

# Digitalization and Its Implications on Unemployment

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**Abstract.** *In recent decades, digitalization has reshaped the global economy, altering how businesses operate and redefining labor market requirements, thus bringing numerous economic changes. In the Romanian context, it can be observed that technological advancements and automation have led to a decline in demand for certain traditional occupations but have opened up new employment opportunities in fields such as information technology and digital commerce. Consequently, the processes improved through digitalization have introduced numerous changes in the economy. This paper aims to analyze the extent to which technological evolution has influenced the unemployment rate in Romania during the period 2014-2023, through a statistical analysis that particularly highlights economic changes and a thorough review of the relevant literature. The research uses a mixed methodology, combining the review of the literature with data analysis, extracted from the Tempo Online database of the National Institute of Statistics and EUROSTAT. The results show that with technological advancements and process automation, new opportunities emerged in IT and other sectors, resulting in a general decrease in unemployment. The main research question is: What are the digital implications on the unemployment rate in Romania between 2014 and 2023? Starting from this, the research hypothesis is obtained, respectively: fixed broadband internet traffic rate had a significant impact on unemployment in Romania, causing an increase during periods of economic transition and a decrease during the expansion of digital technologies. During the research, the hypothesis will be verified, and the conclusions will explain the reasons by which it is confirmed or denied.*

**Keywords:** Digitalization, Unemployment, Labor market, Economy, Romania.

## Introduction

Digitalization is a change driven by the current technological context. It involves adapting to all market requirements by efficiently managing processes and activities that can be automated. Digitalization can be applied at the level of information (physically held data is converted into digital format) and activities (repetitive processes can be programmed for automation for efficiency).

The accelerated digital transformation in recent years is altering not only the structure of economic processes but also the very nature of work itself, which inevitably brings significant changes to the unemployment rate and economic processes. In numerous sectors, especially in manufacturing, logistics, and services, automation has replaced repetitive tasks previously performed by humans, in order to improve and speed up processes. This poses risks for individuals with low digital skills who lack the ability to adapt to the new processes imposed by digitalization.

However, this shift is not entirely negative, as it also stimulates the creation of new jobs, particularly in knowledge-based fields such as information technology, data analysis, and digital security, vital elements that underpin the new digital processes. Those who adapt and develop their digital skills have a better chance of finding well-paid and secure jobs in the long run.

The relationship between digitalization and unemployment largely depends on how well we prepare for this change. If education systems and professional training programs keep up with the

new demands of the job market, digitalization can bring more benefits than risks. Otherwise, many people may struggle to find stable employment.

Therefore, we can say that "digitalization involves the use of digital technologies and data to change the way work is done and the interaction between stakeholders, to attract new revenues, replace or transform certain processes, and create an environment centered on the use of digital information" (Durach et al., 2021, p. 6).

This research is structured in three parts. The first part captures the introduction, the literature review and the methodology representing a analysis of current knowledge, what is to be analyzed throughout this work and also the methods by which the research will be carried out. The second part of the work captures results and discussions, here the bibliometrical analysis will be performed based on the data extracted from the Scopus, but also the evolution and correlation between the two analyzed indicators, respectively the fixed broadband internet traffic rate and the unemployment rate. In the last part of the work, the conclusions will be outlined and the final opinion regarding the confirmation or refutation of the general hypothesis will be announced.

## Literature review

According to Țucanu (2024), the digitalization refers to the transformation of information from physical to electronic format, allowing storage and access from any electronic device, and involves converting manual processes into automated processes. Digital transformation is the process by which the content, form, and method of processing and transmitting data and documents are changed to save time and material resources, thereby increasing efficiency and transparency, regardless of the field of activity.

Tănase et al. (2018) argue that the reason why digitalization has a negative short-term effect is based on its three most important characteristics: speed, depth, and transformation, as they radically change the labor market and how activities are approached within it. The speed of digitalization is seen as a short-term negative factor because its exponential rate of evolution is almost impossible to match by the development of complementary elements necessary for economic activities. The profundity of the changes brought by digitalization refers to the fact that the modifications are numerous and occur simultaneously across all domains and activities, creating a significant challenge for both companies and employees, who must adapt their daily activities to the new methods, with those unable to do so being at risk of becoming unemployed.

An important advantage of digitalization lies in the speed and flexibility of access to information for anyone, from any location. This transformation has enabled organizations to adopt remote work models on an unprecedented scale, detaching professional activity from fixed physical locations and offering greater freedom to employees who now have the opportunity to work remotely. In public administration, digital tools have streamlined administrative tasks, improving both internal efficiency and the experience of citizens in their interactions with institutions, as all processes now take significantly less time and offer broader accessibility. However, these improvements reduce the number of personnel required for such processes, potentially impacting unemployment and the workforce.

The labor market is constantly adapting to meet the demands of new economic realities, offering satisfactory options for both employees and employers. For example, the rise in the popularity of remote work has changed the way employers recruit and manage their teams, with employees gaining more flexibility and proving that this method is productive.

A flexible labor market is one that successfully creates jobs in line with economic demands. For example, the demand for digital skills has grown exponentially, prompting companies to offer

training courses for their employees (Şerban, 2013). This model of the labor market is sought after by any economic environment, but behind a term that makes this phenomenon seem easily achievable are numerous factors that hinder its realization. Although digitalization was introduced to facilitate economic activities, it affects the flexibility of the labor market because it accelerates the normal pace of job evolution, imposing major changes that must be implemented in a short time. This fast pace of changes leads to a situation where the update of material resources and employees' knowledge cannot keep up with the changing job requirements, thus reducing labor market flexibility and impacting the economy.

The unemployment rate is the primary indicator of the labor market and reflects the "health" of the actions carried out within it. A low unemployment rate indicates a strong economy with numerous job opportunities and conditions that satisfy both employees and employers, while a high rate can signal economic problems and dissatisfaction among the people involved in the process.

Since there are studies suggesting this, I consider that digitalization can positively influence the unemployment rate, although the effects vary depending on the region and level of economic development. An article from Revista Cariere (2019) mentions that a 10% increase in the level of digitalization could lead to a 1.02% decrease in the unemployment rate, with notable effects in emerging economies in East Asia, South Asia, and Latin America. In contrast, in today's highly developed economies such as North America and Western Europe, the impact would exist but would not be as significant as in other economies, because these countries are already at a balanced level in terms of digitalization.

A study on the analysis of the impact of digitalization on the unemployment rate conducted at the level of the Nordic countries demonstrates that the influence of digitalization is already being felt in the unemployment rate. The study, carried out over the period 1991-2019, highlights that the two indicators show a negative correlation in most cases, establishing that "The increase of the variable of digitalization by 1% leads to a decrease in the unemployment rate by 0.025% in the case of the Nordic countries." (Ivanitskaia, 2022, p.63)

## Methodology

In this paper, I conducted a bibliometric analysis using VOSviewer to better understand how digitalization influences unemployment and to highlight the links between these two indicators in the literature. The data were collected from the Scopus database, using clear criteria to select relevant articles on the chosen topic.

To study the impact of digitalization on the unemployment rate, I analyzed the evolution of unemployment rates and fixed internet traffic in Romania between 2014 and 2023. This period was chosen because, after 2010, digitalization began to grow rapidly, and analyzing these indicators for a period with complete data (2014-2023) provides a clearer picture of the effects of digitalization on unemployment.

Data on the unemployment rate were obtained from the Tempo Online databases of the National Institute of Statistics, while information on fixed internet traffic was sourced from Eurostat and the official website of the European Union. Data processing and analysis were performed using IBM SPSS, Microsoft Excel, and VOSviewer, ensuring a rigorous and reliable process.

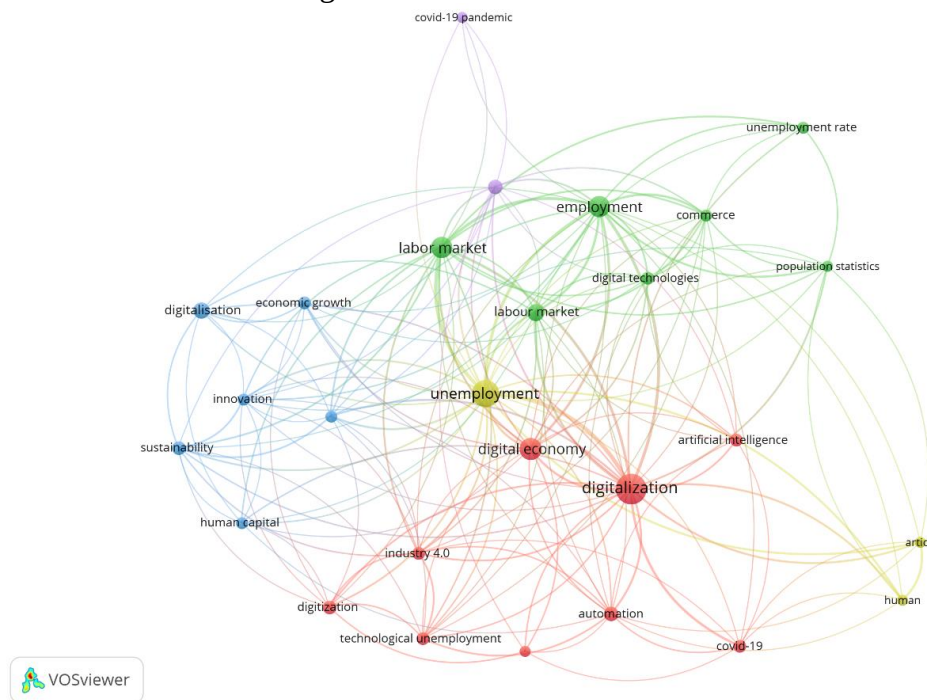
To test the normality of the data distribution, we used the Shapiro-Wilk and Kolmogorov-Smirnov tests. The Shapiro-Wilk test, which is highly reliable for smaller samples, showed that the unemployment rate does not follow a normal distribution (Sig=0.027). In contrast, both tests for fixed internet traffic indicated a normal distribution (Sig=0.865 and 0.088).

Since the unemployment rate does not meet the normality assumption (according to the Shapiro-Wilk test), although fixed internet traffic does, an analysis using Spearman's correlation coefficient was chosen. This method was selected because it is recommended and relevant in the context of data that are not normally distributed, making it suitable for the analysis performed. Spearman's correlation is a non-parametric method that does not require normal data distribution, making it ideal when at least one of the variables does not meet this assumption.

## Results and discussions

### *Bibliometrical analysis*

Through bibliometric analysis using VOSviewer with data from Scopus, I identified the main research directions related to digitalization and its effects on the labor market. The results show that academic interest in this topic has intensified over the past decade, especially in the fields of automation and artificial intelligence.



**Figure 1. Bibliometric map of co-occurrence**

Source: Scopus, processed by the author using VOSviewer.

The Bibliometric map of co-occurrence identified five main thematic clusters (Figure 1).

The first cluster, focused on digitalization and emerging technologies, includes terms such as digitalization, digital economy, artificial intelligence, automation, and industry 4.0, emphasizing the interest in the economic and social transformations driven by technological innovation.

The second cluster, centered on the labor market and employability, reflects the impact of digitalization on workforce employment through terms like employment, labor market, and unemployment rate.

In parallel, the third cluster explores the relationship between digitalization, economic growth, and sustainability, through concepts such as economic growth, innovation, and

sustainability, highlighting the importance of innovation in economic development. The fourth cluster analyzes the impact of the COVID-19 pandemic on the economy and labor market, highlighting the structural changes accelerated by this global crisis.

The relationships between clusters reveal an interdisciplinary integration, emphasizing the close connection between digitalization, innovation, the labor market, and sustainability. The terms digitalization and digital economy are the most significant, with the highest number of connections, indicating the centrality of these concepts in the literature. Additionally, concerns about unemployment and employability remain a major area of interest, while the pandemic has introduced new research directions related to adapting to new economic realities.

This analysis underscores the essential contribution of digitalization to transforming the economy and labor market, as well as the need for adaptive policies to support the transition to a sustainable digital economy.



**Figure 2. Bibliometric map of co-authorship**

Data source: Scopus, processed by the author using VOSviewer.

The co-authorship map (Figure 2) highlights the collaborative networks between countries, revealing the intensity and distribution of co-authorship relationships. The Russian Federation emerges as a central hub, demonstrating significant connections with various countries, including China, Ukraine, Germany, and nations from other clusters. The map is divided into distinct clusters, each represented by a specific color, indicating regions or groups of countries that frequently collaborate. For instance, the cluster containing United Kingdom, Turkey, Australia, and Italy reflects close cooperation within this group, while another cluster comprising Indonesia and Malaysia highlights regional partnerships. The central position of Russian Federation underscores its prominent role in fostering international research collaborations on digitalization and its labor market implications. The varying thickness of the connecting lines further illustrates the strength of these collaborations, suggesting focal points of research interest and influence. This bibliometric analysis sheds light on the global interconnectedness of research efforts in this critical field, offering insights into the geographical distribution of expertise and partnerships.

### ***Statistical analysis of the impact of digitization on unemployment rate***

The registered unemployment rate is determined by computing the proportion of individuals officially recorded as unemployed (those registered with employment agencies) relative to the total civilian active population. The latter includes both employed and unemployed individuals, as defined by the labor force balance methodology.

For this analysis, statistical data on the unemployed population and total active workforce were sourced from the Tempo Online database. The unemployment rate was then computed using Microsoft Excel (Table 1), applying the following formula:

$$\text{Unemployment rate} = \frac{\text{Total registered unemployment}}{\text{Active population}} * 100$$

where:

- *unemployment rate* represents the percentage of unemployed individuals in relation to the active population;
- *total registered unemployment* refers to the number of individuals officially recorded as unemployed by the National Employment Agency;
- *active population* denotes the total number of individuals in the labor force, including both employed and unemployed persons.

**Table 1. Unemployment rate in Romania between 2014 and 2023**

| Year | Total registered unemployment | Active population | Unemployment rate |
|------|-------------------------------|-------------------|-------------------|
| 2014 | 478338                        | 9242420           | 5,18              |
| 2015 | 436242                        | 9159296           | 4,76              |
| 2016 | 418237                        | 8978646           | 4,66              |
| 2017 | 351105                        | 9119887           | 3,85              |
| 2018 | 288896                        | 9068217           | 3,19              |
| 2019 | 257865                        | 9033695           | 2,85              |
| 2020 | 296051                        | 8972820           | 3,30              |
| 2021 | 234757                        | 8214682           | 2,86              |
| 2022 | 239064                        | 8270813           | 2,89              |
| 2023 | 235636                        | 8152036           | 2,89              |

Source: National Institute of Statistics, processed by the author using Microsoft Excel.

**Table 2. Case processing summary**

| Description           | Cases |         |         |         |       |         |
|-----------------------|-------|---------|---------|---------|-------|---------|
|                       | Valid |         | Missing |         | Total |         |
|                       | N     | Percent | N       | Percent | N     | Percent |
| unemployment_rate     | 10    | 100.0%  | 0       | 0.0%    | 10    | 100.0%  |
| internet_traffic_rate | 10    | 100.0%  | 0       | 0.0%    | 10    | 100.0%  |

Source: Eurostat and Tempo Online, processed by the author using IBM SPSS.

The analyzed sample contains statistical data over a period of 10 years and captures the evolution of the unemployment rate and the evolution of the fixed broadband internet traffic rate in Romania.

The statistical data has been entered into the application IBM SPSS with the aim of performing a correlation analysis between the two analyzed indicators.

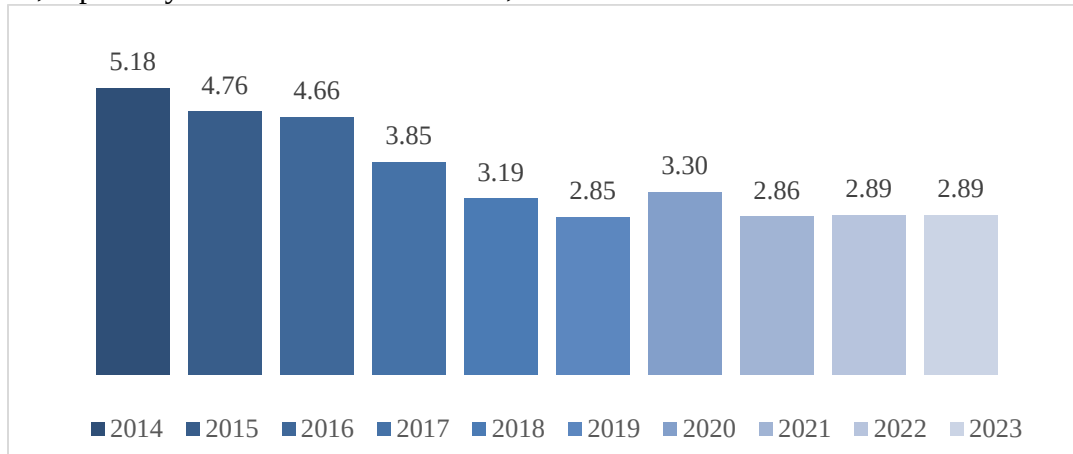
The processed sample presents a total of 10 variables analyzed for each indicator (annual rate of each indicator), of which 100% represents valid data, with no missing values (Table 2).

At first, evolution of the two indicators will be analyzed separately, and finally the correlation and impact between them will be analyzed in order to determine whether the hypothesis we started from, namely the fact that the fixed broadband internet traffic rate had a significant impact on unemployment in Romania, causing an increase during periods of economic transition and a decrease during the expansion of digital technologies, is confirmed or not.

### ***Unemployment Rate in Romania between 2014 and 2023***

The evolution of the *unemployment rate* in Romania between 2014 and 2023 (Figure 3) reflects significant changes in the labor market, influenced by economic factors, public policies and global

events. The data shows a steady decline in the number of unemployed between 2015, when it was 4.76, and 2019, when it reached 2.85. This reduction can be attributed to steady economic growth, government employment stimulus programs and job creation in sectors such as IT, construction and services. However, in 2020, the COVID-19 pandemic reversed this trend, leading to an increase in the rate of unemployed to 3.30, amid restrictions, business closures and reduced economic activities, especially in areas such as HoReCa, tourism and retail.



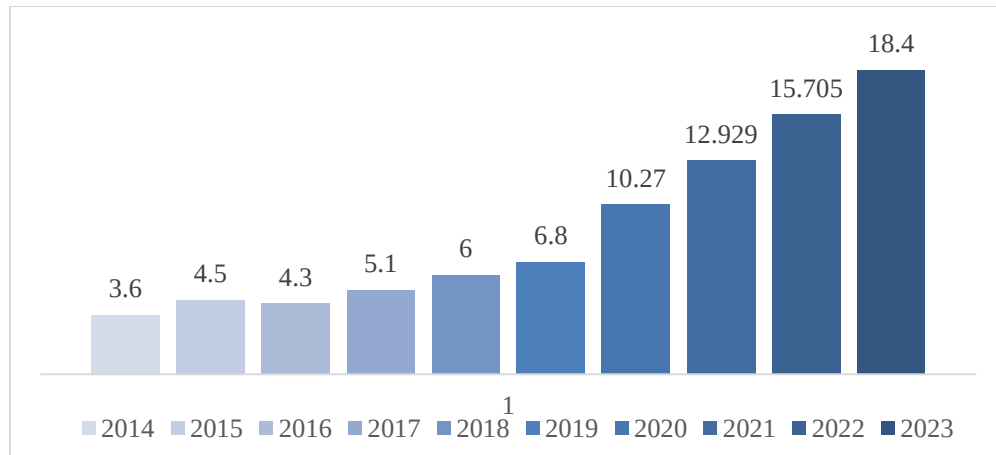
**Figure 3. Evolution of the unemployment rate in Romania between 2014 and 2023**

Source: National Institute of Statistics, processed by the author using Microsoft Excel.

Starting in 2021, unemployment started to fall again, reaching 2.86 and stabilizing around 2.89 in 2023, amid economic recovery and the gradual return of affected sectors. Determinants of unemployment developments include GDP growth, labor migration, which has reduced pressure on the domestic market, and public policies that have supported vocational training and employment. This evolution highlights the adaptability of the Romanian economy to global and regional changes, underlining the need to continue investing in education, professional training and labor market stimulation policies to keep unemployment at a low level.

#### ***Fixed broadband internet traffic rate in Romania between 2014 and 2023***

The indicator entitled fixed broadband internet traffic rate from the database Eurostat represents the total volume of data transferred via fixed broadband connections in a given period of time. This indicator measures both data downloaded and uploaded by users via fixed internet networks, such as fiber optic, coaxial cable or DSL. It is used to assess the level of fixed internet usage and to analyze trends in data consumption at European level. Throughout this research, the fixed broadband internet traffic rate will be used as an indicator of the evolution of digitalization in Romania from 2014 to 2023, aiming to highlight the relationship between this indicator and the unemployment rate, as well as their correlation within the analyzed sample.



**Figure 4. Fixed broadband internet traffic rate in Romania between 2014 and 2023**

Source: Eurostat, processed by the author using Microsoft Excel.

The fixed broadband internet traffic rate indicator in Romania registered a remarkable growth between 2014 and 2023 (Figure 4), reflecting a significant transformation in the use of fixed broadband internet. During this period, the value of the indicator increased more than five times, from 3.6 in 2014 to 18.4 in 2023, highlighting a growing demand for high-speed Internet services.

This evolution has been driven by several key factors, including the digitization of the economy and society, the expansion of fiber optic infrastructure, the increase in the number of connected devices, and the widespread adoption of new technologies. The period of the COVID-19 pandemic (2020-2021) had a significant impact, accelerating traffic growth due to the transition to working from home, online education and intensive consumption of digital entertainment. If between 2014 and 2018 the rate of growth was moderate, after 2018 it accelerated considerably, culminating in a record value of 18.4 in 2023.

This trend highlights the importance of fixed broadband infrastructure in the economic and social development of Romania, underlining the need for investments continue in technology to support competitiveness, equal access to digital resources and improve the quality of life.

#### ***Analysis of the relationship between the unemployment rate and the fixed broadband internet traffic***

Analyzing the correlation of the two variables through the IBM SPSS application, the Test of normality was calculated, being represented by the two tests: Shapiro-Wilk test and Kolmogorov-Smirnov test.

**Table 3. Tests of normality**

|                       | Kolmogorov-Smirnov |    |       | Shapiro-Wilk |    |       |
|-----------------------|--------------------|----|-------|--------------|----|-------|
|                       | Statistic          | df | Sig.  | Statistic    | df | Sig.  |
| unemployment_rate     | 0.248              | 10 | 0.083 | 0.822        | 10 | 0.027 |
| internet_traffic_rate | 0.245              | 10 | 0.091 | 0.865        | 10 | 0.088 |

Source: Eurostat and Tempo Online, processed by the author using IBM SPSS.



Regarding the result of the Kolmogorov-Smirnov test (Table 3), although both indicators present normal distributions, the significance of the unemployment rate being 0.248 (Sig= 0.248), and the significance of the fixed broadband internet traffic rate being 0.245 (Sig= 0.245), the results of this test cannot be taken into account, because this test is representative of large data samples.

Shapiro-Wilk test is known to be more reliable for a sample with a small number of data, as is the case with the given analysis, suggesting an abnormal distribution of the unemployment rate during the analyzed period because the significance level of this test is less than 0.05 (Sig= 0.027) and a normal distribution of the fixed broadband internet traffic rate (Sig= 0.088).

Given that the unemployment rate has an abnormal distribution, according to the Shapiro-Wilk Test, and the fixed broadband internet traffic rate has a normal distribution, the type of correlation that seems to be the most appropriate to analyze is the Spearman correlation.

The Spearman correlation is known as a non-parametric method that does not require a normal distribution of the data, being appropriate when at least one of the variables does not respect the normality hypothesis.

**Table 4. Correlations**

|                |                       |                         | <b>unemployment_rate</b> | <b>internet_traffic_rate</b> |
|----------------|-----------------------|-------------------------|--------------------------|------------------------------|
| Spearman's rho | unemployment_rate     | Correlation Coefficient | 1.000                    | -0.802                       |
|                |                       | Sig. (2-tailed)         | .                        | 0.005                        |
|                |                       | N                       | 10                       | 10                           |
|                | internet_traffic_rate | Correlation Coefficient | -0.802                   | 1.000                        |
|                |                       | Sig. (2-tailed)         | 0.005                    | .                            |
|                |                       | N                       | 10                       | 10                           |

Source: Eurostat and Tempo Online, processed by the author using IBM SPSS.

The Spearman correlation coefficient value (-0.802) suggests a strong negative relationship between the unemployment rate and the fixed broadband internet traffic rate, suggesting that as the internet usage rate increases, the unemployment rate decreases, and vice versa.

The statistical significance of this correlation (Sig=0.005) highlights a statistically significant relationship at the 99% confidence level, because Sig<0.01, which suggests that the relationship between fixed broadband internet traffic rate and unemployment rate in the analyzed situation is justified, with an accuracy of 99%.

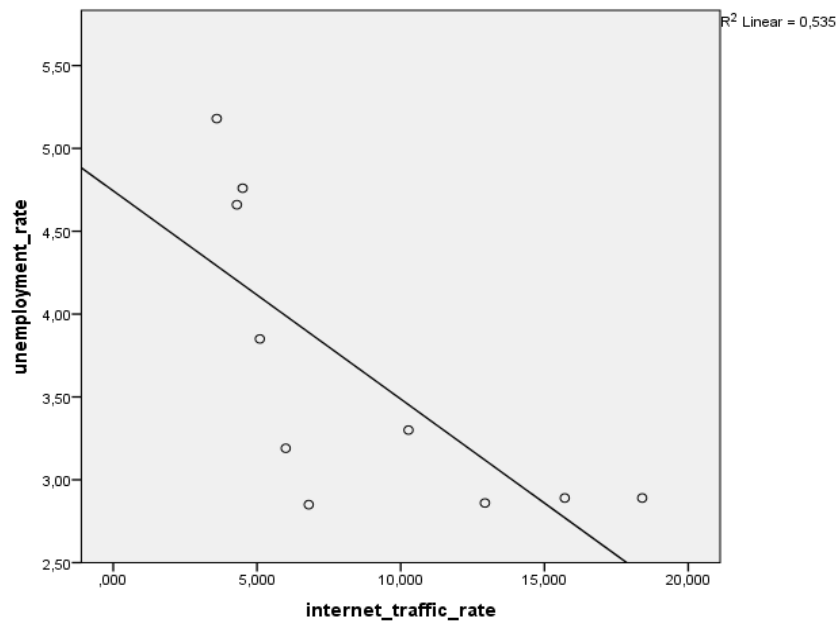
These values (Table 4) suggests that the expansion of internet access and the use of new technologies have had a clear impact on employment in Romania between 2014-2023.

In order to strengthen the previously obtained relationship between the two indicators, a graph was generated that captures the relationship and the trend line between the two variables (Figure 5).

The trend line is downward, which suggests a negative relationship between the two variables, as one indicator increases, the other decreases.

With the effective  $R^2=0.535$ , it indicates that 53.5% of the variation in the unemployment rate can be explained by the variation in the Fixed broadband internet traffic rate, according to the regression line.

The point cloud formed by the graphical representation of the two variables seems to be quite close to the trend line, which suggests a strong relationship between the variables, a relationship also confirmed by the value of the Spearman coefficient obtained previously.



**Figure 5. Correlations graph**

Source: Eurostat and Tempo Online, processed by the author using IBM SPSS.

## Conclusion

The results of this research support the formulated hypothesis, indicating that digitalization has played a significant role in shaping unemployment trends in Romania. A clear inverse correlation is observed, suggesting that increased digital integration contributed to the decline in the unemployment rate during the analyzed period.

Over the 10 years under review, in Romania, the unemployment rate has generally been on a downward trend, reflecting improving economic conditions and increasing employment opportunities. In parallel, internet usage has been steadily increasing, reflecting the development of digital infrastructure and the increasing access to modern technologies. This divergent evolution of the two indicators suggests a inverse relationship, in which increased connectivity and digital skills contribute to reducing unemployment by facilitating access to information, education and jobs.

The results of this research show in the analyzed period, respectively 2014-2023, a significant negative correlation between digitalization and unemployment, suggesting that as digital infrastructure expanded and access to technology increased, the unemployment rate steadily decreased. Digitalization contributed to the creation of jobs in fields such as IT, online services, and e-commerce, but its impact was not uniform. While technology-based sectors thrived, traditional industries like manufacturing were affected by automation, leading to job losses.

The increase in internet access has coincided with a decrease in the unemployment rate, suggesting that digitalization plays an important role in facilitating access to jobs and developing the skills needed in the modern economy. The internet facilitates access to education, continuing professional training and job information, thus contributing to reducing disparities in the labor market. Statistical results, such as the negative and significant Spearman coefficient (-0.802) and the value ( $R^2 = 0.535$ ), support the strength of the relationship between the two variables. These findings suggest that expanding internet access, especially in rural or disadvantaged areas, can significantly contribute to reducing unemployment.

In addition, it is essential to promote digital education and training programs that improve the skills required in an increasingly digitalized labor market. Creating platforms that connect employers with potential employees and integrating digital skills into the education system are other priority measures.

To better understand this relationship, future research should also analyze other factors, such as the level of education and government policies on professional retraining. For example, studies could examine how digital training programs influence employability in different regions.

In conclusion, digitalization plays a crucial role in reducing unemployment and can be an essential pillar for sustainable economic development.

This research has demonstrated a clear connection between digitalization and the unemployment rate; however, certain limitations must also be considered. First, the analysis focused solely on Romania, meaning that the results cannot be automatically applied to other economies, where economic factors and the level of digitalization may differ. Second, I used fixed internet traffic as the primary indicator of digitalization, even though this process is much more complex and includes other aspects such as job automation and the development of artificial intelligence. For a more detailed perspective, future studies could compare the effects of digitalization across different industries and use a broader set of indicators.

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