



Jobs, Competences and training action plan - M18

D7.3

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Abbreviations and Acronyms:	
WMF	World Manufacturing Forum
WEF	World Economic Forum
ML	Machine Learning
ICT	Information, Communication, Technology
IIoT	Industrial Internet of Things
AI	Artificial Intelligence
ML	Machine Learning
GAI	Generative AI
DSP	Digital Signal Processing
HMI	Human Machine Interface
DFs	Didactic factories

1. Executive summary

The advent of Industrial technologies, advanced Data Management systems, and digital platforms, along with the adoption of state-of-the-art technologies like Artificial Intelligence (AI) and Machine Learning (ML), has generated a need for new skill sets within the workforce, which have traditionally been absent. The move towards AI-at-the-Edge intensifies this requirement, underscoring the importance of real-time data processing and decision-making at the source. As a result, continuous learning and innovative educational paradigms are becoming increasingly essential to prepare employees with the necessary skills to fully leverage these groundbreaking technologies. This deliverable (D7.3), [Months: 18] “Jobs, Competences and training action plan” is related to WP7, task T7.2 “Jobs, Competences and training action plan” and presents the following aspects:

Research Background and Related Reports:

Recent investigations have explored the changing demands for skills and job profiles in AI, Data Management, and AI-at-the-Edge technologies, reviewing a range of pertinent initiatives. Studies from the World Economic Forum, World Manufacturing Forum, and “Osservatorio Industria 4.0” at Politecnico di Milano have outlined the essential job profiles and skills required in Data Science and AI management.

The 6Ps methodology, which focuses on the People dimension, has been introduced as a digital transformation model. This model examines six aspects: Product, Process, Platform, People, Partnership, and Performance. It is extensively used by the University of Politecnico di Milano and has been applied in various European projects, including AI REGIO, DIH4AI, BOOST 4.0, MIDIH, Eur3Ka, and CAPRI. The goal of this methodology is to evaluate the current AI and digital maturity levels (AS-IS) of project partners, determine their target maturity levels (TO-BE), and create a specific action plan to address the identified gaps.

New Roles and Professions:

As an initial phase of the methodology, ten specific roles and their associated skills have been identified. These roles fall under the category of “Data Science and AI Management,” representing new positions that have emerged alongside advancements in data science and artificial intelligence technologies. Additionally, the category of “Data and AI Professions and Skills for Enterprise Industry 5.0” encompasses new skill sets designed to enhance the capabilities of existing roles within enterprises. Besides the technical skills assigned to each job profile, a comprehensive review of soft skills has been conducted across managerial, professional, and non-technical levels.

Analysis approach:

Two surveys—Voting and Needed vs. Possessed—were conducted to prioritize the skills specific to each job profile and to analyse the current state of project Didactic factories (DFs) and Pilots, identifying any existing gaps. As the second step in the methodology, corresponding training activities were defined and compiled into a “training activity database” in alignment with the introduced skills and job roles.

Key Words: AI-at-the-Edge, 6Ps People dimension, Artificial Intelligence, Data Science Management, Job Profiles and Skills.

2. Introduction

Emerging trends in industrial technologies are driving the digital transformation of enterprises, addressing challenges associated with implementing digital tools such as AI, advanced collaborative robots, big data, and analytics. Evaluating these transformations and their impact on organizational structures is crucial, particularly in the context of project DFs and Pilots.

A key aspect of this transformation is the emphasis on Skills and Training. To keep up with the rapid advancements in technology and ICT, managers, engineers, and non-technical staff require continuous learning programs. Ongoing education is vital for effectively adapting to and integrating new technologies into digital workflows. Understanding both the technical details and business potential of new technologies is essential.

Skills and job profiles are critical for companies adopting new technologies and practices. The development of these skills must occur in multiple directions simultaneously, combining existing skills with job profiles and fostering new skills through hiring or upskilling current employees. Creating new job profiles that better align with business needs is imperative. With the advent of AI-at-the-Edge technologies, real-time processing and decision-making capabilities at the data source become increasingly important, underscoring the need for targeted skills and training initiatives.

2.1. About this deliverable

Deliverable D7.3, titled "Jobs, Competences, and Training Action Plan," offers a detailed summary of the training programs executed by AI REDGIO 5.0 partners over the first 18 months of the project. The report starts by outlining various roles and profiles within two primary categories: "Data Science and AI Management" and "Data and AI Professions and Skills for Enterprise Industry 5.0." It subsequently reviews the analysis of the initial survey iteration, highlighting the prioritization of essential skills and the identification of gaps, all within the context of AI-at-the-Edge technologies that are vital for real-time data processing and decision-making.

2.2. Document Structure

The document is organized as follows:

- **Chapter 3:** Provides an overview of the state-of-the-art materials and recent reports from the World Manufacturing Forum (WMF) and the World Economic Forum (WEF) to highlight the need for new skills. Additionally, it briefly explains the 6P People dimension methodology.
- **Chapter 4:** Introduces ten job profiles and the associated skills in the fields of "Data Science and AI Management" and "Data and AI Professions and Skills for Enterprise Industry 5.0," along with soft skills required at three different organizational levels: Managers, Professionals, and Non-Technical employees.
- **Chapters 5 and 6:** Analyse the current (AS-IS) conditions, and expectations of project DFs and Pilots concerning the introduced job profiles. Furthermore, the database of training activities is defined.
- **Chapters 7 and 8:** Outline the activities planned for the upcoming periods and conclude the first iteration of the methodology.

3. Research background and related reports

This section will outline the research conducted on the advent of new technologies and trends, leading to the creation of new job profiles. Following this, we will present the 6Ps methodology employed in this project to assess the training initiatives undertaken by the partners.

3.1. An overview of digital transformation

Digital transformation is fundamentally reshaping the organization and manufacturing landscape, driven by the integration of advanced technologies such as Artificial Intelligence (AI), Machine Learning (ML), Industrial Internet of Things, AI-at-the-Edge, etc. This shift is critical for enhancing operational efficiency, creating new business models, and maintaining competitiveness in the global market (WMF-2023).

In addition, the concept of the digital economy is built on the advancements offered by digital technologies, including IoT, cloud computing, big data, and analytics. These technologies bridge the gap between physical and virtual environments, fostering the development of cyber-physical systems. The global digital transformation market was valued at approximately USD 752.17 billion in 2022 and is projected to exceed USD 7,033.01 billion by 2032(WMF-2023). (Figure 1,Figure 2)

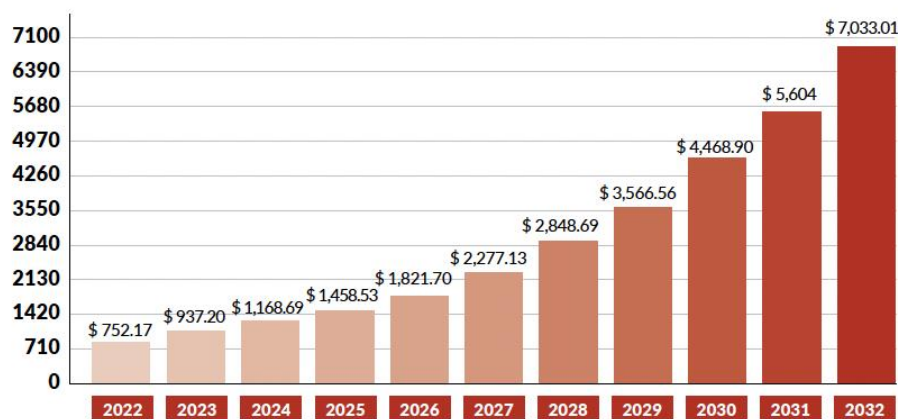


Figure 1 Trends in the digital transformation¹

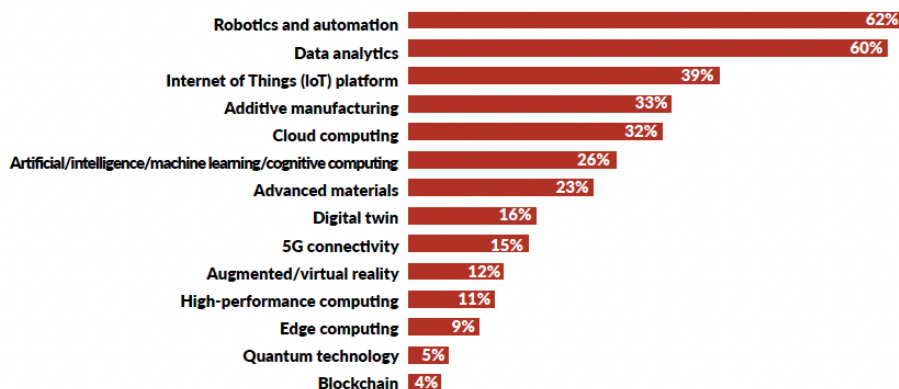


Figure 2 Focus on current investments in manufacturing technologies²

¹ <https://worldmanufacturing.org/report/report-2023-new-business-models-for-the-manufacturing-of-the-future/> (Source: PricewaterhouseCoopers 2023)

² <https://worldmanufacturing.org/report/report-2023-new-business-models-for-the-manufacturing-of-the-future/> (Source: Deloitte 2023)

Emerging New Roles and Skills

The rapid adoption of digital technologies in organizations and manufacturing industries necessitates the evolution of job roles and the development of new skills. This evolution is particularly pertinent in the context of AI, ML, IIoT, AI-at-the-Edge, and others, which emphasizes real-time data processing and decision-making at the data source. The World Economic Forum (WEF-2021,2022) and World Manufacturing Forum (WMF-2019,2023) reports highlight the critical need for a workforce adept in both technical and soft skills to harness the potential of these technologies. (Figure 3)

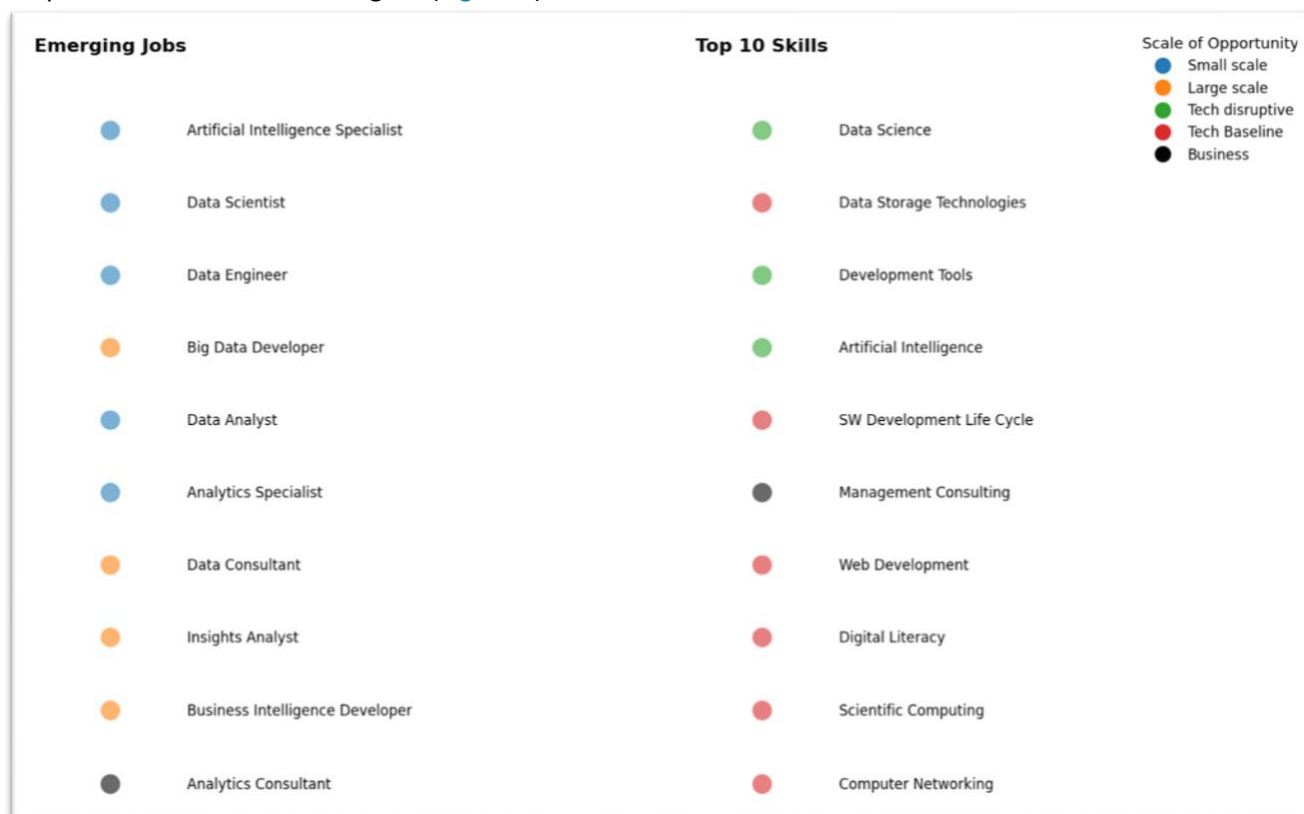


Figure 3 World Economic Forum - Emerging Jobs and Top 10 Skills

The Need for New Skills and Continuous Learning

The integration of AI and ML into manufacturing processes requires a continuous update of skills. Lifelong learning programs and innovative educational paradigms are essential to equip the workforce with the necessary competencies. This includes technical skills for handling advanced machinery and digital tools, as well as soft skills for effective collaboration and problem-solving in a digital environment. The successful application of AI in manufacturing highlights the importance of addressing challenges related to data quality, secrecy, and AI safety. These programs support the development of a workforce capable of adapting to new technologies and optimizing production processes (Harasic et al., 2022).

Skills Development Initiatives:

To address the evolving demands of digital transformation, several skills development initiatives have been introduced. Customized training programs focusing on AI, ML, and edge computing have been developed to equip the workforce with the necessary technical skills. These training modules are designed to be adaptable to the specific needs of different industries and are highlighted in the World Economic Forum (WEF) Annual Reports, which underscores the importance of continuous upskilling in a rapidly changing technological landscape. Studies emphasize the importance of lifelong learning opportunities facilitated by AI, which empowers teaching and learning in education and training institutions (UNEVOC - 2021).

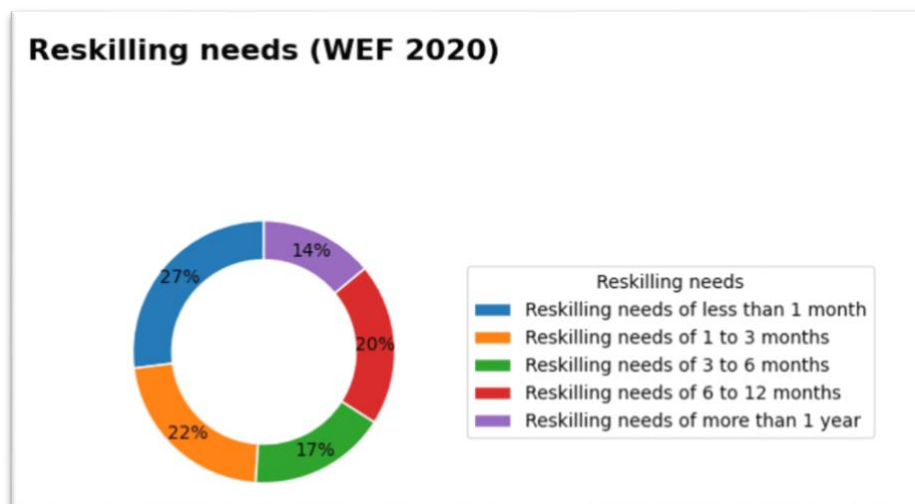


Figure 4 Reskilling needs in Manufacturing according to WEF 2020 report

Furthermore, collaborative learning platforms (Such as I4MS training, Polimi Open Knowledge, Coursera ...) have been established to facilitate ongoing education and skills development. These online platforms provide flexible learning opportunities, enabling employees to acquire new competencies at their own pace. This approach is supported by the WMF annual reports, which emphasizes the role of digital tools in enhancing workforce capabilities. Additionally, industry-academia partnerships play a crucial role in developing curricula that align with industry needs. These collaborations ensure that educational institutions are producing graduates who are well-prepared to meet the challenges of modern manufacturing environments.

Given the critical significance of addressing skill gaps and the necessary training activities to bridge these gaps, as discussed in the previous sections, organizations must undertake a thorough evaluation of their current state to identify deficiencies. This evaluation involves a comprehensive analysis of existing skills, capabilities, and resources to pinpoint areas where the organization falls short. By identifying these gaps, organizations can implement targeted activities that are specifically designed to address their unique needs and circumstances.

One effective approach to this process is the use of maturity analysis models. Maturity analysis models are tools that help organizations assess their current state by examining various aspects such as processes, competencies, technologies, and strategies. These models not only focus on the present capabilities of the organization but also take into account future expectations and the evolving landscape of industry trends. By doing so, they provide a holistic view of where the organization stands in relation to its goals and industry standards.

Through this detailed assessment, maturity analysis models (such as Deloitte Digital Maturity Model¹, BCG Digital Acceleration Index (DAI)², and others) can identify gaps between the current state and desired future state of the organization. They evaluate how well the organization is adapting to growing trends in technology and whether its current strategies align with future market demands. Based on this analysis, the models suggest appropriate programs and initiatives that the organization can implement to cover these gaps. These recommendations are tailored to the specific conditions and needs of the organization, ensuring that the proposed activities are relevant and effective.

By following the guidance provided by maturity analysis models, organizations can develop and implement training programs that are focused on enhancing the skills and competencies of their workforce. These programs can include a variety of training activities such as workshops, courses, on-the-job training, and

¹ <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology-Media-Telecommunications/deloitte-digital-maturity-model.pdf>

² <https://www.bcg.com/capabilities/digital-technology-data/digital-maturity>

other professional development initiatives. The goal is to equip employees with the necessary skills to meet current job demands and prepare them for future challenges.

In this context, our 6Ps methodology, detailed in the following section, aims to assess the current state (AS IS) and the expectations of project partners regarding newly emerged skills and job profiles. By recommending targeted training activities, this methodology seeks to address and bridge their skill gaps effectively.

3.2. 6Ps methodology and People dimension

As outlined in the 2020 WMF Report and the 2020 WEF Jobs of Tomorrow, the digitalization process and the upgrading of skills in response to new technologies like AI must extend beyond mere technological adoption. This evolution must also encompass the empowerment of digital skills at every organizational level and the creation of roles that align with the digital advancements faced by organizations. Metrics that measure the necessary skills and their development at every organizational level are fundamental to transforming these suggestions into practice.

Incorporating AI on the Edge technologies, this chapter focuses on the People dimension while considering the various aspects affected by digitalization in industrial and other environments, namely the Product, the Process, the Platform, the People, the Partnership, and the Performance. The 6Ps Model provides a framework for Digital Transformation across six above-mentioned dimensions: the digitization of Products, Processes, and Platforms; and the digital overhaul of People, Performance, and Partnerships. The objective is to use the 6Ps methodology (Digital Transformation Analysis Tool) to assess the current AI and digital maturity levels of companies and organizations (AS-IS), quantify the desired AI and digital maturity levels these entities aim to achieve (TO-BE), and devise a specific action plan to bridge the identified gaps. The primary emphasis is on the People dimension, involving a comprehensive analysis of current jobs and professions to identify potential skills gaps due to AI and digital adoption.

This process will include organizing workshops and surveys to gather feedback from partners during the project's development stage to ensure the provision of user-friendly AI tools. A structured, survey-based approach will be used to analyse and discuss needed and possessed skills and to identify the most suitable training programs to bridge these gaps. The first step involves identifying new roles, professions, and relevant skills based on the project's content. Related to these new roles and skills, two main questionnaires have been administered to project partners, and the first round of surveys has already been completed.

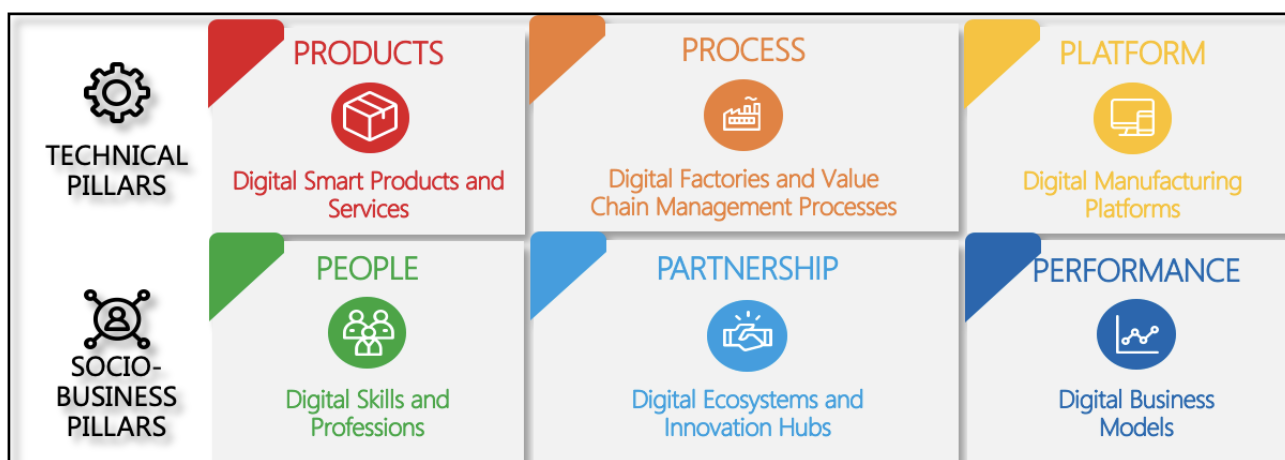


Figure 5 6Ps Digital Transformation Tool

Figure 5 illustrates all six dimensions, and our particular focus will be on the People dimension within socio-business pillars.

According to the analyses conducted, two categories have been identified: "Data Science and AI Management" and "Data and AI Professions and Skills for Enterprise Industry 5.0".

The "Data Science and AI Management" group includes jobs and skills that do not yet exist in industrial and other environments but will be needed in the coming years due to technological trends and demands. Some businesses may have already recognized the value of some skills associated with these jobs and have started to implement them.

The other category, "Data and AI Professions and Skills for Enterprise Industry 5.0," includes roles that companies likely already have but need to upgrade and improve due to emerging technologies. In addition to technical skills, soft skills at three levels (Manager, Professional, and Non-technical Employees) will also be reviewed.

4. New Roles and Professions

In order to start implementing 6Ps methodology in the following two sections, we will introduce the roles and essential skills within two categories: (1) Data Science and AI Management, and (2) Data and AI Professions and Skills for Enterprise Industry 5.0.

The information required to introduce these jobs has been sourced from reliable references, including the annual reports of WMF and WEF from 2019 to 2023. Another significant source is the Osservatorio Industriale from Politecnico di Milano¹. This source is a comprehensive repository containing over 100 technical and managerial skills related to Industrial technologies. These skills are categorized into five key areas essential for defining Industrial strategies and for designing, managing, and enabling Industrial processes and business models. The areas include:

- Smart product-service design management
- Smart Hyperconnected Factories management
- Smart Autonomous Factories management
- IT-OT integration management
- Data science and AI management

Additionally, insights from the study "Edge Intelligence: The Convergence of Humans, Things, and AI" have been integrated. This study highlights the intersection of humans, devices, and artificial intelligence, emphasizing the importance of edge computing in modern intelligent systems.

Furthermore, the article "Designing and Managing Human-AI Interactions" has also been considered. This paper discusses the crucial aspects of creating and overseeing interactions between humans and AI systems, providing valuable insights into the integration of AI in organizational processes.

These jobs have been organized in alignment with the overall content of the project and the current activities of the project partners.

4.1. Data Science and AI Management

As mentioned in the previous chapter, the "Data Science and AI Management" group encompasses jobs and skills that most probably have not yet emerged widely in industrial and other environments but will become essential in the coming years due to technological trends and demands. While some businesses may have already recognized the value of these skills and begun implementing them, many others are still in the process of adapting to these future needs.

Data /AI specialist

build, manage and maintain data/AI pipelines.

Skills:

¹ <https://www.osservatori.net/it/home>

- Integrate data and AI technologies into existing systems.
- Knowledge about data storage, query languages and use of machine learning.
- Use and interact with collaborative robots, systems, and sensors.
- Build AI models from scratch and help the different components of the organization.
- Develop data models and workflows.
- Maintain security, quality, integrity, safety, and availability of data.
- Develop applications from big data /AI & provide operational tools for data and AI analytics.
- Knowledge of (OEE) & hardware platforms for big data and Analysis related to AI.
- Use cloud computing and AI in industrial control software and applications to monitor and control activities.

AI Manager / Head of AI

AI Manager, manages and implements AI according to business objectives.

Skills:

- Adapt technological (new tech. such as AI, VR etc.) innovations to business and Supply Networks.
- Build, implement and manage concurrent Digital/intelligence Supply Networks.
- Understand and take advantage of IT-OT architectures, sensors, communication, data flow, cloud.
- Develop and execute the data and AI strategies according to business objectives.
- Knowledge about data and AI processes /User experience analysis, design, and evaluation.
- Analyze and understand how the value chain is transformed by virtue of Industry 4.0, and 5.0 and new technologies related to AI.
- Improving production process with the introduction of new technologies related to AI and I4.0 and I5.0.

Remote Worker

Remote worker carries out its activities outside a traditional plant environment.

Skills:

- Use applications to increase sensory, remote, and cognitive abilities.
- Interpret quantitative data, graphs (KPIs) and 3D digital models.
- Understand and use additive manufacturing / AI technologies and mathematical models.
- Perform scenario analysis to evaluate and prepare for possible interventions.

4.2. Data and AI Professions and Skills for Enterprise Industry 5.0

As mentioned in the previous chapter, the 'Data and AI Professions and Skills for Enterprise Industry 5.0' category includes roles that companies likely already have, although with different titles, which need to be upgraded and enhanced due to emerging technologies.

I5.0 Professional

An I5.0 Professional leverages Industry 5.0 principles to revolutionize production processes, emphasizing human-machine collaboration and customer-centricity. They analyse and interpret production data to optimize performance through the integration of cutting-edge I5.0 technologies.

Skills:

- Enhance production processes by promoting worker collaboration with AI-driven tools and intuitive human-machine interfaces, focusing on human-centric improvement.
- Use real-time data and predictive analytics to perform dynamic scenario analysis, enabling agile decision-making through AI-driven simulations and classifiers.
- Demonstrate expertise in programming and collaborating with cobots to improve efficiency, safety, and adaptability while conducting virtual testing simulations to enhance cobot performance.
- Design and oversee product data storage systems, emphasizing big data solutions, to facilitate real-time product optimization by seamlessly integrating sensors, actuators, ports, and antennas for data capture and remote monitoring.
- Independently analyse complex demand and supply network data using advanced tools like R, Python, MATLAB, and AI-driven analytics to provide insights supporting data-driven decision-making.
- Master IoT platforms and sensors to enable real-time monitoring and control within the production ecosystem, utilizing IoT applications to boost operational efficiency and respond proactively to changing conditions.
- Leverage advanced application development platforms to create customized solutions that seamlessly integrate with I5.0 principles, prioritizing customization and adaptability.

Plant Worker 5.0

The industry 5.0 Plant Operator optimizes advanced industrial plant operations through the integration of human expertise with cutting-edge technology for unparalleled efficiency and productivity.

Skills:

- Use advanced HMI
- for real-time control and decision-making.
- Use virtual and augmented reality for precision in process visualization and issue resolution.
- Operate exoskeletons and wearable devices to enhance physical capabilities.
- Collaborate with collaborative robots to optimize operations and ensure safety.
- Interpret quantitative data and digital models for continuous improvement.

Technician 5.0

A Technician 5.0 blends practical expertise with theoretical knowledge and excels in a range of essential skills to thrive in the industry 5.0 era.

Skills:

- Achieve mastery in deploying sensors, actuators, ports, antennas, and HMI standards to ensure smooth data capture and integration within the industry 5.0 ecosystem.
- Efficiently operate in automated smart warehouses with automated picking systems and autonomous vehicles.
- Apply analytical skills to interpret operational data, enabling informed decision-making and continuous process improvement.
- Use discrete event simulation to model and optimize complex processes, improving efficiency and resource allocation.
- Use 3D printing technology for rapid and cost-effective fabrication of prototypes, parts, and components, facilitating product development and customization.

Generative AI Application Developer

Generative AI application developer aims to empower enterprises and individuals by harnessing the potential of AI technologies to solve complex problems, foster productivity, and stimulate innovation.

Skills:

- Skilled in collecting, preparing, and pre-processing diverse datasets for language models, including text cleaning and removal of extraneous characters.
- Expertise in choosing the most suitable deep learning framework, such as TensorFlow, based on experience, resources, and project needs for GAI application development.
- Skilled in designing language model architectures, like Recurrent Neural Networks (RNN), tailored to project objectives.
- Skilled in training and fine-tuning language models, iteratively optimizing model parameters for desired output using pre-processed datasets.

Human-AI Interaction Designer

Human-AI Interaction Designer involves designing interfaces and interaction methods to facilitate smooth communication between humans and AI systems, enhancing decision-making and problem-solving in real-time industrial settings.

Skills:

- Skilled in creating user-friendly AI interfaces for a diverse range of users, from AI engineers to domain experts, minimizing the learning curve.
- Skilled in integrating NLP technologies to enable bi-directional human-AI conversations and collaboration, harnessing the potential of AI in understanding and generating natural language texts.
- Skilled in ensuring AI accountability and explainability in system design to improve operator efficiency and accuracy in complex tasks, increasing real-time assistance value.

Edge AI Developer

An Edge AI Developer is responsible for deploying AI on real-world devices at the network's edge, such as wearable devices, rather than relying on centralized data centres. This role requires adapting AI development skills to address the unique challenges posed by edge computing, IoT devices, and evolving AI efficiency while sharing some common skills with traditional AI developers.

Skills:

- Skilled in dissecting use cases, analysing objectives, business, and data requirements, and identifying constraints for edge device compatibility to kickstart the development process.
- Skilled in employing Digital Signal Processing (DSP) techniques for data pre-processing, including outlier removal and domain transformation, to prepare data for embedded machine learning
- Skilled at running memory-constrained machine learning models, like Computer Vision, on embedded devices, addressing memory and processing limitations throughout the data cycle.

Edge AI Safety Architect & Ethics Expert

An Edge AI Safety Architect & Ethics Expert is tasked with ensuring responsible design in the realm of edge AI, addressing both technical safety and ethical considerations. This role requires a diverse skill set that encompasses both the technical and moral dimensions of AI deployment to achieve responsible and secure AI systems.

Skills:

- Skilled in collaborating with Edge AI developers to address the black box nature of edge AI, ensuring safety and ethics by manually reviewing data formats (e.g., photos).
- Identifying and mitigating various types of bias, including human, data, testing, and algorithmic bias
- Proficient in conducting research and analysis in the field of edge AI technology to identify and mitigate potential psychological and societal harms
- Developing adaptive AI-driven safety protocols to safeguard workers and processes

4.3. Soft Skills

This section examines soft skills in addition to the technical skills discussed previously. Soft skills, also known as interpersonal or people skills, encompass a range of non-technical abilities that enable individuals to effectively interact, communicate, and collaborate with others. These skills include attributes like emotional intelligence, empathy, teamwork, problem-solving, adaptability, and leadership. Unlike technical skills, which are specific to particular tasks or jobs, soft skills are universally applicable and crucial for fostering a productive and harmonious workplace environment. The subsequent list outlines the soft skills relevant to various roles, including managers, professionals, and non-technical employees. In the next section, an analysis of the feedback from project partners concerning these soft skills will be presented.

- Emotional Judgment,
- Teamwork,
- Communication,
- Professional ethics,
- Problem solving,
- Critical thinking,
- Innovation,
- Ethical / Legal mindset,
- Second Language Knowledge,
- Time management Judgment,
- Interpersonal skills,
- Critical problem solving,
- Digital literacy,
- Self-management,
- Global perspective,
- Digital skills.

5. Analysis

As mentioned in section 3.2, the 6Ps methodology requires an examination of the current conditions (AS-IS) of the project partners to begin the analysis. To gather information about these current conditions and their expectations, two main surveys (Voting, Possessed and Needed) were designed.

In this section, we examine and evaluate the feedback from our partners. The voting survey aims to prioritize the skills highlighted earlier, while the possessed and needed survey focuses on assessing the partners' current skill levels and identifying any gaps.

5.1. Voting survey¹

This survey was conducted to gather the perspectives of project partners on the roles and skills outlined in the preceding section. Partners were asked to specify the most important and relevant skills for each role, considering their experience and the field in which their company operates. Based on their responses, the skills were then prioritized accordingly.

5.1.1. Analysis of first Iteration

The survey targeted all individuals and project partners, whose familiarity with the project's content makes their input on skill prioritization highly valuable. The results of this survey, based on 23 votes in the first iteration, are as follows.

Data /AI specialist

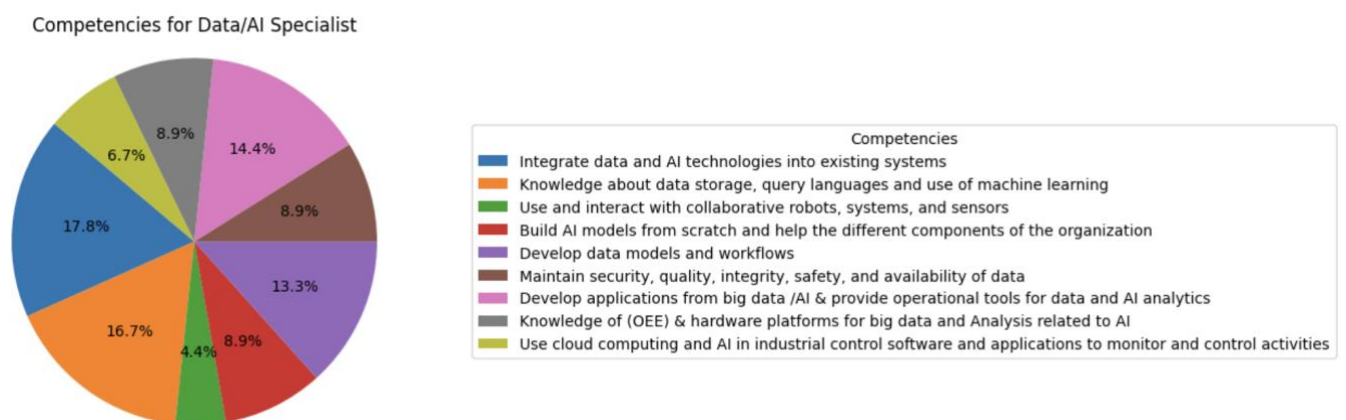


Figure 6 result of 1st iteration - Voting Survey - Data /AI specialist

Overall, the voting results for the competencies required for a Data/AI Specialist (Figure 6) emphasize the importance of integrating AI technologies into existing systems and managing data effectively. The highest-rated competency, "Integrate data and AI technologies into existing systems" (17.8%), underscores the critical importance of seamlessly incorporating AI into current infrastructures. This indicates a strong preference for skills that enhance the utility and efficiency of existing systems through AI integration. "Knowledge about data storage, query languages, and use of machine learning" (16.7%) is also highly valued, highlighting the necessity for robust data management and machine learning skills. This reflects the value placed on ensuring that data is effectively stored, queried, and used to support AI applications.

¹ https://polimi.eu.qualtrics.com/jfe/form/SV_8Caw0vM0JSSy79Y

"Develop applications from big data/AI & provide operational tools for data and AI analytics" (14.4%) emphasizes the need for practical application development skills that translate big data insights into operational tools. This competency is crucial for creating actionable solutions that leverage data and AI analytics.

"Develop data models and workflows" (13.3%) is another significant competency, indicating the importance of creating structured data processes to support efficient data handling and analysis. This highlights the need for specialists who can design effective data models and workflows.

"Build AI models from scratch and help the different components of the organization" (8.9%), "Maintain security, quality, integrity, safety, and availability of data" (8.9%), and "Knowledge of (OEE) & hardware platforms for big data and Analysis related to AI" (8.9%) each received moderate attention, emphasizing various aspects of AI model development, data security, and hardware knowledge. These competencies highlight the need for comprehensive skills that support the creation, security, and implementation of AI solutions.

Lower-priority competencies include "Use cloud computing and AI in industrial control software and applications to monitor and control activities" (6.7%) and "Use and interact with collaborative robots, systems, and sensors" (4.4%). While these skills are valuable, they are seen as more specialized or supplementary compared to the core competencies of AI integration and data management.

In summary, the primary focus for a Data/AI Specialist should be on integrating AI technologies into existing systems, managing data storage and query processes, and developing practical applications from big data. Additionally, designing effective data models and workflows, along with ensuring data security and understanding AI-related hardware, are critical supporting competencies. Skills related to cloud computing, industrial control software, and collaborative robots, while beneficial, are considered supplementary to these core areas.

AI Manager / Head of AI

Competencies for AI Manager / Head of AI



Figure 7 result of 1st iteration - Voting Survey – AI Manager/Head of AI

Overall, the voting results highlight the competencies considered most crucial for the role of an AI Manager or Head of AI (Figure 7). The highest-rated competency, "Develop and execute the data and AI strategies according to business objectives" (19.7%), underscores the importance of strategic planning and alignment with business goals. Closely following is "Knowledge about data and AI processes/User experience analysis, design, and evaluation" (18.3%), which emphasizes the need for a deep understanding of data processes and user-centric design.

Equally important, with 15.5% each, are competencies like "Adapt technological (new tech. such as AI, VR etc.) innovations to business and Supply Networks," "Analyze and understand how the value chain is transformed by virtue of Industry 4.0, and 5.0 and new technologies related to AI," and "Improving production process with the introduction of new technologies related to AI and I4.0 and I5.0." These skills highlight the necessity of incorporating new technologies into business processes and understanding their impact on the value chain.

"Understand and take advantage of IT-OT architectures, sensors, communication, data flow, cloud" (9.9%) emphasizes the need for technical proficiency in leveraging IT and OT architectures, which are essential for effective AI implementation. The lowest-priority competency, "Build, implement and manage concurrent Digital/intelligence Supply Networks" (5.6%), while still relevant, appears to be seen as more specialized or supplementary to the core strategic and technological integration functions.

This suggests that the primary focus for an AI Manager or Head of AI should be on strategic execution, understanding and leveraging new technologies, and maintaining a strong knowledge base in data processes and user experience, ensuring that AI initiatives align with and support overall business objectives.

Remote Worker

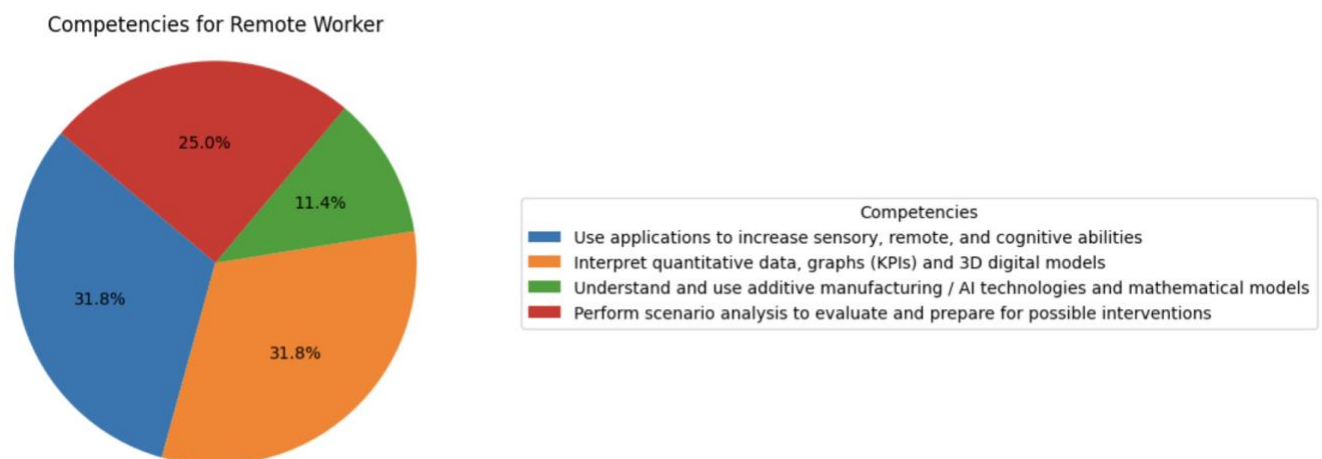


Figure 8 result of 1st iteration - Voting Survey – Remote Worker

Overall, the voting results for competencies required by a Remote Worker (Figure 8) highlight a strong emphasis on technical and analytical skills. The top two competencies, "Use applications to increase sensory, remote, and cognitive abilities" and "Interpret quantitative data, graphs (KPIs) and 3D digital models," each receiving 31.8% of the votes, underscore the critical importance of leveraging technology and data interpretation in remote work. These skills are essential for enhancing productivity and making informed decisions based on quantitative analysis.

The next most valued competency is "Perform scenario analysis to evaluate and prepare for possible interventions" (25%). This indicates the importance of strategic thinking and the ability to anticipate and plan for various scenarios, which is crucial for remote workers who need to be adaptable and proactive in addressing potential challenges.

Lastly, "Understand and use additive manufacturing/AI technologies and mathematical models" (11.4%) received the fewest votes, suggesting that while this competency is beneficial, it is not as critical as the other skills for remote workers. This reflects a view that remote work primarily benefits from strong application use and data interpretation capabilities, with advanced technological and mathematical skills being seen as supplementary.

In summary, the primary focus for remote workers should be on enhancing their abilities through applications and data interpretation, complemented by strategic scenario analysis to ensure preparedness for potential interventions. Advanced technological and mathematical competencies, while valuable, are considered less critical in comparison to these core skills.

15.0 Professional

Competencies for 15.0 Professional



Figure 9 result of 1st iteration - Voting Survey – 15.0 Professional

Overall, the voting results for the competencies required for 15.0 Professional (Figure 9) reveal a balanced emphasis on various technical and collaborative skills. The top-rated competency, "Enhance production processes by promoting worker collaboration with AI-driven tools and intuitive human-machine interfaces, focusing on human-centric improvement" (25.4%), highlights the importance of integrating AI tools to foster collaboration and improve human-machine interactions. This indicates a strong preference for enhancing production through human-centric AI applications.

"Leverage advanced application development platforms to create customized solutions that seamlessly integrate with 15.0 principles, prioritizing customization and adaptability" (17.5%) also received significant attention, emphasizing the need for customized and adaptable solutions in line with Industry 5.0 principles. This reflects the value placed on creating tailored applications that can adapt to evolving production needs. Several competencies share equal importance, each receiving 15.9% of the votes. These include "Use real-time data and predictive analytics to perform dynamic scenario analysis, enabling agile decision-making through AI-driven simulations and classifiers," "Design and oversee product data storage systems, emphasizing big data solutions, to facilitate real-time product optimization by seamlessly integrating sensors, actuators, ports, and antennas for data capture and remote monitoring," and "Master IoT platforms and sensors to enable real-time monitoring and control within the production ecosystem, utilizing IoT applications to boost operational efficiency and respond proactively to changing conditions." These competencies collectively highlight the crucial role of real-time data utilization, predictive analytics, and IoT integration in modern production processes.

"Demonstrate expertise in programming and collaborating with cobots to improve efficiency, safety, and adaptability while conducting virtual testing simulations to enhance cobot performance" (7.9%) is valued for its focus on improving efficiency and safety through cobot collaboration and virtual simulations, although it is seen as less critical compared to the top priorities.

The competency "Independently analyse complex demand and supply network data using advanced tools like R, Python, MATLAB, and AI-driven analytics to provide insights supporting data-driven decision-making" (1.6%) received the fewest votes, suggesting that while this skill is beneficial, it is not considered as crucial as the other competencies.

In summary, the primary focus for enhancing production processes should be on promoting worker collaboration through AI-driven tools and intuitive interfaces, leveraging advanced application development platforms for customization, and utilizing real-time data, predictive analytics, and IoT platforms for dynamic scenario analysis and operational efficiency. Skills related to cobot collaboration and advanced data analysis, while valuable, are seen as supplementary to these core competencies.

Plant Worker 5.0

Competencies for Plant Worker 5.0

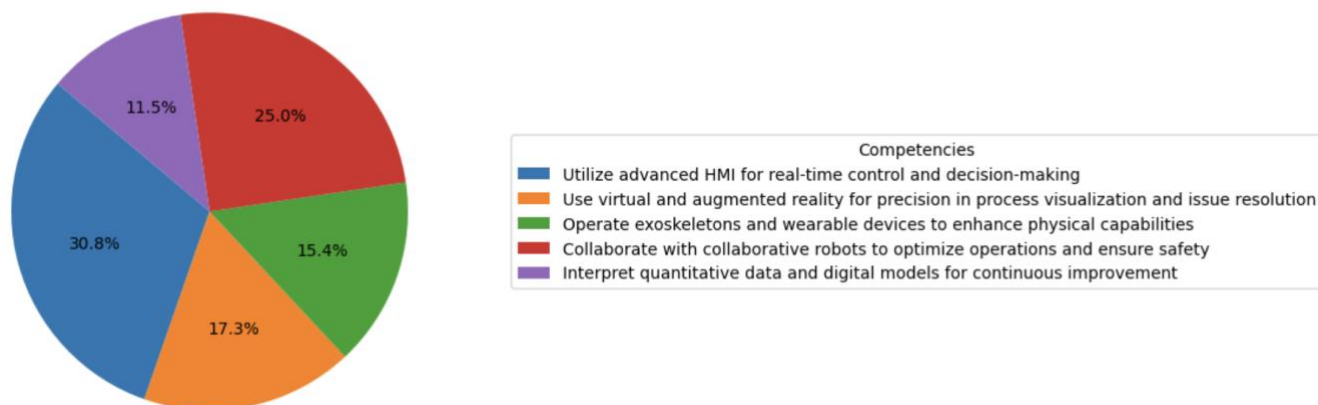


Figure 10 result of 1st iteration - Voting Survey – Plant Worker 5.0

Overall, the voting results for competencies required Plant Worker 5.0 (Figure 10) highlight a strong emphasis on advanced human-machine interactions and collaboration with AI-driven tools. The highest-rated competency, "Use advanced HMI for real-time control and decision-making" (30.8%), underscores the critical importance of sophisticated human-machine interfaces (HMIs) in enhancing real-time control and facilitating effective decision-making. This indicates a strong preference for leveraging advanced HMIs to optimize operations and ensure responsive management.

"Collaborate with collaborative robots to optimize operations and ensure safety" (25%) is also highly valued, reflecting the necessity of working alongside cobots to improve efficiency and maintain safety standards. This competency emphasizes the growing role of cobots in modern production environments and the importance of human-robot collaboration.

"Use virtual and augmented reality for precision in process visualization and issue resolution" (17.3%) highlights the significance of immersive technologies like VR and AR in providing detailed process visualization and effective issue resolution. This reflects the value placed on precision and clarity in monitoring and troubleshooting production processes.

"Operate exoskeletons and wearable devices to enhance physical capabilities" (15.4%) underscores the potential of wearable technology to augment physical abilities, facilitating enhanced performance and reducing physical strain. This indicates the importance of integrating wearable devices to support and improve human capabilities in various tasks.

Finally, "Interpret quantitative data and digital models for continuous improvement" (11.5%) received the fewest votes, suggesting that while data interpretation for continuous improvement is important, it is seen as less critical compared to the competencies directly related to advanced HMIs, cobot collaboration, and immersive technologies.

In summary, the primary focus should be on utilizing advanced human-machine interfaces for real-time control and decision-making, collaborating with cobots to optimize operations, and leveraging virtual and augmented reality for precise process visualization and issue resolution. Competencies related to operating exoskeletons and wearable devices, as well as interpreting quantitative data for continuous improvement, while valuable, are considered supplementary to these core skills.

Technician 5.0

Competencies for Technician 5.0



Figure 11 result of 1st iteration - Voting Survey – Technician 5.0

Overall, the voting results for competencies of Technician 5.0 (Figure 11) ecosystem emphasize the importance of mastering sensor and data integration technologies. The highest-rated competency, "Achieve mastery in deploying sensors, actuators, ports, antennas, and HMI standards to ensure smooth data capture and integration within the industry 5.0 ecosystem" (34.7%), underscores the critical role of seamless data capture and integration. This highlights a strong preference for proficiency in the technical infrastructure required to support advanced Industry 5.0 operations.

"Apply analytical skills to interpret operational data, enabling informed decision-making and continuous process improvement" (20.4%) also received significant attention, indicating the necessity of strong analytical capabilities to drive informed decision-making and enhance process efficiency. This reflects the value placed on data-driven insights and continuous improvement.

"Efficiently operate in automated smart warehouses with automated picking systems and autonomous vehicles" (16.3%) emphasizes the importance of operational proficiency in modern, automated environments. This competency underscores the need for skills in managing and utilizing advanced warehouse automation technologies.

Both "Use discrete event simulation to model and optimize complex processes, improving efficiency and resource allocation" (14.3%) and "Use 3D printing technology for rapid and cost-effective fabrication of prototypes, parts, and components, facilitating product development and customization" (14.3%) received equal votes, indicating that while these skills are valued, they are seen as specialized competencies that complement the more critical areas of data integration and operational analytics.

In summary, the primary focus should be on mastering the deployment of sensors, actuators, ports, antennas, and HMI standards to ensure smooth data capture and integration within the industry 5.0 ecosystem. This is complemented by strong analytical skills for interpreting operational data and enhancing decision-making. Competencies related to operating automated smart warehouses, using discrete event simulation, and leveraging 3D printing technology, while valuable, are seen as supplementary to the core skills required for data integration and continuous process improvement.

Generative AI Application Developer

Competencies for Generative AI Application Developer

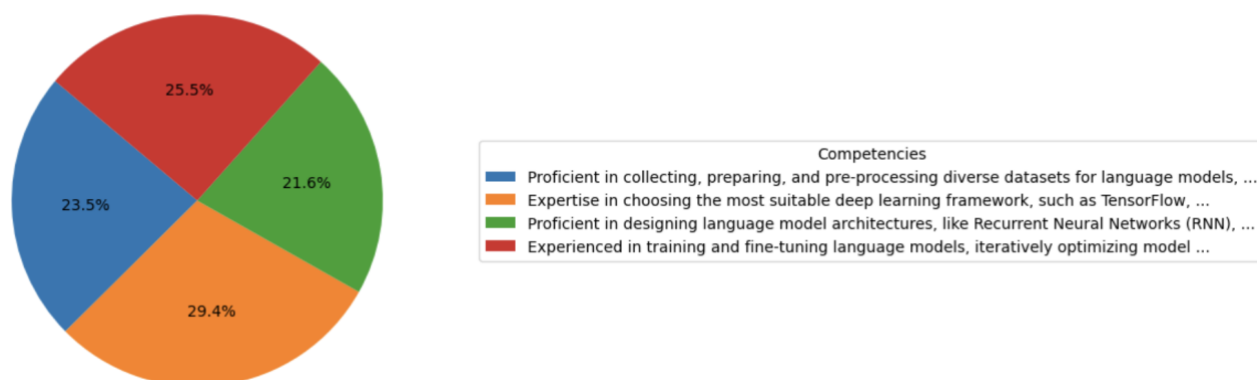


Figure 12 result of 1st iteration - Voting Survey – Generative AI Application Developer

Overall, the voting results for the competencies required for a Generative AI Application Developer (Figure 12) highlight the importance of expertise in deep learning frameworks and practical skills in model training and dataset preparation. The highest-rated competency, "Expertise in choosing the most suitable deep learning framework, such as TensorFlow, based on experience, resources, and project needs for GAI application development" (29.4%), underscores the critical role of selecting the appropriate framework to ensure efficient and effective AI development. This indicates a strong preference for deep learning framework expertise, which is foundational for developing robust generative AI applications.

"Experienced in training and fine-tuning language models, iteratively optimizing model parameters for desired output using pre-processed datasets" (25.5%) also received significant attention, emphasizing the necessity of practical skills in the iterative process of model optimization. This reflects the value placed on the ability to achieve the desired performance through meticulous model training and fine-tuning.

"Proficient in collecting, preparing, and pre-processing diverse datasets for language models, including text cleaning and removal of extraneous characters" (23.5%) highlights the importance of handling and preparing data accurately. This competency underscores the need for thorough data preprocessing to ensure the quality and effectiveness of the language models.

"Proficient in designing language model architectures, like Recurrent Neural Networks (RNN), tailored to project objectives" (21.6%) is also a critical skill, indicating the necessity of architectural knowledge to design models that meet specific project requirements. While this competency is slightly lower in priority compared to framework expertise and model training, it remains essential for creating tailored AI solutions.

In summary, the primary focus for a Generative AI Application Developer should be on expertise in selecting the most suitable deep learning framework and practical experience in training and fine-tuning language models. Proficiency in data collection, preparation, and pre-processing, along with designing language model architectures tailored to project objectives, are also crucial competencies that support the core skills required for effective generative AI application development.

Human-AI Interaction Designer

Competencies for Human-AI Interaction Designer

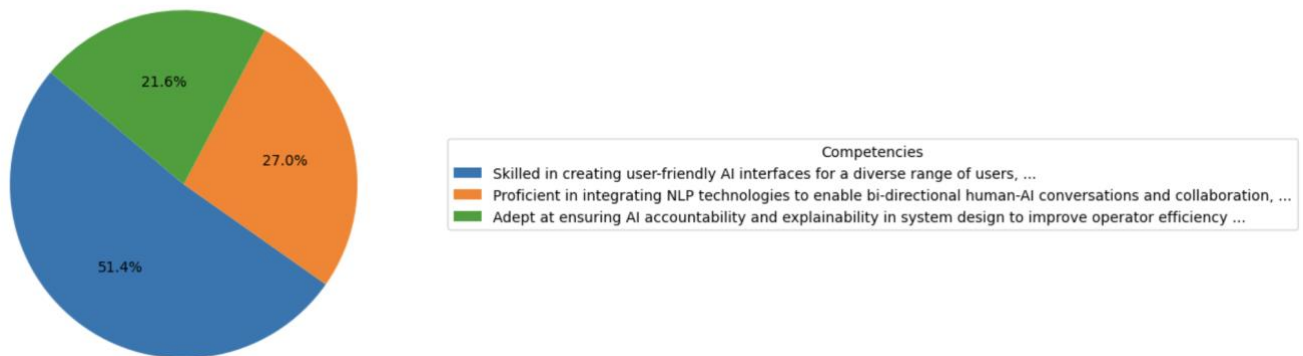


Figure 13 result of 1st iteration - Voting Survey – Human-AI Interaction Designer

Overall, the voting results for the competencies required for a Human-AI Interaction Designer (Figure 13) emphasize the paramount importance of creating user-friendly AI interfaces. The highest-rated competency, "Skilled in creating user-friendly AI interfaces for a diverse range of users, from AI engineers to domain experts, minimizing the learning curve" (51.4%), highlights the critical need for designing intuitive interfaces that cater to a wide variety of users. This indicates a strong preference for ensuring that AI tools are accessible and easy to use, significantly reducing the time and effort needed for users to become proficient.

"Proficient in integrating NLP technologies to enable bi-directional human-AI conversations and collaboration, harnessing the potential of AI in understanding and generating natural language texts" (27%) is also highly valued. This competency underscores the importance of natural language processing (NLP) in facilitating effective communication and collaboration between humans and AI systems. It reflects the necessity of leveraging NLP to enhance the interactive capabilities of AI, making it more responsive and useful in understanding and generating human language.

"Adept at ensuring AI accountability and explainability in system design to improve operator efficiency and accuracy in complex tasks, increasing real-time assistance value" (21.6%) received the fewest votes but remains a crucial competency. This highlights the importance of incorporating accountability and explainability into AI systems, which is essential for building trust and improving the efficiency and accuracy of operators, especially in complex tasks. Ensuring that AI decisions can be understood and trusted is vital for effective human-AI collaboration.

In summary, the primary focus for a Human-AI Interaction Designer should be on creating user-friendly AI interfaces that minimize the learning curve for a diverse range of users. Integrating NLP technologies to enable effective human-AI conversations and ensuring AI accountability and explainability in system design are also critical competencies that support the core goal of enhancing human-AI interaction.

Edge AI Developer

Competencies for Edge AI Developer

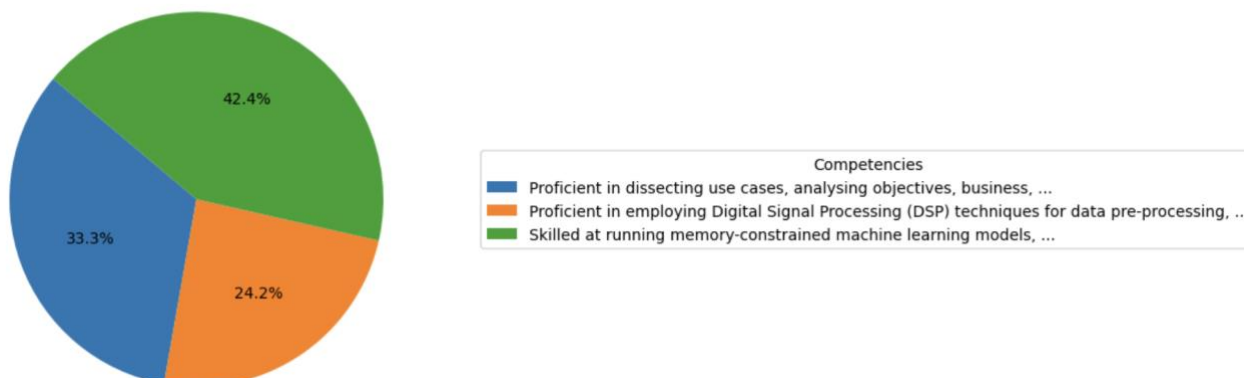


Figure 14 result of 1st iteration - Voting Survey – Edge AI Developer

Overall, the voting results for the competencies required for an Edge AI Developer (Figure 14) highlight a strong emphasis on practical skills related to embedded machine learning and device compatibility. The highest-rated competency, "Skilled at running memory-constrained machine learning models, like Computer Vision, on embedded devices, addressing memory and processing limitations throughout the data cycle" (42.4%), underscores the critical importance of effectively deploying machine learning models on devices with limited resources. This indicates a strong preference for expertise in optimizing AI models to work efficiently within the constraints of embedded systems.

"Proficient in dissecting use cases, analysing objectives, business, and data requirements, and identifying constraints for edge device compatibility to kickstart the development process" (33.3%) is also highly valued. This competency highlights the necessity of thorough initial analysis to ensure that edge AI solutions are aligned with business goals and technical requirements. It reflects the value placed on a detailed understanding of use cases and constraints to guide the development process effectively.

"Proficient in employing Digital Signal Processing (DSP) techniques for data pre-processing, including outlier removal and domain transformation, to prepare data for embedded machine learning" (24.2%) received fewer votes but remains an essential skill. This competency emphasizes the importance of data preparation and preprocessing using DSP techniques to ensure the quality and relevance of data for embedded machine learning applications. It indicates the need for strong technical skills in data handling and transformation to support effective AI model deployment.

In summary, the primary focus for an Edge AI Developer should be on optimizing and running machine learning models on memory-constrained embedded devices. Proficiency in dissecting use cases and understanding the technical and business requirements for edge device compatibility is also crucial. Additionally, employing DSP techniques for data preprocessing is an important supporting competency that ensures the quality and effectiveness of data used in embedded AI applications.

Edge AI Safety Architect & Ethics Expert

Competencies for Edge AI Safety Architect & Ethics Expert



Figure 15 result of 1st iteration - Voting Survey – Edge AI Safety Architect & Ethics Expert

Overall, the voting results for the competencies required for an Edge AI Safety Architect & Ethics Expert (Figure 15) highlight the critical importance of collaboration, bias mitigation, and safety protocol development. The highest-rated competency, "Proficient in collaborating with Edge AI developers to address the black box nature of edge AI, ensuring safety and ethics by manually reviewing data formats (e.g., photos)" (32%), underscores the necessity of working closely with developers to enhance the transparency and accountability of edge AI systems. This indicates a strong preference for ensuring safety and ethics through direct, hands-on collaboration and data review.

"Developing adaptive AI-driven safety protocols to safeguard workers and processes" (26%) is also highly valued. This competency highlights the importance of creating dynamic safety protocols that leverage AI to protect workers and streamline processes. It reflects the value placed on proactive safety measures that can adapt to changing conditions and requirements.

"Identifying and mitigating various types of bias, including human, data, testing, and algorithmic bias" (24%) received considerable attention, emphasizing the critical role of bias detection and mitigation in ensuring fair and ethical AI systems. This indicates the necessity of addressing potential sources of bias to maintain the integrity and trustworthiness of edge AI applications.

"Proficient in conducting research and analysis in the field of edge AI technology to identify and mitigate potential psychological and societal harms" (18%) received the fewest votes but remains an essential skill. This competency highlights the importance of understanding and mitigating the broader impacts of edge AI technology on society and individuals. It indicates the need for a thorough research-driven approach to identify and address potential harms.

In summary, the primary focus for an Edge AI Safety Architect & Ethics Expert should be on collaborating with developers to enhance transparency and accountability, developing adaptive safety protocols, and identifying and mitigating various types of bias. Conducting research to understand and address psychological and societal harms, while receiving fewer votes, is also a critical supporting competency that ensures the ethical deployment of edge AI technology.

5.1.2. Analysis of Soft Skills

As previously noted, we also evaluated soft skills at three distinct levels: Management, Professional, and Non-technical Employees. The survey results from project partners for these categories can be seen.

Managers' Perspective

Managers place a high value on communication, ethical/legal mindset, and a global perspective. Effective communication is crucial for them as they need to convey information clearly and lead their teams efficiently. The strong emphasis on ethical/legal mindset and global perspective reflects their responsibility in making

decisions that are ethically sound and considering the broader impact on a global scale. Teamwork, professional ethics, and skills such as speaking a second language, time management, and interpersonal skills are also critical for managers, highlighting their role in fostering a collaborative and ethically grounded work environment. Although problem solving, critical problem solving, and Digital literacy received lower emphasis, it indicates that managers might delegate these tasks to their teams. (Figure 16)



Figure 16 Important Soft Skills / Manager

Professionals' Perspective

Professionals prioritize professional ethics and self-management, reflecting the importance of maintaining ethical standards and managing their responsibilities independently. Problem solving is also highly valued, indicating their need for strong analytical skills to tackle complex issues. Digital skills are important, showcasing the need for technological proficiency and creative solutions. Communication, teamwork, and time management are essential for professionals, as they often work in collaborative environments and need to manage their workload effectively. While a global perspective is less emphasized, it suggests a more specialized focus within their field. (Figure 17)



Figure 17 Important Soft Skills / Professionals

Workers' Perspective

Workers highly value teamwork, indicating the importance of collaboration in their roles. Self-management, Problem solving, and digital skills are also important, reflecting the need for personal accountability and basic technological proficiency. Communication and professional ethics are moderately valued, ensuring they interact effectively and maintain ethical standards. Critical problem solving is essential but to a lesser extent compared to professionals, highlighting the need for basic problem-solving abilities. Skills such as speaking a second language and having a global perspective are less emphasized, indicating that workers' roles may be more focused on local or routine tasks that do not require extensive language skills or global awareness. (Figure 18)

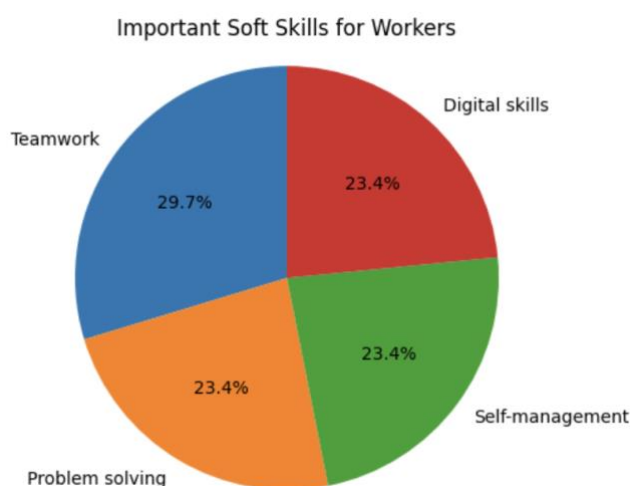


Figure 18 Important Soft Skills / Workers

Overall, the survey highlights that different roles within the organization require different sets of prioritized skills. Managers benefit from strong communication and ethical decision-making abilities, professionals need robust digital skills, and workers require a solid foundation in teamwork and self-management. Tailoring training and development programs to these role-specific needs can enhance overall team performance and efficiency.

5.2. Possessed and Needed survey¹

To evaluate the current status of the DFs and Pilots of the project and their future expectations regarding the roles mentioned in earlier sections, a second survey titled "Possessed and Needed" was conducted. In this survey, participants indicated whether these skills were needed in their company or were currently being used. The responses were measured on a numerical scale from 1 to 5, where 1 represents "basic level required" and 5 represents "expert level required." The primary aim of this survey is to compare the current AS-IS situation with their target conditions, identifying any gaps and potential partner activities to address these gaps.

5.2.1. Analysis of first Iteration

The target group for this survey comprises Didactic Factories (DFs) and project pilots. The outcomes of this survey, based on the first iteration (17 votes), are as follows.

¹ https://polimi.eu.qualtrics.com/jfe/form/SV_bdzOQv1Tu79Cx1k

Data /AI specialist

The survey results indicate a varied level of maturity among partners concerning the role of Data/AI specialists. The majority of partners demonstrate an advanced level of competence in integrating data and AI technologies into existing systems, developing data models and workflows, and maintaining data security, quality, integrity, safety, and availability. Specifically, the highest maturity levels (4 and 5) are prominently seen in integrating data and AI technologies, developing data models, and maintaining data security, with the majority of responses falling within these levels. This suggests that many partners possess a robust foundation and are well-equipped to handle advanced AI and data-related tasks. However, there are still areas where some partners fall behind, such as using and interacting with collaborative robots and AI model building, indicating potential gaps in practical AI application skills.

In terms of addressing these skill gaps, partners have indicated various strategies. Some companies possess the necessary skills internally, while others rely on collaboration with AI REDGIO partners like CTU. To bridge the skill gaps, partners are considering several approaches, including opening new collaborations, hiring new personnel, and offering training courses. There is a consensus that training and re-skilling will be crucial to meeting future demands. For instance, SCAMM plans to address their gaps by opening new collaborations, while other organizations like Gradiant already possess the required skills but recognize the importance of continuous development. This collaborative and proactive approach highlights the partners' commitment to staying at the forefront of AI and data integration, ensuring they remain competitive and innovative.

AI Manager / Head of AI

The survey regarding the role of AI Manager/Head of AI shows varied levels of expertise among the partners. Key areas such as adapting technological innovations like AI and VR to business processes, and improving production processes with new technologies, received mixed levels of proficiency. For instance, while a significant number of partners rated their proficiency at upper intermediate and expert levels in adapting technological innovations (levels 3 and 4), there were no experts (level 5) reported in this area. Similarly, the understanding and application of IT-OT architectures and the development and execution of data and AI strategies were predominantly rated at the intermediate to expert levels (3 to 5), indicating a higher level of maturity in these critical areas.

In addressing the gaps, partners are employing diverse strategies. Several companies, such as Gradiant, report possessing the necessary skills internally, with some highlighting their reliance on practical experience and external collaborations to enhance their capabilities further. For instance, SCAMM typically outsources these skills, indicating a preference for opening new collaborations. Other partners plan to bridge their skill gaps through training courses and upskilling initiatives. The feedback underscores a blend of internal expertise and external partnerships as vital to meeting their strategic AI goals, highlighting a proactive approach towards continuous learning and adaptation to emerging technologies.

Remote Worker

The survey results for the role of Remote Worker show varying levels of expertise among the partners. The skills assessed include using applications to enhance sensory, remote, and cognitive abilities, interpreting quantitative data and 3D digital models, understanding and utilizing additive manufacturing/AI technologies, and performing scenario analysis for potential interventions. Notably, the majority of partners rate their proficiency at the upper intermediate to expert levels (4 and 5) in using applications and interpreting quantitative data, indicating a solid understanding in these areas. However, there's a noticeable gap in intermediate and lower levels of expertise for skills like additive manufacturing and scenario analysis.

In addressing these skill gaps, partners have identified several strategies. Many companies, like SCAMM, are accustomed to equipping their lines with sensors for remote monitoring and process analysis but acknowledge the need for new collaborations to integrate missing skills such as scenario analysis. Other companies report possessing these skills internally or plan to bridge the gaps by training courses, upskilling, and hiring new personnel. The emphasis on training courses highlights the partners' commitment to continuous learning and skill enhancement to keep pace with technological advancements. This proactive

approach, combining internal expertise with external collaborations, underscores the importance of adaptability and lifelong learning in maintaining a competitive edge in the evolving landscape of remote work and AI integration.

I5.0 Professional

The survey results for the role of I5.0 Professional highlight varying levels of proficiency among the partners. Key skills assessed include enhancing production processes through AI-driven collaboration, utilizing real-time data and predictive analytics, programming and collaborating with cobots, and designing product data storage systems. The majority of partners demonstrate upper intermediate to expert levels (4 and 5) in utilizing real-time data and predictive analytics, indicating a high level of maturity in this area. However, there are notable gaps in skills such as programming with cobots and independently analysing complex demand and supply network data, with a mix of intermediate and lower levels of expertise (2 and 3).

To address these skill gaps, partners have outlined several strategies. Some companies report possessing the necessary skills internally, while others plan to fill these gaps by hiring new personnel or opening new collaborations. The feedback also underscores the importance of training courses to enhance existing capabilities. For instance, companies with some expertise aim to further improve by focusing on up-skilling and leveraging training courses and international collaborations. This proactive approach highlights a commitment to continuous improvement and adaptability, ensuring that partners remain competitive and effective in leveraging I5.0 technologies to optimize production processes and enhance collaboration between workers and AI-driven systems.

Plant Worker 5.0

Based on the survey responses from partners, the proficiency levels for these skills vary among the partners. The responses indicate a mix of intermediate to upper intermediate proficiency levels (3 to 4) in using advanced HMI for real-time control and decision-making, as well as in interpreting quantitative data and digital models for continuous improvement. However, there are noticeable gaps in proficiency for skills such as using virtual and augmented reality, and operating exoskeletons and wearable devices, where partners generally fall within the lower intermediate to intermediate levels (2 to 3).

To address these skill gaps, partners have outlined several strategies. Many companies report that these skills are already present within their organizations, while others plan to bridge these gaps by training courses or opening new collaborations. Some partners also emphasize the potential for up-skilling and enhancing existing capabilities through training courses. This approach reflects a proactive stance towards continuous learning and skill development, ensuring that Plant Worker 5.0 roles are equipped with the necessary competencies to leverage advanced technologies and optimize plant operations effectively. This commitment to continuous improvement and adaptability ensures that partners remain competitive and capable of meeting the evolving demands of modern industrial environments.

Technician 5.0

The survey results for the role of Technician 5.0 reveal varied levels of proficiency among the partners. Key skills assessed include deploying sensors, actuators, ports, antennas, and HMI systems, operating in automated smart warehouses, applying analytical skills to interpret operational data, using discrete event simulation to optimize processes, and utilizing 3D printing technology for rapid fabrication. The responses indicate a mix of intermediate to upper intermediate levels (3 and 4) in deploying sensors and using discrete event simulation, while proficiency in operating smart warehouses and 3D printing is generally lower, with some partners indicating basic to lower intermediate levels (1 and 2).

To bridge these skill gaps, partners emphasize several strategies, with a significant focus on training courses. Many partners report that these skills are already present internally or can be developed through up-skilling and training courses. Others highlight the potential for opening new collaborations to enhance their capabilities. The feedback also underscores the importance of training courses as a primary method for acquiring the necessary knowledge and abilities, especially for partners who currently do not possess these

skills. This approach reflects a commitment to continuous improvement and adaptability, ensuring that partners are well-equipped to handle the evolving demands of Technician 5.0 roles and remain competitive in the industry.

Generative AI Application Developer

The survey results for the role of Generative AI Application Developer highlight varying levels of expertise among the partners. The skills assessed include proficiency in collecting and pre-processing diverse datasets, choosing suitable deep learning frameworks, designing language model architectures, and training and fine-tuning language models. The majority of partners demonstrate high proficiency (level 5) in choosing deep learning frameworks and training language models, indicating a strong capability in these areas. However, there are noticeable gaps in proficiency for skills like dataset preparation and designing language model architectures, with a mix of intermediate and lower levels.

To address these skill gaps, partners have outlined several strategies. Some partners report that these skills are already present within their departments, while others plan to fill these gaps by hiring new personnel or opening new collaborations. The feedback also underscores that certain skills are not currently relevant for some companies. A significant emphasis is placed on the importance of training courses to enhance existing capabilities. This approach reflects a proactive stance towards continuous learning and skill enhancement, ensuring that partners can effectively develop and deploy generative AI applications, keeping pace with technological advancements and industry demands.

Human-AI Interaction Designer

The survey results for the role of Human-AI Interaction Designer reveal a diverse range of proficiency levels among the partners. Key skills assessed include creating user-friendly AI interfaces, integrating NLP technologies for bi-directional human-AI interaction, and ensuring AI accountability and explainability in system design. The responses indicate a mix of proficiency, with higher levels (4 and 5) in creating user-friendly AI interfaces and lower intermediate to intermediate levels (2 and 3) in integrating NLP technologies and ensuring AI accountability and explainability.

To address these skill gaps, partners have outlined several strategies. Some companies possess the necessary skills internally, while others plan to bridge these gaps by hiring new personnel or opening new collaborations. The feedback also underscores that certain skills are not currently possessed by some partners, who plan to acquire them as needed. There is a significant emphasis on the importance of training courses to enhance existing capabilities. This approach highlights a commitment to continuous learning and skill enhancement, ensuring that partners can effectively design and implement human-AI interaction systems that are user-friendly, accountable, and explainable.

Edge AI Developer

The survey results for the role of Edge AI Developer highlight varied levels of expertise among the partners. The key skills assessed include dissecting use cases and analysing objectives, employing Digital Signal Processing (DSP) techniques, and running memory-constrained machine learning models like Compute. The responses indicate a mix of proficiency levels, with several partners demonstrating upper intermediate to expert levels (4 and 5) in running memory-constrained machine learning models, while proficiency in dissecting use cases and employing DSP techniques is more varied, spanning from lower intermediate to upper intermediate levels (2 to 4).

To address these skill gaps, partners have identified several strategies. Many companies report possessing the necessary skills internally, while others plan to bridge the gaps by training courses or opening new collaborations. Some partners also highlight the possibility of enhancing their capabilities by hiring new personnel or collaborating with other organizations. The emphasis on training courses as a primary method for skill enhancement reflects a commitment to continuous improvement and adaptability. This approach ensures that partners remain proficient in the latest Edge AI technologies and techniques, enabling them to

effectively analyze use cases, employ DSP techniques, and run memory-constrained machine learning models.

Edge AI Safety Architect & Ethics Expert

The survey results for the role of Edge AI Safety Architect & Ethics Expert show a range of proficiency levels among the partners. Key skills assessed include collaborating with Edge AI developers to address the black box issue, identifying and mitigating various types of bias, conducting research and analysis in the field of edge AI technology, and developing adaptive AI-driven safety protocols. The responses indicate intermediate proficiency levels (2,3,4) in identifying and mitigating bias and collaborating with developers, while proficiency in conducting research and developing safety protocols shows more variability, with some partners at basic to lower intermediate levels (1 to 2).

To address these skill gaps, partners have proposed several strategies. Some companies report partially possessing the necessary skills, while others plan to bridge these gaps by training courses or opening new collaborations. Certain partners, such as university departments, possess these skills internally and can enhance their capabilities by working with other departments. The feedback also highlights that some skills are not currently possessed, and new collaborations will be essential to fill these gaps. The emphasis on training courses underscores the importance of continuous learning and skill development. This approach ensures that partners remain proficient in the latest Edge AI safety and ethics protocols, enabling them to effectively collaborate with developers, mitigate biases, conduct relevant research, and develop adaptive safety protocols.

6. Training Activities

In this section, we highlight the second step of the methodology introduced in section 3.2. Following the introduction of relevant jobs and skills in the initial step, the implementation and analysis of the surveys detailed in the previous section, and the identification of gaps among the project DFs and Pilots, feedback from partners indicated that training courses are among the most effective solutions for addressing these gaps. Consequently, we now recommend training activities designed to help partners enhance the necessary skills for the specified job profiles. (Reported in [Table 1](#))

Three levels of training were initially considered: "Awareness," "Foundations," and "Extended Know-How." "Awareness" pertains to general knowledge and information to familiarize participants with the subject. "Foundations" covers basic, useful information, while "Extended Know-How" includes a comprehensive range of information that enables participants to deepen their knowledge and understand how to effectively use the technology.

Subsequently, we analysed various training courses from sources such as Polimi Open Knowledge, I4MS, Coursera, Udemy, and others. This analysis established a correlation between the jobs, the related skills, and the training courses at all three levels.

It is important to note that this step is an ongoing activity and will continue until the project's conclusion.

Table 1 Example of Training Activities

Matrix: relation between courses and Roles		Provider	I4MS	PoK – Politecnico di Milano	PoK – Politecnico di Milano
		Course name	AI Opportunities for SMEs	Artificial Intelligence - An Overview	Artificial Intelligence and legal issues
Data Science and AI Management	Data /AI specialist				
	Integrate data and AI technologies into existing systems,		2	2	1
	Knowledge about data storage, query languages and use of machine learning,		1		
	Use and interact with collaborative robots, systems, and sensors,		2	1	2
	Build AI models from scratch and help the different components of the organization,		1		
	Develop data models and workflows,		2	1	
	Maintain security, quality, integrity, safety, and availability of data,				
	Develop applications from big data /AI & provide operational tools for data and AI analytics,				
	Knowledge of (OEE) & hardware platforms for big data and Analysis related to AI,				1
	Use cloud computing and AI in industrial control software and applications to monitor and control activities.		1		1
	AI Manager / Head of AI				
	Adapt technological (new tech. such as AI, VR etc.) innovations to business and Supply Networks,		1		
	Build, implement and manage concurrent Digital/Intelligence Supply Networks,				
	Understand and take advantage of IT-OT architectures, sensors, communication, data flow, cloud,		1		
	Develop and execute the data and AI strategies according to business objectives,		1	1	
	Knowledge about data and AI processes /User experience analysis, design, and evaluation,		2	1	
	Analyze and understand how the value chain is transformed by virtue of Industry 4.0, and 5.0 and new technologies related to AI,				
	Improving production process with the introduction of new technologies related to AI and I4.0 and I5.0,		2		
	Remote Worker				
Use applications to increase sensory, remote, and cognitive abilities,					
Interpret quantitative data, graphs (KPIs) and 3D digital models,					
Understand and use additive manufacturing / AI technologies and mathematical models,		1	1		
Perform scenario analysis to evaluate and prepare for possible interventions,					
Data and AI Professions and Skills for Enterprise Industry 5.0	I5.0 Professional				
	Enhance production processes by promoting worker collaboration with AI-driven tools ...		1		
	Utilize real-time data and predictive analytics to perform dynamic scenario analysis, ...				
	Demonstrate expertise in programming and collaborating with cobots to improve efficiency, ...				
	Design and oversee product data storage systems, emphasizing big data solutions, to facilitate real-time ...				
	Independently analyse complex demand and supply network data using advanced tools like R, ...		1	1	
	Master IoT platforms and sensors to enable real-time monitoring and control within the production ecosystem, ...				
	Leverage advanced application development platforms to create customized solutions that ...				
	Plant Worker 5.0				
	Utilize advanced HMI for real-time control and decision-making.				
	Use virtual and augmented reality for precision in process visualization and issue resolution.		1		
	Operate exoskeletons and wearable devices to enhance physical capabilities.				
	Collaborate with collaborative robots to optimize operations and ensure safety.				
	Interpret quantitative data and digital models for continuous improvement.			1	
	Technician 5.0				
	Achieve mastery in deploying sensors, actuators, ports, ...		1		
	Efficiently operate in automated smart warehouses with automated picking systems and autonomous vehicles.				
	Apply analytical skills to interpret operational data, enabling informed decision-making and continuous process improvement.				
	Use discrete event simulation to model and optimize complex processes, improving efficiency and resource allocation.			1	
	Utilize 3D printing technology for rapid and cost-effective fabrication of prototypes, parts, ...				
	Generative AI Application Developer				
	Proficient in collecting, preparing, and pre-processing diverse datasets for language models,...				
	Expertise in choosing the most suitable deep learning framework, such as TensorFlow, based on experience, ...		1	1	
	Proficient in designing language model architectures, ...				
	Experienced in training and fine-tuning language models, iteratively optimizing model parameters ...				
	Human-AI Interaction Designer				
	Skilled in creating user-friendly AI interfaces for a diverse range of users, from AI engineers ...		1	1	
	Proficient in integrating NLP technologies to enable bi-directional human-AI conversations and collaboration,...				
	Adept at ensuring AI accountability and explainability in system design to improve ...				
	Edge AI Developer				
Proficient in dissecting use cases, analysing objectives, business, and data requirements, ...					
Proficient in employing Digital Signal Processing (DSP) techniques for data pre-processing, ...					
Skilled at running memory-constrained machine learning models, like Computer Vision, on embedded devices ...		2			
Edge AI Safety Architect & Ethics Expert					
Proficient in collaborating with Edge AI developers to address the black box nature of edge AI, ...				1	
Identifying and mitigating various types of bias, including human, data, testing, and algorithmic bias				2	
Proficient in conducting research and analysis in the field of edge AI technology to identify and ...				1	
Developing adaptive AI-driven safety protocols to safeguard workers and processes				1	

This database encompasses all ten jobs introduced in the previous sections, along with their related skills, and [Table 1](#) serves as a partial illustration of its functionality. For instance, in the first column of the courses, we have "AI Opportunities for SMEs" presented by "I4MS." This course, set in the context of Artificial Intelligence and aimed at small and medium-sized companies, provides awareness-level explanations for skills such as "Develop Data Models and Workflows" and "Use and Interact with Collaborative Robots, Systems, and Sensors." It also offers foundational knowledge for the skill "Build AI Models from Scratch and Help the Different Components of the Organization." It should be noted that this database is open source,

allowing partners to add any additional training activities they use to improve their required skills, thereby making these resources available to other partners.

6.1. Use Case of training activities

In accordance with the methodology outlined in the previous sections and the recommendation of training courses to project partners for skill enhancement, additional educational activity is being conducted by the project partners. This activity is not only available to internal project participants but is also accessible to external participants. The following sections introduce this initiative and its objectives.

Title: Eclipse Arrowhead framework training workshop series

Type: 10 videos

Target group: Interested newbies to the Arrowhead framework

Provider: LTU (Luleå University of Technology)

1- Arrowhead Framework: An Overview (6:01 minutes)¹

The workshop has four main goals: to enhance understanding and skills related to the Arrowhead Framework. Initially, it aims to provide a solid understanding of the framework's fundamentals, ensuring comprehension of its core principles and functionalities. Next, it covers the practical aspects of installing and managing the framework on various edge devices and servers, an essential skill for effective framework utilization. The third goal is to offer practical, hands-on experience by deploying Arrowhead Local Clouds and Systems, allowing participants to see the framework in action and understand its operational details. Finally, the workshop aims to provide a thorough understanding of the Arrowhead Framework's more complex aspects, such as certificate generation, management tool usage, and inter-cloud rule implementation. In addition to these objectives, the workshop includes ten informative videos with hands-on demonstrations. These demonstrations provide practical experience, clarify the implementation process, and enable the application of newly acquired knowledge to projects.

2- Installing Arrowhead: Edge & Server Setup (34:10 minutes)²

In the second video, the prerequisites for installing the Arrowhead Framework will be discussed. This will include both hardware and software requirements to ensure complete preparation for the installation process. Following that, a step-by-step walkthrough of the Arrowhead installation process will be provided, including detailed instructions for setting it up on both edge devices and servers. The goal is to keep the installation process as simple as possible. Finally, the video will conclude with troubleshooting tips, covering common issues that might be encountered during the installation process and offering solutions to them.

3- Arrowhead Security: Certificate Management (42:25 minutes)³

In the third video, the significance of certificates in Arrowhead will be discussed. Certificates are critical for ensuring secure communication and data exchange within the framework. The video will cover why certificates are needed and how they contribute to the overall security architecture. Various types of certificates used in Arrowhead, including Master, Cloud, and client certificates, will be examined. Understanding these types is essential for successful certificate management. The video will conclude with a walkthrough of the steps for creating certificates.

4- Managing Arrowhead: Tools & Techniques (9:45 minutes)⁴

¹ <https://www.youtube.com/watch?v=Q1tYs6A6YYI&t=1s>

² <https://www.youtube.com/watch?v=DDWD1U5agjc>

³ <https://www.youtube.com/watch?v=805pcBUcsnM&t=4s>

⁴ <https://www.youtube.com/watch?v=tfkWW4PqOI0>

In the fourth video, the various management tools available in Arrowhead will be presented. These tools are designed to facilitate the configuration, monitoring, and maintenance of Arrowhead systems. The video will then discuss how to use these management tools effectively, including demonstrations and examples to illustrate each tool's capabilities in a practical manner. To conclude, a live demo of these management tools in action will be shown, providing firsthand experience with their application in real-world scenarios.

5- Arrowhead Local Cloud: Setup & Use (11:18 minutes)¹

In the fifth video, the concept of an Arrowhead Local Cloud will be explained. A Local Cloud is essentially a customized version of the Arrowhead Framework, often tailored to specific automation tasks. The video will then guide through the steps necessary to set up and run an Arrowhead Local Cloud, including configuration options, service registration, and orchestration procedures. Finally, several use cases where a Local Cloud can be beneficial will be examined, helping to understand the practical applications of deploying a Local Cloud in various industrial settings.

6- Provider Systems: Deployment Guide (19:11 minutes)²

In the sixth video, the deployment of a Service Provider System in an Arrowhead Local Cloud will be covered. A Local Cloud is essentially a localized instance of the Arrowhead Framework, often tailored for specific automation tasks. A Service Provider System is an application system that registers a specific service in the Service Registry and runs a web server to make the service available. The video will guide through the necessary steps to set up a Service Provider System in an Arrowhead Local Cloud.

7- Consumer Systems: Deployment Guide (7:36 minutes)³

In the seventh video, the setup of consumer systems and their interaction with provider systems will be discussed.

8- ActiveMQ in Arrowhead: Configuration (7:19 minutes)⁴

In the eighth video, the configuration and use of ActiveMQ for message queuing in an Arrowhead systems inter-cloud setup will be covered.

9- Arrowhead Intercloud: Setting Intercloud Rules (6:49 minutes)⁵

In the ninth video, the rules for inter-cloud interactions and the setup of service discovery across multiple clouds will be discussed.

10- Intercloud Demo: A Practical Guide (7:20 minutes)⁶

In the final video of this series, a demo for deploying an inter-cloud system will be shown, allowing all the pieces to come together.

¹ <https://www.youtube.com/watch?v=A7ovjY2lwDo>

² <https://www.youtube.com/watch?v=wjWabllUtkg>

³ https://www.youtube.com/watch?v=ZWijqoeD_AA

⁴ <https://www.youtube.com/watch?v=yv1O80dTvTg>

⁵ <https://www.youtube.com/watch?v=-QTvXDz0b9A>

⁶ <https://www.youtube.com/watch?v=aAFP5qw9N74>

7. Plans for next period

Future plans to finalize the "Skills Catalogue and Jobs Certification Program" process should encompass the following steps:

- Complete the databases of training activities by gathering comprehensive information from project partners (by workshops, interviews) (M19-M36)
- Conduct an analysis of success stories and approaches employed by DFs and Pilots to enhance their digital transformation. (M19-M36)
- Implement a second iteration of the methodology to analyze the TO-BE conditions and compare them with the AS-IS situations of DFs and Pilots. (M30 – M36)

8. Conclusion

The results of this deliverable present a comprehensive list of emerging skills and job requirements essential for the evolving landscape of digital transformation, AI, and AI on the edge. Furthermore, it prioritizes critical skills, assessing their necessity and availability within project Didactic Factories (DFs) and Pilots in the context of digital transformation and technological advancement.

Following a thorough review of previous studies in digital transformation, AI, market developments, and technological trends, along with the introduction of the 6Ps People Dimension Model (designed to support DFs and Pilots in defining their current level of digital maturity), ten job profiles related to "Data Science and AI Management" and "Data and AI Professions and Skills for Enterprise Industry 5.0" were developed. Additionally, two surveys were conducted: one to prioritize skills for each profile according to the conditions of DFs and Pilots, and another to analyze the current situation and future expectations regarding identified job profiles and skills.

An online voting survey garnered 23 responses from project partners, prioritizing the skills for each profile based on their importance. This survey also aimed to identify any irrelevant skills; however, feedback indicated that the assigned skills were largely accurate, and no eliminations were necessary for the next steps (second iteration).

The second survey, targeting all project DFs and Pilots, examined their current situation concerning the introduced jobs and skills. Analysis of the responses highlighted existing skill gaps. A significant outcome from this analysis was the consensus among DFs and Pilots that the most effective solutions to bridge these gaps include collaboration with project partners for upskilling and reskilling and utilizing training courses to enhance familiarity with new jobs and skills and improve current skill levels.

Given the importance of training courses in addressing job and skill gaps, a list of recommended training activities (from sources such as the Polimi Open Knowledge website, I4MS, Udemy, and others) was provided to DFs and Pilots. These activities were categorized by field of training and level of information provided (awareness, foundation, and extended know-how). Additionally, the workshop offered by LTU was detailed, noting its availability to both internal and external participants.

The second iteration of these surveys will be conducted in the final months of the project, with slight modifications to the survey content. This iteration will focus on evaluating future conditions and the effectiveness of the proposed approaches in closing the identified gaps.

In conclusion, this deliverable effectively addresses the objectives of task T7.2, "Jobs, Competences and Training Action Plan," ensuring a robust framework for enhancing AI-related skills and competencies on the edge.

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