been accomplished.
- *Ad-hoc evaluations* – these are evaluations that respond to current needs arising from the implementation of the strategy and concerning any topics related to the National RIS3 Strategy.

The evaluation of the National RIS3 Strategy 2021–2027 builds on the evaluation activities carried out in the 2014–2020 programming period. An Evaluation Plan is prepared and updated every two years, specifying in detail the various evaluations (their purpose, focus, evaluation questions, data collection methods, schedule, etc.). **Evaluation activities** will focus both on evaluating quantitative data obtained through monitoring and on collecting and evaluating qualitative data obtained mainly through field research. Based on interpreting the data and information obtained, conclusions and recommendations will be formulated to improve the implementation and overall strategic set-up of the National RIS3 Strategy.
The evaluation activities of the National RIS3 Strategy assume that all links in its implementation and management structure (at both the national and regional levels) will cooperate. **Outputs of evaluations** in the form of Evaluation Reports are discussed and approved by the RIS3 Management Committee. All evaluations of the National RIS3 Strategy adhere to the Code of Ethics for Evaluators and the Formal Standards of Conducting Evaluations and are in line with European legislation and recommendations for evaluations (e.g. Working Documents and Methodologies of the Commission).

Some self-governing regions (e.g. the South Moravian Region) will, on their own, carry out interim and ex-post evaluations through an external entity in order to evaluate the ongoing implementation and propose the future orientation of the tools of the regional RIS3 strategy.

5.5 Financing of RIS3 strategies

The interventions of the National RIS3 Strategy, which are understood as a tool to accomplish the objectives of the National RIS3 Strategy, are implemented through calls that are announced by operational programmes and public competitions of national support programmes. As a result of cooperation between the national and regional RIS3 teams and the managing authorities (MAs) of programmes that – through their focus – support the National RIS3 Strategy and regional RIS3 strategies, the calls and public competitions are targeted to support the priorities of oriented and applied research and innovation set out in the RIS3 strategies. In practice, the projects that are implemented on the basis of announced calls and public competitions are aimed at supporting horizontal objectives, specialisation domains and R&D&I topics defined in the National RIS3 Strategy and regional RIS3 strategies.

The allocations of financial support that have been earmarked to support the priorities of the RIS3 strategies in **operational programmes** are indicated in Annex 3. The amounts of financial resources have been verified with the relevant ministries. The indicative financing proposal for the National RIS3 Strategy is based on experience

of its implementation in the 2014–2020 programming period and the expected allocations of operational programmes for the 2021–2027 programming period.[86]

In addition to operational programmes financed from EU sources, some **national support programmes**, including relevant **programmes of Czech ministries** in which innovative elements corresponding to the National RIS3 Strategy were gradually identified in the 2017–2020 period, are also linked to supporting priorities of RIS3 strategies. These are earmarked national support programmes managed by the TA CR and departmental programmes, whose allocations are listed in Annex 3. The indicative financing proposal for the RIS3 Strategy from national sources is based on experience of the implementation of RIS3 strategies in the Czech Republic and on the expected allocations of national resources approved by the Government of the Czech Republic for the 2021–2027 period. The strategy also envisaged the involvement of funds from private sources, mainly through project co-financing, but it is also envisaged that the involvement of private sources will be encouraged through the EDP process.

Fulfilment of the objectives of RIS3 strategies is also indirectly supported through some EU programmes, notably Horizon Europe and others. However, the specific use of these sources depends on the success of the different Czech entities in the competition for support.

In the 2021–2027 period, in addition to the above sources, there is an opportunity to support some interventions implementing the RIS3 strategies through new EU instruments that are being prepared (e.g. the Recovery and Resilience Facility, the Just Transition Mechanism and the Modernisation Fund). The exact amount of funding from these instruments and the possible links to RIS3 strategies is still being refined at the time of finalisation of the National RIS3 Strategy 2021–2027 and, if relevant, it will be further specified in future updates of the strategy and its annexes.

[86] Data on allocations for operational programmes cannot be confirmed at this time. Until the allocations for operational programmes are confirmed, the data in this chapter and in Annex 3 need to be regarded as unconfirmed and indicative.

6 Annexes

6.1 Annex 1: Cards of thematic areas

6.2 Annex 2: Cards of regional RIS3 strategies

6.3 Annex 3: Monitoring indicators and financing of RIS3 strategies

7 Sources

7.1 Initial analyses

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8 Lists

8.1 List of Tables

8.2 List of Figures

8.3 List of Charts

8.4 List of Abbreviations

BI	The Balassa index
CAS	The Czech Academy of Sciences
CCIs	Cultural and creative industries
Commission	The European Commission
CZSO	The Czech Statistical Office
EDP	Entrepreneurial discovery process
EIS	European Innovation Scoreboard
EOSC	European Open Science Cloud
ESIF	European Structural and Investment Funds 2014–2020
EU	The European Union
FT	Foreign trade

GCI	The global competitiveness index
GDP	Gross domestic product
GVA	Gross value added
HEIs	Higher education institutions
ICT	Information and communication technologies
IoT	The Internet of Things
KETs	Key enabling technologies
LRI	Large research infrastructure
MEYS	The Ministry of Education, Youth and Sports
MIT	The Ministry of Industry and Trade
MRD	The Ministry of Regional Development
NACE (CZ NACE)	Statistical classification of economic activities
NIP	National innovation platform
NP R&D&I	National Research, Development and Innovation Policy
NRIS3	National RIS3 Strategy
OECD	Organisation for Economic Co-operation and Development
OP RDE	Operational Programme Research, Development, and Education
PIAAC	Programme for International Assessment of Adult Competencies
PISA	Programme for International Student Assessment
R&D	Research and development
R&D&I	Research, development and innovations
R&D&I IS	Research and Development and Innovation Information System
RDIC	The Research, Development and Innovation Council
RIS3	Research and Innovation Strategy for Smart Specialisation
RIS3 MC	RIS3 Management Committee
ROs	Research organisations
SITC	Standard International Trade Classification
SMEs	Small- and medium-sized enterprises
SSH	Social sciences and humanities
STEAM	Science, Technology, Engineering, Arts and Maths
STEM	Science, Technology, Engineering and Maths
TA CR	Technology Agency of the Czech Republic
TC CAS	Technology Centre of the Czech Academy of Sciences