

Empowering Croatian Innovation: The Role of EU Financial Support in Shaping the Technology Sector

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University of Zagreb
Faculty of Political Science
Master of European Studies

Master thesis

**Empowering Croatian Innovation: The Role of EU Financial Support in
Shaping the Technology Sector**

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Zagreb, September 2024

Statement on the authorship

I declare that the master thesis " Empowering Croatian Innovation: The Role of EU Financial Support in Shaping the Technology Sector", which I have submitted to my mentor, PhD, Professor Igor Vidačak, is in compliance with ethical rules in academic work. I wrote master thesis independently and it is entirely my authorship. Additionally, I declare that the paper in question was not published or used for the purposes of fulfilling teaching obligations at this or any other university, and that I did not acquire ECTS points based on it.

Furthermore, I declare that I have respected the ethical rules of scientific and academic work, particularly Article 16-19 of the Code of Ethics of the University of Zagreb.

Mihaela Jacmenović

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LIST OF ABBREVIATIONS

AMEUP – Agency for Mobility and EU Programs

BICRO – Business Innovation Centre of Croatia

CRODIS – Croatian Documentation and Information System

DESI – Digital Economy and Society Index

DZRNS – State Institute for Radiological and Nuclear Safety

ERC – European Research Council

EU – European Union

EUR – Euro (currency)

FP – Framework Program

H2020 – Horizon 2020

HAMAG-BICRO – Croatian Agency for Small Business Innovation and Investments

HRK – Croatian Kuna (currency)

IT – Information Technology

MSCA – Marie Skłodowska-Curie Actions

NCP – National Contact Points

NGEU – Next Generation EU

NIC – National Innovation Council

R & I – Research and Innovation

TFEU - Treaty on Functioning of European Union

INTRODUCTION

The thesis investigates the impact of European Union funds on the technological sector in Croatia, focusing on how these funds influence sectoral development and innovation. Technological development, which also includes innovation processes, is a prerequisite for the development of the economy of the Member States, but also of the EU as a whole given its “..ability to drive growth, to create up to 320,000 new highly skilled jobs by 2040 and to leverage... additional investments...”, the R&I policy is an engine of the green and digital transitions on the continent” (European Commission, 2020, 4). Moreover, after the financial crisis that swept the world in 2008 “...R&D, innovation, and knowledge creation capacity started to be seen as crucial productivity sources...” (Čučković, Vučković, 2018, 98) in which an answer to the emerging crisis should be sought.

Before joining the EU, Croatia used various financial instruments of the Union which influenced the development and structure of the technological sector in the country. After becoming a full member of the EU, the possibility of using various funds as well as in participating in programs expanded and “the European Framework Programs...were able to provide stability and growth, both in terms of funding as well as in terms of a political message that placed a high priority on science and technology” (Veugelers, Cincera, 2015, 10). For this paper, we will define the technology sector as a sector that gathers the activities of research, development, management of information systems, and “...covers all technical means used to handle information and aid communication. This includes both computer and network hardware, as well as their software” (Eurostat, 2024).

Development of the technological sector is woven through the main priorities of the EU and is inextricably linked to economic progress, global positioning, as well as climate change and security – all of which are high priority areas in von der Leyen Commission. The EU wants to become an Innovative union where businesses thrive, good ideas move into real undertakings, and citizens are protected from various threats such as climate change. The development of a green, digital economy with the technology sector at the center is imperative and aims to steer greater investments in areas such as microelectronics, quantum computing and AI, biotech and cleantech. Over the years, the EU has redefined its approach to financing innovation and the technological industry, starting in the 70s with low-funded first Community research programs which culminated into

Horizon EUROPE, the Union's latest scientific and research initiative accompanied by numerous programs and other funding tools such as Innovation Fund.

Since joining the EU in 2013, Croatia has been faced with the challenge of positioning own national policies while respecting the high EU standards and while simultaneously addressing the economic and structural problems rooted in the very founding of the state. The use of EU financial programs and initiatives, such as Horizon, has been essential in supporting transition of Croatian technological sector and climate surrounding it, opening it up for cross-border cooperation and providing valuable financial support to Croatian scientists. The importance of such financial frameworks is irreplaceable, especially for small Member States like Croatia, while they enable higher financial resources for proliferation of innovation and infrastructure development as well as building and boosting much needed intersectoral cooperation. Faced with European norms, Croatia was responsible for creating appropriate plans and strategies in this field, something prior to which there was no will or ambition among political elites. Through continuous participation in EU programs that began even before joining the EU through pre-accession assistance, EU funds as well as normative pressure in setting requirements and standards have played a pivotal role in stimulating this modernization, particularly in the technology sector which is considered as a key sector for economic growth and security.

The thesis is structured into nine interconnected chapters. It begins with an overview of the research question and methodology. This is followed by the review of literature to provide a wider background for the research in this thesis. The new European Agenda chapter clarifies the legal basis for the Union's action and explores forms of financing innovation including the Innovation Fund and the Digital Europe Program. This is followed by the evolution of the state of the technology sector in Croatia before entry into the EU, the role the of pre-accession EU funds in Croatia before it became a Member State and followed by analysis of the current state of the technology sector in Croatia. This was done using qualitative and quantitative indicators complemented with analysis of development of the national system of management of the technology sector and innovations, including the overview of relevant Croatian and European strategies, along with observed obstacles for growth. The next chapter is dedicated to HORIZON 2020 Framework Program, Croatia's participation in H2020 and the effects on the technology sector. After that, the analysis of the successor of Horizon 2020, Horizon Europe, is conducted. As

the latest and current platform for financing projects closely related to the topic of this work, the structure of the Horizon Europe program is elaborated, along with the main goals and organization, as well as an overview of its current implementation in Croatia. Finally, the Conclusion summarizes the entire work and highlights the identified problems and key findings.

By examining how EU funds have influenced the development of Croatia's technology sector, this study aims to contribute to new insights on the effectiveness of EU financial support in facilitating structural reforms and fostering innovation in a transitional economy. In that context, this thesis may also contribute to understanding the broader practical and theoretical implications of EU cohesion policies but also offer valuable lessons for other newer EU member and candidate countries navigating similar challenges.

METHODOLOGICAL FRAMEWORK AND RESEARCH

Research question

The forthcoming thesis will try to answer the question on how have specific EU financing frameworks influenced the technological landscape in Croatian technology sector and what are the key challenges and opportunities that affect the effectiveness of these frameworks. This is a question of great importance since many national and European officials often refer precisely to the effectiveness of EU funds and their benefits for Member States, therefore this paper takes a specific sector (technological) and looks at the concrete effects of EU funds in that sector of one national state – Croatia.

Methodology

The research methodology for this thesis will primarily rely on the comprehensive analysis of secondary data to investigate the impact of EU financial instruments on Croatia's technology sector.

This approach is suitable given the extensive availability of relevant data from credible sources, which will allow for a thorough examination of the research question. Secondary data will be

obtained from a variety of sources, including relevant academic literature, official reports, and publications from both Croatian and EU institutions. Specifically, European and national academic articles will provide theoretical and empirical insights into the role of EU funds in economic development and innovation. Additionally, reports from the European Commission, Croatian government agencies, and other relevant bodies will be analyzed to understand the implementation and outcomes of EU financial instruments in Croatia. Statistical data will be sourced from official databases such as Eurostat and the Croatian Bureau of Statistics, which will offer quantitative insights into the technological advancements and economic indicators relevant to the study. The data collected will be analyzed using several analytical techniques to ensure a comprehensive understanding of the topic. Trend analysis will be employed to track changes in key indicators over time, such as the growth of the technology sector, the utilization of EU funds, and their impact on innovation metrics in Croatia. This will help identify patterns and assess the effectiveness of these financial instruments in fostering technological development.

Comparative analysis will be used to evaluate Croatia's performance relative to other EU Member States, particularly those with similar economic backgrounds or those that joined the EU around the same time. This method will help contextualize Croatia's progress and highlight any unique challenges or successes.

Additionally, content analysis of policy documents, strategic plans, and legal frameworks will be conducted to understand the alignment between EU policies and national strategies in Croatia. This will involve a detailed examination of how these documents frame the objectives of financial instruments and their intended impact on the technology sector.

The chosen methodology is appropriate for answering the research question as it allows for a comprehensive and multi-faceted exploration of the topic. By combining quantitative trend and comparative analyses with qualitative content analysis, the research is expected to provide a well-rounded perspective on the impact of EU financial support on Croatia's technology sector. This mixed-methods approach ensures that the research findings are reliable and can have relevant theoretical and practical implications.

BACKGROUND AND LITERATURE REVIEW

The intersection of the EU financial support and the technological sector in new EU Member States, and particularly Croatia, has been the subject of growing academic interest, but still widely under-researched particularly in the context of the post-accession developments. This literature review critically examines the existing body of knowledge, focusing on three key areas: the impact of EU funding on national innovation systems, the role of EU financial instruments in supporting technological advancements, and the specific challenges faced by new EU Member States like Croatia in leveraging these resources.

The European Union's commitment to fostering innovation across Member States is well-documented, with various financial instruments aimed at enhancing research and development capabilities. Series of authors emphasize that EU funding, particularly through frameworks like Horizon 2020, has been pivotal in driving innovation within less-developed Member States (Jurlin, Samardžija, Sertić, 2019; Čučković, Vučković, 2018; Moagar-Poladian et al., 2018). These funds are essential for bolstering national innovation systems and integrating these systems into the broader European Research Area (ERA). Radosevic (2017) argues that the effectiveness of these funds often hinges on the recipient country's pre-existing institutional frameworks and its ability to absorb and utilize the funding efficiently.

In the Croatian context, the literature highlights a transitional phase where the country's innovation infrastructure had to adapt rapidly to meet EU standards. Andrijević Matovac (2003), Švarc and Dabić (2019) provide a historical overview of Croatia's transition from socialism to European membership, emphasizing the role of technology transfer policies. They argue that while EU membership opened new avenues for technological advancement, the legacy of socialist-era policies presented unique challenges in aligning Croatia's innovation system with EU norms. The country's technological sector, initially characterized by fragmentation and limited cross-sectoral collaboration, faced significant challenges in maximizing the benefits of EU funding. However, after Croatia joined the EU, there has been a noticeable shift towards greater alignment with EU norms, evidenced by increased participation in EU-funded projects and a more structured approach to innovation policy (Jurlin, Samardžija, Sertić, 2019).

Numerous studies, including those by Veugelers et al (2015), demonstrate that Horizon 2020 has significantly contributed to technological advancements in newer Member States by facilitating access to cutting-edge research and fostering international collaboration. For Croatia, participation in Horizon 2020 has provided critical financial resources and helped build networks with more advanced EU economies, accelerating technology transfer and innovation diffusion. Čučković and Vučković (2018) explore the specific impact of EU R&D funding on the innovation activities of small and medium-sized enterprises (SMEs). Their study reveals that while EU funding has been instrumental in incentivizing innovation, the overall impact has been uneven, largely due to varying levels of administrative capacity and differences in regional development.

Rešetar, Rešetar, and Grba (2023) further investigate the utilization of European Structural and Investment (ESI) funds in Croatia for developing high-tech projects. Their findings suggest that while ESI funds have significantly supported the growth of Croatia's high-tech sector, challenges such as bureaucratic inefficiencies and a lack of coordination between national and EU policies have limited the full potential of these investments. These findings align with broader observations in the literature that emphasize the need for greater synergy between national innovation strategies and EU funding mechanisms.

Overall, the existing literature reviewed underscores the dual role of EU financial support in both shaping national innovation systems and facilitating technological advancement. For Croatia, the transition from pre-accession assistance to full participation in EU frameworks like Horizon 2020 has been a significant step forward. However, the country's experience also highlights the importance of national policy alignment, institutional readiness, and capacity building in maximizing the benefits of EU funding. There is a need for ongoing research to monitor the long-term impacts of EU financial support on the technological sector in Croatia, particularly as new frameworks like Horizon Europe come into play.

EUROPEAN AGENDA

The legal basis for the Union's action

The EU's legal foundation consists of 2 unanimously agreed Treaties - the Treaty on European Union and the Treaty on the Functioning of the European Union. Within them, the competences of

the Union are defined and are most often categorized as exclusive, shared and supporting competences. According to Article 4 of the Treaty on Functioning of European Union (TFEU), Research, Technological Development and Space belong to the sphere of shared competences, meaning “the EU and its Member States are able to legislate and adopt legally binding acts. Member States exercise their own competence where the EU does not exercise, or has decided not to exercise, its own competence” (EUR-lex, 2022,). To be more concrete, article 4(3) further clarifies tasks in this area. Sufficient for understanding the content of this paper is that “the Union invests in research and innovation to address emerging challenges...to strengthen the Union's scientific excellence, to create cross-border, multidisciplinary networks, to reinforce human capital and the structure of national research and innovation systems” (European Commission, 2020, 7).

For financing the development of the technological sector in the Member States, the European Union has various funds and initiatives intended for the development and growth of aforementioned sector. The following chapters provides an overview of EU instruments in the area - European Structural and Investment Funds, the Digital Europe Program, the European Year of Skills and the Innovation Fund, including analyses of Croatian participation, if possible. Research framework programs (Horizon 2020, Horizon Europe) will be analyzed in detail in subsequent chapters.

EU Funds & Digital Decade

In order to encourage additional investments in R&D and further strengthen the digital transition, the EU ensures various financial instruments such as grants, loans and guarantees for financing projects in the Union. In general, these funded projects “...must be in line with the five main strategic objectives of the EU: Employment increase; Increasing investment in research and innovation; Mitigating climate change, reducing Carbon dioxide (CO₂) emissions and increasing energy efficiency; Better education; Fight against poverty” (Rešetar, Rešetar, Grba, 2023, 1). One of those financial instruments available to Member States are European Structural and Investment Funds (ESI funds) which “...consist of: Cohesion Fund; European Regional Development Fund; European Social Fund; European Agricultural Fund for Rural Development; European Maritime, Fisheries and Aquaculture Fund” (Rešetar, Rešetar, Grba, 2023, 2).

In terms of Croatian utilization of funds within the Operational Programs in the previous financial period 2014 - 2020 “...a total of 78% of the allocation under the Program was contracted with applicants from Croatia, but only 37% of the funds were paid out in the end. Within the Operational Program (OP) of Competitiveness and Cohesion, 81% of the allocated funds were contracted (total allocation), and only 30% were paid, while within the Operational Program (OP) of Effective Human Resources, 71% of the funds were contracted, and 45% were paid. Within the Rural Development Program, 75% of the allocated funds were contracted and 57% were paid, while within the Operational Program (OP) for Maritime Affairs and Fisheries, 52% of the funds were contracted and 50% were paid.” (Rešetar, Rešetar, Grba, 2023, 4). Reasons for such disparities can be found in challenges such as complicated bureaucratic procedures which domestic actors largely do not understand but also in a lack of coordination between national and EU policies, where domestic policies differentiate during implementation. This data confirms generally accepted presumption that, “in many Eastern countries, the absorptive capacity of EU competitive R&I funding remains much below the budgeted destinations approved by the European Commission (EC) through the multi-annual framework programs” (Moagăr-Poladian, 2018, 151).

In the current multi-annual financial framework 2021-2027, in order to further strengthen the development of the technological sector and innovation, EU also offers specific funding under Horizon, the Digital Europe Program, Creative Europe, Connecting Europe Facility and Innovation Fund. This is all a part of the larger policy area - Digital Decade - ambitious vision shaping the digital transformation of EU by encouraging digitalization in e-services, business and infrastructure.

Connecting Europe Facility is an EU financial instrument established for investments in the construction of new and improvement of existing infrastructure in fields of transport, telecommunications and energy. It works in synergy with the existing Structural and Cohesion Funds in order to create high-performance and environmentally sustainable networks. It consists of 3 different instruments: CEF Energy, CEF Transport and CEF Digital. As a part of Europe’s digital transformation, CEF Digital has the following goals: developing high-capacity networks and upgrading existing ones, ensuring uninterrupted coverage with 5G systems, implementing and supporting digital connectivity infrastructure while providing grants in areas such as Operational Digital Platforms, 5G and Edge Cloud for Smart Communities and Quantum communication

infrastructure (European Commission, 2024). The Creative Europe program is a EUR 2.5 billion worth funding program for providing support to the cultural and media projects (European Commission, 2024). It aims to boost economic potential while fostering cultural diversity in the European Union.

An innovation in multi-annual financial framework 2021-2027 are the Next Generation EU funds, where the longstanding tradition of balanced budget in the EU was abolished when Commission began borrowing from financial market. The centerpiece of NGEU funds is Recovery and Resilience facility with an aim to boost economic recovery caused by COVID pandemic and foster a green and digital transition with, “under its umbrella, more than EUR 720 billion made available to Member States for investments in the form of loans and grants” (Korner, 2023, 2). In Croatia, as in any other Member State, the rule of dedicating minimum 20% of the total allocation of funds to digital objectives is applied and “...amounts EUR 1.3 billion (i.e. 20%) devoted to the digital transformation in line with the Digital Decade Targets” (European Commission, 2023, 2). Croatia has so far achieved progress in the areas of the digitalization of government and public administration services aimed at business sector, digital transformation of agriculture, digitalization of the energy renovation process and legislature aimed at addressing regulatory and administrative burdens (European Commission, 2023, 2).

The Digital Europe Program is a Union funding program which provides strategic funding in areas such as cybersecurity, AI, supercomputing, semiconductors and promoting wider use of digital technologies inside of the EU. Its goal is to bring digital technologies to companies, citizens and public administrations in the Union and Member States. To foster industrial competitiveness, the Union aims to eliminate barriers and further promote projects to compete with global actors, like China and USA. For the implementation of Digital Europe Program, more than EUR 8 billion is intended for 2021-2027 period (European Commission, 2024). As for the results, data from 2023 shows that 27 National Cybersecurity Coordination Centers were established improving connectivity and cross-border networking, more than 2 and a half thousand EU students are in short-term training courses or doing digital master’s programs, 4 specialized and large-scale testing and experimentation facilities for artificial intelligence as well as 150 digital innovation hubs across Europe were established (European Commission, 2024). Another achievement is the pilot project - the European Digital Identity Wallet - where around 250 public authorities and private entities

got to use digital services like e-prescriptions, driving licenses and identification, credentials and access to various public services (European Commission, 2024). It complements financial resources available under other EU programs, for example with the already mentioned Recovery and Resilience Mechanism and the Structural and Investment Funds.

Croatia in Digital Europe Program

In Croatia, Central State Office for the Development of the Digital Society is the body responsible for the Union Program, and Ministry of Economy and Sustainable Development is involved in the implementation of this Union Program.

According to EUs Digital Dashboard tool, Croatian projects have ensured total cost of almost EUR 40 million so far, amounting to 1,43% of total Union projects. However, total cost under Digital Dashboard tool encompasses total worth of projects with no distinction between EU and other funding. As for strictly EU funding under Digital Europe Program, Croatia has been allocated 1.34% of the total budget for this program period so far, which amounts to slightly less than EUR 20 million (Digital Dashboard, 2024).

Since 2021, when the project funding started, 21 grants were signed (number also accounts for suspended/terminated or closed grants) with a 45,45% success rate, which is significantly higher than success rate in Croatian Horizon projects (Digital Dashboard, 2024). So far, Croatia accounts for 82 participants, which is 1.6% of the total, with the most prominent organizations being Private for-profit entities (40.6%), followed by Research organizations (21.8%) and Higher and Secondary Education Establishments (20.7%). The organization with the largest number of applications is the Ruđer Bošković Institute with 6 applications, while the Faculty of Electronics and Computing and the University Computing Center of the University of Zagreb have 3 applications each with Erste&Steiermarkische bank being the institution that drew the largest funds within the scope of this program - EUR 2.76 million (Digital Dashboard, 2024). In terms of regional fragmentation, the city of Zagreb is far ahead, both in terms of participation and the amount of funds. In the Digital Europe Program, in terms of cross-border cooperation, Croatia cooperated with Italy, Belgium, France and Greece so far. As for the participation of small and medium-sized enterprises in this program, there are currently 9 of them in Croatia (which is only 0.18% of the total Croatian

participation), each of them having only one application. In terms of the amount of EU funds provided, Magdalena clinic for cardiovascular diseases of the Faculty of Medicine in Osijek stands out with EUR 304 thousand (Digital Dashboard, 2024).

European Year of Skills

Every year, European bodies conduct a form of awareness campaign which highlights a certain issue important for European policymakers. In the first half of 2023, the European Year of Skills officially began. Intending to stir up debate and cross-border cooperation “essential to help people develop the right skills for quality jobs and help companies, in particular small and medium enterprises (SMEs), to address labor shortages in the EU” (European Commission, 2023, 1). Addressing the problem of skill shortages falls under the scope of EU policy framework aimed at responding to the problems of digital and green transition, increasing the competitiveness of European companies, innovation and research. It also compliments reaching 2030 EU social targets of at least 60% of adults in training every year and 78% in employment, as well as 2030 Digital Compass goal of at least 80% of adults with basic digital skills (European Commission, 2024). Activities of European Year of Skills were conducted as conferences, projects, workshops and trainings and involved European bodies and many actors in Member States such as companies, chambers of commerce and industry, social partners, employment services, education and training providers aimed at workers, adults and young Europeans. More than 2000 events were held across Europe with 190 EU led initiatives addressing skills related issues with the financial support for investment in skills of EUR 65 billion in funds from the European Social Fund+ and the Recovery and Resilience Facility in financial period 2021 – 2027 (European Union, 2024).

Innovation Fund

Another European fund available to Member States starting from 2020 is the Innovation Fund which is being financed through revenues of EU Emissions Trading System (ETS), novelty monetization to EU budget through carbon emissions trading scheme. With a budget of estimated

EUR 40 billion until 2030 it aims to boost economic growth and create new jobs while helping companies to improve and increase investments in innovative technologies in clean energy (European Commission, 2024). Regarding regulation on the EU level, European Climate, Infrastructure and Environment Executive Agency is the central body for proposals, monitoring, submissions, evaluation and grant allocation. Usually, calls are opened each year and “the Innovation Fund awards grants through calls for proposals and competitive bidding procedures (auctions)” (European Commission, 2024) while the fund finances up to 60% of the relevant costs with a possibility of distribution up to 40% even before the whole project is fully running. In addition to the Member States, participation is also open to Iceland, Norway, and Liechtenstein.

According to Innovation Fund Dashboard, EUR 6.7 billion has been allocated through 124 projects in the EU, with an average of more than EUR 54 million per project. The biggest number of projects so far was in the hydrogen sector, followed by manufacturing components for production of renewable energy and cement and lime. The biggest participation and the highest financial contributions were granted to Sweden (EUR 967.5 million) and Germany (EUR 1.07 billion), while the lowest financial contribution and participation is evident in Bulgaria, Czech Republic and Portugal (Innovation Fund Dashboard, 2024).

In Croatia, Ministry of Environmental Protection and Green Transition is the central national coordinating body. Croatia has participated with 3 projects under Innovation Fund. Those 3 projects are beneficiaries of almost EUR 126 million, adding up to 1.87% of total EU distribution under this fund, with a project being worth EUR 42 million at average. Key areas covered under aforementioned projects are cement and lime (carbon capture and storage), geothermal (closed-loop geothermal power plant) and solar energy (solar heat plant and storage facility for the malt industry). Croatia has 4 participants through 3 small-scale and 1 large scale projects (Innovation Fund Dashboard, 2024).

EVOLUTION AND THE CURRENT STATE OF THE TECHNOLOGY SECTOR IN CROATIA

Development of Croatian Technology Sector

Within ex-Yugoslavia, Croatia was second most developed out of 6 republics and had quite a growth in a period after the Second World War “..when large industrial corporations were extended or founded, such as Podravka (food), Pliva (pharmacy), Rade Končar (electrical equipment), RIZ (electronics), Nikola Tesla (telecommunications), and Đuro Đaković (machinery), to mention only a few” (Švarc, Dabić, 2019, 1481). However, the first years of Croatian independence represented major turning points for the Republic of Croatia: for the first time in modern history, it became an independent country, and as a result, it was about to transition from a socialist economy to a market economy and everything it encompasses. In post-socialist countries, inextricably linked with their recent socialist history, the differences that divided East and West were visible, meaning that “innovation in the East was not spontaneously driven by the interest of stakeholders, but was centrally coordinated by the state, limiting the mutual co-evolution of industry and science in creating technical change...this considerably reduced the willingness of companies and research institutes to respond to market incentives through innovation and marketable research” (Švarc, Dabić, 2019, 1481).

At that time, part of Croatian political elites advocated the transition to a capitalist system, and a market economy at any cost, so conversion and privatization were carried out quite recklessly and without grandiose supervision in the context of the Homeland war for independence. All these contextual events negatively affected many areas in the newly created country, especially the economic sector, given that “the future development of all contemporary economies, including those in post-socialist countries, is highly dependent on their capacity to generate and exploit various types of innovation and their ability to transfer knowledge and new technologies from the scientific sphere to production, and vice versa” (Švarc, Dabić, 2019, 1477). In this part of the thesis, the development and characteristics of the technological sector in Croatia will be reviewed, considering all the mentioned above.

The first phase in this chronological review begins in 1991, the year Croatia declared independence and was marked by a struggle for power between different groups of elites. In a newly independent state government was "...very slow in adapting to the new technological regime and have demonstrated very low level of the social assimilation of the changes in global economy and the related changes in growth management" (Švarc, 2004, 380). Consequently, there was no great progress in the technological field, which is understandable since in that period Homeland war for independence was the priority of the ruling elites. This period was also marked by the processes that in her article Švarc calls re-traditionalization, de-industrialization and de-scientization.

Re-traditionalization represents a return to old, traditional values, de-industrialization is term for a process of privatization which was done recklessly, "...meaning that the tycoons and corrupted managers suck out the company's substance... and regularly ended in the devastation of company's fixed assets, competences in technology, skills and market competitiveness" (Švarc, 2004, 385). It is precisely because of de-industrialization that "R&D has undergone serious deterioration, corresponding with low levels of absorption capacity in firms in terms of research and technology transfer" (Švarc, Dabić, 2019, 1483). Most devastating effect in terms of Croatian R&D landscape was ignited "during the process of the privatization of state-owned companies, many leading technological companies (with 50 years of accumulated knowledge and technological competences) collapsed or were absorbed by foreign companies" (Švarc, Dabić, 2019, 1483). Third process is de-scientization which is marked by "marginalization of science by both the political and business elites that have induced the climate of anti-intellectualism and anti-academism" (Švarc, 2004, 385) resulting in high migration of skilled workers, low financial support and low productivity in technology and science sector. This was a common experience for European post-socialist countries. However, in cases such as Slovenia and Poland these processes "...were mitigated by the countries' membership in the EU and through their integration into the European techno-economic network. Unlike these countries, Croatia was disabled by this process due to Homeland war and the subsequent isolation of the European integration process until 2013" (Švarc, Dabić, 2019, 1483).

With the end of the war in Croatia, the government aimed to transfer the "recipe" of Western countries to the Croatian system regarding "science/industry cooperation and financial support to innovative small and medium-sized enterprises" (Švarc, Dabić, 2019, 1484) which marked the

beginning of Croatian innovation and development strategy. In this period great achievements were made while “Croatia laid the foundations for new state institutions, exchanged its single-party system for parliamentary democracy, created its own new currency, repaired large-scale homeland war damages, and initiated reforms for its transition to a market economy” (Švarc, Dabić, 2019, 1483). Also, in this period, the opening to international cooperation is noticeable. For example, the international conference "Technology parks: European experience for Croatian development" was held in Croatia which brought together many national and international scientists. It represented a symbolic step in the opening of cross-border cooperation between Croatia and other countries. Moreover, “technical assistance projects with Germany and Italy provided necessary expert knowledge for the modernization of Croatia’s technological policies and technology transfer” (Švarc, Dabić, 2019, 1484). An important strategic document was adopted during this time - National scientific and research program for the period between 1996 and 1998. Besides setting up general guidelines for public policy, “program was oriented towards setting up of the national network of institutions for the development, transfer, implementation and financing of new technologies” (Švarc, 2004, 389). This is a major turning point as it marked the first step towards national innovation system because “enterprise efficiency in creating knowledge and technology is at the highest level in countries that have successful national innovation systems” (Andrijević-Matovac, 2003, 199). Another National Science and Research program was delivered in 1999 which recognized the importance of cooperation between university education, research and private institutions and is intended to further provide initiatives to create national technology centers which were envisioned to be “intermediaries between universities and industry as well as institutions that were to assist the companies in their start-up and expansion phases” (Švarc, 2004, 389). Innovation centers were established in Zagreb, Rijeka, Split, Dubrovnik and Osijek.

Business Innovation Centre of Croatia (BICRO) was created, in large thanks to cooperation with Italy. BICRO was envisioned as the “the pillar institution of the whole innovation system, with a mission to create financial models and instruments to support innovative or research-based entrepreneurship and allow for possible evolution into the national development agency” (Švarc, Dabić, 2019, 1484). However, after a series of failed attempts to revive and exploit the potential BICRO merged with the Croatian Agency for Small Business, Innovation, and Investment (HAMAG) in 2014.

The turning point and beginning of the second stage is marked by launch of HITRA in 2001 - Croatian Program for Innovative Technological Development, finally assimilating scientific and IT sector policies into one area. HITRA was a “first nationwide government program in innovation policy-making” (Švarc, Dabić, 2019, 1485) and consisted “... of two sub-programs which are complementary in their goals and purpose: Technology projects – TEST and Knowledge-based companies – RAZUM (PRUDENCE)” (Andrijević-Matovac, 2003, 200). It was launched by a newly elected left-wing government at that time with an ambitious aim of boosting R&D activity in Croatia as well as encouraging and improving science-industry cooperation and commercialization with a goal of boosting market competitiveness. However, many obstacles became apparent over time regarding “lack of “systemic” innovation policy...” where “...many projects are obstructed by the deficiencies of the remaining parts of the innovation system, which are beyond the sphere of research and beyond the scope of HITRA itself...for example the lack of a sound policy concerning intellectual property protection, lack of venture and risk capital, absorption capacities of companies, etc.” (Švarc, Dabić, 2019, 1485). Another important step in development of integration of science and technology sectors was made by creation of Ministry for Crafts and Small and Medium Businesses which was entrusted with the task of increasing competitiveness in the mentioned sectors, deepening cooperation and investments, as well as other tasks related to small and medium businesses in Croatia. Mentioned newly established Ministry was given a role in innovation policy by “fostering entrepreneurship culture and upgrading technology capabilities... a range of different programs for the provision of credit lines...in the sense of the procurement of the new equipment, training managers, donating grants for innovators” (Švarc, 2004, 391).

The period between 2001 to 2010 was a very successful one for Croatia, significantly because of the strengthening of the national innovation system which encouraged “...programs, infrastructures, and policy documents for improving innovation dynamics and technology transfer” (Švarc, Dabić, 2019, 1485). New institutions were established with a goal of further progression and development of technology sector, such as the Croatian Institute for Technology and the Technological Council of the Ministry of Science and Education, along with a new financing mechanism for transfer of technology (Švarc, Dabić, 2019, 1485). A big step was also marked in

2002 when the National Competitiveness Council was founded and continues existing to this day. The National Competitiveness Council is “an independent advisory body made up of 24 members from four key interest areas – the business sector, government, trade unions and the academic community” (Jurlin, Samardžija, Sertić, 2019, 11).

Additionally, a Croatian Community Innovation Survey was conducted in 2006 with a sample of more than 3000 enterprises where many problems Croatia had before joining the European Union were uncovered.

	No. of firms				Abandoned (n=257)		Delayed (n=221)	
	All (n=3093)	%	Innovators (n=1041)	%		%		%
Lack of internal sources of finances	1846	59.7	838	80.5	235	91.4	188	85.1
Lack of external sources of finances	1559	50.4	707	67.9	199	77.4	154	59.68
Costs too high	1745	56.4	829	79.6	231	89.9	193	87.3
Lack of qualified personnel	1844	59.6	856	82.2	236	91.8	206	93.2
Lack of information on technology	1688	54.6	794	76.3	231	89.9	201	91.0
Lack of information on markets	1662	53.7	774	74.4	225	87.6	190	86.0
Problems with finding co-operator	1380	44.6	624	59.9	188	73.2	171	77.4
Incumbent dominated market	1575	50.92	726	69.7	217	84.4	171	77.4
Lack of demand	1532	49.53	715	68.7	208	80.9	169	76.5

Table 1. Constraining factors reported by enterprises in 2006 survey

Source: Božić, Ljiljana. (2011). Constraints to Innovation Activities in Croatian Enterprises

As can be seen from the table attached above, the largest number of companies reported a lack of internal and external sources of financing as well as a lack of qualified labor as a main constraint in their work in an innovation field.

In the same year, Croatia was listed as a trailing country by European Innovation Scoreboard which means that activities related with innovation and technology sector in Croatia lag behind Member States of the EU (European Commission, 2024). Also in that time frame, less than 34% of Croatian enterprises were involved in innovation activities and 2/3 of enterprises did not make any effort to innovate based on CIS 2006 data which shows that many national companies rather opt for modifying existing products rather than creating new innovative market products (Božić, 2011, 178).

Role of the EU pre-accession funds in developing the technology sector in Croatia

Since the independence of the Republic of Croatia, membership in the EU has emerged as one of the most important strategic priorities of the new state. In 2001 first big agreement was signed - The Stabilization and Association Agreement and the Joint Declaration of the Republic of Croatia and the European Union on the Political Dialogue was adopted. The first EU fund available to Croatia was OBNOVA which provided humanitarian aid regarding refugees from 1996 to 2000. Afterwards, in period from 2001 to 2004, EUR 262 million from the CARDS project were allocated to Croatia within the national component. Program CARDS “consisted of a national component, i.e. funds allocated to individual countries, and a regional component, i.e. funds used by several countries for the implementation of projects of regional importance” (Ministry of Foreign Affairs and European Integration, 2009, 27). CARDS funds supported institution building, technical assistance, support of the non-profit sector and civil society.

New big step was achieved when Croatia applied for membership of the EU in February 2003 which was followed by Commissions handing a Questionnaire in July. In 2004, Pre-accession Strategy for Croatia was published which, among other things, started “opening for Croatia of the pre-accession financial instruments Phare (for institution building and economic and social cohesion), ISPA (for environment and transport), and SAPARD” (Ministry of Foreign and European Affairs, 2009, 24). After years of small steps of establishing and developing relationship with the European Union, in October 2005 negotiations for the accession of Croatia to the EU were opened and the same year Croatia became a beneficiary of the above-mentioned pre-accession programs.

In years 2006 and 2007, Croatia was able to withdraw EUR 245 million in funds from PHARE, ISPA and SAPARD (Jakovac, Maljković, 2010, 66). Projects covered under those funds were in areas such as agriculture and rural development, environmental protection and financing of infrastructure projects, as well as strengthening the institutional capacity and readiness in the process harmonization with the *legal acquis* of the Union. Especially interesting giving the context of foregoing thesis are investments with the goal of implementing projects aimed at increasing economic and social cohesion within the candidate country, aiming to prepare it for the use of funds

from the European Fund for Regional Development and of the European Social Fund which was envisioned by financing restructuring and modernization of existing industrial facilities in candidate country, encouraging small and medium-sized enterprises accompanied by measures for requalification of the workforce.

These pre-accession programs were later unified by a unique program - IPA. The unique goals of the project consist of several components: rural development, developing human resources, encouraging national competitiveness and regional development, assistance in the transition and strengthening of institutions for the acceptance of Union standards, regional and cross-border cooperation and financing of infrastructure projects in the field of environmental protection and transport, all of which are important factors in conducting business and functioning in technology sector in a given country (Jakovac, Maljković, 2010, 62-63).

As for funds aimed strictly at development of technology and research, Croatia was able to participate, before the official accession to the EU, through activities in the programs of the European Union, formerly known as Community Programs. Those Community Programs were aimed at promoting cooperation among the Member States in certain common policies in which the participation of candidate states is sometimes allowed. Firstly, Croatia took part in Fifth Framework Program for Research and Development which took place until 2002. Later, Croatia was involved in projects in the field of environmental protection as well as programs which support informal educational activities for youth. Financing projects in of Croatia such as Youth for Europe and European Voluntary Service benefited the aim of creating skilled and qualified work force, as well as getting citizens acquainted with Unions programs. As for the area of “research and technological development, the Republic of Croatia thus had the right to participate in the Sixth Framework Program for Research and Development as a third country, which means that only some of the calls for project proposals were open to Croatian scientists” (Jakovac, Maljković, 2010, 67), as well as gaining access to programs like Competitiveness and Innovation Program and Lifelong Education Program.

Results in projects such as Fifth Framework Program for Research and Development were relatively modest with a total of 37 Croatian participants and 29 funded projects valued at little above EUR 282 thousand. In the Sixth Framework that number grew, but not sufficiently, by having in total 82 participants in 70 projects extracting more than EUR 10 million (Mataković,

Novak, 2013, 127). Nevertheless, Croatia has shown its desire to continue participating in the scientific programs of the Union, as evidenced by the fact that it applied to become a member of the Framework program in 2005, which it succeeded in 2006 during Sixth Framework Program when a growth in number of participants and funds allocated to Croatia can be identified due to the fact it was no longer considered a third country. Given Croatian pre-existing institutional frameworks, it is part of a group “considered technology users (as opposed to innovators) and this is reflected in their patterns of technology upgrading” (Radosevic, 2017,9) so access to Union programs is seen as beneficial as “EU structural funds and smart specialization strategies represent a historical opportunity for industrial modernization and technology upgrading” (Radosevic, 2017, 9). As off 2010, national analysis was conducted which showed that there are 88 entrepreneurial support institutions in Croatia, out of which are 21 regional development agencies, 10 local development agencies, 16 entrepreneurial incubators, six technology parks and 35 entrepreneurial centers which employed more than 700 people (Croatian Parliament, 2013). However, Croatia has generally poorly used the potential of the pre-accession mentioned programs largely due to country’s fragmented technological sector and limited collaboration between industry and academic sector.

Institutional framework and main features of the national support system

In the Croatian system, the Ministry of Economy and Sustainable Development is responsible for innovation policies whose Innovation sector proposes measures and implements activities related to the instruments for the improvement of the innovation system and removal of obstacles to innovation. It performs tasks related to the encouragement of research and innovation in the economy, strengthening the innovation capacity, deals with issues of protection of intellectual property, aims at creating and promoting innovation cross-sectoral partnerships and networks (Ministry of Economy and Sustainable Development, 2024).

The Ministry of Science, Education and Youth is also responsible for the creation and implementation of policies in the technological sector, specifically for science and technology. The organizational unit of that ministry relevant to the mentioned area is the Directorate for Science and Technology which helps to develop scientific and innovation policies and strategies, prepares

draft laws, regulations and other acts related to scientific activity, tracks the development of the scientific and innovation system and performs tasks related to the achievement of goals and policies of European Union strategies in the field of research, development and innovation. Directorate for Science and Technology works closely with the National Council for Science, Higher Education and Technological Development while monitoring relevant bodies of Croatian scientific activity - Croatian Science Foundation, the Agency for Science and Higher Education, the Agency for Mobility and Programs of the European Union and the Croatian Agency for Small Business, Innovation and Investments (Ministry of Science, Education and Youth, 2024).

The National Council for Science, Higher Education and Technological Development is the highest Croatian body managing development and quality of the entire the system of science, higher education and technological development in the Republic of Croatia. It carries out various tasks such as encouraging measures for higher education and technological development, determining conditions for obtaining scientific degrees, proposing criteria and ratios for the distribution of budget funds for scientific activity and higher education and technological development, proposes and encourages the participation of other entities and civil society organizations and discusses issues of development of the National innovation system and proposes and encourages the adoption of measures for its improvement and stimulation of technological development (National Council for Science, Higher Education and Technological Development, 2024).

The National Innovation Council (NIC) is the central body of the national innovation system which is jointly chaired by the head of the Ministry of Economy and Sustainable Development and the head of the Ministry of Science and Education according to the model of co-chairing and six-month rotating. Membership of NIC consists of the Vice President of the Government responsible for the economy, heads of the central body of state administration responsible for science and education and of the economy, entrepreneurship and crafts, head of the Management Body for the Operational Program Competitiveness and Cohesion and Effective Human Resources Operational Program, representatives of the Innovation Council for Industry, National Council for Human Resources Development, National Council for Science, Higher Education and Technological Development, Croatian Chamber of Commerce and Crafts, Croatian Association of Employers and trade union headquarters. The work of the NIC is assisted by 3 advisory bodies: Innovation Council for Industry of the Republic of Croatia, National Council for Human Resources Development and National

Council for Science, Higher Education and Technological Development (Ministry of Economy and Sustainable Development, 2024). Thematic innovation councils started their work in 2019 with a goal to further provide strategic management and guidance for the relevant thematic priority area in cooperation with competent authorities in defining future directions of development of stimulating environment for innovation. For its membership, a general rule is that it should consist of 70% representatives of the business sector, 20% representatives of the scientific and research community and 10% representatives of public authorities (Ministry of Economy and Sustainable Development, 2024).

Croatian & European strategies in motion

In this part of the paper, a brief overview and perspectives of relevant national and European strategies aimed at improving and encouraging innovation, research and technological development will be provided. Accordingly, the National Recovery and Resilience Plan and National development strategy until 2030 were consulted, since the last adopted innovation strategy expired in 2020 and has not been updated in the meantime. Regarding European strategies, Research and innovation strategy 2020-2024 and a New European Innovation Agenda will be considered.

EUs Research and innovation strategy for period 2020-2024 is a strategic document helping to deliver on 6 general objectives set by Ursula von der Leyens Commission – European Green Deal, Europe Fit for Digital Age, an Economy that Works for People, Stronger Europe in the World, Promoting European Way of Life and a New Push for European Democracy, with an added general objective of a Modern, High Performing and Sustainable European Commission (European Commission, 2020, 2). In Strategy, ambitious specific goals are set in place in harmony with general objectives by creation of excellent science and innovative solutions regarding climate policies and digital transformation, job creation and boosting of economic growth. It also mobilizes Missions and Partnerships of Horizon Europe. For example, “four of five Horizon Europe Missions fall under the Green Deal and will inspire transformation in... Healthy oceans, seas, coastal and inland waters; Climate-neutral and smart cities; Soil health and food; and Climate adaptation, including societal transformation (European Commission, 2020, 11). The strategic document complements the existing policy goals regarding the reduction of greenhouse gas emissions,

domestic expenditure on research and development, gender employment gap, making the European Commission more responsible and transparent and many others.

A New European Innovation agenda was adopted in 2022 and is a part of a larger policy framework which aims at improving innovation and research environment. It is concentrated on 5 flagships by refining decision-making (establishing clearer rules, providing transparent data and support), opened access to funds (ex. by improving mobilization of private sector) and adjusting the rules that would allow innovators greater freedom and easier performance. Another aim is to boost European talent pool (to attract young talents, specifically in tech sector) and creation of regional innovation valleys, while keeping in mind innovation divide and climate neutrality goals by fostering digital and green transition (European Commission, 2024). This document works in synergy with Horizon Europe, often referring to it and advocating greater investments in research and innovation activities.

After the European bodies adopted the Recovery and Resilience Facility in 2021 to help Member States deal with the catastrophic effects of the corona crisis, Croatian Recovery and Resilience Plan 2021-2026 was adopted as well. “Within the RRF, grants in the approximate amount of EUR 6.3 billion will be available to Croatia ...and loans in the approximate amount of 3.6 billion euros” (The Government of Republic of Croatia, 2021, 2) will be granted with a commitment that 30% of the plan will support climate objectives and 20% digital transition. Croatian Recovery and Resilience Plan 2021-2026 consists of five components: Economy, Public administration, justice and state assets, Education, science and research, Healthcare, Labor market and social protection with one initiative regarding Renovation of buildings. Although most of these areas are undoubtedly intertwined with the development of the technological sector, there are still 2 areas that deserve special attention: Economy and Education, science and research. In the field of Economy, there are 6 goals, two of which are relevant specific goals - Encouraging innovation and digitalization of the economy, where emphasis is placed on reforms of the business environment to ease regulatory pressure, simplify conditions and reduce costs for entrepreneurs while increase investment activity and Development of sustainable, innovative and resilient tourism through the green and digital transition. The education, science and research cluster cover the reform of the education system, as well as the increase of research and innovation capacities. The structural reform of the education system and the modernization of higher education will be carried out

through the digital transformation of higher education and the modernization of the "education system in order to...ensure greater employability of individuals with qualifications at all levels of education... to make research careers more attractive through a transparent and results-based approach employment and work policy at universities and scientific institutes" (The Government of Republic of Croatia, 2021, 848). Further development of research and innovation capacity is envisioned through strengthening the institutional capacities of universities and scientific institutes for innovation, development of a system of agreements for university and scientific institutes for funding innovation as well as greater investments in research and technological infrastructure in STEM and ICT fields and by development of an incentive model for advancement in the career of researchers in STEM and ICT fields (The Government of Republic of Croatia, 2021, 849).

The National development strategy until 2030 is a fundamental strategic development document. It recognizes the necessity of technological modernization and productivity increase to strengthen the growth of the Croatian economy. The strategy introduces four development directions: Sustainable economy and society, Strengthening resistance to crises, Green and digital transition and Balanced regional development. Sustainable economy and society cluster, aims for encouraging the development of the circular economy, investments in research, technological development and innovation, cooperation between the business and research sectors, improvement of the business environment and quality in the public sector with a modernization and decarbonization of energy-intensive industries (Croatian Parliament, 2024). The role of small and medium-sized enterprises as is recognized as key for boosting competitiveness and prosperity of the Croatian economy by establishing "supporting financial models... and a stimulating business environment...for the generation of new ideas and the initiation of entrepreneurial innovation activities aligned with the national innovation system" (Croatian Parliament, 2024). Modernizing the legislative framework governing the academic scientific research sector is going to be achieved by reducing fragmentation, strengthening the criteria of excellence and innovation potential in investments, strengthening the protection and management of intellectual property and to provide further encouragement to open science and cooperation with the business sector. The idea is to harmonize education with the needs of the labor market by increasing the accessibility of the high-quality education system and raising the quality of adult education programs, increasing the pool of the adult population that participates in lifelong learning. Work will be done in areas of mobility of the labor force, regulation of relations on the labor market (more flexibility for employers and

workers rights) and improvement of the skills of the working-age population, especially young people, with an emphasis on entrepreneurial and digital skills (Croatian Parliament, 2024). Regarding Green and digital transition, focus is going to be placed on more investments for research, development and application of new technologies in the field of energy policy, agri-food sector, strengthening of competitiveness and innovation in agriculture and aquaculture and improvement of technology transfer. Necessity to plan and ensure the continuation of the development of digital infrastructure is recognized and investments in the further development of digital technologies, innovations and new business models will be made while special focus is placed on strengthening the ability of innovation for small and medium-sized enterprises (Croatian Parliament, 2024). This is especially important given the fact that “SMEs represent a pulsing part of all EU economies, particularly as they are the dominant type of enterprise (on average accounting for 99 percent of the enterprise sector), but also in terms of their participation in total value added (58 percent) and employment (67 percent)” (Čučković, Vučković, 2018,98).

As previously identified in this paper, Croatia is characterized by uneven regional development. In National development strategy, overcoming of this issue is envisioned by policy of smart specialization (taking into an account peculiarities of individual areas and their territorial capital). Priorities for policy implementation in the field are development and improvement of regional infrastructure, strengthening the attractiveness of regions for investments, establishment of regional ecosystems and innovation systems for entrepreneurs, territorial branding and promotion of the regional economy (Croatian Parliament, 2024).

Technology Sector in Croatia – comparative view

In this part of the thesis, data closely related to development monitoring of technological sector of Croatia will be compared if possible. If comparison is not possible, the most recent data will be considered. These data will consist of DESI index, Innovation scoreboard, Analyzes of IT sector by Croatian Chamber of Commerce supplemented with data from the National Bureau of Statistics. Data for 2013, 2018 and 2023 were used as relevant indicators of progress, and where it was not possible to find sources for that year, data closest to the relevant year were used.

The Digital Economy and Society (DESI) index is the first component which will be considered. DESI index is a tool developed by the European Commission in 2014 and was published at the end

of February 2015 which summarizes indicators in the field of digitization and monitors the progress of EU Member States. In 2015, The DESI index was composed of 5 indicators structured into five dimensions: connectivity (broadband connection), human capital, serving the Internet, digital integration technologies and digital public services. The higher the value, the more successful the county is in economic and social digitalization. In this period, Croatia took 26th out of 30 places (28 Member States + Norway and Iceland) and if we count only EU members, 24th place (Ministry of Economy, 2015, 3). It is worth noting that “in the dimension of integration digital technology... Croatia ranks high in the 10th place in the EU” (Ministry of Economy, 2015, 4). In 2018, same indicators were used to measure the DESI index and Croatia ranked 22nd progressing from 2017th 23rd place, while the biggest challenge is in the field of connectivity where Croatia is second to last, 27th, place (European Commission, 2018, 2). For 2023 there is no single DESI index and is integrated into the Digital Decade report, in line with the policy agenda for the Digital Decade to 2030. Because of that, data for 2022 is considered where Croatia ranked 21st among the 27 Member States where the biggest problem is identified in the lack of ICT experts which in result affects the integration of digital technologies in companies (European Commission, 2022, 3).

2015	2018	2022
24 th	22 nd	21 st

Table 2. Croatian DESI index
 Source: European Commission

Innovation scoreboard is a tool which provides evaluations of the Research and Innovation performance of EU Member States. Based on the results of a given Member State, it could be categorized into four performance groups - Innovation leaders, Strong innovators, Moderate innovators and Emerging innovators. Although Croatia is included in the 2013 Report, it is not ranked in relation to other EU countries, only being classified in moderate innovator category with “relative strengths...in Human resources and Economic effects...” and “relative weaknesses...in Open, excellent and attractive research systems and Intellectual assets” (European Commission, 2013, 55). The following year, 2014, Croatia ranked 23rd out of 28 Member States and was again

placed in moderate innovator category. In 2018, Croatia even though was once again classified as a moderate innovator, fell to 26th place. For example, “compared to 2016...performance declined for ten Member States, with the strongest declines for Romania (14.8%) and Croatia (13.1%)” (European Commission, 2018, 23) with lowest results for Croatia in categories of Sales impacts (Medium and high tech product exports and Knowledge-intensive services exports), Innovators (SMEs product/process innovations, SMEs marketing/organizational innovations, SMEs innovating in-house) and Linkages (Innovative SMEs collaborating with others, Public-private co-publications, Private co-funding of public R&D)” (European Commission, 2018, 62). Latest edition of European Innovation Scoreboard was published in 2023 states that “Croatia is an Emerging Innovator with performance at 69.6% of the EU average. Performance is above the average of the Emerging Innovators and performance is increasing at a rate higher than that of the EU...” (European Commission, 2023, 65), with strongest decreases in non-R&D Innovation expenditures, Environment-related technologies and Product innovators since 2022, when it was labelled as emerging innovators and weaknesses in Innovation expenditures per employee, Environment-related technologies, Knowledge-intensive services exports, Design applications and Lifelong learning (European Commission, 2023, 65).

The Croatian Chamber of Commerce issues annual analyzes of the IT industry in Croatia. In this part of the thesis, selected indicators for 2013, 2018 and 2023 (or most recent) will be shown, with the aim of comparing the results. First indicator is number of IT companies which shows continuous growth in Croatia with 3.618 IT companies in 2013, around 5.000 companies in 2018 and latest data of 6.500 IT companies in 2022 with “an above-average growth of 17%, and there were a total of 900 more IT companies than a year ago and 64% of companies more than five years ago was recorded” (Croatian Chamber of Commerce, 2023, 8). Clearly, an increase in the number of IT companies also means an increase in employability in that sector with that number being almost 21 thousand people in 2013 progressing to nearly 30 thousand employees in IT sector in 2018, and that number surpassing 40 thousand in 2022. The next important determinant to look at is the total income of the IT industry. In 2013 the Croatian Chamber of Commerce announced that in the same year Croatian IT sector realized HRK 14.708 million or EUR 1.86 million, with a slight progress in 2018 when it totaled EUR 1.89 million and was increased by more than 80% in comparison to 2022 when it amounted to EUR 3.42 million. An indicator that shows the climate in the IT sector is investments in fixed assets where significant growth is observed. In 2013

investments amounted to a record low EUR 44 million, climbing to EUR 48 million in 2018 and reaching a record high of almost EUR 67 million in 2022. It is also important to note the high jump in the investments of IT companies in research and development, where in 2018 they amount to slightly more than EUR 18 million, and in 2022 they rise to almost EUR 130 million, and in 2023 "...the planned amount of the IT sector for R&D EUR 127.7 million" (Croatian Chamber of Commerce, 2023, 21).

Data on research and development activities in Croatia have been collected from the web pages of the National Bureau of Statistics. Total R&D personnel in 2013 was a little over 15 thousand, in 2018 there were 21,226, and in 2022 28,230, of which even 47.6% are women. When it comes to the sources of funds for financing research and development activities, most companies allocate their own funds in the highest percentage, apart from 2018 when the state and local administration financed 1% more compared to the own funds of IT companies, and in the case of 2013 and 2022, it was in second place in sources for finances. Regarding patents, in 2013, 253 patent applications were submitted, in 2018, that number was 136, and in 2023, 171 patent applications were submitted.

SELECTED INDICATORS OF THE TECHNOLOGICAL SECTOR			
	2013.	2018.	2022.
<i>Number of companies</i>	3.618	>5.000	>6.500
<i>Employment (IT industry)</i>	20.822	29.939	>40.000
<i>Income</i>	EUR 1.86 million	EUR 1.89 million	EUR 3.42 million
<i>Investments, fixed assets</i>	EUR 44 million	EUR 48 million	EUR 67 million
<i>Investments, R&D</i>	-	EUR 18 million	EUR 130 million
<i>R&D Personnel</i>	>15.0000	21.226	28.230

<i>Patent applications</i>	253	136	171*
<i>Funding, type</i>	own funds	state and local administration	own funds

Table 3. Indicators of Technology Sector over the years

Sources: Croatian Chamber of Commerce & National Bureau of Statistics

Based on all the data presented above, noticeable shift was made towards greater alignment with EU standards and norms in Croatia since joining the EU in 2013, which is evidenced by increased progress indicators influenced by participation in EU projects and programs and also by adoption of “...key strategic documents as required by its EU membership” (Jurlin, Samardžija, Sertić, 2019, 27) resulting in improvement of indicators of technological progress in country. However, there is a lot of room for improvement in terms of “effectiveness in implementing a number of set strategies and action plans...” where “...sectoral restructuring must be implemented in areas where Croatia has the greatest potential for smart, inclusive and sustainable growth” (Jurlin, Samardžija, Sertić, 2019, 27). Additionally, work must be done on increasing productivity, creating a better climate for entrepreneurship and innovation, boosting collaboration between the industries with academic sector, developing skills as part of lifelong learning and, as in the EU, increase of investments in R&D.

Obstacles for growth of Tech Sector

The EU faces cohesion problem where the differences in the technological development of the Member Countries are observed, moreover “substantial heterogeneity within Europe... goes beyond the divide between old and new Member States and also involves countries like Greece at the bottom” (Veugelers, Cincera, 2015, 6). This was especially visible following the 2008 financial crisis where “innovation leaders, such as countries in Northern and Western Europe experienced no major shifts in R&D and innovation investments while the Southern-European countries entered a deep recession which has had a severe effect on their R&I systems” (Radosevic, 2019, 22).

Europe has struggled to keep pace in the global tech race. For example, on the list of largest tech companies by market cap there is no European company in top 10 (Companies market cap, 2024). Europe, despite being developed and economically prosperous falls far behind American and Asian counterparts in areas such as 5G, AI, chip manufacturing and electronics.

Apart from its traditional risk aversion culture, more present in American and Asian cultures, more obstacles in EU have been identified:

- Regulatory, language and culture differences – making it harder for European start-ups to expand beyond domestic Member State, hindering development of unique tech landscape. According to European Start-up monitor, adopted by Commission in 2016, enterprises report “differences in legislation and regulation (59.1%), especially regarding taxation (26.8%) ...followed by cultural differences (38.2%) and the language barrier (25.7%)” (European Commission, 2018, 14) as the biggest obstacles for their growth and expansion leading to fragmentation of the market.
- Funding and investment opportunities – risk aversion culture accompanied by a lack of risky investments often backfires producing a culture for safer careers such as in law or medicine, making venture capital landscape almost non-existent in EU. Also, the EU has “long-standing problem of access to finance in the early stages of development for highly innovative companies” (European Commission, 2017, 9). For example, most of European start-ups are “financed through savings (77.8%) business angels (29%)...” and only a smaller portion through “...venture capital (26.3%)” (European Commission, 2018, 11) which significantly affect the establishment and functioning of start-ups and innovation climate.
- Brain drains – as for innovation climate in EU, compared to other regions of the world, there is no innovation hub, such as Silicon Valley in the USA, which is a synonym for tech and innovation, risk taking, and investments attracting the brightest minds in tech, leading to immigration of highly skilled individuals to move for better opportunities.

EU funding opportunities are insufficient in relation to the current state of the technological sector where Member States are lagging behind global competitors and must work together with the EU to achieve an innovative technological ecosystem where innovation hubs and start-ups can thrive. The above-mentioned problems and obstacles certainly affect the state and functioning of the

technological sector in Croatia, as an integral part of the EU single market. Specifically in the use of European funds for the development of the technological sector in Croatia, especially the Horizon Framework programs, there is a lot of progress to be done in terms of greater participation and absorption of funds. Several important factors influence the level of Croatian participation in such frameworks: support and interest of parent institutions/companies, administrative process, visibility and availability of information and organization of the system of the Member States in the field of science, industry and research. In a study of Ministry of Science and Education regarding Croatian participation in Horizon 2020 Framework "...surveyed researchers mostly cited a lack of support at their home institution (61.3%) and an unstimulating promotion system (51%) ... a part mentions the demanding process of preparing application projects (35.5%), excessive additional engagement (32.2%), inadequate/non-existent financial compensation (32.2%) and lack of relevant information (19.4%)" (Exaltum, 2024, 128-129). The situation is similar with applications for other streams for the absorption of European funds, where the complicated administrative procedure of application and monitoring of projects is too demanding for potential users in Croatia. Croatia must work on establishing a more responsive, visible and agile user support system through "strengthening capacity, stronger professionalization and profiling of the network of national contact points (NCP) through the establishment of the NCP network ..." (Exaltum, 2024, 135). It is necessary to launch synergy between different streams of European funds, such as Horizon Europe and the European Fund for Regional Development and increase investments in research and development activities, where Croatia invests less than the European average (Kaštelan Mrak, Vretenar, 2024, 9). Increase in capacity and cooperation between universities and institutes and private for-profit entities in order to create a qualified workforce, improve innovation capacities and better respond to global challenges is needed in Croatia, as shown by data provided in implementation of Horizon Programs. Additionally, "national innovation policy should address issues concerning conditions of doing business (market settings, consumer expectations, policy measures) and support business sector resilience, so that companies themselves can advance their market position and dilute historical power asymmetries between small and companies and traditional industrial towards the new dynamic industrial sectors" (Kaštelan Mrak, Vretenar, 2024, 18).

Taking into account the situation in the world, the differentiated readiness to respond to increasingly frequent crises is extremely worrisome, where "consequences of the crisis on Central-

Eastern European countries have been more ambiguous, with some countries benefiting from the EU funds and using them as strong anti-cyclical devices, and others are experiencing deep depression and inability to use R&I funding as anti-cyclical devices” (Radošević, 2019, 22).

HORIZON 2020 - CROATIA'S PARTICIPATION AND IMPACT ON THE TECHNOLOGY SECTOR

Horizon 2020 is the successor of the 7th EU Framework Program for Research and Innovation, where the most successful Member States “that attracted more than EUR 10 billion over 2007–2013 were Germany, France, Italy, the United Kingdom, Spain, the Netherlands, Belgium, Poland, Sweden, Austria, Denmark, Greece, Finland, Cyprus, Portugal, Ireland, and the Czech Republic” (Moagar-Poladian, 2018, 156). The same group of countries continues to lead in the area in newer Frameworks and while “the new Member States registered... a constant growth... the volume gap between the new Member States and the old Member States has remained constantly significant, starting from a very low base” (Moagar-Poladian, 2018, 157). In this period, Croatia was among the group of countries with low expenditure on R&D, along with many Eastern and Central European Countries. Projects such as Horizon work to complete EU efforts for “strengthening the competitiveness of Member States and the EU as a whole by developing a strategic framework...” and “...integrated policies (industrial, cohesion etc.) ...” (Jurlin, Samardžija, Sertić, 2019, 24), especially pivotal for less-developed Member States.

About HORIZON 2020

The European Union recognized the need to support research and innovation activities as one of the engines of economic development, when in the 70s it first adopted Community research programs. In the beginning, these programs were fragmented and not connected into a meaningful whole but would rather spring up in order to fulfill a need in a particular area. That was until 80s when “European Commission proposed the framework program (FP) for research as a strategic tool to manage the adoption of research programs in a more coherent way” (European Parliament, 2017, 3), and the First framework program ended being adopted in 1983.

Next two Frameworks were adopted every three years and had higher budget each time. However, the real change in operating within these frameworks came with the Maastricht Treaty, effectively transforming these Frameworks into real funding platforms for financing of research activities in the EU. Maastricht Treaty also increased number of research areas which was seen in Frameworks 3 and 4 given that “the focus on pre-competitive research was abandoned for an approach that would see the FP addressing societal challenges and supporting a wider range of activities in the innovation process” (European Parliament, 2017, 3). Sixth and Seventh Framework were heavily influenced by adaptation of European Research Area concept, coined in early 2000s and ultimately becoming a part of Lisbon Treaty, which promoted further unifying innovation at the EU level, coordination of national policies in Member States, broadening research and funding cooperation not only between members of the Union but also between governmental and non-governmental research and innovation actors.

The Eight Framework Program was adopted in 2013. From 2014 to 2020 Horizon became a front project of research and innovation activities with a budget of nearly EUR 80 billion. The program was aimed at strengthening the European research area, improving European competitiveness on the world market, creation of new jobs and tackling policy areas in focus for the EU – climate change and environmental issues, societal issues and clean energy policies among others. Special attention was placed on small and medium enterprises where “SME financial support instrument is exactly targeting SMEs’ ability to produce and commercialize breakthrough innovations to enable the EU economy to advance and better cope with world competitors” (Čučković, Vučković, 2018, 105). Horizon 2020 focused on three key priority areas - creating excellent science, fostering industry leadership to support innovation and business (including SMEs), and tackling societal challenges to directly respond to the challenges Europe faces.

The goal of the Excellent Science pillar was to work on new high-risk ideas with the aim of strengthening the EU scientific base and increase the competitiveness in the market as well as to help scientists and research teams improve their training, cooperate and broaden opportunities (European Commission, 2024). It was consisted of 4 goals:

- European Research Council – public body providing funding for researchers from the Union to finance pioneering innovation and technology projects

- Future and Emerging Technologies– further encouragement for scientific cooperation between disciplines on high-risk projects and of emerging fields of science, as well as the structuring of scientific communities throughout the EU.
- Marie Skłodowska-Curie (MSCA) activities - providing training in the field of research, opportunities for knowledge exchange and ensuring mobility of researchers
- Research infrastructures– develop and support European research infrastructures

Fostering Industry Leadership objective was to “stimulate sustainable economic growth by means of increasing the levels of innovation in SMEs...thereby creating more fast-growing, internationally active SMEs” (European Commission, 2024). Through its activities it aimed at encouraging competitiveness and attracting more private investments in science and innovation. It consisted of three goals: leadership in industrial technologies, access to risk financing and innovations in small and medium enterprises. The third key priority area is Societal challenges which was an area that supported research and innovation in potentially critical areas with an impact on the lives of European Union citizens. Horizon 2020 identified 7 areas which fall within Societal challenges cluster: health and quality of life, food security, clean energy, transport, climate action and environment, inclusive and innovative and secure societies (European Commission, 2024).

The three pillars of Horizon 2020 are complemented by two special goals of building meaningful cooperation between science and society as well as spreading excellence and participation to maximize potential and increase the benefits of the economy based on innovation and their fair distribution also by coordination with European structural and investment fund (European Commission, 2024). Also, the activities of Horizon 2020 framework were completed by its synergy with the Euratom program which financed research and innovation in the field of atomic (nuclear) research and various inter-sectoral support measures.

Horizons 2020 instruments were open for a wide set of public and private bodies including companies, universities, public and private research institutions and NGOs. It was done by providing “financial instruments or types of action...Research and Innovation actions, with 100% contribution from the European Commission offered to participants, Innovation actions, with

funding ranging from 70 to 100% contribution and Coordination and Support actions, with 100% contribution” (Agency for Mobility and EU Programs, 2018, 6).

National support system in Croatia

To maximize potential and further simplify maneuvering through bureaucratic processes in goal of smooth participation, management and use of available funds for research and innovation, national governments of Union Members adopted national support systems to best serve actors in these national sectors. Each support system of Member States was entrusted with a task of giving “advice on administrative and legal procedures, training and assistance in writing a project proposal, creation and distribution of documentation (instructions, manuals, forms, etc.) and assistance in searching for partners” (Exaltum, 2024,24)

Central contact point for exchange of information with European Commission and promotion of Horizon project in Croatia was Ministry of Science and Education which was also tasked with coordination of activities. During the time of implementation of Horizon 2020, Croatia appointed supporting institutions where relevant stakeholders were identified and together with Ministry of Science and Education were a part of national support system. Relevant institutions in case of implementing and functioning of Horizon 2020 in Croatia were: the Agency for Mobility and EU Programs (AMPEU), the Croatian Agency for Small Business, Innovation and Investments (HAMAG-BICRO) and the State Institute for Radiological and Nuclear Safety (DZRNS). Further, that system consisted of National Contact Person Coordinator (which ensured smooth functioning of national support system), Program Committee Members (representatives of Croatia in the program committee at the European Commission), National Contact Points (persons working within above mentioned bodies) and of the reference groups consisting of experts providing professional support. The largest task in regards with scope of thematic activities was given to the Agency for Mobility and EU Programs (AMEUP) which hosts National Contact Persons in many areas including Joint Research Centre, Climate action, nanotechnologies Marie Skłodowska-Curie actions, resource efficiency and raw materials and many others (Agency for Mobility and EU Programs, 2018, 144).

HORIZON 2020 in Croatia

The data used in this part of the thesis were collected from secondary sources from exclusively official national/European sources. Most data were collected by CRODIS - the information center of the European Commission regarding EU projects in research and development, concretely through Horizon Dashboard tool. Complementary data are collected from national studies and analyses, as well as official statistical data.

According for Innovation Union Scoreboard 2014, the year of launch of Horizon project, Croatia was ranked as moderate innovator alongside Spain, Greece, Czech Republic, Hungary, Lithuania, Malta, Italy, Poland, Portugal and Slovakia. The only group worse off, so-called modest innovators was contained of Romania, Bulgaria and Latvia. Croatian innovation performance “started to decline in 2012 (in particular due to a declining sales share of new innovative products) leading to a decrease in the performance relative to the EU from 60% in 2011 to 55% in 2013” (European Commission, 2014, 53). Croatia fell behind EU averages regarding Community designs and trademarks, patent applications and revenues from certain areas, while highlights being relatively higher percentage of “...International scientific co-publications, Youth with upper secondary level education and non-R&D innovation expenditures” (European Commission, 2014, 53).

As part of HORIZON 2014-2021 financing from European funds, Croatia received EUR 137.7 million, which accounts for only 0.2% of the total funds covered by the Horizon project and sets Croatia at 24th place in EU ranking out of (then) 28 Member States (Horizon Dashboard, 2024). Most of these funds were allocated to Societal challenges pillar, followed by Excellent science and Industrial leadership. Croatia signed 585 grant agreements in that program period with a success rate of 13.55% but the frequency of applications and their success varies among applicants, even regionally. For comparison, the overall average success rate of all 28 EU member states is 15.5%, including UK (Horizon Dashboard, 2024). Out of 824 organizations that were involved in designing, coordinating or implementing HORIZON projects, the largest number of them, as expected, was from the City of Zagreb, as many as 538 of them, followed by 91 organizations from the Primorsko-goranska County, creating a problem of regional fragmentation in area of research and development even more visible. In terms of types of organizations regarding extraction of EU contribution, Higher or Secondary Education Establishments were the most successful, making up

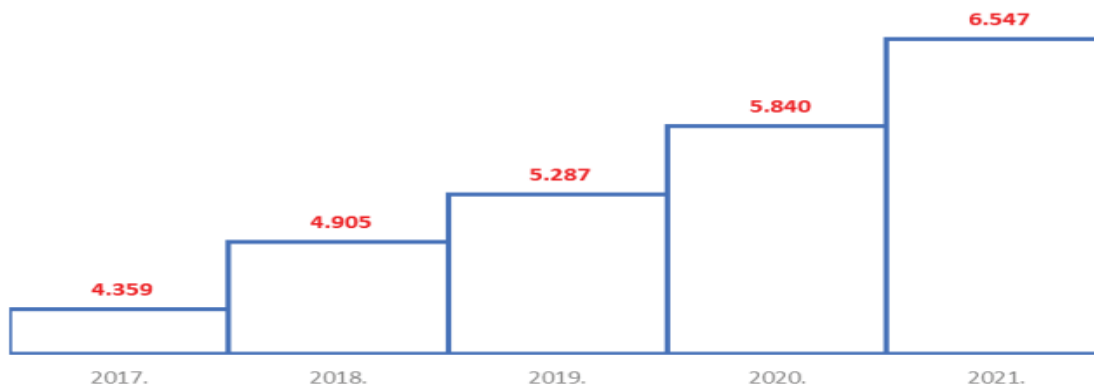
to 32.7% of total EU contribution, followed by Private for-profit entities (27.8%), Research organizations (25.3%) and Public bodies (9.5%). Among these organizations, in terms of the amount of funds received, as well as the participation itself, the Ruđer Bošković Institute stands out in both categories. In terms of Higher or Secondary Education Establishments and applications, University of Zagreb with its Faculties of Electrical Engineering and Computing Mechanical Engineering and Shipbuilding, Science and Mathematics and Medicine were highly successful. The only faculties that are not part of the University of Zagreb, and which stand out in this category are the Faculty of Philosophy in Rijeka in terms of the number of funds and the University of Split in terms of participation (Horizon Dashboard, 2024).

What is evident from the analysis of the available data is that the Croatian applicants (including the entities mentioned above) had a relatively small number of applications compared to the European average and "the success of Croatian project applicants, expressed as the ratio of the amount of funds requested in the applications to the amount of contracted project funds, was 8.2%" (Exaltum, 2024, 29). Disparity rate of 5.3% between contracted project applications and the ratio of requested and contracted financial resources points to the fact that "Croatian applicants have more success when contracting projects with a smaller financial amount or a smaller share in the total financial budget...Croatian applicants participated in 1.4% of all applications, and they were approved for 0.2% of the total budget of the framework program" (Exaltum, 2024, 29). As a part of Horizon 2020, Croatia had 4 European Research Council principal investigators (researcher who applied for grant from ERC), and 342 experts involved in research and innovation programs evaluation process and regarding Marie Skłodowska-Curie actions 73 of Croatian organizations were involved (Horizon Dashboard 2024).

The effect of HORIZON 2020 on the technology sector in Croatia

In this part of thesis, the reflection regarding effects of HORIZON 2020 on technology sector in Croatia will be presented. Results include data on exports and income of the IT industry, number of employees, patents, statistical data on innovations in companies, cross-sectoral forms of cooperation, careers of researchers and the use of information and communication technologies in companies. Of course, all the factual data presented in the text below are not directly correlated with funds exclusively at the European level, but it is worth observing the trends in the industry

since Croatia used European funds and opportunities on projects like Horizon, which are undoubtedly responsible for a part of mentioned indicators. As the HORIZON 2020 projects were implemented in 2021, the analysis of the IT sector of the Croatian Chamber of Commerce for the year 2021 was used for the following data. According to available data, IT industry exports in the period from 2017 to 2021 doubled, culminating to annual growth of 26.3 percent in 2021 and surpassing five-year average by earning HRK 11.9 billion on the foreign markets (Croatian Chamber of Commerce, 2022). What is particularly optimistic is the fact that “the biggest contribution to the growth of export revenue in the IT industry in the last five years comes from the small IT companies whose export revenues increased by more than 2.5 times” (Croatian Chamber of Commerce, 2022, 9). However, the largest share of exports in terms of revenue is still made by large companies. The number of companies in IT sector in the Croatian economy is continuously and stably growing, as can be seen from the graphic representation attached below (Graphic representation 1.).



Graphic representation 1. Number of IT companies in Croatia

Source: Croatian Chamber of Commerce

As the number of companies in the IT sector grew, so grew the number of people employed and income in a given sector. The growth in the number of employees culminated in 2021, when it reached almost 40 thousand people and compared to the situation five years ago, the IT industry had 45% more employees (Croatian Chamber of Commerce, 2022, 6). After a short drop in revenues in 2020 directly impacted by the corona crisis and disruption of the functioning of the global market, a strong recovery followed when revenues increased by more than 14% in 2021, whereas “the largest contribution to the overall growth of IT industry income in the last five years was made by small businesses companies, whose income increased by more than 70%...and in 2021 amounted to a record HRK 9.7 billion” (Croatian Chamber of Commerce, 2022, 7).

Regarding patent activity in Croatia, as can be seen from Table 4. attached below, there is a downward trend (except for 2019) regarding the number of patent application rate and number. In this area, regional fragmentation of the country is especially visible, since the largest part of patent applications comes from continental Croatia, especially the city of Zagreb while actors from other regions participate much less.

Patent applications in Croatia over the years	
2014.	200
2015.	186
2016.	188
2017.	159
2018.	136
2019.	211
2020.	129
2021.	88

Table 4. Patent applications in Croatia
Source: National Bureau of Statistics

The latest announcement by the National Bureau of Statistics regarding innovation in companies is the one for the 2018-2020 period. According to their findings in study conducted on a sample of 4,500 companies, almost half of Croatian companies are innovative - “46.6% of small companies, 61.3% of medium-sized and 79.4% of large companies were innovative” (Croatian Bureau of Statistics, 2020), with manufacturing companies being forefront of innovation activities. As for types of innovation conducted by Croatian enterprises, more often only process innovation was carried out and used by 17.2% of companies (mainly used by large companies) and product innovation conducted by only 5.5% of companies (mainly medium-sized enterprises). Lack of qualified work force, high costs and lack of internal funds are among the most common restraining factors on taking up and conduction of innovation activities (Croatian Bureau of Statistics, 2020).

What can be directly correlated in discussions regarding impact of EU funds and technology sector is the fact that the Horizon 2020 program had an impact on the careers of Croatian researchers by providing opportunities for cross-border cooperation, the development of new research ideas and growth in international framework. According to the data of the National study on the Participation of the Republic of Croatia in the Horizon 2020, conducted by an online questionnaire on a sample of 200 respondents of which 66 responses being collected. When asked about the impact of projects from the Horizon 2020 program on careers “one-fifth of the surveyed scientists continued cooperation with international partners (22.1%), while the smallest share of respondents stated that the implementation resulted in the application of a new project (15.8%)” (Exaltum, 2024, 113). Furthermore, more than 30% of responders stated that the implementation of the project increased the number or impact of their publications and a slightly lesser percentage of them believed that participation in the implementation made it easier for them to get involved in new projects, for example Horizon Europe, among other answers by surveyed actors are the positive impact of project implementation, increased cooperation with the economy or faster progress in their careers (Exaltum, 2024, 114). Young scientists especially benefited from participation in Horizon 2020 projects, where the majority continued their careers at the same academic institution, while a minority continued their careers in the private sector. Building on the restrictive factors, mainly lack of qualified work force, of innovation processes in Croatian companies this is extremely favorable data.

Considering that one of the pillars of the Horizon 2020 program is Industrial leadership and increasing the competitiveness of industry, cross-sectoral forms of cooperation between the scientific sector and the economic sector is of vital importance. Analyses of Horizon 2020 project shows that Croatian companies cooperate with higher education institutions most often, but at the same time “total share of such collaborative projects is only about ten percent of all contracted projects” (Exaltum, 2024, 110). As for other forms of cooperation, companies and research organizations and companies and public bodies were other common cross-sectoral cooperation forms. What is particularly important to highlight in this context, considering large number of registered companies in Croatia, their involvement in Horizon projects is very low (which also explains low level of cross-sectoral cooperation), meaning “Croatia is in the group of countries from which companies participate with less than 1% in the program...” where “...Horizon 2020 mostly supported established innovators, and there are very few such companies in Croatia (the number of companies with research and development activities in Croatia was only 726 - 0.5% of the EU..” (Exaltum, 2024, 113).

NEW EUROPEAN FRAMEWORKS

Horizon Europe as successor to Horizon 2020

The successor of Horizon 2020 for the financial period 2021-2027 is Horizon Europe, new research and innovation framework, with a budget of EUR 95.5 billion and a goal of EU-wide collaboration and strengthening research and innovation while creating jobs, boosting economic growth and competitiveness while tackling global issues such as climate change. EU is aware that progress in innovation and research must also be reflected in greater investments by European businesses themselves, where only 1.5% of them invest in research and innovation activities in comparison to the USA where that percentage is 2.1%, or in Japan, where 2.6% of companies invest in research and innovation activities (European Commission, 2024).

The structure of Horizon Europe consists of 3 pillars: Excellent science, Global challenges and European industrial competitiveness and Innovative Europe. Excellent science pillar activities aim to promote excellent science, attracting global talents to the EU and providing support to researchers with a goal of creating high-quality knowledge, skills and technology. Global

challenges and European industrial competitiveness pillar support the creation and transfer of new knowledge, technologies and sustainable solutions, with a special emphasis on encouraging the development of innovative solutions in small, medium and newly founded companies and in society. Innovative Europe pillar encourages the development, transfer and application of all forms of innovation activities. Like Horizon 2020, Horizon Europe structure contains horizontal part which supports the goals of the European Research Area. The horizontal part is divided into two key areas: Expanding participation and excellence and Reform and strengthening of the European research and innovation system (Horizon Europe, 2024). The graphic representation of Horizon Europe pillars and clusters is shown in the picture attached below (see Figure 1.)

Compared to its predecessor, Horizon Europe introduces some new elements such as European Innovation Council, Open science policy, Missions and introducing novelty to partnerships. European Innovation Council “supports game changing innovations throughout the lifecycle from early-stage research to proof of concept, technology transfer, and the financing and scale up of start-ups and SMEs” (European Innovation Council, 2024) with a budget of more than EUR 10 billion promoting risk taking and agile, pro-active management. The European Innovation Council Forum has also been established to further promote coordination and dialogue while testing ideas and proposals.

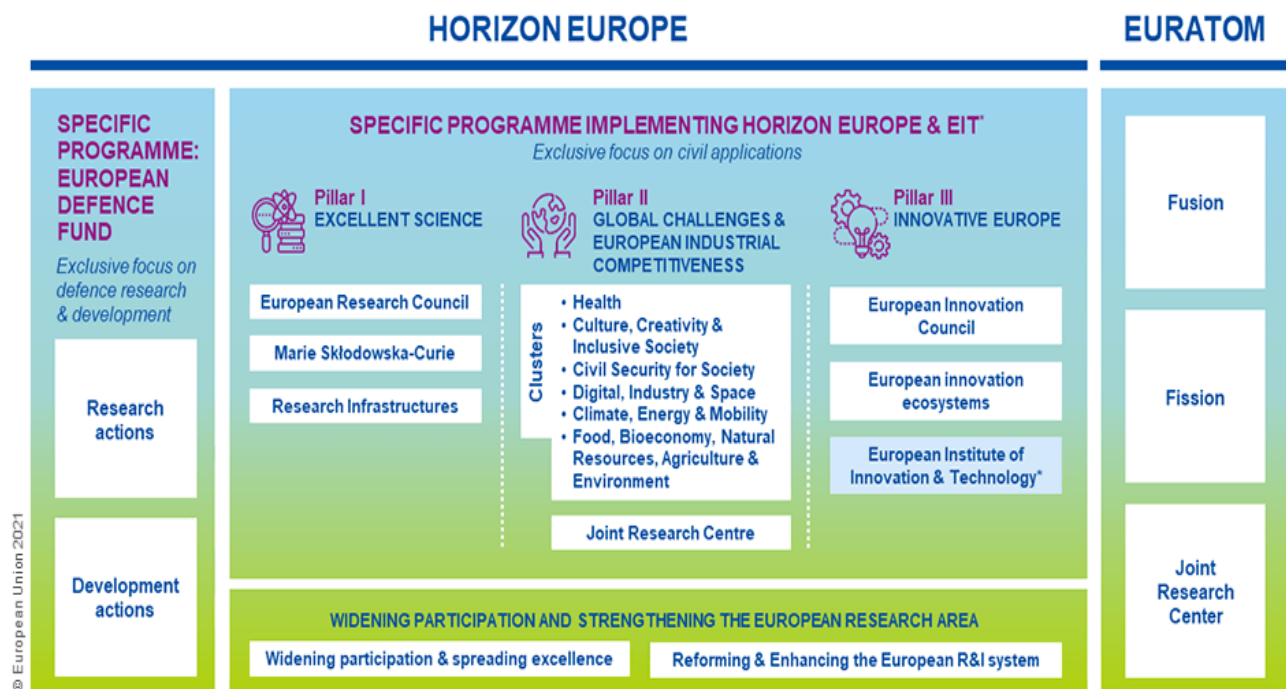


Figure 1. Horizon Europe Structure

Source: European Union, Research and innovation

Under the new open science policy Horizon Europe requires open access to all scientific publications and data management so that information is as open and accessible to the public. Missions are a new instrument creating 5 targeted, measurable, time-limited and with a clear budget area for finding answers to society's challenges and of common importance for the entire Union. 5 mission areas are: Adaptation to climate change, Cancer, Health and food, Climate-neutral and smart cities as well as Healthy oceans, seas and inland waters. The new approach to partnerships is based on efficiency, a clear life cycle and quality of implementation (Horizon Europe, 2024). European Commission also simplified the rules for application and implementation of projects compared to the previous Horizon 2020 program by providing clearer guidelines and simplifying the implementation of the program itself, starting with the Funding and Tenders portal, representing a single-entry point for all EU program tenders encompassing all procedures and documentation, aiming at easing the administrative burden for participants (Horizon Europe, 2024).

The Horizon Europe program distinguishes the following types of activities eligible for funding: Research and Innovation Activities (establishing new knowledge, investigating the feasibility of a new or improved technologies, products, processes and services), Innovation Actions (prototypes, testing, demonstration, pilot research), Coordinating and Support Activities, Program Co-funding Activities, Innovation and market deployment actions, Training and mobility actions, Pre-commercial procurement actions (enabling a multinational group of buyers to strengthen public procurement for research, development, validation and introduction of innovative solutions) and Public procurement of innovative solutions actions (assisting a multinational group of customers in the introduction of innovative solutions to overcome the fragmentation of demand for innovative solutions and to share risks and costs) (Horizon Europe, 2024).

As for the National Support System for participation in the Horizon Europe program, not much has changed with respect to the previous program framework. The Ministry of Science and Education is the central body responsible for coordination, while being supported by the Agency for Mobility and Programs of the European Union, the Croatian Agency for Small Business, Innovation and Investments, the University Computing Center of the University of Zagreb (SRCE) and the Ministry of the Interior. Stakeholders of the national support system also are: National Contact Persons and Coordinators, Members of the program committee, Interdepartmental working group for the Horizon Europe program and Reference groups.

Implementation of Horizon Europe in Croatia

Although the duration of Horizon Europe is planned until 2027, through official Horizon Dashboard page meaningful information about the performance and implementation of the Program in Croatia is obtained. It provides insight into data such as the amount and distribution of funds, the number of completed projects, as well as an overview of the institutions and bodies participating in the program. However, the analysis in this part of the thesis, as in the evaluation of Horizon 2020, begins with a review of the Union Innovation Scoreboard for the year 2021, when the program was launched.

In 2021, Croatia was again placed in group of 7 Member States labeled as Emerging innovators, meaning that their performance levels are below 70% of the EU average. Along Croatia, in this group are Bulgaria, Romania, Slovakia, Poland, Latvia and Hungary. What is worth pointing out is that in terms of digitalization, Croatia is ahead of the Member States that are placed in one of the more advanced innovation groups and that compared to analyses year before "...performance has improved for 24 Member States, with the highest rate of performance increase for Croatia (46.2%)" (European Commission, 2021, 25). However, Croatia has below average shares in areas of Climate change and in terms of innovation it lags behind in terms of "in-house business process innovators and Innovators that do not develop innovations themselves" (European Commission, 2021, 51).

In the past three years in which Horizon Europe has been running, Croatian projects so far are worth almost EUR 100 million, which is a little below 3% of total Union funds allocated to Member States within the new Horizon Framework and Croatia is taking 24th rank in terms of budget share from 27 Member States. Overall majority of these funds in Croatia were secured for Global Challenges and European Industrial Competitiveness pillar, followed by Widening participation and Strengthening the European Research Area and the lowest in Excellent Science pillar.

From total of 11 597 grant agreements signed on EU level, Croatia has ensured 2.4% or 279 of them with total of 424 of organizations involved, taking 22nd place in total Union rating regarding participation. In terms of ratio between retained proposals to total number of eligible applications, Croatia has improved its performance in comparison with Horizon 2020, where it now stands at 17.39% (jump from H2020 where that percentage was 13.55%), but still cutting short of 21.24% of EU average. Application rate and the frequency clearly varies and there is still a problem of

regional disparity, where the city of Zagreb is incomparably ahead of the rest of Croatia. For example, from total of 434 organizations involved as many as 256 are in the city of Zagreb, followed by 53 organizations from Primorsko-goranska county and Splitsko-dalmatinska County with 31 organizations involved. The lowest levels of participation are recorded in Slavonian and Pannonian Croatia, which is significantly behind the aforementioned City of Zagreb and Adriatic Croatia. When it comes to collaborating with other Member States in Horizon Europe, Croatian top collaborations are with partners in Italy, Spain and Germany making up 273 collaborative projects which add up to 2.35% of total EU average.

In terms of types of organizations regarding EU contribution, there has been a shift regarding results from 8th Framework (Horizon 2020). As of now, Private for-profit entities make up 49.2% of total EU net contribution, followed by Higher or Secondary Education Establishments (previously more successful) with 31.7% and Research organizations (10.8%) and Public bodies (9.5%). Top ranked organizations regarding participation are not new actors but rather University of Zagreb with its Faculty of Electrical Engineering and Computing continues to thrive and is followed by Ruder Boskovic Institute and company Research and Innovation Services DOO. In terms of top ranked institutions regarding EU funds, Faculty of Electrical Engineering and Computing is significantly ahead with EUR 7.3 million received, followed by Jadrolinija and GENOS DOO with EUR 4.2 million ensured each (Horizon Dashboard 2024).

As a part of Horizon Europe Framework, Croatia has 1 European Research Council principal investigator (researcher applying for grant from ERC grant) and 278 experts involved in research and innovation programs evaluation process (Horizon Dashboard 2024). In European Innovation Council participation (defined as participation of legal entity in grant agreement selected from EIC specific calls for proposals), Croatia is involved 7 of those grant agreements and regarding Marie Skłodowska-Curie actions 39 of Croatian organizations were involved.

Challenges and restrictions on the use of EU funds

As previously demonstrated, the European Union's investment portfolio in technological development consists of a wide range of funds. Successful management of that range and creation

of greater synergy between existing funds results in far greater outcomes compared to individual programs on their own. This was a reason to launch greater synergy when "2014-2020 legal frameworks of Horizon 2020 and the ESIFs included a specific request to establish synergies between the two programs" (European Court of Auditors, 2022, 4). European Structural and Investment Funds have "...helped to train millions of people with low skills, many of them gaining formal qualifications" (European Commission, 2024) and were one of the main instruments used to face the economic impact of COVID-19 pandemic, fostering socioeconomic change, more cohesion and economic recovery and growth. Specifically, the European Regional Development Fund allocated almost all resources within ESI fund for supporting more social, greener and more connected Europe. Importance of funding synergies continues to grow since late 2000s and both the newest R&D framework – Horizon Europe – "...and the funds implementing cohesion policy (the ESIFs' successor) place even more importance on synergies..." particularly "...Horizon Europe Regulation...which underlines the importance for Member States and the Commission of strengthening coordination and establishing synergies and complementarities with Horizon Europe" (European Court of Auditors, 2022, 7).

The European Court of Auditors (ECA), established by 1993 Maastricht Treaty, represents the supreme audit institution of the European Union performing a crucial task for bettering accountability and transparency by scrutinizing the EU's finances. ECA prepares reports examining EU's revenues and expenditures concluding on legality and regularity of transactions, provides recommendations and informs policymakers and citizens (European Court of Auditors, 2024). In its Special report: *Synergies between Horizon 2020 and European Structural and Investment Funds* ECA introduced 4 types of synergies regarding funding. Upstreamed sequential funding implies use of ESI funding for actions and capacities needed to participate in EU programs such as Horizon as well in international networks while downstreamed sequential funding implies benefiting from projects which are already implemented while utilizing and dispersing their results (European Court of Auditors, 2022, 8). Alternative funding means providing good ideas with ESI funds if the funding was not provided by Horizon due to financial insufficiency and lastly complementary funding opts for funding from both Horizon and ESI Funds in the same undertaking (European Court of Auditors, 2022, 8).

During the implementation of the Horizon 2020 project, shortcomings were observed regarding the full exploitation of synergistic potential. While measures to create upstream synergies were successfully carried out, the same cannot be said for downstream synergies. European Court of Auditors identified “...the lack of alignment between rules and regulations, limited cooperation between the two programs’ research and innovation stakeholders, and the absence of interoperability between their databases...” (European Court of Auditors, 2022, 33) as main constraints, as well as no monitoring system for synergies which made it significantly more difficult to identify obstacles and solve issues. Another problem occurs regarding cooperation within and among the political bodies (Commission, Member States). The planned institutionalization of the "synergy-seeking" dialogue was poorly executed as “Commission did not put in place a regular and structured dialogue process involving relevant Commission DGs and national players responsible for designing and implementing the two programs” (European Court of Auditors, 2022, 14). All of this resulted in the already mentioned Horizon Europe Regulation, especially Annex IV devoted exclusively to synergies aimed to ensure strengthening the European Research Area, regional and local ecosystems and supporting education and developing relevant skills in Europe. Another regulatory change is presented in the Common Provisions Regulation, further strengthening synergies defining they “should be sought in particular between the Funds and other relevant instruments... Those synergies should be achieved through user-friendly key mechanisms, namely the recognition of flat rates for eligible costs from Horizon Europe for a similar operation and the possibility of combining funding from different Union instruments in the same operation as long as double financing is avoided” (EUR-lex, 2024).

CONCLUSION

The findings of this thesis underscore the role that EU financial instruments, particularly Horizon 2020 and Horizon Europe, have played in shaping the development of Croatia's technology sector. Although numerous development programs and strategies concerning innovation capacity and the development of science and research have been adopted in Croatia, their initiatives and results are marginally visible in the use of European funds. The overall impact of these funds remains constrained by structural and systemic issues within the country. These include insufficient domestic investment in research and development, bureaucratic hurdles, relatively low level of

industry-academia collaboration, as well as the weak success rates of Croatian applicants in securing EU funds. In participation in the Horizon 2020 program, Croatia ranked 24th out of 28 members at the time in terms of the use of funds, receiving EUR 137.7 million or 0.2% of the total funds covered by the Horizon project, in the Digital Europe program that percentage is set at 1.43%, and in Horizon Europe it rose to just below 3%.

The biggest obstacles to Croatian participation in such European projects are the lack of support from the parent institutions of potential applicants, lack of national support, as well as complicated European regulatory and administrative procedures. Croatia is an inseparable part of European Union, therefore the unfavorable climate of the European technology sector in the form of a lack of venture capital, immigration of qualified labor and different legal and tax landscapes of Member States significantly affect the Croatian technology industry and expansion of its enterprises outside the domestic market. In terms of participation in Union Frameworks, Croatia is also at the bottom of the European scale, where the same few institutions are the most frequent participants in European programs, whereby the Ruđer Bošković Institute and the University of Zagreb with the Faculty of Electronics and Computing significantly stand out. There is also a big problem of regional disparity, where the City of Zagreb and, to a lesser extent, Adriatic Croatia are significantly ahead of the rest of Croatia, which, according to the National Recovery and Resilience Plan, will try to be solved by smart specialization, the results of which are still to be documented.

What is also evident is that, despite all the above, the Croatian technology sector is growing, adapting to the European market and becoming more adaptive to European standards, as evidenced by the fact that in terms of successful application to Horizon projects, Croatia has improved its performance by almost 4% (from 13.6% in 2021 to 17.4% in 2024). Another positive finding based on “the results of a number of surveyed empirical studies demonstrate that SMEs that participate in EU-funded projects deliver a substantial number of innovations, showing that participation in such projects is beneficial for advancing innovation and commercialization activities, as well as for technological and economic performance and efficiency” (Čučković, Vučković, 2018, 120). However Croatian small and medium enterprises have yet to use full potential of such funded projects. Nevertheless, IT is becoming more and more important in Croatian economy, although still quite low, IT sector share in GDP in 2018 was 2.1% and in 2022 it rose to 3.6% (Croatian Chamber of Commerce, 2023, 7). Growth is also visible in terms of the number of IT companies,

the number of employees in the technology sector and the industry's income, as well as in investments in fixed assets and especially in investment in research and development.

In order to realize greater potential in this area, it is necessary to regulate the domestic climate and improve the absorption of EU funds through reduction of regional fragmentation, strengthening of cooperation between the competent Ministries and the National Support System with relevant stakeholders, the establishment of meaningful financial national programs (for example through grant and loan schemes) aimed at increasing the cooperation of the scientific and entrepreneurial sectors, the establishment of responsive national monitoring and support system to encourage research and innovation in companies and ease regulatory burden.

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