**Evaluation of the knowledge society in the Danube region (2010-2024)**

June 2025 Version 1.0

**Content**

[**Graphs 3**](#_Toc202166677)

[**Tables 4**](#_Toc202166678)

[**Acronyms 5**](#_Toc202166679)

[**1. Introduction 6**](#_Toc202166680)

[**2. Methodology 7**](#_Toc202166681)

[**3. Assessment of the knowledge society in the Danube region 8**](#_Toc202166682)

[**3.1. Investments to research and innovation 12**](#_Toc202166683)

[**3.2. Investments in talent and human resources 14**](#_Toc202166684)

[**3.3. Activities (cooperation between stakeholders and mobility) 17**](#_Toc202166685)

[**3.4. Outputs from research and innovation activities 25**](#_Toc202166686)

[**3.5. Short-term and long-term effects 29**](#_Toc202166687)

[**4. Evaluation of current best practice and SWOT analysis of PA7 32**](#_Toc202166688)

[**5. Recommendations for improving the current situation 34**](#_Toc202166689)

# **Graphs**

[Graph 1 European Innovation Scoreboard - Summary Innovation Index 9](#_Toc202166631)

[Graph 2 European Innovation Scoreboard - Summary Innovation Index - progress 9](#_Toc202166632)

[Graph 3 Regional Innovation Scoreboard - Innovation Index 11](#_Toc202166633)

[Graph 4 R&D investments (%GDP) 12](#_Toc202166634)

[Graph 5 R&D investments (mil. €) 13](#_Toc202166635)

[Graph 6 R&D investments in the business sector 13](#_Toc202166636)

[Graph 7 Gross graduation ratio from first degree programmes (ISCED 6 and 7) in tertiary education (%) 14](#_Toc202166637)

[Graph 8 Graduation ratio in tertiary education, 25-34 years(%) 15](#_Toc202166638)

[Graph 9 Graduates at doctoral level, in science, math., computing, engineering, manufacturing, construction, by sex - per 1000 of population aged 25-34 15](#_Toc202166639)

[Graph 10 Researchers per million ihnabitants (FTE) 16](#_Toc202166640)

[Graph 11 Researchers - % Female 17](#_Toc202166641)

[Graph 12 Innovative companies (%) 18](#_Toc202166642)

[Graph 13 Enterprises that co-operated on business activities with other entities (%) 18](#_Toc202166643)

[Graph 14 Venture capital expenditures (% of GDP) 19](#_Toc202166644)

[Graph 15 EU contribution and participation in Horizon Europe 20](#_Toc202166645)

[Graph 16 EU contribution and participation in Horizon Europe per capita 21](#_Toc202166646)

[Graph 17 EU contribution and participation in Horizon Europe per researcher (FTE) 21](#_Toc202166647)

[Graph 18 Success rate in Horizon Europe 22](#_Toc202166648)

[Graph 19 Average EU Contribution per participation 23](#_Toc202166649)

[Graph 20 Scientific publications among the top 10% most cited 25](#_Toc202166650)

[Graph 21 Number of publication and growth by country with other countries in the Danube region 26](#_Toc202166651)

[Graph 22 PCT patent applications per billion GDP (in PPS) 27](#_Toc202166652)

[Graph 23 SMEs introducing product innovations (% share) 29](#_Toc202166653)

[Graph 24 Employment in knowledge-intensive activities (% share) 30](#_Toc202166654)

[Graph 25 Sales of new-to-market and new-to-firm innovations (%) 31](#_Toc202166655)

[Graph 26 Knowledge-intensive services exports (% share) 31](#_Toc202166656)

# **Tables**

[Table 1 Cooperation between countries in the Danube region 23](#_Toc202166657)

[Table 2 Participation in MSCA 24](#_Toc202166658)

[Table 3 Participation in ERC 24](#_Toc202166659)

[Table 4 Number of publications per million population 25](#_Toc202166660)

[Table 5 EPO patent applications (2019-2024) 27](#_Toc202166661)

[Table 6 European patent applications per million population 28](#_Toc202166662)

[Table 7 Number of EPO patents 28](#_Toc202166663)

[Table 8 Number of EPO patents 29](#_Toc202166664)

[Table 9 SWOT Analysis 33](#_Toc202166665)

# **Acronyms**

|  |  |
| --- | --- |
| Acronyms – Danube region countries and regions | AT – Austria; BA – Bosnia and Herzegovina; BG – Bulgaria; CZ – Czechia; DE – Germany; HR – Croatia; HU – Hungary; MD – Moldova; ME – Montenegro; RO – Romania; RS – Serbia; SI – Slovenia; SK – Slovakia; UA – Ukraine; BAV – Bavaria; BW - Baden-Württemberg |
| Acronyms – other countries | BE – Belgium; CY – Cyprus; DK – Denmark; EE – Estonia; EL – Greece; ES – Spain; FI – Finland; FR – France; CH – Switzerland; IE – Ireland; IL – Israel; IS – Iceland; IT - Italy; LT – Latvia; LU – Luxembourg; LV – Lithuania; MT – Malta, NL – Netherland; NO – Norway; PL – Poland; PT – Portugal; SE – Sweden; TR – Turkey; UK – United Kingdom |
| ERC | European Research Concil |
| MSCA | Marie Skłodowska-Curie Actions |
| SME | Small and medium-sized enterprise |

# **Introduction**

This analysis constitutes the third edition of the evaluation of the state of the knowledge society in the Danube Region. While the first assessment covered the period 2010–2018 and the second extended to 2020, the current edition encompasses developments up to 2024. It builds upon the previous analyses by incorporating progress achieved over the past four years and by offering new insights into the evolution of the knowledge society across the region.

The primary objective of this analysis is to provide an up-to-date overview of the status and progress made in the field of knowledge society development in the Danube countries. The analysis focuses on **Priority Area 7 – Knowledge Society**, which includes research, education, and information and communication technologies (ICT), and is jointly coordinated by Slovakia and Serbia.

The structure of the analysis is composed of three main parts:

1. **Assessment of the Knowledge Society in the Danube Region**  
   This section provides a comprehensive evaluation of the current state of the knowledge-based economy in the region. It applies both quantitative and qualitative methodologies to assess the progress made by individual countries compared to previous years. This key chapter is structured around five thematic areas:
   * Investments in research and innovation
   * Investments in talent and human resources
   * Activities (cooperation among stakeholders and mobility)
   * Outputs from research and innovation activities
   * Short-term and long-term effects
2. **Evaluation of Current Best Practices and SWOT Analysis of Priority Area 7**  
   This section summarises the key findings from the analytical part and presents a structured assessment of strengths, weaknesses, opportunities, and threats (SWOT) relevant to the implementation of Priority Area 7.
3. **Recommendations for Improving the Current Situation**  
   The final section outlines a set of policy recommendations aimed at enhancing cooperation among countries in the Danube Region and strengthening the overall performance of the knowledge society.

This evaluation was commissioned by the **Ministry of Education, Science, Research and Sport of the Slovak Republic** and implemented by the **Slovak Centre of Scientific and Technical Information**.

# **Methodology**

This analysis primarily focuses on assessing the state of the knowledge society in the countries of the Danube Region. Particular attention is devoted to the domains of research and innovation, as well as to other areas that significantly contribute to the development of a knowledge-based society. Where data availability permits, the analysis covers the period from 2010 to 2024. In cases where full time-series data are not available, reference years include 2014, 2017, 2019, and 2023 (or 2024, where applicable).

The evaluation draws on data from a range of internationally recognised sources, including Eurostat, the OECD, UNESCO, the European Patent Office, the E-CORDA database, and the Web of Science Core Collection, as well as the European Innovation Scoreboard.

A mixed-methods approach is applied, combining both quantitative and qualitative methodologies. The primary focus is on the countries of the Danube Region; however, where relevant, comparisons are also made with other EU Member States. As with previous editions, the current analysis is constrained by the availability of data, particularly for countries that are not members of the EU.

The participating countries and regions of the EU Strategy for the Danube Region (EUSDR) are categorised into four groups:

* **EU Member States**: Austria, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Romania, Slovakia, and Slovenia;
* **Accession Countries**: Bosnia and Herzegovina, Montenegro, and Serbia;
* **Associated Countries**: Moldova and Ukraine;
* **Regions**: Bavaria and Baden-Württemberg.

The Danube Region comprises both countries and regions. The first level of differentiation is between national and regional entities. The second distinction is between EU Member States (9) and non-EU countries (5). A further significant differentiation lies in the size of the countries: Germany alone accounts for over 41% of the region’s total population.

Finally, there are substantial disparities in research and innovation performance across the region. These differences necessitate the frequent use of qualitative comparisons, particularly where quantitative data are limited or not directly comparable.

# **Assessment of the knowledge society in the Danube region**

As in the previous analysis, the current assessment of the knowledge society is structured into five interrelated and complementary domains, which together form the innovation chain. The analysis focuses on a comparative evaluation of the years 2010, 2017, and 2023 (or 2024, where applicable). In cases where data are unavailable or the methodology has changed (e.g. in the European Innovation Scoreboard), the comparison is based on the two most recent years.

The innovation chain is broken down into five key components representing the innovation process:

1. Investments in research and innovation
2. Investments in talent and human resources
3. Innovation activities (collaboration among stakeholders, mobility)
4. Outputs of research and innovation (scientific publications, citations, patents)
5. Short-term and long-term impacts (increased innovation, productivity, exports)

The analysis begins with a general overview based on data and reports prepared by the European Commission, particularly the composite indicator used to measure the state and progress of innovation across EU Member States – the European Innovation Scoreboard (EIS). In addition to tracking progress, the EIS enables cross-country comparisons. It comprises 32 indicators covering the entire innovation chain and aims to provide feedback to countries on the performance of their innovation systems. The indicators span areas such as education, research, innovation, and market activities.

Based on the composite indicator, countries are classified into four performance groups:

* Innovation Leaders
* Strong Innovators
* Moderate Innovators
* Emerging Innovators

Among the countries of the Danube Region, none are classified as Innovation Leaders. Austria and Germany are part of the Strong Innovators group. Slovenia, the Czech Republic, and Hungary fall into the Moderate Innovators category. All other countries are classified as Emerging Innovators. The comparative analysis clearly shows that Innovation Leaders are predominantly located in Northern Europe and the Benelux countries. Within the Danube Region, Austria has the highest innovation index, while Moldova, Ukraine, and Bosnia and Herzegovina rank the lowest.

**Graph 1 European Innovation Scoreboard - Summary Innovation Index**

*Source: European Innovation Scoreboard 2024*

Compared to 2017, the most significant improvement in the European Innovation Scoreboard (EIS) in 2024 was recorded by the Czech Republic and Croatia. In contrast, the lowest progress was observed in Moldova, Romania, and Slovakia. In terms of relative progress, the highest increases were achieved by Croatia, Bosnia and Herzegovina, and the Czech Republic, while the lowest were recorded by Moldova, Germany, and Austria.

**Graph 2 European Innovation Scoreboard - Summary Innovation Index - progress**

*Source: European Innovation Scoreboard 2024*

In addition to the EIS, the European Commission also publishes the Regional Innovation Scoreboard (RIS), which compares innovation performance across EU regions. This index does not include regions from non-EU countries (except for Serbia), and therefore data for four countries in the region are missing.

The chart below presents a comparison of the innovation index relative to the EU average (set at 100). Among the regions in the Danube Region, the highest innovation scores are recorded in four German regions: Oberbayern, Karlsruhe, Tübingen, and Mittelfranken. These are followed by Prague. Outside of Germany and Austria, only five other regions in the Danube Region exceed the EU average—two from Slovenia, two from the Czech Republic, and one from Hungary. Conversely, only one German region falls below the EU average. The least innovative regions are in Romania and Bulgaria.

At the EU level, the most innovative regions are Hovedstaden (Denmark), Etelä-Suomi (Finland), and Oberbayern (Germany), which ranks third.

**Graph 3 Regional Innovation Scoreboard - Innovation Index**

*Source: European Innovation Scoreboard 2024*

## **Investments to research and innovation**

Within the Danube Region, there are significant disparities in investments in research and innovation. While Baden-Württemberg reached as much as 5.59% of GDP in 2021, Bosnia and Herzegovina invested only 0.19%. As with other indicators, Austria and Germany lead in R&I investments, being the only countries in the region that invest more than 3% of their GDP. They are followed by Slovenia (2.13%), and then by countries investing between 1% and 2% of GDP. Less than 1% is invested by Serbia, Bulgaria, Romania, Moldova, Montenegro, Ukraine, and Bosnia and Herzegovina.

**Graph 4 R&D investments (%GDP)**

*Data: GERD by sector of performance [rd\_e\_gerdtot\_\_custom\_15359980]; UNESCO; World Bank*

*Note: BW, BAV (2011, 2021); BA(2009,2022); ME (2011, 2019); MD (2022)*

In 2023, total investments in research and innovation in the Danube Region amounted to €161.5 billion. In terms of absolute funding, Germany clearly dominates, accounting for as much as 80% of these investments. Altogether, Germany invested nearly €130 billion. It is followed by Austria (€15.58 billion) and the Czech Republic (€5.82 billion). Both German regions also invest significantly more than other countries in the Danube Region—Bavaria (€22.5 billion) and Baden-Württemberg (€30.35 billion).

On the other end of the spectrum, the lowest levels of investment were recorded in Montenegro (€17.98 million), Moldova (€34.28 million), and Bosnia and Herzegovina (€43.1 million). The absolute disparities in R&I investments across the Danube Region are so substantial that, if Germany were excluded, Austria’s share would rise to 49% of the region’s total investments.

**Graph 5 R&D investments (mil. €)**

|  |  |
| --- | --- |
|  |  |

*Data: GERD by sector of performance [rd\_e\_gerdtot\_\_custom\_15359980]*

*Note: BW, BAV (2011), BA (2012, 2019)*

Private sector investments in research and innovation provide insight into how intensively companies invest in these areas. Since corporate investments are primarily directed toward activities that are close to the market or expected to have market applications, they also reflect the level of innovation activity among firms in individual countries. From this perspective, private investments are highest in Germany (1.93% of GDP), Austria (1.68% of GDP), and Slovenia (0.93% of GDP). Conversely, the lowest levels are observed in Serbia (0.01% of GDP), Bosnia and Herzegovina, and Montenegro (0.07% of GDP).

**Graph 6 R&D investments in the business sector**

*Data: Eurostat; https://doi.org/10.2908/RD\_E\_GERDFUND*

*Note: AT, CZ, RS (2023); DE, EU (2021); ME (2011, 2014); BA (2012, 2019, 2021*

## **Investments in talent and human resources**

Investments in talent represent the second fundamental pillar for building innovation-driven economies.

The highest share of graduates at the bachelor's and master's levels is observed in Bulgaria (53.77%), followed by Germany (47.16%) and Croatia (46.70%). In contrast, the lowest shares are recorded in Hungary (32.12%), Bosnia and Herzegovina (33.96%), and Montenegro (35.09%). Ukraine recorded the highest increase in the number of graduates compared to 2017, with a growth of 37.52%. Austria (13.2%) and Romania (13.03%) follow with the second and third highest increases, respectively. On the other hand, the most significant decline in the number of graduates was observed in Montenegro (-8.18%).

**Graph 7 Gross graduation ratio from first degree programmes (ISCED 6 and 7) in tertiary education (%)**

*Data: UNESCO*

*Note: AT(2013,2018); BG(2020); BA(2009,2018); MD(2014,2020); ME(2010 - N/A, 2021); RO(2016); RS(2017, 2020-N/A); UA(2020)*

Austria has the highest share of tertiary education graduates among individuals aged 25–34 (43.5%). It is also the only country in the Danube Region where this share exceeds the EU average (43.1%). Slovenia and Montenegro also surpass the 40% threshold, which is one of the EU’s strategic priorities. In contrast, Romania (22.5%) and Bosnia and Herzegovina (26.6%) report the lowest shares, both below 30%.

The most significant increase since 2010 has been observed in Austria, where the share of graduates rose by 22.8 percentage points. Serbia and Slovakia follow, each with an increase of 15.8 percentage points. On the other hand, the smallest increases were recorded in Romania (1.8 percentage points) and Hungary (4.0 percentage points).

**Graph 8 Graduation ratio in tertiary education, 25-34 years(%)**

*Data: Eurostat;* [*https://doi.org/10.2908/EDAT\_LFS\_9903*](https://doi.org/10.2908/EDAT_LFS_9903)*; edat\_lfs\_9903*

*Note: BA (2010, 2017-N/A); ME (2011,2020)*

Another important indicator is the number of doctoral graduates in STEM fields per 1,000 inhabitants aged 25–34. This figure is highest in Germany (1.2), followed by the Czech Republic, Austria, and Slovenia (each at 0.8). In contrast, the lowest values are observed in Romania (0.3), and in Serbia, Hungary, and Bulgaria (each at 0.4).

In most countries, this indicator has remained stable over time. The only notable increase was recorded in Croatia, where the value rose by 0.2 between 2017 and 2022.

**Graph 9 Graduates at doctoral level, in science, math., computing, engineering, manufacturing, construction, by sex - per 1000 of population aged 25-34**

*Data: Eurostat; educ\_uoe\_grad07;* [*https://doi.org/10.2908/EDUC\_UOE\_GRAD07*](https://doi.org/10.2908/EDUC_UOE_GRAD07)

*Note: RS(2014)*

Austria also has the highest number of researchers (in full-time equivalents) per one million inhabitants, reaching 6,705. It is followed by Germany (5,811) and Slovenia (5,352). In contrast, the lowest numbers are observed in Bosnia and Herzegovina (535), Ukraine (580), and Montenegro (743).

The highest relative increase since 2010 was recorded in Hungary (121.35%), Bulgaria (77.5%), and Serbia (56.29%). On the other hand, the smallest increases were seen in Moldova (1%), Romania (2.49%), and Montenegro (15.46%). Ukraine experienced a dramatic decline of 56.27%, which is undoubtedly linked to the Russian military invasion in 2022.

**Graph 10 Researchers per million ihnabitants (FTE)**

*Data: UNESCO*

*Note: ME(2011, 2019); BA (2012)*

One of the EU’s priorities is to increase the share of female researchers to at least 40%. In the Danube Region, eight countries have already met this target. The highest shares are observed in Serbia (52.47%), Montenegro (52.08%), and Moldova (50.87%). In contrast, the lowest shares are found in the Czech Republic (27.69%), Hungary (28.76%), and Germany (29.36%).

Since 2010, the share of female researchers has increased in nine countries, while five countries have experienced a decline.

**Graph 11 Researchers - % Female**

*Data: UNESCO*

*Note: ME(2011; 2019); BA (2012); AT, DE (2011, 2021)*

## **Activities (cooperation between stakeholders and mobility)**

This section focuses primarily on collaboration among various innovation actors, as well as on their capacity to innovate.

The highest share of firms that implemented some form of innovation was recorded in Germany (63.4%), followed by Austria (56.7%) and Slovenia (55.4%). In contrast, the lowest shares were observed in Romania (8.8%), Bulgaria (26.1%), and Hungary (30.2%).

The most significant decline compared to 2012 occurred in Romania (a drop of 11.9 percentage points) and Germany (3.5 percentage points). Conversely, the largest increase was recorded in Slovenia (8.9 percentage points). In the remaining countries, a slight upward trend can be observed.

**Graph 12 Innovative companies (%)**

*Data: Eurostat, INN\_CIS11\_BAS; INN\_CIS8\_TYPE;INN\_CIS11\_BAS*

The highest share of firms engaged in collaborative business activities with other entities within the Danube Region is observed in Croatia (31.9%), Slovenia (26.1%), and Hungary (24.3%). On the other hand, the lowest levels of such collaboration are found in Bulgaria (9.3%), Romania (11.9%), and Slovakia (18.3%). The most significant increase was recorded in Austria, with a rise of 5.1 percentage points.

**Graph 13 Enterprises that co-operated on business activities with other entities (%)**

*Data: Eurostat, inn\_cis11\_co;* [*https://doi.org/10.2908/INN\_CIS11\_CO*](https://doi.org/10.2908/INN_CIS11_CO)*; inn\_cis13\_co;* [*https://doi.org/10.2908/INN\_CIS13\_CO*](https://doi.org/10.2908/INN_CIS13_CO)

*Note: NL(2018-N/A)*

Access to venture capital is one of the fundamental prerequisites for financing innovative companies. This is also one of the indicators where the EU significantly lags behind the United States. Across the EU, Estonia stands out with the highest venture capital investment, reaching 1% of GDP.

Among the countries of the Danube Region, Germany performs best (0.17% of GDP), and is the only country in the region above the EU average. It is followed by the Czech Republic (0.15%) and Austria (0.11%). The lowest levels of venture capital investment are observed in Moldova (0.02%), Romania, Serbia, and Slovakia (each at 0.03%).

**Graph 14 Venture capital expenditures (% of GDP)**

*Source: EIS 2024*

*Note: MD (2021); UA, UK (2023); BA (N/A)*

The ability of research institutions, universities, and companies to succeed in international competition for research and innovation funding depends largely on their quality. Horizon Europe is among the most competitive funding schemes globally. Success rates consistently remain well below 20%, and only the highest-performing institutions from Europe and beyond are able to secure funding.

Under the current framework programme – Horizon Europe – Germany is the most successful country in the Danube Region in quantitative terms, having secured €7.3 billion to date. It is followed by Austria (€1.14 billion) and the Czech Republic (€517 million). On the other end of the spectrum, the smallest contributions from the European Commission were awarded to Montenegro (€4.45 million), Moldova (€6.48 million), and Bosnia and Herzegovina (€9.15 million).

In terms of the distribution of EC contributions, a clear divide can be observed between EU Member States and non-member countries in the region. The only non-EU country to receive more than €100 million is Serbia (€122.28 million).

Germany also leads in the number of project participations (11,570), followed by Austria (2,972) and the Czech Republic (1,429). The lowest numbers of participations are recorded in Montenegro (32), Bosnia and Herzegovina (55), and Moldova (66).

**Graph 15 EU contribution and participation in Horizon Europe**

*Data: E-corda*

However, quantitative comparisons do not consider the size of individual countries or the scale of their research and innovation base. Therefore, the following chart presents a comparison of EU contributions per capita and the number of Horizon Europe participations per one million inhabitants.

Slovenia has the highest contribution per capita (€171.86), followed by Austria (€155.33) and Germany (€86.84). At the opposite end, the lowest contributions are recorded in Ukraine (€1.77), Moldova (€2.26), and Bosnia and Herzegovina (€2.91). A similar pattern emerges when comparing the number of participations per million inhabitants: Slovenia leads with 528, followed by Austria (326) and Croatia (143). Ukraine (8.6), Bosnia and Herzegovina (17.5), and Moldova (22) have the lowest participation rates.

**Graph 16 EU contribution and participation in Horizon Europe per capita**

*Data: E-corda*

An even more insightful qualitative comparison can be made by relating participation in Horizon Europe to the number of researchers in each country. From this perspective, Slovenia is the most successful country, with an average European Commission contribution of €32,106 per researcher. It is followed by Austria (€23,164) and Romania (€15,326). On the other end of the spectrum are Moldova (€2,816), Ukraine (€3,050), and Hungary (€4,307).

When looking at the number of participations per 1,000 researchers, Slovenia again ranks first (98), followed by Montenegro (68) and Romania (58). The lowest participation rates are observed in Ukraine (14), Hungary (17), and Germany (23).

**Graph 17 EU contribution and participation in Horizon Europe per researcher (FTE)**

*Data: E-corda*

The success rate for obtaining projects under Horizon Europe has slightly increased compared to Horizon 2020. Among the countries of the Danube Region, Moldova has the highest success rate (20.58%), followed by Slovakia (20.11%) and Hungary (19.86%). In contrast, the lowest success rates are observed in Bosnia and Herzegovina (13.59%), Montenegro (14.36%), and Ukraine (14.42%).

**Graph 18 Success rate in Horizon Europe**

*Data: E-corda*

Several factors influence the amount of EU contribution received. These include the roles of institutions within projects, as well as labor costs—particularly researcher salaries in individual countries. Another important factor is the role of institutions in project coordination, as coordinators typically receive higher EU contributions.

Among EU countries, Germany has the highest average EU contribution per participation (€631,076), followed by Austria (€476,311) and the Czech Republic (€362,027). On the other hand, the lowest average contributions are recorded in Moldova (€98,200), Montenegro (€139,099), and Bosnia and Herzegovina (€166,448).

**Graph 19 Average EU Contribution per participation**

*Data: E-corda*

The most intensive collaboration in Horizon Europe projects is between Germany and Austria, with 1,184 joint participations. Countries collaborate most frequently with German institutions. Following Austria, the strongest partnerships are observed with the Czech Republic (650) and Slovenia (468). In contrast, collaboration is relatively weak among non-EU countries.

**Table 1 Cooperation between countries in the Danube region**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **AT** | **BA** | **BG** | **CZ** | **DE** | **HR** | **HU** | **MD** | **ME** | **RO** | **RS** | **SI** | **SK** | **UA** |
| **AT** | 1929 | 14 | 134 | 300 | 1184 | 132 | 203 | 22 | 8 | 238 | 87 | 241 | 129 | 61 |
| **BA** |  | 44 | 13 | 8 | 25 | 16 | 9 | 5 | 5 | 12 | 15 | 15 | 6 | 4 |
| **BG** |  |  | 415 | 93 | 278 | 74 | 81 | 20 | 9 | 133 | 47 | 62 | 84 | 37 |
| **CZ** |  |  |  | 1009 | 650 | 71 | 150 | 22 | 5 | 152 | 52 | 146 | 118 | 54 |
| **DE** |  |  |  |  | 6019 | 233 | 400 | 41 | 15 | 492 | 221 | 468 | 246 | 156 |
| **HR** |  |  |  |  |  | 360 | 73 | 14 | 12 | 99 | 59 | 107 | 51 | 29 |
| **HU** |  |  |  |  |  |  | 586 | 15 | 7 | 136 | 121 | 54 | 89 | 41 |
| **MD** |  |  |  |  |  |  |  | 56 | 6 | 35 | 17 | 12 | 18 | 15 |
| **ME** |  |  |  |  |  |  |  |  | 24 | 9 | 10 | 9 | 7 | 4 |
| **RO** |  |  |  |  |  |  |  |  |  | 712 | 63 | 143 | 90 | 45 |
| **RS** |  |  |  |  |  |  |  |  |  |  | 351 | 77 | 33 | 26 |
| **SI** |  |  |  |  |  |  |  |  |  |  |  | 748 | 78 | 37 |
| **SK** |  |  |  |  |  |  |  |  |  |  |  |  | 334 | 42 |
| **UA** |  |  |  |  |  |  |  |  |  |  |  |  |  | 227 |

*Data: E-corda*

Support for researchers’ careers and mobility is one of the key components of Horizon Europe. These projects are primarily funded through the Marie Skłodowska-Curie Actions (MSCA). Every country in the Danube Region has at least one MSCA project.

Germany has received the highest EU contribution (€372.99 million), followed by Austria (€84.7 million) and the Czech Republic (€42.24 million). At the opposite end, Bosnia and Herzegovina (€297,550), Montenegro (€1.04 million), and Moldova (€1.48 million) received the lowest contributions. These three countries also have the lowest number of participations, with 6 and 12 respectively. The highest number of participations is recorded in Germany (2,222), Austria (507), and the Czech Republic (301).

**Table 2 Participation in MSCA**

|  |  |  |
| --- | --- | --- |
| **Country** | **EU contribution** | **Participations** |
| DE | 372 989 563,90 | 2 222 |
| AT | 84 697 613,48 | 507 |
| CZ | 42 237 757,00 | 301 |
| SI | 29 153 307,20 | 151 |
| HU | 14 075 274,46 | 113 |
| RO | 9 637 792,17 | 105 |
| RS | 6 826 315,94 | 56 |
| UA | 6 767 727,20 | 41 |
| HR | 4 925 073,76 | 60 |
| SK | 4 597 715,71 | 49 |
| BG | 4 236 990,41 | 69 |
| MD | 1 485 814,00 | 12 |
| ME | 1 036 529,30 | 6 |
| BA | 297 550,00 | 6 |

*Data: E-corda*

ERC grants are the most prestigious individual research grants in Europe. The high level of competition is reflected in the fact that four countries in the Danube Region have not received a single grant. Among non-EU countries, only Serbia has been awarded at least one ERC grant (2). The same number of grants has been awarded to Slovakia (2), while Bulgaria has received one.

Germany leads by a wide margin with 1,144 ERC grants, followed by Austria (217) and the Czech Republic (49). In terms of total EU contribution, Germany again ranks first (€1.86 billion), followed by Austria (€332.47 million) and the Czech Republic (€74.05 million).

**Table 3 Participation in ERC**

|  |  |  |
| --- | --- | --- |
| **Country** | **EU contribution** | **Participations** |
| DE | 1 865 583 878,38 | 1 144 |
| AT | 332 478 294,48 | 217 |
| CZ | 74 045 071,00 | 49 |
| SI | 36 222 663,75 | 27 |
| HU | 27 214 239,50 | 18 |
| RO | 9 093 251,00 | 4 |
| HR | 4 147 500,00 | 5 |
| SK | 1 776 265,00 | 2 |
| RS | 1 571 239,00 | 2 |
| BG | 143 625,00 | 1 |

*Data: E-corda*

## **Outputs from research and innovation activities**

The primary outputs of research and innovation activities are publications and patents. The quality of publications can be assessed by the number of citations they receive. At the country level, one of the key indicators of publication quality is the share of publications among the top 10% most cited globally.

Within the EU, the Netherlands has the highest share of such publications (14.39%). It is followed by two non-EU countries—the United Kingdom (13.84%) and Switzerland (13.78%). Among the countries of the Danube Region, Austria leads with 10.5%, followed by Germany (10.38%) and Slovenia (7.79%). The lowest shares are observed in Moldova (2.31%), Ukraine (2.84%), and Bosnia and Herzegovina (3.09%).

**Graph 20 Scientific publications among the top 10% most cited**

*Source: EIS 2024*

In 2024, Austria recorded the highest number of scientific publications per one million inhabitants (3,605), followed by Slovenia (3,506) and the Czech Republic (2,244). The lowest numbers were observed in Moldova (207), Ukraine (331), and Bosnia and Herzegovina (550). The differences between countries in the Danube Region are substantial.

**Table 4 Number of publications per million population**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
| AT | 2 287 | 2 393 | 2 497 | 2 617 | 2 826 | 2 945 | 3 151 | 3 197 | 3 319 | 3 534 | 3 662 | 3 896 | 3 724 | 3 568 | 3 605 |
| BA | 279 | 290 | 279 | 273 | 287 | 359 | 376 | 457 | 472 | 511 | 532 | 512 | 522 | 473 | 550 |
| BG | 548 | 529 | 621 | 643 | 662 | 662 | 758 | 834 | 872 | 993 | 925 | 936 | 888 | 938 | 1 020 |
| HR | 1 491 | 1 617 | 1 632 | 1 624 | 1 711 | 1 779 | 1 859 | 2 008 | 2 123 | 2 267 | 2 304 | 2 486 | 2 406 | 2 316 | 2 207 |
| CZ | 1 678 | 1 695 | 1 790 | 1 888 | 2 179 | 2 392 | 2 449 | 2 479 | 2 432 | 2 568 | 2 428 | 2 514 | 2 316 | 2 225 | 2 244 |
| DE | 1 773 | 1 820 | 1 879 | 1 936 | 2 040 | 2 097 | 2 203 | 2 235 | 2 275 | 2 437 | 2 406 | 2 545 | 2 387 | 2 239 | 2 242 |
| HU | 920 | 940 | 1 006 | 1 063 | 1 170 | 1 173 | 1 202 | 1 256 | 1 317 | 1 385 | 1 401 | 1 483 | 1 494 | 1 455 | 1 543 |
| MD | 171 | 178 | 190 | 209 | 202 | 208 | 246 | 213 | 249 | 239 | 237 | 204 | 190 | 209 | 207 |
| ME | 475 | 473 | 549 | 653 | 658 | 816 | 892 | 984 | 1 005 | 1 070 | 1 179 | 1 234 | 1 180 | 1 092 | 1 299 |
| RO | 808 | 811 | 868 | 950 | 1 011 | 1 083 | 1 015 | 1 034 | 1 028 | 1 126 | 977 | 984 | 1 007 | 978 | 1 056 |
| RS | 938 | 1 010 | 1 273 | 1 205 | 1 210 | 1 250 | 1 273 | 1 293 | 1 245 | 1 386 | 1 291 | 1 385 | 1 359 | 1 326 | 1 396 |
| SK | 992 | 955 | 1 127 | 1 226 | 1 515 | 1 572 | 1 736 | 1 771 | 1 667 | 1 742 | 1 671 | 1 611 | 1 465 | 1 489 | 1 478 |
| SI | 2 308 | 2 552 | 2 625 | 2 741 | 2 804 | 2 916 | 3 041 | 3 062 | 3 142 | 3 397 | 3 503 | 3 938 | 3 409 | 3 392 | 3 506 |
| UA | 202 | 223 | 235 | 253 | 274 | 280 | 298 | 343 | 354 | 364 | 402 | 388 | 375 | 343 | 331 |

*Data: InCites*

The highest growth in the number of scientific publications in 2024 compared to 2010 was recorded in Montenegro, with an increase of 173.7%, followed by Bosnia and Herzegovina (97.3%) and Bulgaria (86.2%). In contrast, the lowest growth was observed in Moldova (20.9%), Romania (30.7%), and the Czech Republic (33.7%). On a positive note, the number of publications has increased across the entire region, with an average growth rate of 35.9%.

**Graph 21 Number of publication and growth by country with other countries in the Danube region**

*Data: InCites*

Patent activity reflects the efforts of innovators to protect their results. Given the complexity and cost of the patenting system, it is typically the highest-quality outputs that are protected. Within the EU, the highest number of PCT patent applications per one billion euros of GDP is recorded in Sweden (8.59), Finland (7.5), and Denmark (6.7).

Among the countries of the Danube Region, only Germany and Austria are above the EU average. Germany has 5.77 patents per billion euros of GDP, and Austria 4.78. The lowest numbers of patent applications are observed in Montenegro (0.12), Romania (0.17), and Moldova (0.21).

**Graph 22 PCT patent applications per billion GDP (in PPS)**

*Source: EIS 2024*

Germany leads with the highest number of patent applications, totaling 25,033. The patent applications granted in Germany are nearly 8.5 times the total number of patent applications within the Danube region. Significant disparities in patent activities can be observed among the countries. Following Germany are Austria with 2,146 applications and the Czech Republic with 252. In three countries—Moldova, Montenegro, and Bosnia and Herzegovina—the number of patent applications granted in 2024 is less than 10.

**Table 5 EPO patent applications (2019-2024)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** |
| **AT** | 2 346 | 2 306 | 2 309 | 2 381 | 2 332 | 2 146 |
| **BA** | 2 | 4 | 1 | 7 | 8 | 6 |
| **BG** | 35 | 54 | 43 | 46 | 41 | 53 |
| **CZ** | 203 | 206 | 201 | 222 | 239 | 252 |
| **DE** | 26 762 | 25 882 | 25 891 | 24 612 | 24 942 | 25 033 |
| **HR** | 19 | 23 | 27 | 32 | 52 | 41 |
| **HU** | 97 | 109 | 119 | 104 | 109 | 139 |
| **MD** | 2 | 1 | 3 | 0 | 0 | 3 |
| **ME** | 0 | 2 | 1 | 0 | 0 | 6 |
| **RO** | 40 | 55 | 31 | 46 | 42 | 63 |
| **RS** | 9 | 8 | 20 | 13 | 14 | 20 |
| **SI** | 122 | 165 | 116 | 123 | 153 | 156 |
| **SK** | 42 | 54 | 43 | 48 | 56 | 62 |
| **UA** | 21 | 18 | 29 | 18 | 23 | 20 |

*Data: EPO*

As with other comparisons, it is not entirely appropriate to compare countries of different sizes directly. When we look at the number of patent applications per million inhabitants, the situation adjusts slightly. Germany still has the most applications (297), followed by Austria (235) and Slovenia (73). Conversely, half of the countries in the region have fewer than 10 applications per million inhabitants. Ukraine has the fewest (0.51), followed by Moldova (1) and Bosnia and Herzegovina (1.91).

**Table 6 European patent applications per million population**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** |
| **AT** | 257,43 | 253,05 | 253,37 | 261,28 | 255,90 | 235,49 |
| **BA** | 0,64 | 1,27 | 0,32 | 2,23 | 2,55 | 1,91 |
| **BG** | 5,21 | 8,04 | 6,40 | 6,85 | 6,11 | 7,89 |
| **CZ** | 19,13 | 19,42 | 18,95 | 20,93 | 22,53 | 23,75 |
| **DE** | 318,31 | 307,84 | 307,95 | 292,74 | 296,66 | 297,75 |
| **HR** | 4,94 | 5,98 | 7,02 | 8,32 | 13,51 | 10,65 |
| **HU** | 10,07 | 11,32 | 12,35 | 10,80 | 11,32 | 14,43 |
| **MD** | 0,67 | 0,33 | 1,00 | 0,00 | 0,00 | 1,00 |
| **ME** | 0,00 | 3,16 | 1,58 | 0,00 | 0,00 | 9,49 |
| **RO** | 2,12 | 2,91 | 1,64 | 2,43 | 2,22 | 3,33 |
| **RS** | 1,35 | 1,20 | 2,99 | 1,94 | 2,09 | 2,99 |
| **SI** | 57,63 | 77,94 | 54,79 | 58,10 | 72,27 | 73,69 |
| **SK** | 7,67 | 9,86 | 7,86 | 8,77 | 10,23 | 11,33 |
| **UA** | 0,54 | 0,46 | 0,74 | 0,46 | 0,59 | 0,51 |

*Data: EPO*

Patent applications primarily represent efforts to protect intellectual property, while granted patents signify actual protection. Similar to applications, we can observe Germany's dominance in granted patents, with 15,541 patents in 2024. Austria had over ten times fewer patents granted (1,508), and the Czech Republic had over ten times fewer again (144). In Bosnia and Herzegovina and Montenegro, no patents were granted in 2024, and only one was granted in Moldova.

**Table 7 Number of EPO patents**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** |
| **AT** | 1 663 | 1 756 | 1 327 | 1 151 | 1 504 | 1 508 |
| **BA** | 0 | 0 | 1 | 0 | 0 | 0 |
| **BG** | 16 | 18 | 23 | 22 | 23 | 22 |
| **CZ** | 172 | 154 | 133 | 85 | 134 | 144 |
| **DE** | 21 198 | 20 056 | 16 507 | 12 563 | 15 012 | 15 541 |
| **HR** | 13 | 10 | 7 | 13 | 8 | 7 |
| **HU** | 74 | 79 | 53 | 54 | 63 | 56 |
| **MD** | 0 | 2 | 0 | 0 | 0 | 1 |
| **ME** | 0 | 0 | 0 | 0 | 0 | 0 |
| **RO** | 14 | 23 | 12 | 16 | 23 | 19 |
| **RS** | 6 | 5 | 2 | 3 | 6 | 6 |
| **SI** | 72 | 95 | 79 | 46 | 58 | 97 |
| **SK** | 34 | 15 | 33 | 17 | 23 | 30 |
| **UA** | 6 | 7 | 8 | 5 | 14 | 6 |

*Data: EPO*

When recalculating the number of granted patents per million inhabitants, we observe the highest number of EPO patents in Germany (185) and Austria (165), followed by Slovenia (46) and the Czech Republic (14). Only these four countries have more than 10 granted patents per million inhabitants. Six countries have fewer than 1 granted patent per million inhabitants.

**Table 8 Number of EPO patents**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** |
| **AT** | 182,49 | 192,69 | 145,62 | 126,30 | 165,04 | 165,48 |
| **BA** | 0,00 | 0,00 | 0,32 | 0,00 | 0,00 | 0,00 |
| **BG** | 2,38 | 2,68 | 3,43 | 3,28 | 3,43 | 3,28 |
| **CZ** | 16,21 | 14,52 | 12,54 | 8,01 | 12,63 | 13,57 |
| **DE** | 252,13 | 238,55 | 196,34 | 149,43 | 178,55 | 184,85 |
| **HR** | 3,38 | 2,60 | 1,82 | 3,38 | 2,08 | 1,82 |
| **HU** | 7,68 | 8,20 | 5,50 | 5,61 | 6,54 | 5,81 |
| **MD** | 0,00 | 0,67 | 0,00 | 0,00 | 0,00 | 0,33 |
| **ME** | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |
| **RO** | 0,74 | 1,22 | 0,63 | 0,85 | 1,22 | 1,00 |
| **RS** | 0,90 | 0,75 | 0,30 | 0,45 | 0,90 | 0,90 |
| **SI** | 34,01 | 44,87 | 37,32 | 21,73 | 27,40 | 45,82 |
| **SK** | 6,21 | 2,74 | 6,03 | 3,11 | 4,20 | 5,48 |
| **UA** | 0,15 | 0,18 | 0,21 | 0,13 | 0,36 | 0,15 |

*Data: EPO*

## **Short-term and long-term effects**

The highest proportion of SMEs reporting product innovations is found in the Czech Republic (35.15%), Slovenia (34.78%), and Croatia (34.6%). The lowest proportion is in Ukraine (4.43%), Romania (6.66%), and Moldova (9.31%).

**Graph 23 SMEs introducing product innovations (% share)**

*Source: EIS 2024*

The graph below clearly shows that the countries of the Danube region significantly lag behind in the share of employment in knowledge-intensive activities. While Luxembourg has a share of 27.70%, the best-performing country in the region, Austria, has a share of 16%. Following Austria are Germany (15.6%) and Slovenia (15.4%). The lowest shares can be observed in Moldova (4.91%), Romania (8.1%), and Bosnia and Herzegovina (8.5%).

**Graph 24 Employment in knowledge-intensive activities (% share)**

*Source: EIS 2024*

*Note:* *MD, UA, UK (2023); ME(N/A)*

The sales of new or significantly improved products by innovative companies represent another way to measure the innovativeness of countries. This comparison allows us to evaluate both the creation of new products and the improvement of existing ones. In this comparison, Ireland leads the EU with 42.38%. Among the countries in the region, Slovakia ranks highest (14.94%), followed by the Czech Republic (14.43%) and Germany (14.05%). Conversely, the lowest shares are in Montenegro (1.6%), Ukraine (1.1%), and Moldova (1.6%).

**Graph 25 Sales of new-to-market and new-to-firm innovations (%)**

*Source: EIS 2024*

*Note: ME (2022), BA, MK, RS (N/A)*

Finally, we will focus on the ability of countries to export knowledge-intensive services. This indicator provides an overview of the share of such services in total exports. The comparison shows that the highest shares in EU countries are held by Ireland (93.19%), Luxembourg (84.27%), and Cyprus (83.19%). Among the countries in the Danube region, Hungary leads with 56.51%, followed by Bulgaria (54.31%) and Serbia (52.03%). The lowest shares of these services in exports are found in Bosnia and Herzegovina (18.47%), Montenegro (23.05%), and Croatia (23.1%).

**Graph 26 Knowledge-intensive services exports (% share)**

*Source: EIS 2024*

# **Evaluation of current best practice and SWOT analysis of PA7**

In terms of research and innovation capacities, the countries of the Danube region remain significantly divided on multiple levels. The primary division is between EU member states and non-member states. There is a clear dividing line between these groups across almost all indicators, with Serbia being the only non-member state performing at the lower end of the EU member states.

Another clear division is between the so-called "old" and "new" EU member states. Although most "new" member states have been in the EU for over 21 years, there is still a noticeable gap between Germany and Austria on one side and the other countries on the other. Germany and Austria dominate nearly all comparisons and are the only countries in the region with research and innovation investments exceeding 3% of GDP.

Among the other countries, Slovenia and the Czech Republic are making significant progress, followed by Hungary. The third group includes Bulgaria, Croatia, Romania, Slovakia, and Serbia. The last group consists of the non-EU countries—Bosnia and Herzegovina, Moldova, Montenegro, and Ukraine—which lag significantly behind in almost all indicators. It's also important to note that research and innovation performance is affected by the ongoing military aggression by Russia.

This division is also reflected in the performance of countries in the European Innovation Scoreboard 2024. The Danube region is highly heterogeneous, with countries at different levels of research and innovation performance and overall development. Additionally, Ukraine has been in a direct military conflict for over three years. The difference is also evident in whether countries have access to the common market and public investments from European sources, such as structural funds, the Recovery and Resilience Facility, and Horizon Europe.

As mentioned earlier, Germany and Austria are the only countries meeting the EU targets with research and innovation investments above 3% of GDP. Slovenia invests more than 2%, while the Czech Republic, Croatia, Hungary, and Slovakia invest between 1-2%. All other countries invest less than 1%. A similar situation exists with private sector investments, where companies in Germany and Austria invest more than 1%, those in Slovenia, the Czech Republic, Hungary, and Croatia invest between 0.5-1%, and all other countries invest less than 0.5% of GDP.

Germany, the Czech Republic, Austria, and Slovenia have the highest number of PhD graduates. These countries, along with Hungary, also have the most researchers per million inhabitants (in FTE). While Austria has 6,705 researchers per million inhabitants, Bosnia and Herzegovina have only 535. Conversely, the Czech Republic, Hungary, Germany, Austria, and Slovenia have the lowest proportion of female researchers.

The most innovative companies are also found in Germany, Austria, and Slovenia. Germany, Austria, and the Czech Republic have the highest venture capital investments. Slovenia, Austria, Germany, and the Czech Republic are the most successful countries in Horizon Europe.

Austria, Germany, and Slovenia have the highest share of scientific publications among the top 10% most cited publications. These three countries also have the most PCT patent applications per billion GDP.

Based on this analysis, we have prepared a SWOT analysis. Many aspects are repeated from the SWOT analysis in the previous edition.

**Table 9 SWOT Analysis**

|  |  |
| --- | --- |
| **STRENGHTS** | **WEAKNESSES** |
| * Growing innovation performance in most countries * Improving performance, especially in Slovenia and the Czech Republic * Presence of strong innovation leaders – Austria and Germany in the region | * The region is highly heterogeneous. * Significant disparities in research and innovation performance among countries. * In 11 out of 14 countries, investments in research and innovation are below 2% of GDP. * Overall participation of the private sector in R&D investments is very low. * This results in low patent activity in most countries. * Low collaboration between countries in Horizon Europe. * Low number of researchers. |
| **OPPORTUNITIES** | **THREATS** |
| * Increasing investments in research and innovation * Growing proportion of higher education graduates * Presence of strong innovation players – Germany and Austria | * Insufficient research and innovation capacities, especially in non-EU countries * Weak interest in collaborating on research and innovation projects * Inadequate venture capital in the countries * War in Ukraine |
|  |  |

# **Recommendations for improving the current situation**

Based on the analysis, we recommend the following measures:

1. **Support for Capacity Building**: Enhance capacities to tackle joint research and innovation projects.
2. **Regional Mobility Support**: Focus on mobility within the region, not only for researchers and students but also for project managers.
3. **Best Practice Utilization**: Transfer and implement best practices between countries.
4. **Support for Networking Projects**: Promote smaller networking projects aimed at preparing proposals for framework programs.
5. **Engagement of Various Sectors**: Involve stakeholders from different sectors in projects.