Artificial intelligence, Data and Robotics ecosystem

https://adra-e.eu/

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Document summary

The Adra-e Deliverable D2.4 "Cross-project workshop series. Report 2" provides account on the cross-project workshop series, designed, and implemented within Work Package 2 "Awareness and Coordination between European ADR initiatives". This report delineates the package's important role as a nexus between the ADR community and the broader research domain.

At its core, the document outlines the multifaceted objectives of the work package, describes strategies for disseminating information, synergizing initiatives, supporting interdisciplinary collaboration, and incubating novel ventures. It expounds on the nuanced methodologies deployed to realize these aims, spotlighting the pivotal roles of the Joint Research Task Force and the meticulously structured cross-project workshops. Moreover, the document contains detailed report on all 3 events comprising the series implemented within the project lifetime.

It is also touches upon the role the workshops played in preparing the ADR European Convergence Summit 2025 and provides recommendations regarding the sustainability of the series.

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1. WP2 objectives and the role of Cross-project workshop series

In general, work package 2 serves as a linchpin, connecting the ADR community with the broader research ecosystem, and catalysing collaborative efforts that propel the field forward. Through a strategic combination of awareness, synergy identification, support for cross-disciplinary research, and innovation cultivation, the package seeks to contribute significantly to the vibrant and evolving landscape of ADR research and innovation.

In detail the objectives of the work package are:

- ***Raising Awareness within the ADR Community:***
  - ***Information Dissemination:*** *The primary objective of this work package is to actively disseminate information within the ADR community. This involves raising awareness about ongoing research, innovation, and infrastructure development activities within adjacent areas that align with European or national initiatives.*
  - ***Communication Channels:*** *To achieve this, the work package employs various communication channels, such as regular updates, newsletters, and targeted communication campaigns. By keeping the ADR community informed, the goal is to create a well-informed and connected network that stays abreast of relevant developments.*
- ***Identifying and Capitalizing on Synergies:***
  - ***Collaborative Opportunities:*** *Another key goal is to identify and leverage synergies between the initiatives at the European and national levels. By fostering collaboration between these activities, the work package aims to create a more cohesive and impactful landscape for ADR research and innovation.*
  - ***Strategic Alignment:*** *The identification of synergies involves a strategic alignment of goals and resources, with the aim of maximizing the collective impact of European and national initiatives. This collaborative approach seeks to avoid duplication of efforts and enhance the overall effectiveness of the ADR community's endeavours.*
- ***Supporting Cross-Disciplinary Research Topics:***
  - ***Facilitating Interdisciplinary Collaboration:*** *The work package plays a crucial role in supporting the identification of promising cross-disciplinary research topics. This involves bringing together diverse expertise from different fields within ADR to encourage interdisciplinary collaboration.*
  - ***Interaction with WP1 (Task 1.1):*** *Close interaction and collaboration with WP1 (Task 1.1) are emphasized to ensure that the identified cross-disciplinary research topics align with the overarching goals of the broader project. This collaborative effort aims to seamlessly integrate insights from various disciplines, fostering a holistic and comprehensive approach to research.*
- ***Facilitating the Emergence of New Initiatives:***
  - *Cultivating Innovation: A core objective is to cultivate an environment that encourages the emergence of new cross-disciplinary initiatives. By providing the necessary support structures and fostering a collaborative culture, the work package aims to catalyse the development of innovative projects within the ADR community.*
  - *Dynamic Interaction: The work package recognizes the dynamic nature of the research landscape and actively engages with the ADR community to stay attuned to emerging trends and opportunities. This proactive approach ensures that the project remains agile and responsive to the evolving needs of the ADR field.*

The goal of T2.2 is to drive innovation and collaboration in the realm of technology and research involves the initiation of strategic initiatives that bring together diverse stakeholders, foster knowledge exchange, and build synergies. The following key activities outline our commitment to cultivating a collaborative ecosystem:

- ***Joint Research Task Force:*** *Setting up and enabling a Joint Research Task Force bringing together interested coordinators (appointed "ambassadors") based on the mapping activities in T.2.1 and setting up and enabling a Joint Task Force to support discussions about a suitable "ADR Research Infrastructure", with the objective to find commonalities and synergies as well as to provide recommendations for such an infrastructure. A very important activity in this context is to build up strong connections to the HPC and supercomputing community (EuroHPC, etc.).*
- ***Cross-project workshop series:*** *Identification of topics and participating projects through the Joint Research Task Force and in cooperation with WP1 (Task 1.1). Each workshop will be aimed at exchange of knowledge, identification of synergies as well as possibilities for coordination and new research challenges. Jointly co-organise 2 hybrid events/conferences about "AI, Data and Robotics for cross-regional innovation" with relevant EDIHs to support connections between these EDIHs and Adra, facilitate corridor-building activities of the EDIHs, and share best practices. This will be done in coordination with the activities in WP4.*

The following sections explain both the Joint Task Force as the main organizer and the methodology of the Theme Development Workshops as a tool for implementing the objectives described.

2. Objectives and outcomes of Adra-e's cross-project workshop series

The fundamental objective of the workshops is to enable the cross-community awareness raising and discussions about potential join research priorities with the aim to stimulate joint projects. In fact, the focus on projects as very concrete goal-oriented undertakings allows grounding the discussions and achieve very practical results (e.g. new project ideas coupled with suitable funding opportunities, initial project consortia, etc.). Moreover, running projects represent a baseline for the discussions about future research priorities.

2.1 1st cross-project workshop "ADR Convergence in Manufacturing"

2.1.1 Executive Summary

The **1st ADRA-e Cross-Project Workshop "ADR Convergence in Manufacturing"** took place on **28 June 2024, from 9:30-12:00 CET**, held as a stand-alone online event.

The workshop aimed to foster dialogue among the ADR research community and identify joint research priorities in the domain of **Advanced Industrial Production technologies**. This application area, which is the focus of four existing ADRA Topic Groups, represents a critical societal challenge where the convergence of AI, Big Data, and Robotics is already shaping the present and holds significant promise for the future.

The session featured orientation presentations by experts from the fields of AI (presented by the ADRA Topic Group on "Generative AI for Manufacturing" and AI for Manufacturing Network AIM-NET), Data (BDVA Smart Manufacturing Industries Working Group), and Robotics (euRobotics). These presentations served as a foundation for an engaging brainstorming session on joint research priorities.

2.1.2 Workshop programme

The workshop was designed to discuss and formulate the community opinions about the future research and innovation priorities in the area of AI, Data and Robotics convergence.

09:30 – 09:45 **Welcome & Introduction**
Andrey Girenko (DFKI)

09:45 – 10:00 **From Manufacturing Data Spaces to Circular Data Networks and DPPS: the perspective of the BDVA SMI Group**
Sergio Gusmeroli (BDVA)

10:00 – 10:15 **AI for Manufacturing**
Dr. Sotiris Makris (University of Patras)

10:15 – 10:25 **The role of data and AI for robotic assembly and disassembly**
José Saenz (Fraunhofer IFF)

10:25 – 10:35 **Robotics for manufacturing, going beyond the state of the art**
Christian Schlette/Ali Muhammad (University of Southern Denmark)

10:35 – 11:15 **Collaborative Working Groups**

Breakout session 1: Generative AI and Industrial Metaverse for Future Manufacturing: the ADR Convergence Perspective
Moderator: Andrey Girenko (DFKI)

Breakout session 2: Development of European Manufacturing Data Spaces and DPP supporting Technologies based on ADR Convergence,
Moderator: Sergio Gusmeroli (Politecnico di Milano)

11:15 – 11:45 **Plenary Presentations of Key Findings**

11:45 – 12:00 **Closing**

2.1.3 Introductory presentation & Keynotes

The workshop was opened by **Andrey Girenko**, representing Adra-e and the German Research Centre for Artificial Intelligence (DFKI). On behalf of the organising team, he presented key facts and figures of the ADRA-e project, outlined the goals of the workshop, and highlighted the relevance of ADR convergence for Manufacturing.

The opening was followed by inspiring keynote presentations from renowned experts in the manufacturing sector:

- **Sergio Gusmeroli** (Politecnico di Milano)
- **Sotiris Makris** (University of Patras)
- **Dr. Kosmas Alexopolous** (University of Patras)
- **José Saenz** (Fraunhofer IFF)
- **Dr. Christian Schlette** (University of Southern Denmark)

These keynote speeches provided valuable insights into current trends and challenges in advanced industrial production technologies. They set the stage for discussions on the convergence of AI, Big Data, and Robotics and laid the groundwork for the collaborative brainstorming session that followed. The experts' perspectives served as a catalyst for identifying joint research priorities, ensuring an engaging and productive exchange among participants.

2.1.4 Key results

The discussions in 2 breakout sessions allowed to identify a set of potential research priorities laying at the cross-section of AI, Big Data and Robotics for the applications in Manufacturing. Particularly, the two following domains were discussed:

- Development of data super-structures and technologies for the implementation of Digital Product Passport vision thus enabling deep re-manufacturing and circular production
- Potential ADR research priorities for the area of industrial automation and production value chains optimization.

The results have been summarised and made available to the relevant ADRA Topic groups for the use in their activities, including as an additional source of information for SRIDA evolution.

Also, at the workshop the participants agreed to continue the discussion through the subsequent workshops keeping the thematic focus on Industrial Production technologies as a central application area for the ADR convergence. The reasons for this decision are as the following:

- Switching to a completely new application domain would require the changes in the audience and will not allow building sustainable community behind the workshops and achieving in-depth results. The impact of the activity would not be as important as otherwise.
- It was realized that the workshops can play an important complementary role to the activities of the ADRA Topic groups. The chosen area has the largest overlap with the thematic foci of the ADRA Topic groups.

2.2 2nd cross-project workshop "ADR in Advanced Industrial Production"

2.2.1 Executive Summary

The **2nd ADRA-e Cross-Project Workshop on "ADR Convergence in Advanced Industrial Production"** took place on **5 November 2024, from 10:45 to 12:15**, as part of the **Data, Robotics Forum - European Sovereignty in AI, Data and Robotics**, held in Eindhoven, Netherlands.

The workshop aimed to foster dialogue among the ADR research community and identify joint research priorities in the domain of Advanced Industrial Production technologies. This application area, which is the focus of four existing ADRA Topic Groups, represents a critical societal challenge where the convergence of AI, Big Data, and Robotics is already shaping the present and holds significant promise for the future.

The session featured orientation presentations by experts from the fields of AI (provisionally presented by the ADRA Topic Group on "Generative AI for Manufacturing"), Data (BDVA Smart Manufacturing Industries Working Group), and Robotics (euRobotics). These presentations served as a foundation for an engaging brainstorming session on joint research priorities.

This report highlights the outcomes of the workshop "ADR Convergence in Advanced Industrial Production." To ensure accessibility and engagement with the broader European AI, Data, and Robotics community, the findings will be made available through the organisers' online platforms. The insights and feedback gathered during the workshop will be shared with ADRA to guide further strategic planning.

2.2.2 Workshop programme

The workshop was designed to facilitate insightful discussions and foster collaboration through a structured programme. It included expert keynote presentations, interactive topic discussions, and a plenary session to summarize key findings.

Workshop agenda

13:45 – 13:50 Welcome & Introduction
Andrey Girenko (DFKI)

13:50 – 14:00 "Manufacturing-X, the ADR Convergence Foundational Framework for Industry"
Sergio Gusmeroli (Politecnico di Milano)

14:00 – 14:10 "Generative AI for Human-Centered Production and Maintenance in Manufacturing"
Kosmas Alexopoulos (University of Patras)

14:10 – 14:20 "Large Research Infrastructures In ADR Convergence"
Tilman Becker (RICAIP/DFKI)

14:20 – 14:40 Topic discussion

14:40 – 14:45 Plenary Presentation of Key Findings & Closing

2.2.3 Introductory presentation & Keynotes

The workshop was opened by **Andrey Girenko** (DFKI). On behalf of the organising team, he introduced the ADRA-e project, highlighted the significance of the workshop's theme, and outlined its objectives and agenda.

The opening was followed by inspiring keynote presentations from renowned experts in the manufacturing sector:

- **Sergio Gusmeroli** (Politecnico di Milano)
- **Sotiris Makris** (University of Patras)
- **Tilman Becker** (Technical University of Prague, German Research Centre for Artificial Intelligence (DFKI))

Sergio Gusmeroli is Research Coordinator at Politecnico di Milano (Italy), Industrial Engineering Department. He has been and is coordinating several H2020 and Horizon Europe projects in the domain of Digital and Circular Manufacturing, especially focusing on Data Technologies / Artificial Intelligence and Digital Innovation Hub (DIH). In particular the H2020 AI REGIO and HEP AI REDGIO5.0 projects are exploring methods and tools for improving the Digital Maturity of manufacturing SMEs (6Ps method) by accessing D BEST (Data Business Ecosystem Skills technology test before invest) services from DIHs. Sergio is also co-chairing the BDVA working group about Smart Manufacturing Industry and is co-leading the Italian delegation for the International Manufacturing -X Council in the domain of Data Spaces for Manufacturing. Sergio is author of more than 60 articles and papers in National and International Journals and Magazines about digital transformation of Manufacturing Industry.

Kosmas Alexopoulos is leading the group on Manufacturing Systems at the Laboratory for Manufacturing Systems and Automation (LMS) in the University of Patras, Greece. His research area and expertise are in thefields of digital industry, digital transformation, virtual and augmented reality, internet of things, industrialdataspaces, cyber-physical-systems and production scheduling. He has been involved in more than thirty (30) research projects funded by the EC, acting as software engineer, senior researcher and project manager. He has published more than 90 scientific articles. He is the coordinator of Gaia-X Hub in Greece and leads theInternational Dataspaces Association (IDSA) Competence Center in Greece.

Tilman Becker is a German scientist and expert in the field of Industry 4.0. Since 2020 he is the director of the RICAIP Centre for Advanced Industrial Production at the Czech Institute of Informatics, Robotics and Cybernetics (CIIRC) of the Czech Technical University in Prague.
With twenty-five years of experience at DFKI, Germany's largest artificial intelligence research center, he has a broad knowledge of digital transformation, natural language processing, cyber-physical manufacturing systems and human-machine interaction research.

These keynote speeches provided valuable insights into current trends and challenges in advanced industrial production technologies. They set the stage for discussions on the convergence of AI, Big Data, and Robotics and laid the groundwork for the collaborative brainstorming session that followed. The experts' perspectives served as a catalyst for identifying joint research priorities, ensuring an engaging and productive exchange among participants.

2.2.4 Key results

The workshop's discussion based upon and triggered by the speakers' presentation was focused on the area of Multimodal Large AI models (MLAIM) in Advanced Industrial Production. Narrowing the topic was necessary to receive a sufficient feedback from the audience within a very limited time frame.

In order to initiate the discussion, the following narrative was suggested:

"It is a consensus opinion in the professional community that one of the main directions in the development in Generative AI field is increasing multimodality as a way to improve capacities of Ai systems. For instance, the Horizon Europe Call for proposals HORIZON-CL4-2024-HUMAN-03-01 closed in September 2024 aims at delivering a set of technologies at TRL 4-5 enabling the implementation of Large AI models capable of integrating several traditional (speech/video) and non-traditional (e.g. IoT, semantic and other types of data) modalities. Therefore, it is possible to expect that within the next 4-5 years such technologies will be available on lower TRLs.

Please think what application scenarios (use cases) and related RTD topics would represent major challenges for application-oriented (higher TRL) research projects with the horizon of 5 years from now."

The subsequent brainstorm-type discussion allowed to identify the following points:

- Development of Large AI models describing business/manufacturing processes. Companies like SAP AG, other players in the BPM industry, as well as larger system integrators possess big volumes of such data, which can be suitable for model training.
- Architectures and structural design of MLAIMs for particular application scenarios (case-based structural optimization). Design of complex production automation systems, which include MLAIMs.
- As the models become much more complex than today, the challenges of trustworthiness, explainability and robustness will remain high on the agenda. RTD activities delivering methods and tools ensuring trustworthiness of MLAIMs and, thus, enabling their acceptance by the industry will be needed.
- Application-oriented research, technology development and innovation in the field of neuro-explicit MLAIMs will remain a priority. Neuro-explicit models are the way to ensure explainability and grounding of AI models, thus contributing to their acceptance by manufacturing industries.
- Research supporting lifetime management for MLAIMs, including the end of their lifetime.
- More fundamental research on cooperation between different AI models, including model fusion.

The participants of the discussion agreed that the current list is by no way comprehensive nor exhaustive. The format of the workshop was not designed for soliciting a comprehensive overview, but rather to enable express opinions exchange to identify some of the possible research directions. It was also confirmed that the workshop series should be continued and the audience should be extended.

2.3 3rd cross-project workshop "ADR Resilience in Industrial Production"

2.3.1 Executive Summary

This section presents consolidated insights from the 3rd cross-project workshop on **AI, Data, and Robotics (ADR) Resilience in Industrial Production**, held in a hybrid format on 5 February 2025 in Brussels as part of the preparations for the **European Convergence Summit**. The workshop gathered expert input via the **Mentimeter** app[4] to gather real-time input from participants on eight strategic questions, culminating in a **comprehensive SWOT analysis** and a discussion on **aligning ADR technologies with EU policy priorities**.

The SWOT analysis revealed Europe's **key strengths**: a highly skilled workforce, strong collaboration between academia and industry, and a robust ecosystem for research and innovation. **Weaknesses** include fragmented regulations, slow political processes, limited scalability of innovation, and a persistent funding gap. **Opportunities** lie in the deployment of AI and Industry 4.0 technologies, the green and digital transitions, and the development of decentralized, sustainable manufacturing models. However, **threats** such as geopolitical tensions, technological dependence on non-EU actors, and supply chain vulnerabilities present significant risks. A detailed analysis can be found in section *2.3.4 Key results - SWOT Analysis**2.3.4 Key results - SWOT Analysis***. The results from Mentimeter can be found in Appendix 1.

Participants emphasized the **potential of ADR to improve resilience, efficiency, and sustainability in European manufacturing**. **Key recommendations** include aligning ADR development with EU strategies such as the Digital Strategy, Green Deal, and Data Governance Act, ensuring support for SMEs, enabling data

[4] https://www.mentimeter.com/

access, and promoting human-centric innovation that embeds European values. A detailed analysis of the results can be found in section *2.3.4 Key results - SWOT Analysis*.

2.3.2 Workshop programme

14:00 – 14:05 **Introduction**

14:05 – 14:40 **Scene Setting**

Resilient supply chains for Manufacturing-as-a-Service (MaaS), RAASCEAN, Achim Wagner, DFKI

MaaS supply chain predictive twin for critical materials: MaaSiveTwin. Michael Hess, Battronics

Foresight for European Manufacturing's twin transition until 2040: MASTT2040. Haydn Thompson, Thhink

14:40 – 15:30 SWOT Analysis

15:30 – 15:40 Coffee break

15:40 – 16:30 European ADR research strategy in the field of Manufacturing

2.3.3 Introductory presentation & Keynotes

The 3rd workshop was opened by **Andrey Girenko**, representing the German Research Centre for Artificial Intelligence (DFKI). He presented key facts and figures of the ADRA-e project, outlined the goals of the workshop, and highlighted the relevance of resilience in ADR Industrial Production.

Keynote Summary: Achim Wagner (DFKI) – RAASCEMAN Project on Resilient Supply Chains for Manufacturing-as-a-Service (MaaS)

After the introduction, Dr. Achim Wagner, representing the German Research Center for Artificial Intelligence (DFKI), presented the **RAASCEMAN** project (https://raasceman.eu/), which addresses the resilience of supply chains within the paradigm of **Manufacturing-as-a-Service (MaaS)**. The project aims to increase the adaptability and robustness of manufacturing networks in response to disruptions, uncertainties, and global challenges affecting industrial production.

The presentation outlined the central challenges tackled by the project, including the lack of supply chain transparency, fragmented collaboration between manufacturing stakeholders, and the need for rapid reconfiguration of production in the face of unforeseen events. RAASCEMAN responds to these challenges through a comprehensive **concept and approach** that facilitates distributed collaboration, supported by an interoperable and intelligent digital infrastructure.

A foundational element of the project is **establishing a common understanding** among actors in the manufacturing ecosystem to ensure coordinated responses to disruptions. The development of a **technical infrastructure** enables real-time data sharing and predictive analytics to assess potential impacts of supply chain disturbances. This capability supports informed **human decision-making**, enhancing operational responsiveness.

Furthermore, the project introduces methods to **adapt production plans swiftly** and to **generate accurate and competitive quotations** within companies, improving agility and market responsiveness. The implementation and performance of the RAASCEMAN solutions are being validated through **demonstrations in real-world operational environments**, ensuring practical relevance and scalability.

The RAASCEMAN project exemplifies how AI, data, and digital technologies can contribute meaningfully to building resilient, responsive, and collaborative European manufacturing systems in line with strategic EU objectives.

Keynote Summary: Michael Hess (Battronics) – *MaaSiveTwin: MaaS Supply Chain Predictive Twin for Critical Materials*

Michael Hess from Battronics delivered a keynote presentation introducing the *MaaSiveTwin* project[5], which focuses on strengthening the resilience of supply chains involving **Critical Raw Materials (CRMs)** through predictive digital technologies. The project addresses the urgent need to anticipate and mitigate disruptions in the CRM supply chains, which are vital to numerous European manufacturing sectors.

The presentation began with an overview of *MaaSiveTwin*, highlighting its core objectives and technical specifications. Central to the discussion were the **challenges in managing CRM supply chains**, such as global dependencies, fluctuating availability, lack of transparency, and geopolitical risks. These vulnerabilities threaten the security of supply and the continuity of production processes across the EU.

MaaSiveTwin is proposed as a **predictive MaaS platform** that integrates supply chain data and analytics to enable **early decision-making** for key industrial stakeholders. The platform aims to reduce reaction times, enhance foresight, and **prevent disruptions** before they impact operations. It functions by creating a digital twin of CRM supply networks, thereby enabling dynamic simulations and scenario planning.

The keynote also covered the **research activities conducted** within the project, which include data integration strategies, risk modeling, stakeholder engagement, and the development of predictive algorithms. These efforts converge to support the creation of a robust and intelligent tool tailored to real- world industry needs.

Looking ahead, the **expected results** include improved CRM supply chain transparency, increased preparedness among manufacturers, and a scalable platform that supports strategic autonomy for Europe's industrial base. The *MaaSiveTwin* initiative stands as a promising example of how digital innovation can enhance resilience and competitiveness in critical sectors.

Keynote Summary: Haydn Thompson (Thhink) – *Foresight for European Manufacturing's Twin Transition Until 2040: MASTT2040*

Haydn Thompson from Thhink presented the *MASTT2040* initiative[6], a strategic foresight project aimed at guiding Europe's **twin transition**—green and digital—in the manufacturing sector through to 2040. The keynote offered a comprehensive overview of the project's objectives, methodologies, and current outputs, emphasizing its role in shaping future policy and industrial strategies.

The presentation began with an **overview of MASTT2040**, highlighting its mission to build a future-oriented roadmap for European Manufacturing-as-a-Service (MaaS). Among the key achievements to date are a **MaaS**

[5] https://maasivetwinproject.eu/
[6] https://www.mastt2040.eu/

Casebook and the development of a dynamic **on-line Standards Map**, both of which support stakeholder alignment and readiness for the evolving industrial landscape.

Haydn Thompson outlined the **key features of MaaS**, including flexibility, service-oriented models, and digital integration. The project's **strategic foresight work** has identified ten influential trends, receiving broad stakeholder consensus, which are expected to shape the future of manufacturing. These trends include digitalization, sustainability imperatives, AI adoption, global supply chain shifts, and talent transformation.

The keynote also addressed **specific trends driving the MaaS transformation**, including platform-based business models, predictive supply chain capabilities, and customer-driven customization. Various **geopolitical scenarios for 2040** were presented, providing context for resilient and adaptive manufacturing strategies.

Further, Thompson described the **foresight-to-roadmapping process**, which aligns long-term strategic insights with practical implementation pathways. The **MaaS Roadmapping Vision** provides a structured guide for industry and policymakers to coordinate actions and investments. Finally, use cases categorized as **"ambition-driven"** illustrated how different manufacturing futures could unfold depending on choices made today.

In conclusion, *MASTT2040* offers a critical, forward-looking framework to support Europe's industrial transition, anchoring strategic decisions in shared foresight and actionable roadmaps.

2.3.4 Key results - SWOT Analysis

The ca. 60 workshop participants (the pick number was 61, the number varied because of online participation) came from a wide range of professional backgrounds, which are shown in *Figure 1*:

Figure 1: Professional backgrounds of workshop participants

For this analysis, *Table 1: Questions asked during Mentimeter SWOT-Analysis* provides an overview of questions and engagement results. After the questions, a ranking for the SWOT analysis was conducted, see *Table 2: Question and Options for ranking during Mentimeter SWOT-Analysis*.

The participants identified a range of structural and strategic challenges facing European industrial production. Chief among them are the **slow digital transformation**, particularly among SMEs, and **fragmented regulation** that complicates cross-border scalability. Additional challenges include **limited private investment**, a persistent **skills gap**, **dependency on external technologies and raw materials**, and

high energy costs. There is also a widespread difficulty in bridging the so-called "valley of death" between research and market deployment, as well as sluggish **decision-making processes** at both policy and industry levels.

Europe is equipped with several key strengths. These include a **highly skilled workforce**, strong **public R&D infrastructure**, and a well-established **collaborative culture** between academia, industry, and public institutions. Europe also benefits from **internationally respected institutions**, **public funding mechanisms** such as Horizon Europe and Digital Innovation Hubs (DIHs), and a cultural commitment to **human-centric and sustainable innovation**. These assets create a solid foundation for advancing ADR technologies in a responsible and inclusive manner.

Figure 2 shows the ranking results for strengths that were shared in order of importance.

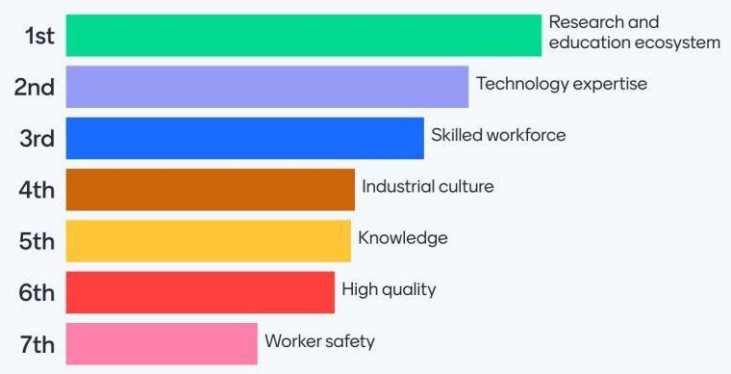

Figure 2: Ranking for strengths shared in order of importance

Despite its strengths, Europe faces notable internal weaknesses. These include **bureaucratic complexity**, **inconsistent standards**, and a **lack of coordination across Member States**. There is an **insufficient culture of entrepreneurship**, and many initiatives struggle with **scaling** due to diverse legal and technical ecosystems. Participants also noted a **low level of automation** in some sectors and a **lack of investor risk appetite**. Research and innovation efforts often operate in **silos**, preventing integrated, system-level advances.

The workshop revealed several capability gaps. Europe lacks a **cohesive industrial vision**, the ability to **rapidly test and scale innovations**, and the infrastructure needed to **translate research into market impact**. Participants stressed the need for **greater agility**, increased **private investment**, and more **intuitive decision-support tools** to aid worker upskilling. There is also a need to better value traditional industrial skills, such as hands-on diagnostics. Achieving resilience requires developing **strategic autonomy** in raw materials, **supporting tech transfer**, and promoting a **culture of experimentation and risk-taking**. In the ranking depicted in *Figure 3*, the participants equally voted most for "slow decision making" and "slow transformation" followed by "lack of capital investment".

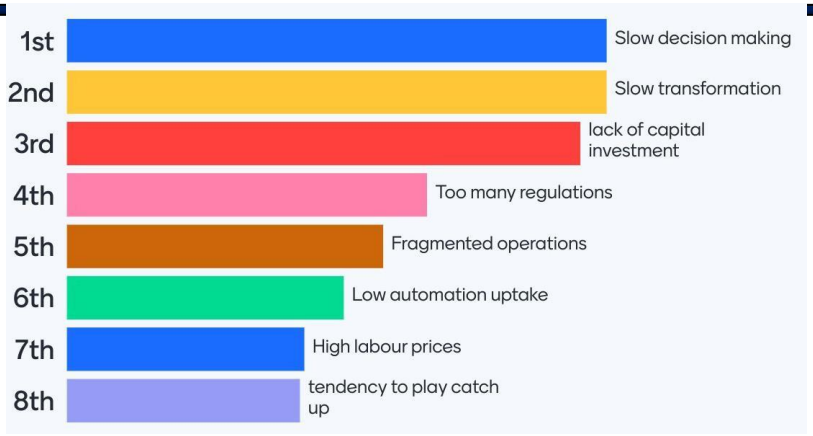

Figure 3: Ranking for the weaknesses shared based on what should be tackled first

The workshop highlighted several compelling opportunities. The increasing accessibility and capabilities of **AI, including generative AI**, open new paths for optimizing production, design, and supply chains. The push toward **sustainable and circular manufacturing**—supported by the **European Green Deal**—creates strong alignment between regulation and innovation. The potential for **pan-European collaboration**, the **digitization of manufacturing**, and the development of **localized production models** (such as micro-factories) offer promising avenues for competitive differentiation. The internal EU market is also beginning to show preference for **European-made products**.

Europe's **collaborative culture**, **focus on sustainability**, and **diverse innovation ecosystem** were seen as highly valuable, especially to startups, SMEs, and like-minded global partners. Broader trends in favor include the **rising importance of circularity**, the **declining cost of AI infrastructure**, and a **growing global appetite for ethical and green technologies**. Many participants emphasized that Europe is well-positioned to lead in **human-centered industrial design** and to benefit from the **trend toward decentralized, data-driven manufacturing**. These results are also mirrored in the participants' ranking shown in *Figure 4*.

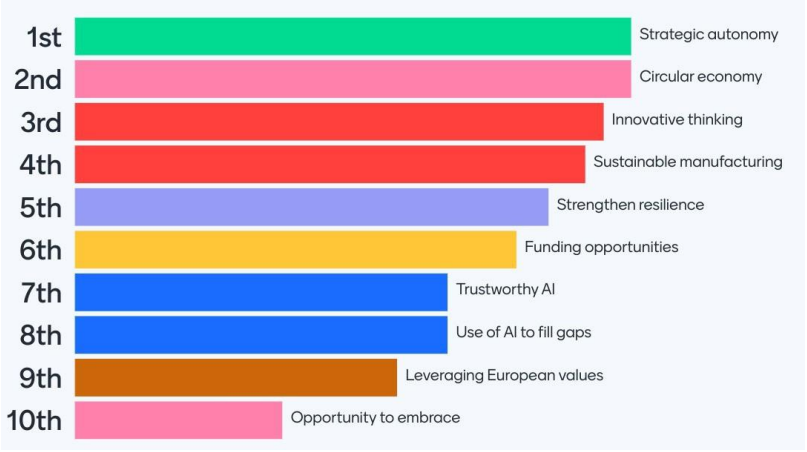

Figure 4: Ranking for the opportunities shared based on how we can grow

The workshops' participants expressed concern about **geopolitical tensions**, especially with the US and China, which could disrupt global supply chains and technology flows. **Dependence on non-EU cloud, AI, and raw material providers** remains a strategic vulnerability. Other threats include **IP leakage**, **cybersecurity risks**, **global under-regulation**, and **unfair competition** from countries that operate outside the EU's regulatory frameworks. Internally, a lack of urgency, **passivity**, and **political division** could undermine the ability to respond to fast-moving global shifts.

In addition to threats, Europe faces structural **headwinds** such as **an aging population**, **declining birth rates**, and **a skills mismatch** in the future workforce. There are also concerns about a **lack of public and private investment in ADR infrastructure**, and the risk of **falling behind in foundational AI models**. Participants noted the danger of **vendor lock-in to foreign platforms**, **internal political fragmentation**, and the potential **failure to adapt quickly enough** to technological change. Climate change and resource scarcity were also identified as potential disruptors.

The overall ranking for the threats that were shared on how much harm there is to Europe is depicted in *Figure 5*.

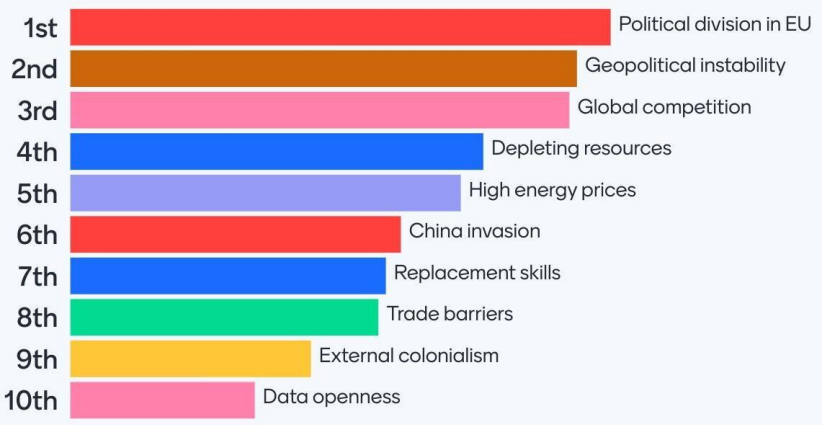

Figure 5: Ranking for the threats shared on how much harm there is to Europe

The SWOT analysis conducted during the workshop on ADR Resilience in Industrial Production identified key factors shaping Europe's position in this domain. **Strengths** include Europe's high-quality industrial culture, strong research and innovation ecosystem, skilled workforce, and collaborative networks between academia and industry. **Opportunities** lie in leveraging AI and digitalisation for sustainable manufacturing, expanding data sharing, and promoting circular economy practices aligned with EU policies like the Green Deal and Digital Strategy.

However, **weaknesses** such as fragmented regulations, slow political decision-making, limited scale-up capabilities, and a shortage of skilled workers hinder competitiveness. **Threats** include geopolitical tensions, dependence on foreign technologies and raw materials, stronger foreign investment in AI, and regulatory imbalances with global competitors. Addressing these factors will be essential to strengthen Europe's strategic autonomy and industrial resilience through ADR. A more detailed overview summarizing the results can be found in *Figure 6.*

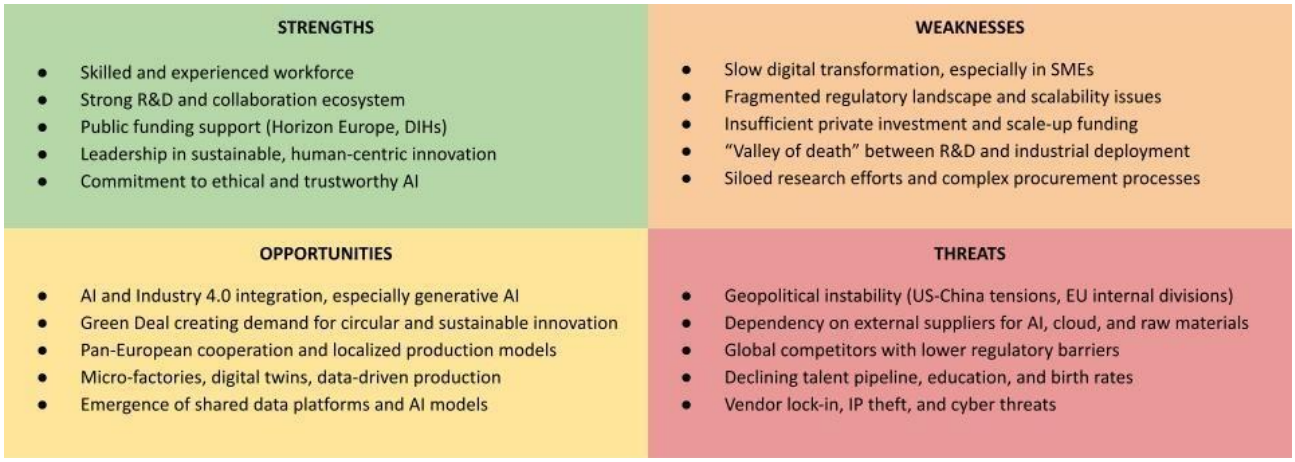

Figure 6: Summary of SWOT Analysis

After the SWOT analysis, the participants were asked about their **expectations from ADR and the alignment with policy at the EU level** to improve the framework and look into the future taking resilience into account.

This final question gathered stakeholder insights with 61 responses on how **AI, Data, and Robotics (ADR)** can enhance **European industrial production**, and how these technologies should align with **EU-level strategies and regulations**. The answers span **technical, policy, and societal dimensions**, and are summarized in key themes below:

1. Human-Centric and Inclusive Innovation

- ADR should augment, not replace, workers — through **cognitive augmentation**, **voice-based assistance**, **HMI for low-skill operators**, and **human-robot hybrid teams**.
- Emphasis on **upskilling** and **transitioning** the workforce to ensure inclusivity and productivity ("**work smarter, not harder**").
- Encourage **situational awareness tools** and respect for **hands-on expertise** through AI-assisted diagnostics.

2. Policy Alignment and Regulatory Enablement

- ADR development must align with **EU policy goals**: **Green Deal**, **Digital Strategy**, **Data Governance Act**, **Twin Transition**, and **Strategic Autonomy**.
- Multiple calls for **streamlining regulation** to avoid barriers for **SMEs** and enable **faster AI adoption**.
- Suggestions include making **Digital Twin models mandatory**, **easier data sharing across projects**, and ensuring **open access to EU-funded data** for AI training.

3. Strengthening Resilience and Competitiveness

- ADR seen as key to **supply chain resilience**, **crisis anticipation**, and **dependence reduction** (e.g. AI to design out critical materials).
- Enhancing **circular economy** through digital twins, simulation, and data-driven lifecycle tracking.
- Encouragement for **vertical integration of domain-specific AI models** to reinforce European leadership in manufacturing.

4. Data and Infrastructure as Strategic Assets

- Strong emphasis on creating **shared, secure, and accessible data infrastructures**: manufacturing data spaces, massive industrial datasets, and research data reuse.
- Use of **AI to map synergies between EU project outcomes**, and enable **cross-project integration**.
- Promote **data-driven decision-making**, **industrial knowledge codification**, and **automated sustainability reporting**.

5. Innovation Support and Industrial Impact

- Recommendations to promote **explainable and trustworthy AI**, especially in robotics.
- Advocate for **AR/VR/XR tools**, **soft robotics**, and **automated software deployment** for industrial use.
- Horizon Europe and other funding mechanisms should accelerate **cross-sector innovation**, pilot demonstration, and **industry involvement in research roadmaps**.

ADR technologies offer transformative potential for European industrial production—**enhancing resilience, competitiveness, and sustainability**—but their impact hinges on **smart, enabling policy frameworks**, **strategic use of data**, and **inclusive human-centered innovation**. EU-level alignment, particularly through **data governance, funding, and digital transition strategies**, is essential to fully harness these advancements in line with European values and goals.

3. Best practices & Lessons Learned

3.1 Best practices

The experiences collected during the workshop organization and implementation represent an important asset for the project team and ADRA secretariat. It includes the various format of events (online, f2f, blended), using discussion facilitation tools, summarization of outcomes. It is important to underline that the workshops shaped the stable core participant group of specialists representing the three ADR domains and, at the same time, allowed a much wider group of specialists to be exposed to the discussion. This micro-community can become an important partner to ADRA in its future activities on research foresight and community building. Narrowing down the focus to a single application area (Industrial production technologies) allowed to go further simple awareness raising – it allowed a professional discussion on research priorities, as well as networking and partnering.

3.2. Lessons Learned

There were several important lessons to learn:

- The key for success in organizing workshops, which do not have a stable community behind shaped by previous joint activities, requires significant efforts. It is important to (1) use the channels of major community representatives, such as in our case AIM-NET, BDVA and euRobotics; (2) select a set of representative keynote presentations as very often the participation decision is based on who is a speaker; (3) lower the participation efforts (e.g. online participation option, collocation with other community events, keep the duration as short as possible).
- It is important to follow up after every workshop providing the participants with summaries, additional information, acknowledgements. For that the secretarial support, potentially provided through the ADRA Topic group organization mechanism, is important.
- Continuity is important, it makes sense to organize an event with the periodicity of 6 months, which would allow keeping the contacts and maintaining the interest. In general, it was demonstrated that workshops can be a very useful activity complementing the activities of Topic Groups. Also, as thematically the series is relevant to the focus of EFFRA activities it might be interesting to organize the joint workshops bringing together ADRA and EFFRA specialists to discuss the future joint calls.

3.2.1. Landscape Mapping

It was also identified that the workshop series can be instrumental for the continuous research landscape mapping. The registration data and the discussions themselves can result in identifying new important projects/initiatives. The opposite is also true: the results of mapping shall be used for promoting the workshops and bringing representatives of new relevant initiatives to the community.

3.2.2. Joint Innovation & Research Task Force (JTF)

The JTF played an important role in supporting the initial design (e.g. setting goals, identifying thematic scope, finding keynote speakers, etc.) of the series. At the same time, it was difficult to ensure the continuous operation of JTF as the key people behind (community multipliers) are typically overloaded with their core tasks and could not commit substantial time to JTF.

4. Conclusion

The workshop series allowed the cross-community awareness raising and team building on the level of joint projects/initiative, thus complementing other Adra-e community-building activities (e.g. WP1 scientific community building centred around scientific disciplines). It allowed to use running and completed projects as a baseline, as cases for joint work on future research priorities, partnering and community building.

The experiences collected throughout the organization of 3 workshops with the subsequent organization of the relevant session at ECS 2025 (which was prepared by the series) represent an important result of Adra-e. Through the active participation of the ADRA secretariat in the 3rd workshop and ECS2025 session organization, these experiences have already been transferred to ADRA.

Thematic workshops are complementary to the ADRA Topic groups activities and can/shall be integrated to achieve a synergy effect. Moreover, the community behind the workshops represents an important pool of specialists - potential ADRA and Topic group members.

One of the side effects of the workshops is the better connection to the activities of EFFRA. The design of the future workshops should consider deepening these links and using the workshop as an instrument for ADRA and EFFRA joint activities preparation.

5. Appendices

Tables

Question	Title	Number of participants	Number of answers
0	Describe your role in one word	23	40
1	List the strengths of European industrial production	22	22
2	What resources can we deploy? What are our advantages? What is working well?	23	23
3	List the weaknesses of European industrial production	19	19
4	What abilities are we lacking? Where are we starting to struggle? How can we overcome these?	19	24
5	List the opportunities of European industrial production	19	32
6	Who might most value our strengths? What trends work on our favour? What is within reach?	16	30
7	List any threats to European Industrial Production	20	44
8	What headwinds might we face? Who might challenge us? What could go wrong?	17	42

Table 1: Questions asked during Mentimeter SWOT-Analysis

Question	Title	Options	Number of participants
1	Rank the strengths shared in order of importance	- Research and education ecosystem - Technology expertise	22

		- Skilled workforce - Industrial culture - Knowledge - High quality - Worker safety	
2	Rank the weaknesses shared based on what should be tackled first	- Slow decision making - Slow transformation - lack of capital investment - too many regulations - fragmented operations - low automation uptake - high labour prices - tendency to play catch up	22
3	Rank the opportunities shared based on how we can grow	- strategic autonomy - circular economy - innovative thinking - sustainable manufacturing - strengthen resilience - funding opportunities - trustworthy AI - use of AI to fill gaps - Leveraging European values - Opportunity to embrace	21
4	Rank the threats shared on how much harm there is to Europe	- Political division in EU - Geopolitical instability - Global competition - Depleting resources - High energy prices - China invasion - Replacement skills - Trade barriers - External colonialism - Data openness	23

Table 2: Question and Options for ranking during Mentimeter SWOT-Analysis

Mentimeter Results

https://mybox.inria.fr/lib/fe2cbafb-b0a3-4b29-b1fc-111f3bd466b8/file/WP4/Tasks/T4.1%20-%20CEA/ECS%202025/(5-6%20Feb)%20Prep%20ECS%20Workshops%20-%20Organization%20Folder/POST%20workshop%20needs/Menti%20Results/ecs_prep_workshops_-_ws2_-_resilience_in_resilience_in_industrial_production.pdf

7. Glossary

ADR	AI, Data and Robotics
CPW	Cross-project Workshop
EDIH	European Digital Innovation Hub
e.g.	for example

etc.	et cetera
JTF	Joint Research Task Force
OC	Organising Committee
SME	Small and Medium Enterprise
T.	Task
TDW	Theme Development Workshop
WP	Work Package