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ARTIFICIAL INTELLIGENCE IN THE CORPORATE SECTOR

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Abstract: *Humanity has made huge progress over the past millennia. We are working with technologies, robots that not only help us to work accurately, efficiently and quickly, but they work in a similar way to the human brain: they perceive, think, learn and solve problems. In my research, I will focus on artificial intelligence, which is becoming more and more popular nowadays, looking at its past, present and future, its main trends in the corporate sector, and how it threatens people's job opportunities. At the same time, one of my research objectives is to investigate how much the development of a country is related to the uptake of AI in the European Union, which I will test with correlation analysis, taking into account indicators of artificial intelligence penetration in the corporate sector from one side and the various AI indicators such as digital penetration, internet usage, computer culture, and economic indicators as GDP per capita from the other side.*

Keywords: *artificial intelligence, enterprise, development, relation, European Union*

INTRODUCTION

Since the creation of mankind, a continuous evolution can be traced. As a result of the curiosity and perseverance that came from basic human nature, our ancestors created a wealth of inventions without which it would be unthinkable to exist in our world today.

While in the first industrial revolution, in the 18th century, mechanical devices improved human productivity, in the second industrial revolution, greater emphasis was placed on electricity and assembly line production, which increased production efficiency; speeding up the work process and reducing costs. The most important discipline of the previous century, and of the third industrial revolution, was computer science, with the great invention of the computer, which automated many activities, while at the same time allowing long-term storage of information. (Senthil & al., 2020)

Today, we are in the era of the fourth industrial revolution (Industry 4.0), which focuses mainly on areas that replace monotonous human labour or work that is harmful to humans. (Nagy & Hajdu, 2021) This era is mainly based on robotics, the rapid processing of large and varied data sets (Big Data), 3D technologies and the growing use of artificial intelligence, whose application will become increasingly important in the coming years, creating a growing gap between producer and consumer countries. (Savas, 2021)

What is artificial intelligence? Jean Paul Simon described it as "the umbrella term for the science of making machines smart". (Simon, 2019) The National Council for Science and Technology report suggests that it is not possible to define artificial intelligence in general terms, due to the different perspectives of experts, which are often contradictory, but it is generally accepted that it is a system based on 4 principles that also characterise human intelligence: learning, reasoning/thinking, problem solving and perception. In fact, these machines solve tasks using algorithms that also involve human intelligence. (Simon, 2019) At the same time, machine learning allows you to learn and grow through experience, data and examples. (Jumani, Laghari, Narwani, & David, 2021)

Henrietta Czibor defines artificial intelligence as a complex system capable of interpreting, synthesizing and processing "human knowledge encoded in different ways (text, numbers, images, sound, video, etc.)". Artificial intelligence is expected to be the technology that will define the new technical-economic paradigm, as it is increasingly embedded in everyday life; it is being used in a growing number of sectors; it will accelerate the development of different disciplines; it will boost the efficiency of activities, whether at the level of process, organisation, enterprise or marketing innovation; it can create industries that could not be created by other systems, while at the same time it can eliminate or transform existing industries and activities. (Czibor, 2020)

The secret to AI's success in the enterprise is in benefits such as: saving money by automating routine, repetitive processes, reducing operational costs and human burden, increasing revenue, predicting customer preferences and providing a more personalised experience, gaining a competitive edge in the marketplace, performing faster work with more deliberate, informed decision-making, personalising learning and improving accuracy. (Sadiku, Fagbohungbe, & Musa, 2020)

Huang, Rust, and Maksimovic argued that in the future, humans will mainly be assigned to tasks dealing with emotions, as robots and machines can still be used to perform mechanical tasks, while AI will be assigned to thinking tasks, in which they process, analyse and interpret data, leaving humans to perform jobs that cannot be left to robots and technology. (Huang, Rust, & Maksimovic, 2019)

According to the World Economic Forum's 2020 ranking, the five most important workforce skills are analytical thinking and innovation, active learning and learning strategies, complex problem solving, critical thinking and analysis, and creativity, individuality and initiative. Overall, therefore, there is no risk of automation in occupations where creativity and aesthetic value, empathy, manual dexterity or artistic inclination are important. (Nagy & Hajdu, 2021)

In recent years, many have questioned the extent to which jobs will be automated and which areas will be most affected by the digital revolution of our time. Frey and Osborne found that about 47% of the 702 occupations they studied would be at high risk of automation in the United States in the next decade or two. (Frey & Osborne, 2013).

According to another article published in the United States, 73 million people in the country could lose their jobs due to artificial intelligence by 2030, but it further emphasised that although many jobs could be affected, only humans will be able to perform the fundamental tasks, so workers should strive to improve their skills to perform their tasks more efficiently, thus contributing to economic growth. (Jumani, Laghari, Narwani, & David, 2021)

In all of the studies mentioned above, there was a consensus that tasks requiring cognitive skills, creativity and human sensitivity are the most difficult to machine. Furthermore, US data have also shown that wages and educational attainment are negatively correlated with the computerisation of occupations, which means that jobs with lower wages or lower educational attainment are more likely to be computerised. (Reisinger, Reisinger, & Nagy, 2022)

At the same time, there is a growing trend, thanks to artificial intelligence, for a smaller workforce to be needed in the coming years for jobs that require thinking, even in the medical or legal sectors. One of the key issues of the coming decades is likely to be how to deal with the mass unemployment that will result from such a continuous transition. A potential solution, according to some, could be to make less use of these systems and technologies, or using the money saved by automation to provide training opportunities for workers to learn new skills that cannot be automated, that machines will not be able to do for them, but another option is to employ people for fewer hours so that the workload can be better distributed. (Haenlein & Kaplan, 2019)

DATA, METHODOLOGY

The main research questions I was looking for answers to were:

- Is there a correlation between the spread of artificial intelligence and development measured by different economic and IT indicators in different countries?
- Where, in which European Union countries, has the most AI been implemented for certain jobs in different sizes of companies?

The data used in the research were mostly downloaded from the Eurostat statistical database, than processed and analysed; the data are focused on the countries of the European Union. I think it is important to mention that this is an area that has gained importance in recent years, and is a recent research area in terms of the indicators and concepts under study, and because of this in many cases the only year in which data were available was 2021.

In terms of the structure of the research, the literature review aims to provide an overview of the concept of artificial intelligence and the industrial revolution of which it is a part, providing information on developments and trends in recent decades, and also highlighting potential future problems it may cause.

After processing the obtained information, statistical methods were used to make calculations, measurements and comparisons between the data, followed by a linear regression test and a two-sided T-test to find the relationship between the different factors, in order to prove the existence of a relationship between two variables (one explanatory and one explained).

The research was divided into two parts: first, I looked for a correlation between indicators of artificial intelligence penetration in the corporate and GDP, purchasing power parity, Human Development Index, internet accessibility, digital intensity and the use of computers in companies by size of enterprises in the European Union countries.

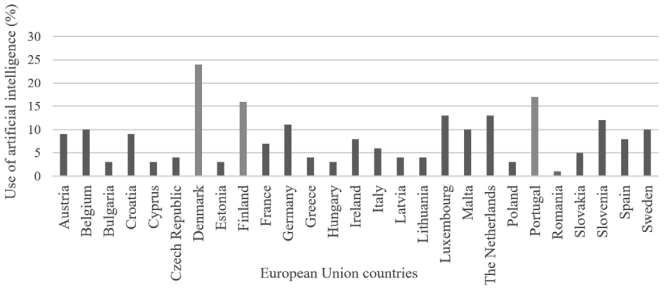
In the second half of the research, I examined the measure in the selected countries of using AI technology in their work in six specific areas (marketing, production, organisation/administration, logistics, IT security, and human resource management/recruitment). As in the first part, in this case too, I divided the aggregated results by company size, attempting to examine which areas use AI the most and least, by establishing average values. At the same time, I also want to look at which countries are leading the way, which are best able to incorporate the most rapidly developing technology of our century into their work processes. I will conclude by evaluating the results.

RESEARCH RESULTS

Data used

As I mentioned earlier, I used various economic and IT indicators to investigate whether there is a correlation with the spread of artificial intelligence in the European Union countries. To do this, I looked at the percentage of countries using at least one AI technology in their work processes in the year of 2021, for companies of any size. This aggregation is illustrated in the following graph:

Figure 1: Use of artificial intelligence in the European Union countries in 2021

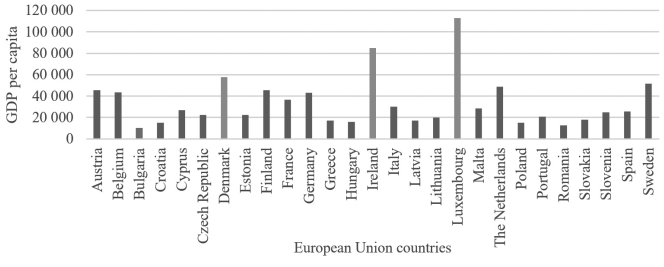


Source: own editing, based on Eurostat

The figure shows that Denmark has a high rate of adoption of AI technologies in most companies. The second highest is in Portugal, while Finland is in third place. The lowest level of any use of AI in the operation of companies is in Romania.

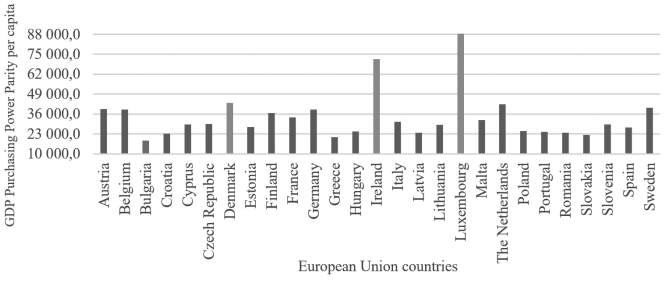
Figure 2 illustrates the value of GDP per capita in 2021 in the studied countries. The results show that, if only this measure is taken into account, Luxembourg, Ireland and Denmark have the highest levels of prosperity, while Bulgaria has the lowest. A similar order was observed in the purchasing power parity ranking, with Luxembourg, Ireland and Denmark leading the list, and Bulgaria coming last again.

Figure 2: GDP per capita in European Union countries in 2021



Source: own editing, based on information provided by Eurostat

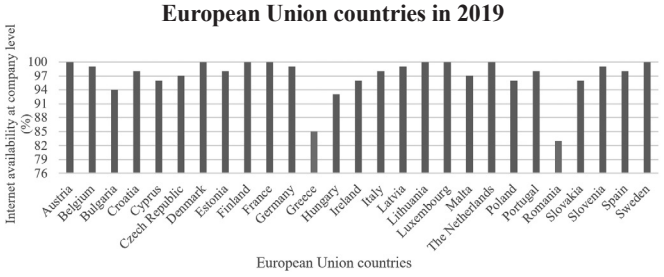
Figure 3: GDP Purchasing Power Parity per capita in European Union countries in 2021



Source: own editing, based on information provided by Eurostat

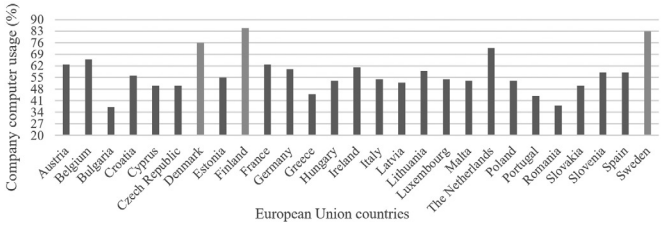
The third factor in the analysis was internet accessibility. Since 2019 is the latest data, I used it for the calculations. What I would like to highlight from the chart is that while 25 countries have internet availability for companies above 90%, Greece and Romania only have 85 and 83% respectively.

Figure 4: Internet availability at company level in European Union countries in 2019



Source: own editing, based on information provided by Eurostat

Figure 5: Company computer usage in European Union countries in 2021



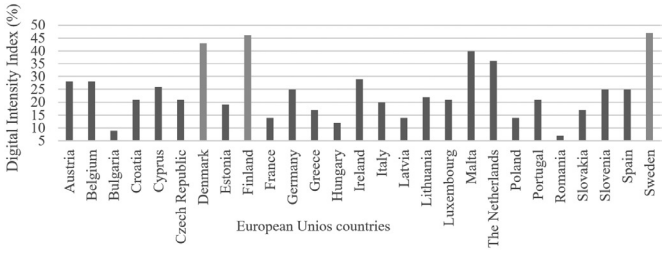
Source: own editing, based on information provided by Eurostat.

Also part of the analysis is an examination of companies' use of computers. These data are presented in Figure 5, where we can see that the highest values are found in Finland, Sweden and Denmark, with 85%, 83% and 76% respectively.

Another important indicator is digital intensity, which measures how many different digital technologies use companies and to what extent they use them in their activities, covering technologies such as: the existence and quality of companies' websites, the diversification of their services, the level of use of 3D printing, the purchase of cloud-based IT services, the possibility of sending bills that can be processed automatically, but also the use of industrial or service robots.

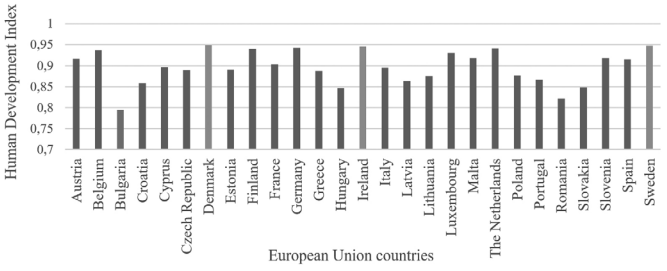
These are summarised in Figure 6, in which, as before, Sweden, Finland and Denmark were in the lead.

Figure 6: Digital intensity in the European Union countries in 2021



Source: own editing, based on information provided by Eurostat

Figure 7: Human Development Index in the European Union countries in 2021



Source: own editing, based on information provided by Statista

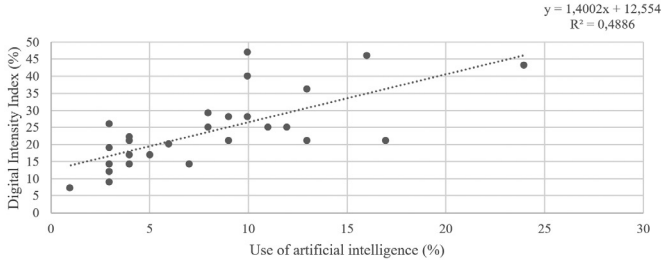
Finally, the last indicator that was examined in the correlation searches was the human development index, which estimates life expectancy at birth as a function of literacy, education and living standards. This value is defined within a 0-1 interval. Denmark, Sweden and then Ireland had the highest scores on this index, in turn the lowest scores at Hungary, Romania and Bulgaria (United Nations Development Programme, 1990).

Correlations

After aggregating the data and searching for correlations, linear regression calculations were used to examine the values of using artificial intelligence with all other variables in turn. Firstly, it was compared with GDP per capita, however, the R2 value did not show a strong relationship between them, which came out to be 0.2704. And although a similar ordering was previously found for the two factors when searching for correlation, the weakest relationship was found between purchasing power parity and the use of artificial intelligence, with an R2 of only 0.1728. When testing for corporate computer use, it was also found that there was no strong relationship between the factors, but was the highest value so far: 0.3635.

As for internet accessibility, the R2 indicator (0.268) also found a weak relationship, similar to the previous aspects, so the existence of a correlation could not be proven. Where the strongest relationship was found was between AI and digital intensity, with a moderately strong relationship based on R^2.

Figure 8: Finding correlations between the use of artificial intelligence and digital intensity in the European Union countries



Source: own editing, based on Eurostat data

Finally, for the last factor, the human development index, a weaker than medium relationship was also observed, although compared to the previous ones, except for the digital intensity, a higher correlation was found, as the R2 value was 0.396.

Then I used a two-sided T-test to determine the significance between the factors. The results show that in all cases, except for the GDP-Purchasing Power Parity per capita, some degree of significance was found (Gosset, 1908)

Table 1: Double-sided T-test

	GDP per capita	Purchasing Power Parity	Internet availability
Correlation (r)	0.519993477	0.415632622	0.517717899
T-stat: r *√(n-2) / √(1-r^2)	3.043851554	2.284869334	3.025638827
p-value	0.54%	3.11%	0.57%
Conclusion	Significant relationship	Not significant	Significant relationship
R2	0.270393216	0.172750477	0.268031823

	Company computer usage	Digital intensity	Human Development Index
Correlation (r)	0.602940924	0.699020788	0.629264804
T-stat: r *√(n-2) / √(1-r^2)	3.77883948	4.887564474	4.048328058
p-value	0.09%	0.005%	0.044%
Conclusion	Strongly significant	Very strongly significant	Very strongly significant
R2	0.363537758	0.488630063	0.395974193

Source: own editing

After examining the strength of the relationships, a regression calculation confirmed the previously mentioned statement, proving that there is a strong correlation between the use of AI and digital intensity. The results of the regression calculation are shown in the following table, where we can conclude that there is a correlation between two factors, when the value of the indicator p is lower than 5%. (Galton, 1889).

Table 2: Results of multivariate regression analysis

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.750653508							
R Square	0.56348069							
Adjusted R Square	0.45954752							
Standard Error	3.925731053							
Observations	27							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	5	417.7687572	83.55375	5.421567476	0.002347122			
Residual	21	323.6386503	15.41136					
Total	26	741.4074074						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-14.5695107	37.27895144	-0.39082	0.699864021	-92.09533423	62.95631282	-92.09533423	62.95631282
GDP per capita	5.82883E-05	4.76566E-05	1.223088	0.234844913	-4.08191E-05	0.000157396	-4.08191E-05	0.000157396
Internet availability	0.259656959	0.236301898	1.098836	0.284278518	-0.231759739	0.751073658	-0.231759739	0.751073658
Company computer usage	-0.043799877	0.134357622	-0.32599	0.747654594	-0.323211848	0.235612094	-0.323211848	0.235612094
Digital intensity	0.309478144	0.143508937	2.156508	0.042788567	0.011034972	0.607921315	0.011034972	0.607921315
Human Development Index	-10.41977319	41.97451919	-0.24824	0.806359741	-97.71056442	76.87101805	-97.71056442	76.87101805

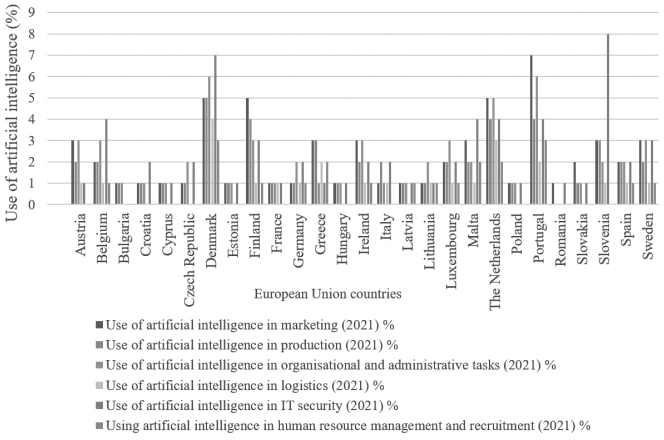
Source: own editing

Based on the multivariate regression analysis (Table 2), the five independent variables (GDP per capita, internet accessibility, corporate computer use, digital intensity and human development index) explain 45.95 percent of the variance of our dependent variable, the AI index. Testing this regression with the F-test, a generalized version of the T-test, we find that there is also a significant relationship between the explanatory variables and the dependent variable.

The use of artificial intelligence in six selected fields in European Union countries

Although we have seen earlier how often companies in some countries have used some AI technology, in the following I would like to look more specifically at the extent of its use in 6 areas: marketing, production, organisation/administration, logistics, IT security and human resource management/recruitment. The following figure summarises, at country level, the percentage of companies that have used an AI technology to simplify the activities and work areas mentioned above.

Figure 9: Use of AI in different workspaces across all sizes of companies in the European Union countries in 2021



Source: own editing, based on Eurostat data

The figure shows that Portugal was the country with the highest use of AI in marketing, Denmark was the main user in production, and Portugal and Denmark were the two countries with the highest use of AI in organisation and administration, with 6%. In logistics, Denmark is also in the lead, with the Netherlands in second place. In IT security, Danish companies also made a high use of a AI technology, but this time they came second with 7%, below Slovenia with 8%, which is the highest value seen in the whole table. Finally, in human resources management, Denmark and Portugal again came out on top with 3%-3%.

Based on the average values calculated in the studied areas, it can be said that the European Union countries use AI most in IT security at 2.296%, although marketing came second with a difference of only a few hundredths of a percent, at 2.259%. And the data also reveals that companies use AI the least in human resource management and recruitment, with a rate of less than 1%. These average values are shown in the below table.

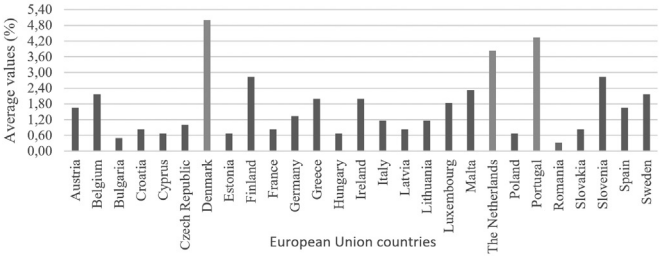
Table 3: Average use of artificial intelligence in selected fields in European Union countries

Fields of application	Marketing	Production	Organisation	Logistics	IT Security	Human resource management
Average values (%)	2.259	1.889	2.148	0.889	2.296	0.778

Source: own editing, based on data supplied by Eurostat

Averages were also calculated for each country, looking at the extent to which companies in the six selected areas were using any of the AI technologies in their work. The chart shows that the highest averages were found in Denmark, Portugal and the Netherlands, and the lowest in Romania, with only 0.33%.

Figure 10: Average use of AI in the six selected areas, by European Union countries in 2021



Source: own editing, based on Eurostat data

I have further disaggregated the previous data by the size of the companies, grouped by the number of employees. Small enterprises are defined as those with between 10 and 49 employees, medium enterprises between 50 and 249, and large enterprises as those with more than 250 employees.

The first summary table shows the degree of using AI technology in small, medium and large enterprises. For small companies, Denmark shows the highest value, with 20%, demonstrating that one in five small Danish companies has used AI technology in their working process. It was followed by Portugal with 16%, Finland and Luxembourg in third place with 12%, and the Netherlands in fifth place with 10%, Romania is in last place with 1%.

In the ranking of medium-sized companies, there are small changes, although Denmark still has the highest value with 37%, followed by Finland, which is now more behind Denmark with 27%, and then Portugal, the Netherlands and Slovenia with 23%, 21% and 20% respectively. Romania continued to be the country with the lowest use of AI, now for companies with 50-249 employees, at 2%.

For companies with 250 or more employees, Denmark also had the highest rate, with an outstanding 66%, which means that two out of every three companies used AI. Finland was also second in this category with 51%, followed by Belgium and the Netherlands with 41% and Sweden with 40%. As in the previous two breakdowns, Romania scored the lowest in this third category with 7%.

Since a correlation with digital intensity has been shown, I would like to highlight this breakdown. What we can see for small companies is that the three Scandinavian countries that have stood out several times before are in the lead, with Sweden at 42%, Finland at 41% and Denmark at 38%. The fourth