

Report on the qualitative analysis of preliminary priority areas in the smart specialization process in the Republic of Serbia

FINAL VERSION

AUTHORS: DOMEN BOLE, LAZAR ŽIVKOVIĆ, VIKTOR NEDOVIĆ

CONTRIBUTING AUTHORS: MILAN ŠOLAJA, JELENA BEGOVIĆ, JASNA
MASTILOVIĆ, MILICA BOŽANIĆ, MIRJANA OPAČIĆ

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1 Introduction

Smart Specialisation is a modern approach to regional development in knowledge-based economies of the European Union. The Smart Specialisation Strategy (S3) provides focus of development investments in areas where the state has the critical mass of knowledge, capacities and competencies and in which it has innovation potential for global market positioning.

The key smart specialisation document is the Research and Innovation Strategy for Smart Specialisation (RIS3). The key element for the successful design and implementation of the strategy is the Entrepreneurial Discovery Process (EDP), which in fact represents a continuous public-private dialogue among 4 spheres of the modern innovation society (so-called quadruple-helix), consisting of academia, government sector, economy and civil society.

The purpose of RIS3 in Serbia is the development and marketing of the highest-quality innovative products and services in the global market. RIS3 is focused on the development of activities, measures and instruments for fostering better cooperation between key stakeholders from the economic, scientific and research sector in the areas of specialization according to the principles of Collaborative Innovation. According to this principle, key stakeholders will be supported in the cooperation preparation stage, partnership formation and development stage and in the global commercialization stage.

1.1 RIS3 Design Process in Serbia

The RIS3 design process in Serbia was initiated in 2017. The Ministry of Education, Science and Technological Development of the Republic of Serbia which initiated this process coordinates the Interministerial Working Group for the development of the Research and Innovation Strategy for Smart Specialisation of the Republic of Serbia.

The Annual report on Serbia's progress in approximation to EU published in May 2018 substantially reinforced the importance of RIS3. Namely, one of the conditions for closing Chapter 20 "Enterprise and Industrial Policy" is to develop a comprehensive industrial policy based on EU principles and RIS3 findings.

A consequence of such binding of industrial policy and RIS3 is the expansion of the circle of significant political, intermediary and financial stakeholders interested in participating in planning and implementation of the smart specialisation process, which requires additional coordination of the future process.

Key stakeholders

Key stakeholders who initiated the process and who are participating in planning and implementation of the smart specialisation process today are the Ministry of Education, Science and Technological Development of the Republic of Serbia, Public Policy Secretariat of the Republic of Serbia, Ministry of Economy of the Republic of Serbia, Serbian Chamber of Commerce and the Joint Research Centre of the European Commission.

In August 2018 they harmonized their stances pertaining to the smart specialisation process in Serbia which are recorded in the interministerially confirmed document „Continuation of the RIS3 Design Process in Serbia“.

Process and coordination

Key stakeholders agree that the future process advised and monitored by JRC must be in accordance with the agreements with JRC, but also in ownership of the Republic of Serbia throughout the process, and adjusted to its specifics adhering solely to the objective that needs to be achieved at all times, with the best possible consideration of the potential and needs of the Republic of Serbia for its optimal development. The process is managed and coordinated professionally, and the activities are implemented by top experts.

The general framework for the design of RIS3 in Serbia is in accordance with the standards of the European Union (EU), and it is defined in the document “Smart Specialisation Framework for Enlargement and Neighbourhood Countries” from 2018. It describes the stages of design and implementation of RIS3, where the first 5 stages are dedicated to drafting:

1. Decisions on Initiating the Smart Specialisation Process
2. Analysis of Strategic Mandates
3. Quantitative Analysis of the Current Economic, Innovative and Scientific Potential
4. Qualitative and Detailed Analysis of Priority Domains
5. Entrepreneurial Discovery Process - EDP

The RIS3 design process in the stage “Qualitative and Quantitative Analysis of Priority Domains” and “Entrepreneurial Discovery Process” is managed and coordinated by the following bodies:

1. Interministerial working group for RIS3 design, which confirms strategic decisions related to EDP.
2. The coordination body of EDP, coordinated by MESTD, consisting of representatives of PPS, MESTD, MoE and SCC, who together with the head advisor for the implementation of EDP confirm tactical decisions and make strategic decisions related to EDP.
3. The EDP team consists of the Coordinator for the RIS3 design process, head advisor for EDP implementation, analytics advisor and coordinators and co-coordinators by areas, who perform operations, make tactical decisions and propose strategic decisions related to EDP.

Considering the general framework of smart specialisation for EU candidates and neighbouring countries, first 3 stages of the design were fully implemented in Serbia by September 2018: Decision on Initiating Smart Specialisation Process, Analysis of Strategic Obligations and the Quantitative Analysis of the Current Economic, Innovation and Scientific potential.

1.2 Summary of the Quantitative Analysis of the Current Economic, Innovation and Scientific Potential

The Quantitative Analysis of the Economic, Innovation and Scientific Potential of the Republic of Serbia was developed by a team of experts from the Fraunhofer ISI Institute from Karlsruhe with the support of the Joint Research Centre (JRC) and the analytics team in Serbia. The report was finalised in November 2017. Data processed for the quantitative analysis was provided by the Statistical Office of

the Republic of Serbia, Intellectual Property Office, Ministry of Education, Science and Technological Development, Faculty of Physics and Mihajlo Pupin Institute.

Since 2011, the statistical system of the Republic of Serbia recognizes five major regions of Serbia: Belgrade, Vojvodina, Šumadija and Western Serbia, Southern and Eastern Serbia and Kosovo and Metohija. Four regions of relatively equal size in terms of population were analysed (between 1.6 and 2 million inhabitants), while their economic size differs significantly - from annual gross domestic product - GDP of approximately EUR 12.5 billion in Belgrade to EUR 4.5 million in Southern and Eastern Serbia. Although the relevant level of per capita income differs, the regions generally do not differ significantly in economic capacity. Therefore, in the first step it was decided that they may be analytically treated under equal conditions, with subsequent identification of additional roles and characteristics.

With a view to mapping economic, innovation and scientific potential, a multidimensional quantitative analysis was used which identifies NACE sectors at regional level with comparative advantage relative to the national level. The measure used to determine regional comparative advantage is Location Quotient (LQ), which compares share of a sector in the regional economy and national economy.

Content-wise, indicators used in the process of identifying preliminary priorities may be divided into two groups:

1. Indicators that do not have available data at NACE level (3 digits) or complete data for all areas does not exist. These are the following indicators:

Economic potential:

- Gross added value
- Number of companies

Scientific potential:

- Number of researchers (FTE) by scientific areas and regions
- Expenditures for research and development by regions
- Share of employees with university education by regions

These indicators were considered in the introductory part of the study which provided a general overview of activities by regions of Serbia.

2. Indicators with detailed information according to NACE 3-digit category for economic and innovation potential and data according to classes Web of Science / Frascati for scientific potential

Indicators used within the quantitative analysis to identify potential priorities are the following:

1. Economic potential

- Employment, labour force statistics, 2011-2016
- Export, statistics 2012-2016

2. Innovation potential

- Innovative companies, CIS 2010-2014
- Patents – data of the Intellectual Property Office, processed by the Mihajlo Pupin Institute

3. Scientific potential

- Publications – data of the Faculty of Physics, processed by the Faculty of Physics and the Mihajlo Pupin Institute

The final selection of the potential priority areas contained three criteria:

1. **Specialization proper.** The LQ value had to be higher than 1.5. According to this criterion, the sector in relative terms needs to have 50% higher significance in regional economy relative to the national economy.
2. **Absolute size.** This criterion was used due to the fact that the sector is relatively more important on regional level than at the national level is irrelevant if it is too small in absolute terms, i.e. it employs only a few hundred people. Therefore, absolute size is an important and necessary criterion.
3. **Growth.** Although growth was not used as a necessary condition for qualification, growth provides important additional information on sector relevance. This criterion provided answer to the question of whether the sector is growing or is it a legacy of previous years that would require efforts focused on economic transformation.

Initially identified preliminary priorities obtained on the basis of indicators which have complete data at the level of NACE (3-digit) were further analysed in two steps:

1. Integration of all indicators with the purpose of identifying the final number of potential priority areas for smart specialisation
2. Use of additional economic indicators to narrow potential priorities, i.e. to identify priorities with the potential to be competitive in the global market. Economic indicators used as additional criteria are as follows:
 - Total employment
 - Salaries
 - Added value
 - Labour productivity
 - Employment growth

One of the messages of authors of the quantitative analysis is that is important for an economy like Serbia, which is still strongly dependent on agriculture and low-tech industry, to also use traditional sectors instead of focusing solely on high-tech sectors. Based on quantitative analysis results, the following NACE sectors (3-digits) were identified as preliminary priority sectors that served for further consideration and adjustments in the quantitative analysis:

Belgrade:

- Computer programming and ICT
- R&D and Technical Consultancy
- Creative economy
- Financial intermediation

Potentially (in the making) innovative sectors:

- Beverages, pharmaceuticals, electrical components, transport equipment

Vojvodina

- Automotive parts
- Agricultural economy (including processing industry)
- Petrochemical industry
- Plastic industry

Potentially (in the making) innovative sectors:

- Agricultural machinery, measurement instruments

Sectors with prominent scientific base:

- Computer engineering, telecommunications

Šumadija and Western Serbia

- Agricultural / horticultural / silvicultural economy (including processing industry)
- Automotive
- Textile industry
- Plastics industry
- Metal industry

Potentially (in the making) innovative sectors:

- Special purpose machines

Sectors with prominent scientific base:

- Mechanical engineering, pharmacy

Southern and Eastern Serbia

- Agricultural / horticultural economy (including processing industry)
- Textile industry
- Rubber industry
- Electrical engineering

Potentially (in the making) innovative sectors:

- Food products, medicine and dentistry

Sectors with prominent scientific base:

- Electrical engineering

Kosovo and Metohija: no data

1.3 Decision on preliminary areas

As set forth in the general framework of the RIS3 design process, analyses of the current economic, innovation and scientific potential serve as a basis for the further process, where preliminary existing and potential areas are first determined with the assistance of experts' interpretation. In that regard, a number of studies and workshops with experts for certain areas have been organized in Serbia.

Multi-criteria analysis

Considering that the initial quantitative analysis used several different indicators and criteria in the process of identifying preliminary priority sectors and that the analysis was developed on the basis of regions of Serbia, a need arose in further dialogue with key stakeholders in Serbia to identify potential priorities at the national level with the aggregation of all available criteria.

With the aim of ranking preliminary priority sectors at the national level, taking into account all previously identified indicators and criteria, the multi-criteria ranking method was applied. A team from the Mihajlo Pupin Institute conducted a multi-criteria analysis based on the previous quantitative analysis. The specific method used is the Ideal Point Method which ranks alternatives according to their closeness to certain "ideal" criteria values. This method defines the alternative with the least distance from the ideal solution in the set of possible solutions as the best alternative.

By using this approach, i.e. by aggregating all economic, innovation and scientific indicators into one unique criterion, using the ideal point method, a ranking list was created for four regions in Serbia according to NACE sectors (3-digits) and another ranking list at the level of the entire country. For further work on preliminary priorities, we will only provide the ranking list of NACE sectors at the national level. Ranking list of the first 30 sectors, formed using the multi-criteria ranking method is presented in Table 1.

Table 1: The ranking list of first 30 activities in Serbia formed using the multi-criteria ranking method

Ranking	Activity name
1	Computer programming, consultancy and related activities
2	Advertising
3	Architectural and engineering activities and related technical consultancy
4	Non-specialised wholesale trade
5	Technical testing and analysis
6	Manufacture of other food products
7	Other retail sale in specialised stores
8	Growing of annual and biennial plants
9	Manufacture of plastics products
10	Manufacture of other general-purpose machinery
11	Manufacture of furniture
12	Research and experimental development on natural sciences and engineering
13	Processing and preserving of fruit and vegetables
14	Manufacture of parts and accessories for motor vehicles and their engines
15	Publishing of books, periodicals and other publishing activities
16	Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks
17	Manufacture of wearing apparel, except fur apparel
18	Retail trade in non-specialized shops
19	Manufacture of beverages
20	Construction of residential and non-residential buildings
21	Manufacture of bakery and farinaceous products
22	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms
23	Processing and preserving meat and meat products
24	Other specialised wholesale
25	Manufacture of computers and peripheral equipment
26	Manufacture of medical and dental instruments and supplies
27	Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus
28	Manufacture of other special-purpose machinery
29	Manufacture of rubber products
30	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations

With the aim of considering broader areas, Table 2 gives first 11 areas to which the activity areas belong according to the official classification of activities.

Table 2: Ranking list of the first 11 NACE sector-groups in Serbia formed using the multi-criteria ranking method

Ranking	NACE sector-group
1	Computer programming, consultancy and related activities
2	Architectural and engineering activities; technical testing and analyses
3	Advertising and market research
4	Manufacture of furniture
5	Manufacture of beverages
6	Manufacture of rubber and plastics products
7	Manufacture of other machinery and equipment
8	Scientific research and development
9	Manufacture of motor vehicles, trailers and semi-trailers
10	Manufacture of tobacco products
11	Manufacture of food products

One of the preparatory steps prior to the initiation of EDP, generalization of the ranking list of NACE 3-digit levels of sectors-groups in Serbia is necessary. This generalization is realized by combining results of the multi-criteria analysis for all NACE 3-digit groups into NACE sectors, and the result of this generalization are vertical and horizontal priority areas that should be combined with Key Emerging Technologies (KETs). Vertical and horizontal priorities obtained by generalization are as follows:

- Priority areas (vertical): Digitization of the Economy and Society; (Smart) Agriculture-Food and Health; (Smart) Industry 4.0 and Smart Materials; Cultural Heritage and Cultural Industries
- Priority areas (horizontal): KET, ICT; Environmental Protection; Energy Efficiency;
- KET, supporting technologies for general development; Micro and Nanoelectronics; Nanotechnology; Industrial Biotechnology; Advanced Materials; Photonics; Advanced Manufacturing Technologies.

Synthesis of previous research in terms of priorities - Preliminary assessment

For the purposes of progress in the development of the smart specialization strategy, the Public Policy Secretariat of the Republic of Serbia initiated and prepared a synthesis of all existing findings of studies dealing with the economic structure, identification of discovered competitive advantages and potential regarding specialization in areas with significant competencies in science. This overview resulted in preliminary assessment of priorities. This synthesis allowed the most objective and specific defining of preliminary priority on the basis of all existing results of which the majority of individual studies was not specific enough to simply identify thematic priority areas.

One of the conclusions of the said synthesis (preliminary assessment) is that certain used indicators of quantitative analysis have limitations. Two important indicators that do not provide a true picture about the innovation ecosystem include information on the number of patents and investment in research and development. The absence of patents in the Serbian innovative ecosystem is an anomaly caused by unresolved matters of intellectual property at universities and inadequate methods of funding research. There is no doubt that slightly different criteria for funding scientific and research activities would result in dramatic increase in the number of patent applications in Serbian and global patent institutes. Investment in research and development is a category optionally filled out by business entities without special incentives to invest or report investment in these activities. This results in confusing findings that the largest development centres, such as the Microsoft Development Center in Serbia, do not have investments in research and development.

Conclusions on the basis of the quantitative analysis also indicate that information regarding ICT is not complete since a large number of those companies (due to tax policy that was in force when those companies were established) are not registered in this area, and due to the fact that a large part of the potential is in the grey zone not visible in the official statistics.

Due to the lack of reliable and relevant information on potential and capacities of the innovation economy, save for information relying on the official statistics, indicators related to pilot projects and one-time programmes supporting innovation in Serbia are also important. Programmes of the Innovation Fund (IF) by their nature attract scientific and research organisations and small and medium enterprises which are already collaborating, thus their activity is an important indicator of the innovation economy potential. Table 3 provides information about areas in which projects were funded through programmes of cooperation of science and industry, early development programme and the programme of cofunding innovations of IF in 2017.

Table 3: Number of projects financed within the programme of cooperation of science and industry, early development and co-financing innovations in 2017 (source: IF)

Scientific area	Programme of cooperation of science and industry	Program of co-financing innovations	Early development programme
Food and agriculture	4		
Electrical engineering	2		
Natural sciences	2		1
Software and app development	1	2	7
Information and communication technologies	1	1	4
Mechanical engineering	1		2
Environmental protection	1		1
Medical and therapeutic devices	1		1
Energy and energy efficiency	1		
Electronics		1	1
New materials and nanotechnologies		1	1
Construction			1
Total	14	5	19

There is an obvious difference in the offering of high-quality proposals for early development programmes and cofinancing innovation on the one hand and programmes of cooperation of science and industry on the other hand. Independent projects most often refer to software development and ICT (11 out of 19 projects) while the cooperation of science and industry is recognized in agriculture, engineering and natural sciences (6 out of 14 projects). This relationship is probably a result of the fact that startups are mostly independent self-financing initiatives that arise independently of academia and available research infrastructure.

One of the “freshest” indicators is the statistics for applying for vouchers of the Innovation Fund and the European Bank for Reconstruction and Development at the end of last year. 47 vouchers were approved at first demand from different areas dominated by “Mechanical Engineering” and “Food Industry and Agriculture” (Table 4). No matter how small and unrepresentative this sample may be, this data shows that areas of mechanical engineering and agriculture have scientific and research organizations and small and medium enterprises which in addition to collaboration on the

development of innovative products and services also seek funds to enhance that cooperation in the short term.

Table 4: Approved innovation vouchers of IF by scientific areas at the competition in 2017 (Source: IF)

Scientific area	Number of approved innovation vouchers
Mechanical engineering	18
Food industry and agriculture	13
Energy and energy efficiency	4
New materials and nanotechnologies	3
Construction	2
Software and application development	2
Medical and therapeutic devices	2
Other industries	2
Information and communication technologies	1
Total	47

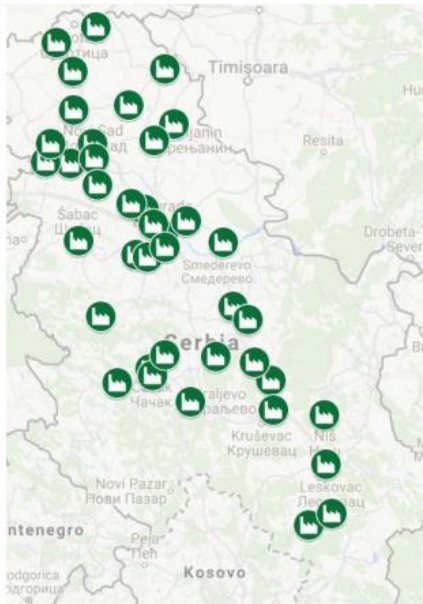
“Green Innovation Vouchers” were also awarded in 2018 which were announced by EBRD, BMF and CEU. The objectives of their call were development and implementation of green technologies in all sectors of the economy, reduction of harmful effects on the environment, promotion and support to transition towards green economy, increase in innovation capacity and competitiveness of SMEs and support to applied research and development. 78 consortia applied (SROs and SMEs). Ten of them were awarded. Topics for which projects were written are given in Table 5. Statistics of applications shows that collaboration in terms of enhancement and more efficient use of machines and equipment is dominant. It is clear that cooperation in these areas exists and that financial instruments such as innovation vouchers would only facilitate it. Another important result from the pilot project of EBRD is the finding that there is a fairly consistent representation of interested SMEs and SROs by regions despite the fact that scientific research organizations are concentrated in a small number of cities (Figure 1).

Table 5: Projects registered for green innovation vouchers in 2018 (Source: EBRD 2018)

Scientific area	Percentage of projects registered for innovation vouchers
Machinery and equipment	27%
IT/IoT	21%
Energy/resource efficiency	18%
Waste management	18%
Renewable sources	8%
Sustainable products	8%

Figure 1: Allocation of SMEs and SROs which participated in the call for green innovation vouchers (source: EBRD)

Mala i srednja preduzeća



Vojvodina
30%

Beograd
35%

Šumadija i zapadna Srbija
27%

Istočna i južna Srbija
8%

Istraživačko-razvojne organizacije



Active business clusters also testify about the business activity and need for joint actions, as well as openness for cooperation with the scientific research sector. Serbia has more than a hundred clusters in the area of information technology, tourism and agriculture, but they are not sufficiently developed. Here we give a list of ten most active clusters. Overview of areas in which they have developed testifies about a specific potential for thematic priority areas:

- Serbian Automotive Cluster, Belgrade
- ICT Network, Belgrade
- Fashion Apparel Cluster Serbia, Belgrade
- “Pannonian Bee” Cluster, Novi Sad
- Cluster of Tourist Micro Region of the City of Sremska Mitrovica, Sremska Mitrovica
- Cluster of Health, Wellness and SPA Tourism Serbia, Belgrade
- Niš Cluster of Advanced Technologies, Niš
- Business Association ICT Cluster of Central Serbia, Kragujevac
- Vojvodina ICT Cluster, Novi Sad
- Vojvodina Organic Cluster, Novi Sad
- Vojvodina Metal Cluster, Temerin

The Republic of Serbia has a relatively small number of high-tech startup companies and a particularly small number of fast-growing companies (“gazelles”) that would attract major investors of entrepreneurial capital. On the basis of a very small sample of startups, it is difficult to predict which areas could be a key factor of future economic growth and progress, start new industries in future years, and which will soon disappear due to international competition or lack of personnel and adequate funding.

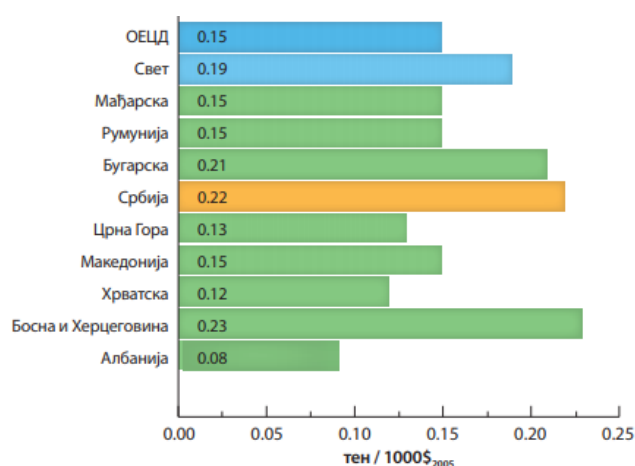
New potential priority areas

There are areas that pervade all other areas where we do not have particularly good economic indicators, but which are a precondition for future economic development, and which are also recognized as global strategic objectives.

Energy and energy efficiency

A traditionally important and successful energy sector in the Republic of Serbia has the human capacity to develop innovative products and services. Despite the fact that research and development are not specifically recognized in the Strategy for Energy Development of RS by 2025 with projections until 2030 (RS Government, 2015), there are elements where it is necessary to connect industry and researchers. The strategy recognizes three priorities: 1) providing energy security, 2) development of energy market within the EU energy market and 3) establishment of sustainable energy (by applying measures of energy efficiency, use of renewable energy sources and application of standards for environmental protection and reduction of harmful influence on the climate).

Figure 2: Consumption of primary energy per unit of GDP in 2010 (source: Energy Development Strategy of RS)



The Republic of Serbia has agreed to apply different directives in the area of renewable energy sources (RES), and in accordance with the Directive 2009/28/EC it has accepted the binding objectives for members of the European Union to ensure that RESs by 2020 have a 20% share in the gross final consumption at the level of the EU; and to improve energy efficiency and improve it by 20% in the same period. These objectives cannot be achieved without innovative solutions and broad application of innovations in energy.

The Republic of Serbia belongs to countries with a very low energy consumption efficiency (Figure 2). Fixing vulnerabilities that caused this position of Serbia will certainly be a public policy priority in the following years. Application of innovative and environmentally friendly solutions for production, transmission and use of energy will require the greatest possible scale, i.e. inclusion of all users from large industrial facilities to rural households.

The capacity of the Republic of Serbia for the development and innovation in the area of energy and energy efficiency is reflected in the existence of significant industrial capacities for electrical equipment for electrical power systems, long tradition and experience in designing and building power plants, transmission lines, transformer stations and control systems with global export potential, existence of natural resources suitable for the production of energy from renewable sources, numerous educational institutions and study programmes in this area, scientific research organisations that may support and enhance competitiveness of the industry through research and development, and the existing market which requires an upgrade and expansion of production capacity.

The best example of a successful high-tech company in this area is Schneider DMS which originated as a spin-off of the Faculty of Technical Sciences in Novi Sad which then attracted significant foreign investments with the quality of its solutions. This is an excellent example of creating a globally significant intellectual property as a precondition for foreign investment in research and development and employment of high-tech personnel.

Important multidisciplinary topics for research, development and application of innovations are definitely smart networks, integration of renewable energy sources, advanced systems for energy storage and distribution, monitoring energy efficiency, smart city development, energy efficient lighting, sustainable biomass production, use of the internet of things for infrastructure maintenance, etc.

Key Enabling Technologies (KET)

Key Enabling Technologies (KET) include micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics and advanced manufacturing technologies. They will provide the technological basis for the development of all industries in the foreseeable future. KETs will create added value in different industrial chains within thematic priority areas - from materials for equipment and devices to final products and services. Due to their horizontal nature and importance for the entire innovation system of the Republic of Serbia, KETs represent technologies and research topics that must be particularly supported. A smart choice of topics for research and focus on development and application of certain KETs will contribute to successful application of the smart specialisation concept. Due to their “*spill over*” effects on the economy in different parts of the innovation value chain, KETs may support innovation, increase productivity, lead to new applications in economy and, finally, help in responding to current social challenges.

It is important to note that every progress in the field of automation, robotics, use of sensors or 3D printing directly depends on the speed of adoption of key enabling technologies.

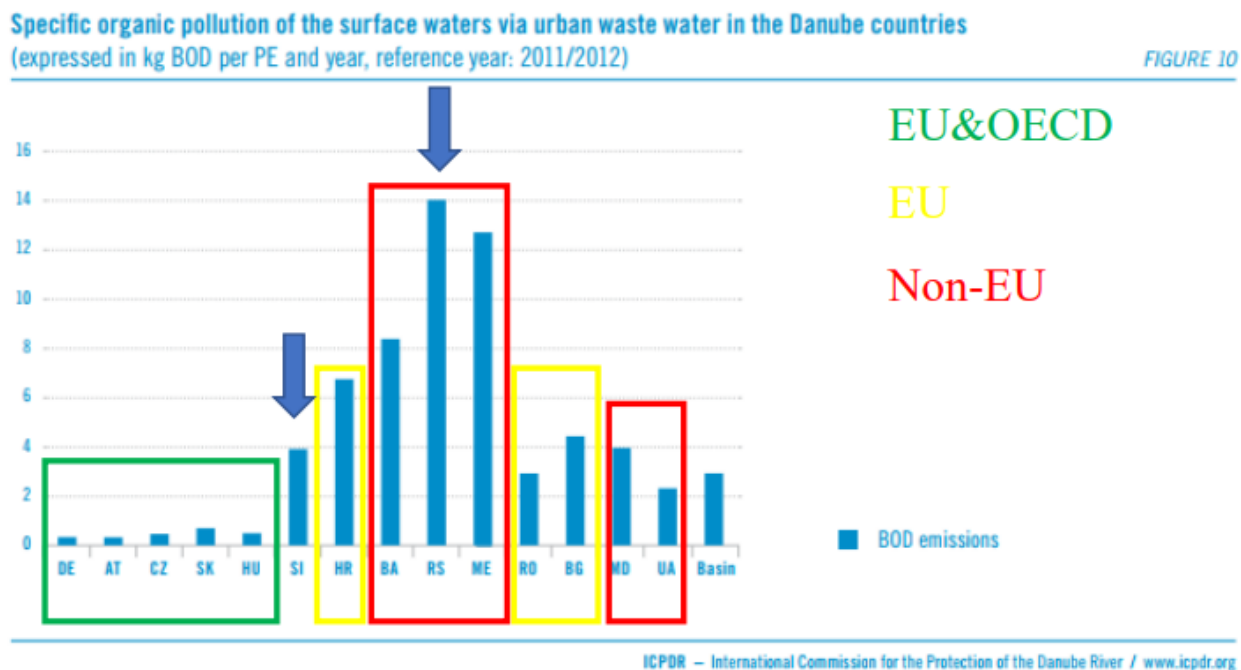
Environmental protection

The area of environmental protection has been very actively researched in Serbia for decades. However, the industries based on “green” technologies, water and land purification or waste recycling are not prominent. The European Union recognizes ecology as an area that requires big investments in order for Serbia to reach environmental standards of the EU. It is estimated that Serbia should invest fifteen billion euros in environmental protection over the next three decades. The European Union is ready to finance a half of that amount¹.

Environmental projects in the domain of water protection and purification are particularly important in the countries of the Danube region. Figure 3 was displayed during the event “Macro-Regional Innovation Week” 2018 organized by JRC illustrating the need for regional projects for water protection. It is evident that the European Union and the countries of the Danube region will seek much larger investment in projects for water protection and purification.

¹ <http://www.rts.rs/page/stories/sr/story/125/drustvo/3039537/poglavlje-27--najobimnije-i-najskuplje-u-procesu-pristupanja-eu.html>

Figure 3: Information on water pollution in the Danube region (Source: ICPDR)



The interest of European institutions is also visible in a series of programmes which are already available to researchers and companies that would direct cooperation toward sustainable development and ecological innovations such as the IPA Cross-border Co-operation Programmes or green innovation vouchers.

Despite the fact that economic results in the areas of renewable energy sources, recycling, reduction of the amount of exhaust gasses or preservation of the quality of the environment are not significant, the area of eco-innovations is a top priority of sustainable development in the long term.

Considering that the said three new areas (energy and energy efficiency, key enabling technologies and environmental protection) were not recognized in the process of mapping economic, scientific and innovation potential, their additional analysis will be performed within the entrepreneurial discovery process – EDP.

The preliminary assessment has therefore demonstrated 4 potential vertical and 3 horizontal thematic priority areas. Draft version of thematic priority areas that may serve as a basis for the entrepreneurial discovery process at the national level may be represented by the following matrix of vertical and horizontal thematic priority areas:

Table 6: Matrix of vertical and horizontal thematic priority areas

	Production and processing of food and beverages	Production of machines and electrical appliances	Creative industries	Energy and energy efficiency
Key enabling technologies				
Information and communications technologies				
Environmental protection				

Workshops of the EDP team and key domestic stakeholders

The findings of the quantitative analysis of the current economic, innovation and scientific potential and findings of further analyses were discussed, validated and improved on the basis of conclusions from workshops of the EDP team which has presented the final proposal of preliminary priority areas, which has also been confirmed by the key stakeholders in the document “Continuation of the RIS3 Design Process in Serbia”.

Preliminary priority areas that will be further analysed in the stage “Qualitative and Detailed Analysis of Priority Domains” are:

1. Information and communications technologies - Digitization of Economy and Society
2. Production and processing of food and beverages - Food and health
3. Cultural and Creative Industries
4. Production of machines and electronic devices - Industry 4.0
5. Environmental Protection and Energy Efficiency
6. Key Enabling Technologies (KET) and Emerging Technologies

Table 7: Preliminary priority areas and regions in which the said areas are strong

	Belgrade	Vojvodina	Šumadija and Western Serbia	Southern and Eastern Serbia
Information and communications technologies - Digitization of Economy and Society	x	x		x
Production and processing of food and beverages - Food and health		x	x	x
Cultural and Creative Industries	x	x		
Production of machines and electronic devices - Industry 4.0	x	x	x	
Environmental protection and energy efficiency	x	x	x	x
Key Enabling Technologies and Emerging Technologies	x	x		x

1.4 Decision on the National Dimension

Depending on the country’s size, existing sub-national administrative structure and general political context in the RIS3 design process, the decision on national or regional dimension of S3 must also be adopted.

A number of factors influenced the decision in the Republic of Serbia:

- Serbia’s size and its relatively low potential in global terms.
- Lack of adequate divisions into regions and consequently lack of developed subnational administrative structure.
- Uneven distribution of research and development potential and the necessary R&D infrastructure.
- One of the conditions for closing Chapter 20 “Enterprise and Industrial Policy” is to develop a comprehensive national industrial policy based on EU principles and RIS3 findings.

- All key domestic political and intermediary stakeholders desire to conduct the dialogue in several regions, that dialogue is sensitive to characteristics of the environment and to include relevant partners from the entire territory of RS.

Based on views of key domestic political and intermediary stakeholders and guidelines of JRC, a harmonized decision was adopted to conduct EDP activities in various parts of Serbia. The stance of all relevant stakeholders is to design the strategy at the national level taking into account regional specificities and leave the possibility of developing regionally adjusted activities, measures and instruments in future areas of specialization if needed.

In continuation of the smart specialisation process in the Republic of Serbia, RIS3 design is conceived at the national level, and in the following phase “Qualitative and Detailed Analysis of Priority Domains”, the EDP team will analyse preliminary priority areas validated at the interministerial level.

2 Qualitative analysis and collection of qualitative data

The fourth phase of the general framework of smart specialisation for enlargement countries and neighbouring countries of the EU is “Qualitative and Detailed Analysis of Priority Domains”, abbreviated as the Qualitative Analysis. Qualitative interpretation of results is necessary for overcoming limitations of the existing classification of industry and science and discovering actual priority areas and value chains they represent.

Qualitative data is collected on the basis of in-depth interviews, focus groups or case studies with experts representing key and most innovative companies, sectoral experts and researchers who work closely with the business sector. If taking into account discussions, at least 10-15 interviews with key organizations should be organized per priority domain.

The result of this analysis is a better definition of preliminary priority domains for entering the next phase of the general framework of smart specialisation, namely the Entrepreneurial Discovery Process - EDP.

The purpose of the qualitative analysis in Serbia was to collect information on the following matters related to the preliminary priority areas:

1. Who are key players in the preliminary priority areas?
2. What are subspecialisations within the area?
3. Where in the value chain was the largest value created globally and what is the position of Serbian players in global value chains?

Specifically, for the process in the Republic of Serbia, the purpose was to collect key information for developing adequate entrepreneurial discovery process (EDP) to adjust it to the needs and capabilities of representatives.

The purpose was also to identify “ambassadors” of processes in every priority area, and these are representatives of the economic, scientific and civil sector, who quickly recognized the usefulness of EDP and who were influential enough to be able to ensure participation of other important stakeholders and prepared to contribute to the quality of the process by frequently providing opinions and recommendations.

Qualitative data was collected on the basis of detailed interviews and the case study of ICT sectors in Serbia.

2.1 Methodology

2.1.1 Case study of ICT sectors

After the discussion on quantitative analysis results, operational and analytics team for the preparation of RIS3 in the Republic of Serbia together with JRC experts concluded that additional evaluation of ICT sectors in Serbia needs to be carried out. The key reason for selecting ICT sectors for additional evaluation through case study is that the value of the Serbian ICT market is estimated at EUR 1.73 billion in 2016, equal to 6% of GDP in Serbia. ICT is the fastest growing sector over the last 10 years. The software sector in Belgrade significantly contributes to added value, growth and wages that are the highest in the country. The total role of hardware production, on the other hand, remains relatively small, although there is a large number of smaller companies in this industry.

Activities on ICT case study were started in October 2017 with special focus on the software industry. The Mihajlo Pupin Institute was in charge of the implementation of the entire study. The main objective of the ICT case study was to identify strengths and challenges of ICT sectors in Serbia, subspecialisations, position of sectors in the global value chain, future development trends, level of internationalization and future directions of development. The results of the case study serve as an input for decision makers in Serbia to assess the current state of the software industry in Serbia in order to plan future activities and EDP.

In addition to evaluation of the current state of the ICT sector in Serbia, an additional objective of the ICT case study was to raise awareness of the stakeholders about the Smart Specialisation Strategy. During interviews, respondents were informed about the process and objectives of RIS3 and further steps in the process of designing Smart Specialisation Strategy in Serbia

2.1.2 Qualitative Interviews

As soon as key stakeholders harmonized their stances pertaining to the smart specialisation process in Serbia in August 2018, which are recorded in the interministerially confirmed document „Continuation of the RIS3 Design Process in Serbia“, work on the development of qualitative analysis was continued in Serbia.

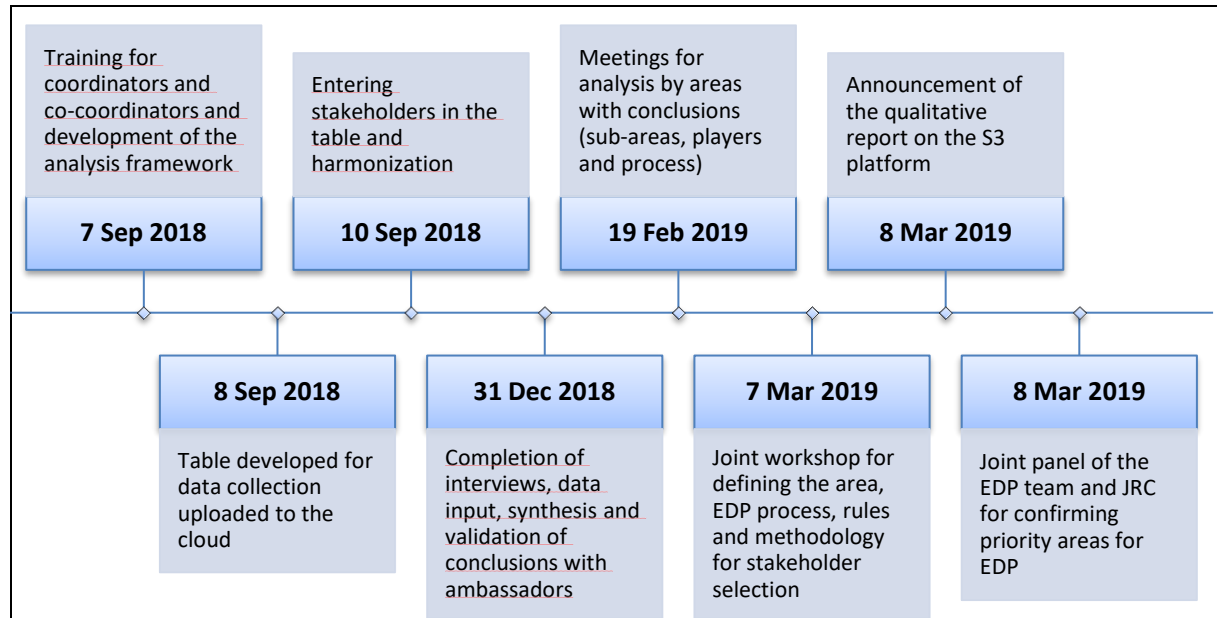
In September 2018 workshops of the EDP team and coordination body of EDP were held as preparation for collecting qualitative data through interviews. The objective was to conduct at least 10 interviews with stakeholders per preliminary priority domain.

In order to ensure participation of key stakeholders and obtain quality information through qualitative interviews by areas we can also compare, the following were developed on workshops of the EDP team and coordination body of EDP:

- texts (pitches) used for presenting the process in public for various target groups and purposes
- standardized questions related to areas:
 - Is your area really as strong as shown by statistics?
 - What makes it strong (export, human resources, innovation...)?
 - Who are key players in your industry?
 - Do you collaborate with them and how much?
 - Who are key players in science for your area?
 - Do you collaborate with them and how much?
 - Are you innovative (do you have R&D, manage innovations, have intellectual property)
 - Who earns how much in your value chain? How far are you from the final customer?
 - What is the potential of your area (grade 1-5)? Why?
 - Who are new prospective subjects?
 - In which field within your area do you see the largest chance for future?
- standardized questions related to further EDP
- standardized questions for identifying “ambassadors”

A protocol was also developed in workshops for documenting data and a team communication protocol, as well as a schedule with the aim of completing the qualitative phase with the panel for confirming chosen priority areas, which precedes the event “Smart Specialization in Serbia”.

Figure 4: Schedule for the Qualitative Analysis phase



In order to implement this ambitious plan with high quality and within deadlines, a large EDP team has been hired consisting of experts from academia and economy by certain areas and experts for process and analytics with the great support of the Serbian Chamber of Commerce, whose experts serve as co-coordinators:

- Viktor Nedović, coordinator of the interministerial working group and coordination body of the EDP team,
- Milan Šolaja, Coordinator for the area Information and communications technology
- Jelena Jovanović, Co-coordinator for the area Information and communications technology
- Jelena Begović, Coordinator for the area Food and beverage production and processing
- Jasna Mastilović, Co-coordinator for the area Food and beverage production and processing
- Saška Biorčević, Co-coordinator for the area Food and beverage production and processing
- Aleksandar Bogunović, Co-coordinator for the area Food and beverage production and processing
- Milica Božanić, Coordinator for the area Creative industries
- Srđan Markotić, Co-coordinator for the area Creative industries
- Mirjana Opačić, Coordinator for the area Production of machines and electronic devices
- Ana Raičević, Coordinator for the area Production of machines and electronic devices
- Mirjana Opačić, Coordinator for the area Environmental protection and Energy efficiency
- Dušan Stokić, Co-coordinator for the area Environmental protection and Energy efficiency
- Siniša Mitrović, Coordinator for the area Environmental protection and Energy efficiency
- Petko Šišović, Coordinator for the area Environmental protection and Energy efficiency
- Srđan Verbić, Coordinator for the area KET and emerging technologies
- Dražen Miletić, Co-coordinator for the area KET and emerging technologies
- Domen Bole, head advisor for EDP

- Jasna Atanasijević, Coordinator of expert support for competitiveness policies
- Lazar Živković, analytics consultant
- Tijana Knežević, operational and expert support
- Jelena Todorović, operational and expert support
- Ankica Momčilović, operational and expert support

2.2 Data collection by preliminary areas

2.2.1 ICT case study

The total duration of data collection within the ICT case study was 3 months, from October to December 2017. Two methodological approaches were used in the preparation of the ICT case study:

- *Surveying respondents by filling out an electronic survey* The target population of the survey were companies operating in the sector of information technologies (software) in Serbia. The database on software companies was provided by the Serbian Chamber of Commerce. The call for filling out questionnaires was sent to 1,089, out of which 195 companies responding, which approximately 18% of responses.
- *Interviewing key stakeholders* The purpose of conducting an interview was to collect qualitative answers of the stakeholders on the identification of key characteristics of sectors, innovations and growth limitation, key drivers of innovation and business and technological trends in the software industry. Interviews were conducted with the key stakeholders from the following groups: managers of large companies; leading researchers; government officials; small and medium enterprises and other organisations supporting business operations.

From November to December 2017 a total of 35 interviews were conducted, 23 of which with the leading companies in the area of software industry in Serbia; 6 interviews with stakeholders from Academia; 2 interviews with the government sector; and 4 interviews with stakeholders from organizations supporting business operations (incubators and science and technology parks). Interviews were conducted with stakeholders from the entire Serbia with the aim of obtaining a clearer picture of the strength of this sector in all regions.

2.2.2 Qualitative Interviews

In the period 10-26 September a total of 143 interviews were conducted with relevant representatives of the economic, academic and civil sector. Within the defined preliminary areas, the following number of interviews was conducted:

Preliminary area	Number of conducted interviews
Information and communications technologies	22
Production and processing of food and beverages - Food and health	25
Creative Industries	20
Production of machines and electronic devices - Industry 4.0	31
Environmental protection and energy efficiency	20
Key Enabling Technologies (KET) and Emerging Technologies	25

3 Data analysis by preliminary areas

Based on data collected through interviews and certain focus groups with the key representatives of the economic, academic and civil sector, members of the EDP team and coordination body presented conclusions pertaining to:

- identification of current and potential (sub)areas,
- identification of key stakeholders by areas
- and key inputs for planning the next phase in RIS3 design

3.1 Current and potential (sub)areas

3.1.1 Information and communication technologies

In the area *Information and Communication Technologies* a total of 22 interviews were conducted with the relevant stakeholders from academia and economy in the period 10-17 October 2018. In addition to these interviews, the source of data for the qualitative analysis of the ICT sector included the results of the ICT case study, in the scope of which 35 interviews were conducted with the relevant stakeholders from academia, civil sector, economy and the government sector, as well as the main conclusions of the study “ICT in Serbia – At a Glance” published by the Vojvodina ICT Cluster. This section presents conclusions of conducted interviews and other studies by the coordinator for this area, Milan Šolaja.

Within the broader area, on the basis of systematized data obtained from a number of sources, the following sub-areas have been proposed:

- **Big data & Analytics**
- **Cloud Technologies**
- **Internet of Things (IoT)**
- **Custom Software Development**
- **Embedded Systems**

According to data from 2016, more than 2,000 companies were registered in the area of ICT employing more than 21,000 people, accounting for 1.4% of the workforce on Serbia's market. Profit per employee index in ICT sector is 6-fold the average profitability of the economy as a whole. This sector has been the fastest growing sector in Serbia in the last 10 years. About 200 new ICT companies are registered in Serbia every year. Most startups hire programmers and are targeting strong and liquid international IT markets. Total net assets of the Serbian IT industry record significant increase. In 2006 total net assets stood at about EUR 150 million, while 10 years later, in 2016, equalled EUR 504 million, generating annual growth in excess of 15%. This trend represents a driving force for the private sector, which is dominant in ICT industry. Software exporters account for the highest net assets – about EUR 212 million. About 70 organisations in ICT sector in Serbia have been identified as potential excellence centres. The table below presents ICT organisations which implemented project under the Horizon 2020 programme.

Organization	No. of projects in the HORIZON 2020 programme
BIOSENSE INSTITUTE NOVI SAD	12
INOSENS NOVI SAD	7
NISSATECH INNOVATION CENTRE NIŠ	6
DUNAVNET NOVI SAD	5

INSTITUT MIHAJLO PUPIN BEOGRAD	5
BELIT BEOGRAD	3
RT-RK NOVI SAD	2
BITGEAR WIRELESS BEOGRAD	2
NOVELIC BEOGRAD	1
BIOIRC KRAGUJEVAC	1

The largest and most significant companies are located in three major centres: Belgrade, Novi Sad and Niš. The general conclusion for all sub-areas is that two dominant business models have been identified: development of own solutions and *outsourcing*. Competitive advantage in the global market is based on the quality of labour force and competitive prices. Domestic IT companies mostly provide advanced level of service whose quality is recognized in the global market. If they sell own solutions, they directly supply their end customers. Serbian IT companies generally do not create full value chains and they do not see each other as competitors due to huge demand in the global market. Overlap with other areas and technologies is very common due to horizontal nature that enables development of other areas.

Sub-area 1 - Big Data and Analytics

The *Big Data* area refers to large and growing sets of unstructured data, which cannot be processed using typical data bases, tools and techniques, while the *Business Analytics* area refers to technologies, techniques, processes and methods for data analysis and involves human resources who turn data into information to help companies to better understand business processes and support decision-making.

The majority of Serbian companies in this area dealt with the development of ERP solutions and subsequently, following international trends, upgraded business solutions toward business development and analytics. The leading companies are M&I Systems Co and ComData from Novi Sad and IIB from Belgrade. There are also other companies in this area whose target market is different, such as Seven Bridges Genomics from Belgrade, who do not use principles of Big Data and Analytics in business, but rather in the field of medical research. Most companies in this subsector work for end clients and compete with domestic and foreign companies in target markets.

Overlap with other areas: Big Data and Analytics is increasingly present in other areas. The best example is the Internet of Things, where a variety of physical devices generate huge amounts of new data that needs to be managed and analysed. Other overlapping sectors include medicine, financial sector, demographic sector, agriculture. Having in view the trend of data collection in almost all sectors, this list is not exhaustive.

Overlap with other technologies: Cloud, IoT, AI, Blockchain.

Critical mass - Currently there is not a large number of companies in this sub-area, but there is a significant growth.

Potential – Strong potential in the Western Balkan region, there are companies that started expansion to other European markets.

Sub-area 2 - Cloud Technologies

Cloud computing is an on-demand service, which gained mass consumption in corporate data centers. The cloud enables central data to function as the Internet and computer resources accessed in a secure and scalable manner. Most companies in this subsector in Serbia work for end clients and compete with domestic and foreign companies in target markets.

Overlap with other areas: Practically, any sector that requires data storage and management represents a potential market for Cloud technologies.

Overlap with other technologies: Big Data and Business Analytics, IoT, Content technologies and IM.

Most companies in this subsector work for end customers and compete with domestic and foreign companies in target markets.

Critical mass – Cloud technologies require a strong and stable Internet infrastructure. Considering the progress in the development of IT infrastructure in Serbia in the past several years, a stronger presence of Serbian companies is expected in this subsector.

Potential - Strong, given the penetration of IT in other sectors.

Sub-area 3 - Internet of Things (IoT)

The Internet of Things represents an internetworking of physical objects, vehicles (including “connected devices” and “smart devices”), buildings and other things with built-in electronics, software, sensors and connectivity which allow objects to exchange data with the manufacturer, operator and/or connected devices, creating a possibility for direct integration of the physical world into systems based on computers, which leads to improvements in efficiency, economic benefits and reduction of human effort.

Number and position of Serbian players: Further research is necessary, but most Serbian IoT companies are associated with research and development projects funded by the EU.

Overlap with other areas: agriculture, medicine, process automation, asset and infrastructure management, transport, etc.

Overlap with other technologies: Cloud, Big Data&BA, AI, Smart Anything.

Critical mass - Requires further research.

Potential - Strong, global demand is on the rise.

Sub-area 4 - Custom Software Development

Custom Software Development (CSD) is the designing of software applications for a specific user or a group of users within an organization. Such software is designed to meet the clients’ needs as an alternative to the traditional and widespread software which is not available.

Serbian companies in this sub-area mostly come from the outsourcing industry and from there they developed in CSD sub-areas by specializing in a market niche and/or one client. This sub-area has dozens of companies and generates a large part of software export in Serbia. Some of them are Ekecom, Levi9, Endava, GTech and ComData. The basic concept of CSD determines the market position

of Serbian IT companies in CSD – sale of own solutions to end customers which provides greater value for these companies.

Overlap with other areas: applicable solutions within all areas.

Overlap with other technologies: Cloud, Big Data & BA, Embedded Systems, Smart Anything, Content technologies and IM.

Critical mass – Yes, there is a large number of companies in Serbia in this sub-area.

Potential - Strong, global demand on the rise.

Sub-area 5 - Embedded Systems

Embedded software is computer software written to control machines that are not typically thought of as computers. It is typically specialized for the particular hardware it runs on and has time and memory constraints.

Number and position of Serbian players: Not numerous, but strong position on the market. Examples include RT-RK from Novi Sad, Mikroelektronika from Belgrade.

Overlap with other areas: automotive industry, telecommunications, signal processing, electricity distribution and management, medicine, transportation, machinery, production automation.

Overlap with other technologies: Cloud, Big Data & BA, Smart Anything.

Critical mass - There is not a large number of players on the market. Requires further research.

Potential - Strong, influenced by development and automation in other sectors.

Rapid sector growth (average growth above 25% in the past 10 years) is a strong indicator of current and future potentials. Investment in and support to the SME sector is considered as the decisive factor for further development of IT industry in Serbia. The general conclusion in the area of *Information and Communications Technology* is that it is difficult to say whether a critical mass exists for certain sub-areas, and for research of this matter the upcoming EDP workshops will provide a clearer picture of potentials within each sub-area and definition of the final names of priorities within the ICT sector.

In addition to the said 5 sub-areas, the coordinator proposed 2 additional sub-areas that do not have the critical mass but have strong horizontal influence on the development of other areas, namely:

- Artificial Intelligence (AI)
- Blockchain technologies

Cross-sectoral innovation: A unique characteristic of the information and communication technologies are their horizontal nature and applicability in almost any other sector. Accordingly, particular attention during the upcoming EDP workshops will be devoted to the horizontal aspect of ICT and networking of key stakeholders in this area with other sectors. The number and position of Serbian players differs depending on the sector and type of business (e.g. digital companies specialised for a sector and sector companies with widespread use of digital technologies).

3.1.2 Food and beverage production and processing

In the area of *Food and beverage production and processing* a total of 25 interviews were conducted with the relevant stakeholders from academia, civil sector and economy in the period 10-26 September 2018. This section provides conclusions of the conducted interviews by the area Coordinator: Jelena Begović and Co-coordinators: Jasna Mastilović and Aleksandar Bogunović.

The interviews indicated the high potential and numerous innovative trends in the area of food and beverage production through which existing natural resources of Serbia for agricultural production are used in optimized manner, and through which the centuries-old tradition of Serbia as a farmland is turned into a modern development resource. In accordance with these observations, the area of food and beverage production and processing should be set as one of the strategic directions of Serbia in the process of designing smart specialisation, the name suggested for the broader area is: **Food for Future F³**

Three sub-areas are proposed within the broader field based on systematized data obtained in interviews:

- **High Tech Agriculture**
- **Value Added Food products**
- **Sustainable Agrifood Production**

Sub-area 1 - High Tech Agriculture

Agricultural production in Serbia for decades was based on conventional production methods that marked the agriculture of the 20th century. At the present time, achieving competitive position in agriculture involves use of high technologies that enable:

- To achieve yields per unit of arable land that are a few times larger than those obtained using the traditional approach to production
- The crop to be minimally dependent on agro-climatic conditions and climate changes
- To achieve product quality which meets increasingly stringent requirements of the modern consumer and distribution chains

There is an increasing number of manufacturers in Serbia who are successfully transitioning to a high-tech agricultural production that is continuously growing. Agricultural manufacturers, investors who gained capital in other business areas and foreign investors invest in high-tech and labour-intensive production. **High-tech fruit plantations** are raised (apple, apricot, peach, cherry, sour cherry, raspberry, aronia, walnuts, hazelnuts, etc.), **greenhouses for vegetable production** (tomato, pepper, cucumber, etc.), production of horticultural products and **vineyards** is initiated. In the largest number of cases, raising modern plantations is also accompanied by construction of storage capacities (cold storage, ULO cold storages) or processing capacities (wineries) that belong to manufacturers themselves, thus enabling direct market access.

All produced quantities are seamlessly placed on the market, mostly foreign markets at prices that are considerably higher than products of lower quality obtained by conventional production methods. Unfortunately, conventional production is still dominant in the agricultural production structure, but broad possibilities of strengthening Serbian agriculture are identified in the shift to high-tech, labour-intensive agriculture that would also include other types of fruit, vegetables and horticultural plants in addition to the said plants. Although field crops are dominant according to produced and exported quantities, a high development potential is observed in this area, but the **application of modern**

agricultural techniques and adoption of measures of agrarian policy are necessary for enhancing this area considering that available arable surfaces make production of field crops inevitable.

High-tech agricultural production requires new resources, thus generating innovations in a range of ancillary activities – **production of seeds and crops, production of mineral and microbiological fertilizers, production of infrastructural crop elements** (pillars, nets, irrigation systems), **production of measurement and control equipment** (sensors, data loggers, information systems for data collection, processing and management), **growth regulators, biological and chemical agents for combating pests and diseases, production of packaging, logistics systems**, etc. Some of the activities have already been developed by entrepreneurs in Serbia, and there is development potential in many of them.

Products obtained from high-tech agricultural crops have already been recognized as highly competitive on the market. This area is on the rise, there is a developed pool of knowledge of domestic experts connected with manufacturers, funding of the expansion of this type of production is planned in pre-accession funds (IPARD), and with numerous other advantages this area has been identified as one of Serbia's development potentials.

Sub-area 2: Value Added Food products

Almost without exception, all respondents who were interviewed stressed the need to encourage and make a step in the food production chain towards **products of higher degree of finalization** and to transform Serbia from an exporter of agricultural products into a food exporter. In the area of food production, there are already numerous companies that successfully produce, place on the domestic market and export food products. In this respect, confectionery industry, fruit and vegetable processing industry, oil production industry and others particularly stand out.

A special role in further development of the food industry is played by added value products that encompass several different groups of food products with increasing demand both in the domestic and particularly in foreign markets. These include:

- **Functional food** marked by one or more nutritional or health statements (rich in fibre, protein, minerals, antioxidants...)
- **Enriched food** with added nutrient(s) from natural sources that are necessary in the diet of a modern consumer
- **Fortified food** with added nutrients that are deficient in diet
- **Organic products** with emphasis on a shift from certified primary agricultural products to processed organic products (frozen organic products, organic dairy products, etc.)
- **Foods for special dietary use** such as gluten-free products, products intended for diabetics, products intended for different groups of consumers such as athletes, children, etc.
- **Products for the food production industry** (modified starches, mixtures for bakery products, etc.)
- **Products obtained from raw materials of special characteristics protected by geographical origin labels** (GI food)
- **products obtained using traditional methods** (Traditional food)
- Products adjusted to **easier use by consumers** (highly convenience food) (tea in the form of a teaspoon)

- Products of **extended durability** with preserved nutritionally valuable components of raw material (lyophilized fruit)

Numerous products from the said product groups already represent a part of the range of products of successful food producers. A part of products is exported, mostly to neighbouring countries, but there are also examples of successful export to farther markets.

A substantial number of researchers in Serbia is focused on research in the area of development of different value-added products, which additionally strengthens this area, but it is necessary to establish mechanisms so that numerous existing results and developed products go to production.

Sub-area 3: Sustainable Food Chain

Sustainability of food production chains involves application of manufacturing practices, procedures and technologies along the entire production and processing chain that will ensure **products that are competitive on the market, without degrading natural resources** on which agricultural production is based. When it comes to agriculture, sustainable production represents an integrated system of plant and livestock production that enables **optimal utilization of resources** in the manner that provides **maximum energy efficiency, top quality of products and care about preserving resources for agricultural production**. In food production, sustainable production implies full utilization of agricultural products so as to optimally use all nutrients, while reducing waste to a minimum. Sustainable production also includes taking measures for reducing losses and waste of agricultural and food products in the chain of production, storage, processing, distribution and consumption.

In agriculture and food production in Serbia there are more and more examples of companies that operate on the principles of sustainable production, invest in innovations in this domain and support research projects aimed at enhancing production sustainability.

Examples include:

- Increasing number of agricultural companies with **integrated production**
- numerous plants for the production of **biogas and biodiesel**
- numerous examples of restoring previous waste from food production and nutrients from by-products into **secondary food and feed products**
- numerous examples of using by-products from food production for **alternative food and non-food products**
- Numerous research projects in this area

Companies applying principles of sustainable production additionally contribute to the reduction of expenses, thus increasing their competitiveness in the market. Application of sustainable production principles involves investments into power plants and other plants which represents a potential for the launch of machine building.

Cross-sectoral innovation: Development of high-tech agricultural production initiates development of innovations in other related areas, notably in KET and ICT, as inseparable support technologies for future agriculture growth and development. Production of plant material for the generation of green energy (biomass energy) is in the focus of research and industry.

Research and cross-sectoral innovations in horizontal priority areas, including notably KETs (nanotechnology, industrial biotechnology, sophisticated machines, sensor technologies) represent a significant part of the development in added value food products. ICT solutions (Blokchain, IoT, Big

Data) play an important role in the transformation of food industry by increasing transparency, efficiency, safety and cooperation along the entire chain of the production of food products.

Development of key aspects of sustainable food chain, which implies reduction of losses and waste of agriculture products and food, is closely related with new solutions being developed in ICT and KET areas.

The general conclusion is that the identified sub-areas have the critical mass of stakeholders necessary for successful implementation of the EDP process, that there is a high potential that needs to be further explored and utilized in the process of smart specialisation strategy. Traditional food production dominated by mostly smaller entities such as small farms and handicraft shops represent a special sub-area with the potential that should not be neglected. This area has great but economically untapped potential. Traditional foods especially acquire value when marketed within a tourist offer, through rural and other forms of tourism. Taking into account the insufficiently visible sector of receptive tourism which is developed in Serbia in different areas (**medical tourism** (dentists, cosmetic surgery), **organisation of high-attendance events** (Exit, Guča), **spa tourism**, visits with the purpose of performing certain activities (film-making), etc. perhaps it would be advisable to review whether to identify the area of **HOSPITALITY** as one of vertical strategic priorities.

3.1.3 Creative industries

In the area of Creative Industry, a total of 20 interviews were conducted with the relevant stakeholders from academia, civil sector and economy in the period 10-26 September 2018. This section provides conclusions of the conducted interviews by the area Coordinator: Milica Božanić and Co-coordinator Srđan Markotić.

Interviews stressed the high potential in certain sub-areas, particularly in high-quality personnel, but also pointed to infrastructural constraints.

Based on systematized data obtained in interviews, three sub-areas are proposed within this area:

- **Creative Digital Media Production and Services**
- **Gaming industry**
- **Smart and Active Packaging**

Sub-area 1: Creative Digital Media Production and Services

This sub-area may broadly be called creative digital production of audio-visual content, and it includes: production of 3D animation, visual effects and a variety of sub-processes and disciplines in creating a partially or fully digitally created image for film, TV, advertising industries, animated film, gaming and active expansion towards VR and various AI applications and upgrades through use of “deep learning”, artificial intelligence and machine learning. While high-tech development within this discipline takes place abroad in scientific and corporate centres, there are about a dozen studios in Serbia which actively produce high-quality content for foreign markets. The number of companies and teams is substantially higher taking into account great possibilities of working “online” and finding jobs abroad “under the radar”. This market emerged in Serbia in the late 1990s, concurrently with the global rising trends, self-taught under the conditions of complete isolation. Most players in the field have secondary technical education, and the narrow domestic market made them turn toward foreign clients, from whom they learned the ropes, manner of organization and work, so that at present they are almost exclusively export-oriented, with foreign clients accounting for between 50% and 70% of

work performed. It should be noted that “brain drain” in this area has been extremely pronounced for a decade, due to which Serbia now has a very strong and successful expatriate community of professionals in computer graphics.

The global industry of visual effects is estimated to reach the value of \$20.7 billion by 2022, with estimated growth by 9.9% and 11.2% respectively for the USA and Europe, where the majority of current clients are based. All respondents have assessed the current strength of the sector with a certain amount of reservation attributable to various distortions and unregulated market, domestic legal framework, etc. However, they highly rated the prospects of the industry since the volume of current production is only a small part of the total potential.

The Ministry of Economy, through the programme of incentives for investors in audio-visual productions, grants 25% refund for private investments in a film (foreign or domestic), including all phases of production. This is one of the successful mechanisms underlying many industries worldwide. Owing to this mechanism, the volume of foreign assignments carried out in Serbia in film, TV and advertising production has tripled in the period 2016-2018. With strong growing tendency, it might easily reach EUR 50-60 million per year by 2020. At the same time, through the system of financing of the Ministry of Culture, the investment of TV corporations in the production of series has resulted in the expansion of the domestic market, while the market for advertising in the media is declining, providing an increasing space for export.

The main competitive advantage on the foreign market is low price, i.e. “good price-quality ratio”. The challenges of the industry include provision of continuous business flow, since it is related to project cycles and possibilities to create and distribute own content – shift from the subcontractor towards the author.

The academic sector has recognised the need to introduce new study programmes and to modernise the existing educational programmes, with greater emphasis on the use of digital tools and focus on creating content that is relevant for the present point in time. The challenges of the academic sector include: insufficient number of academic staff and absence of incentives for scientific and research work in the field of art toward practical value of theoretical works. Interdisciplinary character and establishment of links between art universities and universities of humanities and sciences is among the key barriers for the completion of competences that could produce better results in R&D process. Striking of balance between the academic research and responding to the needs of the commercial sector seems as the main challenge in the present environment which has discouraging effect on: resources in the form of equipment at the disposal of faculties, inertia of a significant part of teaching staff toward contemporary technologies and trends, inability to hire new teaching staff, lack of interdisciplinary cooperation, lack of resources for participation in international competitions, research projects, conferences, etc.

The number and position of Serbian players in the global (regional) value chain: Depending on their specialization and niches, they perform mostly advanced or segmented parts of the value chain, thereby competing in the domestic market, but on the foreign market they complement each other so as to obtain larger jobs. The degree of cooperation remains low. They have a big competition problem among staff as all members of the staff are employed on projects. They are not too distanced from customers, with usually one or two mediators, and sometimes they are directly hired. Margins are low (10% and lower) due to poor negotiating power and high expenses of investment into hardware and foreign software licences (degree of illegal software use is still a significant factor of low price).

Teams are good, achieving high-quality content with small number of persons, but most respondents suffer of the grow crisis – they prefer to run a “boutique studio” with small number of employees and without excessive hierarchy, than to build up a structure and introduce procedures in their work that would make it possible for the company to grow. They can establish shorter chains; larger studios are already using smaller studios for subcontracting in the periods of heavier workload. They are lacking managerial skills and common infrastructure (creation of unique production capacity that would provide sufficient capacity of the working space, cyber security, optical network, space for testing and development, space for expansion toward new disciplines).

Current and future overlap:

- with other areas: film, advertising, gaming, education
- with technologies: VR, AI, drone, cloud

Sub-area 2: Gaming industry

Gaming industry in Serbia encompasses some 5 large companies, each employing over 100 persons, as well as a large number of smaller studios and teams involved in different segments of the video game production and distribution chain. The Serbian Gaming Association was founded in mid-2018, gathering 28 members and with the perspective of expansion with the ultimate goal to separate the gaming industry from the IT sector, strengthening the development of small companies and talents in gaming through development of capacities for attracting investments in the game development. It is estimated that the wider community engages about 2,000 persons in Serbia with potential annual turnover about EUR 50 million. The existing development is the result of good engineering staff, while further investment in art disciplines is necessary. The sub-sector is only beginning to organise into an alliance. Cooperation with the academic sector is stronger in Novi Sad, but it refers only to education, but not to research and development potential. According to interviewees, present investments in education may be expected to yield notable results only after 5 years.

Number and position of Serbia’s players in the global (regional) value chain: services involved are advanced, provided in full to the end customers at prices entirely competitive on the global market; sometimes they perform a part of outsourcing for other companies or have perfected a part of the service production. They work fully independently from each other, they are not direct competitors as their markets are global and they sell their services to customers abroad. They do not complete a chain, with the exception of talent resourcing.

Current and future overlap:

- with other areas: e-sports: organization of large-scale gaming competitions, destination branding through major events (MICE tourism subsection, small potential impact)
- with technologies: mobile technologies, blockchain technologies (gamecredits)

Conclusion:

- Critical mass: Yes and on an upward path owing to attraction of high earnings
- Potential: high, as a result of global growth
- They do not see the need for networking with other areas, but have capacities. The main market of end users is clearly defined and sufficiently large

Sub-area 3: Smart and Active Packaging

The key strength of the smart and active packaging sub-area is in the technology - modern trends and production machines, human resources and innovation are tracked. Great willingness to move towards smart and active packaging was presented in interviews with companies. Future trends and directions of development were identified which allow development of this sub-area:

- Development of green materials (degradable, from renewable resources) - packaging which is not based on oil, but on nanocellulose and starch.
- New colours and pigments that will allow switching to smart packaging.
- Development of information technologies which is applied in all areas of the production process.

Great willingness for cooperation with food producers and merchants (retail chains) was emphasized. Due to proximity to the market, Serbia may offer good-quality packaging at prices lower than those on the markets of Western and Central Europe. The main advantage of protective packaging and so-called smart packaging is prevention of fraud or packaging of wrong products or the possibility to monitor freshness of packed products.

The number and position of Serbian players in the global (regional) value chain:

- For products: Raw material producers, suppliers of simple/advanced intermediate or final products compete in the local/mass market, compete with price or quality, sell to end customers by themselves.
- For services: they perform simple or advanced services, compete with price or quality, perform partial or full service for the end customer, sell to end customers by themselves.

Current and future overlaps:

- with other areas: food industry, transport

Conclusion:

- Confirmation of the critical mass: Yes
- Confirmation of the current or future potential: Yes
- Potential further divisions or association with other areas

The general conclusion is that in identified sub-areas within broader area of creative industry there is a critical stakeholder mass necessary for the successful implementation of EDP process. Respondents in interviews confirmed the sub-area potential as well as current and future overlap with other areas.

3.1.4 Production of machines and electronic devices

In the area of Production of machines and electronic devices a total of 31 interviews were conducted with the relevant stakeholders from academia, civil sector and economy in the period 10-26 September 2018. This section provides conclusions of the conducted interviews by the area Coordinator: Mirjana Opačić

Proposed broader field name: **Future Machines and Manufacturing Systems**

Based on systematized data obtained in interviews, five key sub-areas are proposed within this area:

- **Specific purpose machines (Application Machines)**
- **Information serving smart management – Industry 4.0 (Data to Decision – Industry 4.0)**
- **Premium tools and components for automotive, railway and aviation industry (Premium Tools and Smart Mobility Solutions)**
- **Devices burning eco-friendly and sustainable fuels (Sustainable heat appliances and devices)**
- **Solutions for smart Ecosystems**

Sub-area 1: Application Machines

This sub-area encompasses all machine producers, including those who manufacture individual assemblies and parts. Although manufacturers are not solely linked by the same field of application, production of machines and individual components follows the same or similar parts of the process. Problems encountered in this type of production are common for all manufacturers. Within this sub-area, participants in EDP workshops, in addition to producers of machines and electro-mechanical components, should also include other participants in the production chain (key players in the metals industry, service activities within the metals industry, companies engaging in engineering and development in the mechanization field, quality assurance (testing and certification of new products), penetration of new markets and preserving the existing ones. There are several manufacturers in Serbia operating in the global market, such as Stax from Čačak which produces packaging lines, then companies which produce machines for paper production, driers, medical machines, etc.

The *Application Machines* sub-area encompasses all participants in the chain, from the production of specific-purpose materials, through mastered engineering technological processes (metals alloying, thermal treatment, welding technology and production technology), components assembling to the final version of product. Most processes within these activities are carried out with the support of domestic infrastructure, inherited knowledge combined with the adoption of new trends present in the international manufacturing and development. In most cases, Serbian manufacturers made their way to the European markets with isolated cases of penetration to the international market. There is huge potential for strengthening certain processes in the production chain within domestic manufacturers and service activities (driving technology). This would greatly contribute to upgrading the infrastructure of activities ancillary to manufacturing of machines and components, and to strengthening further development and increasing competitiveness on the global market. There is a coupling with a measurable number of service activities, such as engineering, production technology, potential for cooperation with scientific institutions, product development and testing, quality assurance and certification according to applicable standards in the aim of providing access to European and global markets.

Position in the value chain:

- manufacturers who deliver final products are at the very top of the value chain, while for the rest of participants it would be necessary to further assess the situation and potential for upgrading the value of their final products and services

Current and future overlapping:

- Energy efficiency, environmental protection, ICT

Conclusion:

- Confirmation of the critical mass: Yes

- Confirmation of the current or future potential: Yes
- Potential further divisions or association with other areas: Yes

Sub-area 2: Data to Decision – Industry 4.0

This sub-area encompasses automatic system management, collection of process data and parameters and their further processing, conversion into information and further application, as well as automation in industry with a step toward Industry 4.0: system integrators, automation, measuring and regulation equipment, industrial engineering, industrial pneumatics. This sub-area enjoys developed infrastructure and won domestic and foreign markets. There is large potential in further development of process automation and digitization (system integrators with software solutions for system integration, management, improvement of process management based on “data to decision” feedback, automation in food industry, water treatment, water supply, oil, gas, rubber industry, electric power industry, as well as in energy and efficiency systems). Key companies in this area export over 60% of their output. Based on the present situation, there is great potential in the development towards Industry 4.0. There are individual companies which operationally belong to Industry 4.0 more than Siemens and DMS-Schneider, but these two companies are key players for getting jobs in the country and abroad. One of the main challenges of this sub-area is positioning on the global market as a “lead project/job partner”.

The number and position of Serbian players in the global (regional) value chain:

- For products: Manufacturers of final products necessary for marketing engineering, which is the basis of their business, compete on the mass market, compete with price or quality, sell to end customers by themselves and operate with other companies as subcontractors.
- For services: they have their software solutions + accompanying installations (microcontrollers, PLCs, connectors, sensors...), which make these solutions “smart”. They provide advanced services, compete with price or quality, perform partial or full service for the end customer depending on the project’s nature, sell to end customers by themselves and as sub-suppliers.

Current and future overlap:

- with other areas: energy efficiency, environmental protection, IT, food and beverage production
- with technologies – this area fundamentally goes in the direction of Industry 4.0.

Conclusion:

- Confirmation of the critical mass: Yes
- Confirmation of the current or future potential: Yes
- Potential further division or association with other areas – absolutely applicable in food industry, water management, power industry, environmental protection, utilities, oil industry and mining

Sub-area 3: Premium tools and components for automotive, railway and aviation industry (Premium Tools and Smart Mobility Solutions)

Evident production growth and industry development at the national level made it necessary to recycle former tools and modernize them, as well as to develop new production systems that would accompany and support industrial development. Tools are directly connected with the manufacturing

of individual components intended for wide industrial applications. Individual components and new quality requirements dictate a direction for the development of tools. It is highly desirable that all stakeholders in this area work together during EDP workshops.

The main challenge in this area is to fabricate a tool of desired characteristics, satisfactory level of quality, required geometry and other mechanical properties, make it quickly and make it in such a way that it is compatible with automated lines. The need for this service is on the rise, which was recognized by some domestic companies, as well as by some globally renowned companies (e.g. in the automotive industry) which came to Serbia with their production facilities with the aim of further development. In addition, design is the area that is inexhaustible and ever changing over time. Changes in design imply change of tools in the production. However, what most serious companies stressed during interviews is that Serbia as a country does not enjoy good reputation on the global market. The winning strategy is to deliver good-quality products and services in “impossible” time-frames, and such production has to be supported by specialized toolrooms ready to provide instant response.

Main directions and requirements of this sub-area:

- Modernisation of the development strategy process for the medium term (3/5 years);
- Modernization of the production stock in cooperation with the R&D sector and in accordance with the chosen strategy, with the aim of improving competitiveness in global commercialization;
- Cooperation with educational institutions (secondary and higher education) with the aim of forming a young generation of specialized workers and engineers, which also has the positive result in increase of employment of personnel with secondary and high qualifications;
- Bringing together present tool manufacturers with representatives of component producers to assess actual needs and directions of further development.

Number and position of Serbian players in the global (regional) value chain: tools can be both a final product and intermediary product. Components are custom-made for clients.

Current and future overlap:

- with other areas: applicable in all manufacturing industries, IT
- with technologies: Industry 4.0, production technology, quality assurance and metrology

Conclusion:

- Confirmation of the critical mass: Yes
- Confirmation of the current or future potential: Yes
- Potential for further division or association with other areas: Yes

Sub-area 4: Appliances running on eco-friendly and sustainable fuels (Sustainable heat appliances and devices)

This sub-area includes production of furnaces, stoves, cooking ranges, fireplaces and low- and high-power boilers. The efficiency of these appliances is over 90%. The potential lies in the creation of added value through greater process automation and movement toward industry 4.0. The potential also lies in the development of individual components (automatics, burners) that are presently mainly imported.

Position in the value chain: companies in Serbia manufacture the entire product, but some components are bought. They compete in the domestic, European and world market. They compete in terms of price and quality. When sale is concerned, in certain markets they sell under their own brand and in others under someone else's brand. There are two reasons for this. The first one is that they cooperate with another company which uses them as producers, ordering a certain number of units (usually in thousands of units) which the domestic company manufactures according to the specified documentation. The second reason is that although Serbian companies are strong and competitive in terms of price and quality, the foreign market is not familiar with their brand, which is their main handicap (the space to do something in this regard).

Current and future overlap:

Energy efficiency, environmental protection, creative industries, ICT

Conclusion:

- Confirmation of the critical mass: Yes
- Confirmation of the current or future potential: Yes
- Potential further divisions or associations with other areas: Yes

Sub-area 5: Solutions for Smart Ecosystem

Within this sub-area, the largest potential lies in the production of lamps and solutions for smart lighting systems, sensors for detection (e.g. degree of air pollution, waste water, land degradation, resistance to climate change, degree of occupancy of containers at the level of the city, village, production plant...).

Production of lamps and equipment for lighting is of high quality, as well as smart solutions for lighting systems for special purposes in the field of industrial, sports, medical, office and public lighting (smart management, high degree of energy efficiency, top quality and compliance with the requirement of environmental protection).

The number and position of Serbian players in the global (regional) value chain: Manufacturers of raw materials and end products compete in mass market, compete with quality, sell to end customers with the assistance of distributors and consultants.

Current and future overlap:

- with other areas: production of electrical devices, ICT
- with technologies: LED technology, smart management and digitization.

Conclusion:

- Confirmation of the critical mass: very likely taking into consideration foreign firms that opened their plants here
- Confirmation of the current or future potential: Yes
- Potential for further division or association with other areas: Yes

The general conclusion of the coordinator for the area *Production of Machines and Electronic Devices* is that there exists a critical mass of stakeholders necessary for the implementation of EDP process. The potential of the sub-area, as well as current and future overlap with other areas, have been confirmed by respondents in interviews. It is necessary to continue communication with identified stakeholders. In the further course of EDP workshops, it would be advisable to provide the possibility for involvement of new players that could contribute to the entire process, particularly in terms of

definition of specific sub-groups within sub-areas. The final version of priorities should be defined only after workshops are held and inputs by stakeholders processed.

3.1.5 Environmental protection and energy efficiency

In the area of *Environmental Protection and Energy Efficiency* a total of 20 interviews were conducted with the relevant stakeholders from academia and economy in the period 10-26 September 2018. This section provides conclusions of the conducted interviews by the area Coordinator: Mirjana Opačić.

Proposal for the broader area name: **Energy Efficient and Eco-Smart Solutions**

Based on systematized data obtained in interviews, a sub-area: **Eco-Smart Energy Sources** has been identified. Within this sub-area, the following potentials which require additional research have been identified:

- biomass (pellet, biodegradable waste)
- efficient batteries
- residues from other waste-treatment processes: dry farm waste (dairy, cattle, pig, chicken farms), meat industry residues – their reclamation and further exploitation,
- municipal waste treatment,
- geothermal energy
- solar power

There is a potential for a large centre for car recycling, design and production of special purpose machines within unique project solutions for the municipal waste treatment, construction of regional waste treatment systems, solving waste collection problems, recycling waste after separation, utilization of waste in energy and further production, closure and rehabilitation of all dumps and unregistered landfills, safe removal and disposal of hazardous waste. In the area of water treatment, there is a certain number of domestic companies designing electro-hydraulic plants for water intake in small hydro power plants.

Current and future overlap:

- overlap with automation, Industry 4.0, power generation from renewable sources, ICT.

Production of machines, assemblies, definition of production technology and welding are fully compliant with the definition of measures and procedures relating to current energy efficiency requirements, as well as with environmental protection measures. Energy efficiency is a requirement addressed in the course of production processes and it provides opportunity for association and overlapping, i.e. for involvement of manufacturers and service providers whose sole business is energy efficiency in the processes of plant and production optimization. On the other hand, finished products must be designed in such a way that they follow and comply with the applicable requirements concerning energy aspects of use (efficient energy consumption, harmful gas emissions within permitted limits, optional operational optimisation depending on input parameters...). Production processes, further use and exploitation of products, as well as components and materials used must meet applicable requirements according to European standards with a view to preserving and protecting the environment.

The general conclusion for the *Environmental Protection and Energy Efficiency* area is that it has both innovation and scientific potential. Due to horizontal nature and importance for the innovation

system, the *Environmental Protection and Energy Efficiency* area will be horizontally supported within EDP workshops. Horizontal linking of identified companies in this area with key stakeholders in machine-building and electrical industries, as well as with those in agriculture and food industry will contribute to successful implementation of the smart specialisation concept in Serbia. All identified priority domains to a lesser or greater extent have to address energy efficiency and environmental protection requirements, which makes the key difference in building competitiveness on the world market.

3.1.6 Key Enabling Technologies (KET) and Emerging Technologies

In the field *Key Enabling Technologies (KET) and Emerging Technologies* a total of 25 interviews was conducted with the relevant stakeholders from the economy and academia in the period 10-26 September 2018. This section provides conclusions of the conducted interviews by the area Coordinator: Srđan Verbić and Co-coordinator Dražen Miletić.

Sub-areas identified in the current discussions regarding KET and Emerging Technologies are as follows:

- Photonics
- Advanced materials
- Advanced manufacturing technologies and electronics
- Industrial biotechnology
- Blockchain technologies
- Autonomous driving, aerospace systems and engineering

The general conclusion for the area *Key Enabling Technologies (KET) and Emerging Technologies* is that there is no critical mass of companies necessary to create competitiveness in the global market. Cooperation with academia is on a very low level. Domestic companies do not sell in the domestic market and do not manage sale abroad, they mostly hire foreign companies to run sales abroad. Intellectual property protection, when it comes to patents, is at a very low level.

On the other hand, there is a trend of arrival of large companies from the EU and other countries like China, which increasingly invest in the areas of applying advanced technologies in Serbia (the latest examples include ZF from Germany, one of the largest companies in the world in the field of electric drives and accompanying systems for the automotive industry, Siemens in the production of railway vehicles and wind turbines, development IT centers of large companies such as Microsoft, but also announced serious IT investments from China, announced opening of jadarite mine, which is the basis for the production of electric batteries, etc.).

Sub-area 1: Photonics

Interview results have demonstrated that certain technologies, particularly optoelectronics, possess certain scientific and innovation potential. Optoelectronics is currently a small group of innovative and high-tech companies in the area of image digitalization, sensors, etc. They produce products for both domestic and primarily foreign market, including cameras and lenses for night surveillance, thermal vision, accompanying camera systems, special purpose cameras and custom-made optical systems lenses, fibre optic sensors and a relatively broad range of optoelectronic components. In the area of photonics, there are more than 10 spin-off companies that participate in the development of new advanced systems, e.g. the EU-Horizon Programme resulted in the first prototype for obstacle

detection (at far distances) in railway traffic. The Innovation Fund of the Republic of Serbia supports development of systems for the detection with application in the area of firefighting (detection in difficult conditions of fire and smoke). In the area of optoelectronics and accompanying areas such as display, traffic lights and image digitization (image processing) the following are also present in addition to the above: Teleoptik, Damiba, Zodax, Vlatacom and in the broadest sense of optoelectronic area DMV, Fazi, Mihajlo Pupin Institute, DSP motion, Frame, Biosense, Niri, Visaris and others.

Overlap with other areas and technologies: Advanced manufacturing technologies and electronics, autonomous driving aerospace systems and engineering, signal processing, image digitization, software development, telecommunications, production automation, electronics and practically various industry sectors.

Sub-area 2: Advanced materials

There are smaller companies in the production of advanced materials that are already dealing with the development and use of composite materials. According to the opinions of respondents, there is a good chance that advanced materials will be used in the automotive and other transportation industries, textile industry and in the furniture industry. In cooperation with agriculture in the production of basic material of natural fibres (e.g. hemp) biodegradability of advanced materials and expansion of capacities in agriculture is achieved, while also creating additional competitiveness on global markets. Serbia has a very well developed agro-business and related service (seed, research, science) for starting products. Natural fibres (e.g. hemp) through the process of mixture with polypropylene would be a composite material on the basis of biodegradable material, which has a high functional value in the automotive industry. Serbia has several successful manufacturers of plastic components for the automotive industry (primarily export-oriented, e.g. to the German market), which could close the circle and the entire value chain – from natural fibre, through processing into composite material and export of specific product for the automotive industry.

The additional potential lies in the application of biopolymers in the packaging of food products and the application of nanotechnology in the packaging of food products. The said examples of packaging can be used in all areas of food industry. For example, cooperation on the development and quality control of polymer barrier and high-barrier films with the manufacturer “Spektar” Gornji Milanovac has already been negotiated, and these materials areas are used by the industries for processing meat, milk and other industries (e.g. packaging of cured meat products in vacuum or modified atmosphere, packaging of cheese or snack products, etc.). There is also multi-decade contractual cooperation with “Tipolastika” Gornji Milanovac.

Overlap with other areas and technologies: Biotechnology, autonomous driving, aerospace systems and engineering, advanced manufacturing technologies and electronics, creative industries, various industry sectors, from food through textile to automotive industry.

Sub-area 3: Advanced manufacturing technologies and electronics

In the area of advanced manufacturing technologies and electronics, companies were identified that are related to industrial automation, introduction of “custom” systems, robotization, connecting hardware and software, etc. This area is very promising since government institutions have also recognized digitization and Industry 4.0 as strategic goals. Due to the need of connecting hardware and software, and electrical components, electronics was added to the name of the area. The current cooperation between economy and science is not at optimum levels. From an institutional

perspective, additional investment is necessary in equipment and human resources of mechanical engineering, electrical engineering and IT faculties, of which some are already “producing” extremely professional and demanded labour force on the market.

Overlap with other areas and technologies: Advanced materials, photonics, autonomous driving, aerospace systems and engineering, and practically all industry sectors and connected topics of Future machines, IT sector in general, software development, etc.

Sub-area 4: Industrial biotechnology

Serbia has experts in this area in the scientific and research community. Due to the extreme importance of agriculture and food industry, new biotechnologies for the enhancement of food and agricultural industry are of paramount importance for the maintenance and creation of new competitive advantages in the global market. Serbia is a major exporter of agricultural products, but the great importance of the food industry has also been recognized. Topics that can potentially be considered:

1. Application of PGPB (plant growth promotion bacteria) for the improvement of yields and functional properties of plant cultures. Institute for Medicinal Plant Research “Dr Josif Pančić” and the Institute of Soil Science, Belgrade cooperated on this topic. A possible cooperation is in preparation with Iceberg Salat Centar Beograd and mushroom growers, Ecofungi Beograd. Generally, the application of bacteria in agriculture increases the possibility of organic food production.

2. Application of microbial fermentation for the enhancement of yields of extractions and functional properties of plant extracts (polyphenols, antioxidants) Possible companies are manufacturers of dietary supplements, e.g. Probotanic Beograd and Dr Josif Pančić Institute.

3. Application of new-generation probiotics for the improvement of functional properties and safety of fermented food. Generally, companies may be included that deal with milk and dairy products fermentation, such as Pirot Milk School, but also other smaller and larger dairies

4. Application of microbial preparations for the improvement of health and yield of bees, company that would be indirectly interested is e.g. Medino from Krnjevo, but generally, all honey manufacturers (beekeepers)

5. Biotechnology in environmental protection. Those companies may be included which generate organic waste and treat waste themselves, applying composting or another microbial process.

Overlap with other areas and technologies: Advanced materials, environmental protection, creative industry and mainly agriculture and food industry, also application machines, medicine, etc.

The general conclusion regarding biotechnology is that more time and many additional interviews are needed to evaluate the entire current and development picture of this area.

Sub-area 5: Blockchain technologies

Around 150 *blockchain* programmers have been identified in Serbia, who mostly work for foreign markets, but also increasingly on their own solutions. Blockchain technology may be applied in various sectors ranging from data storage to financial transactions. Overlap with other areas and technologies: IT area in general, software solutions, in addition to the possibility of use in various sectors such as the financial sector.

Sub-area 6: Autonomous driving, aerospace systems and engineering

This industry is in its infancy and has good potential, both from a scientific perspective but also from the perspective of business entities, which have started to develop and manufacture advanced systems such as unmanned aircraft with different purposes (from border surveillance to application in agriculture like the company Konalek Aerospace Entered, which has its first prototype of unmanned quadcopter with large capacity up to 80 kg intended for spraying plants in agriculture, and at the same time it is also a certified supplier for Airbus). Also, this industry is very focused on new advanced composite materials and use of various advanced technologies. In the area of autonomous driving RT-RK has developed cooperation with AUDI from Germany, thus a good basis exists here as well in terms of adequate developers and development centers. There are great overlaps with other areas and technologies: Photonics, advanced materials, advanced manufacturing technologies, telecommunications, signal processing and image digitization, control systems, software, transport, specialized machines, production automation.

The general conclusion is that in the area of KET and Emerging technology there is no critical mass of companies, strong research infrastructure or large research centers engaged in the production of new technologies and materials. Due to the horizontal nature and importance for the innovation system, identified technologies in the area of *KET and Emerging Technologies* should be horizontally supported. Horizontal connection of identified companies in this area with vertical priorities would contribute to successful implementation of smart specialisation concepts in Serbia.

3.2 Key stakeholders and identified process ambassadors

3.2.1 Information and communication technologies

List of key stakeholders and process ambassadors:

	Ambassador	BD & BA	Cloud	IoT	CSD	Embedded	AI	Cross-sectoral
Economy								
M&I Systems Co.		x						
Execom				x				
Devoteam Serbia					x			
Levi9					x			
RT-RK						x		
Zesium	x						x	
TIAC	x				x			
Intens	x				x			
XLRT					x			
GreenSoft								x
NewTech Solutions					x			
Runa Media								
Prozone					x			
To-Net				x				
Typhoon HIL				x		x		
Seven Bridges Genomics		x					x	
Endava					x			
HTech				x		x		
Vega IT Sourcing					x			
Positive			x					
Infostud								x
ProkomSoft					x			
Mineco Computers								x
Schneider Electric DMS Novi Sad				x		x		
ComData	x	x		x	x			
Academia								
BioSens Institute								x

Mihajlo Pupin Institute				x			x	x
Faculty of Technical Sciences, Novi Sad	x			x		x	x	
Faculty of Natural Sciences, NS								x
ETF Belgrade								x
FON Belgrade								x
Government sector								
Ministerial Council for IT								x
Ministry of TTT								x
Government of the RS								x
UNDP								x
Office of the President of the RS								x
Civil sector								
Zrenjanin IT cluster								x
Subotica IT cluster								x
ICT Network	x							x
ITK of Central Serbia	x							x
NiCat								x
Startit / SEEIT								x
DSI	x							x

3.2.2 Food and beverage production and processing

List of key stakeholders and process ambassadors:

	Ambassador	High-tech Agriculture	Added value food	Sustainable agriculture and food production
Economy				
Delta, Beograd		x		
Biofor doo, Beograd	x	x		
Agrounik doo, Beograd	x	x		

Superior doo, Velika Plana		x		
Pulcap doo, Beograd	x	x		
Vinarija Temet, Beograd (Lozovik)	x	x		
Invetlab doo, Adaševci	x	x		
Zdravo Organic, Selenča			x	
Desing doo, Beograd, Knjaževac			x	
Drenovac doo, Arilje			x	
Vinarija Aleksić, Vranje	x		x	
ALL NATURAL FOODS doo, Nova Pazova	x		x	
Bilje Borča, Beograd	x		x	
Real Red Raspberry doo Bečej			x	
Golden Oil doo, Bačko Petrovo selo			x	
Phytonet doo, Novi Sad	x		x	
Global seed doo, Čurug	x			x
Mirotin, Savino Selo				x
Sirogojno	x			x
UrbiGo doo, Beograd				x
Box System, doo, Beograd				x
Pan Union Oil DOO, Novi Sad				x
CAM Engineering, Novi Sad				x
Academia				
Scientific Institute of Food Technology, Novi Sad	x		x	x
Institute of Field and Vegetable Crops, Novi Sad	x	x		
Faculty of Technology Novi Sad	x		x	x
Faculty of Agriculture Novi Sad	x	x		
BioSens Institute, Novi Sad		x		
Faculty of Agriculture, University of Belgrade	x		x	x
Faculty of Technology and Metallurgy, University of Belgrade	x		x	x
Faculty of Chemistry – Center of Excellence for Molecular Food Sciences, University of Belgrade	x		x	x
Institute of Meat Hygiene and Technology, Belgrade			x	x
Institute for science application in agriculture		x		
Government sector				
Ministry of Agriculture, Forestry and Water Management, Belgrade	x	x		

Provincial Secretariat for Agriculture, Water Management and Forestry, Novi Sad	x	x		
Information Centre for Business Standardization and Certification			x	
Provincial Secretariat for Economy and Tourism				x
Civil sector				
Fruit growers' associations		x		
The Center for Viticulture and Oenology LLC, Niš		x		
Serbian Chamber of Commerce, Belgrade	x	x	x	x

3.2.3 Creative industries

List of key stakeholders and process ambassadors:

	Ambassador	Computer graphics	Gaming industry	Smart and active packaging
Economy				
Crater Studio		x		
Crater VFX Trening Centar	x	x	x	
VRHabitat	x	x	x	
DigitalKraft		x		
SpringOnion		x		
Primer Studio		x		
Digital Asset Tailors		x		
Bunker VFX		x	x	
3Lateral (NS)	x	x	x	
Fried		x		
QL Beans		x		
Take One		x	x	
Primer Studio		x		
Digital Mind		x		
Case 3D	x	x		
Deamdust		x		
Mosquito ADV		x		
Eipix			x	
Cofa Games			x	
Mad Head Games			x	

Nordeus			x	
Ubisoft			x	
Demagog Studio			x	
Comex	x			x
Foka				x
Tuli štamparija	x			x
Papir print				x
Tipoplastika				x
Spektra				x
Tetra pak	x			x
Kej-komerc				x
Sipex				x
Akademija				
University of Arts in Belgrade	x	x	x	
Faculty of Dramatic Arts, University of Arts in Belgrade	x	x	x	
College of Fine and Applied Arts Vocational Studies, Belgrade		x		
School of Electrical and Computer Engineering of Applied Studies, Belgrade		x		
Metropolitan University, Belgrade		x		
Faculty of Technical Sciences, University of Novi Sad		x	x	
Academy of Arts Novi Sad		x	x	
Faculty of Technology and Metallurgy, University of Belgrade				x
Belgrade Polytechnic, Belgrade	x			x
Government sector				
Council for Creative Industries	x	x	x	
Center for Promotion of Science		x	x	x
Ministry of Culture and Information		x	x	
Civil sector				
Serbian Film Association	x	x		
Serbian Gaming Association	x		x	
VFX Serbia		x	x	
Polyhedra				x
Nova Iskra				x

3.2.4 Machines and production processes of the future

List of key stakeholders and process ambassadors:

	Ambassador	Application machines	Information for Industry 4.0 decision	Premium tools and components for automotive, railway and aviation industry	Devices using eco-friendly and sustainable fuels	Smart environment solutions
Economy						
Stax		x				
Indas			x			
T&P PLASTIC SRB	x			x		
HDD surgery				x		
Konelek				x		
IVA 28				x		
Kvalitet Niš		x				
OEM papir mašine		x				
Valis			x			
Gasteh			x			
Metal Klaster				x		
EDEPro						
HBIS Železara		x		x		
EPS					x	
FKL Temerin				x		
Kolubara Metal					x	
Goša FOM					x	
Sever Subotica					x	
Metalac FAD				x		
Milanović inženjering				x		
Pasubio				x		
Pepsi Co				x		
ACE Zrenjanin			x			
Lukas			x			
Tipteh			x			
Mirkrokontrol			x			
Aero-East-Europe				x		
Beta electronic			x			
Simil						

Montavar Belgrade (former Lola)				x		
Servoteh	x		x			
Promaschinen Nova Pazova		x				
M-Tools Stubal – Kraljevo				x		
Idas Mol						
Fabrika Armature	x			x		
Tim Sistem	x				x	
Trgo Produkt	x				x	
Alfa Plam					x	
Termomont					x	
Fyltris	x			x		x
Keep Light	x					x
Radijator	x				x	
Buck	x					x
Weiss light						x
ABC Užice						x
Crown Forest						x
Soko inženjering					x	
Termovent			x		x	
Unipromet						x
Siemens			x			
AMM			x	x		
Uram sistem			x			
DMS Schneider electric			x			
Suez			x			x
Feniks BB			x			
Nitehnoklima			x			
Ansal Steel			x			
Mikoterm			x			
ČIP			x			
NS radijatori			x			
Flama			x			
Em Dip			x			
Alfa clima			x			

D-Company				x		
Gama Consulting				x		
Ming kovačnica				x		
Dahop Utva				x		
Metalurg				x		
Tim industriiel steel				x		
Korali doo						x
Academia						
Faculty of Technical Sciences, University of Novi Sad		x				
Faculty of Mechanical Engineering, University of Belgrade	x		x	x	x	
Faculty of Mechanical Engineering, Niš	x	x	x	x	x	
Faculty of Mechanical Engineering, Kraljevo, University of Kragujevac	x			x	x	
Government sector						
Ministry of Mining and Energy	x	x	x		x	

3.2.5 Energy efficient and Eco-Smart solutions

List of key stakeholders and process ambassadors:

	Ambassador	Eco-Smart energy sources
Economy		
Fabrika Hartije Beograd		x
Crown Forest		x
Agrounik		x
Energetika		x
Eko Fungi		x
Strawberry energy		x
Academia		
Faculty of Mechanical Engineering, University of Belgrade		x

Faculty of Mechanical Engineering, Niš	x	x
Faculty of Technical Sciences, University of Novi Sad		x
Government sector		
Ministry of Environmental Protection		x
Civil sector		
UNDP		x
Mikser		x

3.2.6 Key Enabling Technologies (KET) and Emerging Technologies

List of key stakeholders and process ambassadors:

	Ambassador	Advanced electronics	Photonics	Advanced production technologies	Advanced materials	Blockchain	Biotechnology
Economy							
Harder Digital Sova			x		x		
Visaris			x				
Typhoon Hill		x					
Paneleven						x	
CTT					x		
NovellC		x					
HTEC Group		x					
Ekofungi							x
Iva 28				x			
Game Credits						x	
Inmold					x		
Mitex					x		
RT-RK		x					
Konelek Aerospace Engineering							
Mikrokontrol		x		x			
Servoteh		x		x			
Blockchain Technologies						x	
RealMarket						x	

Academia							
Faculty of Technology and Metallurgy, University of Belgrade					x		
Institute of Physics, University of Belgrade			x				
Faculty of Mechanical Engineering and Civil Engineering in Kraljevo , Laboratory 3D Impuls				x	x		
Faculty of Electrical Engineering, University of Belgrade		x	x	x		x	
Faculty of Organizational Sciences, University of Belgrade		x	x	x		x	
Faculty of Technical Sciences, University of Belgrade		x	x	x		x	
Vinča Institute of Nuclear Sciences							
Faculties of mechanical engineering		x	x	x	x		
Medical schools			x		x		
Technical Faculty Mihajlo Pupin, Zrenjanin					x		
Faculty of Technology in Leskovac, University of Niš					x		
Government sector							
Ministries of Economy, Science, Finance, Agriculture...							

3.3 Input for future entrepreneurial discovery process

In accordance with the general framework for RIS3 design in Serbia the next phase is the Entrepreneurial Discovery Process - EDP. EDP is the key element for the successful design and implementation of the strategy, and it represents a continuous public and private dialogue among stakeholders from 4 spheres of modern innovative society, namely economy, academia, government and civil society. EDP is carried out through a series of joint workshops for each field of specialization and through consultations before and after them. Workshops during EDP cover the following four topics:

- EDP conference which presents all priority domains
- SWOT analysis
- Vision of future development and final name of the priority domain
- Mix of policies (objectives and actions with indicators)

It is of exceptional importance for EDP to be adjusted to the vision and capabilities of stakeholders since RIS3 design cannot be performed well without their participation. For that reason, a number of questions in qualitative interviews was intended for detection of stakeholders' preferences in order to ensure their participation.

3.3.1 General conclusion of qualitative interviews

General conclusions after the analysis of qualitative interviews by the EDP team and the coordination body for EDP are the following:

- EDP workshops should last no more than 2-3 hours, i.e. half a day.
- Period between workshops should be one month. It is generally very preferable to determine the workshop dates as soon as possible.
- Preferences regarding official summoning are very different: from personal calls for smaller representatives of the economy, to formal summons for academia, large companies and the government sector. Official summons should be sent at least 2 weeks in advance.
- In areas represented throughout the territory of the Republic of Serbia, stakeholders are ready to come to workshops in other areas of Serbia. On the other hand, in areas that are geographically concentrated, it is not desirable to organise them in parts of Serbia where there are no stakeholders.
- Content and details regarding the method of work should be prepared accurately prior to the workshop in dialogue with the stakeholders. Conclusions from every workshop should be checked in dialogue with stakeholders after each workshop.

3.3.2 Framework and first proposal of further EDP in Serbia

General conclusions from qualitative interviews indicate that EDP will be implemented differently for each area, even for certain (sub)areas, to ensure the performance of dialogue needed for high-quality design of RIS3. However, rough schedule of activities following each of 4 workshops is presented below.

Table 8: Rough schedule of activities for each series of workshops

Activity	Week
Stakeholder consultations on the next workshop agenda	1
Official invitation for the next workshop	2
Stakeholder consultations on the next workshop execution details	3 - 4
1. Workshop execution	4
Stakeholder consultations on minutes from the last workshop & on the next workshop agenda	5
Stakeholder consultations on confirmation of conclusions from the last workshop & the next workshop execution details	7-8
2. Workshop execution	8

On the basis of such schedule of activities, the first proposal of further EDP in Serbia was drawn up and presented in the table below.

Table 9: Proposal of further EDP in Serbia

Task	Week of	Deadline	Week
Final QA report	18.02.2019	24.02.2019	1
Panel with JRC - decision on priority domains	25.02.2019	3.03.2019	2
Stakeholder selection methodology	25.02.2019	3.03.2019	2
Defined working groups	25.02.2019	3.03.2019	2
EDP timeline and rules	25.02.2019	3.03.2019	2
DEFINITION OF KICK OFF DATE	4.03.2019	10.03.2019	3
Ambassadors consultations on first WS date & draft agenda	4.03.2019	10.03.2019	3
Training on EDP (process, rules, reporting) & EDP team meeting - define next WS agenda & invitation & PR	11.03.2019	17.03.2019	4
Inviting stakeholders - sending official invitation for the Kick off	11.03.2019	17.03.2019	4
EDP team meeting - define next WS execution details	25.03.2019	31.03.2019	6
WS1 (Kick off + SWOT) execution – (29.3. tentative)	25.03.2019	31.03.2019	6
EDP team meeting - analysis joint report & draft conclusions, next WS agenda & invitation	8.04.2019	14.04.2019	8
Inviting stakeholders - sending official invitation for the next WS	8.04.2019	14.04.2019	8
EDP team meeting - Update of the final joint report from the last WS & define next WS execution details	22.04.2019	28.04.2019	10
WS2 (VISION) execution – (22.4. or 23.4.)	22.04.2019	28.04.2019	10
EDP team meeting - analysis joint report & draft conclusions, next WS agenda & invitation	6.05.2019	12.05.2019	12
Inviting stakeholders - sending official invitation for the next WS	6.05.2019	12.05.2019	12
EDP team meeting - Update of the final joint report from the last WS & define next WS execution details	20.05.2019	26.05.2019	14
WS3 (ACTION PLAN) execution	20.05.2019	26.05.2019	14
EDP team meeting - analysis joint report & draft conclusions	3.06.2019	9.06.2019	16
EDP team meeting - Update of the final joint report from the last WS	17.06.2019	23.06.2019	18
DELIVERY OF THE FINAL EDP INPUT FOR RIS3	17.06.2019	23.06.2019	18

4 Conclusions

4.1 Proposal of areas for EDP and sub-areas for EDP

On the basis of systematised data obtained in interviews and according to the proposal of coordinators and co-coordinators for individual areas, the first proposal for the name of broader areas and sub-areas is the following:

Vertical priority areas:

1. Information and communication technologies

- Big Data
- Cloud Technologies
- Internet of Things
- Custom Software Development
- Embedded Systems

2. Food for Future

- High Tech Agriculture
- Value-Added Food
- Sustainable Food Chain

3. Creative industries

- Creative Digital Media Production and Services
- Gaming industry
- Smart and Active Packaging

4. Future Machines and Manufacturing Systems

- Application Machines
- Data to Decision – Industry 4.0
- Premium Tools and Smart Mobility Solutions
- Sustainable heat appliances and devices
- Solutions for smart Ecosystem

Horizontal (supporting) areas:

1. Energy Efficient and Eco-Smart Solutions

- Eco-Smart Energy Sources

2. Key Enabling Technologies (KET) and Emerging Technologies

- Photonics
- Advanced materials
- Advanced manufacturing technologies and electronics
- Industrial biotechnology
- Blockchain technologies
- Autonomous driving, aerospace systems and engineering