

Industry 5.0 in EU Macro-Regional Policies – Past, Present and Future

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Abstract The Industry 5.0 approach to the industry is to contribute to three of the Commission’s priorities: “An economy that works for people”, “European Green Deal”, and “Europe fit for the digital age”. One of the possibilities for implementing the approach is through Macro-regional Strategies and Interreg, an interregional cooperation programme, co-funded by the European Union. The beneficiaries of the programme are not only the EU member states that are part of the regions, but also regions from Albania, Bosnia and Herzegovina, Moldova, Montenegro, North Macedonia, Norway, Serbia, Switzerland, and Ukraine, which represents an essential spillover effect. This paper aims to present the integration of the Industry 5.0 strategy into macro-regional strategies and how it is already reflected in EU macro-regional strategies today. In doing so, we will also demonstrate opportunities for future macro-regional strategies to upgrade them or introduce elements of Industry 5.0 into macro-regional development.

Keywords: • Industry 5.0 • macro-regional strategies • interreg programmes • European Union

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1 Introduction

According to the European Commission documents, Industry 5.0 represents a significant evolution of industrial strategy in Europe. Unlike Industry 4.0, which is primarily technology-driven and focused on efficiency and productivity, Industry 5.0 is defined by the European Commission as an approach that goes beyond efficiency and productivity. It is explicitly putting research and innovation at the service of the transition to a sustainable, human-centric, and resilient European industry. It places worker well-being at the centre of the production process and leverages new technologies to deliver prosperity that extends beyond jobs and growth, all while respecting the planet's boundaries. Industry 5.0 emphasizes industry's contribution to societal well-being, environmental protection, and economic prosperity. It also recognizes the role of industry in tackling societal goals such as climate action, social stability, and resource preservation, making it an enabler of the green and digital transitions. This human-centric, sustainable, and resilient model supports three major EU policy goals - an economy that works for people, the European Green Deal and Europe fit for the digital age (European Commission, 2024; European Commission, Breque, De Nul, & Petridis, 2021; 'Industry 5.0 - European Commission', 2024a).

The European Union envisions Industry 5.0 as a paradigm shift that transcends the technological focus of Industry 4.0, placing a greater emphasis on human-centricity, sustainability, and resilience (Vasquez et al., 2023). This evolution acknowledges the need to integrate human intelligence and creativity with advanced technologies, ensuring that industrial progress aligns with societal values and environmental responsibility (Kiran K., Adarsh, & Pattali, 2020). The EU's approach is driven by the understanding that technology should serve humanity, fostering inclusive growth and enhancing the well-being of citizens.

The purpose of this article is to demonstrate the integration of the Industry 5.0 concept into macro-regional strategies and related documents. The overview is not only important for assessing the traceability of the implementation of European policies and their retention but also for the eligible regions. The beneficiaries of the programme are not only the EU regions that are part of the Baltic Sea Region, the Alpine Region, the Danube Region and the Adriatic Ionian Region, but also regions from Albania, Bosnia and Herzegovina, Moldova, Montenegro, North Macedonia, Norway, Serbia, Switzerland, and Ukraine, which represents an essential spillover effect to neighbouring countries facing similar regional challenges, which are strategic partners and potential future Member States

For the purpose of our research we determine the criteria according to which we will conduct the review, followed by the identification of these documents and their analysis. In defining the criteria, we rely entirely on the terminology and understanding of the

European Commission. We are aware that scientific literature, may deviate from the EU terminology, as it has its own insights and understanding, but in this case, we must take into account the common denominator, which is the European Commission or its institutions.

This study adopts a qualitative document analysis approach to examine the integration of Industry 5.0 concepts into EU macro-regional strategies. First, we selected the documents and reviewed official EU strategy documents and action plans for the four macro-regions: Baltic Sea Region (EUSBSR), Adriatic and Ionian Region (EUSAIR), Danube Region (EUSDR), and Alpine Region (EUSALP).

The selection criteria included original strategy documents and their latest action plans (2009–2025) as well as documents published by the European Commission or official EU bodies. The analysis was guided by the European Commission’s definition of Industry 5.0 (‘Industry 5.0 - European Commission’, 2024b), focusing on three pillars: Human-centricity, Sustainability, and Resilience. We searched for explicit mentions of “Industry 5.0” and related keywords (e.g., digitalisation, AI, circular economy, upskilling, social cohesion), including artificial intelligence (European Commission, 2021c), up-skilling and re-skilling European workers, particularly digital skills (European Commission, 2020b, 2025d), modern, resource-efficient, sustainable industries, transition to a circular economy (European Commission, 2025c), a globally competitive and world-leading industry, speeding up investment in research and innovation (European Commission, 2020b).

There are several limitations, the most important ones being the age of the documents and availability. Older strategies (2009–2015) predate the Industry 5.0 concept, so findings rely on thematic alignment rather than explicit terminology. The analysis is limited to publicly available EU documents and does not include national implementation reports.

2 Literature overview

The EU’s Industry 5.0 priorities are multifaceted, encompassing technological advancements, ethical considerations, and societal impact. One of the central priorities is the human-centric approach, emphasizing the role of human workers in the advanced industrial landscape. It involves creating work environments that are safe, inclusive, and empowering, where human skills are valued and augmented by technology. The focus shifts from mere automation to fostering collaboration between humans and machines, thereby enhancing productivity and job satisfaction (Fant-Male & Pieters, 2025). The human-centricity necessitates a re-evaluation of workforce architecture and the development of new competencies for the future, moving beyond the traditional understanding of Industry 4.0’s technological demands (Flores, Xu, & Lu, 2020). Furthermore, the European Commission advocates for increased research and industrial

attention on the human element, acknowledging the potential risk of an overemphasis on technology sidelining human resources (Ammirato, Felicetti, Linzalone, Corvello, & Kumar, 2023). This approach seeks to overcome limitations of traditional management by fostering greater agility and responsiveness to innovation and socio-cultural shifts (Alviani, Hilmiana, Widiyanto, & Muizu, 2024). It further underpinned by the necessity to address potential labour market disruptions, biases inherent in artificial intelligence, and emerging moral dilemmas arising from technological advancements (Khoruzhy, Khoruzhy, Kubrushko, Karataeva, & Bitkova, 2023). Moreover, the EU recognizes that sustainable development, encompassing environmental concerns, economic prosperity, and social well-being, is a cornerstone of Industry 5.0, differentiating it from prior industrial paradigms that primarily prioritized economic growth (Gao & Feng, 2023). This includes fostering a circular economy, reducing resource consumption, and promoting the use of renewable energy sources in industrial processes. The comprehensive vision for Industry 5.0 is deeply rooted in the EU's broader agenda for digital sovereignty and ethical technological development (Stix, 2021; Xia, 2024). Furthermore, commitment extends to ensuring resilience within industrial ecosystems, preparing them for future shocks and fostering adaptive capabilities in the face of global challenges (Costa, 2024; Kiran K. et al., 2020), which entails developing robust frameworks for evaluating the integration of human-machine collaboration, assessing the reduction in environmental footprint, and measuring the adaptive capacity of industrial systems (Sgarbossa, Grosse, Neumann, Battini, & Glock, 2020). Key performance indicators for human-centricity could include metrics related to worker well-being, skill development, and the effectiveness of human-robot collaboration, while sustainability indicators might encompass energy efficiency, waste reduction, and carbon footprint mitigation (Zeb et al., 2022). Moreover, resilience indicators could involve assessing supply chain robustness, cybersecurity preparedness, and the ability of manufacturing processes to adapt to unforeseen disruptions (Dahmani, 2024). These comprehensive indicators are crucial for tracking progress and ensuring that Industry 5.0 initiatives deliver tangible benefits across economic, social, and environmental dimensions. These metrics move beyond traditional economic output measures, reflecting a broader societal value proposition that integrates technological advancement with ethical considerations and sustainable practices. The emphasis on sustainability in Industry 5.0, particularly concerning environmental impacts, highlights a significant evolution from previous industrial revolutions, where the focus was predominantly on economic growth and technological advancement without sufficient consideration for ecological consequences (Cioffi, Travaglioni, Piscitelli, Petrillo, & Parmentola, 2020).

As mentioned above, the Industry 5.0 is framed around human-centricity, resilience, and sustainability, aiming to overcome some limitations of Industry 4.0 in achieving EU 2030 goals. (i) Human-centricity: Puts people—especially workers and communities—at the heart of the industrial process. Emphasizes well-being, safety, inclusion, continuous upskilling, and treating human capital as an investment (European Commission et al.,

2021; ‘Industry 5.0 - European Commission’, 2024a), (ii) Sustainability: Seeks to ensure that industrial activity actively contributes to environmental restoration and climate goals, using circular and regenerative production models and efficient resource use (European Commission, 2021b; European Commission et al., 2021; ‘Industry 5.0 - European Commission’, 2024a), and (iii) Resilience: Focuses on building robust, adaptable industry that can withstand economic and supply shocks, including pandemics and geopolitical disruptions (European Commission et al., 2021; ‘Industry 5.0 - European Commission’, 2024a). This shift opens up new avenues for macroregional policies that focus on sustainable and inclusive industrial transformation (Jiménez Rios, L. Petrou, Ramirez, Plevris, & Nogal, 2024). A complex hybrid evaluation model has been proposed to assess projects improving sustainability and health in regions and cities, explicitly integrating Industry 5.0 concepts alongside the European Green Deal. It suggests policy frameworks at regional levels are beginning to embed Industry 5.0 principles for sustainable development (Kelemen, Gavurova, & Polishchuk, 2022). Research on regional inequalities and technological dependence highlights the fractal and networked structure of EU regions, stressing the importance of tailored Smart Specialisation strategies that promote diversification towards advanced technologies—aligned with Industry 5.0’s push for technological and social innovation in macro-regions (Wirkierman, Ciarli, & Savona, 2025).

The EU’s industrial policy debates emphasize strategic autonomy and competitive sustainability but also reveal tensions between ecological goals and prevailing economic models. This critique underlines the need for post-growth industrial policies that integrate Industry 5.0 values, which is essential for shaping macroregional development strategies (Bärnthaler, Mang, & Hickel, n.d.; Cappellin, 2020). While studies on Industry 4.0 diffusion at regional scales exist, the specific integration of Industry 5.0 within EU macroregional policy frameworks has yet to be the primary focus, but is gaining attention as Industry 5.0 concepts proliferate in academia and policy discussions (De Propriis & Bailey, 2021; Testi, 2023).

3 Research

3.1 Key Priorities of Industry 5.0 in the EU

The EU’s perspective on Industry 5.0 involves integrating government, university, industry, and civil society with the environment to shape innovation and entrepreneurship ecosystems (Carayannis, Christodoulou, Christodoulou, Chatzichristofis, & Zinonos, 2022). This perspective is embedded in policies and initiatives aimed at fostering a competitive and sustainable industrial base (Camarinha-Matos, Rocha, & Graça, 2024). By emphasizing the importance of human capital and ethical considerations, the EU aims to create a future where technology empowers workers, promotes environmental

stewardship, and builds resilient supply chains (Dhirani, Mukhtiar, Chowdhry, & Newe, 2023).

3.2 Industry 5.0 in the macro-regional context

Since 2009, the EU has been developing strategies for the Baltic, Danube, Adriatic – Ionian Sea and Alpine macro-regions. These macro-regional strategies are instruments of EU governance that wishes to combine territorial cooperation and community cohesion policies with intergovernmental "regional cooperation" involving EU member states and partner countries. They aim to mobilise EU member states and non-member states to promote and coordinate territorial and cross-governmental cooperation by creating comprehensive governance structures for cross-sectoral and cross-border policy coordination in the areas of transport infrastructure and environmental protection. Both macro-regions and macro-regional strategies have aroused growing interest in multiple disciplines, including geography, regional planning, political science, and public administration, raising questions about their impact on existing territorial co-operation practises and their relevance for regional co-operation (Gänzle, Stead, Sielker, & Chilla, 2019; Gløersen, Balsiger, Cugusi, & Debarbieux, 2019). A characteristic of macro-regional cooperation is that the strategies cover different policy issues and are not limited to a single topic, such as environmental protection of shared marine or river systems. However, some topics play a more vital role in certain macro-regional strategies than others, reflecting regional geographical specificities and political priorities. These areas vary from strategy to strategy and reflect specific regional interests and priorities. The results in the four macro-regions are very different, which is partly due to their development periods, however, they vary depending on the geopolitical context, organisational landscape, administrative capabilities and political priorities (Gänzle et al., 2019). Promoting macro-regional integration facilitates the flow of knowledge, information, technologies, and good practises, which is particularly important for regions lagging behind in development (Pandiloska Jurak, 2024).

Macro-regional strategies can play a role in future cohesion policies. Indeed, they represent a meso-level intervention that can effectively implement transnational multi-level governance and co-operation, including in innovation policy (Faludi, 2010; Metzger & Schmitt, 2012; Pagliacci, Pavone, Russo, & Giorgi, 2020; Stead, Sielker, & Chilla, 2016). Promoting territorial cooperation and cohesion leads to better economic, social and territorial outcomes (Pagliacci et al., 2020).

The macro-regional strategies are in synergy with the Interreg transnational programmes, which fund projects and support governance. Macro-regional strategies and Interreg programmes strive to reduce disparities in the levels of development, growth and quality of life in and across Europe's macro-regions.

3.3 European Union Strategy for the Baltic Sea Region

For the Baltic macro-region, we obtained three documents- the European Union Strategy for the Baltic Sea Region (European Commission, 2009), the European Union Strategy for the Baltic Sea Region, Action plan 2015 (European Commission, 2015), and the European Union Strategy for the Baltic Sea Region, Action plan 2021 (European Commission, 2021a). The European Union Strategy for the Baltic Sea Region (EUSBSR) identifies its four pillars -environment, prosperity, accessibility, and security. The strategy was adopted in 2009, so there is no point in looking for concepts related to Industry 5.0 in its thread, but we can certainly expect this in the action plans. These two describe the framework for regional cooperation. The plans present in detail the governance structures (such as national coordinators and thematic policy areas), the financing methods, and the objectives of the strategy ("Save the Sea", "Connect the Region", and "Increase Prosperity"). The documents emphasize the integration of horizontal aspects, in particular climate change and cooperation with neighbouring non-EU countries in 14 policy areas, such as transport, energy, health, innovation, and culture. In addition, they describe concrete actions and flagship projects within these policy areas, with the aim of promoting sustainable development, competitiveness, and security in the Baltic Sea region.

The Action Plan for the EU Strategy for the Baltic Sea Region (EUSBSR) and its 2021 update do not explicitly mention the term "Industry 5.0", however, the 2021 updated Action Plan addresses a number of related concepts relating to digitalisation, innovation, and industrial development:

- Innovation and digital transformation - the Innovation policy area focuses on digital innovation and transformation. Digitalisation, automation, 5G technology, blockchain technology, and synchromodal transport solutions are mentioned as key instruments to reduce bottlenecks and improve capacity utilisation.
- Industry 4.0 - the Innovation policy area explicitly mentions "Industry 4.0" as a key challenge for small and medium-sized enterprises (SMEs) and addresses it through international sharing of best practices. The project INNOCAPE: Industry 4: transforming innovation ecosystem through better capacity of public enablers is also planned.
- EU Industrial Strategy - the Action Plan links to the EU Industrial strategy as one of the key actions of the European Green Deal.
- Digital Single Market - the Innovation policy area contributes to the realisation of the Digital Single Market.

Thus, the revised action plan (2021) emphasizes advanced digital technologies and transformation ("Digital innovation and transformation" and "Industry 4.0"), although it does not use the specific phrase "Industry 5.0".

3.4 European Union Strategy for the Adriatic and Ionian Region

For the Baltic macro-region, we obtained two documents, namely the European Union Strategy for the Adriatic and Ionian Region (European Commission, 2014) and Action Plan of the EU Macro-Regional Strategy for the Adriatic and Ionian Region (European Commission, 2025a). The strategy, which includes four EU Member States and six candidate or non-member countries, focuses on promoting cooperation and sustainable development in the region and is aligned with objectives such as the EU Green Deal and the enlargement process. The core of the revised plan consists of five pillars – transforming the blue and sustainable economy, connecting the region (transport and energy), environmental quality, sustainable tourism, and improved social cohesion, with the fifth pillar (social cohesion) being a new addition. The sources also highlight the importance of horizontal themes, such as digitalisation and EU enlargement, and sustainable financing of the strategy's objectives, using existing EU financial instruments, in particular cohesion policy funds and the Instrument for Pre-Accession Assistance.

The term "Industry 5.0" does not appear explicitly in the documents, but they extensively address related concepts and objectives that are often linked to the topic of "Industry 5.0", such as:

- Green and digital transitions - the documents strongly emphasise the need to accelerate the green and digital transitions. This "twin transition" is seen as essential for the competitiveness of businesses, the sustainable development of tourism, and the modernisation of transport and energy systems.
- Social cohesion and training - the revision of the Action Plan introduced a new fifth pillar focused on improved social cohesion. This pillar aims to address skills, education, and inclusion of young people, enhance labour market opportunities, and tackle demographic, industrial, and geopolitical challenges, themes that closely overlap with Industry 5.0's focus on human-centredness and resilience.
- Innovation and research - the plan emphasises that all pillars must contribute to strengthening research and innovation, including innovative solutions in the areas of blue and green technologies, social innovation, and digitalisation.
- Although no explicit reference to "Industry 5.0" was made, the themes of training for future labour markets, accelerating innovation, and social transition are key parts of the revised strategy. Moreover, all the objectives addressed in the analysed strategies are key priorities and are largely covered by the revision of the EUSAIR Action Plan 2025. In particular, the revised Action Plan places strong emphasis on: Human-centricity in digital technologies (including artificial intelligence) – the revised Action Plan highlights digitalisation as a cross-cutting theme, integrated into all pillars of the strategy. Although the term "human-centric approach" is not directly used, the emphasis is on social cohesion and inclusion.

- Up-skilling and re-skilling- the strategy strongly emphasises the acquisition and development of relevant skills for future labour markets, which is a key part of the new Pillar 5 – Improved social cohesion.
- Modern, resource-efficient and sustainable industry and the transition to a circular economy-Circular economy is identified as a cross-cutting topic, which is crucial for achieving climate neutrality and reducing pressure on natural resources.
- Globally competitive and leading industry, accelerating investment in research and innovation- Research, innovation and development is identified as a horizontal topic that must be addressed by all pillars in order for the region to prosper.

3.5 European Union Strategy for Danube Region

For the Danube macro-region, we obtained two documents - European Union Strategy for Danube Region (European Commission, 2010) and European Union Strategy for Danube Region Action Plan (European Commission, 2020a). The documents address the main challenges facing the region, such as organised crime, corruption, climate change and social inequality, while highlighting opportunities such as the rich natural and cultural heritage and development potential. The strategy is structured around four pillars and twelve priority areas – from transport connectivity and sustainable energy to environmental protection and institutional capacity building – with clear actions and targets to foster transnational cooperation. The EUSDR Action Plan is designed as a ‘rolling’ and integrated framework, requiring national commitment and coordination of funding from different EU and national instruments to achieve tangible results.

The 2010 Action Plan for the European Union Strategy for the Danube Region (EUSDR) and its 2020 revision (Commission Staff Working Document SWD(2020) 59 final) do not explicitly mention the term ‘Industry 5.0’.

The 2020 revision of the Action Plan, although it does not mention "Industry 5.0", includes certain advanced concepts and objectives that are relevant for the digital transformation and technological competitiveness of the region, in particular under Priority Area 8 (Competency of Enterprises):

- Digitalisation and Artificial Intelligence (AI) - the 2020 update explicitly mentions new topics such as artificial intelligence. The Action Plan highlights that digitalisation brings challenges and new opportunities, with cooperation between the Danube countries being key to preventing growing disparities.
- Digital transformation of SMEs - the document states that the competitiveness of enterprises, especially small and medium-sized enterprises (SMEs), needs to be improved by generating concrete technological offers, technological requirements, and knowledge exchange. It highlights that SMEs are facing the effects of the digital transformation.

- Digital Ecosystem and AI (PA 8) - the objectives of the Action Plan include: Establishing an Innovative Digital Ecosystem in the Danube Region to support SMEs in tackling the challenges of a digitalised world (ACTION 2) and strengthening the use of Artificial Intelligence (AI) technologies in SMEs in the Danube Region (ACTION 5). The aim is to establish five new Digital Innovation Hubs (DIHs) in the Danube Region by the end of 2024, which would spread artificial intelligence, cybersecurity, and high-performance computing.
- Knowledge Society (PA 7) - the Action Plan envisages exploiting the benefits of digitalisation for citizens, businesses, and governments and developing skills for smart specialisation, industrial transition, and entrepreneurship. The Digital Europe Programme (DEP) is mentioned as supporting capacity building (including AI).

It is important to note that the 2020 revision of the Action Plan refers to digitalisation as the "third industrial revolution". Although this terminology is not aligned with the more recent concepts of Industry 4.0 or 5.0, the measures relating to artificial intelligence, the digital ecosystem, and the improvement of digital skills are in line with the general objectives of advanced industrial modernisation. The original 2010 Action Plan (COM(2010) 715 final) focuses on the Europe 2020 strategy and objectives, such as improving competitiveness and sustainable development, but does not mention specific industry terminology such as "Industry 5.0". The concepts of Industry 5.0 are also reflected in:

- Adopting a human-centric approach to digital technologies, including artificial intelligence (Proposal for a Regulation on Artificial Intelligence)- The 2020 Action Plan addresses artificial intelligence (AI) and digitalisation.
- Upskilling and reskilling Europe's workforce, in particular digital skills (Skills Agenda and Action Plan for Digital Education)- the revised Action Plan places a strong emphasis on improving skills and knowledge (Pillar 3: Building Prosperity).
- Modern, resource-efficient and sustainable industry and the transition to a circular economy (Green Deal); the concepts of Green Europe and sustainable development are central to the revised Action Plan (PO 2 – a greener Europe).
- A globally competitive and leading industry, accelerating investment in research and innovation- promoting competitiveness and innovation is a key pillar of the Action Plan (Pillar 3: Building Prosperity).

3.6 European Union Strategy for the Alpine Region

For the Alpine macro-region, we obtained two documents, namely the European Union Strategy for the Alpine Region (European Commission, 2011) and Revised Action Plan of the EU Macro-Regional Strategy for the Adriatic and Ionian Region (European Commission, 2025b). Both action documents constitute a framework for cooperation, detailing the priorities, objectives, and actions aimed at improving the economy, sustainable development, and institutional cooperation in each of the regions concerned.

The EUSALP documents focus on thematic areas, such as economic growth, mobility, and the environment in the Alpine region. In contrast, the EUSAIR resources define five pillars, including the blue economy, connectivity, and social cohesion, with an emphasis on the digital and green transitions. Both documents emphasise that the strategies do not have their own financing, but rely on the mobilisation and coordination of existing national and European funds.

The 2015 Action Plan (for the EUSALP strategy) and the 2025 Action Plan update (for the EUSAIR strategy) do not explicitly mention the term “Industry 5.0”. The 2015 EUSALP Action Plan focuses on the challenges and objectives that were relevant at the time, including economic growth and innovation (policy theme 1), and supports the Europe 2020 strategy. The key concepts related to industrial and technological development contained in the documents are:

In the EUSALP Action Plan (2015):

- Innovation ecosystem - Objective 1 was to develop an efficient research and innovation ecosystem that would combine the existing potentials of the Alpine Region and exploit synergies in strategic sectors.
- Strategic sectors - the focus was on increasing the economic potential of strategic sectors such as agriculture, forestry, tourism, energy, and the high-tech sector.
- Digital connectivity - the importance of electronic connectivity for opening up the entire Alpine Region to the information economy and society is mentioned, especially in view of the declining rural regions, which was addressed under theme 2 (Mobility and connectivity).

In the revised EUSAIR Action Plan (2025):

- Green and Digital Transitions - the document strongly emphasises the need to accelerate the green and digital transitions as they are key to achieving the goals of a sustainable and competitive economy.
- Innovation and Research - this is listed as a horizontal and cross-cutting theme. The aim is to strengthen research and innovation in the region, align science and research in candidate countries with the European Research Area (ERA), and encourage innovative small and medium-sized enterprises (SMEs) to exploit the potential of green and digital solutions.
- Blue and Green Technologies - Pillar 1 (Blue Sustainable Economy) focuses on promoting research, innovation, and business opportunities in blue economy sectors, with a focus on blue and green technologies.
- Digitalisation and AI - Digitalisation is considered a cross-cutting theme. The establishment of a network of digital innovation hubs and the integration of digital innovation tools such as artificial intelligence (AI) and the Internet of Things are prioritised. AI is also mentioned as a key instrument in the management of energy networks.

Although the specific term “Industry 5.0” (which emphasises sustainability and people at the centre) is not used, the EUSAIR 2025 Action Plan covers related concepts such as the green transition, digitalisation, and social cohesion (Pillar 5, which emphasises labour market coordination, skills, and equal opportunities), which are essential components of modern industrial strategies:

- Adopting a human-centred approach to digital technologies, including artificial intelligence (Proposal for a Regulation on Artificial Intelligence),
- Upskilling and reskilling Europe's workforce, in particular in digital skills (Skills Agenda and Digital Education Action Plan),
- Modern, resource-efficient and sustainable industries and the transition to a circular economy (Green Deal),
- A globally competitive, world-leading industry, and boosting investment in research and innovation.

4 Discussion

To briefly summarize, the selected macro-regional strategy documents address many areas that are part of the understanding of the term Industry 5.0, even though the basic documents do not include more detailed elements due to their age. The analysis reveals that while the term Industry 5.0 is not explicitly present in EU macro-regional strategies, many of its core principles - human-centricity, sustainability, and resilience—are embedded in recent action plans. Concepts such as digitalisation, circular economy, social cohesion, and innovation ecosystems strongly align with Industry 5.0 objectives, indicating an implicit integration of its values.

However, an examination of these elements indicates that, whether intentionally or unintentionally, the fundamental term was entirely omitted. It is unsurprising that certain strategies do not incorporate this term, given that they were formulated as early as 2009, and some have not yet undergone revision. Nevertheless, one would anticipate that more recent action plans would introduce and clearly define this concept. The underlying issue may lie in the outdated nature of the strategic documents, suggesting that a comprehensive update should precede any enhancement through action plans. It is also plausible that the authors of these plans remain constrained by frameworks established over fourteen years ago.

This is not problematic in itself, especially if we focus only on the narrow field of document review. However, the challenge arises when looking at the macro perspective, i.e., the desire for a unified overview of the integration of the European strategy, its integration, implementation and reviews of indicators. The inconsistency leads to a lack of transparency, loss of common ground, and ultimately, loss of the terminology itself, its understanding, and its essence. Industry 5.0 is not a term that would otherwise be invented

by officials for the purposes of the new financial perspective. The term is, and will continue to be, used across all domains concerned with the development of industry and services, encompassing scientific fields such as industrial development, change management, human resource management, societal responses to new technologies, and education. However, it will not be possible to do clear and transparent studies of how the EC responded to this new level of industrialization. It will be even more difficult to review the use of funds in this area. This also completely loses transparency, not only for researching European policies as such, but also for determining their effectiveness and achieving key indicators. It is also very clear and evident that the systematic approach to building policies from the top down has been completely lost in the drafting of documents.

Given the above findings, we can consider possible solutions avoid the above mentioned issue and to strengthen the link between Industry 5.0 and macro-regional development. The guidelines offered for future strategies development could be grouped into the following three sets: (i) update existing frameworks to explicitly reference Industry 5.0 principles, (ii) introduce measurable indicators for human-centricity, sustainability, and resilience, enhance governance transparency by aligning macro-regional objectives with EU industrial policy goals (iii) promote capacity building through upskilling, digital innovation hubs, and cross-border research collaboration.

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