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Digital Transformation Based on AI Technologies in European Union Organizations

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Abstract: This study aims to investigate the influence of emerging digital technologies, such as artificial intelligence (AI), the Internet of Things (IoT), and cloud computing, on the digital intensity index (DII). The research method employed involves quantitative analysis of the indicators regarding DII and emerging digital technologies, conducted based on data published by Eurostat for EU members in 2021. During our research, we formulated and tested hypotheses about the relationship between the DII and emerging digital technologies, and the effect on the DII of using AI-based technologies in various economic processes. The formulated hypotheses were validated via four regression models designed during this study, using the most relevant factors. Our research results demonstrate that the DII is positively influenced by emerging IoT and cloud computing digital technologies, as well as the use of AI technologies based on machine learning and AI-based robotic process automation (RPA) software. Furthermore, the same positive influence was identified in human resource management and recruitment processes compared to the intensity with which these technologies are used in other economic processes. Based on these findings, this study offers persuasive arguments for implementing emerging digital technologies at the EU organizational level to achieve significant increases in digitalization levels.

Keywords: digital technologies; artificial intelligence; Internet of Things; digital intensity index; machine learning; cloud computing

Citation: Mihai, F.; Aleca, O.E.; Gheorghe, M. Digital Transformation Based on AI Technologies in European Union Organizations. *Electronics* **2023**, *12*, 2386. https://doi.org/10.3390/electronics12112386

Academic Editors: Gurjot Singh Gaba, Yassine Sadqi, Najlae Idrissi and Abdul Wahid

Received: 23 April 2023
Revised: 16 May 2023
Accepted: 21 May 2023
Published: 25 May 2023

1. Introduction

Emerging digital technologies such as AI, machine learning, robots, big data, and cloud computing have sparked a growing interest in economic process automation as a means of driving economic growth [1]. Applications that integrate AI are increasingly replacing tasks traditionally performed by professionals such as lawyers, accountants, teachers, and people in other professional categories [2]. These changes also cause controversy regarding social inclusion [1]. The degree to which digital technologies are integrated into economic processes and activities is known as digital intensity. For instance, the European Union's (EU) digital transformation target is that 90% of small and medium-sized enterprises in the EU should reach a basic level of digital intensity by 2030. This target involves the use of at least four digital technologies in each organization [3]. The literature includes many studies tackling the topic of digital transformation in various sectors of the economy. However, implementing emerging digital technologies has only resulted in some targeted analyses of the increased digitalization level within EU organizations. It is becoming more evident that organizations everywhere are undergoing a process of change, and this new mentality is directed by the aspiration to increase quality of life. Therefore, organizations are trying to reduce their digital gap by embracing the adoption of new digital technologies [4]. To address this knowledge gap, this study's primary objective is to explore the impact of implementing certain emerging digital technologies, such as AI, IoT, and cloud computing,

on the DII. Therefore, this research considered essential factors: the type of technology used, the organizational process for which emerging technologies are used, and how the systems based on these technologies are used. The originality of this paper is given by the multidimensional approach of the research topic, which enables the identification of the most relevant emerging digital technologies and the economic processes to which they can be applied at the level of EU organizations in order to have a positive impact on the DII. The EU encourages implementing policies designed to increase innovation and digitalization so that the infrastructure of, access to, and use of new technologies may be developed. The European Commission wishes to turn this decade into the "digital decade" [5]. Furthermore, the EU should adopt a more robust and positive approach regarding financing research and development activities in individual countries and industrial enterprises or groups to promote innovation and technological development [6].

Among the priority points within the European Commission are the stimulation of the technological and industrial capacity of the EU and the adoption of AI throughout the economy [7]. A study by PricewaterhouseCoopers estimates a 14% increase in global GDP by 2030 due to the development of AI and emerging digital technologies [8]. The competitive advantage of using emerging technologies cannot be neglected at the macroeconomic and microeconomic levels. AI adoption can widen the economic gap between countries, requiring different AI adoption strategies for each country [9].

Considering the varying levels of economic development of EU member states, and the different levels of digital intensity and use of innovative technologies, carrying out studies to assess the level of use of emerging digital technologies within organizations in each EU countries is justifiable.

Our research strategy included the formulation of three research questions that align with the research objective:

RQ1: Which emerging digital technologies have a significant impact on the digital intensity of organizations in the EU?

To facilitate digitalization efforts, it is imperative for organizations and national decision-makers to prioritize the adoption of digital technologies that have the most significant impact on digital intensity.

RQ2: Which economic processes in organizations are most affected by AI technologies in the EU?

When an organization decides to incorporate AI technologies, decision-makers can determine the economic processes that will benefit the most from the integration of AI.

RQ3: Which AI-based technologies will have the greatest impact on the digital intensity of businesses in the EU?

These questions aim to provide investors with the means to choose promising investment projects that include technologies that will have the most significant impact on digital intensity. In order to answer these questions, our research was conducted based on 18 selected indicators (determining factors) that characterize the leading digital technologies and subtypes of AI technology. Additionally, this study examined the level of education of information and communications technology (ICT) specialists in organizations across the 27 EU member states in 2021. To achieve the paper's objectives, several statistical and econometric models (descriptive statistics, correlation and regression analysis) were used. This analysis aims to provide decision-makers with valuable insights into economic processes that use AI technologies and how they can improve digital intensity. Unfortunately, the literature in this field does not provide many studies that analyze the DII, so the originality of our research is given by the four regression models that reveal the most important influencing factors.

This paper is structured into five main sections, apart from the introduction, as follows: The first section presents the literature in the field, providing a relevant overview of emerging digital technologies, the impact of implementing these technologies on economic processes, and the types of AI-based technology used by organizations that influence the DII. The following three sections describe the research methodology, the data analysis, a

discussion, and the results. Finally, the last section presents the research conclusions and limitations, and offers directions for future research.

2. Scientific Literature Review

Due to its advantages, digitalization is essential to economic growth, an aspect highlighted globally [10] and at the EU level [6,11]. The interest in digitalization and digital technologies has led to a significant increase in papers on these subjects. To better understand how organizations use emerging technologies, in this study, these papers are divided into three categories:

- Emerging digital technologies and DII;
- AI technologies used in economic processes;
- AI technologies.

Emerging digital technologies and DII

The DII reflects the level of adoption of digital technologies in the economy. It also reflects its degree of economic integration in different economic sectors, such as manufacturing, financial services, health, and retail. Therefore, the DII can be used to compare the digital strengths of different countries. It can also identify areas where further investment in digital technologies is required. Finally, it can also assess the impact of digital technology on economic growth and living standards. The digital intensity index calculated by Eurostat is a composite indicator obtained based on a survey on the use of ICT and e-commerce by companies. Using the values of the 12 variables included in the digital intensity index, we can identify four digital intensity levels: very low (between 0 and 3 points), low (between 4 and 6 points), high (between 7 and 9 points), and very high (between 10 and 12 points) [12]. From year to year, Eurostat revises and adapts the survey to better reflect new changes in the digital environment and the current state of digital development in business. The DII is used as the main monitoring tool of the EU's Digital Decade, which sets targets for Europe's digital transformation by 2030 [13].

Previous scientific research has explored both the challenges and drawbacks of emerging digital technologies [14,15]. Other studies offer a pessimistic view of the widespread adoption of these technologies within organizations from an efficiency perspective [16]. Nevertheless, it is widely recognized that emerging digital technologies have the potential to enhance productivity, efficiency, and safety in the workplace [17]. The authors of [18] evaluated the level of digital maturity of businesses in Europe and identified large diversity in EU countries as regards digital maturity, and [6] analyzed the digitalization level within organizations in EU member states. The authors of [19] analyzed the use of digital technologies within organizations, concluding that cloud computing is the most frequently used solution due to its simplicity compared to other technologies. Cloud computing significantly impacts economic growth in the EU by creating a few hundred thousand new small and medium-sized enterprises [11]. Infrastructure based on cloud computing provides business opportunities and obstacles for small and medium-sized enterprises [20] and can stimulate digital innovation [21]. However, the adoption of AI technologies is complex, requiring organizations to possess the necessary knowledge and resources [19]. Other studies have analyzed the determining factors of innovation in AI within European enterprises [22] and the impact of digital technology on European small and medium-sized enterprises, identifying a range of risks, such as a lack of qualified labor [23]. The adoption of emerging technologies is a complex process that is influenced by cultural differences between countries and the population's attitude towards these technologies. For example, ref. [24] analyzes the acceptance of autonomous robots in the agricultural sector in Germany, while [25] concentrates on studying the acceptance of autonomous robots at the EU level. AI technologies have a significant impact on the DII, as they increase the use of digital technologies in various economic sectors, such as manufacturing, financial services, healthcare, and retail. AI technologies help to automate specific processes, improve product quality, and provide better investment recommendations [26]. Thus, they positively impact digital technology adoption in these sectors, increasing the DII

and promoting economic growth and living standards. AI is the most common emerging digital technology, and hybridization with other technologies contributes the most to an organization's performance [27].

The Internet of Things (IoT) can also significantly influence the DII by enhancing the ability to collect, store, and analyze data. By enabling real-time data acquisition through millions of connected devices [28], the IoT can collect valuable information about products, business processes, and consumer behavior [29]. These data can improve decision-making and process automation, increasing efficiency and productivity. Therefore, the IoT can positively impact the DII by improving the digital technologies used in various sectors of the economy.

Cloud computing is another technology that can significantly influence the DII. It facilitates access to technology, data, and applications that are essential to an organization's activities without requiring the purchase and maintenance of its IT infrastructure. As a result, organizations can focus more on their areas of expertise, gain a competitive advantage through the efficient use of resources, and increase their DII. Efficient cloud infrastructure integration into value-added activities requires the development of new IT and organizational skills through digital development [21].

Previous research analyses the impact of emerging digital technologies from the point of view of the increase in the productivity, efficiency, and economic performance of companies. We noticed a gap in the scientific literature we analyzed, namely, the connection between the adoption of advanced digital technologies by companies and the digital intensity index; our study will examine this to identify the emerging digital technologies with the most significant impact on this indicator.

AI technologies used in economic processes

The implementation of AI technologies in marketing and sales has enabled the automation and optimization of various processes, including customer segmentation, the personalization of messages and campaigns, and data analysis, among others. This has resulted in improved efficiency and effectiveness of marketing and sales actions, leading to enhanced business outcomes [30]. Marketers use language-based AI as sales tools, payment processors, and engagement managers to improve user experience [30]. Mobile shopping apps (MGSs) can positively impact the DII by increasing digital technology use in the food sector. They allow customers to shop for groceries via mobile phones without going to a physical store [31]. The technology used in this sector can drive efficiency, convenience, and safety in shopping and increase digital satisfaction [32]. Additionally, MGSs have the potential to enhance product information management and the identification of buyer needs and preferences, contributing to the improvement of the DII. Organizations with a focus on research and service delivery tend to implement AI technologies in internal manufacturing locations [33].

AI technologies can also be utilized to automate and optimize production processes, such as monitoring production parameters in real-time, forecasting the need of raw materials or finished products, optimizing production schedules, and managing resources efficiently. Furthermore, AI technology can identify and prevent quality [28] or operational issues before they affect production [33].

AI technologies for business administration processes are designed to automate and optimize various business management aspects, and may include: data processing automation, big data analysis, financial and accounting activity automation, assistance in decision-making, supply chain process improvement, human resources (HR), process automation, and others. As a result, AI technologies can help eliminate manual errors, speed up processes, make more informed decisions, save on costs [34], and facilitate automated process management through AI [35].

AI technologies can also be utilized to optimize logistics processes, such as route planning, inventory management, product delivery, and vehicle fleet optimization, resulting in greater efficiency and productivity, improved customer service, and reduced costs. The most commonly used AI technologies for supply chain management have been identified

in a study [36]. AI technologies in human resource management and recruitment automate one or more activities, such as evaluating CVs, interviewing candidates, pre-screening, or classifying candidates [37]. For instance, machine learning algorithms can evaluate specific characteristics, such as candidate experience, skills, and knowledge, to present employers with only those candidates who meet the necessary criteria, thereby reducing subjectivity and improving efficiency in the recruitment process [38,39].

The analyzed studies highlight the diversity of economic processes during which AI technologies are used to automate and optimize business processes. We have identified a field that has not been explored until now (knowledge gap), which is the connection between the DII and the fields of application of AI technologies in organizational processes; this study aims to research this topic to enable decision-makers inside companies to choose the best directions for investment.

AI technologies

In the context of the organizational use of artificial intelligence (AI), various types of AI technology can be identified, including those that perform analyses of written language (text mining), convert spoken language into a machine-readable format (speech recognition), generate written or spoken language (natural language generation), identify objects or persons based on images (image recognition and image processing), utilize machine learning, automate different workflows or assist in decision-making, and enable the physical movement of machines via autonomous decisions based on observations of their surroundings (autonomous robots, self-driving vehicles, and autonomous drones).

AI technologies that perform written language analysis, such as text mining, can be utilized to summarize content or classify text according to specific marketing or artificial business intelligence criteria. They can thus process invoices, checks, receipts, and other documents that follow a standardized format [40].

Speech recognition plays a critical role in promoting positive consumer experiences, as identified in a study [41]. However, some disadvantages exist, such as reduced voice recognition accuracy in certain acoustic conditions, difficulty recognizing fast or accented speech, and the possible need for continuous training algorithms to adapt to new voices and dialects [42,43]. Speech recognition is an evolving technology that has the potential to transform how people interact with devices and technology [44,45].

Natural language generation technologies, or NLP (natural language processing), use AI to generate written or spoken text that mimics how humans speak. They are based on machine learning models that have been trained with enormous amounts of text data. As a result, they can automate translation, transcription, summarization, and content generation tasks. NLP is a chatbot used in marketing campaigns, online advertising, supply chain management, customer relationship management, and data collection [36].

AI technologies that identify objects or people based on images are called "image recognition" or "image processing" technologies. However, they rely on machine learning and deep learning algorithms, allowing the system to understand and "recognize" elements in images, such as objects, people, girls, and animals. Nevertheless, these technologies have several applications, such as security and surveillance, photography, and digital marketing. For example, a possible use is to find similar images in Internet searches for checking, for example, personal data or facial recognition [6].

AI technologies based on machine learning and deep learning focus on developing algorithms for automated learning. These can learn from data and can be used to carry out complex tasks without specific instructions. Different scholars have applied machine learning and deep learning to several topics related to air quality, including spatiotemporal interpolation, prediction, and feature extraction [46]. Another use for machine learning may be to predict equipment failures [47].

RPA technologies utilize automated software to imitate human actions, such as collecting data, updating files, or sending emails, thereby automating repetitive manual tasks and improving efficiency, reducing errors, and lowering costs. RPA applications are used in many areas, such as financial services, healthcare, retail, and government services. Even

though AI and RPA are two different technologies, they can support and complete each other and coexist via integration to form a more solid platform for intelligent automation; this implies the automation of any business process. AI can help RPA to automate tasks more efficiently. RPA enables information regarding AI to be processed faster without manual intervention.

AI technologies enable the physical movement of machines via autonomous decisions based on observations of their surroundings (autonomous robots, self-driving vehicles, and autonomous drones). Using AI, these systems can perform complex and dangerous tasks without direct human intervention, which can help improve efficiency and safety in various industries, such as transportation, construction, and agriculture.

3. Research Methodology

Based on previous research [6,18,20,21,48–50] into the most relevant emerging digital technologies that contribute to the digital transformation of companies, we collected and performed data analysis related to the DII, company expenditure on research and development, employee education, and emerging digital technologies used within organizations in the EU. The variables regarding emerging technologies (Internet of Things, cloud computing, and artificial intelligence) and their association with digitalization as pillars of Industry 4.0 were also used in the papers [18,21,48,50].

The following stages were completed during the study (Figure 1):

- Definition of the research objectives;
- Analysis of the specialized literature and definition of the hypotheses;
- Data collection from the Eurostat database [51];
- Data analysis to identify the correlations between the DII, digital technology characteristics, expenses for research and development, employee education, and the factors influencing the DII;
- Presentation of research results, conclusions, and research limits.

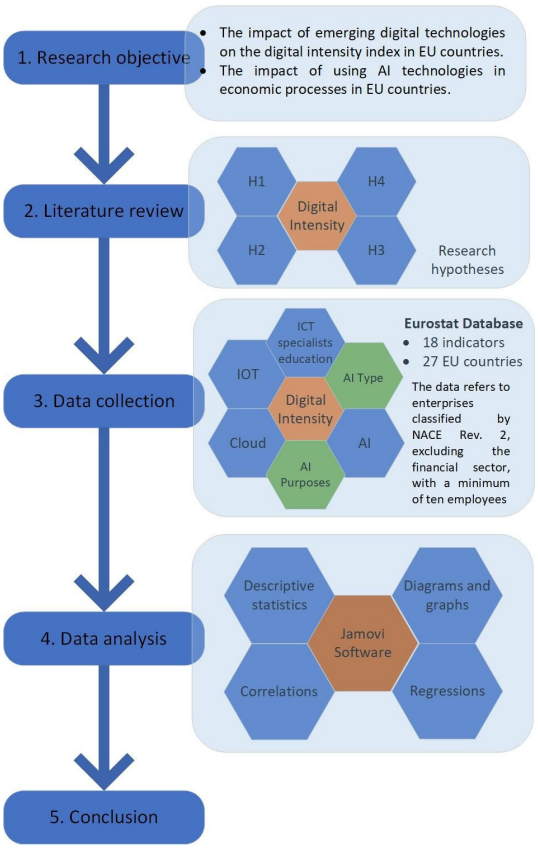

Figure 1. The research methodology diagram.

The digital intensity index values represent the percentage of organizations with a high digital intensity level, calculated as a percentage of the total number of businesses. The variables selected for the emerging digital technologies and digital intensity characterization also consider similar studies by other authors [6,18,21,49,50], as shown in Table 1.

Table 1. Description of variables used (data source: Eurostat [51]).

Variable Code	Variable Name/Description	Measure Unit
	A. General	
DII	Enterprises with high and very high digital intensity indexes	Percentage of enterprises
ITS	Employed information and communications technology (ICT) specialists with tertiary education	Percentage
	B. Emerging Digital Technologies	
IOT	Enterprises using the Internet of Things (IoT) (interconnected devices or systems that can be monitored or remotely controlled via the internet)	Percentage of enterprises
CLO	Enterprises buying cloud computing services used over the internet	Percentage of enterprises
AI	Enterprises using artificial intelligence (AI) technologies	Percentage of enterprises
	B.1. AI Technologies	
LG	Enterprises using AI technologies to perform analysis of written language (text mining)	Percentage of enterprises
SPO	Enterprises using AI technologies to convert spoken language into machine-readable format (speech recognition)	Percentage of enterprises
WRI	Enterprises using AI technologies to generate written or spoken language (natural language generation)	Percentage of enterprises
OBJ	Enterprises using AI technologies to identify objects or persons based on images (image recognition and image processing)	Percentage of enterprises
ML	Enterprises using machine learning (e.g., deep learning) for data analysis	Percentage of enterprises
RPA	Enterprises using AI technologies to automate different workflows or assist in decision-making (AI-based robotic process automation software)	Percentage of enterprises
MAC	Enterprises using AI technologies to enable the physical movement of machines via autonomous decisions based on observations of surroundings (autonomous robots, self-driving vehicles, and autonomous drones)	Percentage of enterprises
	B.2. Economic Processes of the Organization (AI Purposes)	
SAL	Enterprises using AI technologies for marketing or sales	Percentage of enterprises
PRO	Enterprises using AI technologies for production processes	Percentage of enterprises
ORG	Enterprises using AI technologies for the organization of business administration processes	Percentage of enterprises
MAN	Enterprises using AI technologies for the management of enterprises	Percentage of enterprises
LOG	Enterprises using AI technologies for logistics	Percentage of enterprises
SEC	Enterprises using AI technologies for ICT security	Percentage of enterprises
HR	Enterprises using AI technologies for human resource (HR) management or recruiting	Percentage of enterprises

This research aims to analyze the impact of new digital technologies and the types of AI technology on the DII, and to evaluate the effect of using AI technology in various economic processes. This study's novelty resides in how the research gap related to the connection between digital transformation and emerging digital technologies used by organizations is approached. This study distinguishes itself from others by examining the relationship between the DII and the fields of application for AI technologies within organizations, a connection that is still unexplored. The research hypotheses were formulated based on the identified gap and the research questions (RQ1, RQ2, RQ3).

H1. *The digital intensity measured using the DII is positively influenced by using technologies based on IoT and technologies based on cloud computing (CLO) within the processes of organizations in the EU.*

H2. *The digital intensity measured using the DII is positively influenced by the use of AI-based technologies in organizations in the EU for human resource management or recruitment (HR) compared to the intensity of use of these technologies in other processes.*

H3. *The digital intensity measured using the DII is positively influenced by the level of use of AI technologies based on machine learning (ML) and robot process automation (RPA) within organizations in the EU.*

H4. *The digital intensity measured using the DII is positively influenced by using AI technologies of the speech recognition (SPO) type within organizations in the EU.*

Four multiple linear regression models were designed to study the potential impact of each AI-based technology on digital intensity as measured by the DII (dependent variable). The reasons for designing several linear regression models were related to reducing the risks of using many independent variables in a single model: overfitting, multicollinearity, estimation errors, and difficult interpretation. Each regression model focuses on studying the influence that a single technology type based on AI can have on the processes carried out in organizations (Figure 1). In addition, complementary technologies closely related to AI technologies were introduced as independent variables in each model: technologies based on cloud computing and technologies based on the IoT. Additionally, in each model, an independent variable related to human resources was added, this being very important for the study from at least two points of view: the higher level of education of the human resource and potential problems related to social inclusion. As shown in the literature review, the integration of technology based on AI can generate controversy [1] due to concerns about making employees redundant.

4. Data Analysis

The information collected for this study refers to enterprises with high and very high DIIs, enterprises that employ ICT specialists with tertiary education, enterprises using the IoT, and enterprises using AI, divided by all the types of economic process. The data were extracted from the Eurostat database for 2021 for all fields of activity, except for the financial sector, for all 27 EU member states.

The data refer to enterprises classified by NACE Rev. 2 with a minimum of ten employees, excluding the financial sector, and were measured as a percentage of the total number of enterprises. The 18 indicators used in this research were grouped into four categories, as can be seen in Table 1. The statistical processing from the data analysis was performed using the JAMOVI software [52].

Table 2 shows the descriptive statistics for the selected variables used in this research.

Table 2. Descriptive statistics (source: developed by the authors using JAMOVI software, Sydney, Australia, Version 2.3 [52]).

Variables	N	Minimum	Maximum	Mean	Std. Deviation
DII	27	6.1	47.4	23.889	10.9834
IOT	27	10.5	50.8	27.915	9.6256
CLO	27	12.8	75.4	42.767	17.2648
ITS	27	41.3	84.2	67.62	10.76
LG	27	0.4	10.0	3.026	2.5114
SPO	27	0.4	4.5	1.744	1.1036
WRI	27	0.1	5.1	1.448	1.1206
OBJ	27	0.4	7.6	2.356	1.5636

Table 2. *Cont.*

Variables	N	Minimum	Maximum	Mean	Std. Deviation
ML	27	0.5	8.8	2.726	2.0212
RPA	27	0.7	16.9	3.189	3.2611
MAC	27	0.1	3.6	0.956	0.7827
SAL	27	0.5	6.7	2.152	1.5926
PRO	27	0.4	4.9	1.815	1.1983
ORG	27	0.4	6.4	2.022	1.5902
MAN	27	0.2	9.0	1.563	1.7781
LOG	27	0.3	3.8	0.900	0.7879
SEC	27	0.5	8.0	2.296	1.8873
HR	27	0.0	3.0	0.796	0.7871

Figure 2 shows the DII values at the EU level. There is a big difference between European areas regarding the digitalization of organizations. The Eastern European area is less digitized than the Western one, which has undergone tremendous digital advancement.

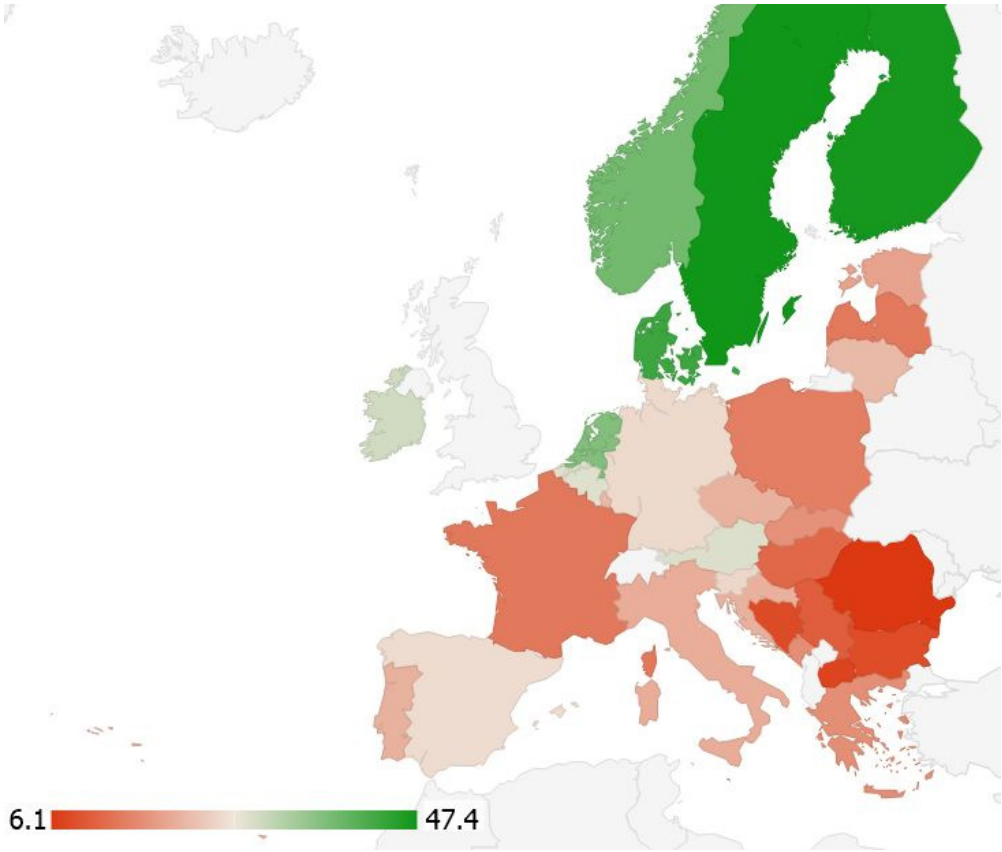

Figure 2. DII at the European level (data source: Eurostat; high and very high DII [51]).

Figure 3 shows the percentage values for organizations using emerging IoT, AI, and cloud computing digital technologies in EU countries. Again, significant differences exist between the percentages of organizations using cloud computing and AI technologies.

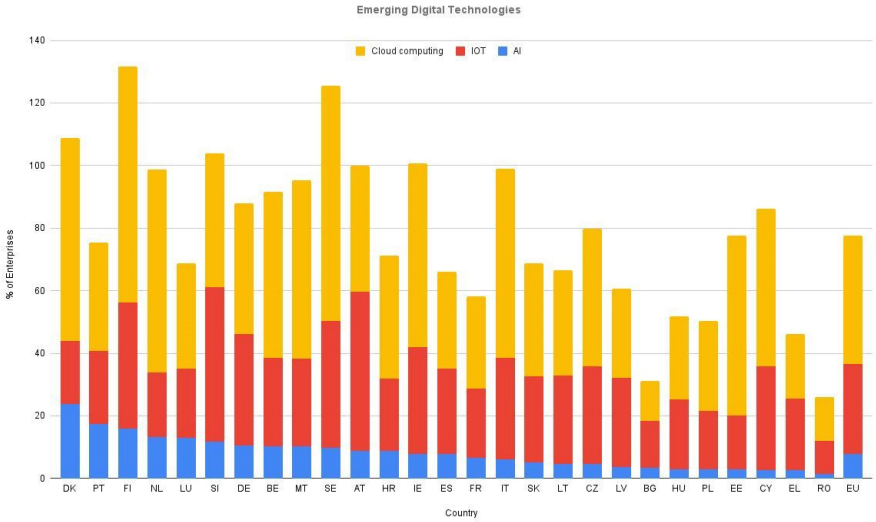

Figure 3. The percentage of organizations that use emerging IoT, AI, and cloud computing digital technologies in EU countries (data source: Eurostat [51]).

The most used AI technologies in organizations from EU countries are robotic process automation and machine learning, and the least used are those based on autonomous robots (Figure 4).

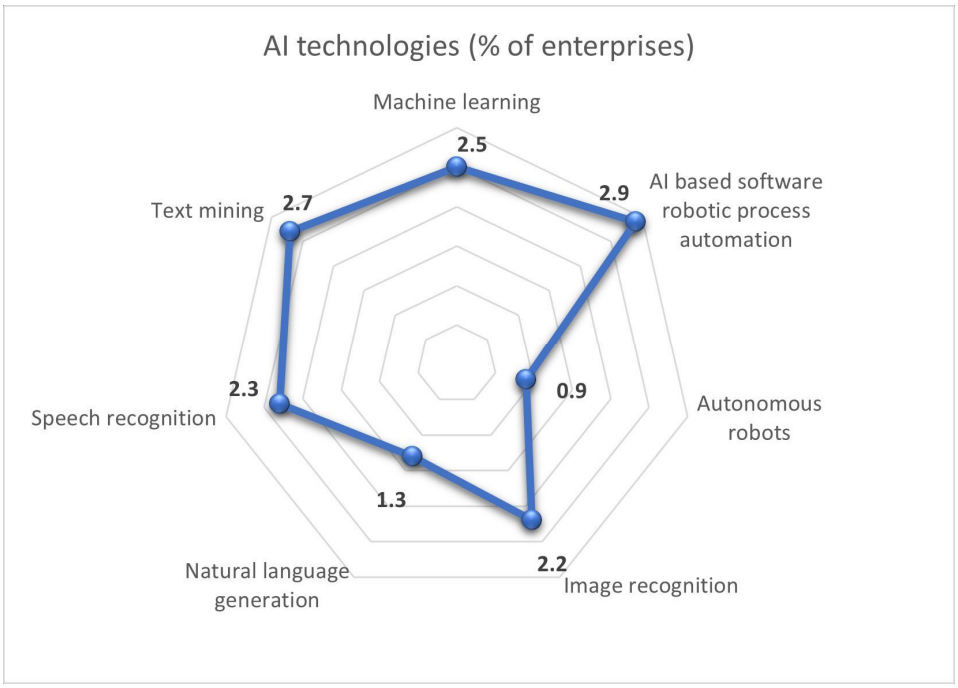

Figure 4. AI technologies used by organizations (average values for the year 2021 at EU level) (data source: Eurostat [51]).

From the analysis of the correlation table (Table 3), we see only one indirect link ($r \in [-1;0]$) between the digital intensity and the percentage of employed ICT specialists with tertiary education (ITS). The percentage of employed ICT specialists with tertiary education represents an essential element in the company's employee structure. The increase in the digitalization level through AI-based technologies may have decreased the percentage of ICT specialists from the total number of company employees. Aspects referring to potential problems related to social inclusion due to the implementation of new digital technologies have also been presented in other research papers [1].

Table 3. The correlations between DII and the other predictors (source: developed by the authors using JAMOVI software, Sydney, Australia, Version 2.3 [52]).

Row Number	Predictors	Pearson Correlation	Sig. (2-Tailed)
1	DII-IOT	0.490	0.009
2	DII-CLO	0.870	<0.001
3	DII-LG	0.452	0.018
4	DII-SPO	0.621	<0.001
5	DII-WRI	0.687	<0.001
6	DII-OBJ	0.567	0.002
7	DII-ML	0.857	<0.001
8	DII-RPA	0.706	<0.001
9	DII-MAC	0.722	<0.001
10	DII-SAL	0.668	<0.001
11	DII-PRO	0.704	<0.001
12	DII-ORG	0.604	<0.001
13	DII-MAN	0.519	0.006
14	DII-LOG	0.661	<0.001
15	DII-SEC	0.599	<0.001
16	DII-HR	0.634	<0.001

All other correlations between the DII and the other predictor variables are direct links ($r \in [0;1]$). There is a very close interdependence ($r \in [0.8;1]$) of the digital intensity measured using the DII and technologies used in companies based on cloud computing (CLO, 0.870), respectively, with technologies that use machine learning (ML, 0.857). Technologies based on cloud computing allow companies to use flexible, scalable solutions with optimal costs, and are complementary to the most used digital technologies [21]. Machine learning technologies allow organizations to optimize repetitive activities accurately [53] or predict equipment failures [47]. Regarding the correlations between the DII and the types of AI-based technology used within organizations, we noted a strong interdependence ($r \in [0.6;0.8]$) with AI technologies converting spoken language into a machine-readable format (SPO, 0.621), AI technologies generating written or spoken language (WRI, 0.687), AI-based robotic process automation software (RPA, 0.706), and AI technologies enabling the physical movement of machines via autonomous decisions based on observations of their surroundings (MAC, 0.722). Regarding the correlations between the DII and the processes within the organizations where AI-based technologies are used, we noted a strong interdependence with AI technologies for marketing or sales (SAL, 0.668), AI technologies for production processes (PRO, 0.704), AI technologies for business administration processes organization (ORG, 0.604), AI technologies for logistics (LOG, 0.661), and AI technologies for human resource management or recruiting (HR, 0.634). These links reflect correlations between digital intensity, as measured using the DII, and five core processes carried out within organizations. Organizations are concerned with implementing digital technologies to increase productivity and efficiency [4,17,32].

Regression analysis

We applied the JAMOVI software [52] for each regression provided in the research methodology. For each model, the most significant values are presented in Tables 4 and 5.

Table 4 shows the values of F for each regression with a significance coefficient of less than 0.001. These values indicate that the regression equations obtained are helpful for the intended purpose of this research. Therefore, all models are valid.

The multicollinearity (Table 5) study using variance inflation factor (VIF) values reveals no multicollinearity in the models.

Table 4. Measures of model fit for linear regression models (source: developed by the authors using the JAMOVI software, Sydney, Australia, Version 2.3 [52]).

Row Number	Model Fit Measures	Regression 1	Regression 2	Regression 3	Regression 4
1	R	0.958	0.961	0.965	0.950
2	R square	0.918	0.923	0.930	0.902
3	Adjusted R square	0.887	0.905	0.914	0.878
4	F	30.3	50.5	56.2	38.6
5	p	<0.001	<0.001	<0.001	<0.001

Table 5. The VIF values (source: developed by the authors using the JAMOVI software, Sydney, Australia, Version 2.3 [47]).

Row Number		Regression 1	Regression 2	Regression 3	Regression 4
1	IOT	1.74	1.59	1.65	1.57
2	CLO	2.29	2.37	2.58	2.04
3	ITS	1.28			
4	SPO	2.04			
5	ML		4.66		
6	RPA			5.15	
7	MAC				4.98
8	ORG	9.47	6.51		6.90
9	MAN			6.34	
10	LOG	7.09			
11	HR	6.95	7.00	4.04	7.22

These values indicate that the regression equations obtained are suitable for the intended purposes of this research. Therefore, the models are valid. The remaining predictors in each significant model are presented in Table 6.

Table 6. The coefficients for the regression models (source: developed by the authors using the JAMOVI software, Sydney, Australia, Version 2.3 [52]).

		Regression 1		Regression 2		Regression 3		Regression 4	
Dependent Variable		DII		DII		DII		DII	
Row Number	Predictors	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value	Coef.	*p*-Value
1	Intercept	−18.42	0.011	−1.239	0.606	−4.035	0.074	−4.098	0.122
2	IOT	0.347	0.002	0.268	0.006	0.423	<0.001	0.352	0.002
3	CLO	0.348	<0.001	0.254	<0.001	0.226	<0.001	0.311	<0.001
4	ITS	0.175	0.033						
5	SPO	1.943	0.052						
6	ML			2.818	<0.001				
7	RPA					1.997	<0.001		
8	MAC							5.962	0.011
9	ORG	−3.342	0.027	−2.380	0.037			−2.386	0.068
10	MAN					−3.146	0.002		
11	LOG	4.667	0.071						
12	HR	6.390	0.016	4.945	0.038	6.274	<0.001	4.997	0.065

Table 4 shows that the equations for each regression explain more than 90% (value of R square—coefficient of determination) of the DII variance. The values of R (0.958, 0.961, 0.965, and 0.950) reveal that the correlation between the variables of the predictors and the DII dependent variable is robust. The regression equations obtained are presented in Formulas (1)–(4).

$$DII = -18.42 + 0.347IOT + 0.348CLO + 0.175ITS + 1.943SPO - 3.342ORG + 4.667LOG + 6.390HR \quad (1)$$

$$DII = -1.239 + 0.268IOT + 0.254CLO + 2.818ML - 2.380ORG + 4.945HR \quad (2)$$

$$DII = -4.035 + 0.423IOT + 0.226CLO + 1.997RPA - 3.146MAN + 6.274HR \quad (3)$$

$$DII = -4.098 + 0.352IOT + 0.311CLO + 5.962MAC - 2.386ORG + 4.997HR \quad (4)$$

The regression analysis shows that the proposed models are statistically significant and reflect a strong correlation between the DII and some of the AI technologies used within organizational processes.

All the regressions (Table 6, Equations (1)–(4)) reveal a positive association between the DII and interconnected devices or systems that can be monitored or remotely controlled via the Internet of Things (IOT) and cloud computing technologies (CLO) used in most organizational processes. These technologies are complementary to many other technologies. Therefore, following the analysis of regressions, we consider the first hypothesis to be confirmed. The same positive association is identified between the DII and artificial intelligence technologies for human resource management or recruitment (HR) (Table 6, Equations (1)–(4)). Therefore, AI technologies for human resource management or recruiting (HR) are essential for most companies [38,39], which is highlighted by the second hypothesis in this paper. Regressions 2, 3, and 4 (Table 6, Equations (2)–(4)) reveal a negative association between the DII and AI technologies for the organization of business administration processes (ORG). Furthermore, the same negative association exists between the digital intensity measured using the DII and AI technologies for enterprise management (MAN) within regression 3. Therefore, integrating AI technologies within management processes is more expensive, and the effects on efficiency will be observed over a long time [35].

The first regression (Table 6) and Equation (1) reveal a positive association of the DII and the percentage of employed ICT specialists with tertiary education (ITS) with AI technology for converting spoken language into a machine-readable format (SPO). In the context of AI technologies for speech recognition, the employee's role remains important, even if it is lower. Both converge to increase performance efficiency within logistics and human resource processes [42]. These results confirm the fourth hypothesis, where we propose that the DII is positively influenced by using AI technologies of the speech recognition (SPO) type within organizations. The second regression (Table 6) and Equation (2) reveal a positive association between the DII and AI-based machine learning technologies (ML). The third regression (Table 6) and Equation (3) reveal a positive association between the DII and AI-based robotic process automation (RPA) software. Therefore, based on regressions 2 and 3 (Table 6, Equations (2) and (3)), following regression analysis, the third hypothesis is confirmed. The fourth regression (Table 6) and Equation (4) reveal a positive association between the DII and AI technologies that enable the physical movement of machines via autonomous decisions based on observation of their surroundings (MAC).

5. Results and Discussion

The first research hypothesis (H1) is validated by the first regression model, where we can observe that factors such as the IoT and cloud computing technologies positively influence the DII. Other authors also obtained this result in their papers [6,19]. The authors

of [6] state that cloud computing services are the most used technology in EU countries with a high level of digitalization. Their data analysis revealed the widespread organizational use of IoT technologies and those based on cloud computing. The IoT and cloud computing technologies provide efficiency and scalability solutions in various areas, such as resource management, device monitoring and control, and remote access to information and applications. In addition, AI technologies can provide advanced solutions for automation, optimization, and complex data analysis [32,44]. IoT, cloud computing, and AI technologies can coexist within organizations, each of which can complement the others through their features and benefits. These technologies can help increase digital intensity by increasing efficiency, automation, and the accessibility of technology.

As for the second research hypothesis (H2) regarding the use of AI technologies in the economic processes of EU organizations, this study has revealed that organizations are interested in using AI technologies, particularly in management or personnel recruitment. AI technologies can provide advanced solutions to automate, optimize, and choose people, and for management or recruitment decisions, such as identifying suitable candidates, automating the recruitment process, and evaluating employee performance [38,39]. However, using AI technologies in this field can also be accompanied by challenges, such as guaranteeing the fairness and integrity of recruitment processes and protecting personal data privacy and security.

In terms of the third and fourth research hypotheses (H3, H4), concerning the technologies based on AI with the most significant impact on digital intensity within EU organizations, we have identified speech recognition AI technologies, as well as technologies based on machine learning, RPA, and AI technologies that enable the physical movement of machines via autonomous decisions based on observations of their surroundings.

The data analysis from this study showed that digital intensity, measured through digital intensity indices, has an indirect relationship with the percentage of employed ICT specialists with tertiary education. Increasing the digitalization level through AI-based technologies causes a decrease in the percentage of ICT specialists from the total number of company employees. As other research has shown, a decrease in the number of employees can generate controversies related to social inclusion [1]. Education and training in technological innovation should be supported at national and European levels, an idea also highlighted by other specialists [6]. Digital intensity, as measured using the DII, is strongly associated with AI technologies that convert spoken language into a machine-readable format, AI technologies that generate written or spoken language, AI-based robotic process automation software, and AI technologies that enable the physical movement of cars through autonomous decisions based on observations of their environment. In the context of AI for speech recognition, the roles of technology employees remain essential, albeit to a lesser extent. This research determined a negative association between the measurement of digital intensity using the DII and AI technologies for organizing business administration processes and AI technologies for enterprise management. As a result, AI technologies in management processes may be more expensive, and their effects on efficiency may require a long time to be seen [35].

6. Conclusions and Limitations

There are significant gaps between EU member states in terms of the level of digitalization of organizations. Although the Council of Europe encourages digitalization through its adopted policy, member states have low DIIs. Furthermore, the gaps regarding adopting emerging digital technologies (AI, IoT, and cloud computing) are also retained. As a leader in implementing new and innovative technologies, the EU must support and monitor digitalization processes in each country, paying particular attention to countries with low levels of digitalization by creating a separate digitalization strategy for each country [6].

The economic processes that use AI technologies the most are personnel management and recruitment. An increase in digitalization using technologies based on AI reduces the percentage of ICT specialists from the total of a company's employees. However, as

regards AI technologies for speech recognition, the role of employees is still essential, albeit to a lesser degree. Technologies based on RPA and automated learning (machine learning) contribute to an increase in the performance of the logistics and human resources processes. The findings of this research are valuable not only to decision-makers at the national level, but also to investors who can identify promising investment projects that incorporate the most impactful emerging digital technologies, particularly those related to AI. This study highlights the correlation between digital development and the adoption of emerging digital technologies, providing decision-makers with insight into the factors that have the greatest impact on digital intensity. These findings may inform the development of initiatives in areas such as management, professional development, and academic education, aimed at implementing digital transformation through the integration of emerging digital technologies such as AI, the IoT, and cloud computing.

A limitation of this study is that emerging digital technologies are relatively recent, and there needs to be more data collected over several years regarding them. Another area for improvement is that this study only focuses on organizations in the EU, and the research on this topic could be expanded globally as more organizations implement emerging digital technologies. The availability of indicators characterizing digital intensity and emerging digital technologies in the Eurostat database constituted another limitation of this research. The EU comprises 27 countries with diverse economic and technological gaps. Grouping countries could generate additional information regarding the level of digitalization and the impacts of digital technologies on digitalization. Various analyses may provide an assessment of the changes introduced to these countries and may help develop strategies for the directions for subsequent development. Assessing fields of activity and industries could enable an even more detailed analysis of the digitalization process.

Author Contributions: Conceptualization, F.M., O.E.A. and M.G.; Methodology, F.M., O.E.A. and M.G.; Validation, O.E.A. and M.G.; Formal analysis, F.M., O.E.A. and M.G.; Investigation, F.M., O.E.A. and M.G.; Resources, F.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Data available on request due to restrictions.

Conflicts of Interest: The authors declare no conflict of interest.

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