IMPACT ASSESMENT OF DIGITAL SKILLS ON R&D INVESTMENT

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ABSTRACT

In nowdays society, especially in the world affected by the pandemic, the need to digitalize all aspects of the economy and society has grown tremendously in a relatively short period of time. Digital transformation, digital economy, digital intelligence and all other aspects of digital society are topical issues nowdays. In order for the digital transformation to be successful, one of the preconditions is the development of society's digital skills. Therefore, we are faced with a situation where digital skills are one of the basic skills sought in the modern society, supported by the fact that in recent years digitalisation is increasingly being measured by various indicators to more accurately identify society's development needs in digitalization. On the other hand, investing in research and development is mentioned in all strategic documents and plans as a basis for global competitiveness, business and growth. The digital economy is mentioned in the context of the innovation market and innovators, and as a bridge that should eliminate certain sore spots in social and economic interactions. In this regard, investment in research, development and innovation should increase in terms of R&D expenditure in GDP, which currently stands at around 1% in Croatia according to the World Bank collection. Numerous indicators have been developed on the state level, but also at the European and global level, that should measure the success of such ventures. From all this it is clear that digital skills and investment in research, development and innovation are imperatives for the European Union and the Republic of Croatia regarding the economic growth and development and achieving competitive advantage, and that their connection and continuous growth and development are both key to Croatia's success but also to the society as a whole. Given the interconnectedness and interdependence of these two concepts and the fact that all economic and social goals concern investment in research, development and innovation, and digitalization and digital skills at the same time, this study was conducted through a comparison of different data sets connected to these two terms, seeking to identify the level and source of their interdependence and suggest possible improvements.

Keywords: *digitalization, digital skills, R&D investment, business intelligence tools*

1. INTRODUCTION

In the last two decades, technology has been evolving at a rapid pace, and in the line with development of technology. Companies face numerous challenges on a daily basis that are forcing them to make changes. In order for companies and various organizations to keep up with the times and be competitive in the markets in which they are positioned, it is necessary to invest in research, development and innovation. (Satalkina, Steiner, 2020) According to Georgescu et al. (2021), digital transformation requires cultural change as digitalization is more about people than just technology.

In the near future it is expected that young entrepreneurs, representing the generation using the technology from their early age, will just need to work on improving their digital skills on their path of becoming digital entrepreneurs (Bejinaru, 2021). Babic (2019) states that, in order for people and employees to keep up with digital transformation nowdays, it is important for them to continuously improve their digital skills which are no longer regarded as only computer skills, but include a range of skills that extend from operational to cognitive, social and systemic skills, collectively referred to as digital literacy. This set of skills enables an individual to succeed in finding, evaluating and creating information, and they are considered a prerequisite for young people to successfully enter and stay in the labor market but also be active citizens of the knowledge society. Since the education system often does not sufficiently respond to the needs of the labor market for a development of digital skills, cooperation between academia and industry is necessary to adequately fulfill the needs to develop certain skillsets, but also to promote entrepreneurship from the earliest stages. In the process of creating innovation ecosystem, universities should play a huge role and their innovation ecosystem role should help their stakeholders and collaborating actors but also their policy-makers to act according to this role in various contexts. (Taxt et al., 2022) For companies, on the other hand, digital skills have proven to be one of the key factors for the development of innovations, and they believe that the current working population needs retraining in order to compensate for their lack in knowledge. According to Milenkova, Lendzhova (2021), developed digital skills of individuals are not only the main prerequisite for a successful integration in the labour market but also a condition to become a digital citizen. This tends to get challenging when considering different perspectives and especially in regard to gender digital gap. The ability to follow changes in terms of digitalization and improve their digital skills should ensure women's digital inclusion and diminish inequalities on many other fields as well (Mariscal et al., 2019). However, by restructuring business patterns in all industrial sectors, digitalization is becoming the result, but also the source of innovation, and entrepreneurs are no longer just drivers of change but also influential factors of digital transformation. According to available research, Satalkina and Steiner (2020) state that 96% of leaders in the business world consider digital skills to be key to innovative development and constant growth. The leading countries in Europe in terms of digital entrepreneurship are precisely the countries whose population's digital skills are most developed. Satalkina and Steiner (2020) maintain that this is greatly influenced by external system conditions such as institutional influence, new market trends and changes in competitive advantage, but also by social patterns such as digital trust and technology adoption. On the other hand, when talking about investing in R&D, the main issue is a lack of connection between departments and a manager's education about its importance. "Closeness to science" and awareness about its importance either by doing it or just understanding it are first steps companies should take when becoming aware of a contribution of basic research to innovation (Nagane, Sumikura, 2020). Once firms engage in R&D, their size and especially financial resources are the factors that mostly define their future engagement and performance in it. According to Perez-Alaniz et al. (2022), for larger-sized firms, a precondition to be engaged in process and product innovation are their financial resources, however, small-sized firms may consider R&I only as a counter-measure to when their performance in the market falls, and not as the opportunity to grow. Cahyadi and Magda (2021) state that there exists a positive and significant connection between digital readiness, innovation, and 4.0 competitiveness. The process of research and innovation is changing rapidly, while digital technologies enable science and innovation to become more collaborative, international and open to citizens. It is very important that Europe accepts these changes and thus strengthens its position as a lead for science, new ideas and sustainable investment in the future. (European Commission, 2016) That the Republic of Croatia is also moving in the direction of science, innovation and research is indicated by the "National Recovery and Resilience Plan of the Republic of Croatia" (2021),

which was created in accordance with guidelines and key documents of the European Union. Its measures are focused on recovering the economy and reducing imbalances primarily through investment in research and innovation capacity and the application of advanced technologies, all with the aim of encouraging innovation. On the other hand, as regards to the digitalization process, the current need to reduce administrative and regulatory burdens and achieve greater transparency could be accomplished by digitizing various business processes and services (Government of the Republic of Croatia, 2021). The problem that lies behind the research's topic stems from the growing need to develop digital skills due to the current digitalization process on the one hand, and emphasizing the importance of investing in research, development and innovation on the other. Due to the above, the subject of this paper is the analysis of the connection between digital skills and the investment in research, development and innovation, i.e. linking the development of digital skills with investment in research, development and innovation at the European Union level. Therefore, the aim of this research is to link digital skills and investment in research, development and innovation through available models for monitoring the above. The research question formulated at the beginning of creating the framework in which the work would move was: Is there a connection between the level of development of digital skills and investment in research and development? Based on this question, the following hypotheses were made:

- H1: The level of digital skills development is positively related to business enterprise expenditure on R&D (BERD).
- H2: Countries with lower digital skills have a higher share of foreign-funded GERD.

2. METHODOLOGY

For the purpose of conducting the research, public databases of the World Bank, OECD, UNICEF, Central Bureau of Statistics, Digital Economy and Society Index and Eurostat were analyzed and basic comparisons of the type and scope of data offered and related to the topic were made. After analyzing the information, it was decided that the data from the Eurostat public database would be analyzed for the purposes of this paper, since it contains the necessary information on digital skills and investment in research and development. From the available Eurostat databases by topics, a database Science, technology, digital society was chosen, as it contains all the necessary data sets. After the additional analysis of the available frameworks, the following data was selected:

- A set of data called Digital skills was taken from the Digital economy and society database, which refers to individuals between the ages of 16 and 74 who have only basic digital skills and those with better developed digital skills. The data set was taken in such a way that it contained the total percentage of all individuals in the specified category, the total percentage of male individuals in the specified category, and the total percentage of female individuals in the specified category,
- Data sets within the category Research and development were downloaded from the Science and Technology database, as follows:
  - Gross domestic expenditure on R&D (GERD), tables in the category GERD by source of funds, which show the relative shares of different sources of funds in research and development, 5 tables showing the percentage of shares of GERD funded by different sectors: business sector, government, higher education, private non-profit sector and the rest of the world.
  - Business enterprise expenditure on R&D (BERD), tables in category BERD by NACE Rev. 2 activity and source of funds, which show expenditures of companies for research and development, category all sectors, amount in millions of euros.

The scientific methods used in the research are methods of analysis, synthesis and description, and the data were processed using the POWER BI tool. Downloaded excel tables contained 3 sheets: *summary* with basic information about a table, *structure* with a more detailed insight into the structure of the displayed data, and *Sheet 1* with a display of data fields by year. The data was analyzed and it was noticed that the amount of data varies by country. Excel spreadsheets have further been refined, leaving only data for the planned analysis framework by country and all data by year. The above tables were then linked in the three categories mentioned above with sheets containing different data sets for possible analysis and comparison. The three described tables were loaded in the Microsoft Power BI software tool and the first row was set as the column heading. The tables were then linked together by a country name. Finally, an analysis was made and the results are presented in the next chapter.

3. RESULTS

Due to the large amount of available data, and taking into account the topic of the research and the link between digital skills and investment in research and development, the following indicators were used to visualize research results:

- **Digital skills:** individuals between the ages of 16 and 74 who have basic or better overall digital skills. This indicator is based on selected activities performed by individuals aged 16 to 74 on the Internet in four specific areas (information, communication, problem solving, content creation). It is assumed that individuals who have performed certain activities have appropriate skills, and the indicator could be considered as a replacement for digital competencies and skills of individuals.
- **Gross domestic expenditure on research and development**: percentage of GERD (gross domestic expenditure on research and development) financed by industry, government, higher education and the private non-profit sector. The fifth source of funding shown is GERD funded from abroad. Research and development is an activity in which there are significant transfers of resources between units, organizations, sectors and countries. The importance of funding sources is recognized in one of Barcelona goals of the Lisbon Agenda, which considers that the appropriate ratio for research and development is 1/3 financed from public funds and 2/3 from private ones.
- **R&D expenditure**: measure of intramural R&D expenditure within the business sector during a given reference period, for all statistical classifications of economic activities and sources of resources, amount in millions of euros.

It was also noted that the most complete set of data is the data from EU member states, Norway and Switzerland. Therefore, it was decided that the analysis should be conducted within the mentioned framework. The ratio of all listed indicators by specific European Union countries, including Norway and Switzerland, for the observed year 2019 that contained all the data in the required categories, is shown below.

3.1. Comparison of digital skills development in male and female population by countries

Using the digital skills indicator, the percentage of the population aged 16-74 that has developed basic or better overall digital skills, according to the Eurostat base unit, is shown below. The representation is shown separately for men and women.

Figure following on the next page

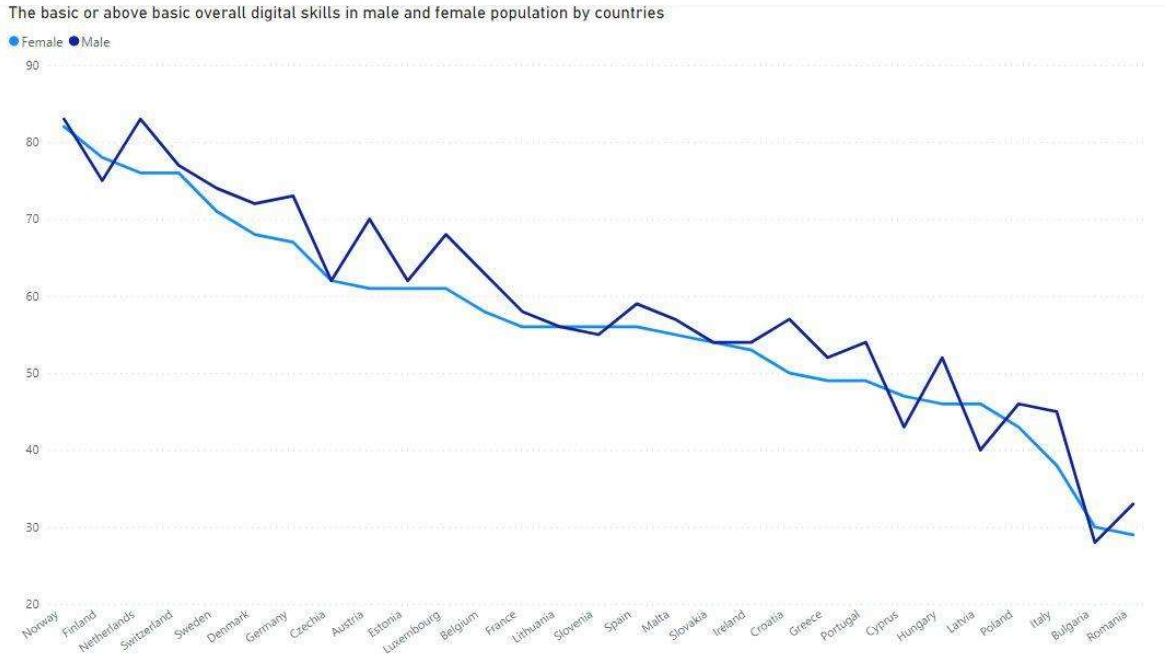

Figure 1: Review of the comparison of digital skills development in women and men by specific countries
(Source: author's work, 2022)

3.2. Relative shares of different sources of funds in R&D

For the purpose of presenting the structure of investments in research and development for the observed country and year, the indicator gross domestic expenditure on research and development (GERD) was used: percentage of GERD financed by industry, government, higher education, private non-profit sector and the rest of the world was shown as a relative share by sector.

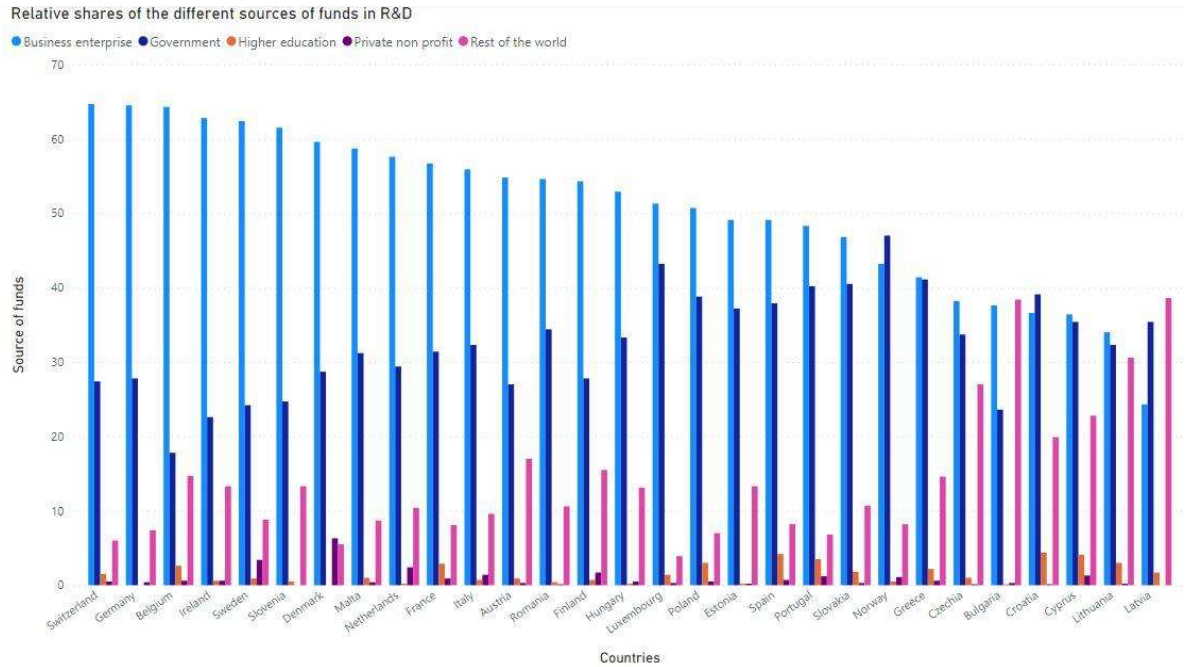

Figure 2: Relative shares of the different sources of funds in R&D
(Source: author's work, 2022)

3.3. The relationship between relative shares of different sources of funds in R&D and development of digital skills by countries

After analyzing the level of development of digital skills and gross domestic expenditure on research and development, the two categories were compared. As a result, a graph representing the relationship between relative shares of different sources of funds in R&D and development of digital skills by country, in the observed year, is shown.

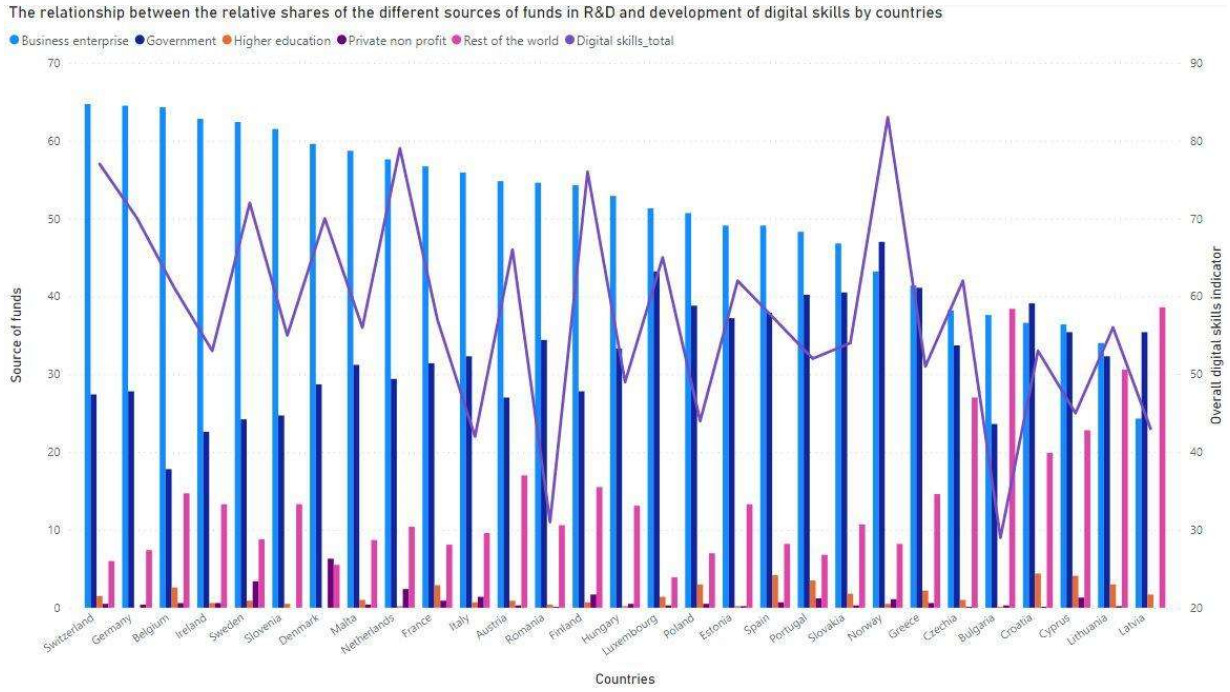

Figure 3: The relationship between the relative shares of the different sources of funds in R&D and development of digital skills by countries
(Source: author's work, 2022)

3.4. The relationship between digital skills development and share of gross domestic expenditure on R&D by industry

Given the mentioned importance of funding sources, recognized in one of Barcelona goals of the Lisbon Agenda, pointing out that the appropriate division for research and development is 1/3 of funding from public funds and 2/3 from private funds, a comparison was made between the level of development of digital skills and relative share of gross domestic expenditure on research and development financed by industry in the observed year.

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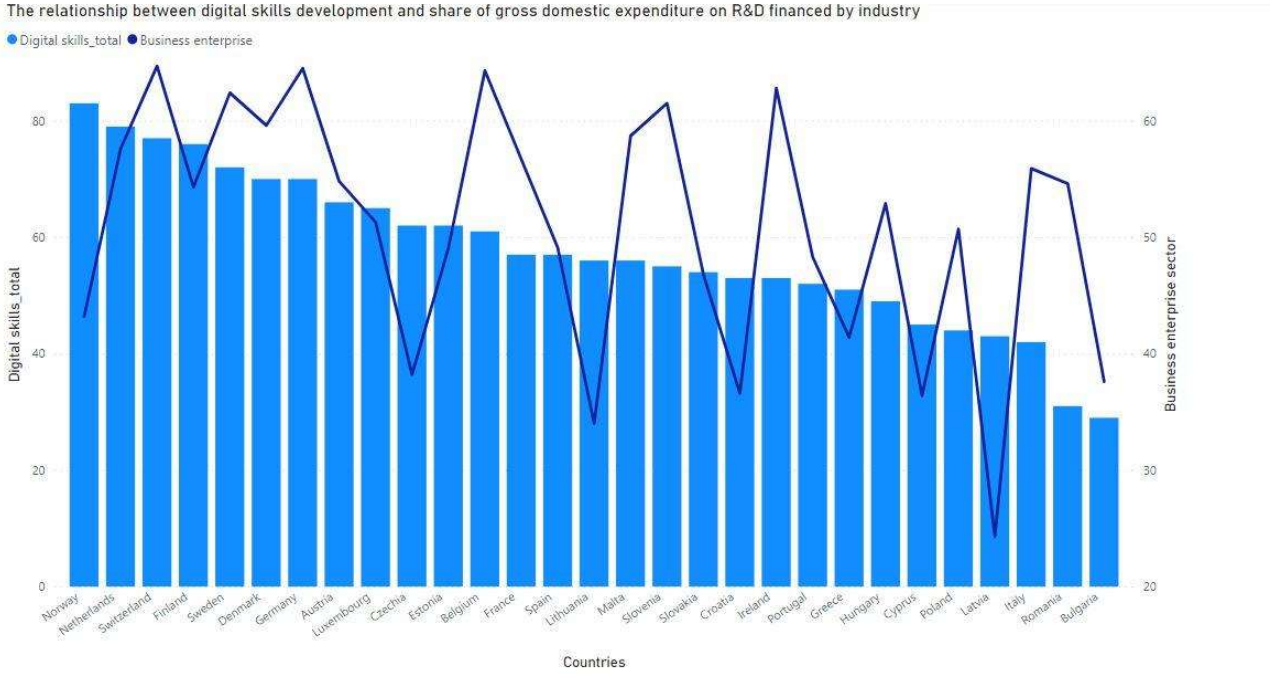

Figure 4: The relationship between digital skills development and share of gross domestic expenditure on R&D by industry
(Source: author's work, 2022)

3.5. The relationship between digital skills development and investments from abroad

Using the category of funding sources, and in order to compare the rate of digital skills development and investment from abroad, the relationship between digital skills development and relative share of gross domestic expenditure on research and development financed from abroad / the rest of the world in the observed year was analyzed.

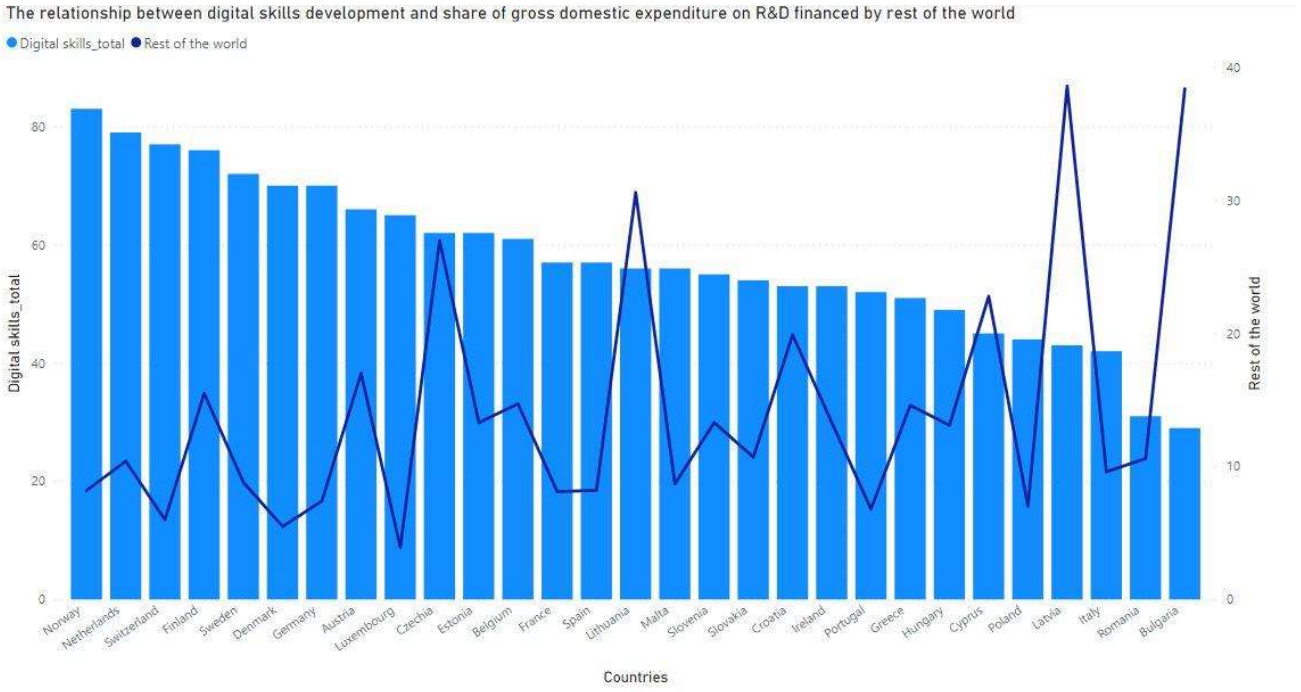

Figure 5: The relationship between digital skills development and share of gross domestic expenditure on R&D financed by rest of the world
(Source: author's work, 2022)

3.6. The relationship between digital skills development and R&D spending (BERD)

Using the indicator of the level of development of digital skills and the indicator of expenditures of companies for research and development presented in millions of euros, a comparison of the level of development of digital skills with the activities of companies related to research and development was made.

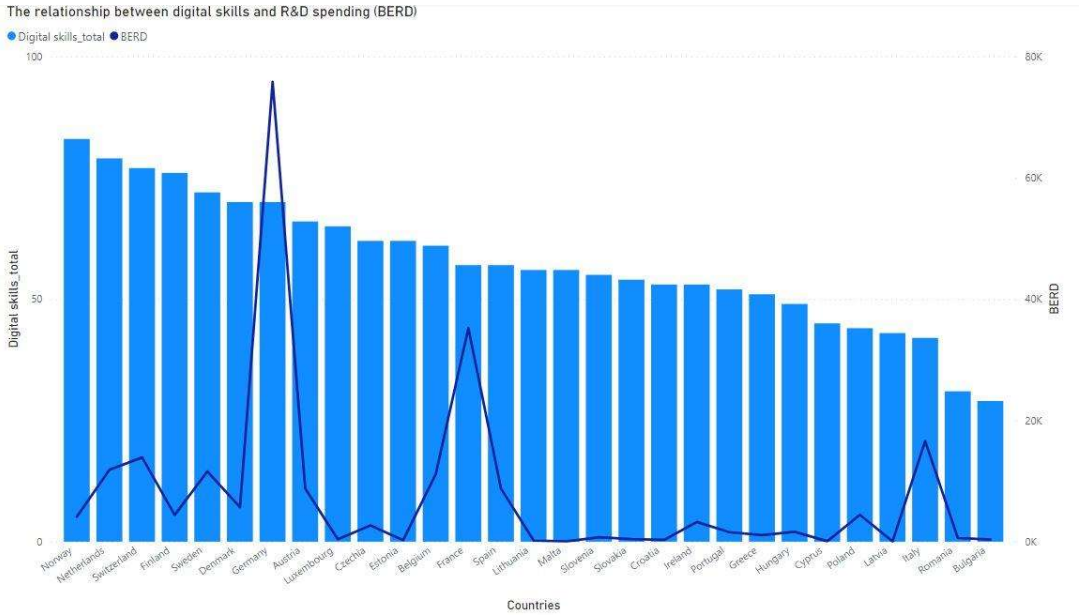

Figure 6: The relationship digital skills development and R&D spending (BERD) (Source: author's work, 2022)

The survey analyzed only data for the European Union and Norway and Switzerland. For a more relevant data set and comparison, it would be useful to supplement the data with countries that are world leaders in R&D investment, but also to take into account the context of each country when processing results so that certain phenomena could be analyzed and explained separately. The indicators used are limited to certain frameworks in terms of digital skills and investment in research and development. For a broader picture and more accurate results, the research should include several interrelated factors and certainly consider data and indicators for innovation separately. This could not be done for this research since the data for innovation activities are available for different years. The results obtained present a need for conducting a much larger research that would require covering larger data sets in order to obtain a more detailed picture. Therefore, it is proposed to use these results as a basis for a more detailed study of a larger set of data that could be used to clarify certain deviations from the overall trends / results.

4. DISCUSSION

The research results presented in the third chapter are divided into six separate units, depending on the observed indicators. In the first part, the degree of development of digital skills among women and men in certain countries is presented. In order to make the graph, a set of data was used that refers to individuals between the ages of 16 and 74, for those who have only basic digital skills and those with better developed digital skills. Graph 1 shows that in most cases men have better developed skills. Women predominate in Latvia, Cyprus, Italy, Slovenia, Lithuania, Sweden and Finland. Moreover, in Sweden and Finland they exceed a percentage of 75% and more percent. When it comes to men, in the Netherlands and Norway they predominate with percentages of over 82%. Countries with the lowest numbers of women and men with developed digital skills are Romania, Latvia and Bulgaria.

The second part shows the amount invested in research and development divided by sectors for each country. Business sector investments, public sector investments, higher education investments, private non-profit sector investments and investments of the rest of the world were observed. Countries with the biggest business sector investments in research and development are: Switzerland, Germany, Belgium, Ireland, Sweden, Slovenia and Denmark. Countries whose business sectors invest the least are: Latvia, Lithuania, Cyprus, Croatia, Bulgaria and the Czech Republic. For countries that see a decrease of share of investments by the business sector, the trend of growth of the share of investment by the government or from abroad can be noticed. The third section represents a comparison of indicators considered in the section 1 and 2. Namely, graph 3 shows the ratio of investment of different sectors in research and development and the percentage of digital skills development in certain countries. When we look at the results obtained, we can see that a number of questions arise. Interestingly, the chart shows that certain countries with large amounts of dedicated research and development funds invested by business sector have a low percentage of population with developed digital skills. Such countries include Romania and Italy. However, there is also an opposite situation, such as with Norway and Greece, where a population with highly developed digital skills has a low amount of shares of investment in research and innovation by business sector, and which grows in favour of the government. Finland and France, like Greece, have highly developed digital skills, which surpass investments in R&D by business sector. Ultimately, the least investment in all observed countries comes from higher education and the private nonprofit sector. The chart also shows that countries with low percentage of digital skills development have high investments from the rest of the world (Latvia, Lithuania, Croatia). Chapter 4 shows the relationship between digital skills and the share of investment in research and innovation of a country's business sector. In this case, there are large oscillations when it comes to digital skills and the order of countries according to the percentages of business sector investment, which is evident from the digital skills curve. Namely, Norway, which has digital skills of over 80% and is the strongest in terms of digital skills development, has amongst lowest shares of GERD financed by industry. A similar case is with Latvia, the Czech Republic and Lithuania, only the percentages are slightly lower, but the ratio of digital skills in the population and investment is equal. Luxembourg has an equal ratio of population with digital skills and GERB financed by industry, and Spain and Estonia are closest to it in terms of population with digital skills developed and investment ratio of GERB financed by industry. Chapter 5 shows the relationship between digital skills and the share of investment in research and development from abroad / the rest of the world. Namely, in this instance it is visible that countries with the lowest percentage of people with developed digital skills have a fairly high share of foreign investments (Lithuania, Cyprus, Latvia and Bulgaria). It can be concluded that the result from the previous chart is not only repeated and confirmed, but that external and foreign stakeholders have a high level of interest in such countries. Chapter 6 shows the total investment of companies in research and development in millions of euros per year in relation to the percentage of digital skills development. It can be seen that Germany invests the most of all countries (approximately 72,000,000.00 €). Namely, no other country has invested as much as Germany and has a ratio of money invested higher than the percentage of the population with developed digital skills. The countries that invest the least financially, but have a mediocre development of digital skills are Malta, Slovenia, Slovakia, Croatia, Bulgaria, Luxembourg, Cyprus and Belgium. Following all of the above, we can conclude that the answer to the research question (Is there a link between the level of digital skills and investment in research and development?) is that the link exists and there is a visible and fairly uniform trend for some of the observed categories and countries. However, some countries show some deviations from the trend, and the political, economic, legal and social context of each country should be analyzed in more detail in order to explain these deviations.

It is also concluded that hypothesis H1 (The level of digital skills development is positively related to the business enterprise expenditure on R&D (BERD) was rejected because there is no clear link between the trend of the chart showing digital skills development and the one showing the BERD. Hypothesis H2 (Countries with lower digital skills have a higher share of foreign-funded GERB) was partially confirmed in most cases in that a decrease in the percentage of digital skills increases the percentage of foreign-funded GERB, but there are discrepancies that should be analyzed in isolation.

5. CONCLUSION

Based on the conducted research, it is clear that the countries with the highest level of development of digital skills are those countries that are highly developed and economically advanced in other respects. The same percentage of countries shows a significant share of corporate investment, while this share shifts to forein investments as the level of development of digital skills per country decreases. The interdependence of digital skills and their impact on the investment in research and development could not be clearly determined in this way, but the foundations for a more detailed analysis have certainly been laid. The Eurostat database analysis conducted for the purpose of this paper identified indicators for digital skills and the investment in research and development, which consists of gross domestic expenditure on research and development for different sectors and expenditure of research and development of companies. The analysis concluded that the interdependence of digital skills and their impact on investment in research and development could not be clearly defined in this way.

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