European Commission

# Qualitative analysis of economic, innovation and scientific potential in North Macedonia

Radovanovic, N., Lazarov, D., Arizankovska, J., Majstoroska, J. and Bole, D.

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SMART SPECIALISATION IN

# North Macedonia




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### *Authors*

Nikola Radovanovic, European Commission, Joint Research Centre (JRC), Seville, Spain

Darko Lazarov, Associate Professor at the Goce Delchev University, Shtip, North Macedonia

Jadranka Arizankovska, Economic Chamber of North Macedonia, Skopje, North Macedonia

Jasmina Majstoroska, Ministry of Economy of North Macedonia, Skopje, North Macedonia

Domen Bole, independent expert, co-creation, Trzic, Slovenia

## Executive summary

**Policy context**. North Macedonia launched the Smart Specialisation process in 2018 with the main goal of identifying priority areas in terms of economic, innovation and scientific potential for implementing targeted action for further economic development. By enforcing its innovation policy with the Smart Specialisation concept, it looks to boost its economic transformation efforts and enhance its competitiveness in a sustainable manner. The process has been undertaken with strong political commitment by national authorities and the devotion of the nominated inter-institutional Smart Specialisation working group composed of representatives of the government, relevant ministries and the academic community. The Joint Research Centre is continuously providing technical assistance to these efforts. So far, the Smart Specialisation process in North Macedonia has been based on following the S3 Framework for the EU Enlargement and Neighbourhood Region (S3 Framework) (Matusiak and Kleibrink, 2018).

**The mapping process**. In 2019, North Macedonia conducted the first phase of the mapping exercise, which is the quantitative mapping of economic, innovation and scientific potential. The results of this stage revealed preliminary priority areas in the country based on the analysis of various statistical data and indicators. These results were fed into the qualitative mapping phase, which focused on validating the findings through customised discussion with a number of different stakeholders and, hence, further profiling of priority domains.

The qualitative mapping stage, which is presented in this report, included preparations for the interviews with the stakeholders (elaboration of questionnaires, identification of stakeholders, development of procedures for interviews and similar); conducting the interviews; the analysis of the information and data received; organisation of focus groups meetings; and the development of the report based on the findings. The focus group meetings were organised to address the information missing from the interviews and discuss the early findings from the interim report on qualitative mapping. In order to complement the findings, where applicable, the local expert team used the results from various available studies.

**Results**. The work on qualitative mapping succeeded in establishing initial contact with the key stakeholders for the Smart Specialisation process in North Macedonia. The importance of this achievement is in establishing the grounds for the efficient upcoming stakeholder dialogue and continuity of stakeholders' contribution to the Smart Specialisation process in the country. This stage of the Smart Specialisation process ended with an evidence-based decision on the final list of priority domains which will enter the entrepreneurial discovery process stage. This list includes the following priority domains: 1) Sustainable food and beverage production and value chains; 2) Information and communication technologies; 3) Smart/sustainable buildings and materials; and 4) electrical equipment and mechanical parts. The decision on the final list of domains was confirmed during the focus groups meetings, which also helped in bridging the gaps when obtaining the information required from the stakeholders. The main points of the report include validation of the selected preliminary priority areas and identification of key relevant stakeholders in each priority area. With regard to the limitations of this exercise, the analysis occasionally suffered from a lack of available data to determine comprehensive information on value chains and strengthen the justification of certain priority (sub-)areas, and these should be further investigated at the entrepreneurial discovery process stage. For this purpose, the report also includes recommendations for the activities in relation to the upcoming stakeholder dialogue. These relate to justification elements concerning final priority domains to be further improved, analysis of suggested preparatory steps, key topics to be discussed within the thematic EDP workshops, key stakeholders to be invited to working groups during the EDP and advice regarding promotional activities and resources management.

## Abstract

In 2018, the Republic of North Macedonia launched the process of designing its first Smart Specialisation strategy in accordance with the methodology and guidance provided by the Joint Research Centre. From its outset, the process was regarded to be of utmost importance to the future growth of the economy, strengthening competitiveness based on the country's innovation potential and unleashing smart growth by defining high-priority domains in which new added value would be created. One of the key goals of this venture is to identify and apply smarter and more competitive solutions within the identified priority domains, taking into account new challenges for digital and green transition, as well as challenges caused by the COVID-19 pandemic.

After the quantitative mapping of the country's economic, innovation and scientific potential, 19 industries have been identified as having potential in terms of Smart Specialisation, and these were grouped into 6 preliminary priority domains. These domains were analysed in-depth in the qualitative mapping phase, which provided the rationale for the final selection of priority domains in North Macedonia and served as a preparatory stage for the stakeholder dialogue within the entrepreneurial discovery process. This report includes the analysis of each preliminary priority area in terms of justification for their selection. The findings in this report are based on the input from more than 100 interviews held with the key stakeholders, subsequent focus group meetings and information obtained from additional external analyses.

# 1 Introduction

Smart Specialisation was introduced by the European Commission to align the allocation of the European Structural and Investment Funds' spending with overarching policy objectives, as defined in the 'Europe 2020' strategy for smart, sustainable and inclusive growth. Under this approach, regions and countries are developing Research and Innovation Strategies for Smart Specialisation through evidence-based analysis embodied in the quantitative and qualitative mapping of economic, innovation and scientific potential, followed by an entrepreneurial discovery process that includes a dialogue between the public and private sectors as well as academia and civil society in a quadruple-helix approach. Such a sequence of the Smart Specialisation steps is intended to lead to the prioritisation of a limited number of fields where cross-sectoral policy interventions can bring about promising outcomes in terms of innovation and economic growth. In such a way, Smart Specialisation is helping a region or a country to be better equipped to streamline R&I investments, increase competitiveness, encourage R&I business cooperation and strengthen R&I ecosystems, as well as contribute to the further integration into the regional and EU research community (Guzzo and Gianelle, 2021; Woolford et al., 2021; Marques Santos et al., 2021; Gianelle et al., 2020).

Smart Specialisation is a tool for concentrating public and private investment in areas where the country has a critical mass of knowledge, capacities and competences, and where there is innovation potential to position the country within the global markets and thus enhance recognition. The basic concept of Smart Specialisation is mainly to increase the added value of economic activities through public and private investments in research, technological development and innovation, targeted to the areas with the highest potential impact.

Within the EU, having a Smart Specialisation policy framework has been an *ex-ante* conditionality to receive Cohesion Policy funding under the current programming period, while for the EU enlargement economies there is no conditionality for Smart Specialisation. Nevertheless, the basic concepts of the approach – with its quadruple-helix entrepreneurial discovery process; evidence-based policy-making; prioritisation; cross-sectoral perspective; and subsequent implementation and monitoring – are expected to contribute to the modernisation of innovation policies in these economies. In this regard, all Western Balkan economies expressed a political commitment to support the development of their own Smart Specialisation strategies, and each of them launched their respective Smart Specialisation processes by 2018.

North Macedonia launched the Smart Specialisation process in March 2018 and formed an inter-institutional working group for Smart Specialisation composed of representatives of the government, relevant ministries and the academic community. The initiative for the development of the Smart Specialisation strategy for North Macedonia started with an exchange of letters of interest between the Deputy Prime Minister of the Republic of North Macedonia, in charge of economic affairs and coordination with the economic sectors, and the Joint Research Centre as the European Commission's science and knowledge service. The Ministry of Education and Science of North Macedonia created the S3 Working Group and together with the Ministry of Economy are coordinating the development process for the strategy, cooperating intensively with the Cabinet of the Prime Minister of North Macedonia, Cabinet of the Deputy Prime Minister of North Macedonia, the Fund for Innovation and Technology Development as well as other competent ministries, institutions, business representatives, academics and non-government sectors under the quadruple-helix governance model. The process is supported by the European Commission's Joint Research Centre who is collaborating with the Directorate-General for Neighbourhood and Enlargement Negotiations in providing expert support to the EU Enlargement and Neighbourhood Region in developing national Smart Specialisation strategies.

In conducting its Smart Specialisation process, the country is following the S3 Framework. In 2019, North Macedonia initiated the mapping exercise to identify its economic, innovation and scientific potential. This exercise comprises quantitative and qualitative analyses of key indicators and factors related to the economic, innovation and scientific performance of a country or region (Kyriakou et al., 2016; Sorvik and Kleibrink, 2015). In late 2019, the country finalised the quantitative part of the mapping with the identification of different industries with a high level of potential. While the quantitative part analyses statistical data and indicators and applies different techniques for revealing specialisation fields in the form of preliminary priority areas, the qualitative stage aims at validating these findings through customised discussion with a number of different stakeholders and, hence, further profiling of priority domains.

The qualitative analysis, as the final part of the mapping exercise in North Macedonia, was carried out in the second half of 2020 and the beginning of 2021 in order to verify the results of the quantitative analysis in the mapping exercise. This report aimed at providing thorough analysis of preliminary priority areas with particular focus on validating results of the qualitative analysis and discussing justification for the list of selected priority domains. The qualitative analysis of the preliminary priority areas was based on the in-depth interviews with

the selected stakeholders for each preliminary priority area, focus group meetings and desk research of existing external studies. This report also aimed at providing crucial input for the start of the EDP process by setting a framework for stakeholder dialogue. The EDP, which in fact represents a continuous dialogue between four spheres of modern innovation society (known as a quadruple helix, consisting of academia, the government sector, economy and civil society), represents one of the key elements for the successful design and implementation of the Smart Specialisation strategy.

The potential Smart Specialisation priority domains should be supported by targeted, comprehensive and tailored support through government programmes and measures from using national, regional and local budgets; business investments by business sector funds; as well as other relevant sources. By identifying key priority areas, S3 aims to put North Macedonia's research potential at the service of business and societal needs. Additionally, the key advantage of the S3 concept is the participative role of all stakeholders in the process of designing and implementing the strategy, which represents a challenge for North Macedonia.

# 2 Summary of the quantitative analysis of economic, innovation and scientific potential

In 2019, with the support of the German development agency GIZ, the National Centre for Development of Innovation and Entrepreneurial Learning (NCDIEL) conducted the quantitative mapping with the aim of assessing potential S3 priority domains based on economic, innovation and scientific indicators.

The assessment started with collecting data at national level. The data largely originated from the State Statistical Office of the Republic of North Macedonia, State Office of Industrial Property of the Republic of North Macedonia, as well from relevant European and international databases. The research methodology applied for the mapping of economic potential for Smart Specialisation in North Macedonia was based on the analysis of the statistical data elaborated in the descriptive part, while the second step included the analysis based on comparisons of the statistical economic indicators (growth rate, export value, productivity level, average wage) for North Macedonia with respect to the EU average. Mapping of the innovation potential was based on the statistical data originating from the State Statistical Office. Lastly, mapping of the scientific potential was based on the data that originated from various data sources (databases with scientific publications – Web of Science, Scimago Journal & Country Rank database, National and University Library, State Office of Industrial Property and World Intellectual Property Organisation)[1].

Based on the comprehensive analysis, the final, refined list of industry groups with economic or innovation potential with respect to the industry sections mapped for their scientific potential is given as follows.

**Table 1**. Mapped industries with economic/innovation and scientific potential

| Mapped industries with economic/innovation and scientific potential | Pillar |
|---|---|
| C10.6 Manufacture of grain mill products, starches and starch products | Innovation, scientific |
| C10.8 Manufacture of other food products | Innovation, scientific |
| C11.0 Manufacture of beverages | Innovation, scientific |
| C18.2 Reproduction of recorded media | Economic, scientific |
| C22.1 Manufacture of rubber products | Economic, scientific |
| C23.7 Cutting, shaping and finishing of stone | Innovation, scientific |
| C27.1 Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus | Innovation, scientific |
| C27.9 Manufacture of other electrical equipment | Innovation, scientific |
| C28.4 Manufacture of metal forming machinery and machine tools | Economic, scientific |
| C29.3 Manufacture of parts and accessories for motor vehicles and their engines | Innovation, scientific |
| C31.0 Manufacture of furniture | Innovation, scientific |
| I56.1 Restaurants and mobile food service activities | Economic, scientific |
| I56.2 Event catering and other food services | Economic, scientific |
| J58.1 Publishing of books, periodicals and other publishing activities | Innovation, scientific |

[1] GIZ, Mapping economic, innovative and scientific potential in the Republic of North Macedonia, NCDIEL, September 2019.

| | |
|---|---|
| J59.2 Sound recording and music publishing activities | Economic, scientific |
| J60.1 Radio broadcasting | Economic, scientific |
| J61.2 Wireless telecommunications activities | Innovation, scientific |
| J61.9 Other telecommunication activities | Innovation, scientific |
| J62.0 Information technology services activities | Economic, innovation and scientific |

*Source*: GIZ, Mapping economic, innovative and scientific potential in the Republic of North Macedonia, NCDIEL, September 2019.

The mapped industry groups possess potential in at least two of the main pillars for S3: economic, innovation or scientific. In total, 19 industries were selected as a base for further analysis in the development of the national S3 strategy. Overall, it was evident that industry C (manufacturing) is the most dominant industry section, represented by 11 subsequent industrial groups. The second most dominant industry section is J (information and communication), represented by 6 subsequent industrial groups. And finally, the last industry section listed in the table is I (accommodation and food service activities), represented by 2 subsequent industrial groups.

In order to continue with a further analysis based on interviews with key stakeholders, the Inter-ministerial Working Group responsible for leading the process for the development of the Smart Specialisation strategy in the Republic of North Macedonia grouped the 19 industries identified in the quantitative analysis into 6 areas according to their interrelatedness, their sector characteristics and connections, also proposing the consideration of further smart and sustainable joint growth opportunities.

The proposed names of the areas for Smart Specialisation represented a framework for further discussion and possible evolution.

**Table 2**. Grouping of the industrial sectors

| Name of the proposed area for S3 qualitative analysis | Sustainable food and beverage production and value chains | Information and Communication Technologies | Electrical equipment and mechanical parts | Sustainable tourism and catering | Smart/Sustainable buildings and materials | Energy for the future |
|---|---|---|---|---|---|---|
| Industries identified in the quantitative analysis with economic/innovation/scientific potential | - Manufacture of grain mill products, starches and starch products.<br>- Manufacture of other food products.<br>- Manufacture of beverages. | - Information technology service activities.<br>- Other telecommunication activities.<br>- Wireless telecommunication activities.<br>- Radio broadcasting.<br>- Sound recording and music publishing activities.<br>- Publishing of books, periodicals and | - Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus.<br>- Manufacture of other electrical equipment.<br>- Manufacture of metal-forming machinery and machine tools.<br>- Manufacture of parts and accessories | - Restaurants and mobile food service activities.<br>- Event catering and other food services. | - Cutting, shaping and finishing stone.<br>- Manufacture of furniture.<br>- Manufacture of rubber products.<br>- Civil engineering. | New area proposed for analysis. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | other publishing activities.<br>- Reproduction of recorded media. | for motor vehicles and their engines. | | | |

*Source*: Working material of the S3 Working Group of North Macedonia based on the 'GIZ, Mapping economic, innovative and scientific potential in the Republic of North Macedonia, NCDIEL, September 2019'.

At the qualitative analysis stage, the proposed domains were further analysed in relation to their potential and interconnections with other sectors/value-chains and refined in order to be further discussed in the EDP.

**Energy for the future as a newly proposed potential S3 priority area**

A new potential area, 'Energy for the future', was proposed for the qualitative analysis, being an area that was not covered in the quantitative analysis but with potential for further growth due to the existing capacities in science, innovation and new business opportunities. The development of the energy sector, use of renewable energy sources (RES) and the enhancement of energy efficiency are one of the main government priorities and strategic objectives in the country.

In January 2020, the Government of the Republic of North Macedonia adopted the new Strategy for Energy Development of the Republic of North Macedonia until 2040[2]. This strategy provides a platform for modernisation and transformation of the energy sector in accordance with EU energy development processes, enabling better access, integration and availability of energy services, a reduction in pollution and increased private sector participation.

The Strategy relies on the five-dimensional framework of the EU Energy Union (pillars): security, solidarity and trust; fully integrated energy market; energy efficiency; climate action – de-carbonising the economy; research, innovation and competitiveness, taking into account the country's development potential and domestic particulars. The strategy integrates climate and environmental aspects of the energy sector, while proposing affordable, reliable and sustainable energy for the future. The vision for 2040 is: 'a secure, efficient, environmentally friendly and competitive energy system that is capable of supporting sustainable economic growth of the country.' The strategy defines six strategic goals for North Macedonia, mapped along five energy pillars: maximise energy savings; maintain current levels of energy dependence; limit the increase of greenhouse gas emissions; increase the share of renewable energy sources; minimise system costs; and ensure continuous harmonisation with the EU *acquis*. These strategic goals are in line with the new Energy Law and the EU's energy directives.

Energy trends highlight the more ambitious transition to a low-carbon economy, with renewable energy sources (RES) and energy efficiency (EE) being amongst the most important factors enabling transition.

The part of the strategy dealing with R&D and innovation states that research, innovation and competitiveness cover the following priorities from the Energy Law[3]:

- stability, competitiveness and economic functionality of the energy sector;
- promotion of energy efficiency;
- promotion of the use of renewable energy sources.

The newly adopted strategy represents a framework that will enable support to further develop and promote this sector. There is a strong base for research and development within academia in North Macedonia. There are several institutions that are focused on R&I in the energy sector. North Macedonia has a broad range of research institutions in this area, such as: the Research Centre for Energy and Sustainable Development of the Macedonian Academy of Sciences and Arts ICEOR – MANU[4], faculties of the Ss. Cyril and Methodius University of Skopje (Faculty of Electrical Engineering and Information Technologies, Faculty of Mechanical Engineering, Faculty of Computer Science and Engineering); faculties of the Goce Delchev University - Shtip (Electrical Engineering and Mechanical Engineering); the Faculty of Technical Sciences of the St Kliment Ohridski University – Bitola; The South East European University - Tetovo (Contemporary Sciences and Technologies), Faculty of Technical Sciences at the Mother Teresa University - Skopje; as well as a few NGOs/associations: ZEMAK, MACEF, MAKO CIGRE, North Macedonia Innovation Centre, E-Mobilnost, Analitika, Ekosvest, Front 21/42, Go Green, Solar

[2] http://www.economy.gov.mk/doc/2759.
[3] https://economy.gov.mk/Upload/Documents/Zakon%20za%20energetska%20efikasnost.pdf
[4] http://iceor.manu.edu.mk/.

Association, CeProSARD, etc. The strong capacities and potential for research and innovation for this sector is also demonstrated by the number of projects supported by HORIZON 2020[5] and the number of projects supported through the Fund for Innovation and Technology Development.

As another argument about the existing research and innovation capacities of the sector is the fact that, in the period 2014-2020, according to an internal database review by the Ministry of Education and Science, 37% (EUR 5.06 million) of the total EU financial contributions (EUR 13.7 million) under Horizon 2020 for North Macedonia were associated with projects focused on various topics from the thematic area of energy (28 participants or 25% of the total number of awarded projects). Most of the spending was used for the topic of secure, clean and efficient energy – EUR 3.8 million (21 participants) – while the rest of the projects covered activities under climate action, environment resource efficiency and raw materials and smart, green and integrated transport (EUR 1.3 million).

In terms of stakeholder involvement in the sector, most of the spending was used by the private sector, i.e. 9 SMEs participated with net contributions of EUR 1.6 million. Public sector and research institutions participated with 10 projects and EUR 1.5 million, while higher education took part in 5 projects with EUR 0.9 million. Other institutions, such as associations or chambers of commerce, participated with EUR 1 million. On the other hand, according to the official report of the Fund for Innovation and Technology Development (FITD), 7.7% of the projects supported by the FITD are from the sector energy and energy resources, with more than EUR 3 million grants for projects in this area in the last 5 years. Additionally, according to data from the State Office of Industrial Property, 6% of the total number of patent applications in the last decade belong to this area[6], while 6.6% of the total approved budget for innovative projects of the Fund for Innovation and Technology Development also comes from this area[7].

One example of an active NGO in this sector is the association for solar energy, 'Solar Macedonia', as an expert, scientific, educational and cultural association, founded to act in the Republic of North Macedonia and abroad. The association's primary development focus is to boost and facilitate cooperation between companies in North Macedonia, as well as connecting experts (producers, designers, performers, importers, services) and scientists from all scientific branches to promote solar energy. The organisation works at every stage of the solar energy systems; from production to service and maintenance.

[5] Reports of the Ministry of Education and Science of North Macedonia, https://mon.gov.mk/category/?id=2061.
[6] State Office of Industrial Property (SOIP), http://www.ippo.gov.mk.
[7] Reports of the Fund for Innovation and Technology Development, https://fitr.mk/en/#.

# 3 Qualitative analysis and collection of data

The qualitative analysis is one of the key stages in the process of developing a Smart Specialisation strategy. The main aim of the qualitative analysis is to provide more information and evidence about the economic, innovation and scientific potential of the strategic areas/domains identified in the quantitative analysis and to validate and refine potential priority domains.

The collection of data used to perform the qualitative analysis is based on in-depth interviews with representatives of the business sector, academia, state and non-government institutions. More than 15 interviews were held within each of the identified strategic areas. The main findings of the qualitative analysis based on the interviews conducted and on the results of the six focus group meetings were meant to clarify the previously identified preliminary areas and to go deeper in the process of defining strategic subsectors that have the highest development potential within each of the preliminary identified areas. Lastly, the qualitative analysis should represent the main input for further discussions within the EDP.

The interviews had several purposes. The first was to collect information to verify the results of the quantitative analysis in mapping the current areas and defining the potential sub-areas where the country has latent comparative advantages, as well as identifying key stakeholders by area. This should be the main input for the EDP as a crucial stage for designing the Smart Specialisation strategy. The second purpose is to identify 'ambassadors' for each priority area – representatives of the business sector, scientific community, state institutions and civil sector, who would quickly recognise the usefulness of the EDP and were influential enough to be able to ensure the participation of other important stakeholders, as well as being prepared to contribute to the quality of the process by frequently providing opinions and recommendations. The third purpose was to identify key inputs for planning the next phase in the RIS3 design, i.e. EDP. Finally, the last purpose was to analyse the current impact of the COVID-19 crisis on each strategic area and to identify the influence of the crisis on the future development pathway of each area in the post-crisis period.

## 3.1 Methodology

**Qualitative interviews**

The qualitative analysis was performed by an internal team from the Economic Chamber of North Macedonia (ECNM) with the support of a few external domestic experts. The team worked in close cooperation with the Smart Specialisation Working Group of North Macedonia.

The interviews were held with 10-15 main stakeholders per preliminary priority area, of which at least 50% of the interviewed stakeholders had to represent businesses (major companies and SMEs), while the other 50% were relevant researchers, government officials, business and civic organisations. Following the advice from business associations within the Economic Chamber of North Macedonia and in consultation with other stakeholders (MASIT- Chamber of Commerce for Information and Communication Technologies), the Fund for Innovation and Technology Development – FITD, national S3 working group, etc.), a list of representatives from the business sector (companies) was drafted. In the process of selecting stakeholders from the business sector, the ECNM team has used several criteria such as growth potential, number of workers, turnover, export and innovativeness of the companies within each preliminary priority area. Accordingly, a list of government and academic institutions was drafted in consultation with the national S3 working group.

Questionnaires for the business sector, academia and the government sector were developed based on the S3 methodological guidance. The questionnaire was composed of a list of questions which were specifically created for the business sector, academia and government sector according to the specific characteristics of each group of stakeholders. The structure of each questionnaire was made up of three types of questions:

- general questions for the sector (status/structure, development stage, perspectives, key players, COVID-19 effects, etc.),
- EDP-related questions, and
- questions concerning the identification of 'ambassadors'.

At the same time, the ECNM organised meetings with internal and external experts, as well as with the coordinator and members of the national S3 working group, where a detailed working plan for interviews was created in accordance with the defined methodology, and the capacities to conduct the interviews were built. Additionally, the ECNM team, S3 working group and the external experts created the list of potential stakeholders, prepared the protocol and the invitation letter from the Minister of Education and Science of the

Republic of North Macedonia. Institutional support was also secured in order to motivate the participation of the key stakeholders in the qualitative analysis.

Minutes were prepared after every meeting, and had to be confirmed by the person interviewed. Following that, they were uploaded to the cloud system, which was accessible by the members of the S3 working group and other experts.

**Questionnaire structure**

The list of guiding questions that were considered in the interviews are given below. In the interviews, a specific list of questions would take priority, depending on the type of stakeholder. This was due to the fact that each stakeholder group (business sector, academia and government sector) has a different position, role and responsibility in the Smart Specialisation process and in the country's development process.

1. General questions for the specific domain:

a) Standardised questions for the business sector[8]:

- Is your sector really as strong as shown by statistics? What makes it strong (export, human resources, innovation, etc.)?
- Which subsectors are developed the most within your sector? Which parts of the value chains of those sectors are present in the country?
- Who are the key players in your industry? Do you collaborate with them and to what extent?
- Who are the key players in science in your area? Do you collaborate with them and to what extent?
- With which other sector(s) does your business sector predominantly cooperate?
- Is the level of internationalisation generally high or low? Which business (sub)sector(s) have the greatest export potential? Which business (sub)sector(s) exercise the best collaboration with the academic community?
- How dynamic is the sector and what is the role of start-up, scale-up and other small and medium enterprises in its development?
- Do you invest in innovation and technology improvement?
- What are the main strengths and challenges of your sector?
- What is the development potential of your sector (on a 1-5 scale)? Why?
- How do you see the future of your sector? In which part of the supply chain within your sector do you see the greatest opportunity for the future?
- Could you please identify the state measures that could help your sector grow?
- What are the expected impacts of the economic crisis caused by the COVID-19 pandemic on your sector?
- What are the actions that the government should take in order to address the potential effects of the COVID-19 pandemic on your sector?
- Which companies are the most innovative in the sector and which success stories could be used as lessons for other companies?
- Which actors from academia are the most innovative in the sector and which success stories could be used as lessons for others?
- Who are the key stakeholders from the government and civil sectors in the preliminary priority areas?

b) Standardised questions for the academic sector:

[8] For some of the defined questions in the proposed questionnaire, the ECNM team has not succeeded in collecting more detailed information. Hence, some specific fields within the defined preliminary areas, such as innovation potential and value chain, should additionally be explored in the upcoming EDP process.

- How would you assess the R&I conditions in your institution/department in relation to international centres of academic and research excellence?
- How would you assess the number and quality of research personnel in your institution/department?
- How would you assess the relevance of educational programmes delivered by your institution/department in relation to business sector needs?
- How would you assess the importance of our state's participation in international publications in your scientific field?
- What are the specialised topics within your scientific field that are most commonly addressed by domestic authors in international publications?
- How would you assess the collaboration of your institution/department with the business sector?
- What are the specialisation topics that your institution/department most commonly addresses in collaboration with the business sector?
- How would you assess the innovation activity within your institution/department?
- Who are the key stakeholders from the governmental and civil sectors in the preliminary priority areas?
- How would you assess the government support to academia? Do you think the government should have a more active role in building stronger research and innovation capacity in this sector?
- How would you assess the innovation and development potential of this sector? How innovative are the companies within this sector?
- How do you see the future of this sector? In which part of the supply chain within this sector do you see the greatest opportunity in the future?
- Could you please identify the state measures that could help this sector grow?
- What are the expected impacts of the economic crisis caused by the COVID-19 pandemic on the construction sector and production of sustainable materials?
- What are the actions that the government should take in order to address potential effects of the COVID-19 pandemic on this sector?

c) Standardised questions for government institutions:

- How do you evaluate the development potential and opportunities of the sector?
- Are there any institutional obstacles for the development of the sector?
- Is the government ready to make regulatory and institutional improvements to increase the opportunities in the sector?
- Do you think that the government or other institutions are willing to eliminate obstacles and improve the business environment to boost sector development and create opportunities for its advancement?
- What measures do you recommend to further increase sector development?
- Who are the key stakeholders from the governmental and civil sectors in the preliminary priority areas?
- How would you assess the government support to academia? Do you think the government should have a more active role in building stronger research and innovation capacity in this sector?
- How would you assess the innovation and development potential of this sector? How innovative are the companies within this sector?
- How do you see the future of this sector? In which part of the supply chain within this sector do you see the greatest opportunity in the future?

- Could you please identify the state measures that could help this sector grow?
- What are the expected impacts of the economic crisis caused by the COVID-19 pandemic on the construction sector and production of sustainable materials?
- What are the actions that the government should take in order to address the potential effects of the COVID-19 pandemic on this sector?

The second and third part of the questions in the questionnaires was identical for all stakeholders. The intention was to provide recommendations for the EDP process and identify ambassadors.

2. Standardised questions related to the organisation of the EDP process were the following:

- How often would you come to the workshops?
- How long should the EDP workshop last?
- Would you attend the EDP workshop in other regions of North Macedonia?
- Would you need a formal invitation to the workshop? Who should be the institution sending the invitation (national ministry, chamber of commerce, academia)?

3. Standardised questions to identify 'ambassadors' within the priority area/sector included the following:

- Could you assure the participation of other stakeholders?
- Are you willing to provide in-depth feedback on the process and content between two EDP workshops?
- How often can we contact you regarding the S3?

In order to conduct face-to-face interviews of high quality and within deadlines, the ECNM created a team of internal sectoral experts who served as co-coordinators for each priority area and hired external experts from the academia who were the coordinators of each area and were involved in the development of the qualitative analysis. The lead internal expert was Jadranka Arizankovska from the ECNM, while the lead external expert was Professor Darko Lazarov.

## 3.2 Data collection by preliminary areas

In total, 100 interviews were conducted with the representatives of the business sector, academia and government sector in each of the previously defined preliminary priority areas. A total of 63 interviews were conducted in the Skopje region; 5 were conducted with stakeholders from the Polog region; 5 with stakeholders from the South-West region; 10 with stakeholders from the Vardar region; 2 with stakeholders from the Pelagonija region; 13 with stakeholders from the East region; and 2 with stakeholders from the Southeast region.

The responsiveness of the companies was very high and more than 90% of the interviews were conducted face-to-face. The interviews with academia were held with relevant representatives from the largest state universities. Despite the fact that 13 interviews with representatives from academia were carried out, there is a need for further analysis in relation to detailed mapping of the innovation and scientific potential for each area proposed for Smart Specialisation. It is expected that after the finalisation of the development process for the research infrastructure roadmap of the Republic of North Macedonia, a better overview of existing institutional capacities will be given.

Some interviews were conducted online due to the limitations of the communication procedures caused by COVID-19 restrictions. All interviews were held in the period September–December 2020. Other identified relevant stakeholders that were not interviewed in this phase because of the COVID-19 restrictions were additionally invited to participate in the focus group meetings that were organised in January 2021.

The number of interviews that were conducted within each of the defined preliminary areas is presented in the following table[9].

[9] In Annex 2, the table is presented with all interviewed stakeholders.

**Table 3.** List of interviewed stakeholders

| Preliminary area/sector | Number of conducted interviews | | | | Total |
|---|---|---|---|---|---|
| | Business sector | Business associations | Academic sector | Government sector | |
| Information and Communications Technologies (ICT) sector | 8 | 1 | 3 | 1 | 13 |
| Sustainable food and beverage production and value chains | 11 | 1 | 4 | 3 | 19 |
| Smart/Sustainable buildings and materials | 11 | / | 2 | 2 | 15 |
| Electrical equipment & mechanical parts | 14 | 1 | 3 | 2 | 20 |
| Energy for the future | 8 | / | 3 | 3 | 14 |
| Sustainable tourism and catering | 14 | 1 | 1 | 2 | 18 |
| Total | 71 | 4 | 13 | 12 | 100 |

*Source*: Authors.

## 3.3 Assessment of possible effects of the COVID-19 pandemic on promising priority domains

In 2020, the effects of COVID-19 on the science, technology and innovation (STI) ecosystem and policy responses were very diverse. The openness and speed of research on COVID-19 increased compared to prior established practices. Meanwhile, the shock resulting from the COVID-19 lockdown and 'social distancing' measures negatively affected the entire STI ecosystem. Immediate effects on research institutions and universities included interrupted research projects due to limited access to research labs; restricted research mobility; the diversion of research efforts towards COVID-19 topics; and disruptions in human capital training.

Innovative businesses were relatively resilient to the COVID-19 shock in 2020. However, this is not to say that business innovation did not suffer. Access to innovation facilities and opportunities for research collaboration were severely hampered, possibly reducing future rates of innovation. A range of low R&D-intensive service sectors (in particular involving tourism, entertainment and necessary in-person interaction) did not see a recovery in demand with implications for opportunities to invest. Small firms were also affected more than their larger counterparts. Differences were also observed between regions, depending on their sectoral composition, the severity of local COVID-19 outbreaks and subsequent restrictions implemented[10].

The detailed assessment of possible effects of the COVID-19 pandemic on each promising priority area is given as an integral part of the priority area sections in the following chapter of the document.

[10] Paunov, C. & Satorra, S., *Science, technology and innovation in the time of COVID-19*, 2020. 10.1787/234a00e5-en.

# 4 Data analysis by preliminary areas

Based on the data collected through the interviews with the key representatives of the business sector, academia and government institutions, as well as from the input from focus group meetings and the input from additional sectoral analyses, the analysis of the preliminary areas was conducted to identify:

- areas of specialisation;
- key players in areas;
- innovation potential, R&D capacity, internalisation level and export potential;
- key strengths and challenges for Smart Specialisation and government policies to accelerate the development process of each identified area;
- the proposal for the future EDP process; and
- the influence of COVID-19 on each identified area.

## 4.1 Sustainable food and beverage production and value chains

The preliminary defined area of 'Sustainable food and beverage production and value chains' included 12 interviews with representatives of the business sector; the Agricultural and Food Industry Association of the Economic Chamber of North Macedonia as a business association; 4 representatives from academia (Faculty of Agricultural Sciences and Food, Faculty of Veterinary Medicine, Faculty of Technology and Metallurgy within Ss. Cyril and Methodius University - Skopje and the Centre for Transfer of Technology within Goce Delchev University, Shtip); and 2 representatives of government institutions (the Food and Veterinary Agency and the Cabinet of the Deputy Prime Minister in charge of economic affairs and coordination with the economic sectors). Additionally, answers to the questionnaire were also received from the Ministry of Agriculture, Forestry and Water Economy. The interviewed stakeholders are located in different regions of the country: 4 interviewed stakeholders are located in the East region; 2 companies are located in the Pelagonija region; 3 companies in the Vardar region; 1 company in the Polog region; while 9 stakeholders (primarily from academia and the government sector) are located in the Skopje region.

**Table 4**. List of interviewed stakeholders with proposed process ambassadors for the 'Sustainable food and beverage production and value chains' area[11]

| No. | Business sector | Ambassador | Smart agriculture | Food processing with high added value |
|---|---|---|---|---|
| 1 | MIK SVETI NIKOLE | | X | X |
| 2 | PIVARA AD | | | X |
| 3 | PEKABESKO | X | | X |
| 4 | BRILIJANT SHTIP | | | X |
| 5 | MLEKARA AD BITOLA | X | | X |
| 6 | KOZUVCANKA KAVADARCI | | | X |
| 7 | FLOREO KAVADARCI | | X | X |
| 8 | LARS | | X | X |
| 9 | MAKPROGRES DOO, VINICA | X | | X |
| 10 | VITAMINKA AD | X | | X |
| 11 | VESE SHARII | | X | X |
| 12 | ASSOCIATION FOR AGRICULTURAL AND FOOD INDUSTRY | X | X | X |
| No. | Academic sector | | | |
| 1 | FACULTY OF VETERINARY MEDICINE | X | X | X |
| 2 | CENTRE FOR TRANSFER OF TECHNOLOGY - UGD | | X | X |
| 3 | FACULTY OF AGRICULTURAL SCIENCES AND FOOD SKOPJE, UNIVERSITY SS. CYRIL AND METHODIUS IN SKOPJE | X | X | X |

[11] The classification is based on the proposed sub-area(s), while the ambassadors are identified in the process of interviews according to the results of the previously developed questionnaire.

| | | | | |
|---|---|---|---|---|
| 4 | FACULTY OF TECHNOLOGY AND METALLURGY, SS. CYRIL AND METHODIUS UNIVERSITY IN SKOPJE (TMF-UKIM) | X | X | X |
| No. | Government sector | | | |
| 1 | FOOD AND VETERINARY AGENCY OF THE REPUBLIC OF NORTH MACEDONIA | X | X | X |
| 2 | CABINET OF THE DEPUTY PRIME MINISTER RESPONSIBLE FOR ECONOMIC AFFAIRS AND COORDINATION WITH THE ECONOMIC SECTORS | X | | |
| 3 | MINISTRY OF AGRICULTURE, FORESTRY AND WATER ECONOMY | X | X | X |

*Source*: Authors.

Moreover, a focus group meeting was organised with 3 ambassadors from the business sector (BiMilk Bitola, Veze Sharri Tetovo and Pekabesko Skopje), 3 representatives from the government sector (Cabinet of the Prime Minister, Ministry of Economy and Cabinet of the Deputy Prime Minister) and 2 representatives from the academic sector (professors from the Faculty of Technology and Metallurgy, Skopje, and the Faculty of Agricultural Sciences and Food, Skopje). The focus group participants contributed to the finalisation of the strategic sub-areas and the clarification of some of the open questions from the interviews. The participants' discussion in the focus group meeting concluded that 'agriculture and food processing' was one of the most strategic domains for the future development of the country, given that these identified sub-areas have significant economic, innovation and scientific potential for Smart Specialisation.

In the broader area, based on systematised data obtained from a number of sources (conducting interviews, focus group meetings, additional existing studies, etc.), a proposal was made to rename the domain as '**Smart agriculture and food processing with high added value**', which will comprise the following sub-areas:

- Smart agriculture
- Food processing with high added value.

The conclusions from the conducted interviews, the organised focus group meetings and the in-depth sectoral analysis of each defined sub-area are described in the section below.

- **Sub-area 1 – Smart agriculture**

The agricultural sector makes a significant contribution to the economy of North Macedonia in terms of the number of employees, contribution to the GDP, investments in new technology and exports. The gross added value of this sector in 2019 reached EUR 800 million, which is 7% of the country's GDP. This value was generated by 110 000 workers. Over 110 companies exported EUR 168 million of agricultural products (of animal and plant origin) in 2019, which amounted to 2.85% of the country's total exports. This export value has shown an increasing trend in the last several years, which demonstrates that the internalisation level of this sub-area is increasing[12].

The country recorded a comparative advantage in 50 agricultural products (Revealed Comparative Advantage - RCA>1), which is more than 15% of the total export products in which the country specialises (470 products with RCA>1). The top export products in the agricultural sector are brassica (cabbages), fresh grapes, fresh tomatoes, peaches, apples, cucumbers, peppers, cereals, raspberries, blackberries, lamb, milk and others[13]. A major share of these export products goes to the Western Balkans region, the EU market and Russia, while a very small share is exported to other regions across the world.

The country has favourable natural potential (climate, soil quality) for agricultural production. The agricultural sector of North Macedonia has established a long-standing tradition and accumulated knowledge of the production of quality agricultural and food products (in particular, vegetables and fruits, rice, wine and lamb

[12] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia.
[13] Identification of development opportunities and potential for export diversification and structural transformation of the North Macedonia's economy, Economic Chamber of North Macedonia, Skopje, 2020, working document..

meat), which are regionally recognised. The untapped potential for further development results from the availability of uncultivated land and the abundance of ecological pastures combined with the low-cost labour in the rural areas, as well as the country's position in Europe and the already established traditional trade partners.

According to the representatives of academic and business sectors that were interviewed, the challenges associated with climate change will require strengthening of the collaboration between academia and the agricultural producers in defining the next steps in the development of new innovative agriculture products with high added value and the implementation of new modern technologies and smart production methods. This intention is provided for in the Smart Specialisation concept as a global trend that should be adopted by the local farmers and agri-food companies. Changes in consumer demand and orientation towards modern and healthy lifestyles involve searching for new products for which there is potential – such as medical cannabis, different types of flours, avocado and other high-added value fruits – and new markets where the companies from North Macedonia could start exporting, such as the Middle East countries. In fact, transforming the agricultural sector by initiating the production of new products with high added value and investments in new technology and the implementation of smart production concepts are the main challenge and opportunity in the Smart Specialisation process for this sub-area.

The opportunities to increase the production volume and exports offered by several Free Trade Agreements (FTAs), mainly CEFTA within the EU, can be unlocked with investments that boost the productivity and modernisation, the implementation of food quality and safety standards and the concentration of supplies coming from numerous small farmers with improved vertical integration. Better investments in marketing and promotional activities to diversify the limited export destinations can trigger a high return considering the current low level.

The introduction of modern technology and innovations, transfer of knowledge and digitalisation can increase production efficiency, overall competitiveness and income level and combat climate change. This trend of transformation to more high-tech agricultural production (smart agriculture) is continuously growing, and an increasing number of companies – such as ZIK Pelagonija Bitola, Veze Sharri Tetovo, Perm Index Gradsko, Fruktana Shtip, Oaza Samantov, Green Food - Sv. Nikole and others – are introducing modern techniques into their production processes. There is also a critical mass of individual farmers, farmers' organisations and small agri-business firms with the capacity to adopt innovations and new technology. The number of modern fruit plantations (apple, peach, cherry, raspberry and other fruit products), greenhouses for vegetable production (tomato, pepper, cucumber and other vegetables) as well as the number of modern facilities for the production of horticultural products, cereals, wine and other agricultural products is increasing. Additionally, there are many investments in growing organic agricultural products, as well as investments in the production of medical cannabis as one of the sectors with the highest potential. As an example, Oaza Samantov, Zaum Struga, Fruktana Shtip and others produce organic agricultural products; Oaza Alkaloidi Shtip and several other companies started the production of medical cannabis according to EU standards, while Antura Kocani produces different types of flours.

Apart from the investments in new technology, another very important element in the process of transformation from the traditional agricultural sector to high-tech smart agriculture that was pointed out by the interviewed representatives of academia is in building stronger R&D capacities and utilising the innovative potential of the academia itself. The key players in academia are the Faculty of Agricultural Sciences and Food and the Institute of Agriculture within Ss. Cyril and Methodius University - Skopje, the Faculty of Agriculture within Goce Delchev University, the Faculty of Veterinary Medicine - Skopje and the Faculty of Technology and Metallurgy within Ss. Cyril and Methodius University - Skopje. There are more than 200 professors and researchers that work in these state institutions, which include several institutes and research laboratories, such as the Institute of Animal Science, whose activities include: the nutrition and dietetics of domestic animals as well as finding solutions to obtain animal products with improved qualities; controlling herd books and the biodiversity of endemic and domestic animals; collaboration with the farmers as well as finding solutions to obtain animal products with improved qualities; research in the field of aquaculture; as well as the UNILAB as a part of the Faculty of Agricultural Sciences – Shtip, whose activities include: sophisticated agrochemical soil analysis, seeds, raw products, oils, wines, the determination of macro, micro and trace elements in solids and liquid samples. These key players in academia have scientific and research capacities and innovative potential. They are actively involved in collaboration projects with the business sector regarding the preparation of project applications for IPARD, USAID and other EU calls, conducting laboratory experiments and scientific research. Research and innovative capacities of this sub-area are demonstrated by 7 successfully finished H2020 projects in the field

of food security, sustainable agriculture and forestry[14]; more than 25 projects financed under the Fund for Innovation and Technology Development instruments in the field of agriculture; and over 3% of the innovation vouchers (for collaboration between academia and the business sector) awarded under the first Fund for Innovation and Technology Development call that were granted in this field[15]. Additionally, according to the data from the State Office of Industrial Property, 4% of the total number of patent applications in the last decade came from this area (agriculture and food)[16], while 10.5% of the total approved Fund for Innovation and Technology Development projects came from this area (EUR 1.6 million approved budget for projects from agriculture and EUR 2.9 million approved budget for projects in food processing)[17]. Moreover, the FITD has created a special instrument for digitalisation in the agricultural sector as a way to stimulate the implementation of the ICT tools in this sector.

An effective upgrade of the knowledge and skills of the farmers and other stakeholders in the sector and the introduction of innovation is also going to be stimulated through functional links established with the science and advisory services, achieved within the newly established Agricultural Knowledge and Innovation Systems of the Government of the Republic of North Macedonia. The role of the business organisations and clusters is of no less importance. In fact, there are more than 15 active clusters in the field of agriculture and several business associations and organisations, and they make a particularly important contribution to delivering on the main goal of further developing this sub-area. Although the current production structure of the agricultural sector is unfavourable (most of the export products for which the country already built comparative advantages are agricultural products with relatively low added value), there are opportunities to improve its position in the value chain by: protecting the geographical indications and traditional specialties of the products; shifting to organic production; increasing the value-added substance; producing less-represented non-traditional crops that generate a higher yield from limited resources (aromatic and medical herbs, spices, indigenous races and varieties); as well as by linking agriculture with non-farm activities, especially rural tourism.

Smart agricultural production requires new resources, thus generating innovation in a range of ancillary activities – the production of seeds and crops, production of mineral and microbiological fertilisers, production of infrastructure 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 as well as modern agricultural equipment. Even though there is development potential in these activities, many of them have not yet been developed in North Macedonia. However, there are many parts of the value chain which are well-established. For example, Alkaloid Skopje produces and exports various types of fertilisers (liquid mineral fertilisers and mineral fertilisers), bio-stimulants and soil conditioners under the brand names Agrosal and Alkafert. Additionally, there are well-established modern storage, packaging, processing, logistics and distribution capacities for agricultural products (for example, Atlantik Skopje, Badzo Bogdanci, AlMa Savik and Pego Agrofruit are among the successful companies in this regard). There are also several producers (Agrobar Vinica, Delta Metal Kavadarci, Agromehanika Bitola) of agricultural equipment and IT companies which create modern IT tools for smart agricultural production.

Another key element to develop this sub-area is state support with an active role played by key government institutions (the Food and Veterinary Agency of the Republic of North Macedonia; the Ministry of Agriculture, Forestry and Water Economy; the Agency for Financial Support in Agriculture and Rural Development; the Ministry of Finance; the Ministry of Economy; and others) in terms of regulation and agricultural policy, as well as building greater capacities for utilisation of the EU Instrument for Pre-accession Assistance – IPA. Moreover, the government should create new public financing instruments for investments in new production capacities that would be characterised by high EU standards and fully implemented sanitary and phytosanitary measures, modern technology based on the application of ICT tools and solutions (sensors, data loggers, information systems for data collection, processing and management), production of suitable biodegradable packaging, building modern storage and logistic systems which are missing in the current supply chain. The role of academia, clusters, research and innovation centres, as well as start-ups and innovative SMEs, is crucial for the future specialisation of this sub-area.

According to the respondents, there are several additional challenges that the government should address in order to support the further development of this sector. The need for land consolidation and privatisation of

[14] Reports of the Ministry of Education and Science of North Macedonia, https://mon.gov.mk/category/?id=2061.
[15] Reports of the Fund for Innovation and Technology Development, https://fitr.mk/en/#.
[16] State Office of Industrial Property (SOIP), http://www.ippo.gov.mk.
[17] Reports of the Fund for Innovation and Technology Development, https://fitr.mk/en/#.

agricultural land, as well as the investments in infrastructure (roads and irrigation systems) and organised cultivation of primary agricultural products along with complete modernisation as foundations to increase productivity and yield per hectare of land represent some of these challenges. Additionally, the current approach of segregation of competencies across the agri-food policies between the Ministry of Agriculture, Forestry and Water Economy (MAFWE) – responsible for primary agricultural production – and the Ministry of Economy for food processing and trade is not in line with the concept of the EU's Common Agricultural Policy, which implies integrated policy interventions 'from farm to fork'[18]. The lessons learnt from the previous period have shown that the disintegration of state policies for the primary production, processing and trade of agricultural products leads to partial policy solutions and complicates the process of reaching consensual decisions in the common interest of all value-chain stakeholders. This does not help to overcome one of the main problems in the agricultural sector, which is the prominent vertical disintegration in the supply chains. Therefore, the horizontal cross-sectoral connection should be intensified in this regard, especially within areas of marketing promotion, packaging, storage and logistics, the implementation of ICT solutions for managing and trading, more joint initiatives with the representatives of the tourism sector to promote local agricultural products, promotion of the mineral and microbiological fertilisers production as well as promotion of biological and chemical agent production for combatting pests and diseases. There are several well-established storage and logistics centres for agricultural production in the country and they have a crucial role in the supply chain of this sub-area. However, the missing piece in the supply chain that should be developed in the future is better marketing promotion of domestic products on international markets and the sector for packaging and branding.

Moreover, the horizontal connection with the food processing industry represents another important step in the process of Smart Specialisation and ensures a circular economy approach by reutilising agricultural waste and turning it into high-added-value material. The biogas plants built by ZIK Pelagonija and Veze Sharri represent examples of practicing the circular economy model in the agricultural production. There are several other ongoing investments in building biogas plants which indicates that this sub-area is transforming by applying modern and sustainable concepts.

This sub-area is connected with the machinery sector in terms of implementation of new agricultural equipment and new machines for production, as well as with the civil engineering sector in terms of construction of smart facilities for storage and logistics regarding agricultural products. AgroBar Vinica and Agromehanika Bitola are companies which produce agricultural equipment and machines, which are good examples that should be used in other parts of this sub-area (the production of machines and equipment for the production of different agricultural products).

The agricultural sector was largely hit by the COVID-19 crisis through the shutting down of restaurants and the reduced demand for fruit, vegetables and meat. There were also issues during the export activities of agricultural products in the first couple of months of the crisis (April and May 2020). However, the expected impact of the economic crisis caused by the COVID-19 pandemic on this subsector is not significant in terms of demand for agriculture products, number of workers or the value of export. Moreover, the crisis is not expected to have any serious effects on the future development of this sub-area in terms of the Smart Specialisation process and transformation to smart agriculture. The government should create a set of post-crisis measures that will be development-oriented with the single aim of boosting the process of transformation of this sector in terms of the implementation of new technologies, production methods, new products, etc. In this regard, the government should support the investment activities of big companies, as well as the innovative SMEs, which have limited access to finance.

During the health and economic crisis caused by the COVID-19 pandemic, work in the agricultural and food sector did not stop, but only slowed down due to the new rules on restricted movement introduced by the Government of the Republic of North Macedonia in response to the pandemic. The biggest challenges facing the agricultural and food sector were the organisation and logistics of importing and exporting the products from this sector, as well as the organisation of current agricultural and production processes in enterprises due to limited working hours and movement. A total of 50.98% of companies faced cancellations/delays of orders, which shows the extent of the impact of the COVID-19 crisis on companies from this sector. Estimated losses in the agricultural and food sector in the first quarter of 2020, compared to the first quarter of 2019, are calculated at 22-40%. Therefore, the industry expected reduced profitability of 41-60% in 2020. Given that the agricultural and food sector is of vital importance and has the potential to be a driving force in the recovery of

[18] The Farm to Fork Strategy is at the heart of the European Green Deal aiming to make food systems fair, healthy and environmentally-friendly. See more at https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en

the economy, various financial instruments, in cooperation between banks and the state, provided in particular for export-oriented companies, are proposed in the short term. Additionally, in the long run, it is necessary for companies to adapt and improve their technology and application of knowledge, improve their specificity and then become more resilient to future similar challenges such as this health economic crisis[19].

- **Sub-area 2 – Food processing with high added value**

The food processing industry is one of the primary manufacturing sectors in North Macedonia. Even though the country is net importer of food, the export performance and development potential of this sector is significant. The majority of respondents interviewed noted that the most important step for future Smart Specialisation in the country in this sector should be based on moving towards the production of high-added-value products, as well as healthy and organic food products and local food brands.

The food processing sector shows growing trends in terms of number of companies, workers, turnover, exports and other indicators. The number of active companies in the food processing industry was over 1 700 in 2019 (which is almost 23% of the total number of manufacturing companies), and these are located in almost every region (Skopje, Vardar, East, Pelagonija, Polog) of the country. The number of active companies grew by 10% in the period from 2016-2019. These companies have created more than 16 000 jobs, which is more than 10% of the total number of workers in the manufacturing sector. This number of workers shows slight growth over the last several years. At the same time, there is a positive trend in the companies' total turnover (over 5% growth rate in the period 2016-2019)[20]. Moreover, the export value of the food processing industry has reached more than EUR 350 million (over 50% of the total turnover of the entire sector), which shows that this subsector has strong export performance. More importantly, according to the information from the interviewed companies, based on the growing trends in the global demand for food products, the export potential of high-added-value food products is immense and should be utilised, with the support of the government in the process of building comparative advantages by exporting these products to new markets and by including academia in the process of increasing the innovative capacity for the transformation of basic products into high-added-value products.

The conclusion based on the results from the conducted interviews shows that there are numerous companies that successfully produce and sell a wide range of food products on the domestic and global markets, such as Vitaminka Prilep, Makprogres Vinica, Evropa Skopje, Donia Prilep, Cermat Bitola, Swisslion in the confectionery industry (wheat snacks, chocolate products, wafers, cookies and cakes, ice-cream, lokum and other products); Diam Gevgelija, Maks Strumica, Lars Shtip, Vipro Gevgelija in the canning industry (ajvar, lutenica, marmalade, jam); Veze Sharri Tetovo, Mik Sv. Nikole, Agria Veles, Pekabesko Skopje in the meat industry (processed meat products – beef salami, smoked beef, chicken fillet, hot dog and breast, pate and other products); Kadino Skopje, Zito Luks in the baking industry (frozen filo dough pastries, pasteurised breads); BiMilk, Zdravje Radovo, Sutash Skopje in the dairy industry (milk, buttermilk, yogurt, butter, sour cream and other products); Brilijant Shtip, Blagoj Gjorev Veles in the cooking oil industry (sunflower, olive cooking oil). Many of these companies could be classified as innovative SMEs that invest in new technologies and innovations, implement EU standards, have traditions and accumulated knowledge and are well-established on the global markets, representing their comparative advantages. This indicates that the food processing industry is a very dynamic sector from the aspect of technology and innovation with the critical mass of innovative SMEs that have the capacity to accelerate the future development of this sub-area. Additionally, there are seven active clusters (Agri-exporters cluster, 'Wines of Macedonia', Wine cluster – Enolozi, milling and baking industry cluster, food confectionary industry cluster, TWR Tikves Wine Route and Map F&V Cluster) and several business associations that have an important role in the development of different branches within the food processing industry.

The results of the interviews showed that this sub-area has well-established supply chains. There are several wholesale/retail distributors (Dauti Komerc, Kam Market, Stokomak, Rudine, Kolid, Atlantic Trade and others) with well-established distribution networks, storage and logistic capacities, and these have an important role in the promotion and distribution of food products in the Western Balkans region, Bulgaria and other EU countries. Additionally, there are several initiatives among the food producers (in particular, the initiative by the confectionery industry) for creating international distribution networks to better promote food products, which could represent a key step towards further internationalisation of this sub-area. Packaging and marketing

[19] Study on the effects on agriculture and the food industry caused by the health and economic crisis,COVID-19 with recommendations, https://biznisregulativa.mk/mk-MK/Pages/Publications, https://biznisregulativa.mk/Upload/Documents/THE%20EFFECTS%20ON%20AGRICULTURE%20AND%20THE%20FOOD%20INDUSTRY%20CAUSED%20BY%20THE%20HEALTH%20AND%20ECONOMIC%20CRISIS%20COVID-19%20WITH%20RECOM.pdf.

[20] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia.

promotion are parts of the supply chain that are crucial in the process of building stronger competitive advantages of the food processing sector on the global markets.

This sub-area has R&D and innovation potential. The key players from academia are the Food Institute (Department of Food Security and Department of Fruit and Vegetable Processing) within the Faculty of Agricultural Sciences and Food of Ss. Cyril and Methodius University, the Institute for Food Technology and Processing within Goce Delchev University, the Institute for Food within the Faculty of Veterinary Medicine - Skopje, the Faculty of Technology and Metallurgy (Department of Food Technology and Biotechnology) of Ss. Cyril and Methodius University - Skopje, the Faculty of Biotechnical Sciences of St. Kliment Ohridski University - Bitola and the Macedonian Academy of Science and Arts - MANU. There are over 200 professors and researchers active in the institutes and research centres within these institutions. They play a key role in the transfer of new technology, in the implementation of new innovative production techniques and new EU standards, the development of new products as well as in testing product quality, laboratory accreditation, theoretical research and in issuing quality standards for production. An additional argument regarding the existence of research and innovation capacities in this sub-area is the fact that there are 7 successfully finished H2020 projects in the field of food security, sustainable agriculture and forestry; more than 20 projects financed within the Fund for Innovation and Technology Development instruments in the field of food processing in the last 4 years; and more than 10% of the innovation vouchers (for collaboration between academia and the business sector) awarded under the first FITD call were granted to the food processing sector. At the same time, there are many collaborative and applicative projects financed by the EU programmes, such as IPARD, to support innovative ideas in the food processing industry[21].

The stakeholders interviewed pointed out the following main strengths of this sub-area: 1) increasing number of new modern facilities and production capacities with highly flexible opportunities; 2) accumulated knowledge, experience and long production tradition; 3) natural resources; 4) CEFTA and other free trade agreements and huge international market opportunities; as well as the existing distribution network. Therefore, the development potential and untapped opportunities for further production specialisation and export diversification of this sub-area are significant and should be utilised. The companies and faculties interviewed put forward several recommendations based on the challenges addressed that this sub-area is facing in the process of further Smart Specialisation.

The main challenges addressed and recommendations based on these identified challenges are:

- increasing industrialisation – scale of production. Current production is on a smaller scale, investments to increase production capacity, as well as new investments to increase the production capacity for raw materials, are needed;
- increasing diversity in food production and export by using national and EU funds. There are many possibilities that have not yet been utilised in the field of starting the production of new products by having a more active collaboration between academia and the business sector;
- increasing automation and competitiveness through new investments in modern technology, new organisation and business models;
- enhancing the quality and quality control of final products by implementing new ICT management systems and digitalisation;
- increasing know-how of R&D by enhancing scientific and research capacities, as well as the cooperation between the business sector and academia; and
- better marketing promotion of traditional food products that characterise certain regions. This branch is dominated by smaller entities and could be promoted together with cultural and rural tourism. This area has great, but economically untapped, potential that should be utilised.

The production of beverages as a part of the food industry has plenty of development potential, considering the fact that there is tradition, modern technology and experience in terms of trained labour and engineers for the production of high-quality beverages according to international standards. The export opportunities of beer and non-alcoholic beverages are limited to regional markets, while the export activities of wine are highly internationalised – reaching the EU market and beyond. The key players in beer production are Pivara Skopje and Prilepska Pivarnica, while Kozuvchanka Kavadarci, Gorska, Viva Skopje, Pivara Skopje and Prilepska Pivarnica are the key players in the production of water and non-alcoholic beverages. On the other hand, there are many wine producers, but the key players are Tikvesh Kavadarci, Bovin, Stobi Gradsko, Popova Kula Demir

[21] Official Reports of the Fund for Innovation and Technology Development and the Ministry of Education and Science of North Macedonia, https://fitr.mk/en/# and https://mon.gov.mk/category/?id=2061.

Kapija, Ezimit Shtip and others. The wine industry has a long-standing tradition and its products are highly praised on the international market. According to the data obtained by the Ministry of Economy, there are few active clusters for the production and promotion of wine as well as the promotion of wine tourism. 'Wines of Macedonia' (WoM) is the organisation that unites wine producers from North Macedonia, committed to the promotion of the quality and image of the wine from North Macedonia across the world. This is a good example of how an important branch of the country should be promoted and further internationalised on the global markets. However, a considerable share of the producers still sells their products on the foreign markets directly to their trade partners without domestic wholesale companies. According to the information gathered from the interviews, there is an institutional obstacle to the development of the beer and wine production/retail sector. Due to some provisions, this is namely the sale of alcoholic beverages and wines in retail from 7. p.m. to 6 a.m. in winter and from 9 p.m. to 6 a.m. in summer is prohibited. This had a serious impact on beer and wine sales on the domestic market, but also on the sales of the filling stations in the summer period, usually generated by tourists transiting the country. Moreover, the rise in excises increased the price, thus reducing the demand while simultaneously allowing imports of foreign beer and wine. In addition, the licences reduce the interest of the retail network and negatively affect the demand for these products. This sub-area was seriously hit by the crisis resulting from the restrictions in the catering and tourism sector. On the other hand, the main challenge in the wine sector is to build competitiveness and a brand to export more bottled wine with high added value, and government support to brand the wines from North Macedonia and export bottled wines should be high on the priority list of the Agency for Foreign Investment and Export Promotion and other competent state institutions.

Health supplements, healthy food and organic products is a very important branch of the food processing industry when considering future global market trends. The key players in this branch of the business sector are Vitalia Skopje, BiMilk Bitola, Zoralek Kavadarci, Nelkoski Organic Food Ohrid, Replek Farm Skopje, Alkaloid Skopje, Agro Fila Shtip and a few smaller producers of organic fruit, vegetables and other organic products. The healthy and organic food segment showed positive development trends in the last period in terms of the number of companies that produce organic and healthy food, the number of products and brands that are developed. For example, Good Nature – healthy teas from Alkaloid Skopje, Floreo – different types of organic honey and organic honey products, organic dairy products; different types of healthy oils from Agro Fila, ZAUM – organic hazelnut paste and crème; Vitalia – organic and health products such as immune boosters, cereals, oatmeal, bars, snacks, sweeteners, beverages and teas; organic fruits and vegetables from different small producers; and oil from cannabis. According to the data obtained by the Ministry of Economy there are a few active clusters in this area.

This branch has critical strategic strengths such as natural resources, innovation capacity, geographic position, but there is untapped development potential that should be utilised by increasing the cooperation between the companies, the government and academia. Additionally, the health crisis caused by the COVID-19 pandemic and people's increased awareness of the importance of healthy and organic food is another argument concerning the existence of development potential for this sub-area. This sub-area is closely related to the ICT sector in terms of implementation of new business and organisation models, as well as new production processes based on ICT solutions, such as AI, Big Data and Business Analytics, IoT. At the same time, the food processing industry is related to the machinery sector in terms of using new machines and equipment, as well as being related to tourism in terms of wine tourism, gastronomic tourism and supplying traditional food. There are links with energy efficiency solutions and greening the industry, with a special focus on a circular economy.

The impact of the economic crisis caused by COVID-19 on the food processing industry does not seem to be as serious as in other industrial sectors (in tourism, for example). This implies that the domestic demand is stable without bigger negative trends, which largely results from the government support in initiating the anti-crisis measure called 'buy domestic products'. At the same time, there were no negative effects concerning the declining number of workers and export activities. However, this sector experienced some indirect consequences such us problems with sick leave (which led to reduced production), delays in the delivery of raw materials and packaging, a decline in purchasing power, the slowdown of new investment projects, etc. According to the official statistical data, the industrial production of food and beverages experienced a decline of -5%, while export recorded a decline of -8% in the period from March 2020 to March 2021. On the other hand, the COVID-19 pandemic had a positive impact on the sector by increasing consumers' awareness of the need to maintain good health, increasing the consumption of healthy supplements and high-added-value food products.

The government and its key state institutions (the Food and Veterinary Agency of the Republic of North Macedonia; the Ministry of Agriculture, Forestry and Water Economy; the Ministry of Economy; and others) could assist this sector in the process of recovery and stimulate further development in the post-crisis period through several actions: supporting international presentation, promotion and branding; engaging foreign experts in all

business processes; favourable credit lines for export arrangements and for increasing competitiveness; assistance in standardisation and certification; new free trade agreements; protection against unfair competition and transfer prices; customs and tax relaxation concerning export-oriented products; de-bureaucratisation of procedures; stimulation of cluster associations and other measures.

## 4.2 Information and Communication Technologies (ICT) sector

In the ICT area, the interviews were conducted with 9 representatives of the business sector including the Chamber of Commerce for Information and Communication Technologies – MASIT, as the largest business association within the ICT sector; 3 representatives of academia (Faculty of Computer Science and Engineering within Ss. Cyril and Methodius University - Skopje, Faculty of Computer Science of Goce Delchev University - Shtip and the Centre for Technology Transfer and Innovation – INNOFEIT within the Faculty of Electrical Engineering and Information Technologies at Ss. Cyril and Methodius University - Skopje); and the Agency for Electronic Communications as a government institution. The majority of the interviewed stakeholders are located in the Skopje region, while one academic institution is located in the East region and one company is located in the Vardar region.

**Table 5.** List of interviewed stakeholders with proposed process ambassadors for the 'Information and Communication Technologies sector' area[22]

| No. | Business sector | Ambassador | Custom software development | ICT infrastructure |
|---|---|---|---|---|
| 1 | MAKEDONSKI TELEKOM | X | | X |
| 2 | A1 MAKEDONIJA | | | X |
| 3 | INBOX | | X | |
| 4 | KABTEL | | | X |
| 5 | ULTRA & UNET GROUP | X | X | |
| 6 | EDUSOFT DOO SKOPJE | | X | |
| 7 | INTERWORKS | X | X | |
| 8 | SEMOS | | X | |
| | Business association - cluster | | | |
| 9 | MASIT | X | X | |
| No. | Academic sector | | | |
| 1 | GOCE DELCHEV UNIVERSITY, FACULTY OF COMPUTER SCIENCE | X | X | X |
| 2 | CENTRE FOR TECHNOLOGY TRANSFER AND INNOVATION-INNOFEIT, Faculty for Electrical Engineering and Information Technologies - Skopje | X | X | X |
| 3 | FACULTY OF COMPUTER SCIENCE AND ENGINEERING AT SS. CYRIL AND METHODIUS - Skopje | X | X | X |
| No. | Government sector | | | |
| 1 | AGENCY FOR ELECTRONIC COMMUNICATIONS | X | X | X |

*Source*: Authors.

A focus group meeting was organised consisting of 3 ambassadors from the business sector (Ultra, Semos and Telekom), MASIT as the largest business association within the ICT sector, 4 representatives of the government sector (Cabinet of the Prime Minister, Ministry of Economy, Ministry of Education and Science, Ministry of Information Society and Administration and Cabinet of the Deputy Prime Minister) and 2 representatives of academia (professors from the Faculty of Computer Sciences and Engineering - Skopje and INNOFEIT – Faculty of Electrical Engineering and Information Technologies - Skopje). The focus group participants contributed to

[22] The classification is based on the proposed sub-area(s), while the ambassadors are identified in the process of interviews according to the results of the previously developed questionnaire.

the finalisation of the strategic sub-areas and the clarification of some of the open questions from the interviews. The participants' discussion in the focus group meeting was focused on several key questions related to the S3 process, such as questions about the innovation potential of start-ups and the role of innovative SMEs in the process of transforming the existing concept based on outsourcing ICT software services towards advanced ICT services and customised software development, as well as the question of building the digital infrastructure and improving the quality of education.

Additionally, several sector studies were consulted in the qualitative analysis, such as the 'ICT General Mapping Report for North Macedonia 2020' and 'Study for the effects on the private sector of the ICT industry affected by the health-economic crisis caused by the COVID-19 pandemic with recommendations for the management of consequences'[23].

The results of the qualitative analysis show that the ICT sector was one of the most dynamic and fastest growing sectors in the Republic of North Macedonia during the last decade. The growth rate in this area has been roughly 47% in the last 5 years. The IT industry is gaining importance in the overall economic development of the country.

According to the national statistical data and the General Mapping Report on the ICT industry in North Macedonia, this area is a high performer in terms of the number of companies, number of employees, added value and exports. In 2019, the number of registered ICT companies was 2 198, which represents an increase of 8% compared to 2018. The number of employees in ICT companies in 2019 amounted to 15 514, which is a 7% rise in comparison with 2018, when this figure was 14 541 employees. The average number of employees per company is 7.46, with the possibility to soon decline to 7.17. If the interest in start-ups and new companies intensifies, and there is no solution to the education (supply) problem, the total number of employees in the next few years may grow even faster, but the average will further decrease. Exports are continuously growing – from EUR 121 million in 2014 to EUR 210 million in 2019 – but the export growth in the IT segment from EUR 60 million to EUR 179 million in the same period is even more impressive. If this trend continues with an average growth of 25%, in the next few years the IT segment will reach almost EUR 300 million. Moreover, 63% of the total value (generated revenue in 2019) of the IT segment is exported and only 23% imported with a 41% share in the trade surplus, which again is highly positive[24].

More than half of companies (52%) are selling on both markets and the other 48% are solely selling on either the domestic or international market. If the answer is both, the international market usually dominates, since almost 84% of all companies are selling there, compared to the 68% selling on the domestic market.

With regard to the type of service portfolio, the companies in the ICT industry are divided into five sub-segments (software and IT services, telecommunication, ICT manufacturing, ICT trade and other IT services). A large share of the companies (56% of the total) are concentrated in the 'software and IT services' sub-segment and 27% in 'ICT trade' and 'ICT Manufacturing'[25].

According to the stakeholders interviewed, one group of IT companies is offering final products by developing their own solutions for final customers, while the other group is based on the 'outsourcing' business model. However, the majority of the IT companies try to combine these two business models by delivering final products and outsourcing. To a certain degree, it is positive that companies offer such a 'final product' at a higher percentage, considering that this type of service brings added value, revenue and greater profit to the companies.

According to the ICT Export Report[26] and findings from the conducted interviews, most of the IT companies do business internationally, and they generate revenue from exporting IT services abroad. The findings show that domestic IT companies are working in many different countries where they mostly have partners or sell directly, while a small share of the companies are subsidiaries. It is rather positive that almost all interviewed companies consider that there is future export potential. Considering that exports are the most valuable aspect of the IT segment, the previous conclusion follows the same thread that companies will strive to develop additional export potential[27].

The ICT segment in the country received over USD 65 million in FDIs between 2003 and 2017 for custom computer programming services, management services for computer facilities and software publishing[28]. The

[23] https://biznisregulativa.mk/mk-MK/Pages/Publications.
[24] ICT INDUSTRY IN NORTH MACEDONIA GENERAL MAPPING REPORT, Skopje, North Macedonia | June 2020, MASIT.
[25] ICT INDUSTRY IN NORTH MACEDONIA GENERAL MAPPING REPORT, Skopje, North Macedonia | June 2020, MASIT.
[26] ICT EXPORT REPORT CURRENT SITUATION AND POTENTIALS June 2020 | Skopje, North Macedonia.
[27] ICT EXPORT REPORT CURRENT SITUATION AND POTENTIALS June 2020 | Skopje, North Macedonia.
[28] Seizing a brighter future for all – WB Systematic Country Diagnosis 2020.

ICT sector is increasingly attracting international companies such as Seavus (Sweden), Netcetera (Switzerland), M Soft (France), 6PM (UK/Malta), which are developing software in North Macedonia for export, while others provide customer support to multinational IT companies. Major international companies in South-East Europe that are present in North Macedonia are: S&T AG (Austria), Ness Technologies (Israel), Musala Soft AD (Bulgaria), Melon AD (Bulgaria), Matrix IT Ltd. (Israel), IN2 Group (Croatia), Endava Ltd. (UK), Dekra SE (Germany), Cisco Systems Inc. (USA), Asseco SA (Poland). A growing number of companies from neighbouring countries enter the labour market of North Macedonia in the outsourcing industry, without owning any offices or subsidiaries, by hiring freelancers or remote employees in North Macedonia[29].

At a time of COVID-19 crisis, the ICT sector demonstrated strong resilience. Companies from this sector reorganised themselves very quickly, mainly through working from home. This primarily led to investments in technical equipment and telecommunications infrastructure to create uninterrupted working conditions at home while maintaining the level of quality set when performing work assignments from the office. On the other hand, the value of digital transformation has never been more significant. The application of digital technology in the newly created situation is invaluable to both the economy and the general population. Statistics show a massive increase in accomplished activities through digital channels, mainly in households with regard to running the necessary errands and certainly in businesses, which inevitably moved to the application of specific tools, be it communication as a basic need or to improve the business processes and the overall business activity.

This section analyses the impact of the COVID-19 crisis on specific aspects of ICT companies' operations, such as the cancellation of orders, collection of claims, liquidity, productivity, logistics and distribution and administrative procedures.

The results of the qualitative analysis related to COVID-19 effects on ICT companies states that the cancellation of orders, as a consequence of the COVID-19 crisis, has the biggest negative impact on their operations. As a result of the crisis, most companies expect it to affect their performance results in the near future. This prediction stems from companies' expectations of a reduction in sales in 2021. Therefore, profitability expectations are similar, with an expected decline.

The majority of IT companies in the country are export-oriented[30]. Most of them export their services and products to Europe, while others export further to the USA and Asia. Most of the interviewed ICT companies that export believe that the consequences of COVID-19 has had a significant impact on their operations. Many of them say that their operations are partially affected, followed by companies whose operations are barely affected or have not experienced any impact on exports.

According to the results of the conducted interviews, almost all ICT companies noted that the COVID-19 crisis does not affect the number of their employees, while the others had to reduce their number of employees. However, during the crisis, there were a small number of companies which experienced employee growth. The predictions on the future impact on the number of employees affected by the COVID-19 crisis are similar to the current impact. The majority of employers believe that the situation will not lead to a reduction in the number of employees in the future, while a select few think that they will lay off a relatively small proportion of the employees. A rather significant percentage believes that the number of employees will increase in the post-crisis period.

To mitigate the consequences of the COVID-19 crisis on employees in the ICT sector, companies believe that the government could choose from several measures to retain most of the jobs. Moreover, most companies consider that measures with a particular impact include the provision of interest-free loans, reduction of tax burdens and subsidies for part of an employee's salary. Some of the measures concerning the effectiveness of the aforementioned are the reduction of social contributions, grant loans to maintain the liquidity and working capital of the companies, exemption from paying pension insurance contributions, reduction of the advance payment of income tax, deferral of income tax payments, provision of low-interest loans, securing loan guarantees and working capital loans and the acceptance of sick leave shorter than 30 days by the Health Insurance Fund (FHI)[31].

The start-up community is becoming increasingly organised and active especially in the ICT industry. A few faculties have developed innovation centres intended to support start-ups in the ICT industry[32].

[29] https://investnorthmacedonia.gov.mk/invest-ict/.
[30] ICT EXPORT REPORT CURRENT SITUATION AND POTENTIALS June 2020 | Skopje, North Macedonia.
[31] Study for the effects on the private sector of the ICT industry affected by the health-economic crisis caused by the COVID-19 pandemic with recommendations for the management of consequences, https://biznisregulativa.mk/mk-MK/Pages/Publications.
[32] https://www.eu-startups.com/2020/04/north_macedonia_skopje_ecosystem_at_a_glance/.

According to the information gathered through interviews and additional related analyses, we can conclude that companies are, for the most part, involved in outsourcing, but the future lies in the further development of customised software for domestic and foreign partners and advanced ICT services in close collaboration with the ICT support centres. ICT is seen as an important partner of the entire economy and society in the process of digital transformation of the industry and development of an e-society.

ICT has shown high innovation capacities. Projects from the ICT industry make up 35% of the portfolio of projects granted through the Fund for Innovation and Technology Development in the last 4 years. Furthermore, the sector obtained 17 of the total number of granted projects through the latest instrument for innovation grants for collaboration between the university and the business sector[33].

Considering the broader area of the ICT sector, based on systematised data obtained from a number of sources (conducted interviews, focus group meetings, in-depth sectoral analysis, etc.), the following sub-area has been proposed: **Custom software development**. The conclusions of the conducted interviews, organised focus group meetings and in-depth sectoral analysis for each defined sub-area are presented below.

- Sub-area 1 – Custom software development

Software development is a very dynamic sub-area. Start-up, scale-up and other SMEs as innovation-driven entities become particularly important in the development process of this sector, with a crucial role in the process of Smart Specialisation for this sub-area.

In 2019, 1 234 companies were registered under Software and IT Services (which is 2% of the total number of registered companies in the country) and most of them are located in Skopje. The number of active companies has shown exceptional growth, rising by 55% between 2016 and 2019 or with an average growth of 16% in the same period. Total revenue in 2019 amounted to EUR 272 million, which is a growth of 80% in 2019 compared to 2016 and an average growth of 22.4% (2016/2019). Most of this revenue (over 85%) is generated through the export of ICT services (development of software solutions) to foreign markets. ICT companies sell software services in more than 60 countries. The growth of the net profit follows the growth of the operating income, from EUR 17.33 million in 2016 to EUR 41.91 million in 2019, and an average net profit margin of 12% to 15%. According to some estimations based on the working hours in 2019, there are more than 8 500 workers in this sub-area, which represents a growth of 69% in comparison to 2016[34].

The aforementioned growth trends, as well as the existing potential and advantages such as skilled labour, high level of interest in ICT studies, high-paying positions, English language fluency, vibrant innovation ecosystems[35] – boosted by efforts from the Fund for Innovation and Technology Development (FITD) – in particular, high innovativeness in the sector, growing start-up society, experience in outsourcing, experience on international markets, existing support infrastructure at the universities supporting ICT start-ups (for example, INNOFEIT functions as a local hub for technology transfer at the Faculty of Electrical Engineering and Information Technologies, and several start-ups and spin-offs have been formed and are active in the area), favourable business conditions[36] and good internet infrastructure show that software development, being one of the fastest growing sub-areas, has significant development and export potential.

The academia recognised the need to introduce new programmes for software development, integrating problem-based learning as a part of the study programmes. Over 650 students a year graduate from the universities in the country in the field of ICT and, today, it represents the main source of human resources for the rapid development of this sub-area. The demand for IT experts is high. In the period 2016-2018, 52 students at the state universities gained PhDs in Electrical Engineering, Computer Science and Information and Communication Technologies. Many students continue their MA and PhD studies abroad.

High R&D potential is demonstrated by the number of international projects, local activities in the area of contract research, digital transformation activities, as well as the support of the entire innovation ecosystem.

The professors and young researchers are involved in international research projects financed by EU funds (Horizon 2020, and others) and national projects financed by the Fund for Innovation and Technology

[33] Reports of the Fund for Innovation and Technology Development (FITD), https://fitr.mk/en/#.
[34] ICT industry in North Macedonia – General mapping report, Skopje, North Macedonia, June 2020.
[35] The innovation ecosystem within this area is based on well-established innovation centres and hubs, as well as business incubators and accelerators (for example, Centre for Technology Transfer and Innovations – INNOFEIT, Business Accelerator UKIM - BAU, Seavus Accelerator, SEEUTechPark, NewMan's Business Accelerator, X Factor Accelerator, CEED Hub, YES Business Incubator, and others).
[36] WB Doing Business 2019 report ranks North Macedonia as 17 out of total of 190 economies, https://www.doingbusiness.org/en/rankings?region=europe-and-central-asia.

Development (FITD), and other donors contributing to the process of delivering new innovative software solutions to almost all sectors in the economy (agriculture, manufacturing, energy sector, services).

As an example, the ICT sector, under the 'Horizon 2020' programme, carried out 10 projects with 11 participants, receiving EUR 1.72 million[37]. Furthermore, North Macedonia became the 30th member of the European High-Performance Computing Joint Undertaking (2019). The Faculty of Computer Science and Engineering within Ss. Cyril and Methodius University in Skopje – the designated institution in charge of the obligations under this Joint Undertaking, joined by relevant institutions and national SMEs – was also awarded a grant under a Horizon 2020 call to establish a National High Performance Computing Competence Centre.

ICT has shown high innovation capacities. Projects from the ICT industry make up 35% of the portfolio of projects granted through the Fund for Innovation and Technology Development (development of new software applications and ICT solutions in different industries). Moreover, the sector received 17% of the total number of projects through the latest instrument for collaborative grants between the university and business[38]. The key players in this sub-area from the business sector are Endava Skopje, Seavus Skopje, Ultra Skopje, Semos Skopje, Interworks Kavadarci, Edusoft Skopje, Nextsense Skopje, Asseco Skopje and others, which are largely located in Skopje.

Relevant stakeholders from academia are the Faculty of Computer Science and Engineering within Ss. Cyril and Methodius University - Skopje (UKIM), the Faculty of Electrical Engineering and Information Technologies (FEEIT) within Ss. Cyril and Methodius University in Skopje, the Faculty of Computer Science of Goce Delchev University - Shtip, SEE University Tetovo, Faculty of Information and Communication Technologies – UKLO Bitola and their related centres for innovation and business support, focused on solving industrial problems and finding ICT solutions as a custom software development. Other relevant stakeholders are the institutes, clusters, business accelerators and innovation hubs such as MASIT – IT cluster, Centre for Technology Transfer and Innovations – INNOFEIT, SEEUTechPark, NewMan's Business Accelerator, X Factor Accelerator, CEED Hub, YES Business Incubator and others.

Additionally, there are several academies and centres in the informal educational system such as Brainster, Semos Education, Seavus Education and Development Centre, and many others, which have a key role in educating young ICT professionals in different ICT fields.

An example of the close cooperation between academia and the industry is the 'Centre for Technology Transfer and Innovations - INNOFEIT' which was established in 2018 by the Faculty of Electrical Engineering and Information Technologies (FEEIT), Ss. Cyril and Methodius University in Skopje (UKIM), as part of its efforts to close the gap between academic education and practical expertise, prepare its students to better cope with the industrial challenges ahead and stimulate and foster intensive contract research services for local and international partners. INNOFEIT is a hub for interaction between FEEIT staff, FEEIT students and industrial partners, enabling connections and transfer of technology as well as novel innovative ideas that aid the economic growth of the sector and society in general. As such, INNOFEIT plays an important part in the North Macedonia's innovation ecosystem, being the catalyst for commercialisation of university ideas.

In its 3-year existence, INNOFEIT's operations can be summarised as:

- 5 research contracts for industrial partners amounting to over EUR 300 000 for R&D and technology transfer,
- 3 developed prototypes currently being commercialised by industrial partners,
- 6 innovation vouchers from the FITD (the highest number granted to a single stakeholder in the country),
- founder of an annual innovative interdisciplinary programme for UKIM students (INNO-SAE),
- founder of Business Accelerator UKIM (BAU),
- local partner for the EU4TECH and EU4TECH PoC projects,
- part of regional TT-networking initiative in the Western Balkans,
- the only R&D&I entity in the country mentioned in the EC progress reports published in 2019 and 2020,
- the first and currently only fully operational Digital Innovation Hub (DIH) in MK[39].

'Startup Macedonia', as an organisation for strengthening the start-up and innovation ecosystem predominantly in the field of ICT, supports the further growth of the sector.

[37] Reports of the Ministry of Education and Science of North Macedonia, https://mon.gov.mk/category/?id=2061.
[38] Reports of the Fund for Innovation and Technology Development (FITD), https://fitr.mk/en/#.
[39] http://inno.feit.ukim.edu.mk/.

This sector is very dynamic with many SMEs being formed. The Fund for Innovation and Technology Development supported the establishment of several accelerators[40]. The Business Accelerator UKIM (BAU) was founded at the Ss. Cyril and Methodius University in Skopje (UKIM) to promote entrepreneurship among the students and encourage them to form start-ups. BAU has already started investing and it is expected that the dynamic will intensify in the next 2 years.

According to the interviews, outsourcing is dominating at present, but many companies are focusing on their specialisation related to custom software development in the following industries: e-solutions for production processes and services, banking, insurance, agriculture, energy, etc. All markets are considered to be target markets. Custom-developed IT solutions have potential for almost all sectors in the economy (agriculture, manufacturing, energy sector, services). This is part of their process for digital transformation, improving and automating processes.

Most of the ICT companies do not create full value chains, but only participate in the production of some elements of the final software solutions. The number of companies that develop and export custom software is constantly increasing.

At the interviews, the companies emphasised the following challenges as barriers to the further development of the sector and this sub-area: 1) taxation and high taxes and social contributions on top of salary; 2) regulatory policy – unsuitable and incomplete institutional and regulatory framework concerning building digital infrastructure; 3) education – unsatisfactory level of skills and knowledge that the younger generations get from the secondary education system; 4) Brain Drain syndrome – emigration of high-skilled labour force to developed economies such as the USA and western Europe.

Furthermore, with regard to the further growth and future Smart Specialisation of this sub-area, one of the main challenges addressed by the interviews in the field of research and innovation was the need to strengthen the cooperation between academia and the private sector in the process of building capacities to develop own software IT solutions for final consumers, instead of exclusively delivering outsourced ICT services.

The existing cooperation predominantly involves the education programme, it was on the project basis and the innovation and research potential of the academia is therefore still not adequately utilised. The projects financed by the FITD, as well as the scientific and research centres in the faculties, are a very significant step forward, but the government should assume a more active role by supporting the research and innovation potential. The government should increase the national funds for research and should improve the national research infrastructure in the strategic area. Academia has critical innovation and research potential that should be utilised to further develop this sub-area.

However, the general conclusion is that the majority of the ICT companies of North Macedonia in the software development sub-area have applied business models based on delivering software solutions and outsourcing software services for other multinational ICT companies, while a small proportion of them base their business activities on developing their own IT solutions for end consumers. The crisis caused by the COVID-19 pandemic increased the global and domestic demand for ICT services, especially the need for digitalisation of businesses, society and the public sector. Hence, this is a new opportunity to further develop this sub-area.

The EDP as a subsequent activity under the development of S3 will be supported by ICT companies. Ambassadors from the business sector, academia and the government sector were identified as key players who will participate in the EDP workshops. They have expressed interest in participating in the meetings. In their view, the meetings should be concise and productive and not last an entire day. They prefer online meetings of no longer than 2-3 hours. There were recommendations for further discussions in the EDP process about the potential of an additional sub-specialisation area related to advanced ICT services as a new trend on the global market for ICT services (Big Data and Business Analytics, IoT, Cloud) due to the rapid technology improvements and, on the other hand, increased interest from several domestic start-ups in this sub-area. However, the ECNM team has not succeeded in providing sufficient evidence of the existence of critical mass innovation and scientific capacities, as well as the critical mass of companies during the qualitative analysis. Hence, we suggest this potential be additionally explored in the EDP in order to see if this sub-area could be part of the ICT area in the process of Smart Specialisation in the Republic of North Macedonia.

**ICT as a horizontal issue – digital transformation of businesses and society**

In the quantitative mapping, ICT was the only sector that was shown to have potential for Smart Specialisation in all three components: economic, innovation and scientific areas. ICT can be regarded as a potential priority

[40] https://fitr.mk/en/#.

domain for Smart Specialisation in the aforementioned area, as well as a horizontal issue relevant to the digital transformation of the society and, in particular, the digital transformation of the industry in terms of implementing a new method of doing business by using ICT management systems and business solutions.

ICT can be regarded as a horizontal area of extreme importance to the growth of the entire industry – the so-called Industry 4.0 – by developing interconnectivity; utilising new software; better business processes and models; digitalisation and automation of the industry; creating new added-value products and services; utilising the new potential of block chains; improving safety with cyber security in mind. In particular, there are opportunities in the segment of constructing smart systems for cooling and heating, lighting systems, access control, smart systems for monitoring and control, digitalisation and automatisation of the production processes, that is, management of industrial processes. Additionally, there is rapid growth in the demand for e-services in the business and public sector, medicine (e-health services), trade (e-commerce), education (e-education), tourism and culture (e-tourism, creative industries), government (e-government) etc.

ICT is very important to the digital transformation of the society, offering new opportunities for growth and promotion of many sectors such as tourism and creative industries by developing virtual tourism platforms and other ICT solutions for the promotion of various e-services. In the digitalised world, this sector is interlinked with all segments of society and should therefore receive strong support from the government. In this context, the government should make several steps towards meeting this strategic goal: 1) to build a clear regulatory framework harmonised with EU regulations and to increase institutional capacity in this field; 2) to build a robust and modern ICT and digital infrastructure aiming for easier connectivity by developing a better wired and wireless network – 5G network; 3) to transform the educational system and set it on a course towards information and technical sciences, as well as to develop lifelong learning; 4) to increase the level of digital literacy of the society; 5) to increase public investments in building and upgrading research infrastructure in the field of ICT; 6) to increase the cooperation between academia and business in the field of ICT by working on joint projects.

## 4.3 Smart/Sustainable buildings and materials

The preliminary defined area of 'Smart/Sustainable buildings and materials' included 14 interviews: 11 interviews were conducted with representatives of the business sector, 2 interviews with representatives of academia (Faculty of Civil Engineering and Faculty of Technology and Metallurgy within Ss. Cyril and Methodius University - Skopje) and 2 interviews with representatives of the government sector (Cabinet of the Deputy Prime Minister in charge of economic affairs and coordination with the economic sectors and the Ministry of Transport and Communications). The majority of the stakeholders interviewed (10 stakeholders from the business sector, academia and government sector) come from the Skopje region; one interviewed company is located in the East region; two companies in the Vardar region and two companies in the Polog region.

**Table 6.** List of interviewed stakeholders with proposed process ambassadors for the 'Smart/Sustainable buildings and materials' area[41]

| No. | Business sector | Ambassador | Smart buildings | Sustainable materials |
|---|---|---|---|---|
| 1 | CEMENTARNICA USJE | | | X |
| 2 | BIM AD SVETI NIKOLE | | | X |
| 3 | KNAUF RADIKA | X | | X |
| 4 | BETON AD SKOPJE | | X | |
| 5 | VARDAR DOLOMIT | | | X |
| 6 | RENOVA TETOVO | | | X |
| 7 | ADING | X | | X |
| 8 | GD GRANIT AD SKOPJE | X | X | |
| 9 | CIVIL ENGINEERING INSTITUTE MACEDONIA JSC SKOPJE | X | X | |
| 10 | AKTIVA SHTIP | X | X | |
| 11 | IGM TRADE KAVADARCI | | X | |

[41] The classification is based on the proposed sub-area(s), while the ambassadors are identified in the process of interviews according to the results of the previously developed questionnaire.

| No. | Academic sector | | | |
|---|---|---|---|---|
| 1 | SS. CYRIL AND METHODIUS UNIVERSITY, FACULTY OF CIVIL ENGINEERING - SKOPJE | X | X | X |
| 2 | SS. CYRIL AND METHODIUS UNIVERSITY, FACULTY OF TECHNOLOGY AND METALLURGY - SKOPJE | X | X | X |
| No. | Government sector | | | |
| 1 | MINISTRY OF TRANSPORT | X | X | X |
| 2 | CABINET OF THE DEPUTY PRIME MINISTER RESPONSIBLE FOR ECONOMIC AFFAIRS AND COORDINATION WITH THE ECONOMIC SECTORS | X | | X |

*Source*: Authors.

Additionally, a focus group meeting was organised, consisting of 3 ambassadors from the business sector (Ading Skopje, Granit Skopje, GIM Skopje, and TT Plast Skopje), 3 representatives of the government sector (Ministry of Economy and the Cabinet of the Deputy Prime Minister) and 2 representatives from academia (professors and researchers from the Faculty of Civil Engineering - Skopje, and the Faculty of Technology and Metallurgy - Skopje). The focus group participants contributed to the finalisation of the strategic sub-areas and the clarification of some of the open questions from the interviews. The participants of the focus group meeting noted that this sub-area has significant economic and innovative potential. The representatives from academia presented arguments about the research and scientific capacities of this sub-area, especially in the field of advanced materials and the development of smart construction solutions.

Based on the systematised data obtained from a number of sources (conducted interviews, focus group meeting, existing sectoral studies, etc.), the ECNM team proposed the area of **'Smart/Sustainable buildings and materials'** to be one comprehensive area, consisting of two branches (smart buildings and sustainable materials). The ECNM team in the qualitative analysis phase did not succeed in finding sufficient evidence for the scientific and innovation potential to propose these branches as separate sub-areas. In the next phase they should be further elaborated.

The conclusions from the conducted interviews and the recommendations from the focus group meeting are presented in the following section.

The area of Smart/Sustainable buildings and materials encompasses:

1) sustainable materials (sustainable building materials; nanomaterials – sensors, composites, coatings; and new polymer-based materials), and

2) smart buildings and smart construction solutions.

The main goals of the Smart Specialization process in the field of **sustainable materials** are: 1) more efficient use of natural resources in the production of construction materials, especially through their planned exploitation (mining potential) and development of innovative technologies that enable the production of construction materials from industrial waste abundant in North Macedonia, which is in correlation with fulfilling the goal of developing a concept of a green and circular economy; and 2) structural transformation and export upgrading by commencing the production of products/materials with higher added value. One truly relevant aspect with potential involves new materials, as sustainable materials, utilising existing resources and adding value to new construction products with the re-use of used construction materials and re-use of waste, as well as renewable, eco-friendly and healthy materials. This will enable the transition to a circular economy.

There are 830 active companies (producers and sellers of building materials) in the field of sustainable materials (which is 11% of the total companies in the manufacturing sector) with an upward trend in the last several years. These companies create more than 10 000 jobs, which is more than 6% of the total number of workers in the manufacturing sector[42]. The key players in the sustainable building materials segment from the business sector are Ading Skopje, Renova Djepchishte, Pofix Tetovo, Titan Skopje, Mermeren Kombinat Prilep,

[42] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

Tondah Vinica, Vardar Dalomit Gostivar, Fragmat Kumanovo, which are predominantly located in Skopje, Pelagonija and the north-western region. A large proportion of these companies is export-oriented with significant comparative advantages in terms of well-established international relations and trade partners in regional and EU markets, accumulated knowledge, long-standing tradition and adopted modern technology, natural mineral resources and a skilled workforce.

As an illustration, the total export of building materials in 2019 surpassed EUR 400 million, which is more than 6% of the country's total exports[43], showing that this sub-area is highly internationalised, but much of those exports are made up of products (minerals, stones, cement, marble, dolomite) that are characterised as products with relatively lower added value. However, there are some outstanding export products with higher added value such as: admixtures, grounding and sealing, concrete repair, joint sealants, levelling compounds, decorative coatings and mortars, adhesives, acryl, acryl colour, acryl finish, gypsum materials and other building materials.

The results of the conducted interviews show that there are several domestic innovative and high-tech companies, such as Microsam Prilep and Plasma Skopje, as well as foreign companies, such as Jonson Matty Skopje, Kostal Ohrid, Aptive Skopje and others, which produce advanced materials based on the composites and nanostructured materials that produce composite materials, and several domestic innovative SMEs (TT Plast, VA PLAST, ING Plast), which produce new polymer-based materials and products for these companies. All these companies are highly innovative and export-oriented with a high level of potential for future development. The export value of the advanced materials and components is more than EUR 1.5 billion, which is more than 25% of the total exports of the country and this export segment has registered a significant upward trend in the last several years, showing that this sub-area is highly internationalised and has huge export potential[44].

However, according to the interviewed companies there are considerable untapped exports that could be exploited by building comparative advantages in the production and export of products with high added value. Such products are plaster articles, additives for concrete and additives for cement, products and systems used for rehabilitation and reconstruction of reinforced concrete structures, protective coatings, fire protection for steel construction and electric installations, modified polymer bitumen products for civil construction, waterproofing membranes for building construction, different components based on nanostructures and polymer-based materials. Hence, the government should create policies to build innovative and technological capabilities for commencing production of new semi-products and products from the basic chemical industry, which are missing in the value chain, by promoting the establishment of new innovative SMEs in those fields.

There are several research institutions such as the Faculty of Technology and Metallurgy, the Faculty of Civil Engineering, the Faculty of Architecture, the Faculty of Mechanical Engineering within Ss. Cyril and Methodius University in Skopje, the SDEWES centre and MANU, which work on scientific and research projects for technological innovations and the production of new building and advanced materials, as well as improvements to the quality of the existing materials. Additionally, there is an Institute for Advanced Composites and Robotics whose mission is to build an appropriate research infrastructure for the development of fundamental and applied science in the area of advanced composites and robotics through the interdisciplinary approach.

The interviewed representatives from academia pointed out that the research institutions in the country related to this area have remarkable results in terms of research projects (several finished and ongoing H2020 projects), a number of published papers and editing in highly ranked international scientific journals, well-established links and cooperation with other national stakeholders (municipalities, government institutions, NGOs, businesses), which shows that the innovation and research capacities and potential in this field can contribute to the further development of this sub-area. The role of start-ups and SMEs in the development of this sub-area is still quite limited and we do not have information about any outstanding start-ups or other innovative SMEs in the field of building materials. Additionally, some international partnerships have already been established, in particular through active involvement in CEEPUS, MATERA, ERA-NET, EU-Robotics, etc. Links with similar clusters in European countries (Italy, Germany, Austria, Poland, the Czech Republic, Slovenia) and the Balkans (Croatia, Serbia, Romania, Bulgaria) have also been established in the field of sustainable materials. Such links will serve as the basis for cooperation, in particular in the framework of territorial cooperation projects. Furthermore, it is rather important that academia are involved in educational programmes for the

[43] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

[44] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

professional development of human resources, as well as in delivering training and lectures in this field of energy efficiency.

The final conclusion based on the results of the conducted interviews, focus group meetings and in-depth sectoral analysis is that the field of sustainable building materials has high development potential stemming from the strategic strengths, such as: accumulated knowledge and adopted technology, critical mass of companies competing on international markets, research and innovation capacities, natural resources that can be used appropriately for further development and Smart Specialisation.

The second branch of this priority area is **smart buildings and smart construction solutions** as an especially important segment in increasing energy efficiency, being one of the country's strategic goals. Smart buildings have unquestionable development potential as there are huge investments in infrastructure projects, as well as the construction of industrial facilities, new/modern individual and collective buildings, tourism accommodation facilities, malls and business representative offices by using sustainable and energy-friendly materials and developing new engineering designs and solutions. The total investments in buildings constructed in 2020 reached more than EUR 440 million which is 4% of the country's GDP. There are more than 5 000 active companies in the construction sector (which is more than 5% of the total active companies in the country) with an upward trend in the last several years. These companies create more than 31 000 jobs, which is more than 4% of the total number of workers in the entire economy[45].

The key players from the business sector in the field of infrastructure are Granit Skopje, Beton Skopje, Strabag, Pelagonija Gostivar, Ilinden Struga, while the key players in the field of civil engineering and smart buildings are Torax Skopje, Aktiva Shtip, Adora Inzenering Skopje, Golden Art Skopje, Nastel Skopje, Cevahir Skopje. They have extensive experience and tradition, accumulated knowledge and use adopted modern technology.

The innovation and scientific potential is to some extent limited, but the Faculty of Civil Engineering and the Faculty of Architecture within Ss. Cyril and Methodius University in Skopje as key academic institutions in this field have the capacity to deliver professional services related to the design and planning of specific infrastructure projects, such as seismic tests and designing routes, measuring the energy efficiency of buildings, as well as research capacities concerning construction-related techniques and modern building design. The Civil Engineering Institute Macedonia - Skopje is also worth mentioning, with expertise and knowledge in the field of infrastructure and civil engineering, especially in the field of designing new and smart construction solutions. Additionally, the Institute of Earthquake Engineering and Engineering Seismology is one of the oldest institutes, established in 1965. The institute has a long-standing tradition in experimental, in-situ forced and ambient vibration testing and an experimental laboratory for quasi-static and shaking table testing. It consists of three research laboratories: the Dynamic Testing Laboratory, Laboratory for Dynamics of Soils and Foundation and the Laboratory for Non-destructive Tests.

However, the collaboration between academia and the business sector needs to be intensified, especially in the field of searching for new construction techniques and materials for energy-efficient and smart buildings. Some attempts have already been made under projects financed by the FITD and EU funds. One example of a successful collaboration between academia and the business sector in the field of innovation and the implementation of innovative ideas in business that was pointed out during the interviews is the project by the Centre for Transfer of Technology and Innovation - INNOFEIT and TORAX, as an innovative SME, which develops and installs new smart photovoltaic modules for more energy-efficient buildings. This project involved several young researchers from the Faculty of Electrical Engineering and Information Technologies - Skopje. This case of collaboration between academia and the business sector in the field of innovation and creating new innovative products should be applied by other companies (start-ups and spin-offs), as well as innovators, researchers and scientists. Additionally, according to data from the State Office of Industrial Property, 5% of the total number of patent applications in the last decade has come from this area[46], while 4.9% of the projects financed by the FITD is also attributed to this area[47].

The key players in this sub-area from the government sector are the Ministry of Transport and Communication, the Cabinet of the Deputy Minister in charge of economic affairs and coordination with the economic sectors, the Ministry of Finance, the Ministry of Economy and the Technology Industrial Development authority. At the same time, there are several active NGOs and business associations such as the Association of Construction,

[45] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.
[46] State Office of Industrial Property (SOIP), http://www.ippo.gov.mk.
[47] Reports of the Fund for Innovation and Technology Development, https://fitr.mk/en/#.

Building Materials and Non-metal Industries within the Economic Chamber of North Macedonia, the Macedonian Chamber of Certified Architects and Certified Engineers.

The participants of the focus group meeting pointed out several challenges that this sub-area is facing in the process of future development: digitalisation, modernisation and building a high skills level with all types of construction workers. In that regard, it was mentioned that the Economic Chamber of Macedonia implemented a project from the framework programme of the EU - HORIZON 2020, as part of the Energy Efficiency call, the project 'TowaRd market-based skills for sustAINable Energy Efficient construction' (TRAINEE). The activities in the project aimed at the further promotion of the skills of middle- and senior-level professionals and blue-collar workers in the area of sustainable and energy-efficient construction (400 people trained and certified) throughout the entire value chain of the construction sector. In order to enhance the multidisciplinary approach to sustainable construction, there were activities to initiate the Building Information Modelling concept at national level. Additionally, the interviewed stakeholders noted that the new innovative energy efficiency business models should be further stimulated with an adequate financial mechanism for investment in energy-efficient buildings, and a new regulatory framework should be adopted that will promote the innovations by supporting new innovative SMEs since they are crucial to the further development of this field.

This sub-area has strong horizontal connections with several other sectors, such as the ICT sector in the field of applying new ICT business solutions in smart buildings (the aforementioned example of TORAX and FEIT), as well as the production of sustainable materials mentioned above. Additionally, this sub-area is closely related to the energy sector (the aforementioned example of the TRAINEE project), chemical and mining industry (the example Ading Skopje, which used chemical raw materials/inputs and Vardar Dolimit, Renova Tetovo and Knauf Radika which used non-metallic minerals as inputs for the production of sustainable construction materials), transport, metalworking and machinery – the successful story of Activa Shtip and IGM Kavadarci concerning the construction of new modern industrial facilities based on the metal parts and structures that they produce was noted by the interviewed stakeholders as a good example of interconnections between the metalworking and smart buildings sub-area. All of these horizontal industrial linkages illustrate that the sub-area of smart buildings and smart construction solutions already has an established value chain which should be upgraded in the process of Smart Specialisation, especially in the field of smart construction solutions and engineering. However, the ECNM has not succeeded in collecting more detailed information about the value chain of this area by the interviewed stakeholders, so more attention needs to be paid to this question in the EDP in order to identify the missing parts of the value chain that should be supported in the Smart Specialisation process.

These horizontal connections also exist in the field of research and innovation, not only in the business sector. There is a successful collaboration within joint research projects between the Institute of Chemistry - Skopje, Faculty of Technology and Metallurgy - Skopje, Faculty of Civil Engineering - Skopje, Faculty of Mechanical Engineering - Skopje and the Faculty of Mining and Geology - Shtip. However, more effort should be invested in building additional research infrastructure through investments in new laboratories and research equipment for developing new innovative products/materials and testing the quality of the existing ones.

This area is hit by the effects caused by the COVID-19 pandemic in terms of declining construction activities as a result of disrupted supply chains and delayed construction projects. However, the added value in the construction sector did not record a negative trend in 2020 compared with 2019. On the other side, there are positive trends in industrial production and the export value of building and other materials despite the global crisis. Additionally, no decrease in the number of workers in the field of production of construction materials has been recorded, while a decline of 4% is recorded in the construction sector in 2020 compared with the previous year[48].

The companies interviewed suggest a set of measures to support the companies in this area during the crisis period and actions to boost development in the post-crisis period. Some of those potential measures are: increasing government spending on infrastructure projects – in consideration of the local experienced contractors; the promotion of local companies to perform in major infrastructure and government projects; government support for R&D activities to develop new, efficient, durable and high-added-value materials; covering the cost of issuing CE certification for products; and government support for the promotion of domestic SMEs' exports.

[48] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

## 4.4 Electrical equipment and mechanical parts

The qualitative analysis involved 15 interviews with representatives of the business sector, predominantly export-oriented companies, including MAMEI - Macedonian Association of Metal and Electrical Industry as a business association, with three representatives of academia (Faculty of Electrical Engineering and Information Technologies and Faculty of Mechanical Engineering within Ss. Cyril and Methodius University in Skopje, and the Faculty of Mechanical Engineering of Goce Delchev University - Shtip) and two representatives of government institutions (Department for Industrial Policy within the Ministry of Economy and the Cabinet of the Deputy Prime Minister in charge of economic affairs and coordination with the economic sectors).

Most of the interviewed stakeholders (10 stakeholders from the business sector, academia and government sector) are located in the Skopje region, four interviewed companies are located in the East region, four companies in the Vardar region and two companies in the Southwest region.

**Table 7.** List of interviewed stakeholders with proposed process ambassadors for the 'Electrical equipment and mechanical parts' area[49]

| No. | Business sector | Ambassador | Metal and mechanical products | Electrical and automotive components |
|---|---|---|---|---|
| 1 | RADE KONCHAR SERVICE | | | X |
| 2 | RADE KONCHAR TEP | X | X | X |
| 3 | FAKOM | X | X | |
| 4 | SMELT-ING | | X | |
| 5 | BRATSTVO INOX OHRID | | X | X |
| 6 | KOSTAL OHRID | X | | X |
| 7 | TM SHTIP | | X | X |
| 8 | AKTIVA SHTIP | X | X | X |
| 9 | RADE KONCHAR – KONTAKTORI AND RELEI | | | X |
| 10 | ZAVAR COMPANY | | | |
| 11 | IGM TRADE | | X | |
| 12 | LEOV COMPANY VELES | | X | X |
| 13 | DINAMO HIT VELES | | X | X |
| 14 | AGRO BAR VINICA | | X | |
| | Business associations | | | |
| 1 | MAMEI | X | X | X |
| No. | Academic sector | | | |
| 1 | GOCE DELCHEV UNIVERSITY, FACULTY OF MECHANICAL ENGINEERING - SHTIP | X | X | X |
| 2 | FACULTY OF ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGIES - SKOPJE UNIVERSITY SS. CYRIL AND METHODIUS IN SKOPJE | X | X | X |
| 3 | FACULTY OF MECHANICAL ENGINEERING, UKIM SKOPJE | X | | |
| No. | Government sector | | | |
| 1 | MINISTRY OF ECONOMY | X | | |
| 2 | CABINET OF THE DEPUTY PRIME MINISTER RESPONSIBLE FOR ECONOMIC AFFAIRS AND | | | |

[49] The classification is based on the proposed sub-area(s), while the ambassadors are identified in the process of interviews according to the results of the previously developed questionnaire.

| | | | | |
|---|---|---|---|---|
| | COORDINATION WITH THE ECONOMIC SECTORS | | | |

*Source*: Authors.

Additionally, a focus group meeting was organised consisting of 3 ambassadors from the business sector (Kostal Ohrid, IGM Kavadarci and Rade Konchar TEP Skopje), 3 innovative SMEs (TT Plast, VA Plast, INGPlast), 3 representatives of the government sector (Cabinet of the Prime Minister, Ministry of Economy and Cabinet of the Deputy Prime Minister) and 2 representatives of academia (professors from the Faculty of Mechanical Engineering - Skopje and the Faculty of Technology and Metallurgy - Skopje).

The focus group participants contributed to the finalisation of the strategic sub-areas and to the clarification of some of the open questions from the interviews. The participants of the focus group meeting noted that this area has significant economic and innovative potential. The representatives from academia presented arguments about the research and scientific capacities of the identified sub-areas, especially in the field of machinery and electrical engineering, while the participants from the business sector noted that there is a critical mass of innovative and export-oriented companies which show that North Macedonia has a comparative advantage in this area. In addition, the results from the in-depth sectoral analysis of the export performance of North Macedonia and export opportunities based on product space methodology conducted by the Economic Chamber of North Macedonia were used to support the findings from the qualitative interviews and the recommendations from the focus group meeting.

Based on systematised data obtained from the conducted interviews, the recommendations from the focus group meeting and the results of the in-depth sectoral analysis, one proposal is that this priority area for Smart Specialisation should be named '**Electrical equipment & mechanical parts**'. It is considered to be one comprehensive area consisting of two sub-fields: 1) **metal and machinery products** and 2) **electrical parts and products and automotive components**. During the qualitative analysis phase, the ECNM team did not succeed in finding sufficient evidence for the scientific and innovation potential to propose these branches as separate sub-areas. However, the ECNM team proposed the question about the opportunities for defining separate sub-areas within the proposed priority area to be further elaborated in the next phase.

This proposed priority area for Smart Specialisation includes metal parts and products; electrical components and equipment; machinery, machinery tools and engine parts; mechanical appliances; as well as automotive parts and components. This area also includes the transformation and upgrade of several strategic industries (metalworking, machinery, electrical engineering industry and others) by automation and the digitalisation of production and the business processes.

There are more than 1080 active companies in this area, 831 companies in the metalworking sector, 153 companies in the machinery sector, 102 companies in the electrical engineering industry – which covers 13.5% of the total number of companies in the manufacturing sector. The majority of these companies are SMEs that continually invest in new technology and adopt new methods of production. This sub-area creates more than 18 599 jobs, which is over 12% of the total number of workers in the manufacturing sector. Additionally, there was significant growth in the number of workers in the last period. More than 7 500 jobs were created in the period 2016-2019, which represents an annual growth of 22% in the period analysed[50].

The production of **metals and metal products** (metal structures, steel pipes in various shapes, storage tanks, heat exchangers, mixers, metal furniture parts) makes a significant contribution to the economy of North Macedonia in terms of added value, export, employment and other indicators. There are over 870 companies in this sector, which is 11% of the total registered companies in the manufacturing sector[51]. A large share of these companies are located in Skopje and the Vardar region.

Key companies in the sector are: Fakom Skopje, IGM Kavadarci, FZC 11 Oktomvri, Dojran Steel, Brako Veles, RZ Institute Skopje, Zavar Skopje, Metalopromet Strumica, Smelt-ING Veles and other companies. IGM Kavadarci, Brako Veles and Fakom Skopje are examples of success stories noted in the interview process in the field of automation and digitalisation of the production and business processes as a step towards Industry 4.0. IGM began constructing a smart factory for the production of sophisticated metal pipes, while Brako and Fakom invested in new cutting-edge technology for the production of high-added-value metal products based on fully automated system management.

[50] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

[51] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

This branch generated EUR 66 million gross added value (GVA) in 2019 and the annual growth rate has averaged 11% over the last 5 years. Such a significant growth had a positive impact on the relative share of the sector's GVA in the manufacturing sector, from 4% in 2015 to 4.5% in 2019. With regard to the number of workers, the trends are considerably positive. According to the official data, over 4 000 jobs in the metalworking sector were created in the last 5 years[52]. These growing trends are expected to continue in the next period considering the rising demand for metal products on the global markets and the current investments in new technology and production capacities on the part of several domestic companies such as IGM Kavadarci, Brako Veles, Fakom Skopje and others.

This branch has significant export performance. Total exports in this branch in 2019 generated by 158 export companies reached EUR 230 million, which is more than 80% of the total turnover for the entire sector. Additionally, the sector has comparative advantages[53] in the production and export of 20 products (metal structures, steel pipes in various shapes, storage tanks, heat exchangers, mixers, pressure vessels and other metal parts). However, the main weaknesses are the high export concentration (the top 10 exporting products create more than 90% of total exports) and the unfavourable position of the export products in the global value chain[54]. There are many products in the supply chain for which the companies possess latent comparative advantages and potential to start production and export. Such products are: different metal parts for constructions (railway or tramway track constructions from iron or steel; rails, check and track rails; switch blades; crossing frogs; point rods; sleepers, fish-plates; chair wedges; sole plates; bedplates; ties), machinery (metal machine parts), furniture (sanitary, table, kitchen, other household articles and parts thereof), energy (tubes, radiators for central heating) as well as other metal products such as tanks, casks, drums, cans, boxes and similar containers.

The **machinery** sector, which includes the production of machinery parts and tools as well as mechanical appliances, makes a significant contribution to the economy of North Macedonia in terms of added value, exports, employment and other indicators. There are over 153 companies in this sector, which represent 2% of the total registered companies in the manufacturing sector. The majority of the companies are located in Skopje. Key companies in the sector are Johnson Matty, Mikrosam Prilep, Zavar Skopje, Rade Konchar Services, Agrobar Vinica, Dinamo Hit Veles and other companies, while the main products are machinery for filtering or purifying gases, parts of the machinery for heading, polyester and metal boxes, metal cable trays and other metal products, stainless-steel household dishes, composite machining, machinery for agricultural production, pressure reactors, vacuum vessels and other products.

The machinery sector generated EUR 145 million gross added value (GVA) in 2019 and showed an annual average growth rate of 5% over the last 5 years. The relative share of the sector's GVA in manufacturing has dropped, but it is still high (around 34%). With regard to the number of workers, the trends are considerably positive. According to the official data, more than 16 000 jobs were created in the machinery sector in the last 5 years (from 12 500 workers in 2015 to 28 000 workers in 2019)[55].

This area shows significant export performance. Total exports of the machinery sector in 2019 generated by 48 exporting companies reached EUR 677 million, which is over 90% of the total turnover of the entire sector. Additionally, there are more than 40 export products with a value above EUR 200,000, while only 12 with comparative advantages, according to the estimations based on the Revealed Comparative Advantages (RCA) index. This shows that there is a high export concentration in terms of the number of export products (the top 10 export products create more than 95% of the total exports) and export companies (the top 10 export companies create over 90% of the total exports)[56]. Even though the main export products are well-positioned in the value chain and are characterised as products of medium complexity, there is plenty of room in the supply chain that could be covered by export diversification (increasing the number of export products) and export upgrade (export products with higher added value). Some of these products are different types of machines or parts/accessories for machines such as parts and accessories solely/principally suited for machine use ; plates, cylinders and other printing components; winches and capstans; machine tools for working wood, cork, bone, hard rubber, hard plastics or similar hard materials; agricultural, horticultural, forestry, poultry-keeping, bee-keeping machinery; machine tools for working stone, ceramics, concrete, asbestos-cement; machinery for

[52] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

[53] According to the estimations based on the Revealed Comparative Advantages (RCA) index.

[54] Identification of development opportunities and potentials for export diversification and structural transformation of the North Macedonia's economy, Economic Chamber of North Macedonia, Skopje, 2020, working document.

[55] Ibid.

[56] Ibid.

washing, cleaning, wringing, drying, ironing, pressing, bleaching, dyeing, dressing, finishing, coating or impregnating textile yarn; machine tools for working any material by removing material; and other products.

The strategic strengths of the companies in this branch – such as the accumulated knowledge, human capital, extensive experience and tradition, adopted cutting-edge technology and established global market relations – provide immense opportunities for further export promotion by starting production of the aforementioned products that are missing from the supply chain.

The production of **electrical parts and products** is one of the priority branches in this sub-area represented by capital- and high-technology- intensive industries. The country has a long-standing history of electronic-component manufacturing dating back to the 1960s when Rade Konchar Skopje and Emo Ohrid were established. They were privatised and transformed during the period of transition and today several successful companies stem from these two Yugoslavian brands. Rade Konchar TEP, Rade Konchar Services, Rade Konchar Relei and Kontraktori Skopje, Dast Ohrid (part of Bratstvo Inox Ohrid) and TM Shtip are the key players in this sector. They produce different types of electronic parts for electricity networks such as insulators, low-voltage distribution switch boards, distribution transformers, disconnectors, automatic power factor correction devices, etc. Additionally, there are several producers (Dinamo Hit Veles, Leov Veles, Frinko Bitola) of electrical apparatus such as electric heaters, boilers, refrigerators, boasting a long-standing tradition, which are well established on the foreign markets. Lastly, the entry of several multinational companies (Dräxlmaier Kavadarci, Gentherm Prilep, Key Safety Systems Kichevo, Kondevo Shtip and others) as producers of electrical cables, sound-signalling equipment, electrical capacitors, other electrical products and parts for the automotive industry has dramatically changed the structure of this branch.

Total exports of this branch reached EUR 862 million in 2019, which represents 15% of the total exports from the country. This illustrates that this sub-area has strong export performance, and it is one the most important export sectors for North Macedonia. However, there is a high export concentration in terms of the number of export companies (only 37 export companies, the top 10 of which create more than 92% of the total exports) and the number of export products (only 34 export products with a value above EUR 200,000)[57]. The stakeholders interviewed noted many products that the companies in this branch produce and export as having a comparative advantage. Some of those products are: relays, switches, contractor assemblies, suspension and jointing equipment for electrical distribution networks, consoles and insulation sockets, electrical epoxy insulators, measuring transformers and other electrical parts and products. This indicates that this branch is predominantly export-oriented and has a high internationalisation level. However, a proportion of the production of electrical components and equipment is sold on the domestic market, specifically intended for EVN Macedonia, which is the national company for energy distribution and supply.

The production of **automotive components** has been the most dynamic emerging sub-area in North Macedonia in the last decade. The results of the conducted interviews show that there are more than 30 companies – such as Lear Tetovo, Technical Textiles Shtip, Key Safety Systems Kichevo, Amphenol Kochani, Adient Shtip, Van Hool Skopje, Kondevo Shtip, ODV Electric Struga, LTH Ohrid, Kostal Ohrid, Dräxlmaier Kavadarci, Gentherm Prilep, Kemet Skopje, Kromberg & Schubert Bitola, Marquardt Veles and many others – that set up large export-oriented production facilities in the country as Tier-1 and Tier-2 suppliers of electrical components and parts to the European, Russian and Turkish markets, among others. Many of these companies have already reinvested multiple times, which indicates that this sector has development potential.

The investments of foreign companies in- and outside of the Technological Industrial Development Zones (TIDZs) predominantly from the automobile industry have created more than 30 000 jobs, which is 20% of the total manufacturing jobs, and generate EUR 187 million of added value in the economy, which is 13% of the added value of the entire manufacturing sector[58].

More importantly, this sector is highly export-oriented and the export value in 2019 reached EUR 350 million, excluding the export of electrical and machinery parts that are used in vehicles. The electrical and automotive parts are one of the fastest growing export sectors with a high internalisation level, primarily as a result of the FDIs located in- and outside of the TIDZs in the country.

The key institutions from academia are the Faculty of Mechanical Engineering and the Faculty of Technology and Metallurgy within Ss. Cyril and Methodius University - Skopje, the Faculty of Mechanical Engineering within Goce Delchev University - Shtip and the Faculty of Technical Sciences of St. Kliment Ohridski University - Bitola. Over 150 professors and researchers are active in these research institutions. They play an essential role in the

[57] Identification of development opportunities and potentials for export diversification and structural transformation of the North Macedonia's economy, Economic Chamber of North Macedonia, Skopje, 2020, working document.
[58] Reports of the North Macedonia Free Zones Authority, http://investnorthmacedonia.gov.mk.

transfer and adaptation of new technology, implementation of new innovative methods and processes, development of new products, implementation of Total Quality Management systems (TQM) as well as in the creation of qualified engineers. Additionally, there are several laboratories, such as the Laboratory for Electrical Measurements (LEM) within the Faculty of Electrical Engineering and Information Technologies - Skopje as a national reference laboratory for calibration of reference standards for electrical energy and power, providing measurement traceability and unity of measurements in this segment of legal metrology. Academia are actively involved in many research and applicative international and H2020 projects in the field of advanced manufacturing and processing, as well as mechanical engineering[59]: over 84 projects financed by the FITD instruments in the field of engineering and technology in the last 4 years, and more than 17% of innovation vouchers (for collaboration between academia and the business sector) awarded under the first FITD call which were granted in the metals, machinery and electrical sector[60]. One of the success stories of collaboration between academia and the business sector is the project 'Increasing the export competitiveness of the metalworking, machinery and electrical industry through improvements of the production and technological capabilities of selected SMEs' financed by the FITD and the World Bank, where four innovative SMEs (Rade Konchar TEP, Bratstvo Inox Ohrid, Agrobar Vinica and TM Shtip) transferred new technology and implemented new production methods through the technical support of academia.

At the same time, there are several collaborative and applicative projects financed by EU programmes, such as the IPA to build the capacities of the domestic SMEs in this sub-area. Good examples are FENI Industry Kavadarci, BUCIM Radovish, Makstil Skopje as companies which have already participated in several EU-financed projects in cooperation with the Faculty of Technology and Metallurgy - Skopje, as well as the project financed through the IPA Competitiveness and Innovation Framework Programme which aimed at increasing competitiveness of the local SMEs in order to improve the cooperation with foreign companies, where several domestic innovative SMEs were involved in cooperation with the Faculty of Mechanical Engineering - Skopje. However, there is plenty of room to improve the R&D capacity in this sub-area by building stronger research networks, creating a national research fund that will support research and applicative projects and by motivating young researchers in technical sciences. These success stories show that this sub-area is very dynamic from a technological and innovation point of view and the innovative SMEs have a crucial role in its development.

Additionally, according to data from the State Office of Industrial Property, 13% of the total number of patent applications in the last decade were recorded in this priority area[61], while 19% of the approved FITD project volume also comes from this area.

The cooperation of the private sector with vocational secondary schools such as SSU Koce Metalec - Skopje and SSU 8 Septemvri - Skopje regarding the development of a qualified workforce to meet the requirements of the industry is of great importance. The companies from this sector actively participate in the process of developing educational programmes, which involves practical classes in the production plants and factories. This is important for the creation of qualified workers that will be able to participate in the new production process based on the concept of Industry 4.0.

With regard to the representatives of the business sector, MAMEI – the Macedonian Association of Metal and Electrical Industry and the Association of the Metalworking, Mechanical and Electrical Engineering Sector of the Economic Chamber of North Macedonia have an important role in offering support and quality business services that would accelerate the development process in this area. The recently created association for advanced technologies, as a part of the Chamber of Commerce of North Macedonia, includes participants from key foreign companies that are involved in this business and their focus is on enabling further collaboration and growth in the area of advanced technologies. On the other hand, there are several important governmental institutions that support the development of this sub-area: the Ministry of Finance; the Ministry of Economy; Technological Industrial Development Zones; the Cabinet of the Deputy Prime Minister in charge of economic affairs and coordination with the economic sectors; the Agency for Foreign Investment and Export Promotion; and the Fund for Innovation and Technology Development (FITD).

The results from the interviewed stakeholders and the additional existing studies[62] suggest that this sub-area has significant development and export potential considering the strategic strengths, such as its geographic location in Europe and attractiveness to FDIs, an appropriate business climate, macroeconomic stability and low tax rates. Among the main comparative advantages of the domestic companies in this area are also production

[59] Reports of the Ministry of Education and Science of North Macedonia, https://mon.gov.mk/category/?id=2061.

[60] Reports of the Fund for Innovation and Technology Development and reports of the Ministry of Education and Science of North Macedonia, https://fitr.mk/en/# and https://mon.gov.mk/category/?id=2061.

[61] State Office of Industrial Property (SOIP), http://www.ippo.gov.mk.

[62] Positioning FYR Macedonia for the Global Economy: The Impact of Reforms and Investment Promotion in the Automotive Components Manufacturing sector, WB, 2017.

flexibility and capabilities for quick adaptation in accordance with market requirements and the regional opportunities for connecting with companies from the immediate region, with the aim of exporting to third markets, as well as accumulated knowledge and long-standing tradition in manufacturing, skills and resource endowments, and relatively cheap labour compared to other EU countries. However, quotas imposed by the EU on steel pipes and sections, institutional weaknesses and the inefficiency of public institutions (Public Revenue Office, Customs Administration, regulatory bodies), as well as the shortage of a qualified workforce (engineers), are the main challenges to the further development of this sub-area. Another challenge is the weak industrial links between the domestic SMEs and the foreign investors, and the need for further technological modernisation of domestic companies through more active involvement of academia.

According to the stakeholders interviewed, the government should have a more active role in building the competitiveness of the domestic companies by supporting investments in new technology, machinery and equipment in order to optimise the production process and to implement the concept of Industry 4.0 based on AI, IoT, Big Data and Business Analytics as global trends. Investments in building skills and a qualified workforce by improving the vocational education system and through the installation of new quality management systems are the key steps towards a structural transformation and further Smart Specialisation within this sub-area. Additionally, the government should support the development of modern R&D infrastructure (R&D and innovation centres, knowledge alliance and science parks), support start-ups and innovative SMEs by creating a friendly environment and stimulate young researchers by financing industrial masters and doctoral degrees related to real business and industrial problems.

The crisis caused by the COVID-19 pandemic had serious negative implications on this sub-area both on domestic and global markets. There was a massive decline in industrial production and exports (more than 30%) in the second and third quarter of 2020 (March-October), while the situation improved during the last quarter of 2020. Nevertheless, companies have succeeded in saving most of the jobs as a result of government support, but it remains unpredictable how long the crisis will persist at a global level, and how it will reflect on the companies in this sub-area. These companies view this crisis as an opportunity for additional development and transformation according to the new trends, which would inevitably end up on the global supply chains. In that regard, the government should support this sub-area in the post-crisis period through several actions such as: 1) the provision of favourable credit lines through the Development Bank of North Macedonia, intended to support the investment projects in modernisation and digitalisation of the production processes, and to support export activities including the provision of guarantees, purchase of export receivables and customs debts; 2) the consideration of a possibility to coordinate and reduce the tariff rates to the level of EU import rates. This is essential, given that some companies pay high import duties on raw materials coming out of the EU, which significantly increases the cost of their production process. In terms of customs charges, the reduction of duties on machinery from non-EU countries should be seriously considered. This could provide a powerful impetus to the companies in their technological modernisation and production upgrade.

With regard to cross-sectoral connections, individual industries in this priority area are horizontally linked in the supply chain, which increases the opportunities for structural inter-sectoral transformation, avoiding shifting from only one product with lower added value to other products with high added value, by upgrading production and technological capabilities. The companies interviewed noted that there are strong industrial backward and forward linkages between the metalworking and machinery sector, the metalworking sector and the production of transport equipment, as well as between the machinery and electrical engineering sector. Some branches of this sub-area, such as the machinery sector, are closely related to the agriculture and the food processing sector as well as the civil engineering sector. Several examples were presented in the interview process as arguments for the strong cross-sectoral correlations, such as the case of AgroBar Vinica, that produces agricultural equipment and parts for transportation equipment; Zavar Skopje, that produces equipment for food processing industries; Brako Veles, that produces mechanical parts for the automobile industry and for small hydropower plants; while Fakom Skopje, Metalo-promet Strumica, Aktiva Shtip, IGM Kavadraci produce metal parts and structures for the construction industry.

There are enormous opportunities concerning the digitalisation and automation of business and industrial processes by using advanced ICT services such as AI, IoT, Big Data and others. In particular, there are opportunities in the segment of constructing smart systems for cooling and heating, lighting systems, access control, smart systems for monitoring and control, digitalisation and automatisation of the production processes – that is, the management of industrial processes. There are also several success stories of cross-sectoral relations between this sub-area and the ICT sector in the field of integration of ICT solutions to optimise

industrial processes. Examples are Duna Computers, Kabtel Skopje and other ICT companies that carry out successful industrial projects with the companies from this sub-area[63].

Finally, the defined sub-areas have huge development potential that could be utilised by overcoming the addressed challenges, for example: through reforms in the educational system with a focus on practical and technical skills; increasing the technological and production capabilities of the domestic companies as a fairly important step towards Industry 4.0; bridging the gap between foreign investors and domestic companies; increasing innovation and R&D capacity; and boosting the cooperation between academia and the business sector.

## 4.5 Sustainable tourism and catering

The preliminary defined area of 'Sustainable tourism and catering' involved 18 interviews: 15 interviews were conducted with representatives of the business sector, 1 interview with representatives of academia (Faculty of Tourism and Hospitality - Ohrid) and 2 interviews with representatives from the government sector (Ministry of Economy and the Agency for Promotion and Support of Tourism). The interviewed stakeholders are located in different regions of the country: 2 interviewed stakeholders are located in the Southwest region, 1 company is located in the East region, 1 company is located in the Vardar region, while 13 stakeholders (most of them from academia and the government sector) are located in the Skopje region.

**Table 8**. List of interviewed stakeholders with proposed process ambassadors for the 'Sustainable tourism and catering' area[64]

| No. | Business sector | Ambassador | Sustainable tourism and catering |
|---|---|---|---|
| 1 | MAKEDONIJA TURIST | X | X |
| 2 | HOTEL AMBASSADOR M | X | X |
| 3 | TA FIBULA AND HOTEL IZGREV STRUGA | X | X |
| 4 | TASiMONIUM TRAVEL (INCOMING) | X | X |
| 5 | TA BALKAN PRIME (INCOMING) | | X |
| 6 | HOTEL ALEKSANDAR PALACE | | X |
| 7 | TOURIST GUIDE | | X |
| 8 | HOTEL ARKA | X | X |
| 9 | ENJOY BALKANS | X | X |
| 10 | HOTEL SIRIUS | | X |
| 11 | NEGORSKI BANJI | | X |
| 12 | HOTEL STONE BRIDGE AND HILTON | X | X |
| 13 | MOUNTAIN EXPERIENCE LLC | X | X |
| 14 | AURORA RESORT AND SPA | X | X |
| 15 | RESTAURANT OREOV LAD | | X |
| No. | Academic sector | | |
| 1 | FACULTY OF TOURISM AND HOSPITALITY | X | X |
| No. | Government sector | | |
| 1 | MINISTRY OF ECONOMY | X | X |
| 2 | AGENCY FOR PROMOTION AND SUPPORT OF TOURISM | X | X |

*Source*: Authors.

In addition, a focus group meeting was organised consisting of 3 ambassadors from the business sector (Makedonija Turist, TA Fibula, Metropol Ohrid), 2 representatives of the government sector (Ministry of Economy and the Cabinet of the Deputy Prime Minister) and 2 representatives of academia (professors from the Faculty

[63] However, the ECNM team have not succeeded in collecting more detailed information about the cross-innovation potential of this area, so this part should additionally be addressed in the EDP.

[64] The classification in the table is based on the proposed sub-area(s) and the defined branches within those sub-areas, while the ambassadors are identified in the interview process according to the previously developed questionnaire.

of Tourism and Hospitality – Ohrid and the Faculty of Tourism and Business Logistics – Shtip). The focus group participants contributed to the finalisation of the strategic sub-areas and the clarification of some of the open questions from the interviews. The participants' main conclusion in the focus group meeting indicated that this area is very important to the North Macedonia's economy in terms of the number of companies, total turnover, number of workers and other indicators. Additionally, the participants concluded that tourism is one of the most strategic sectors for the country with huge opportunities and significant potential for future development.

Based on systematised data obtained from a number of sources (conducting interviews, focus group meetings, sectoral studies, etc.), the following potential priority area is proposed: **Sustainable tourism and catering**. Below are the main findings of the conducted interviews and the focus group meeting conclusions related to this preliminary priority area. Even though the findings indicate that this area has significantly contributed to the economy of North Macedonia and has a critical mass of firms with development potential, sufficient evidence has not been found of innovation and scientific potential. Hence, the ECNM team and the national working group suggest that these issues be additionally explored during the EDP process in order to provide a clearer picture on whether this preliminary area has enough potential for Smart Specialisation.

The tourism sector plays a significant role in the national economy. The most developed types of tourism in North Macedonia are: lake tourism; mountain tourism; cultural and religious tourism (churches, monasteries, mosques, museums, archaeological sites); event tourism; alternative tourism; city tourism; wine tourism; health and spa tourism; and other types of tourism. Rural, village and mountain tourism have great potential as tourism categories, considering that even international statistics on the growth rate of these activities in the domestic market before the coronavirus period – and even during the coronavirus period – showed that mountain tourism registered high growth rates (30-40% before the coronavirus crisis, against 4% mass tourism)[65]. The interviewed stakeholders noted that North Macedonia offers various types of mountain products, being a generally mountainous country. Foreign tourists always regard these types of organised tourism arrangements in North Macedonia positively and highly. National parks, the advantage of having endemic species of birds and animals that live there, the thriving flora and fauna still represent untapped potential in terms of developing tourist attractions in the national parks, adhering to all measures for nature protection.

In the past 10 years, the tourism sector has been on the rise and has seen an increase of about 140%. The average annual increase in tourists is 15%[66]. These growing trends are a result of the fact that the country has established a new approach towards building modern and sustainable tourism with an active role of government institutions. In recent years, the number of tourists on the country registers has been continuously growing, with the number of tourists in 2010 amounting to 586 241 going up to 1 126 935 in 2018, which is a 92% increase. With regard to domestic tourists, their number in 2010 was 324 545, and 419 590 in 2018, or a 29% increase. In 2015, our country was visited by 485 530 foreign tourists, whereas in 2019, this number was 757 593. We can conclude that in the last 5 years, the number of foreign arrivals has constantly increased, whereas the number of domestic tourists, although showing growth, is still unsatisfactory.

With regard to the number of nights spent in the analysed period, we observed that the figure reached 2.4 million in 2015 and went up to 3.3 million in 2019. In 2015, domestic tourists spent 1.3 million nights in total, and 1.7 million in 2019. On the other hand, foreign tourists in 2015 spent 1 036 383 nights in total, reaching a number of 1.5 million in 2019[67]. Similar to the number of visitors, there is an evident increase in the number of nights spent by foreign tourists in comparison to the nights spent by domestic tourists. In this regard, comprehensive analyses are necessary in order to undertake measures for domestic tourists to extend their stay, but also to maintain the upward trend of nights spent by foreign tourists in this country. Major destinations that attract tourists in the Republic of North Macedonia are the lakes, mountain resorts, spa centres, wine regions and the city of Skopje. Basically, most of the domestic and foreign tourists visit the two prime destinations in the country, Ohrid and Skopje. The touristic offer in Ohrid is characterised by lengthier stays owing to organised holidays, and tourists that visit Skopje stay for a shorter period (tourism related to business activities).

According to the official national statistics, the total number of enterprises in the tourism and hospitality sector in 2018 was 4 494, 3 899 of which were in activities relating to meal preparation and food services (being activities with the largest share), followed by accommodation facilities and travel agencies – 305, travel

[65] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

[66] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

[67] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

organisers (tour operators) and other booking services as well as related activities – 290. The results of the interview process show that the key players from the tourism business sector are Metropol Ohrid, Hotel Drim Struga, Inex Gorica, Izgrev Struga, Sileks Ohrid, Istatov Dojran, Romantic Dojran, Lateraca Dojran, Polin Dojran in the field of lake tourism; Aurora Resort and Spa Berovo, Manastir Berovo, Fershped Mavrovo, Slavia, ELEM Popova Shapka, Montana Palas Krushevo in the field of mountain tourism; Tikvesh Restaurant Kavadarci, Stobi Gradsko, Popova Kula, Vila Marija – Demir Kapija, Kamnik Skopje, Dalvina Strumica in the field of wine tourism. There are many professional tourist guides in almost every tourist destination in the country, as well as incoming travel agencies such as Fibula Travel, Karaci Skopje, Badem Tour, Maksan, Ohrid Holiday and others.

The companies in this sub-area have comparative advantages in attracting domestic and foreign tourists. Some of those advantages are: rich culture and tradition, natural resources for different kinds of tourism, favourable climate conditions, gastronomy and traditional food, UNESCO destinations, a qualified working force and the country's favourable geographic location. The largest share in turnover generated by the enterprises in the tourism and hospitality sector including activities related to meal preparation and food service in 2017 was EUR 220 million; turnover of travel agencies, tour operators and other booking services in the same year was EUR 110 million; while accommodation facilities come third with a turnover of EUR 77 million. The total turnover of the entire sector, including all services, surpassed EUR 470 million, which shows how important this sector is to the national economy[68]. More importantly, the majority of these revenues are based on foreign tourists, indicating that this sector has a high internationalisation level. There are foreign tourists from many countries, but they predominantly come from Serbia, Albania, Bulgaria, Germany, the Netherlands and other countries.

According to official national statistics concerning the size of the enterprises in this sector in 2019, most of the accommodation facilities and food service activities were micro-, small and medium-sized enterprises, predominantly enterprises with 1-9 employees, followed by enterprises with 10-19 employees as well as enterprises with 20-49 employees. Observing the structure of the enterprises, those with 50-249 were the least common, and in 2015 there was only one existing enterprise with over 250 employees[69].

According to the number of employees in the tourism and hospitality sector in 2019, the activities of meal preparation and food service claimed the largest share, followed by accommodation facilities, travel agencies, tour operators and other booking services, while related activities came in third place.

The results of the interviews suggest that tourism has potential for innovation and further growth. There are companies that invest in innovative and creative solutions, aiming to establish tourism and certain locations in the country as attractive tourist destinations, often in cooperation with the Faculty of Tourism and Hospitality in Ohrid and the Agency for Promotion and Support of Tourism and the tourism and hospitality sector within the Ministry of Economy in the Government of the Republic of North Macedonia. Plans for tourism development regarding ten destinations across North Macedonia were developed under the Local and Regional Competitiveness Project (LRCP) (based on the programme for the support of innovation and North Macedonia's competitive activities), financed by the European Union and carried out through the office of the World Bank in the Republic of North Macedonia, with a goal to 'improve the capacity of the government and public entities to foster tourism growth and facilitate destination management.' Another important policy document is the National Tourism Strategy of the Republic of North Macedonia.

The tourism sector should support research and innovation activities that will focus on social innovation based on rich cultural heritage and local creativity by promoting a complex network of environmentally friendly activities and consumer-friendly services that will consider the sustainable use of natural resources and introduction of innovative tourism programmes. The tourism sector is a multidisciplinary sector with great potential for structural transformation of many subsectors. It contributes to the preservation of local traditions and culture including handicrafts and heritage structures. In addition, tourism activities create an entrepreneurial environment and increase the number of SME and job opportunities. Equally important are the opportunities created by the increasing demand for local products, especially in relation to the domestic tourism sector (using eco-tourism as a tool to foster the transition to organic farming). This area is characterised by well-established supply chains, including retailers of agricultural products and food, transportation firms, marketing and travel agencies, tourist guides, hotels, restaurants, traditional and small local stores (food service and local products), firms for entertainment services.

Travel agencies (primarily in the segment of incoming tourism) as a particularly important part of the supply chain invest in new programmes – websites on tours that tourists follow on their own, connected via GPS. In

[68] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

[69] Own calculation based on official statistical data from the State Statistical Office of the Republic of North Macedonia, https://www.stat.gov.mk.

cooperation with the Faculty of Information Science and Computer Engineering (FINKI), they invest in destination mapping, ICT technology mountain guides; they map the route and supplement it with the places to be visited. The package is formed, and the tour is investigated independently. It concerns young people that travel by themselves with low-cost carriers, book by themselves and investigate by themselves. To conquer market segments that have not yet been tapped into, travel agencies invest in innovations, aiming to automate parts of the processes. By following the processes in tourism, new and attractive services are being created called 'creating experiences', which are part of the tourism arrangement programmes and which provide a competitive advantage. They also invest in human capital aiming to create services and programmes that attract tourists.

Travel agencies play a very important role in attracting tourists. However, the government should support the capacity-building process of the domestic tour operators so as to undertake larger organisations and groups and bring foreign tourists directly and independently to North Macedonia, but also to the regional economies – Albania, Bulgaria, Serbia, Kosovo, Romania, Montenegro, etc. – instead of doing so via intermediaries. The second part of the supply chain is hospitality. According to the budget, hospitality is the largest domain, but not according to the product offering, although there is potential.

According to the information from the conducted interviews, there are investments in gastronomy, innovative solutions to save electrical energy and regulate wastewater in accordance with environmental protection. There are no proper records on the turnover and the effects of tourists in the segment of restaurant operations, which complicates the perception of the visibility of the role and the impact of restaurant operations on the development of the sector.

The third part involves hotels located in tourist spots such as Ohrid, Dojran, Mavrovo, Berovo, Krushevo and Skopje. According to statistics, hotels have the largest share in the tourism and hospitality sector. According to the interviewed stakeholders, hotel capacities invest in innovative solutions, for example: in new wastewater treatment plants with a broader impact on the environment; in infrastructure to secure water from rainwater; in electricity by placing photovoltaic panels; in heating and cooling systems that apply the highest international standards for energy conservation and environmental protection. Through stimulation and cooperation with the populations in rural areas, they use the products from domestic agricultural and food production. They make procurements from the local population which contributes to a reduction in the emigration of people from the rural regions. However, the main challenges to intensifying this cooperation and building the capacity for the development of rural tourism are the weak infrastructure network and undeveloped rural areas in many potential tourist regions within the country. Hotel operators also invest in the promotion of service quality by process automation, IT solutions and the installation of property management systems (integration of all aspects related to the guest). Hotel facilities in Skopje are still at the highest level of development in terms of the hotel business.

The chain-brand hotels and several large hotels in the capital city meet infrastructural preconditions for congress tourism. The brands transfer know-how to the country, which positively reflects on the development of human resources. Active programmes are being followed on how to treat guests, employee training to increase the market value of the employees. However, there is a shortage of high-category hotels in the tourist centres, Ohrid, Mavrovo and Dojran. There is also a shortage of spa hotels across the country.

**Cross-sectoral relations.** Tourism and hospitality are connected to more than 15 other economic branches through their operations. Cooperation with the agricultural and food sector, apart from business entities, involves individual farmers participating as part of the value chain of the products of North Macedonia. The development of organic agriculture and tourism is also a related priority[70].

There is untapped cooperation potential between the hotels and the wine producers. Wine routes have been mapped and they have promotional potential, especially along the Corridor 10, for developing into wine roads that would represent attractive tourism offerings. In addition, connecting wine tourism with accommodation in rural areas also holds potential for wine tourism.

The eco-friendly hotels, through cooperation and communication with agriculture and forestry, initiated the possibility of combining several species of flora that may survive in the hotel environment. Cooperation with the health sector exists in terms of practising medical massage (spa and wellness) and introducing medical technologies. Only the spas from all thermal water resources are being utilised, and these are classified as health rehabilitation. There is informal health tourism in the bordering regions.

[70] However, the ECNM team have not succeeded in collecting more detailed information about the cross-innovation potential of this area, so this part should additionally be address in the EDP process.

Key players in the field of science are the Faculty of Tourism and Hospitality – Ohrid, the Faculty of Tourism and Business Logistics within Goce Delchev University in Shtip, Skopje and Gevgelija, as well as the Faculty of Tourism – Skopje. There are over 80 professors and researchers working in these research institutions. They carry out scientific and research projects concerning the promotion and development of the tourism sector, development of series of guidebooks (on religious tourism, tourism potential in the region, significant events in the Republic of North Macedonia, Ottoman monuments, guidebooks on rock climbing, flavours of North Macedonia, gastronomic experience, Via Egnatia) with the active engagement of professors. There are also several research projects of the Faculty of Tourism and Business Logistics – Shtip in the field of tourism and gastronomy financed by EU programmes, as well as 16 projects in the field of tourism and hospitality financed by the FITD[71]. However, there is no trace of H2020 projects in this area. Key players from the civil sector are the Tourism and Hospitality Association of the Chamber of Commerce of North Macedonia, Hotel Association of Macedonia – HOTAM, Chamber of Commerce of Tourism, National Association for Incoming Tourism in Macedonia – NAITM. They play an active role in the development of this sector and could be essential for Smart Specialisation in this sector.

The interviewed stakeholders noted the necessity to connect with the ICT sector in order to implement new innovative solutions to develop tourism and hospitality. The hospitality and tourism sector should pay special attention to this segment. Diverse building architecture should initiate value-added activities, with the objective to increase attractiveness, save energy, protect the environment, etc., which would contribute to sustainable development. The connection to the ICT sector may contribute to a new innovative approach in the sector's offering and achieve economic prosperity by applying big data analytics and artificial intelligence. Developing offerings in accordance with the needs and requirements of the individual users in the tourism sector, which could be in the segment of science and research or EU-funded projects, are exclusively intended for the development of hospitality and tourism in North Macedonia.

With regard to science and research and EU-funded projects to develop hospitality and tourism, the segment of virtual reality is of special importance in terms of using 3D animations to explore cultural heritage and monuments.

The tourism and hospitality sector was seriously affected by the health and economic crisis caused by the COVID-19 pandemic in terms of the dramatic decline in the number of tourists, revenue and number of workers. According to the official statistical data and the analyses conducted on the effects of the COVID-19 crisis, revenue reduced by over 30% in 2020, in comparison to 2019; many jobs in this sector were lost, while the number of tourists sharply reduced[72]. The recovery process for this sector is still unpredictable, and it depends on the country's ability to deal with the pandemic, as well as the globally applicable circumstances. However, the impact of the crisis on tourism and hospitality will be the main challenge for further development of this sub-area and will slow down the process of Smart Specialisation in this sub-area.

The interviewed companies suggest a set of measures that the government should take in order to mitigate the negative effects in this sector. Some of those measures are: the extension of favourable credit lines through the Development Bank of North Macedonia to maintain the liquidity of the companies in the tourism and hospitality sector; reducing VAT from 18% to 10%; providing salary subsidies for the companies that show a decline in their revenues of over 20-30% during 2021; providing health protocols for some of the branches, such as wedding organisers; issuing new tourist vouchers for domestic tourists; as well as providing favourable conditions for foreign tourists during the upcoming tourist season.

**General conclusion.** Strengths that stimulate growth of the sector in the country's general economy are the E75 north-south road connection with Greece, Serbia and central Europe; high awareness of being a tourist destination in regional economies; transit tourism; a relatively good price-quality ratio and competitive tourism product; natural resources and cultural heritage.

This high level of potential for tourism development is predetermined by the scale and the diversity of tourism resources (natural, anthropogenic and man-made) and infrastructure. If these resources are adapted, they can be used in support of tourism, which may ensure dispersion in tourism production and will represent considerable potential for the multiplication of the economic effects of tourism via the designated export destination, ensuring that a larger number of municipalities and citizens feel the economic benefits of tourism.

Prospects in a regional context offer significant opportunities. Initially, considering its location, much of the regional tourist traffic passes through North Macedonia, which provides an opportunity for offerings that would

[71] The reports from of the Fund for Innovation and Technology Development (FITD), https://fitr.mk/en/#.

[72] Study for the effects on the private sector of the tourism sector affected by the health-economic crisis caused by the COVID-19 pandemic with recommendations for the management of consequences, https://biznisregulativa.mk/mk-MK/Pages/Publications.

attract transit tourists to short stays. The strong demand for regional tours is another indicator of the attractiveness of the cross-border offerings in the area of culture, history and religion. Balkan economies share a common history and largely shared culture, making the development and promotion of these experiences at regional level quite beneficial to the entire region, especially for North Macedonia, being situated in the centre of the Balkans. A third key opportunity is the access to good practices from the region by sharing good examples from the area of rural tourism and nature activities, culinary and traditional living offerings. Drawing on ideas and models from the neighbouring economies is more effective and easier to implement due to the culture similarities and the surroundings.

Tourism is the sector with substantial economic potential for North Macedonia, which represents a possibility for quick positive results even after the end of the crisis, such as the one caused by the ongoing pandemic. However, it requires support to open new markets, develop GIS tourist maps for urban and rural areas, develop applications on various topics from tourism with electronic maps according to interests (for example, wine routes, mountain and biking trails, religion) and the designated development loans for tourism in rural areas and marketing. However, the ECNM team has not succeeded in finding more evidence for the existence of research and innovation capacities, so the limited innovation potential may be the most binding constraint in the process of Smart Specialisation in this area.

## 4.6 Energy for the future

The preliminary defined area of 'Energy for the future' involved 14 interviews: 8 interviews were conducted with representatives of the business sector; 3 interviews with representatives of academia (Faculty of Mechanical Engineering and Faculty of Engineering and Computer Sciences within Ss. Cyril and Methodius University – Skopje and the Macedonian Academy of Science and Arts – MANU) and 3 interviews with representatives of the government sector (the President of the Energy and Water Services Regulatory Commission, the Director of the Energy Agency of the Republic of North Macedonia and the Head of the Energy Department under the Ministry of Economy).

The majority of the interviewed stakeholders are located in the Skopje region (13); one company is located in the Vardar region and one company in the Polog region.

**Table 9**. List of interviewed stakeholders with proposed process ambassadors for the 'Energy for the future' area[73]

| No. | Business sector | Ambassador | Energy for the future | Cross-sectoral connections |
|---|---|---|---|---|
| 1 | PIXEL GROUP | X | X | Manufacturing |
| 2 | EMK MALI HIDRO ELEKTRANI | X | X | |
| 3 | CAMEL SOLAR | X | X | Sustainable materials |
| 4 | MALI HIDROELEKTRANI – FERO INVEST | | X | Metalworking and machinery |
| 5 | FONKO HYDRO | | X | Services |
| 6 | THOR | | X | |
| 7 | ARESE SOLUTIONS | | X | Services |
| 8 | ELEKTRO SHARRI | | X | Smart agriculture |
| No. | Academic sector | | | |
| 1 | SS. CYRIL AND METHODIUS UNIVERSITY, FACULTY OF MECHANICAL ENGINEERING – SKOPJE | X | X | X |
| 2 | SS. CYRIL AND METHODIUS UNIVERSITY, FACULTY OF ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGIES | X | X | X |
| 3 | MACEDONIAN ACADEMY OF SCIENCE AND ARTS – MANU | X | X | X |

[73] The classification in the table is based on the proposed sub-area(s) and the defined branches within those sub-areas, while the ambassadors are identified in the interview process according to the previously developed questionnaire.

| No. | Government sector | | | |
|---|---|---|---|---|
| 1 | ENERGY AND WATER SERVICES REGULATORY COMMISSION | X | X | X |
| 2 | ENERGY AGENCY OF THE REPUBLIC OF NORTH MACEDONIA | | X | X |
| 3 | MINISTRY OF ECONOMY | X | X | X |

*Source*: Authors.

A focus group meeting was organised, consisting of 3 ambassadors from the business sector (Fero Invest, Camel Solar and Pixel Group), 3 representatives of the government sector (Energy Agency of the Republic of North Macedonia, Ministry of Economy and Cabinet of the Deputy Prime Minister) and 2 representatives of academia (professors from the Faculty of Electrical Engineering and Information Technologies – Skopje and MANU). The focus group participants contributed to the finalisation of the strategic sub-areas and the clarification of some of the open questions from the interviews. The participants' main conclusion in the focus group meeting was that this area has a huge development opportunity that should be used. There are several aims that were pointed out:

- the first one is the transformation to green energy by using the renewable energy sources;

- the second aim is increasing energy efficiency and environmental protection;

- the third aim that was noted was building the production capacities of some parts of energy equipment, such as turbines, electrical equipment, photovoltaic panels and other parts.

Based on systematised data obtained from a number of sources (conducted interviews, focus group meetings, additional studies, etc.), the ECNM proposes the following area as an area for Smart Specialisation: '**Energy for the future**'. This area is considered to be a horizontal one, because it has strong cross-sectoral relations with other proposed priority areas and is in line with the process of greening the industry and protecting the environment. Within this area, the following potential fields needing additional research have been identified: biomass/biogas, solar energy, hydro energy, wind energy.

Below are the main findings of the conducted interviews and focus group meetings related to this preliminary priority area. The overall conclusion for this area is that there is economic, scientific and innovation potential, but the main problem is that this area does not have the capacity to create higher added value; it is not export-oriented and there is no critical mass of firms in each branch.

However, this area has strong cross-sectoral connections with other defined strategic areas (ICT, smart agriculture and food processing, electrical equipment and mechanical parts, as well as smart/sustainable buildings and materials). Due to these cross-sectoral links with other vertical priorities, the ECNM team and the national working group suggest that this area be horizontally supported within the EDP workshops. The companies within the different branches of the defined sub-area could contribute to successful implementation of the Smart Specialisation concept in North Macedonia by creating added value for other strategic areas.

Developing the sustainable energy sector by using renewable energy sources (RES) is one of the main priorities of the Government of the Republic of North Macedonia. Hence, the new 2020-2040 Strategy for Energy Development will focus on the transition to a low-carbon economy by developing every renewable energy source (hydro, wind, solar, biomass/biogas, etc.). The country's total nameplate capacity of renewable energy sources is 730.5 MW, 562 MW of which stem from big hydroelectric power stations (over 10 MW), 109 MW derived from small hydroelectric power stations (under 10 MW), 36.8 MW from wind parks, 18.5 MW from photovoltaics and 6.9 MW from biogas, making North Macedonia one of the leading countries in the region in the renewable energy sources segment. The total nameplate capacity of renewable energy sources surpassed 40% of the total installed capacity of the entire energy sector or 35% of the total gross production of electricity in the country from all sources[74]. This area has a significant impact on the national economy in terms of its contribution to the GDP, number of companies, jobs and other indicators. In fact, the energy sector's relative share in the national GDP is around 3.5%, while most of this added value is generated by renewable energy source. Additionally, this area generated more than 9 000 jobs and 3% of the total number of companies in the whole industry sector are companies from this area. The growth of this area through investments in new renewable energy projects will have significant multiplicative effects on the national economy because it is horizontally

[74] Strategy for Energy Development of the Republic of North Macedonia until 2040.

related to many sectors such as construction, machinery, trade and others. Furthermore, it will have positive effects on environmental protection and benefits in terms of substituting the import of electricity.

The findings of the qualitative analysis show that the significant progress in the **hydroelectric energy sector** has been made in the past 15 years under the plan to increase the share of renewable energy sources. Over 100 small hydroelectric power stations have been built, and today North Macedonia is a regional leader in hydropower energy in terms of the relative share of the total installed energy capacity. With regard to the utilisation of hydropower potential, the strategic projects in the country are Chebren and Galishte. The last tender bidding for the Chebren project showed considerable interest on the part of private investors, however, the state should have a clear strategy for selecting the optimal model and technical solution that would provide the largest long-term benefit to the country. Additionally, granting concessions for small hydroelectric power stations undergoing a stage of design, planning or construction and the potential for new concessions regarding this type of hydroelectric power stations across the country is a significant component of the development of the energy sector using renewable energy sources.

Key players from the business sector in this branch are: AD ESM Skopje (as a national energy company), EMK Skopje, Fero Invest Skopje, FONKO Hydro and other smaller investors. FONKO Hydro and Fero Invest Skopje are both investors in small hydroelectric power stations, as well as companies for designing, construction and managing hydroelectric power stations. Additionally, Fero Invest manufactures some metal (metal structures) and mechanical parts (turbines) for hydroelectric power stations, and it has already accumulated knowledge and expertise for designing and developing unique solutions and building, optimising, managing and maintaining small hydroelectric power stations.

According to the interviewed stakeholders and conclusions from the focus group meeting, the main strategic advantages of this sub-area are: the country's hydropower potential; accumulated know-how and experience of the existing investors that could be used for further development of this sector; interest from foreign investors; existing historical database on hydrology that provides foreseeability and consistency to the projections about the production of electrical energy; and the considerable profitability of the investments in small hydroelectric power stations. With regard to the strategic advantages pointed out during the interview process, it could be concluded that this branch has development potential.

It should be also mentioned that the new Energy Law established the framework for developing the **photovoltaic sector**, where, by introducing premium tariffs, tenders were put out for granting concessions related to investments on state land with projected nominal power of 35 MW where the state had the obligation to facilitate the institutional procedures, including MEPSO's obligation to provide appropriate connections to the photovoltaic power station[75].

According to the information collected during the interview process, there are several companies and investors which showed a keen interest at the bidding stage to construct the photovoltaic power station in the municipality of Makedonski Brod, which generated inflow in the state budget of EUR 28 million. There was less interest in the concessions concerning investments in photovoltaic power stations on private land due to the higher risk in ensuring a connection and numerous institutional obligations that are quite complex and demand longer periods of time. Nevertheless, premium tariffs and concessions were granted for the construction of photovoltaic power stations, which render the development of this sector increasingly certain. Moreover, the state company AD ESM Skopje is starting a project to transform TEC Oslomej into a photovoltaic power station with a nameplate capacity of 2x40 MW, following the principle of public-private partnership. There is an ongoing process of construction and commissioning of a photovoltaic power station with a nameplate capacity of 10 MW, with investment by AD ESM. Additionally, the company's plan is to use the same principle to gradually transform TPP Bitola by initially shutting down the first unit and, eventually, the remaining two units in the following 15 years, whereby the country would completely abandon the production of electrical energy from fossil fuels. However, this plan must proceed together with the provision of a suitable alternative in the segment of ensuring security and stability of the energy sector.

According to the interviewed stakeholders, the new Energy Law laying down the installation of photovoltaic panels of up to 4 MWh on individual households and of up to 400 MWh on commercial buildings is of no less importance to the development of this branch. These possibilities for additional institutional facilitation and bylaws could provide an opportunity for households and legal entities to secure proprietary energy sources that are cheaper, which would certainly reduce the burden on the entire energy system. In this regard, increasing the nominal power from 4 MWh to 6 MWh for collective buildings by using the new technologies for combining

[75] Energy Law and Law on Energy Efficiency, https://economy.gov.mk.

thermal pumps to heat water would increase the interest in investments in photovoltaic systems on collective buildings. Furthermore, there is an increasing number of companies (such as Arese Solutions Skopje, Solar Spektar, Sector Cert Macedonia, Tim Inzenering, EKO Solar Shtip and others) with a critical mass of accumulated knowledge and experience in engineering and the installation of photovoltaic and thermal systems.

The main strategic strengths to develop this branch are the accumulated knowledge and innovation capacity of several manufacturers/producers of thermal collectors and photovoltaic panels. An example of good practice in the field of innovation is the case of Plasma, as a scientific and research centre, the innovations of which are commercialised together with Camel Solar. Moreover, the cooperation between Plasma as a manufacturer of solar collectors and the Pixel Group as a manufacturer of photovoltaic panels resulted in the development of an innovative product: the hybrid photovoltaic collector and combined hybrid systems, a project supported by the Fund for Innovation and Technology Development – FITD. This illustrates that the innovative SMEs have a crucial role in the development of this branch.

On the other hand, the key obstacles to further development of this sector are the unsatisfactory level of scientific and research capacities, lack of qualified workforce, incomplete harmonisation with EU standards in terms of issuing certificates for fitters of solar and photovoltaic systems, the lack of institutional and regulatory capacity, etc.

With regard to **wind power**, the national energy company AD ESM Skopje has already installed a wind park with nominal power of 36.5 MW, which proved to be an exceptionally profitable project and the company now plans to expand the capacity to 50 MW. Additionally, concessions with feed-in tariffs were granted to three private investors with foreign capital on locations in the municipalities of Sveti Nikole, Demir Kapija and Gevgelija with projected nominal power of 100 MWh. These investments are in their initial stages; however, in accordance with the dynamics, they are expected to start on the realisation soon. Moreover, there is interest by a foreign company in investing in a huge wind park with a nameplate capacity of 400 MW in the municipality of Kriva Palanka, but there are ongoing preliminary examinations and analyses regarding this potential investment. All of these upcoming and potential investments may surpass EUR 500 million in the next period, which suggests at the development potential of this sub-area. This will also stimulate the construction and machinery sector, being interconnected sectors.

With regard to **biogas and biomass** as renewable energy sources, two power stations already exist with a total nameplate capacity of 7 MW (Elektro Sharri – Tetovo and ZIK Pelagonija – Novaci) and concessions were granted (temporary status of preferential producers) for construction of new similar power stations with an additional nameplate capacity of 11 MW. These ongoing projects are in strategic partnership with domestic companies and foreign companies where the possibilities for the transfer of technology and knowledge are certain regarding the capacity of the domestic companies. However, we should highlight that the capacities are limited due to the limited amount of waste as a main input material in the production process. In this regard, a study should be conducted to investigate the total amount of waste from all farms in the country, its power density, and of course, the amount of other materials of plant origin in order to define the future development opportunities in this sector.

The key institutions from academia in this area are the Faculty of Mechanical Engineering – Skopje, the Faculty of Electrical Engineering – Skopje and the Macedonian Academy of Science and Arts (MANU). We do not have detailed information about the number of researchers in the field of renewable energy, but there are several prominent professors/researchers with strong international scientific references.

The information collected from the interviewed stakeholders shows that the cooperation between the business sector and academia is primarily in the field of development feasibility and other types of technical studies (searching for new innovative technical solutions in the design, planning and construction of hydroelectric power stations), as well as in several R&D projects. An example can be found in one Horizon 2020 project on redesigning turbine assembly for greater flexibility in the production process, which is a project carried out by the Faculty of Mechanical Engineering within Ss. Cyril and Methodius University along with other European universities. There are also several other H2020 projects in the field of renewable energy, climate action, environment and 20 projects financed by the FITD in the field of energy and energy resources. Additionally, there are several new NGO initiatives for programmes for social innovation in the field of renewable energy and energy efficiency[76]. For illustration, in the period 2014-2020, according to an internal database review by the Ministry of Education and Science, 37% (EUR 5.06 million) of the total EU financial contributions (EUR 13.7 million) under Horizon 2020 for North Macedonia were associated with projects focused on various topics from

[76] Reports from the Fund for Innovation and Technology Development (FITD), https://fitr.mk/en/#, and the Ministry of Education and Science of North Macedonia, https://mon.gov.mk/category/?id=2061.

energy-thematic areas (28 participations or 25% of the total number of awarded projects). Most of the spending was used for the following topics: secure, clean and efficient energy – in the amount of EUR 3.8 million (21 participants) – while the rest of the projects covered activities under climate action, environment resource efficiency and raw materials, as well as smart, green and integrated transport (EUR 1.3 million). In terms of sector involvement, most of the spending was used by the private sector, i.e. 9 SMEs participated with net contributions of EUR 1.6 million. Public sector and research institutions (e.g. education) participated with 10 projects and EUR 1.5 million, while higher education took part in 5 projects with EUR 0.9 million. Other institutions such as associations or the Chamber of Commerce participated with EUR 1 million.

According to data from the State Office of Industrial Property, 6% of the total number of patent applications in the last decade came from this area[77], while 6.6% of the total approved budget of the FITD for financing projects was allocated to this area[78]. This indicates that there are already existing scientific and research capacities, but with insufficient evidence on the innovation potential of the start-ups and other innovative SMEs. However, the case of Thor in the field of wind power and Fero Invest in the field of biogas, which are in the initial phase of building capacities by accumulating and transferring knowledge from abroad, shows that in one branch of this sub-area North Macedonia has not yet created a critical mass of innovation capacities. On the other side, in the field of hydroelectric and photovoltaic/solar branches, several innovative SMEs possess critical knowledge of designing solutions, manufacture and installation of hydroelectric and photovoltaic/solar systems. The findings obtained from the interview process show that the government and regulatory institutions, including the Energy Agency of the Republic of North Macedonia and the Ministry of Transport and Communications, are willing to eliminate the identified obstacles and to improve the business environment in order to boost the development of the renewable energy sector.

The key players in the civil sector are the North Macedonia's Energy Association – MEA, Association of Power Supply Industry, North Macedonia's solar association PVMAK and others.

The level of internationalisation is low in terms of exporting electricity. With regard to the export of equipment for hydropower stations and technical services of design and construction, Fero Invest has export experience and makes internationalisation efforts, boasting several successful projects in Georgia, Albania, Kosovo and other economies in the region. Moreover, investing in new, small hydroelectric power stations is a rather attractive business for foreign investors, which could make a positive contribution to the national economy. Additionally, the Pixel Group and Plasma are companies with successful international experience in the field of production and installation of photovoltaic and solar power stations and systems. However, we do not have detailed information on the export value of these systems for hydroelectric and photovoltaic/solar stations.

The main findings of the conducted interviews and focus group meetings is that the objective of the '**Energy for the future**' area is to apply innovation and scientific potential in order for the country's dependence on the import of electrical energy to be reduced by using renewable energy sources, to provide greater environmental protection by applying smart-eco solution systems and to boost local economic development by new investments in renewable energy projects in local regions.

The 'Energy for the future' area has cross-sectional cooperation with the construction sector concerning the construction activities related to investments in renewable power stations, as well as a strong connection with smart buildings in the field of energy efficiency. There are several good examples of such a cross-sectoral cooperation: the collaboration between Granit Skopje (as the biggest construction company in the country) and Fero Invest in the field of hydropower, as well as the cooperation between Intebako and Torax in the field of smart and energy-efficient buildings. Additionally, this area has strong horizontal links with machinery and the electricity sector in the field of production of different parts such as turbines and other mechanical parts of the hydroelectric, photovoltaic power stations, metal structures for wind power stations as well as electrical equipment for all renewable power stations. Other notable collaborations include those between Fero Invest and Brako Veles in the field of production turbines and other metal parts for hydropower stations, as well as the cooperation between Bratstvo Inox Ohrid, TM Shtip, Rade Konchar Kontraktori and Relei as producers of electrical equipment, and EVN and MEPSO as national energy companies for the distribution of electricity. At the same time, the management and control systems of the hydroelectric, photovoltaic, wind, biomass/biogas power stations are supported by ICT software solutions, which implies that there is also a close connection to the ICT sector. In addition, biomass/biogas is closely related to the circular economy, while photovoltaic/solar power is connected to smart agriculture and food processing.

[77] State Office of Industrial Property (SOIP), http://www.ippo.gov.mk.
[78] Reports of the Fund for Innovation and Technology Development, https://fitr.mk/en/#.

All of these energy sector horizontal industrial linkages with other sectors, as well as the well-established electricity network and the existence of electricity traders such as EVN Home, EDS and other smaller traders, suggest that eco-smart energy sources have well-established elements within the value chain which could be further analysed in the process of Smart Specialisation. However, the ECNM team has not succeeded in collecting more detailed information about the cross-innovation potential of this area, so this topic may additionally need to be elaborated in the EDP.

This area is not directly hit by the crisis caused by COVID-19 pandemic in terms of production, the number of workers, investment and other indicators. However, this sub-area could be one of the most important sectors for the economic recovery of the country in the post-crisis period because there are several ongoing investment projects which will have positive effects on the national economy. In this context, the government and state institutions should create a set of measures to boost the development of this sub-area in the post-crisis period. Some of those measures are improvements to the institutional and regulatory capacity, more public investments in renewable energy, improvements in the vocational education system, increasing state capacities to better utilise the EU funds for renewable energy. The new Energy Law and the established framework for renewable energy sources, the country's natural resources, high level of interest of domestic and foreign investors in renewable energy projects as well as the government's development strategy for this sector and the commitment of the state institutions (agencies, regulatory bodies, ministries) demonstrate that the development potential in this sector will be explored and utilised.

However, it should be noted that there are several serious deficiencies in the energy sector: 1) the country is still a net importer of electricity; 2) the use of fossil fuels for electricity production causes serious environmental problems; 3) there is a notable loss of electricity within the electricity distribution system as a consequence of problems in the transmission infrastructure – the costs for which are covered by the consumers, which increases electricity price; 4) the renewable energy sources are still insufficiently used (solar, wind and hydropower potential).

There is a growth potential for this sector, which appears to be attractive for foreign investments, as well as significant potential for further development of production of electricity with renewable energy sources. Directions for further development of innovation and research efforts exist, but these are not adequately utilised so to provide sufficient justification for standalone S3 domain. There is also insufficient evidence on innovation potential of start-ups and SMEs in this area. On the other hand, the potential for cross-sectoral innovation with other priority domains is high. Having in mind all these findings, we propose that 'Energy for the future' is to be included in the EDP as a horizontal area supporting the development of identified vertical domains.

# 5 Conclusions and recommendations for the Entrepreneurial Discovery Process

## 5.1 Proposal of areas and sub-areas for the EDP

The Republic of North Macedonia continued the process of the development of a Smart Specialisation strategy, showing commitment to evolving their policies for economic growth based on innovation and specialisation. The qualitative analysis was performed in the period September 2020 – March 2021. The analysis involved more than 100 stakeholders in further discussions and analysis on the proposed specialisation areas, derived from quantitative mapping of economic, innovative and research potential. The interviews were held in difficult circumstances, due to the negative socio-economic effects of the COVID-19 pandemic and changes in the priorities of companies and their way of functioning, and unclear growth perspectives.

The main aim of the qualitative analysis was to better elaborate the proposed priority areas of Smart Specialisation in North Macedonia that should be further subjects of the entrepreneurial discovery process. The qualitative analysis used input from interviews with relevant actors from the business, scientific and government sector; focus group meetings for each proposed area; and the findings from different existing sectoral studies. Another objective of the qualitative analysis was to understand the challenges caused by the COVID-19 pandemic crisis as well collecting information for the development of the EDP. After processing all information obtained from a number of sources, the ECNM team proposes the following vertical priority areas and sub-areas as being subject to further elaboration within the EDP:

1) Smart agriculture and food processing with high added value
    - Smart agriculture (sub-area)
    - Food processing with high added value (sub-area)
2) Information and Communication technologies (ICT) sector
    - Custom software development (sub-area)
    - (Advanced ICT services (potential sub-area))
3) Smart/Sustainable buildings and materials
4) Electrical equipment & machinery parts.

In general, the information gathered confirmed the relevance and importance of the proposed areas for Smart Specialisation.

The ECNM team, based on the analysis of the systematised data obtained from a number of sources, made a proposal to rename the domain from 'Sustainable food and beverage production and value chains' as initially proposed by the S3 working group of North Macedonia to 'Smart agriculture and food processing with high added value'. This proposal was made due to insufficient evidence for emphasising the sustainability element in the agri-food sector. The proposal also includes division into the following two sub-areas: 1) 'Smart agriculture' and 2) 'Food processing with high added value'.

In the quantitative analysis, the ICT sector was the only sector that was shown to have potential for Smart Specialisation in all three components: economic, innovation and R&D areas. ICT can be regarded as a potential priority domain for Smart Specialisation. Considering the broader area of the ICT sector, based on systematised data obtained from a number of sources (conducted interviews, focus group meetings, in-depth sectoral analyses, etc.), one sub-area has been proposed: 'Custom software development'. The ECNM team also recommends that another sub-area is additionally explored in the EDP, which is 'Advanced ICT services', being a sub-specialisation area related to new trends on the global market for ICT services (Big Data and Business Analytics, IoT, Cloud) and due to rapid technology improvements and, on other hand, due to increased interest from domestic start-ups in this sub-area.

In the new digitalised world, ICT is interlinked with all segments of society and industry. It is of extreme importance to the digital transformation of society and especially the digital transformation of the industry in terms of implementation of a new method of doing business by using ICT management systems and business solutions. ICT is offering new opportunities for growth and promotion of many sectors, such as tourism and creative industries, by developing virtual tourism platforms and other ICT solutions for the promotion of various e-services. ICT should be seen as a separate area for Smart Specialisation, but also as a horizontal area for Smart Specialisation due to its specificities and cross-sectoral interrelatedness. It was also concluded that the COVID-19 pandemic did not have a substantial effect on the economic, innovation and scientific potential of the ICT industry.

With regard to the area of Smart/Sustainable buildings and materials, the ECNM team, based on the systematised data obtained from a number of sources (conducted interviews, focus group meetings, existing sectoral studies, etc.), proposed that this area be seen as a comprehensive priority domain with two sub-fields (smart buildings / construction solutions and sustainable materials). During the qualitative analysis phase, the team did not succeed in finding sufficient data for the economic, scientific and innovation potential to propose these sub-fields as separate S3 sub-areas. It is suggested that they should be further investigated during the EDP, focusing in particular on: 1) smart buildings and smart construction solutions and 2) sustainable materials (sustainable building materials; nanomaterials – sensors, composites, coatings; and new polymer-based materials). One highly relevant field with potential concerns new materials, as sustainable materials, utilising existing resources and adding value to new construction products with the re-use of used construction materials and the re-use of waste, as well as renewable, eco-friendly and healthy materials. This process is important due to enabling the transition to a circular economy. The conclusion regarding the COVID-19 pandemic was that its effect would be substantial on the economic, innovation and scientific potential of this area if the measures that would compensate the lack of export were not implemented.

With regard to the area Electrical equipment and mechanical parts, based on the systematised data obtained from the conducted interviews, the recommendations from the focus group meeting and the results of the in-depth sectoral analysis, one proposal by the ECNM is that the potential area for Smart Specialisation – Electrical equipment and mechanical parts – should be considered to be one comprehensive domain consisting of two sub-fields: 1) Electrical parts and products and automotive components and 2) Metal and machinery products. This domain proposed for Smart Specialisation includes metal parts and products; electrical components and equipment; machinery, machinery tools and engine parts; mechanical appliances; as well as automotive parts and components. In the qualitative analysis phases, the ECNM team did not succeed in finding sufficient data for the economic, scientific and innovation potential to propose these sub-fields as separate S3 sub-areas. It is suggested that they should be further investigated during the EDP. It could be concluded that the COVID-19 pandemic did have a substantial effect on the economic, innovation and scientific potential of this area, but it also accelerated the transition when a crisis is seen as an opportunity for additional development and transformation.

These four areas are proposed as vertical areas for Smart Specialisation, having economic capacities, as well as scientific and innovative potential to be further elaborated in order to create a new niche market for their specialisation. The overall conclusion is that the COVID-19 pandemic did not critically affect the four priority domains suggested for the EDP. Moreover, it is perceived as a source of opportunity that will be marked by those willing to transform according to new trends, which will inevitably emerge on global markets. The further process of designing RIS3 and the future EDP could be one of the main catalysts that would facilitate this transformation.

The ECNM team did not succeed in finding enough information concerning existing critical mass of firms that would create a base for the justification of the Energy for the future as the vertical priority area for Smart Specialisation. It should be mentioned that there are a lot of initiatives in the research sector, which present a good base for further growth. However, this area has strong cross-sectoral connections with other defined strategic areas (ICT, smart agriculture and food processing, electrical equipment and mechanical parts, as well as smart/sustainable buildings and materials). Due to these cross-sectoral links with other vertical priorities, the ECNM team suggests that this area should be further explored as a potential horizontal area for Smart Specialisation. This means that the component for climate change, decarbonisation, energy efficiency, green economy and new methods of energy production should be discussed in all proposed areas for Smart Specialisation within the EDP workshops. The companies within the eco-smart energy sources, as a potential sub-area, could contribute to the successful implementation of the Smart Specialisation concept in North Macedonia by creating additional value for other strategic vertical areas.

Lastly, the findings of the qualitative analysis related to Sustainable tourism and catering as a preliminary proposed area in the quantitative analysis indicate that this area provides a significant contribution to the North Macedonia's economy. However, there is little evidence of any innovation implemented, which could be enhanced with the demonstration of outstanding innovative products, services and business models. The added value and growth of this sector is not significant. In addition, value-chain and regional/international competitiveness are not fully elaborated and the dynamics of the sector and role of SMEs are insufficiently covered. With regard to the stakeholders in this area, the number of actors from the academic sector should be increased and the success stories, facts and figures should be related to stakeholders from businesses and academia active in this area, and not the entire tourism sector. The tourism sector was negatively affected by the COVID-19 crisis and the recovery process is still unpredictable for this sector. The impact of the crisis on

tourism and hospitality will remain the main challenge for further development of this sub-area and will also hamper possible Smart Specialisation processes in this area.

The EDP should also take into account the link between Smart Specialisation and the sustainability and inclusiveness dimension, including: digital and green transition of the economy; environmental, climate and energy challenges; societal challenges; and health challenges, in particular. Adequate identification of S3 development priorities may enable the consolidation of research capacities and infrastructure, gathering a critical mass of researchers and innovators that would work together on strategically significant topics of research and development, with a view to achieving research excellence and strengthening the potential of domestic products for commercialisation. In addition, S3 may also enable the development of new economic sectors through investments in research and innovation in areas that contain strategic potential within the national framework.

## 5.2 Priority area justification elements to be further improved in the next stage

There are certain elements related to the justification of priority areas and sub-areas that need to be addressed during the EDP. They should be the focus of the upcoming stakeholder dialogue workshops. The recommendations for improving this field are given below per priority area and sub-areas.

1) Priority area – Smart agriculture and food processing with high added value

Sub-area – Smart agriculture

- Additional examples should be given of outstanding innovative products, production or business models where smart agriculture (sensors, smart tools & machines) is already being implemented, demonstrating that some potential already exists. These examples would show the direction in which other stakeholders should develop in order to improve competitiveness, optimise processes, reduce costs and increase added value.
- The regions with the strongest stakeholder presence should be clearly indicated. The regional distribution of other key stakeholders could also be indicated. Instead of simply listing regions, a map or similar illustrative representation of regional coverage could be provided.
- It could be better described how dynamic the identified sectors are and what is the role of start-up, scale-up and other small and medium companies in their development. The role of SMEs should be better elaborated, e.g. examples of small producers implementing new technologies could be given.
- Insights on missing elements of the value chain (not the supply chain) should be provided. It should be analysed whether there are any international brokers and wholesalers that could be skipped or replaced by national wholesalers to retain more added value in the country.
- It should be explained how companies from North Macedonia can compete with similar companies from the macro-region, but also at global level. Comparative strengths and specific niches with no or few competitors from the region could be highlighted.
- While the critical mass of stakeholders and their outputs is well elaborated, the identification of stakeholders could be improved by expanding the list of from the business sector to beyond producers. This implies that the value chain is short, producers export themselves and there are no key national wholesalers facilitating sales on international markets or innovative companies developing sensors, smart tools and machinery and software facilitating smart and cost-effective production.

Sub-area – Food processing with high added value

- Additional examples should be given of outstanding innovative products, services or business models in research, development, production or sales of food, beverages, health supplements, etc. that prove there is already some existing potential. These examples would show the direction in which other stakeholders should develop in order to improve competitiveness, optimise processes, reduce costs and increase added value.
- The desired future position in the global value chain is provided, however insights on the current position could also be elaborated.

- The regions with the strongest stakeholder presence should be clearly indicated. The regional distribution of other key stakeholders could also be indicated. Instead of simply listing regions, a map or similar illustrative representation of regional coverage could be provided.
- To prove the dynamics of the sub-area, figures, e.g. growth of the number of SMEs should be provided or at least examples of several best-case growing SMEs given.
- It should be explained how companies from North Macedonia can compete with similar companies from the macro-region, but also at global level. Comparative strengths and specific niches with no or few competitors from the region should be highlighted;
- Insights into the specificities of the global market and trends in technologies and business models could be provided;
- The critical mass of stakeholders from the academic sector and their R&I potential should be strengthened (e.g. by the share of total research FTEs, recent international publications, intellectual property rights, number of international competitive projects won, cases of successful collaboration with industry or successful spinoffs, etc.) and the identification of key stakeholders from the academic sector could be improved by adding concrete success stories, fact and figures.

2) Priority area – Information and communication technologies sector

Sub-area – Custom software development

- An explanation on how companies in custom software development grown on a larger scale could be provided. Additionally, best-case examples could be given in order to prove that there is a certain existing potential. It is essential that the focus does not remain on FDI-related companies performing outsourcing for their mother companies abroad due to the cheaper labour force in North Macedonia.
- The regions with the strongest stakeholder presence should be clearly indicated. The regional distribution of other key stakeholders could also be indicated. Instead of simply listing regions, a map or similar illustrative representation of regional coverage could be provided.
- It should be explained how companies from North Macedonia can compete with similar companies from the macro-region, but also on a global level. Comparative strengths and specific niches with no or few competitors from the region should be highlighted.
- Concrete success stories, facts and figures related to business and academic stakeholders involved in custom software development should be provided.
- The elaboration of potential EDP stakeholders could be provided in terms of their role, motivation and contribution to this particular sub-area.

3) Priority area – Smart/sustainable buildings and materials

- Additional examples should be given of outstanding innovative products, services or business models in research, development, production or sales of smart/sustainable building materials that can support the view that there is already some existing potential. These examples should show how the main goals of Smart Specialisation were already implemented and should also indicate in which direction other stakeholders should develop in order to improve competitiveness, optimise processes, reduce costs and increase added value.
- An explanation on which parts of the value chain (not the supply chain) are present in the country and which are missing could be added.
- Figures on export should be more focused on the exports undertaken by companies in this area.
- The regions with the strongest stakeholder presence should be clearly indicated. The regional distribution of other key stakeholders could also be indicated. Instead of simply listing regions, a map or similar illustrative representation of regional coverage could be provided.
- It should be explained how companies from North Macedonia can compete with similar companies from the macro-region, but also at global level. Comparative strengths and specific niches with no or few competitors from the region could be highlighted.

- Detailed information on the potential for cross-sectoral innovation and on international competitiveness strengths should be provided.
- The dynamics of the sector and role of SMEs could be elaborated more consistently.
- Insights into the specificities of the global market and trends in technologies and business models could be provided.
- The identification of key stakeholders from could be improved and more concrete success stories, fact and figures related to the stakeholders active in this area could be added.

4) Priority area – Electrical equipment and mechanical parts

- Some figures related to export performance, number of employees, gross added value are provided for the entire metalworking sector, machinery sector and electrical engineering industry. However, providing clearly distinguished figures related only to the most innovative companies from the electrical equipment and mechanical parts priority area would improve the justification.
- An explanation on which parts of the value chain are present in the country and which are missing should be added.
- The regions with the strongest stakeholder presence should be clearly indicated. The regional distribution of other key stakeholders could also be indicated. Instead of simply listing regions, a map or similar illustrative representation of regional coverage could be provided.
- The explanation on competitiveness on international and regional level should be enhanced. It should be explained how companies from North Macedonia can compete with similar companies from the macro-region, but also on a global level. Comparative strengths and specific niches with no or few competitors from the region could be highlighted.
- The dynamics of the sector and role of SMEs could better be demonstrated.
- Insights into the specificities of the global market and trends in technologies and business models should be provided.
- The identification of key stakeholders could be improved. Business clusters are indeed typically registered as non-profit organisations; however, they represent business interest and therefore cannot be considered as a civil sector stakeholders.

## 5.3 Detailed analysis of suggested preparatory steps

The EDP was a new topic for all interviewed individuals and they expressed a willingness to learn about the concept of entrepreneurial policymaking, promoting a broader consultation with local business and research institutions. All of them expressed an interest in being part of the dialogue and discussions, understanding that there are opportunities for the creation and strengthening of networks and collaboration partnerships between businesses, academia, civil society and the government that would result in finding new development solutions, new market opportunities, new innovations and new funds to support ideas and projects. It should be noted, however, that adding more stakeholders from the government and academia in the future EDP would improve the structure of the workshops and reduce the potential bias caused by a high prevalence of stakeholders from the business helix. Additionally, the gaps mentioned in the stakeholder input need further attention and segments of the future EDP workshops should be dedicated to gathering some of the missing data.

The EDP is enabling their active participation in the creation of a forward-looking document. This will bring new innovation and growth opportunities for them, for the domain and for the region. They are jointly willing to discuss their potential (resources) and find solutions to facing the challenges of global competition, the green and digital transition of the economy and society as well as new challenges caused by the COVID-19 crisis. The key benefit is bringing together all relevant stakeholders in the development of a joint vision for growth and concrete measures and actions needed to reach the pre-defined goals.

The identification and involvement of the right representatives from businesses, academia, public institutions and civil society, who are willing to share their knowledge and ideas, remains a challenge. Another issue to be considered is how sufficient financial resources will be secured for the implementation of the defined priority actions after the EDP. At the same time, the restrictions to personal communication in this time of the COVID-

19 pandemic is identified as an additional challenge. This will impose on-line communication, and the need for very well-organised and focused meetings that will last only a few hours.

According to the information collected in the interview process, there are several recommendations for the EDP in order to adjust it to the needs and abilities of stakeholders:

- EDP workshops should be organised once per month and last half a day (not more than 2-3 hours);
- with regard to the invitation to participate in the meetings, the interviewed stakeholders have different expectations. Some prefer an unofficial invitation, while the others prefer formal invitation by the government institution. Such invitations can be sent by email;
- with regard to the preferential place of the EDP workshops, the majority of stakeholders prefer the workshops to be organised in Skopje, but some of them prefer to be outside of the capital city. The majority of interviewed parties expressed a readiness to participate in the workshops in different regions of North Macedonia;
- due to restrictions imposed as a result of the COVID-19 pandemic, most of the stakeholders would prefer on-line meetings;
- the discussions must be productive so the content and details regarding the method of work should be accurately prepared prior to the workshop, in dialogue with the stakeholders;
- the stakeholders are ready to send in-depth feedback from any workshop and they are ready to provide suggestions and comments in order to improve the efficiency of the workshops.

The RIS3 design can only be successful with a high level of stakeholder participation. The S3 Framework highlights the need for high standards of continuous and active stakeholder participation. Stakeholders should come from businesses, academia, the government and civil sector and need to engage in intensive constructive dialogue. To reduce the risk of potential failure in securing the required stakeholder participation, the process leading to stakeholder dialogue needs to provide crucial input for the EDP to be successful. This requires feedback on the following questions:

- What are the preliminary priority areas and their basic characteristics?
- Who are the relevant stakeholders in these areas?
- What are the preferences of the relevant stakeholders regarding the execution of the EDP?

The strengthening of promising priority domains justification should be considered in preparation for the EDP. In this regard, the following aspects divided per priority area should be taken into account.

1) Priority area – Sustainable food and beverage production and value chains

- Sub-area – Smart agriculture

  Insights into what the missing parts of the value chain are should additionally be provided. It should be analysed whether there are any international brokers and wholesalers that could be skipped or replaced by national wholesalers to retain more added value in the country.

- Sub-area – Food processing with high added value

  The desired future position in global value chain is provided; however, further insights into the current position should be provided. It should be also explained how companies from North Macedonia can compete with similar companies from the macro-region, but also at global level.

2) Priority area – Information and Communication Technologies (ICT)

- Sub-area – Custom software development

  The competitiveness at international and regional level should be further elaborated.

3) Priority area – Smart/Sustainable buildings and materials

- Sub-area – Smart/Sustainable building materials

  Insights into what the missing parts of the value chain are should additionally be provided. Insights into the specificities of the global market and trends in technologies and business models could also be provided.

4) Priority area – Electrical equipment & mechanical parts

- Sub-area: –Electrical equipment & mechanical parts

Insights into what the missing parts of the value chain are should additionally be provided. Insights into the specificities of the global market and trends in technologies and business models could also be provided.

A common need for all priority areas and sub-areas is that further efforts should be invested in elaborating on how companies from North Macedonia can compete with similar companies from the macro-region, but also at global level. Additionally, it is recommended that comparative strengths and specific niches with no or few competitors from the region are further highlighted.

## 5.4 Key topics to be discussed within the thematic EDP workshops

According to the S3 Framework, the EDP process should include a series of thematic workshops organised for each priority domain. No less than the following thematic workshops should be organised and attended by the required number of working group members:

- EDP kick-off,
- SWOT analysis,
- vision, and
- policy mix (objectives and actions with indicators).

In addition, organising the final EDP workshop is recommended, as it provides the opportunity for the RIS3 design team to get additional feedback from stakeholders on the main inputs for the future strategy document.

The EDP kick-off workshop is intended to officially announce the process of stakeholder dialogue, attract and motivate stakeholders and provide grounds for future collaboration between the priority domains. The main recommended actions are to present all priority domains, a clear value proposition for all types of stakeholders and to collect suggestions for cross-innovation initiatives. The SWOT analysis workshop is primarily intended to obtain stakeholders' input for the analysis of the current state-of-the-art of each priority domain and to further justify the selected domains. The key recommended actions for this type of workshop are to define strengths, weaknesses, opportunities and threats for priority (sub-)areas; enhance the definition of priority domains (justification and definition of sub-areas); discuss cross-innovation; and discuss COVID-19-related issues. With regard to the vision workshop, this is mainly intended to co-create a future vision of each priority domain, main strategic goals to reach the vision and to establish the final definition of priority domains. It should include the following actions: provide a joint vision statement of all stakeholders; define strategic goals that lead to the vision; provide a final definition of priority domains (justification and definition of sub-areas); elaborate on cross-innovation; and discuss COVID-19-related issues and organisation of the working group after the EDP is concluded. Finally, the policy mix workshop's purpose is to get stakeholder input on specific policy objectives that will support the achievement of strategic goals, the input on preferred policy action and indicators that will monitor the performance of the policy mix. The key recommended actions are to define SMART strategic objectives and specific policy objectives that lead to them, as well as defining policy actions with indicators.

The final (joint) workshop is intended to get additional feedback from stakeholders on the overall input for the RIS3 strategy document. It should include presenting stakeholder input and an action plan with next steps, and plans for the implementation of a continuous EDP, i.e. definition of activities of working groups after the EDP is concluded.

Additional recommendations that will facilitate the execution of EDP workshops include defining invitations, documentation, marketing and management protocols for the EDP; developing well-thought-out scenarios for every workshop in order to get the desired input from all stakeholders; and securing an adequate number of experienced and skilful facilitators.

## 5.5 Key stakeholders that should be invited to working groups during the EDP

Relevant stakeholders need to be identified for each priority domain. They include key players in value chains, innovative companies, cluster members, chambers of commerce and other business associations, researchers and organisations from related fields. They can be identified through desk research and interviews or a more objective network analysis of scientific and innovation cooperation. Another 'objective' network analysis of scientific and innovation cooperation that may help in identifying the stakeholders includes the analysis of recent R&I public calls within programmes launched by the Fund for Innovation and Technology Development, Horizon 2020 or OECD green vouchers.

Optimally, at least 40-50 stakeholders for each priority area should be identified and they should all meet the specific criteria to be considered relevant. They should possess in-depth knowledge of the sector, including knowledge about its position in the global value chain, competitiveness at global and regional level, trends, key actors and best-case examples of (open) innovation activities. Ideally, they should also demonstrate a proactive attitude and willingness to share ideas, have a good reputation in the community and an extensive personal network.

Past experience in the EU Enlargement and Neighbourhood Region emphasised the potential impact on the perception and behaviour of innovation ecosystem stakeholders by 'influencers'. Namely, there may be widely recognised individuals in different preliminary priority areas that better understand the S3 concept and are truly willing to participate in it. They are often willing to promote the S3 process and secure the participation of other stakeholders in the EDP, to provide substantial feedback on the design process and its content and to dedicate more resources for RIS3 implementation. It is important that the identification of these 'ambassadors' starts at the quality analysis stage, through qualitative analysis interviews. They should come from industry, academia and the government sector of all preliminary priority areas.

EDP working groups should be ideally composed of at least 30 stakeholders that all formally agreed to join. The composition of the working group should have the following structure:

a. managers of major companies and SMEs (at least 50% of stakeholders),

b. relevant researchers (no less than 10%),

c. government officials (no less than 10%),

d. civil organisations.

It is important to include at least 10% of stakeholders from academia and at least 10% from the government sector.

It is also important to have proactive stakeholders from the government sector on-board from the beginning of the process. The importance of their presence is usually underestimated, but their input is crucial for the development of a feasible S3 policy mix that can also be implemented later on.

## 5.6 Adequate promotion of the EDP to ensure stakeholder involvement

The RIS3 design process at the EDP stage should become fully visible; however, it is very important that it is not aggressively promoted. The main reason for this is because S3 is normally characterised as the consultative process among top stakeholders from industry and academia. As such, it becomes attractive to anyone who may see the EDP as an opportunity for individual promotion without actually contributing to the quality of the process. This continuous presence of such 'imposters' can hamper the participation of key stakeholders. Another reason is that the S3 is not a neutral policy; it is about prioritising and its promotion at the RIS3 design stage should therefore be focused on attracting and retaining key stakeholders.

A balanced communication campaign should be developed by professionals and should include some important elements, such as clearly defined objectives, defined target groups, communication channels, brand management, uniform messages and similar elements. Some of the key messages that have to be developed and used by all coordinators and facilitators in the process should answer important questions, such as: What is S3 and who is it for? What are the main benefits & expected engagement? What is the role of the government? Process ambassadors, web pages, targeted events and social media can serve as primary communication channels, while the content could include international testimonials and best practices from the EDP and video interviews from events.

## 5.7 Resources management

Resources needed to conduct the RIS3 design process according to the JRC framework are often underestimated. The process becomes increasingly resource-demanding at the quality analysis stage, where extensive expert support in different priority areas is needed. Only the preparation of the EDP process plan, organisation and implementation of the EDP workshops demands significant human and financial resources. However, a lack of resources for the RIS3 design can seriously hamper the quality and fluidity of the process. The EDP stage is very complex with a great number of activities. It is also lengthy and can be even further extended if insufficient resources are employed.

Human resources for EDP should normally include national S3 coordinators and an accompanying team, local expert team members, a local policy expert, a local analytical expert, facilitators, junior staff and a technical assistance expert. Service providers are also needed for professional planning and the execution of services that are not specific to the EDP but are essential for the quality execution of the EDP stage. These service providers should support the national S3 team in planning and executing a media campaign, event management and IT support.

# 6 Conclusions

The assessment of the conformity of the qualitative analysis process with the methodology showed that the process was carried out in a satisfactory manner. Deficiencies were identified, mainly in terms of comprehensive and uniform data collection and structured documentation of stakeholder input, as well as the use of additional data sources and referencing. However, this was also due to the fact that stakeholder input could not be obtained face-to-face due to the COVID-19 pandemic, and, perhaps more importantly, due to the lack of deeper knowledge of local stakeholders on the topics discussed during the interviews.

The results of the assessment of the justification of the promising priority domains indicate that there is currently enough evidence that four preliminary priority domains should be proposed for the EDP. These domains are: 1) Sustainable food and beverage production and value chains; 2) the Information and Communication Technologies (ICT) sector; 3) Smart/Sustainable buildings and materials; and 4) Electrical equipment and mechanical parts. It is strongly recommended that justification of these priority domains is further enhanced through the future EDP. There is insufficient data for justifying sustainable tourism and catering and energy for the future as vertical priority domains for the EDP, although it should be emphasised that additional data was lacking due to difficulties encountered during the data collection, as described in the previous paragraph.

The overall conclusion is that the COVID-19 pandemic did not have a critical impact on the four proposed priority domains for the EDP. Moreover, the pandemic is seen as a source of opportunities that can be exploited by those willing to adapt to new trends that will inevitably emerge on global markets. The continued process of designing RIS3 and the future EDP could be one of the primary catalysts that would facilitate this transformation.

The work conducted within the qualitative mapping exercise and its outputs provided a better understanding of the stakeholder network in the identified priority areas and sub-areas. This is one of the most critical sources for preparing for the upcoming stakeholder dialogue in the next stage of the Smart Specialisation process. As this stage features diverse arrangements and comprehensive interactions between stakeholders, this document presents very important suggestions and recommendations for conducting the EDP in an efficient manner. It should, however, be emphasised that more detailed recommendations will be developed as part of dedicated training on the EDP which is organised before the launch of the EDP, in accordance with the S3 Framework.

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## Annex

### Proposed list of stakeholders for the future entrepreneurial discovery process (EDP)

Below is the list of proposed stakeholders for the future entrepreneurial discovery process (EDP) in North Macedonia. The list is based on the information collected through the interview process, focus group meetings as well as consultations with external experts.

**Table 10**. List of key proposed stakeholders and process ambassadors for the EDP for the 'Smart agriculture and food processing with high added value' priority area

| No. | BUSINESS SECTOR | Ambassadors | Smart agriculture | Food processing with high added value | Cross-sectoral |
|---|---|---|---|---|---|
| 1. | MIK SVETI NIKOLE, Sveti Nikole | x | | x | |
| 2. | PIVARA AD, Skopje | | | x | |
| 3. | PEKABESKO, Skopje | x | | x | |
| 4. | BRILIJANT Shtip | | | x | |
| 5. | MLEKARA AD BITOLA , Bitola | x | | x | |
| 6. | KOZUVCANKA, Kavadarci | | | x | |
| 7. | FLOREO, Kavadarci | | | x | |
| 8. | LARS, Shtip | x | | x | |
| 9. | MAKPROGRES DOO, Vinica | x | | x | |
| 10. | VITAMINKA, Prilep | x | | x | |
| 11. | VEZE SHARRI, Tetovo | x | x | | |
| 12. | VITALIA, Skopje | | | x | |
| 13. | VIVAKS, Skopje | | | x | |
| 14. | EVROPA, Skopje | | | | |
| 15. | EKO OAZA SAMANDOV, Shtip | | x | | |
| 16. | OAZA ALKALOIDI, Shtip | | x | | |
| 17. | SWISSLION, Skopje | | | x | |
| 18. | SOLETA, Skopje | | | x | |
| 19. | MLEKARA ZDRAVJE RADOVO, Skopje | | | x | |
| 20. | KADINO INDUSTRY GROUP, Skopje | | | x | X |
| 21. | VV TIKVESH, Skopje | | | x | X |
| 22. | ZITOLUKS, Skopje | | | x | X |
| 23. | ZIK PELAGONIJA, Bitola | | x | | |
| No. | ACADEMIC SECTOR | Ambassadors | Smart agriculture | Food processing with high added value | Cross-sectoral |
| 24. | FACULTY OF VETERINARY MEDICINE, Skopje | x | | | X |
| 25. | FACULTY OF TECHNOLOGY AND METALLURGY, Skopje | x | | | X |
| 26. | FACULTY OF AGRICULTURAL SCIENCE AND FOOD, Skopje | x | | | |
| 27. | CENTER FOR TRANSFER OF TECHNOLOGY – UGD, Shtip | | | | X |
| No. | BUSINESS ASSOCIATIONS | Ambassadors | Smart agriculture | Food processing with high added value | Cross-sectoral |
| 28. | ASSOCIATION FOR AGRICULTURAL AND FOOD INDUSTRY, Skopje | x | | | X |

| No. | GOVERNMENT SECTOR | Ambassadors | Smart agriculture | Food processing with high added value | Cross-sectoral |
|---|---|---|---|---|---|
| 29. | CABINET OF THE PRIME MINISTER IN THE GOVERNMENT OF THE REPUBLIC OF NORTH MACEDONIA, Skopje | | | | X |
| 30. | MINISTRY OF AGRICULTURE, FORESTRY AND WATER ECONOMY, Skopje | x | | | X |
| 31. | FOOD AND VETERINARY AGENCY OF THE REPUBLIC OF NORTH MACEDONIA, STARTUP MACEDONIA, Skopje | | | | x |
| 32. | FUND FOR INNOVATION AND TECHNOLOGY DEVELOPMENT, Skopje | x | | | X |

*Source*: Authors.

**Table 11**. List of key proposed stakeholders and process ambassadors for the EDP for the 'Information and Communication Technologies (ICT)' priority area

| No. | BUSINESS SECTOR | Ambassadors | Custom software development | Cross-sectoral |
|---|---|---|---|---|
| 1. | MAKEDONSKI TELEKOM, Skopje | x | | x |
| 2. | A1 MACEDONIA, Skopje | | | x |
| 3. | INBOX, Skopje | | x | |
| 4. | KABTEL, Skopje | | | x |
| 5. | ULTRA & UNET GROUP, Skopje | x | x | |
| 6. | EDUSOFT DOO, Skopje | | x | |
| 7. | INTERWORKS, Kavadarci | x | x | |
| 8. | SEMOS, Skopje | x | x | |
| 9. | ELEVATE GLOBAL, Skopje | | x | |
| 10. | NEOTEL, Skopje | | x | |
| 11. | NEOCOM, Skopje | | x | |
| 12. | ASSECO SEE, Skopje | | x | |
| 13. | INPLAYER, Skopje | | x | |
| 14. | ELIKOSOFT, Skopje | | x | |
| 15. | PIKSEL, Skopje | | x | |
| 16. | SIMIT, Skopje | | x | |
| 17. | IT LABS, Skopje | | x | |
| 18. | NEXTSENSE, Skopje | x | x | |
| 19. | GIS DATA, Skopje | | x | |
| No. | ACADEMIC SECTOR | Ambassadors | Custom software development | Cross-sectoral |
| 20. | GOCE DELCHEV UNIVERSITY, FACULTY OF COMPUTER SCIENCE, Shtip | | x | x |
| 21. | CENTRE FOR TECHNOLOGY TRANSFER AND INNOVATION-INNOFEIT, Skopje | x | x | x |
| 22. | SS. CYRIL AND METHODIUS UNIVERSITY, FACULTY OF ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGIES, Skopje | x | x | x |
| 23. | FACULTY OF COMPUTER SCIENCE AND ENGINEERING, SS. CYRIL AND METHODIUS UNIVERSITY, Skopje | x | x | x |
| No. | BUSINESS ASSOCIATION | | | |

| | | | | |
|---|---|---|---|---|
| 24. | STARTUP MACEDONIA, Skopje | x | | x |
| 25. | MASIT ICT CHAMBER, Skopje | x | | x |
| No. | GOVERNMENT SECTOR | | | |
| 26. | CABINET OF THE PRIME MINISTER IN THE GOVERNMENT OF THE REPUBLIC OF NORTH MACEDONIA, Skopje | | | x |
| 27. | MINISTRY OF INFORMATION SOCIETY AND ADMINISTRATION | x | | x |
| 28. | FUND FOR INNOVATION AND TECHNOLOGY DEVELOPMENT, Skopje | x | | x |
| 29. | AGENCY FOR ELECTRONIC COMMUNICATIONS, Skopje | x | | x |

*Source*: Authors.

**Table 12**. List of key proposed stakeholders and process ambassadors for the EDP for the 'Smart/Sustainable buildings and materials' priority area

| No. | BUSINESS SECTOR | Ambassadors | Smart/Sustainable buildings and materials | Cross-sectoral |
|---|---|---|---|---|
| 1. | PIXEL GROUP, Skopje | x | | x |
| 2. | APTIVE, Skopje | | | |
| 3. | CAMEL SOLAR, Skopje | x | | x |
| 4. | MALI HIDRO ELEKTRANI – FERO INVEST, Skopje | | x | |
| 5. | VA PLAST, Ohrid | | x | |
| 6. | INGPLAST DOOEL, Ohrid | | x | |
| 7. | TETEPLAST, Skopje | | x | |
| 8. | TECHNICAL TEXTILES, Shtip | | x | |
| 9. | ARESE SOLUTIONS, Skopje | | | x |
| 10. | KEMET ELECTRONICS, Skopje | | X | |
| 11. | CEMENTARNICA USJE, Skopje | x | x | |
| 12. | TORAX, Skopje | x | x | |
| 13. | BIM AD SVETI NIKOLE, Sveti Nikole | x | x | |
| 14. | KNAUF RADIKA, Skopje | x | x | |
| 15. | BETON AD Skopje | | | x |
| 16. | VARDAR DOLOMIT, Gostivar | | x | |
| 17. | RENOVA, Tetovo | | x | |
| 18. | ADING, Skopje | x | x | |
| 19. | GD GRANIT AD Skopje | x | | x |
| No. | ACADEMIC SECTOR | Ambassadors | Smart/Sustainable buildings and materials | Cross-sectoral |
| 20. | CIVIL ENGINEERING INSTITUTE MACEDONIA JSC Skopje | x | | x |
| 21. | SS. CYRIL AND METHODIUS UNIVERSITY, FACULTY OF MECHANICAL ENGINEERING – Skopje | x | | x |
| 22. | SS. CYRIL AND METHODIUS UNIVERSITY, FACULTY OF CIVIL ENGINEERING, Skopje | x | | x |
| No. | GOVERNMENT SECTOR | Ambassadors | Smart/Sustainable buildings and materials | Cross-sectoral |
| 23. | MINISTRY OF TRANSPORT AND COMMUNICATIONS, Skopje | x | | x |
| 24. | ENERGY AND WATER SERVICES REGULATORY COMMISSION OF THE REPUBLIC OF NORTH MACEDONIA, Skopje | x | | x |

| | | | | |
|---|---|---|---|---|
| 25. | CABINET OF THE PRIME MINISTER IN THE GOVERNMENT OF THE REPUBLIC OF NORTH MACEDONIA, Skopje | | | |
| 26. | MINISTRY OF ECONOMY, Skopje | x | | x |
| 27. | FUND FOR INNOVATION AND TECHNOLOGY DEVELOPMENT, Skopje | x | | x |
| 28 | ENERGY AGENCY OF THE REPUBLIC OF NORTH MACEDONIA, Skopje | x | | x |
| No. | BUSINESS ASSOCIATIONS | Ambassadors | Smart/Sustainable buildings and materials | Cross-sectoral |
| 29. | MACEDONIAN ENERGY ASSOCIATION – Skopje | x | | X |
| 30. | MACEDONIAN SECTION OF THE INTERNATIONAL CENTRE FOR SUSTAINABLE DEVELOPMENT OF ENERGY, WATER AND ENVIRONMENT SYSTEMS (SDEWES), Skopje | x | | X |

*Source*: Authors.

**Table 13**. List of key proposed stakeholders and process ambassadors for the EDP for the 'Electrical equipment and machinery parts' priority area

| No. | BUSINESS SECTOR | Ambassadors | Metal & mechanical parts | Electrical equipment & automobile components | Cross-sectoral |
|---|---|---|---|---|---|
| 1. | RADE KONCAR SERVICE, Skopje | | | x | |
| 2. | RADE KONCAR TEP, Skopje | x | | x | X |
| 3. | FAKOM, Skopje | x | x | | |
| 4. | SMELT-ING, Skopje | | x | | |
| 5. | BRATSTVO INOX, Ohrid | | x | | |
| 6. | KOSTAL, Ohrid | x | | x | |
| 7. | TM SHTIP, Shtip | | | x | |
| 8. | AKTIVA, Shtip | x | x | | X |
| 9. | RADE KONCAR – KONTAKTORI AND RELEI, Skopje | x | | x | |
| 10. | ZAVAR COMPANY, Skopje | x | x | | |
| 11. | IGM TRADE, Kavadarci | x | x | | |
| 12. | LEOV COMPANY, Veles | | | x | |
| 13. | DINAMO HIT, Veles | | x | | |
| 14. | AGROBAR, Vinica | | x | | |
| 15. | BRAKO, Veles | x | x | | X |
| 16. | MIKROSAM, Prilep | x | x | | |
| 17. | MALI HIDRO ELEKTRANI – FERO INVEST, Skopje | | | | X |
| 18. | APTIVE, Skopje | | | x | |
| 19. | TECHNICAL TEXTILES, Shtip | | | x | |
| 20. | KEMET ELECTRONICS, Skopje | | | x | |
| 21. | ATOM SANTEX, Kochani | | | x | |
| 22. | PN METAL, Ohrid | | x | | |
| 23. | TAB MAK, Probistip | | | x | |

| No. | ACADEMIC SECTOR | Ambassadors | Metal & mechanical parts | Electrical equipment & automobile components | Cross-sectoral |
|---|---|---|---|---|---|
| 24. | GOCE DELCHEV UNIVERSITY, FACULTY OF MECHANICAL ENGINEERING, Shtip | | | | X |
| 25. | SS. CYRIL AND METHODIUS UNIVERSITY FACULTY OF MECHANICAL ENGINEERING, Skopje | x | | | X |
| No. | BUSINESS ASSOCIATIONS | Ambassadors | Metal & mechanical parts | Electrical equipment & automobile components | Cross-sectoral |
| 26. | MAMEI, Skopje | | | | X |
| 27. | STARTUP MACEDONIA, Skopje | x | | | X |
| No. | GOVERNMENT SECTOR | Ambassadors | Metal & mechanical parts | Electrical equipment & automobile components | Cross-sectoral |
| 28. | CABINET OF THE PRIME MINISTER IN THE GOVERNMENT OF THE REPUBLIC OF NORTH MACEDONIA, Skopje | | | | x |
| 29. | FUND FOR INNOVATION AND TECHNOLOGY DEVELOPMENT, Skopje | x | | | X |
| 30. | MINISTRY OF ECONOMY, Skopje | x | | | X |

*Source*: Authors.

**Table 14**. List of key proposed stakeholders and process ambassadors for the EDP for the 'Sustainable tourism and catering' potential priority area

| No. | BUSINESS SECTOR | Ambassadors | Sustainable tourism & catering | Cross-sectoral |
|---|---|---|---|---|
| 1. | MAKEDONIJA TURIST | x | x | |
| 2. | HOTEL AMBASSADOR M | | x | |
| 3. | TA FIBULA AND HOTEL IZGREV STRUGA | x | x | |
| 4. | TA SiMONIUM TRAVEL (INCOMING) | | x | |
| 5. | TA BALKAN PRIME (INCOMING) | | x | |
| 6. | HOTEL ALEKSANDAR PALACE | | x | |
| 7. | TOURIST GUIDE | x | | X |
| 8. | HOTEL ARKA | | x | |
| 9. | ENJOY BALKANS | | x | |
| 10. | HOTEL SIRIUS | x | x | |
| 11. | NEGORSKI BANJI | | x | |
| 12. | HOTEL STONE BRIDGE AND HILTON | | x | |
| 13. | MOUNTAIN EXPERIENCE LLC | | | X |
| 14. | AURORA RESORT AND SPA | x | x | |
| 15. | METROPOL OHRID | | x | |

| | | | | |
|---|---|---|---|---|
| 16. | AURORA SPA AND RESORT | | x | |
| 17. | SILEKS OHRID | | x | |
| 18. | MONTANA PALAS KRUSHEVO | | x | |
| 19. | ISTATOV DOJRAN | | x | |
| 20. | STOBI | | x | |
| 21. | BISTRA MAVROVO | x | x | |
| No. | ACADEMIC SECTOR | Ambassadors | Sustainable tourism & catering | Cross-sectoral |
| 22. | FACULTY OF TOURISM AND HOSPITALITY – OHRID | x | | X |
| 23. | FACULTY OF TOURISM AND BUSINESS LOGISTIC – SHTIP | | | X |
| 24. | FACULTY OF TOURISM AND BUSINESS – SKOPJE | | | X |
| No. | BUSINESS ASSOCIATIONS | Ambassadors | Sustainable tourism & catering | Cross-sectoral |
| 25. | ASSOCIATION OF TOURISM AND HOSPITALITY – SKOPJE | x | | X |
| 26. | ASSOCIATION OF HOTELS – HOTAM | | | X |
| 27. | CHAMBER OF COMMERCE FOR TOURISM – SKOPJE | | | X |
| 28. | NATIONAL ASSOCIATION FOR INCOMING TOURISM IN MACEDONIA – NAITM | x | | x |
| No. | GOVERNMENT SECTOR | Ambassadors | Sustainable tourism & catering | Cross-sectoral |
| 29. | AGENCY FOR PROMOTION AND SUPPORT OF TOURISM | x | | X |
| 30. | MINISTRY OF ECONOMY | | | X |

*Source*: Authors.

## List of abbreviations and definitions

| | |
|---|---|
| AAGR | Average annual growth rate |
| AI | Artificial intelligence |
| BA | Business analytics |
| CEFTA | Central European Free Trade Agreement |
| CSD | Custom software development |
| ECNM | Economic Chamber of North Macedonia |
| EDP | Entrepreneurial discovery process |
| FITD | Fund for Innovation and Technological Development |
| FTE | Full-time equivalent |
| GDP | Gross domestic product |
| GERD | Gross domestic expenditure on research and development |
| GI | Geographic indication |
| GVA | Gross value added |
| H2020 | Horizon 2020 |
| ICT | Information and Communication Technologies |
| IM | Information management |
| IoT | Internet of Things |
| IPO | Intellectual Property Office |
| KET | Key enabling technologies |
| LFS | Labour Force Survey |
| LQ | Location quotient |
| MICE | Meetings, incentives, conferences, exhibitions |
| NACE | French Nomenclature statistique des activités économiques dans la Communauté européenne (Statistical classification of economic activities in the European Community) |
| NGO | Non-governmental organisation |
| NUTS | Nomenclature of Territorial Units for Statistics |
| OEM | Original equipment manufacturer |
| PGPB | Plant growth-promoting bacteria |
| PoC | Proof of concept |
| R&D | Research and development |
| R&I | Research and innovation |
| RCA | Revealed comparative advantage |
| RIS3 | Research and innovation strategy for Smart Specialisation |
| S3 | Smart Specialisation |
| SBS | Structural business statistics |
| SMEs | Small and medium enterprises |
| VR | Virtual reality |
| WoS | Web of Science |

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