

# Romania's Digitalization in the Business Sector: A Comparative Perspective within Europe, with Leadership Implications

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## **Abstract**

*This article provides a comprehensive, data-driven analysis of Romania's level of digitalization in the business sector, positioning it within a comparative European framework. The study focuses on three key indicators that reflect the degree of digital transformation in enterprises: the adoption of cloud computing services, the use of Internet of Things (IoT) systems, and the share of enterprises receiving online orders. The research methodology is predominantly quantitative and comparative, relying on official statistical data from the National Institute of Statistics and Eurostat, covering the period 2009–2024. By analysing long-term trends and cross-country differences, the paper highlights Romania's persistent lag behind the European Union average, while also identifying signs of gradual progress and emerging digital maturity. The findings reveal significant disparities between Romania and more digitally advanced European economies, particularly those in Northern and Western Europe, but also underline the existence of development potential supported by improving infrastructure and increasing engagement with digital solutions. The study contributes to the understanding of digital transformation dynamics in emerging European economies and provides a foundation for policy-oriented discussions regarding the acceleration of business digitalization in Romania.*

**Keywords:** IoT, integration, e-commerce, digital maturity, digital transformation

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## **1. Introduction**

Digital transformation has become a central pillar of the European Union's strategy for economic modernisation and competitiveness (Francu et al., 2025). At

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the European level, policy frameworks such as the Digital Agenda and the Digital Compass 2030 establish ambitious targets for business digitalisation, including the objective that at least 75% of EU enterprises adopt advanced digital technologies, such as cloud computing, big data solutions, and Artificial Intelligence (AI), by 2030. Digital transformation is widely recognised as a key driver of productivity growth, innovation, and long-term economic resilience (Toma & Săseanu, 2023). Empirical evidence further suggests that the adoption of digital technologies can generate substantial benefits at firm level, including significant increases in profitability over the long term (Mihăilescu & Karabulut, 2024).

Within this broader European context, Romania's progress and challenges in the digitalisation of its business sector have attracted increasing academic and policy attention. Although Romania has been a member of the European Union since 2007, it consistently ranks among the lowest-performing countries on composite digitalisation indicators (Săseanu et al., 2020). For instance, according to the European Commission's Digital Economy and Society Index (DESI) 2022, Romania ranked 27th out of 27 EU member states. While the country performs relatively well in certain sub-dimensions, such as internet connectivity and aspects of human capital, it continues to lag behind in the integration of digital technologies by businesses and in the provision of digital public services.

Against this background, the aim of the present study is to examine Romania's level of business-sector digitalisation from a comparative European perspective. The analysis focuses on three key indicators that capture essential dimensions of digital transformation in enterprises: (1) the adoption of cloud computing services, (2) the use of Internet of Things (IoT) systems, and (3) the share of enterprises receiving online orders, reflecting engagement in e-commerce activities. These indicators are particularly relevant due to their direct impact on operational efficiency, innovation capacity, and market reach, and they are measured in a consistent manner across EU countries using Eurostat and national statistical sources.

Cloud computing enables enterprises to scale information technology resources and support more flexible and innovative business models, while IoT systems facilitate real-time, data-driven operations and automation. At the same time, e-commerce adoption allows firms to expand beyond geographical constraints and access broader markets. Given their economic and strategic relevance, these dimensions are closely monitored at European level through instruments such as the DESI and the Digital Intensity Index, underscoring their importance for both policy evaluation and business competitiveness.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature on digital adoption in Europe, with particular attention to Romanian small and medium-sized enterprises. Section 3 outlines the quantitative and comparative research methodology. Section 4 presents and discusses the empirical findings based on national and European statistical data. Finally, Section 5 formulates the main conclusions and outlines policy-relevant implications.

## 2. Literature Review

A growing body of academic literature examines the state of digitalization across European economies, with particular emphasis on cross-country disparities and the factors influencing technology adoption. Comparative studies consistently indicate that Romania, alongside several other South-Eastern European countries, continues to lag behind the European Union average in terms of digital adoption and performance metrics. For example, Crisan and Popescu (2025) analyse Romania's digital position within the EU and show that, despite extensive EU-level support aimed at enhancing digital potential, the country performs weakly across key dimensions of the Digital Economy and Society Index (DESI). Their findings highlight Romania's structural lag in business digitalization, while also identifying specific areas with potential for improvement. Similar conclusions are reached by Manea and Bența (2023), who observe that digitalization has expanded across most sectors of the Romanian economy, albeit unevenly, and stress the need for comprehensive assessment in order to fully understand and address existing shortcomings. Although progress is evident in areas such as connectivity and the diffusion of basic digital services, the socio-economic impact of digitalization remains uneven across sectors.

A recurring theme in the literature concerns the identification of barriers and enabling factors affecting digital transformation in Romanian enterprises. Insufficient digital skills, limited managerial awareness, and financial constraints are frequently cited as major obstacles. The European Investment Bank's assessment of Romanian small and medium-sized enterprises highlights persistent gaps in digital knowledge and skills, as well as difficulties in accessing financing for digital investments, despite acknowledging improvements in broadband infrastructure and connectivity. In a comparative analysis of SME digitalization in Romania and Turkey, Mihăilescu and Karabulut (2024) argue that strong government policies and targeted support mechanisms are essential for creating an environment conducive to digital uptake. They emphasize that digitalization has become a strategic necessity for SMEs seeking to remain competitive in the context of globalisation and rapidly evolving customer expectations. Empirical evidence further suggests that Romanian firms invest relatively little in digital technologies, as reflected in Eurostat data showing that more than 65% of enterprises exhibit very low levels of digital intensity. This pattern underscores the slow diffusion of digital technologies, particularly among smaller firms, and highlights the need for sustained policy intervention.

Beyond structural and financial constraints, the literature increasingly emphasizes the role of organizational readiness and behavioural factors in shaping digital adoption. Theoretical frameworks such as the Technology Acceptance Model (TAM) posit that technology adoption decisions are primarily driven by perceived usefulness and perceived ease of use. Although initially developed to explain individual behaviour, TAM has been widely extended to organizational contexts. Rusu et al. (2023), for instance, apply an extended TAM framework to analyse

acceptance of digital transformation in Romania and demonstrate that behavioural variables, including openness to innovation, significantly influence attitudes toward digital technologies. Their findings suggest that Romania's lagging digital performance cannot be explained solely by infrastructural or economic factors, but is also closely linked to the human dimension of digital transformation. Other theoretical perspectives, including the Unified Theory of Acceptance and Use of Technology (UTAUT) and Diffusion of Innovations theory, further reinforce the view that digital adoption depends on skills, perceived value, and cultural readiness. In the Romanian context, low levels of digital skills among both employees and managers remain a critical limiting factor, particularly in the absence of coherent and effective digital skills development policies (Crisan et al., 2023).

The concept of digital maturity has also gained prominence in recent scholarly work, with researchers employing digital maturity models and composite indices to assess the progression of countries and firms along the digital transformation trajectory. These models typically evaluate multiple dimensions, including strategy, technology, and organizational capabilities. At the European level, the Digital Intensity Index (DII) classifies enterprises according to their degree of digital maturity. Available evidence indicates that Romania has an exceptionally high share of firms in the "very low" digital intensity category and a negligible presence in the "very high" category, findings that are consistent with its low DESI scores. Comparative analyses further reveal that countries with higher levels of digital maturity, such as Finland and Denmark, tend to combine technological investments with supportive institutional ecosystems, including innovation-friendly policies, government incentives, and high levels of trust in digital solutions. Although studies such as Umbach and Tkalec (2022) focus primarily on e-government, their conclusions underscore the importance of a holistic policy framework encompassing education, infrastructure, and governance in fostering digital progress, with clear implications for the business sector.

Empirical research on digitalization trends frequently employs quantitative methods, reinforcing the robustness of existing findings. Cross-country regressions and cluster analyses have been used to group European economies based on digital performance. For example, Crisan et al. (2023) classify EU member states into high-tech and low-tech clusters in the post-COVID context, placing Romania among the countries facing the most significant challenges in closing the digital gap. Their analysis identifies strong correlations between digitalization levels and labour market outcomes, suggesting that persistent digital underdevelopment may adversely affect employment and productivity. Sector-specific studies, such as those examining maritime transport or other industries, further demonstrate that organizational, technological, and environmental factors jointly influence digital adoption, many of which are highly relevant for Romanian enterprises. At the same time, the literature documents instances of rapid digital advancement when favourable conditions are present. Romanian firms integrated into global value chains or operating in IT-intensive sectors tend to adopt digital tools more quickly,

indicating that exposure to international competition and best practices can accelerate digital uptake.

Overall, the academic literature offers a nuanced assessment of Romania's digital transformation in the business sector. While comparative research consistently confirms the country's lagging position in the adoption of cloud computing, IoT systems, and e-commerce relative to EU peers, it also identifies the underlying causes of this gap, including skill shortages, financial barriers, and policy limitations. Studies employing indices such as DESI and DII emphasize that Romania's digital competitiveness deficit is significant but not insurmountable. Importantly, prior research highlights pathways for progress, including investment in human capital, the development of supportive innovation ecosystems, and the strategic use of European funding instruments. Building on these insights, the present study contributes to the existing literature by providing an updated, data-driven analysis of Romania's position on key business digitalization indicators, situating the findings within the broader context of European digital transformation, and identifying areas with potential to support Romania's convergence toward EU digital benchmarks.

### **3. Research Methodology**

The research approach adopted in this study is predominantly quantitative, based on the analysis of statistical indicators that assess the level of digitalization in Romania and at the European level. The methodology involves the collection, processing, and interpretation of descriptive statistical data, enabling the identification of trends, structural characteristics, and disparities across different dimensions of digitalization within the business environment and in the use of digital services. In addition to its descriptive nature, the research incorporates a strong comparative dimension, as Romania's level of digitalization is systematically benchmarked against European Union averages and selected European countries. This comparative perspective provides an essential framework for assessing Romania's relative position and for identifying areas of convergence or divergence with broader European trends.

The analysis is not limited to EU member states, but also includes several geographically European non-EU countries, with the objective of constructing a broader and more coherent regional perspective on digitalization patterns. This approach allows for a more comprehensive understanding of Romania's performance within the wider European context.

The primary objective of the study is to provide an accurate representation of the degree of digitalization in Romania and of the manner in which enterprises engage with digital transformation processes. By analysing selected indicators and situating them within a comparative European framework, the research aims to illustrate the level of digital maturity among Romanian enterprises across economic sectors and to position Romania relative to other EU member states. The results

contribute to a deeper understanding of Romania's strengths, structural challenges, and development needs in accelerating national digitalization.

Three key indicators were selected in order to capture core dimensions of digital transformation in the business sector: (i) the proportion of enterprises that have purchased cloud computing services via the internet; (ii) the proportion of enterprises that have used interconnected devices or systems that can be monitored or controlled remotely via the internet (Internet of Things – IoT); and (iii) the proportion of enterprises that have received online orders, reflecting engagement in e-commerce activities.

Data for Romania were obtained from the statistical database of the National Institute of Statistics, accessed through the official Tempo Online platform. The analysis focused on the "ICT Usage" category, specifically the subcategory coded TIC100A, which provides key indicators on the use of information and communication technologies in enterprises with ten or more employees. To ensure a comprehensive dataset, all available years were included, covering the period 2009–2024, and aggregated data across all economic sectors were used for each of the selected indicators. The extracted data were subsequently processed and analysed using spreadsheet-based tools.

At the European level, data were sourced from Eurostat, within the "Science, technology and digital society" domain, under the "Digital economy and society" category. For the indicator measuring the share of enterprises receiving online orders, data were retrieved from the "ICT usage in enterprises" theme, covering the period 2013–2024 for each country, including the EU average. For the indicators related to cloud computing and IoT usage, data were collected from the "E-business" theme. The time frame for cloud computing spans 2014–2024, while IoT data are available only for the years 2020 and 2021, reflecting the more recent introduction of this indicator into European statistical reporting.

The selection of these three indicators is justified by their capacity to capture fundamental aspects of digital transformation in enterprises. Cloud computing adoption reflects the modernization of information technology infrastructure and provides the foundation for the implementation of advanced digital solutions. The use of IoT systems illustrates the degree of automation and operational efficiency achieved within business processes. At the same time, the receipt of online orders indicates the extent to which enterprises are integrated into the digital economy and able to respond to changing consumer behaviours.

Taken together, these indicators are closely interconnected and provide a cohesive and nuanced picture of digital maturity in Romania and across Europe. Cloud-based infrastructure supports the deployment of IoT technologies and e-commerce solutions, while IoT adoption signals more advanced stages of digitalization characterised by innovation and data-driven decision-making. This integrated methodological approach enables a comprehensive assessment of the different stages of digital transformation within the business sector.

#### 4. Research Findings and Discussion

At European level: Percentage of enterprises that have purchased cloud computing services used on the internet.

For this indicator, the period analysed covers the years 2014–2024, at both the European average level and across EU and selected non-EU countries. Overall, the European average share of enterprises that purchased cloud computing services via the internet shows a clear upward trend over the analysed period. In 2014, the European average stood at 17.82%, increasing to 45.32% in 2023, indicating a substantial expansion in the adoption of cloud-based solutions among European enterprises. Although year-to-year variations are relatively moderate, the overall growth trajectory is statistically and economically significant.

It should be noted that data are not available for certain years, specifically 2015, 2017, and 2024, which limits the continuity of the time series. Nevertheless, the most pronounced increase occurred between 2018 and 2020, when the share of enterprises using cloud computing services rose from 23.90% to 36.10%, representing an increase of 12.2 percentage points. This sharp acceleration coincides with the outbreak of the COVID-19 pandemic in 2020, a period during which many enterprises were compelled to adopt digital solutions in order to ensure operational continuity. Following this period, the growth trend remained positive, albeit more gradual.

With regard to country-level performance, Finland consistently recorded the highest values for most of the analysed period, maintaining the leading position between 2014 and 2020, with an increase from 50.78% in 2014 to 75.49% in 2020. In 2021, Sweden temporarily overtook Finland, registering a share of 75.39%, compared to Finland's 75.29%. However, by 2023, Finland had regained the leading position, reaching a level of 78.29%. At the opposite end of the distribution, the lowest levels of cloud computing adoption were observed in Serbia (a non-EU country) in 2014, with a share of 3.73%, in Bulgaria during the period 2015–2017, with values ranging between 5.36% and 8.01%, and in Bosnia and Herzegovina (non-EU) between 2018 and 2021, where adoption rates remained between 8.27% and 8.85% (Table 1).

**Percentage of Enterprises that have Purchased Cloud Computing Services Used on the Internet (Europe); Source: Eurostat (2025), processed by the authors**

**Table 1**

GEO	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2020 (%)	2021 (%)	2023 (%)	2024 (%)
Albania	:	:	:	:	:	:	20.11	:	:
Austria	11.67	:	17.05	21.03	23.27	38.13	40.4	46.48	:
Belgium	21.24	24.62	28.46	39.59	40.25	53.23	52.96	51.69	:
Bosnia and Herzegovina	:	:	:	:	8.27	8.54	8.85	20.66	:
Bulgaria	7.72	5.36	6.7	8.01	8.35	10.85	12.79	17.5	:
Croatia	22.2	22.44	22.61	31.21	30.71	38.95	39.15	45.08	42

GEO	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2020 (%)	2021 (%)	2023 (%)	2024 (%)
Cyprus	10.16	13.02	15.26	21.75	26.58	34.59	50.29	52.93	:
Czechia	15.13	:	18.08	22.03	26.48	28.89	43.75	47.15	:
Denmark	37.67	36.65	41.6	50.53	55.62	66.9	64.82	69.48	:
Estonia	14.85	:	22.84	:	33.91	56.32	57.54	58.57	:
European Union	17.82	:	18.98	:	23.9	36.1	40.97	45.32	:
Finland	50.78	53.45	56.92	65.64	65.26	75.49	75.29	78.29	:
France	11.91	:	17.11	:	19.42	26.86	29.35	26.76	:
Germany	11.29	:	16.26	:	22.43	33.32	41.6	47	:
Greece	7.6	9.37	9.21	11.03	12.83	16.7	20.72	23.59	:
Hungary	8.08	10.56	12.19	16.34	18.01	25.21	26.41	44.94	48.34
Iceland	43.13	:	:	:	:	:	:	:	:
Ireland	27.6	35.24	36.08	:	45.18	50.9	58.79	63.1	:
Italy	40.1	:	21.51	:	22.53	59.14	60.47	61.39	:
Latvia	5.69	8.31	8.37	12.04	14.53	21.31	28.55	35.76	:
Lithuania	13.47	16.24	16.64	23.17	22.56	30.77	33.58	38.39	:
Luxembourg	12.52	:	18.83	:	24.54	29.09	33.48	37.04	:
Malta	17.35	24.64	28.45	:	36.55	52.16	57.09	66.74	:
Montenegro	:	:	12.42	:	18.02	:	:	31.66	:
Netherlands	27.65	:	34.53	:	48.25	52.56	64.94	64.19	71.02
North Macedonia	11.89	:	6.87	:	:	14.38	13.55	:	:
Norway	29.31	37.56	39.74	48.02	50.66	63.73	64.02	71.34	:
Poland	5.76	7.28	8.17	10	11.48	24.42	28.7	35.67	:
Portugal	12.56	:	17.95	22.6	24.68	29.9	33.97	37.58	:
Romania	4.86	8.17	7.29	10.79	10.29	15.73	14.14	18.4	:
Serbia	3.73	:	:	9.24	15.35	18.61	28.89	37	:
Slovakia	19.32	20.41	17.89	22.21	21.14	25.57	36.14	34.42	:
Slovenia	15.42	17.49	22.17	22.07	26.28	38.6	42.69	40.21	:
Spain	14.44	14.56	18.34	23.54	21.99	26.15	30.92	30.04	35.83
Sweden	39.44	:	48.16	:	57.21	69.51	75.39	71.62	:
Türkiye	:	:	18.33	:	18.09	14.09	19.83	16.39	:
United Kingdom	23.97	:	34.66	:	41.86	53.03	:	:	:

Source: Authors' own research results.

Percentage of enterprises that used interconnected devices or systems that can be monitored or controlled remotely via the internet (IoT):

For this indicator, data availability is limited, as Eurostat provides comparable information only for the years 2020 and 2021, with no values recorded for 2020. This limitation is primarily explained by the relatively recent inclusion of the Internet of Things (IoT) indicator in Eurostat statistical series, which became operational for most countries only in 2021. Although the COVID-19 pandemic may have contributed to increasing interest in automation and the deployment of IoT systems, the absence of data for earlier years does not allow for a robust empirical assessment of this relationship.

At the European level, the average share of enterprises using IoT systems in 2021 was 28.67%. Austria recorded the highest level of adoption, with a value of 50.77%, followed closely by Slovenia at 49.46%. In contrast to the results observed for cloud computing adoption, Finland ranked third for this indicator, with a share of 40.48%. At the lower end of the distribution, Romania registered the lowest level of IoT adoption, at 10.51%, alongside neighbouring Bulgaria with 14.99% and Bosnia and Herzegovina, a non-EU country, with a share of 17.24%.

An important observation emerging from this ranking is that, despite the limited temporal coverage of the data, cross-country variations are relatively moderate. Differences between countries are generally small, in many cases amounting to only a few percentage points or even fractions of a percentage point. This pattern suggests a broadly similar level of IoT adoption across European countries at the initial stage of measurement, reflecting the early diffusion phase of this technology within the business sector (Table 2).

**Percentage of Enterprises that have Used IoT Systems (Europe)Source: Eurostat (2025), processed by the authors**

**Table 2**

<b>GEO</b>	<b>2020 (%)</b>	<b>2021 (%)</b>
<b>Albania</b>	:	35.32
<b>Austria</b>	:	50.77
<b>Belgium</b>	:	28.16
<b>Bosnia and Herzegovina</b>	:	17.24
<b>Bulgaria</b>	:	14.99
<b>Croatia</b>	:	23.19
<b>Cyprus</b>	:	33.25
<b>Czechia</b>	:	31.45
<b>Denmark</b>	:	20.01
<b>Estonia</b>	:	17.37
<b>European Union</b>	:	28.67
<b>Finland</b>	:	40.48
<b>France</b>	:	22.01
<b>Germany</b>	:	35.61
<b>Greece</b>	:	22.83
<b>Hungary</b>	:	22.32
<b>Ireland</b>	:	34.01

<b>GEO</b>	<b>2020 (%)</b>	<b>2021 (%)</b>
<b>Italy</b>	:	32.26
<b>Latvia</b>	:	28.42
<b>Lithuania</b>	:	28.4
<b>Luxembourg</b>	:	22.21
<b>Malta</b>	:	28.02
<b>Montenegro</b>	:	:
<b>Netherlands</b>	:	20.73
<b>North Macedonia</b>	:	17.31
<b>Norway</b>	:	23.56
<b>Poland</b>	:	18.65
<b>Portugal</b>	:	23.1
<b>Romania</b>	:	10.51
<b>Serbia</b>	:	19.57
<b>Slovakia</b>	:	27.36
<b>Slovenia</b>	:	49.46
<b>Spain</b>	:	27.46
<b>Sweden</b>	:	40.29
<b>Türkiye</b>	:	21.06

*Source: Authors' own research results.*

Percentage of enterprises that received orders online:

For the indicator measuring the share of enterprises that received online orders, Eurostat provides data over a relatively long time horizon, covering the period 2013–2024. At the European level, the average value increased from 13.79% in 2013 to 20.75% in 2024, indicating a steady upward trend, albeit characterised by relatively moderate annual variations. A temporary deviation from this trend occurred in 2018, when a slight decrease was recorded, followed by a rapid recovery in the subsequent year.

The ranking of countries for this indicator exhibits considerable variation over time, particularly at the upper and lower ends of the distribution. In 2013, Denmark ranked first with 27.14%, followed closely by the Czech Republic at 25.72%, while the lowest values were recorded in North Macedonia (4.07%) and Bulgaria (4.76%). In 2014, Ireland replaced Denmark in the leading position with 26.56%, while the Czech Republic remained second with 26.54%. At the bottom of the ranking, North Macedonia continued to record the lowest value (5.18%), accompanied by Italy with 5.34%.

In 2015, Ireland maintained its leading position, reaching 32.18%, followed by Sweden, which entered the top ranks with 26.29%. The lowest values were again observed in North Macedonia, which experienced a sharp decline to 1.89%, and Bulgaria with 5.84%. A similar pattern persisted in 2016, with Ireland remaining first at 30.25% and Denmark returning to the top ranks with 27.72%. North Macedonia and Bulgaria continued to occupy the lowest positions, despite marginal increases compared to the previous year.

In 2017, Ireland remained the leading country with 29.97%, followed closely by Sweden at 29.20%. Bulgaria recorded the lowest value at 7.26%, although this represented a notable improvement compared to previous years, while Romania appeared among the lower-ranked countries with 8.04%. In 2018, Denmark regained the leading position with 31.51%, while Ireland moved to second place with 30.94%. At the lower end of the ranking, Bulgaria and Romania continued to record low values, at 5.70% and 8.63%, respectively.

The year 2019 marked a renewed increase for Ireland, which reclaimed the leading position with 35.59%, followed closely by Denmark at 33.51%. Bulgaria remained the lowest-ranked country with 7.41%, while Luxembourg emerged near the bottom of the ranking with 9.18%. In 2020, Denmark and Ireland exchanged positions once again, recording values of 38.40% and 32.58%, respectively. North Macedonia and Bulgaria occupied the lowest positions, with a substantial gap between them, at 3.65% and 8.31%.

In 2021, Denmark maintained the highest share of enterprises receiving online orders at 38.33%, followed by Sweden with 34.13%. North Macedonia remained at the bottom of the ranking with 5.62%, while Luxembourg followed at a considerable distance with 9.07%. In 2022, Sweden temporarily overtook Denmark, recording 36.57%, while Denmark declined to 35.58%. Both North Macedonia and Luxembourg continued to occupy the lowest positions, experiencing further decreases.

In 2023, Denmark returned to the leading position with 36.46%, followed closely by Sweden at 35.36%. Variations compared to the previous year were relatively small. Luxembourg recorded the lowest value at 9.38%, while Romania ranked just above with 12.33%, values that, although low, were higher than the minimum levels observed in earlier years. Finally, in 2024, Denmark remained the leading country with 38.58%, while Ireland returned to second place with 35.64%. At the lower end of the ranking, Luxembourg recorded the lowest value at 8.65%, followed by Bulgaria with 12.92%, indicating a substantial gap between these two countries (Table 3).

**Percentage of Enterprises that Received Orders Online (Europe); Source: Eurostat (2025), processed by the authors**

**Table 3**

GEO	2013 (%)	2014 (%)	2015 (%)	2016 (%)	2017 (%)	2018 (%)	2019 (%)	2020 (%)	2021 (%)	2022 (%)	2023 (%)	2024 (%)
Austria	12.58	13.27	14.59	15.26	17.23	14.42	19.62	22.31	22.99	21.78	21.26	25.36
Belgium	20.78	22.95	24.57	23.95	24.27	28.77	29.62	25.54	30.65	29.47	30.48	31.55
Bosnia and Herzegovina	:	:	:	:	:	21.54	20.74	19.15	20.18	23.51	22.94	23.92
Bulgaria	4.76	5.58	5.84	5.39	7.26	5.7	7.41	8.31	10.48	11.46	13.31	12.92
Croatia	:	:	19.55	18.61	17.7	18.18	21.9	30.72	29.75	29.73	30.04	32.03
Cyprus	7.25	10.4	16.6	12.67	11.71	12.15	12.66	14.7	17.6	20.12	20.25	21.43
Czechia	25.72	26.54	23.69	26.59	23.95	24.34	29.21	29.65	24.54	23.78	23.59	22.8
Denmark	27.14	26.37	26.04	27.72	28.53	31.51	33.51	38.4	38.33	35.58	36.46	38.58
Estonia	10.44	12.34	12.52	15.71	15.81	16.13	17.72	16.89	18.66	19.19	18.02	20.53
European Union	13.79	14.52	16.29	17.59	17.46	16.76	17.19	18.1	18.93	19.75	19.74	20.75
Finland	15.82	15.19	15.6	18.23	20.58	20.62	23.2	19.12	23.54	27.71	24.51	29.26
France	11.45	11.76	16.5	16.62	16.5	16.19	16.83	13.63	12.89	13.25	13.43	:
Germany	22.38	22.59	24.63	26.19	24.18	19.76	18.64	17.86	19.34	19.87	19.56	20.66
Greece	7.94	9.19	6.27	10.23	10.84	10.84	9.47	7.75	13.26	17	18.37	22.07
Hungary	9.98	10.27	10.55	12.18	12.96	12.58	13.83	13.96	18.58	20.94	22.43	21.66
Ireland	22.79	26.56	32.18	38.25	29.97	30.94	35.59	32.58	33.61	35.27	38.47	35.64
Italy	4.99	5.84	6.74	7.63	8.21	10.61	9.98	11.58	13.13	13.4	13.48	15.13
Latvia	7.49	7.1	8.59	8.35	10.8	10.67	11.29	11.8	14.61	15.87	17.43	16.95
Lithuania	19.71	18.19	17.76	18.61	22.05	21.52	24.22	27.83	31.95	31.97	31.1	35.19
Luxembourg	15.73	7.25	6.51	9.28	6.07	12.45	9.19	9.79	9.07	8.62	9.38	8.65
Malta	10.74	16.06	16.08	18.41	15.51	20.96	23.35	24.45	26.68	29.98	31.75	32.03
Montenegro	:	:	:	:	14	9.6	12.14	:	:	:	:	:
Netherlands	12.33	13.28	17.05	16.49	15.73	17.11	21.28	19.5	23.08	24.98	26.65	25.15
North Macedonia	4.07	5.18	1.89	2.96	:	:	:	3.65	5.62	2.96	:	:
Norway	25.37	25.42	26.2	26.5	28.59	27.51	26.91	21.87	26.06	29.33	27.11	31.11
Poland	8.98	9.87	18.24	16.66	18.21	12.56	13.66	14.18	14.79	14.52	14.83	14.71
Portugal	13.19	14.92	19.31	18.62	17.93	18.54	16.35	19.56	16.98	18.39	17.84	20.54
Romania	9.13	7.48	7.66	7.42	8.84	8.63	11.74	17.67	12.05	19.54	12.33	13.59
Serbia	:	:	21.24	:	:	23.75	26.87	29.85	26.37	26.53	27.62	28.78
Slovakia	17.57	11.92	13.21	12.22	15.42	13.34	12.34	17.46	14.18	14.89	15.24	14.91
Slovenia	11.15	14.28	16.27	14.02	18.49	17.82	17.95	18.38	19.92	20.22	18.05	20.43
Spain	12.51	16.65	16.53	19.12	20.83	18.71	19.99	24.73	25.82	29.58	30.17	29.14
Sweden	24.14	24.51	26.29	26.75	29.2	30.33	31.24	31.45	34.13	35.57	35.36	33.85
Türkiye	:	:	12.36	11.94	10.69	9.43	11.16	9.76	12.46	19.31	18.18	17.45
United Kingdom	19.09	19.08	20.44	19.38	19.93	20.9	24.67	26.96	:	23.51	22.94	23.92

*Source: Authors' own research results.*

At Romania level: Percentage of enterprises that have purchased cloud computing services used on the internet.

For this indicator, data availability in the National Institute of Statistics database is discontinuous. No data are recorded for the years 2009–2013, 2019, 2022, and 2024. Consequently, the analysis is based on the available observations for the periods 2014–2018, 2020–2021, and 2023.

During the interval 2014–2018, the share of Romanian enterprises purchasing cloud computing services followed a fluctuating trajectory. The indicator recorded a value of 4.9% in 2014, followed by a substantial increase to 8.2% in 2015. In 2016, the share declined slightly to 7.3%, before rising again in 2017 to 10.8%. In 2018, a marginal decrease was observed, with the indicator reaching 10.3%.

A marked increase occurred in 2020, when the proportion of enterprises using cloud computing services rose to 15.7%. This was followed by a decline in

2021, when the value decreased to 14.1%, representing a reduction of more than one percentage point compared to the previous year. In 2023, the indicator registered a notable increase, reaching 18.4%, which represents the highest value recorded over the entire analysed period.

The observed variability in the indicator reflects both the intermittent availability of statistical data and the uneven pace of cloud computing adoption among Romanian enterprises. However, due to the absence of data for several years, a comprehensive assessment of the underlying drivers of these fluctuations remains limited (Table 4).

**Percentage of Enterprises that have Purchased Cloud Computing Services Used on the Internet (Romania); Source: INS (2025), processed by the authors**

**Table 4**

<b>Year</b>	<b>Percentage (%)</b>
2009	:
2010	:
2011	:
2012	:
2013	:
2014	4.9
2015	8.2
2016	7.3
2017	10.8
2018	10.3
2019	:
2020	15.7
2021	14.1
2022	:
2023	18.4
2024	:

*Source:* Authors' own research results.

Percentage of enterprises that used interconnected devices or systems that can be monitored or controlled remotely via the internet (IoT):

For this indicator, data availability is limited, similarly to the European-level analysis, with observations recorded only for the years 2020 and 2021. In 2020, the share of Romanian enterprises that used IoT systems was 6.6%. In the following year, 2021, this share increased substantially, by approximately four percentage points, reaching 10.5%.

Although the data cover a very short time span, the observed increase suggests a growing interest among Romanian enterprises in the adoption of IoT technologies. However, the limited temporal coverage restricts the possibility of drawing broader conclusions regarding longer-term trends in IoT adoption within the Romanian business sector (Table 5).

**Percentage of Enterprises that have Used IoT Systems (Romania); Source: INS (2025), processed by the authors**

**Table 5**

<b>Year</b>	<b>Percentage (%)</b>
2009	:
2010	:
2011	:
2012	:
2013	:
2014	:
2015	:
2016	:
2017	:
2018	:
2019	:
2020	6.6
2021	10.5
2022	:
2023	:
2024	:

*Source:* Authors' own research results.

**Percentage of enterprises that received orders online:**

For the indicator measuring the share of Romanian enterprises that received online orders, data are available for the period 2010–2024. Similar to other digitalization indicators, the trend exhibits a degree of instability over time. In 2010, the share of enterprises receiving online orders was 6.5%, followed by a notable decline in 2011 to 4.4%. In 2012, the indicator recovered slightly to 5.4%, before recording a more substantial increase in 2013, when it reached 9.6%.

This upward movement was followed by a decline in 2014, when the share decreased to 7.9%. In 2015, a marginal increase was observed, with the indicator reaching 8.0%, while in 2016 it declined again to 7.4%. During the period 2017–2020, the indicator followed a consistent upward trajectory, increasing from 8.4% in 2017 to 19.1% in 2020. The year 2020 thus represents the highest value recorded over the entire analysed period.

After this peak, a period of contraction followed. In 2021, the share of enterprises receiving online orders decreased significantly to 13.3%, and this downward trend continued in 2022, when the indicator reached 11.2%. In the most recent years, 2023 and 2024, the indicator shows signs of recovery, increasing from 12.9% to 14.7%, respectively. These developments suggest a gradual rebound in e-commerce engagement among Romanian enterprises, although levels remain below the peak observed in 2020 (Table 6).

**Percentage of Enterprises that Received Orders Online (Romania); Source: INS (2025), processed by the authors**

**Table 6**

<b>Year</b>	<b>Percentage (%)</b>
2009	:
2010	6.5
2011	4.4
2012	5.4
2013	9.6
2014	7.9
2015	8
2016	7.4
2017	8.4
2018	8.8
2019	11.9
2020	19.1
2021	13.3
2022	11.2
2023	12.9
2024	14.7

*Source: Authors' own research results.*

**Comparative analysis Romania-Europe**

With regard to the first indicator analysed, namely the use of cloud computing services, Romania is positioned near the bottom of the European ranking throughout the entire observed period, 2014–2024. In 2014, Romania occupied the penultimate position, with a value of 4.9%, while the last position was held by Serbia, with 3.73%. Between 2015 and 2021, Romania gradually improved its relative position, advancing by one rank in several consecutive years and reaching its highest placement in the ascending order of the ranking during the period 2020–2021, when it ranked fifth. However, in 2023, Romania experienced a decline, dropping two positions in the European ranking.

For the indicator concerning the use of Internet of Things (IoT) systems in the business environment, comparative analysis is possible only for the year 2021. Although data for Romania are available for 2020, corresponding European-level data are not recorded for that year. As shown in the previous analysis, Romania ranked last among the analysed countries in 2021, with a share of 10.5% of enterprises using IoT systems. Despite occupying the lowest position, the recorded value is not negligible, and the gap compared to the immediately higher-ranked country, Bulgaria, which registered 14.99%, is relatively moderate.

In the case of the indicator measuring the share of enterprises that received online orders, Romania’s unstable trend over the period 2013–2024 is reflected in frequent changes in its position within the European ranking. In 2013, Romania was placed in the upper half of the ascending order, ranking eighth with a value of 9.6%. In 2014, it dropped two positions and remained at a similar level in 2016. Between 2016 and 2018, Romania experienced a sharp decline in ranking, moving toward the

lowest positions, despite registering slight but consistent increases in absolute values during this interval.

In 2019, Romania improved its position, climbing several places to reach seventh position in the ranking. In 2020, it recorded its highest placement during the analysed period, occupying the 14th position in the ascending order, which also coincided with the highest recorded value of the indicator, at 19.1%. In the subsequent period, 2021–2024, Romania's relative position deteriorated again, as it rapidly fell back toward the lower end of the European ranking.

## 5. Conclusions

This study provides a comparative analysis of Romania's level of digitalization in the business sector in relation to the European context, focusing on three key indicators: the adoption of cloud computing services, the use of Internet of Things (IoT) systems, and the share of enterprises receiving online orders. The empirical results highlight that Romania remains significantly below the European Union average across all analysed dimensions, confirming the persistence of a digital gap between Romania and more digitally advanced European economies.

The analysis of cloud computing adoption shows that, despite gradual progress, Romanian enterprises continue to record some of the lowest levels of uptake at the European level. Although periods of growth can be identified, particularly after 2020, the overall trajectory remains uneven and constrained by discontinuities in data availability and by structural limitations within the business environment. Similar patterns are observed in the case of IoT adoption, where Romania records the lowest values among the analysed countries for the only year allowing comparative assessment. While the gap relative to neighbouring countries is not exceptionally large, the results indicate a delayed integration of advanced digital technologies in Romanian enterprises.

Regarding e-commerce, the findings reveal a fluctuating trend in the share of enterprises receiving online orders. Although Romania experienced a notable increase during the period 2017–2020, reaching its highest recorded value in 2020, this progress was followed by a subsequent decline and only partial recovery in recent years. The comparative analysis demonstrates that Romania's position within the European ranking has varied considerably over time, reflecting instability in digital adoption rather than sustained convergence with EU leaders.

Overall, the results confirm that Romania's digital underperformance is not solely the result of technological constraints, but also reflects broader structural challenges related to skills, organizational readiness, and uneven adoption across sectors. At the same time, the observed improvements in certain periods indicate that progress is possible, particularly when favourable conditions are in place, such as increased digital demand, access to funding, or external competitive pressures. Bridging the digital gap with the European Union remains a critical objective for Romania, given the central role of digitalization in enhancing productivity, competitiveness, and economic resilience.

Beyond technological infrastructure and policy support, leadership plays a crucial role in shaping the success of digital transformation processes. Effective leadership is essential for articulating a clear digital vision, fostering a culture open to innovation, and guiding organizations through the structural and behavioural changes associated with digitalization. In the Romanian context, where digital maturity remains relatively low, leaders act as key mediators between technology and human capital, influencing employees' willingness to adopt new digital tools and practices. Transformational and adaptive leadership styles are particularly relevant, as they encourage learning, collaboration, and resilience in environments characterised by rapid technological change. Consequently, digitalization should be understood not only as a technological or economic process, but also as a leadership-driven organizational transformation, in which strategic vision, communication, and trust are central to achieving sustainable digital development.

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