METHODOLOGICAL CONSIDERATIONS REGARDING THE SELECTION AND IMPORTANCE OF DIGITALIZATION INDICATORS IN THE ECONOMIC ANALYSIS

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Abstract: The selection of statistical indicators employed in this paper is governed by a set of explicit methodological criteria, designed to faithfully capture the complexity of digitalisation and its significance for contemporary economic dynamics. Given that digitalisation constitutes an inherently multidimensional construct, the retained indicators encompass both technological infrastructure and the degree of digital adoption among enterprises and public administration, as well as the structural reconfigurations induced at the level of the labour market. The data sources utilised (Eurostat, DESI reports, and European Commission databases) were selected according to geographic coverage, temporal consistency, and methodological comparability, with their inherent limitations transparently acknowledged within the analytical framework. This rigorous empirical foundation underpins the robustness of the article's conclusions.

JEL classification: B41, C80,O33

Key words: digitalisation indicators; methodological framework; DESI index; digital economy; labour market transformation

1. INTRODUCTION

The acceleration of digital transformation has fundamentally reshaped the architecture of modern economies, generating structural shifts that extend far beyond technological infrastructure. In this context, the rigorous measurement of digitalisation phenomena has become a prerequisite for sound policymaking, economic analysis, and academic research alike. However, the complexity of digitalisation as a multi-dimensional construct raises a fundamental methodological question: which indicators are capable of capturing its true depth, and on what criteria should their selection rest?

The present article addresses this question by examining the theoretical and methodological foundations underlying the selection and significance of digitalisation indicators within economic and labour market analysis. Rather than proposing an empirical investigation, the article situates itself within the growing body of literature concerned with measurement frameworks, index construction, and the critical evaluation of statistical instruments used at the European level. In doing so, it draws on established sources such as Eurostat, the Digital Economy and Society Index (DESI), and European Commission databases, while acknowledging their inherent limitations.

The relevance of this inquiry is further underscored by the persistent asymmetries observed across European Union (EU) member states in terms of digital infrastructure, human capital, enterprise adoption, and public service digitalisation. Understanding the methodological scaffolding behind the indicators used to track these disparities is essential for interpreting results accurately and for designing targeted, evidence-based interventions.

2. OBJECTIVES

The article pursues the following objectives:

- To examine the theoretical role of socio-economic indicators in monitoring, evaluation, and forecasting within the context of digitalisation;
- To identify and discuss the methodological criteria governing the selection of digitalisation indicators, with particular emphasis on relevance, compatibility, scientific validity, and data availability;
- To critically assess the principal European data sources used in digitalisation analysis, including Eurostat, the European Central Bank (ECB), Organisation for Economic Co-operation and Development (OECD), and United Nations (UN) databases, highlighting their strengths and limitations;
- To critically evaluate the Digital Economy and Society Index (DESI) as a composite measurement instrument, examining its structural dimensions and methodological underpinnings in the context of EU-wide digital performance assessment;
- To examine the key dimensions of digitalisation measurement across three interconnected domains: the access and use of digital technologies, the digital transformation of enterprises and public administration, and labour market dynamics within digital and ICT sectors.

3. METHODOLOGY

Given its theoretical orientation, the present article does not employ primary data collection or quantitative empirical analysis. Instead, it adopts a systematic documentary and conceptual review methodology, grounded in the critical examination of academic literature, institutional reports, and official statistical frameworks.

The methodological approach unfolds across three complementary layers. The first consists of a literature review, through which foundational contributions on indicator theory, composite index construction, and digital measurement frameworks are identified, analysed, and synthesised. Sources include peer-reviewed articles, institutional publications from the European Commission, Eurostat, OECD, and the ECB, as well as methodological documentation accompanying key indices such as DESI.

The second layer involves a critical comparative analysis of the data sources and indicator frameworks discussed throughout the article. Particular attention is paid to issues of methodological harmonisation, temporal consistency, geographic coverage, and the transparency of aggregation procedures, factors that directly affect the comparability and reliability of digitalisation indicators across EU member states.

The third layer is conceptual systematisation, through which the indicators examined are organised according to the dimensions they measure (connectivity, human

capital, enterprise digitalisation, public services, and labour market transformation) allowing for a structured and coherent presentation of the analytical framework.

This methodological triangulation ensures that the article's conclusions rest on a solid, reproducible, and critically informed foundation, consistent with the standards of theoretical research in socio-economic analysis.

4. ANALYSES

Socio-economic indicators serve as a tool for continuous monitoring, evaluation of results and forecasting of trends, providing essential data for substantiating and adjusting public policies. They transform statistical observations into decision-making signals for targeted interventions.

Indicators are tools that transform data about the economy and society into clear and useful information for decision-making. They help to understand the current situation, evaluate results and anticipate future developments.

They fulfill three main roles, which complement each other:

• Monitoring involves continuous tracking of developments, identifying deviations from normal and signaling risks that may arise (Gurewitz, 2009; Pereira Junior & Hernandes, 2019);

• Evaluation helps to measure how well public programs and policies are working, in terms of efficiency and results obtained (Popper et al., 2015);

• Forecasting allows for the estimation of future developments, by building medium and long-term scenarios, providing support for strategic decisions (Trofimchuk & Koloizd, 2024).

Together, these functions provide a complete picture: what is happening now, how well interventions are working, and in which direction things are heading.

4.1 DATA SOURCES USED AND LIMITATIONS IN ACCESSING THEM

To carry out a European-level analysis, the main sources of statistical data are Eurostat, including the European Union Statistics on Income and Living Conditions database (EU-SILC), the ECB and the national statistical institutes of the member states. These institutions provide official, comparable and up-to-date data, which form the basis for monitoring the economy, social conditions and public policies.

To complement international comparability, particularly in areas such as education, employment or macroeconomic indicators, the OECD provides standardised data sets, which allow for an assessment of Europe's position in the global context and for comparisons to be made between countries.

Eurostat is the focal point for official statistics in the EU, coordinating and harmonising statistical data between member states. Its aim is to provide comparable and reliable information on social, economic and demographic topics, supporting research, monitoring developments and the development of public policies. Eurostat also manages databases widely used in detailed analyses and statistical studies.

The areas covered by Eurostat include income and its distribution, living conditions, employment, migration, health and demography. The indicators provided are compatible at European level, allowing comparisons between member states and monitoring of long-term social and economic trends.

A key database managed by Eurostat is EU-SILC, which provides micro-level data on income and living conditions. EU-SILC is used for analyses of poverty, social

inclusion and income distribution, providing detailed information for researchers and authorities.

However, there are practical limits to the use of these data. Comparability can be affected by methodological variations between countries (e.g. use of administrative registers versus interviews), treatment of zero or negative income and net-to-gross conversion. Sampling issues, household dynamics and differences in the definition of variables also reduce the comparability of data between countries. Nevertheless, Eurostat remains the main source of official data for European socio-economic analysis (Kilpeläinen et al., 2012).

The ECB serves as a key provider of statistical information on the Euro Area economy, with its data production oriented towards monetary, financial and external domains. The underlying data are drawn from coordinated national contributions, ensuring a consistent and comparable framework for the construction of macroeconomic aggregates and the support of monetary policy decisions.The ECB, together with the national central banks, develops common tools and databases aimed at improving the quality and detail of financial information.

The data provided by the ECB cover several key areas: statistics on the financial sector, including non-bank institutions, financial accounts, monetary data and the balance of payments or international investment relevant to the euro area. This information allows for the analysis of capital flows, the assessment of the health of the financial sector and the monitoring of economic trends at European level.

An important tool is the Centralised Securities Database, which allows security-by-security reporting and provides detailed information on portfolios and capital flows. This contributes to transparency and to improving the quality of data on financial securities, which is used by both authorities and researchers for macroeconomic and financial analysis.

From a methodological point of view, ECB data comply with international standards and promote conceptual harmonisation between national contributors. External statistics follow international manuals and data have been aligned to be comparable at the level of euro area aggregates. However, there are also challenges: financial innovations and the expansion of non-bank intermediation require constant adaptations of collection systems to maintain the relevance, coherence and quality of the statistics published (Israel & Munoz, 2007; Iacovou et al., 2012).

The OECD provides a range of comparable international statistics and comparative analyses between member countries. These data are frequently used for international studies and comparative analyses on social and economic issues, providing a global perspective on the economic and social performance of European countries. In practice, OECD data are often used in conjunction with regional or global sources, such as Eurostat or the UN, to support research and policy formulation.

The main role of the OECD is to provide international comparative indicators, which allow European countries to be placed in a global context and to identify differences and similarities with other countries. For example, OECD data are frequently used in studies on migration, education, employment and social inequalities, providing useful references for analysing relative performance.

However, the comparability of OECD data can be limited. International statistics can show discrepancies caused by differences in definitions, sources and collection methods used at national level. This means that although the indicators are

harmonised, users should be aware of potential methodological variations that may affect strictly comparative interpretation.

From a methodological point of view, the OECD makes efforts to adjust and harmonise data to maximise comparability, but users should consult metadata and possible national exceptions before using the data in strict comparisons. In this way, the OECD remains an essential source for international perspectives and comparative assessments, but critical and informed use of the data is essential for correct conclusions (van Oorschot, 2008).

The United Nations (UN), through the United Nations Statistics Division (UNSD) and other agencies, plays an important role in initiatives to standardise international statistics. Its activities are particularly focused on areas such as migration, sustainable development and social inclusion, supporting the harmonisation of data between countries and international organisations. Through collaborations with Eurostat and other bodies, the UNSD has contributed to the creation of common questionnaires for migration statistics, demonstrating its active involvement in the standardization and international comparability of data.

The UN also provides the global framework for monitoring the Sustainable Development Goals (SDGs), which includes social, economic and environmental indicators. These indicators are used to assess the progress of member countries in achieving the goals set at global level, providing a comparative framework across countries and regions.

However, the documentation provided in the materials consulted presents important methodological limitations. There is no detailed information on the exact structure of the SDG indicators, the methodological procedures or the way in which data are collected. This limits the possibility of assessing the comparability and reliability of UN data without additional access to official sources (van Oorschot, 2008).

4.2 INDICATORS OF DIGITALIZATION OF THE ECONOMY AND LABOR MARKET

4.2.1 DIGITAL ECONOMY AND SOCIETY INDEX (DESI)

Digital Economy and Society Index (DESI) is a tool developed by the European Commission to assess the level of digital development of the Member States. It integrates a complex set of indicators organized on several essential pillars, covering dimensions such as connectivity, digital human capital, use of internet services, integration of digital technologies in the business environment and digital public services. Through this structure, DESI provides an overview of how European economies and societies are adapting to the digital transformation and its pace.

The role of the index transcends a simple description of the existing situation, being used as a tool for continuous monitoring and strategic orientation of public policies at the level of the EU. By comparing performances between countries and over time, DESI facilitates the identification of areas where interventions are needed, helping to formulate specific measures to reduce gaps and accelerate the digital transition. The index contributes to supporting European initiatives regarding the digital single market and to aligning national strategies with common objectives.

The analysis of the evolution of the DESI highlights, in general, a steady progress of the Member States towards digitalization, but this progress is not uniform,

as significant differences persist between countries. Both in terms of digital infrastructure and the skills of the population, and the degree of economic digitalization, there are gaps that reflect different structural factors, such as the level of economic development, investment in technology or institutional capacity.

Among the components of the index, connectivity stands out as a determining factor, having a cross-cutting impact on the other dimensions. Access to fast and reliable broadband infrastructure conditions both the use of digital services by the population and the adoption of advanced technologies by businesses or the efficiency of public services (Masoura & Malefaki, 2023).

The DESI index adopts a five-dimensional structure designed to capture the breadth of digital transformation across EU Member States. Each dimension corresponds to a distinct area of intervention, collectively encompassing both the supply side represented by technological infrastructure and the demand side reflected in the capacity of society and the economy to effectively adopt and leverage digital technologies. This approach provides a balanced assessment between the offer of digital services and their degree of effective use at European level.

The first dimension, connectivity, measures the availability and quality of digital infrastructure, including fixed and mobile networks, broadband coverage, the implementation of 5G technologies and the capacity of networks to support high speeds (gigabit). This is the foundation of the entire digital ecosystem, as access to quality infrastructure conditions the development of the other dimensions.

The second dimension, human capital, refers to the digital skills of the population. Both the general level of digital literacy and the share of specialists in information and communication technology (ICT) are assessed. The human capital dimension is essential for the efficient use of technologies and for the development of a competitive digital economy.

The use of internet services constitutes the third dimension and reflects the behavior of users. It analyzes the extent to which citizens use online services, such as e-commerce, digital communication, media consumption or cloud solutions. The indicators in this category provide an image of the degree of integration of technology in everyday life and implicitly the degree of use of technological solutions.

The fourth dimension, integration of digital technology, targets the business environment and measures the level of adoption of digital solutions by enterprises. The use of technologies such as cloud computing, big data, Internet of Things (IoT) or e-commerce is analyzed. This dimension reflects the ability of companies to innovate and increase their competitiveness through digitalization.

Digital public services also assess the availability and use of online government services. This level of digitalization includes aspects such as access to digital administrative services, the use of electronic prescriptions or conducting transactions with authorities in digital format. The level of development of this dimension indicates the degree of modernization of public administration and the efficiency of interaction between the state and citizens through digital techniques.

From a methodological point of view, each of these dimensions is built on a set of sub-indicators that capture both supply (e.g. infrastructure, available services) and demand (e.g. skills and effective use). This combination allows for a clear assessment of digitalization, evident understanding not only the existence of digital resources, but also the real desire and ability of society to use them (Česnauskė, 2019).

The DESI Index is constructed as a composite indicator, an indicator created by combining the values of several indicators, which synthesize a large number of statistical variables into a single score, used to compare the digital performance of EU Member States.

Its calculation process follows a staged logic: relevant indicators are selected for each dimension of digitalization, then they are aggregated within the five main pillars, and finally the global score is calculated. This structure allows the transformation of heterogeneous data into a comparable tool at European level, facilitating the analysis of the relative positioning of each state.

A central element of the methodology is the weighting system, through which the different components contribute differentially to the final score. Olczyk and Kuc-Czarnecka (2022) highlight the importance of these weights, as they significantly influence the results and hierarchies obtained. Sensitivity analyses have shown that changes in the weight structure can lead to variations in rankings, but in many cases the explanatory power of the index remains relatively stable. In this context, the connectivity dimension is frequently identified as having a major influence on overall digital performance, reflecting its fundamental role in supporting the other components.

From a data source perspective, DESI is based on information from official EU statistical databases and national sources, which helps to ensure a high level of credibility and comparability. However, while the general principles of the index construction are transparent, the available literature does not always provide full details on the exact aggregation formula or the precise values of the weights used in each step. This limitation requires some caution in interpreting the results, especially when performing fine-grained analyses or sensitive comparisons (Česnauskė, 2019).

4.2.2 Access and use of digital technologies

Access to digital technologies must be understood as a material and economic condition: the existence of the infrastructure (networks, connections, devices) and the real possibility of using it, including from a cost perspective. Beyond this dimension, use introduces a more complex component, which relates to the digital skills of individuals and the way in which they integrate technology into their activities.

Access to digital technologies and their use represent two distinct but deeply interdependent dimensions of digital inclusion. Access refers, in essence, to the concrete possibility of benefiting from the digital infrastructure, which implies the existence of an internet connection, the availability of appropriate devices and the financial capacity to support these resources. In this sense, the specialized literature distinguishes between physical access (related to infrastructure and equipment) and economic access, which reflects the extent to which the costs of digital services are compatible with the incomes of users.

This conceptualization is clearly operationalized within composite indicators, such as the Australian Digital Inclusion Index (ADII), where the Physical Access dimension captures both the place and the way of connection, while the Economic Access component assesses the relationship between costs and the ability to pay, so access is not reduced to the simple existence of the infrastructure, but is analyzed in terms of actual possible use, depending on economic availability.

The use of digital technologies also introduces a qualitative dimension, which relates to the way in which individuals capitalize on these resources. This includes the

diversity of online activities undertaken, the level of digital competencies possessed, and the degree of confidence with which technology is integrated into everyday practices.

The conceptual distinction between access and use proves critical in the analysis of digital inequalities, as it underscores that the physical or economic availability of technology does not automatically translate into meaningful participation in the digital society. Even in contexts where the infrastructure is well developed, differences in skills, experience or purposes of use can generate persistent forms of digital exclusion (Thomas et al., 2020).

The assessment of access to and use of digital technologies is based on a set of dimensions that capture both the conditions of connection and the effective capacity to use. Typically, these dimensions are integrated into composite analytical frameworks, which allow for comparison between countries and the identification of structural gaps. They reflect a dual approach: on the one hand, the supply of digital infrastructure and services, and on the other hand, the demand, expressed through skills and usage behaviors.

The access (connectivity) dimension focuses on the availability and quality of digital infrastructure, including network coverage, types of connections and devices used. This constitutes the foundation of digital inclusion, but the presence of infrastructure is not sufficient in the absence of conditions that allow effective use. In this sense, the economic component highlights the role of costs and financial accessibility in determining the actual degree of connection.

A second essential dimension is represented by digital skills and effective use. This includes the level of digital literacy, the types of activities carried out online and the ability of users to interact effectively and safely with the digital environment. From this perspective, the differences are not only generated by access, but also by the way in which technology is integrated into everyday life, which can lead to subtle forms of exclusion.

The analytical framework is further enriched by dimensions that transcend the individual level, notably the integration of digital technologies within the business environment and the development of digital public services. These dimensions capture the broader degree of digitalisation across the economy and public administration, while simultaneously exerting an indirect influence on technology adoption and usage patterns at the population level (Masoura & Malefaki, 2023).

In terms of measuring access and use of digital technologies, there are numerous indicators that, through analysis and comparison, give us a clear picture of the phenomenon under analysis

One of the most widely used indicators is the internet penetration rate, which reflects the degree of connectivity and availability of infrastructure. This includes measures such as access to fixed or mobile broadband and provides a basic picture of the expansion of technology among the population. Although essential for assessing access, this measure does not directly capture how technology is used.

To complement this perspective, indicators are used that target the adoption of technologies in the economic environment, such as the level of use of e-commerce or the integration of digital solutions in the activity of enterprises. These indicators highlight the degree to which e-Digitalization contributes to increasing productivity and transforming business models.

Another relevant set of indicators is related to the use of digital public services, which reflects citizens' interaction with the administration in the online environment. Measures such as the use of e-government platforms or access to advanced digital services indicate not only their availability, but also the level of trust and competence of users.

In addition to these individual indicators, composite measures are frequently used, which aggregate dimensions such as access, costs and skills into a synthetic score. They allow comparisons between regions or social groups and provide a more comprehensive picture of digital inclusion (Masoura & Malefaki, 2023).

Access and use of digital technologies are not evenly distributed in society, but reflect a series of structural inequalities that persist even in contexts with relatively developed infrastructure. The specialized literature highlights the existence of recurring patterns of digital divides, mainly associated with socio-demographic characteristics such as age, level of education, income or area of residence. These differences affect not only access itself, but also the ability to use and capitalize on technology.

One of the most consistent empirical findings is related to age and education. Older people and those with a low level of education tend to have lower internet usage rates and limited digital skills. These groups often face difficulties in adopting new technologies, leading to reduced participation in the digital environment and the risk of social exclusion. This pattern is confirmed by various indicators of the digital divide at European level, which show that these differences persist over time. Persistent structural inequalities linked to age, education, income, and geographic location continue to shape patterns of digital exclusion, even in relatively well-connected economies, with regional disparities representing one of the most consistent barriers to inclusive digital participation across EU member states (Noja et al., 2022).

At the same time, income and geographical context play a determining role. People with lower incomes are less likely to have the resources necessary for consistent and quality internet access, while residents of rural or less developed areas often face infrastructure limitations. These conditions generate significant variations in digital inclusion across regions and social groups, affecting both access and use.

From a macro perspective, the digital performance of countries is influenced by economic and institutional factors. The level of Gross Domestic Product (GDP) per capita, as well as public investment in education and research and development, are positively associated with the degree of digitalization. These relationships suggest that economic development and public policies play a key role in creating an environment conducive to digital inclusion.

Last but not least, infrastructure and public policies are decisive structural factors. Investments in connectivity, the development of digital services and the implementation of national digitalization strategies contribute to expanding access and stimulating use. In the absence of such interventions, existing gaps tend to widen, highlighting the need for integrated policies that simultaneously address the economic, educational and technological dimensions of digital inclusion (Masoura & Malefaki, 2023).

4.2.3 DIGITALIZATION OF ENTERPRISES AND PUBLIC ADMINISTRATION

Digitalization is a complex concept that is not limited to the mere existence of technologies, but includes both access to infrastructure and software, and the way in

which they are integrated into economic and administrative processes. From this perspective, it is essential to distinguish between technical access, which refers to the availability of connectivity, platforms and equipment, and effective use, expressed through the adoption and transformation of organizational processes. The two dimensions are complementary but do not overlap: the existence of infrastructure does not automatically guarantee the functional digitalization of an organization or an administrative system (Lynn et al., 2020).

In the context of enterprises and public administration, this differentiation becomes all the more relevant, since digitalization involves not only the use of technological tools, but also structural changes in the way activities are organized. The integration of digital technologies into internal processes, in relations with customers or citizens, and in decision-making mechanisms reflects a more advanced level of digital maturity than simple access to infrastructure. Consequently, the assessment of digitalization must capture both the technical and operational dimensions.

To address this complexity, measurement tools use mixed sets of indicators, combining elements such as connectivity, digital skills, costs and level of advanced use. In the case of organizations, digital maturity assessment tools, such as those developed at European level, attempt to capture this dual dimension, analyzing both the available resources and the degree of integration of technology into current processes (Nisioi et al., 2025).

The assessment of digitalization at the level of enterprises and public administration requires a set of indicators that reflect both the degree of technological adoption and the level of integration of these technologies into organizational processes. In practice, these indicators are aligned with existing international frameworks and are designed to allow both comparisons across sectors and the substantiation of targeted public policies.

In the case of enterprises, a key indicator is the adoption of cloud services, which reflects the extent to which companies use flexible digital infrastructures and applications for data storage, processing and management. Another relevant indicator is e-commerce, measured by the share of online sales in total turnover, which provides an image of the degree of digitalization of commercial activities.

The level of internal digitalization is also captured by the use of Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) systems, which indicate the degree of automation and integration of business processes. At a more advanced level, the adoption of emerging technologies such as artificial intelligence or big data analysis is used as an indicator of the transition to production and management models specific to Industry 4.0, reflecting the capacity of firms for innovation and technological adaptation (Krčelić et al., 2025).

Regarding public administration, a central indicator is represented by digital public services, which measure the availability and use of e-government platforms. It captures the extent to which the relationship between the state and the citizen has undergone digital transformation, constituting a fundamental determinant of administrative efficiency and the broader accessibility of public services.

Another important aspect is the development of digital identity systems, which facilitate secure authentication and access to online services, contributing to the simplification of administrative procedures. In addition, the level of open data and transparency is used as an indicator of the degree of institutional openness, by assessing

the availability of public data in digital format. Together, these indicators provide an integrated picture of the degree of digitalization of the public and private sectors, highlighting both progress and areas where additional interventions are needed (Lynn et al., 2020).

The adoption of digital technologies is influenced by a set of structural, economic and institutional factors that determine both the speed and the extent of the digitalization process. One of the most important determinants is broadband infrastructure, which constitutes the technical basis of connectivity. The level of development of internet networks, the quality of connections and territorial coverage directly influence the ability of individuals, firms and institutions to adopt digital technologies (Lynn et al., 2020).

A second major factor is represented by public policies and investments in the digital field, including spending on education ation, research and development, and the existence of coherent national digitalization strategies. These interventions can accelerate the adoption of technologies by creating a favorable framework for innovation, digital skills training and infrastructure modernization. In the absence of consistent policies, digital divides tend to perpetuate or even deepen (Krčelić et al., 2025).

Financial access plays a key role in determining the degree of adoption of advanced technologies. The initial costs of equipment, digital services or complex solutions can represent significant barriers, especially for low-income households or small and medium-sized enterprises. Thus, the investment capacity directly influences the pace of digitalization.

In terms of impact, the literature highlights several positive effects associated with digitalization. At the economic level, there are correlations between digitalization indicators and increased productivity or economic efficiency, although the relationships are complex and vary depending on the component analyzed. In the public sector, the development of digital services contributes to increasing administrative efficiency and facilitating citizens' access to services, which can also support higher forms of civic participation (Lynn et al., 2020).

4.2.4 EMPLOYMENT IN DIGITAL AND ICT SECTORS

Employment in digital and ICT sectors is one of the most relevant indicators of the structural transformation of modern economies. These sectors include activities such as software development, IT services, telecommunications, data analytics and, more recently, emerging areas such as artificial intelligence or cybersecurity. The increase in the share of employees in these areas is often interpreted as a signal of the move towards a knowledge-based economy.

From a labour market perspective, the expansion of the ICT sector reflects a dual dynamic: on the one hand, the creation of new specialised jobs and, on the other hand, the transformation of traditional occupations through digitalisation. In many European economies, this sector has become an important engine of growth, being associated with high productivity, above-average wage levels and capacity for innovation. At the same time, the increased demand for digital skills has led to a reconfiguration of education and training systems.

The analysis of ICT employment also highlights certain structural imbalances. There are significant differences between regions, between urban and rural areas, and

between socio-demographic groups, especially in terms of women's participation in these fields. These disparities indicate that access to opportunities generated by digitalization is not evenly distributed, but depends on educational, economic and institutional factors.

From a methodological point of view, the measurement of employment in digital sectors is carried out through occupational classifications and labor force statistics, but the exact delimitation of the "ICT sector" may vary between sources. This lack of uniformity may affect international comparability and the interpretation of trends, especially in the context of the emergence of hybrid occupations, which combine digital skills with other economic fields (Gavrilescu, 2025).

The labor market in the digital and ICT sector reflects one of the most visible transformations generated by digitalization, by reorganizing the occupational structure and changing the demand for skills. This dynamic is not limited to the IT sector itself, but is progressively expanding throughout the economy, as digital technologies become integrated into production, service and administration processes. In this context, the labor market is experiencing both an expansion of specialized occupations and a reconfiguration of traditional ones.

One of the most prominent structural shifts associated with digitalisation is the polarisation of labour demand. The digital transition tends to disproportionately favour highly skilled occupations, particularly those requiring advanced proficiency in technology, data analysis or software development. At the same time, medium-skilled jobs are relatively affected, leading to a more polarized employment structure. This evolution reflects technological changes that favor either complex tasks or routine automatable activities (Mosteanu & Fathi, 2020).

In parallel, a diffusion of digital skills is observed outside the ICT sector. Digital skills requirements are no longer limited to IT professions, but appear increasingly frequently in areas such as marketing, finance, education or public administration. Job posting data analysis has become a useful tool for identifying these trends and for guiding vocational training and retraining policies, contributing to adjusting education systems to the real needs of the labor market. The expansion of specialised occupations within digital and ICT sectors, combined with the growing diffusion of digital competencies across non-ICT domains, has prompted a fundamental reconfiguration of educational and vocational training systems, which are increasingly required to align their curricula with the evolving demands of the digital labour market (Cristea et al., 2023).

Another important aspect is the resilience of employment in the digital sector in the face of economic shocks. The high level of digital skills has contributed to maintaining activity in the ICT sector even in times of crisis, such as the pandemic, when many activities were transferred to the online environment. This highlights the strategic role of digital skills in ensuring economic continuity and organizational adaptability (Pîrvu et al., 2025).

Regarding the competency landscape of the digital labour market, specialised technical skills such as programming and application development remain central to employer demand within the sector. Alongside these, foundational digital literacy emerges as a significant determinant of employability, underscoring the relevance of basic technological proficiency across a broad range of roles. Both are increasingly complemented by transversal competencies, notably the capacity for continuous

learning and adaptability, which have become indispensable in a professional environment defined by rapid and sustained technological change. At the same time, important transformations are occurring due to the adoption of artificial intelligence and new technologies, which are redefining professional roles and requiring continuous retraining processes. In this context, data-driven planning, including the analysis of job advertisements, is becoming a useful tool for anticipating skills needs and underpinning policies training, oriented towards the real developments of the digital labour market (OECD, 2022).

Digitalisation has profound effects on the labour market, determining both opportunities for economic development and structural tensions related to the redistribution of jobs. Overall, the digitalisation process contributes to the transformation of economic models, accelerating the transition towards economies based on services and high value-added activities. In this context, new occupations specialized in digital technologies are emerging, which supports the process of industrial modernization and "upgrading". These dynamics are particularly visible in emerging EU economies, where digital transformation has generated simultaneous pressures on labour market restructuring and skills adaptation, underscoring the need for targeted policy interventions capable of addressing both the opportunities and vulnerabilities associated with accelerated digitalization (Cristea & Tălăban, 2024).

On the other hand, these developments are also accompanied by less favorable effects. Automation and digitalisation of processes can lead to a reduction in the share of medium and low-skilled jobs, which generates risks of exclusion on the labour market for certain categories of the population. In the absence of adaptation mechanisms, these changes can favor the emergence of structural unemployment, especially among people with low or outdated digital skills (Mosteanu & Fathi, 2020).

An essential role in how these effects manifest themselves is played by infrastructure and education systems. The ability of an economy to integrate digitalization depends largely on the speed with which the education and vocational training system adapts to the new demands of the labor market. In the absence of adequate investments in digital education and continuous training, the gaps between the demand and supply of skills tend to increase.

From this perspective, one of the main challenges is the skills mismatch. The mismatch between the skills of graduates and the real requirements of employers can simultaneously generate a shortage of qualified labor in certain fields and a surplus in others. This situation requires coordinated interventions in educational policies, as well as the development of professional reconversion programs.

Concurrently, investments in reskilling and upskilling programmes emerge as a strategic imperative for aligning the workforce with the evolving demands of the digital economy. In this regard, collaboration between the public and private sectors plays a decisive role in broadening access to lifelong learning opportunities and accelerating the pace at which workers are able to adapt to emerging technological requirements. At the same time, companies are increasingly having to adjust their recruitment and retention strategies in a context characterized by intense competition for digital talent and the redefinition of professional roles under the influence of artificial intelligence (Bitkom, 2026).

Also, the use of data-driven tools, such as job posting analysis or regional monitoring of skills demand, can support the early identification of training needs and the adaptation of public policies.

Reducing regional and social inequalities requires integrated policies that combine investments in digital infrastructure, education and incentives for innovation, especially in areas with low technology absorption capacity, to avoid consolidating long-term gaps (Pîrvu et al., 2025).

5. CONCLUSIONS

This article provides a thorough analysis of the methods used to select and assess digitalization indicators in economic and labor market studies. By considering the theoretical, conceptual, and institutional aspects of this topic, several conclusions of both academic and practical importance are drawn.

First, the process of selecting indicators is not simply a technical or neutral task. It is a significant methodological choice, influenced by factors such as relevance, compatibility, scientific accuracy, data availability, sensitivity, and consistency over time. Each of these factors brings specific challenges, and careful analysis of them is essential to ensure that the chosen indicators accurately reflect the phenomena they aim to measure. In the case of digitalization, a complex and rapidly changing concept, this level of attention becomes particularly important.

Second, the DESI is identified as the most extensive and institutionally supported tool for assessing digital performance in EU countries. Its structure, based on five interconnected domains (connectivity, human capital, use of internet services, integration of digital technologies and digital public services) allows for a detailed and comparative assessment of progress. However, some limitations of the DESI are also highlighted, in particular the lack of clarity in how weights are assigned and how rankings are affected by changes in the way data are combined. While these issues do not diminish the value of the index, they suggest the need for careful interpretation, especially in detailed or policy-oriented studies.

Third, the analysis of access to and use of digital technologies shows that connectivity and use are separate but interrelated aspects of digital inclusion. Having the necessary infrastructure does not ensure meaningful participation in the digital economy. Persistent social and economic disparities (related to age, education, income and location) continue to affect who can fully benefit from digital opportunities, even in countries with good infrastructure. This highlights the need for policies that address not only infrastructure, but also economic and educational barriers.

Fourth, the examination of digital transformation across enterprises and public administration reveals that digitalisation extends well beyond the mere adoption of technological tools, necessitating deeper structural and organisational change. Indicators such as cloud computing utilisation, the integration of enterprise resource planning and customer relationship management systems, the availability of e-government services, and the degree of open data transparency collectively reflect the level of digital maturity attained within organisations. These indicators highlight the gap between access to technology and its effective use.

Fifth, employment in the digital and ICT sectors is a useful measure of how economies are changing. The growth of specialised jobs, the spread of digital skills beyond the ICT sector and the changing demand for labour all point to major changes in

the labour market. These changes require flexible and responsive policies. Challenges such as skills shortages, regional disparities and the growing role of artificial intelligence complicate this change, making continuous monitoring and forward-looking policy approaches essential.

Overall, these findings suggest that accurate measurement of digitalisation is crucial for effective digitalisation policy.

Poorly designed or inconsistently applied indicators can lead to incorrect conclusions and misallocation of resources. On the other hand, a strong and transparent system of indicators, based on reliable data and sound methods, forms the basis for informed and effective decision-making. From a research perspective, this article contributes to the ongoing discussion on how to measure and assess the digital economy, providing a clear summary of the main tools, frameworks and challenges relevant for analysis at European level. Future research could build on this work by testing the effectiveness of these indicators, exploring their ability to predict future trends or developing frameworks more tailored to specific national or regional contexts.

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