D7.3 Testing and Experimental Facilities Network

Author:	Brainport Industries
Work Package:	WP7.2 Testing and Experimental Facilities Network
Delivery date:	28.03.2022
Due date:	31.03.2022
Classification:	PU

H2020 Innovation Action - This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N. 952003

Contents

Figures

Tables

List of acronyms and abbreviations

AAS	Assets Administration Shell
AGV	Autonomous guided vehicles
AI	Artificial Intelligence
AIC	Automotive Intelligence Centre
AR	Augmented reality
BIC	Brainport Industry Campus
CA	Competent Authority
CEN	European Committee for Standardization
CFD	Computer Fluid Dynamics
CGI	Common Gateway Interface
CI	Continuous Improvement
CMM	Capability Maturity Model
CNC	Computerized Numerical Control

CPPS	Computer Program Performance Specification
CPS	Cyber Physical Systems
DF	Didactic factory
DIH	Digital innovation hub
DR BEST	Data Remote Business Ecosystem Skills Technology
EDIH	European Digital Innovation Hub
EIT	Electronic Instrumentation and Technology
EL	Ethics & Legal
ERP	Enterprise Resource Planning
EWV	Europäische wirtschaftliche Interessenvereinigung
FAIR	Findability, Accessibility, Interoperability and Reusability
FEM	Finite Element Method
FEUP	Faculty of Engineering of the University of Porto
FSI	Fluid Structure Interaction
GDPR	General Data Protection Regulation
HF	Human Factors
HMI	Human Machine Interface
HPC	High Performance Computing
HRC	Human-Robot Collaboration
IDSA	International Data Spaces Association
IOT	Internet of Things
ISO	International Organisation for Standardisation
LEF	Lean Experience Factory
MES	Manufacturing Execution Systems
PLC	Programmable Logic Controller
RPA	Robotic Process Automation
SCADA	Supervisory Control and Data Acquisition
SPS	Sustainable Production System
SSF	Swiss Smart Factory
SWOT	Strength Weaknesses Opportunities and Threats
TEF	Testing and Experimental Facility
TERESA	Technical and Regulatory Sandboxes
UCP	Use Case Program
VR	Virtual Reality
WP	Work Package
WSN	Wireless Sensor Node

Table 1 Acronyms and abbreviations

Executive Summary

AI Regio WP7 "AI DIH exploitable assets", started in month 1 and is expected to last until month 36. The aim of this WP is to:

- To address regulatory and ethical issues derived from the full adoption of AI in Production Systems, via the development of technology-regulatory sandboxes in the different regions, supported by DIH facilities
- To particularly stress the People digital transformation pathway towards "AI for Manufacturing" by studying and analysing new skills / roles and by putting in place the proper training and education activities
- To integrate pan-EU Didactic Factories in Germany, Italy, France, Spain, United Kingdom, Finland, Switzerland and Greece towards a common education and training program targeting students and SMEs
- To carefully analyse the market of ICT solutions for DIHs and to position the AI REGIO exploitable assets with respect to the market and to the competition (e.g. marketplaces)
- To develop and implement a Joint Exploitation Strategy and common Exploitation Vehicle on the basis of regional smart specialisation strategies and funding / sustainability models

To address all the goals mentioned above four specific tasks are identified (WP 7.1 – WP 7.4). The current deliverable D7.3 "Testing and Experimental Facilities Network" is mainly related to the third bullet point.

To set the stage for collaboration within the AI REGIO consortium, this deliverable identifies, organizes and defines Testing and Experimental Facilities and introduces the network of Didactic Factories (DF). In collaboration with AI Regio partners a working definition for Didactic factories is formulated. This deliverable introduces the first wave of DFs part of the DF network. The first wave of DFs are called champions. The champion network consists of 10 Didactic Factories from 5 different countries. In the first phase the champions where identified and the network was created. In the deliverable the second phase for the champions is announced which is dedicated to disseminating knowledge across the network. Several suggestions are introduced in a Gantt chart to stimulate knowledge exchange. In the coming period those suggestions will be presented to the champions and the agenda will be finalized with the input of the champions. The service portfolios of the champions are presented according to the DR Best taxonomy.

Moreover, Technical and Regulatory Sandboxes (TERESA) for AI enabling a direct testing environment for innovative CI-empowered products and services aimed at addressing ethical challenges and shortcomings of the regulatory framework concerning such products and services are introduced. The TERESAs allow to test/experiment innovative AI applications/tools/services for CI-driven human-machine interaction by running experiments on a limited scale, in a secure, gradual and controlled way, as well as in real regulatory conditions and pursuant to a specific testing plan, including also the involvement of volunteers and of the Competent Authority (CA). AI REGIO through its network of Didactic experimental facilities, has already started the planning of the TERESAs, whose implementation relies on a "hands-on" bottom-up approach tailored to the specific needs of manufacturing. The first subset of 5 TERESAs are introduced with their initial ideas.

1 Introduction

To achieve the European Artificial intelligence strategy's aim to optimize development and deployment of AI, the European Commission introduced AI Testing and Experimentation Facilities in the Digital Europe program. Multiple initiatives arises in the field of AI and manufacturing. To set the stage for collaboration within the AI REGIO consortium, this deliverable identifies, organizes and defines Testing and Experimental Facilities and introduces the network of Didactic Factories.

1.1 About this deliverable

In the second chapter of this deliverable the terminology used to refer to Testing and Experimental Facilities is introduced and a working definition of didactic factories is presented. In the second chapter the AI Regio network of didactic factories is described and the motivation of didactic factories for joining the network is explained. Hereafter, the concept of Testing and Experimentation Facilities (TEFs) will be explained and the future ecosystem of TEFs will be elaborated on. Next, the current associated didactic factories of the AI Regio network will be introduced and the future action plan regarding the network will be explained. In chapter 4 the service portfolios of the didactic factories will be analysed through the DR Best methodology. Hereafter, in chapter 5 the concept of TERESA will be introduced along with examples.

2 Didactic Factories and Testing & Experimentation Facility

This document addresses the European Testing and Experimental Facilities network. In recent years, with the rise of Industry 4.0, several initiatives have started to accelerate innovation in the field of AI and manufacturing. These initiatives aim at sharing experiences among industry partners and providing education by universities to industrial companies, for example by creating local networks, making equipment available, and providing supporting services. To gain insight in such an initiative the next paragraph provides an example.

Initiated by Flanders Make from Belgium, Brainport Industries from The Netherlands and SmartFactory-KL from Germany, SmartFactoryEU EWIV was founded in September 2019 as an association based on EU law. Within the EU, the desire has been expressed since 2017 to place the numerous smart manufacturing activities in member states under one roof. The goal is to strengthen Europe's position on the world market. The founding members have defined the following aims and values for the organization. Goal is to strengthen the European ecosystem and to become the frontrunner in manufacturing:

- Connecting manufacturing and digital transformation research and demonstration centers
- Being their common voice towards the EU
- Sharing and promoting a common vision and roadmap to enable and speed up "Industry 4.0 adoption"
- Serving as a reference for the future of sustainable, inclusive and climate neutral manufacturing
- Supporting the creation of digital talents

SmartFactoryEU appointed six focus points in order to strengthen the position of Europe on the world market, especially in times of crises like the current COVID-19 pandemic:

1. **Accelerate digital transformation**
   An acceleration in the digital transformation of products and production environments is needed and, more specifically, the digitization of all processes along the supply chain must be pushed forward. Industry 4.0 approaches provide a solid framework for this digital transformation, but many companies are just at the start of their transformation journey to Industry 4.0. Smart manufacturing, invented in Europe, must be broadly installed in the European industry, in both large corporations and SMEs. Yet industrial companies of all sizes still face significant challenges to adoption. Slow decision making is hindering Industry 4.0 implementation in large corporations, while SMEs typically have fewer financial resources and think more short term, so are lagging behind in their own transformation efforts. Yet the internet has made both the corporate and the consumer worlds more global for all these companies. That has increased the pressure and the importance of highly efficient and high-performing manufacturing environments to remain competitive, and has made the need for urgent action critical to future success.

2. **Strengthen networks of suppliers**
   We need to strengthen our networks of suppliers. That involves three key elements: working with multiple suppliers to ensure continuity amid disruption; building closer collaboration with suppliers and customers for better and faster product design and more effective production environments tailored to needs; and finally, strategies that are able to cope with high wages by creating flexible, agile, lot size 1 manufacturing environments based on the latest digital technologies. This will not only make it easier to setup agile production processes but also help SMEs to connect and learn from the frontrunners.

3. **Harness research and innovation**

We must support these changes by harnessing Europe´s research knowledge. Europe already has strong leaders in the research sector and by rapidly transferring research results into industrial applications we can help support successful industrial conversion. This accomplished tradition of innovation is of paramount importance to making the leap to a new world of manufacturing. Only the best is good enough and the majority of companies have to become frontrunners or fast followers in this process. For this reason, it is important to (1) connect research institutes to industrial companies, (2) foster collaboration between research institutes, (3) encourage companies to participate in local industrial networks, and (4) create strong local digital transformation ecosystems that can positively impact the economy and the well-being of the companies involved.

4. **Create agile, fast learning, data rich businesses**
   We need to create agile, fast learning organizations, production environments, and businesses that can take full advantage of all the means that digitalization has to offer. This means: (1) embracing connectivity and new communication networks to help create large data lakes enabling data driven business models, (2) rethinking business models that better fit the current market and customer needs, (3) maximizing the use of automation to create adaptable production environments based upon the use of data, and by employing algorithms to support decision making and create actionable intelligence about manufacturing environments processes and beyond, and (4) last but not least, creating an environment in which humans can work together comfortably, safely, and productively with machines.

5. **Build digital talent and digital cultures**
   A new focus on strengthening digital talent and establishing digital cultures in companies will be needed to fully capture the benefits of the transition to digitally enhanced manufacturing environments. The war for talent is still going on and the efficient use of those talents will be needed to cope with any shortages. To this end, creating a digital culture in companies will be instrumental for acceptance, faster adoption, and the successful roll-out of digital technologies. Human-machine interaction will continue to increase on the shopfloor as humans are still the most flexible and agile of resources, driving the need to create more sustainable, flexible, human-machine manufacturing environments for the future.

6. **Deliver the European Green Deal Plan**
   Companies and research institutes should advocate, support, and help drive the roll out and realization of the European green deal plan. Actions that actively increase sustainability, a manufacturing industry able to manage an intermittent green energy supply, climate neutral manufacturing strategies, enabling a circular economy, minimizing and optimizing energy, and reducing the use of natural resources wherever possible, need to be fundamental aspects of every innovation or digitalization trajectory to ensure that the European industry makes the maximum contribution to advancing both regional and global environmental sustainability. To support this goal, we propose a coordinated activity to install environmentally conscious European production networks to set a leading example of sustainable industrial best practices in action.

SmartFactoryEU aims at creating a network of manufacturing partners within Europe. They believe that as a community Europe is stronger than 27 individual countries. This joint initiative is designed to harness the power of that community to strengthen the European innovation ecosystem as a global leader in advanced 21st century manufacturing by:

- connecting manufacturing and digital transformation research and demonstration centers
- providing a unified and cohesive common voice towards the EU
- sharing and promoting a common vision and roadmap to enable and accelerate Industry 4.0 adoption
- connecting people and key players across borders within Europe

- sharing best practices between actors of different regions to accelerate the take-up
- serving as a reference point for the future of sustainable, inclusive, and climate neutral manufacturing
- supporting the creation of digital talent across the region

Different labels have been used to refer to such initiatives, including the labels Digital Innovation Hubs and Didactic Factories, that we will use in this document. Other related labels are Learning Factories and Teaching Factories.

In this introductory chapter, we set the state of play for this document. We introduce the terminology that we use to refer to the Testing and Experimental Facilities (Didactic Factories). And we loosely define what we mean by the concept of a Didactic Factory.

Next, we describe what a network of Didactic Factories can be and how it can bring value to the different Didactic Factories in Europe.

2.1 Didactic Factories: Definition

To set the stage for collaboration within the AI REGIO consortium, it was necessary to find a working definition of a 'Didactic Factory'. During preliminary meetings between partners it became clear that there was a lot of confusion around the topic of Didactic Factories. Furthermore, looking at other European initiatives there are a lot of concepts being used and mixed together, for example: TEFs, DIHs, EDIHs, Learning Factories, etc. To avoid further confusion on the topic, the following paragraph will illustrate how the project came to the current working definition and what current working definition is being used. This has be done through three methods: 'Research', 'Collaboration & Communication', and 'The Golden Circle' method.

2.1.1 Research

In the last decade, the concept of Learning Factories or Didactic Factories started to arise and spread, especially in Europe, both in industry as well as in academia to support education, training and innovation in manufacturing[1].

Abele et al. (2015) give a clear description of the basic concept of Learning Factories. They state that a Learning Factory addresses both words of the term: It should include elements of learning (and teaching) as well as a production environment. The term learning as opposed to teaching emphasizes the importance of learning by doing which leads to greater retention than following lectures. Learning factories provide a reality-conform production environment for students to learn in.

Abele et al. (2015) further make a distinction between Learning Factories in the narrow and Learning Factories in the broader sense. The latter are further away from reality and less hands-on but offer advantages regarding the scalability and location independence. In a Learning Factory in the narrow sense students and factory personnel can learn about the production of a physical product on-site. In a Learning Factory in the broader sense, the product can be a service, or the representation of the product can be virtual.

Didactic Factories take the services of Learning Factories and extend this with services related to drive innovation. As such, the purpose of Didactic Factories is mainly twofold: competency development of students and factory personnel and driving innovation. To allow driving innovation Didactic Factories can also function as a bridge between the Manufacturing SMEs and universities or technology providers.

---

[1] Abele, E., Metternich, J., Tisch, M., Chryssolouris, G., Sihn, W., ElMaraghy, H., Ranz, F. (2015). Learning factories for research, education, and training. Procedia CIRP, 32, 1-6. doi:10.1016/j.procir.2015.02.187

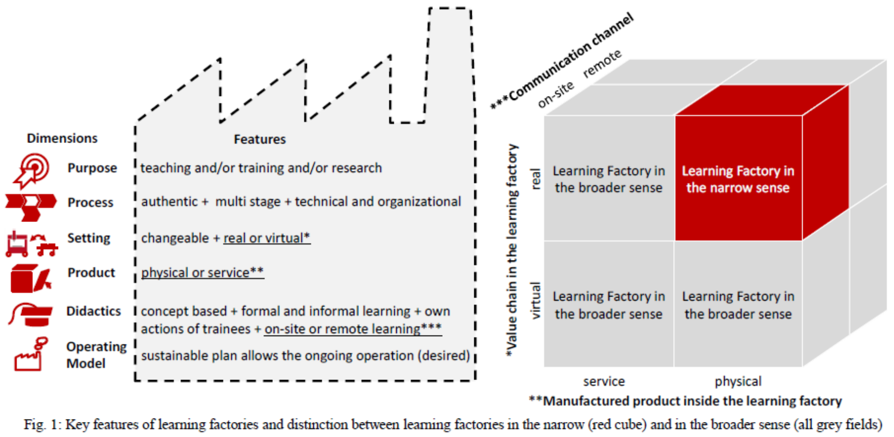


Figure 1 Learning factory

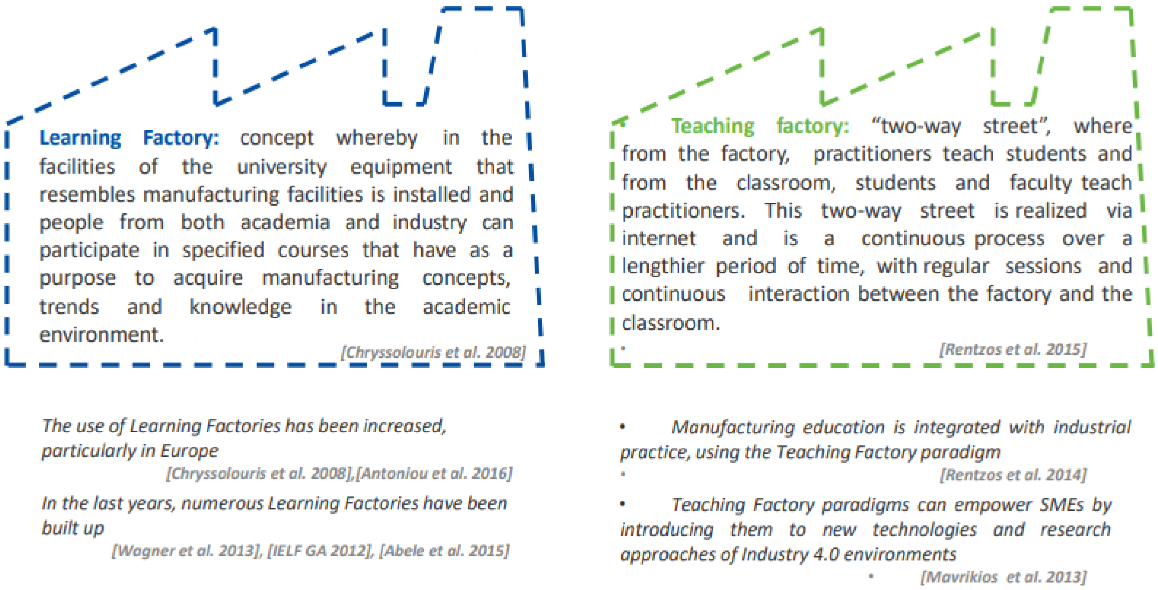


Figure 2 Learning factory vs Teaching factory

Like Learning Factories, Didactic Factories can be both organized around a physical product or around a service, and the learning can take place on-site or virtually. However, due to the experimentation aspect, Didactic Factories are more likely to be on-site (and hence of the narrow kind). The didactic factory typically offers means and spaces to companies to allow experiments with new products or production methods. Thus, these companies can test before they invest and run lower risks in their innovation activities.

2.1.2 Collaboration & Communication

As stated in 5.2.1, there was a lot of confusion around the topic of Didactic Factories inside and outside the AI REGIO consortium. Therefore, the following question had to be asked: *''How do partners and other members perceive a Didactic Factory?''* With these insights it helps understand the role and position of a DF in a business context.

The input for this question has been gathered through: Extensive communication between partners of AI REGIO, Surveys and Workshops, and by using other examples of prominent learning examples like the Competence Centre Kaiserslautern in Germany.

1 Survey result review

5 minutes

		CNR	EURECAT	ART ER	COMET	GUALINI	INESCTEC	POLIMI	BRAINPORT	PAPER
WHAT / HOW	**Factory**	Pilot factory	Space	Facility	Laboratory / space	on site	Place	Laboratory	Experimentation facilities	• On real industrial sites; • Real value chain for a physical product (narrow sense)
	Didactic (by doing)	Learn by doing	learning and experimentation	Train operators ; making use of real machines	Learning environment	learning environment	where people can learn		where people develop skills and knowledge	• Experimental learning • Learning by doing
	Real life environment	Real industrial application		next to real conditions	real-like environment		hands-on experience with technologies	An environment to test before using		Reality conform production environment as learning environment
	Research			Enhance R&I	research activities			Mainly in the context of R&I		
WHY	**Innovation**		New technologies		face industry 4.0 challenges	face industry 4.0 challenges	face industry 4.0 challenges	new digital technologies; industry 4.0		goal is innovation (if used for research)
	Competency development	Make available to student and personnel theoric and technical skills			Reskill / Upskill	Reskill the competences	Perfectionate digital skills	education support	higher levels of digital skills in SMEs	or competency development (if used for education and training)

Figure 3 Survey results DFs

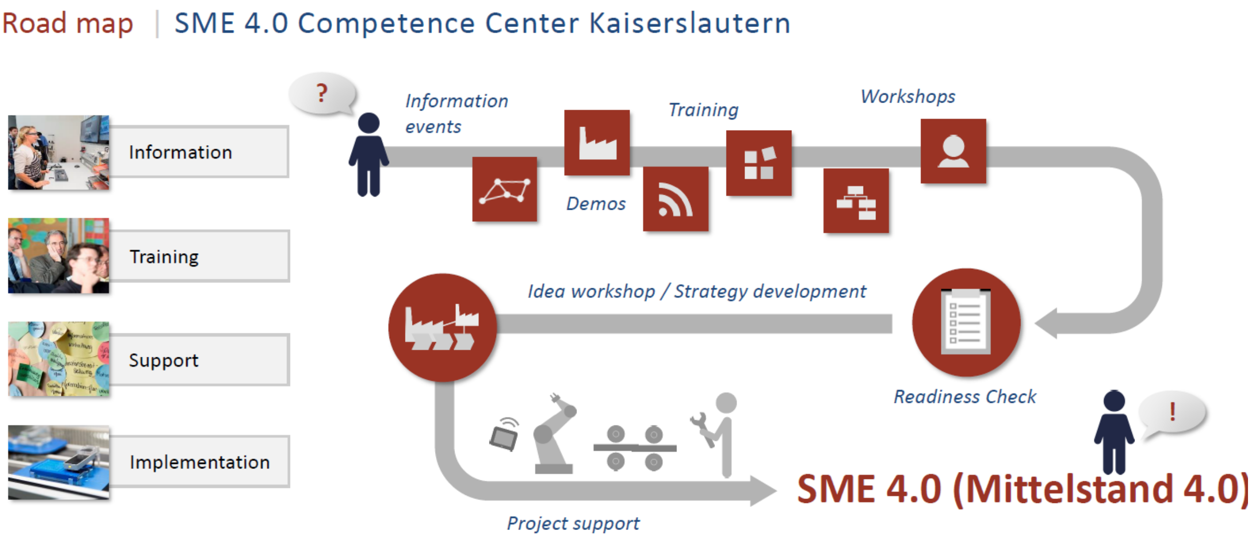


Figure 4 SME 4.0 Competence Center Kaiserslautern

2.1.3 The Golden Circle Method

With the 'Golden Circle' method we have looked at the purpose of a Didactic Factory within the AI REGIO project. Commonly used in marketing practices, this method helps to truly understand the value proposition of a product or service. In this case: a Didactic Factory and its purpose. The following dimensions of a Didactic Factory have been identified:

Why: A DF aims at developing practitioners' competencies and introducing innovation, and also at providing training to students. DFs also function as a bridge between the Manufacturing SMEs and universities or technology providers.

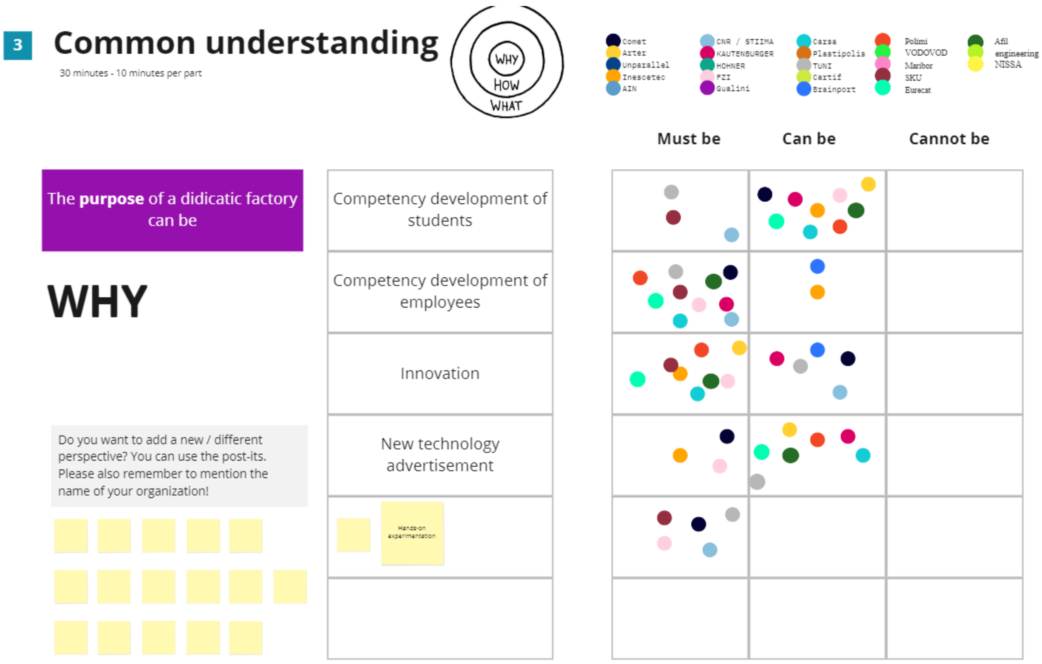


Figure 5 Golden circle method: Common understanding

How: A DF is based on a physical location and might provide virtual tours of its premises and equipment. A DF consists of elements of learning (and teaching) as well as a reality-conform production environment.

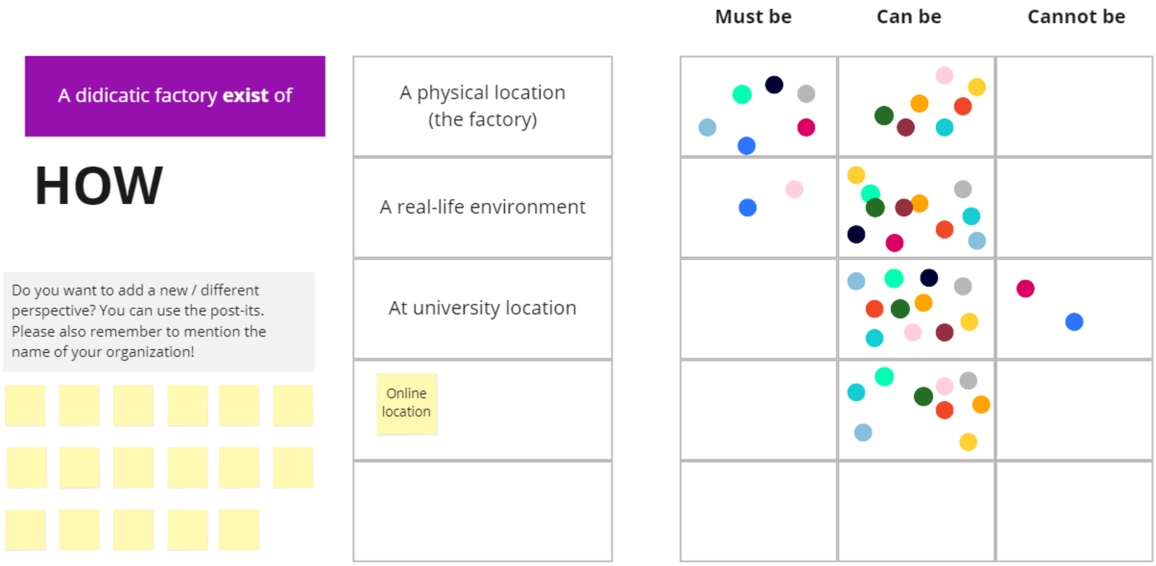


Figure 6 A didactic factory exists of

What: A DF offers training and education by ‘learning by doing’ and class-room methods, and with its hardware and software assets can perform testing and experimentations.

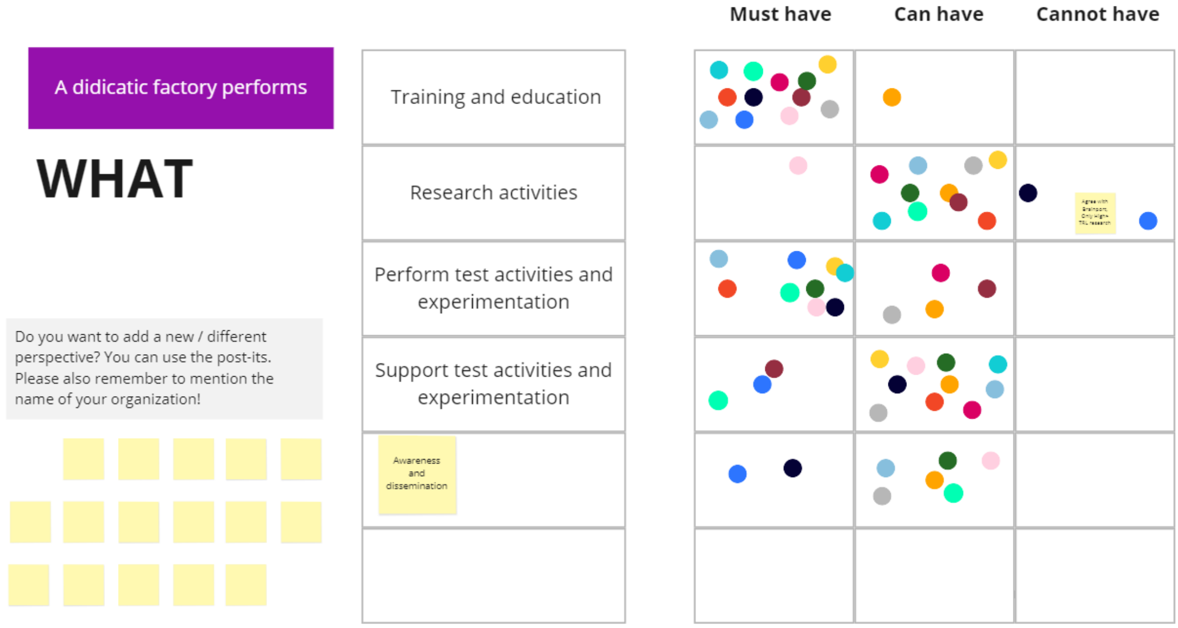


Figure 7 A didactic factory performs

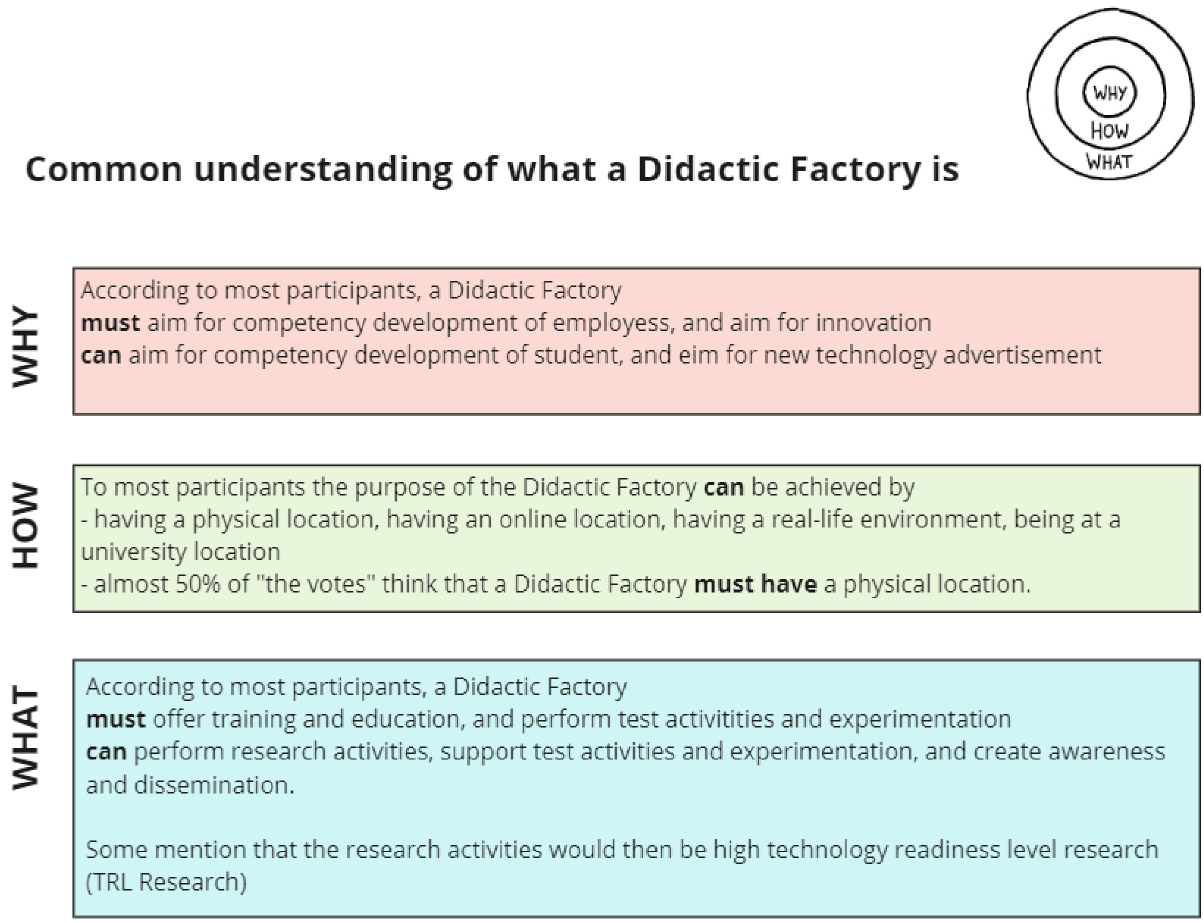


Figure 8 Common understanding of what a didactic factory is

2.2 Didactic Factories Network

In this chapter the purpose of a Didactic Factories Network will be explained. There will be a focus on the motivation of Didactic Factories for joining such a network. Looking at the reason(s) for possible joining such an initiative helps us better understand the overall goals and needs of the participants. It helps us define what the actual network should entail. For this we also take inspiration from other examples within the European Union with same premise as the network we aim to create.

2.2.1 Motivation

Currently, at different places in Europe, Didactic Factories have started. As a new type of initiative, they are facing new challenges. To prevent reinventing the wheel and instead learn from each other, it is useful to set-up a European network of Didactic Factories. Other benefits from such a network could be the sharing of resources such as people and data.

Currently interested didactic factories mention expected benefits along three axes:

- **Broadening the offer**
  Specific didactic factories may have specific offerings. In some cases, customers of one specific didactic factory may be looking for a service that is not offered by that didactic factory. To be able to still serve these customers, it would be beneficial to be able to redirect customers to other didactic factories in the network that do offer the required service. This would in effect broaden the portfolio of each of the didactic factories in the network.
- **Cooperation**
  Some different didactic factories may offer the same or at least similar services to their individual customers. In those case, it can beneficial to share tools and competences. In general, being able to share capacity for tools and people will result in lower long-term cost for both parties.
  Along the same lines, network members may share material such as assignments and study cases.
  Also, if several different network members identify similar demand for services from their individual customers, they may together develop these services or material used in the services, such as learning tools.
- **Mutual learning**
  The concept of being a didactic factory is relatively new. All didactic factories are facing learnings in their start-up years. And probably also in later stages. For network members, it would be very useful to learn from best practices and less successful actions of other members. For example, they could share which services are successful, and what made them successful. And which obvious mistakes to avoid.

2.2.2 Inspiration

In order to explain and broaden the understanding of the concept of a Didactic Factory Network we aim to create within AI REGIO, we will be zooming in on other projects involving several of these Learning Factories.

2.3 Testing and Experimentation Facility: definition

To achieve the European Artificial intelligence strategy's aim to optimize development and deployment of AI, the European Commission introduced AI Testing and Experimentation Facilities (TEFs) in the Digital Europe program. Moreover, it is important to understand what TEFs actually are. The large-scale reference TEFs will offer a combination of physical and virtual facilities, in which technology providers can get primarily technical support to test their latest AI-based software and hardware technologies (including AI-powered robotics) in real-world environments. This will include support for full integration, testing and experimentation of latest AI-based technologies to solve issues/improve solutions in a given application sector, including validation and demonstration. They will focus on testing mature AI–based technologies and solutions that have already been tested in the labs, and have to be tested in real-world environments.

TEFs seek to support technology providers with the necessary expertise to integrate and validate their solutions in the TEFs, but we also expect TEFs to involve end-users of the technologies to maximise its impact (in particular end-users can be involved in defining testing scenarios, protocols and metrics, most relevant and impactful to their sectors).

2.3.1 AI TEF for Manufacturing in the Digital Europe Program

TEFs will be an important part of building the AI ecosystem of excellence and of trust in Europe as laid out in the AI White Paper from February 2020. On the one side, TEFs will give regions a further boost in attracting funding to upgrade its facilities and also attracting innovative players to collaborate with its own champions. On the other side, TEFs will contribute to more trustworthy AI made in Europe.

To optimise investment, the Commission foresees to co-fund (through Digital Europe Programme) with Member States a limited number of specialised large-scale reference sites to serve the needs of European technology providers. The TEFs will focus on four sectors – manufacturing, healthcare, agri-food and smart cities and communities – as well as on edge AI as a technology. TEFs can also support regulatory sandboxes by setting up a dialogue with competent national authorities for supervised testing and experimentation under real or close to real conditions.

Under the Digital Europe Programme (DIGITAL), the European Commission expects to open calls for proposals to fund AI Testing and Experimentation Facilities (TEFs) in February 2022. These TEFs will be in the sectors of agri-food (€30 million), healthcare (€30 million), manufacturing (€30 million) as well as smart cities and communities (€20). These calls will be co-funded equally at EU and Member States level. The European Commission foresees one large-scale project of €40 - €60 million overall funding per sector, each of them requiring a consortium of several testing facilities across Europe.

2.3.2 A precursor network for AI TEF for Manufacturing

AI TEF for Manufacturing will in the future fulfil a similar role as AI Regio. AI Regio aims to create a network which facilitates cooperation between DFs. Moreover, allow exchanges of resources, best practices and lessons learned. While AI Regio also aims at collecting and sharing manufacturing data spaces (metadata, ontologies, datasets) to be used for didactic purposes all over Europe. On the other side, TEFs will play an important role in providing regions a boost and attract innovative players to collaborate with. TEFs will also be an important part of building the AI ecosystem of excellence. To summarize, both AI Regio and AI TEF for Manufacturing have didactic purposes.

Therefore, AI Regio can function as a precursor network for AI TEF for Manufacturing. The AI Regio network, additional services and assets can be used to develop AI TEF for Manufacturing. Moreover, AI Regio also has the ambition to function as a precursor network.

3 AI REGIO and its Network of Didactic Factories

In this chapter the current Didactic Factories within the AI REGIO network will be presented. First off, the 'First Wave of DF Champions' will be introduced. Followed by the addition of several more Didactic Factories that have expressed interest in joining the network in later instances.

3.1 AI REGIO First Wave of Didactic Factory Champions

To start the creation of a network of Didactic Factories within Europe we have firstly looked at the consortium partners for input. The following champion Didactic Factories have been identified within the AI REGIO consortium:

DF Name	AI REGIO Beneficiary	Location
Brainport Industries Campus	10-Brainport_IND	Eindhoven, The Netherlands
Radboud Industrial Sustainability	12-SKU	Nijmegen, The Netherlands
LIAM Lab	15-ART-ER	Bologna, Italy
MUSP Lab	15-ART-ER	Piancenza, Italy
Lean Experience Factory	18-COMET SCRL	San Vito al Tagliamento, Italy
Tampere Robotics Didactic Factory	13-TAU	Tampere, Finland
I4.0 LAB	23-CARSA	Bilbao, Spain
SMILE	29-IMECH	Parma, Italy
Industry and Innovation Lab	14-INESC TEC	Porto, Portugal
Smart Lab	29-IMECH	Bergamo, Italy

Table 2 Didactic factory champions

In order to visualize the current coverage throughout Europe, a PowerBI dashboard has been created to monitor this. Furthermore, through this visualization its easier to see where gaps exist and where the project requires more input or effort. The following image represents this dashboard:

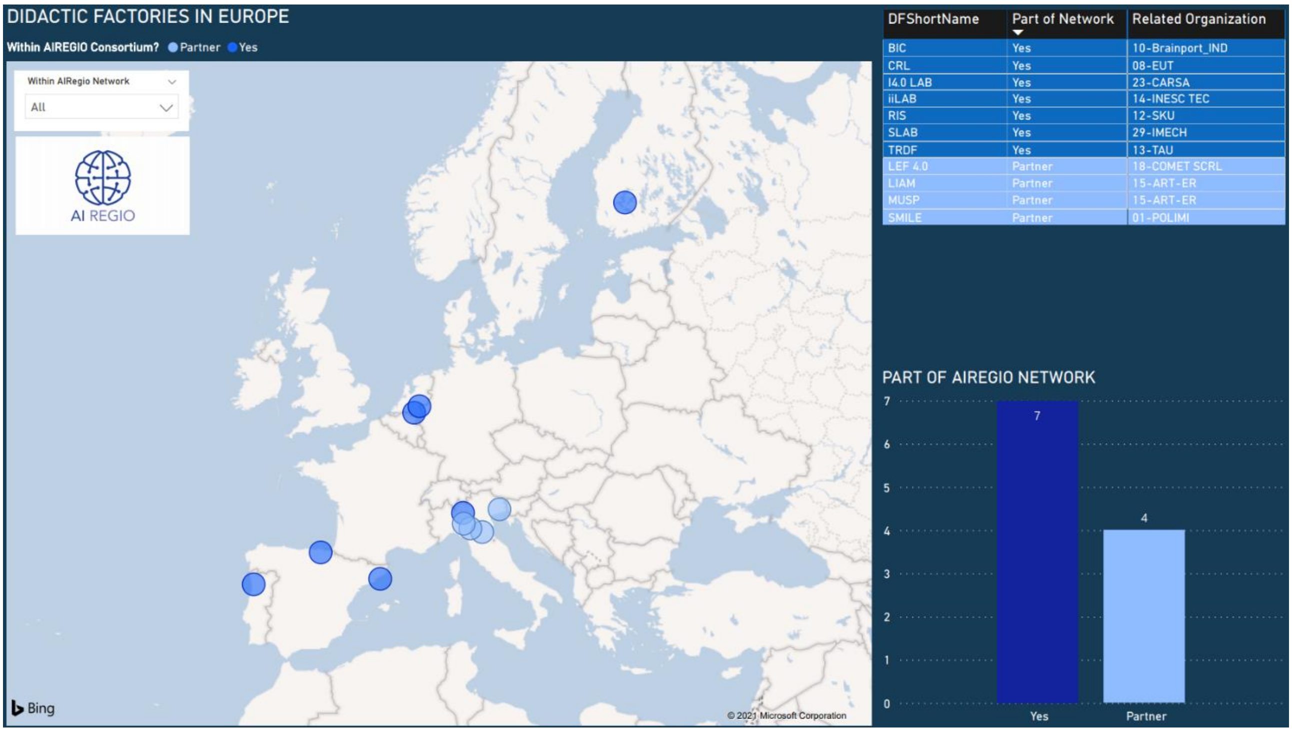


Figure 9 Didactic Factory Network PowerBI Dashboard

3.1.1 Didactic Factory 1: ‘Brainport Industries Campus’

Figure 10 Brainport Industries Campus (Eindhoven

Location: BIC 1, 5657 BX Eindhoven, The Netherlands

Website: https://www.brainportindustriescampus.com/en/

AI REGIO Beneficiary: 10-Brainport_IND

Contact Point: John Blankendaal | j.blankendaal@brainportindustries.nl

Short Summary: From presentation rooms to machine park and anything in between. To facilitate innovation, the campus has everything under a single roof and it offers all the facilities to create a pleasant production and business climate. The BIC has a close connection with the Digital Innovation Hub SOUTH-NL.

Current Experiments / Field Labs:

- ‘Flexible Manufacturing’:
    - Flexible production and assembly solutions
    - Focus on robotization of manufacturing processes
- ‘Multi Material 3D’:
    - Research Pilots with a focus on automation for multi-industry 3D applications
- ‘High Tech Software Cluster’
    - Focus on AI, ML, Big Data Analytics, Data Services, Industrial 5G, Industrial IOT, and Wireless Communication
    - Virtual Prototyping and Design
- ´Smart Connected Supplier Network
    - Platform for information exchange in supply chains
- ’FutureTec’:
    - The development of educational content
    - Implementation of innovative technical education in the region

3.1.2 Didactic Factory 2: 'Radboud Industrial Sustainability'

Figure 11 Radboud Industrial Sustainability

Location: Radboud Universiteit Nijmegen, Faculty of Science, Heyedaalseweg 135, 6525ED Nijmegen, the Netherlands

Website: https://www.ru.nl/english/

AI REGIO Beneficiary: 12-SKU

Contact Point: Geert Postma | g.j.postma@science.ru.nl

Short Summary: A new initiative from the Radboud University, where education through lectures meets actual practical application within the manufacturing scope. There is no industrial facility as of yet, but building plans are currently in full effect. The (coming) Didactic Factory has a close connection with the Digital Innovation Hub OOST-NL.

Current Experiments / Field Labs:

- Courses (e.g. Industrial Chemistry, Handheld Spectroscopy in Industrie, Data protection, Data architecture)
- Master track 'Science, Management and Innovation / Green Information Technology'
- Fieldlab for companies to (co-)develop AI software
- Projects, partly publicly funded, to develop AI applications with manufacturing-, chemical- and food industry
- Radboud Centre for Green IT
- Also Ecosystem and Business support.

3.1.3 Didactic Factory 3: 'LIAM Lab'

Figure 12 LIAM LAB

Location: LIAM LAB - via Piero Gobetti, 52/3 - 40129 Bologna – Italy

Website: https://www.liamlab.it/

AI REGIO Beneficiary: 15-ART-ER

Contact Point: Matteo Sartini | info@liamlab.it

Short Summary: LIAM LAB (also known as CONTRAI LAB - AI-enhanced machine controlling strategy Laboratory: quality, maintenance, automation improvement) is an industrial research laboratory born from the experience of leading companies in the automatic machine market.

Current Experiments / Field Labs: The AI-enhanced machine controlling strategy Laboratory will be able to provide services to SMESs in order to implement the collection, elaboration, analysis of Data from production lines, and the definition of AI-enhanced controlling strategies. A particular focus will be on manufacturing SMEs. Training activities for operators are foreseen. It will be deployed on an inter-regional, geographically distributed form, with a central coordinating hub located in Emilia-Romagna.

3.1.4 Didactic Factory 4: 'MUSP Lab'

Figure 13 MUSP LAB

Figure 14 Machinery MUSP LAB

Location: MUSP Consortium - Strada Torre della Razza – 29122 Piacenza, Emilia-Romagna, Italy

Website: https://www.musp.it/

AI REGIO Beneficiary: 15-ART-ER

Contact Point: Massimo Goletti | info@musp.it

Short Summary: MUSP, a research center applied to manufacturing, is also part of the Tecnonet network(www.tecnonet.eu) capable of guaranteeing the entire development and engineering chain of a product. The role of MUSP in Tecnonet is to develop technological solutions capable of minimizing the problems in the construction phase and during the use of production plants in order to drastically reduce the typical trial & error loop that embraces design and prototyping / production.

Current Experiments / Field Labs: The Cooperative Robots, Machines and Production Lines Facility Laboratory will be able to provide services to SMESs in order to implement AI-enhanced cooperating machines and robots, able to interact with the operators in a profitable way in terms of safety, production rates, operators' health. A particular focus will be on manufacturing SMEs. Training activities for operators are foreseen. It will be deployed on an inter-regional, geographically distributed form, with a central coordinating hub located in Emilia-Romagna.

3.1.5 Didactic Factory 5: 'Lean Experience Factory scarl'

Figure 15 Lean Experience Factory'

Figure 16 Lean Experience Factory (2)

Location: Via Casabianca, 3, 33078 Zona Industriale Ponte Rosso, San Vito al Tagliamento – Pordenone (Region: Friuli Venezia Giulia, Italy)

Website: http://lef-digital.com/

AI REGIO Beneficiary: 18-COMET SCRL

Contact Point: Lorenzo Ava | lorenzo.ava@lef-digital.com

Short Summary: LEF is a model company with real machines, products, and operators which serve as… a unique environment for delivering hands-on capability building, a test base for piloting and scaling up innovative solutions, a go-to place for learning from leading technology players, and research institutions. LEF helps you drive the next level of performance improvement and build the required technical, management, and people skills needed to achieve world-class operations – be it in introducing lean management principles or by capturing the value from state-of-the-art digital and analytics solutions. Our motto is: *explore, try, and apply.*

Current Experiments / Field Labs:

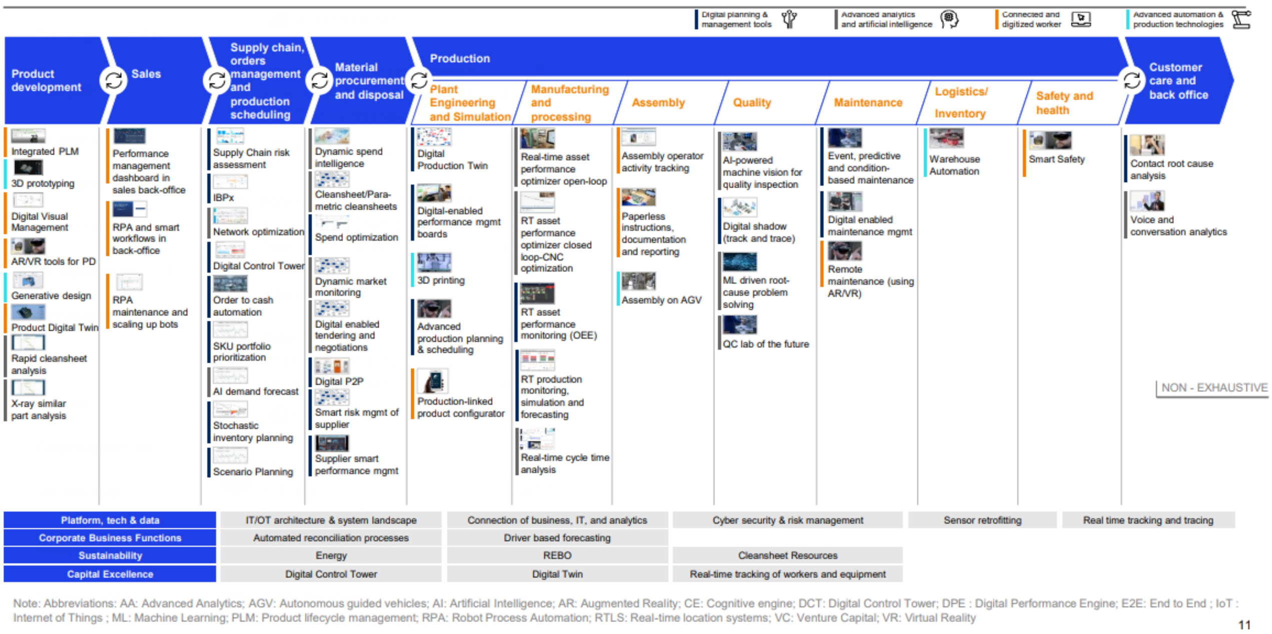


Figure 17 Experiments LEF'

3.1.6 Didactic Factory 6: 'Cognitive Robotics Laboratory'

Figure 18 Eurecat's Robotic Didactic Factory: 'Cognitive Robotics Laboratory

Location: Av. Universitat Autònoma, 23, 08290 Cerdanyola del Vallès, Barcelona (Spain)

Website: https://eurecat.org/en/field-of-knowledge/robotics-automation/

AI REGIO Beneficiary: 08-EUT

Contact Point: Mireia Dilmé i Martínez de Huete | mireia.dilme@eurecat.org

Short Summary: The Didactic factory is located in an innovation hub in Barcelona (Spain). It is located in the Parc Tecnològic del Vallès area, well-connected to the industrial companies around the area.

Current Experiments / Field Labs:

- Technology benchmarking experiments to compare components performances
- Feasibility studies to check/test the technical feasibility of the most critical part of a solution for a company using available components
- Proof of Concept, Test-before-invest type of experiment to conceptualize a full solution and test the estimated performances of a robotic system design at a reduced scale and controlled operational conditions. Possibility to borrow components from providers.
- Piloting solutions, Test-before-invest type of experiment to assess the operations, performance and cost of a solution with real components and in realistic conditions at 1:1 scale. Possibility to borrow equipment and components from providers.

Figure 20 Cognitive Robotics Laboratory Setup

Figure 19 Cognitive Robotics Laboratory

3.1.7 Didactic Factory 7: 'Tampere Robotics Didactic Factory'

Figure 21 Human-Robot-Collaboration Pilot Line

Location: Finland, Pirkanmaa, Tampere, 33520

Website: https://www.tuni.fi/en/research/research-tampere-university

AI REGIO Beneficiary: 13-TAU

Contact Point: Minna Lanz | minna.lanz@tuni.fi

Short Summary: The developed environment supports both formal and non-formal education and industry-academy collaboration in research. From the education perspective the robotics learning environment was developed to facilitate the learning process and to allow different robotics projects originating from industry to be carried out. From the society's perspective the accessibility and visibility to the environment was made as easy as possible yet ensuring the safety of the users. (*There are two main facilities, namely: Robolab Tampere and Human-Robot-Collaboration Pilot Line.)*

Image 12 Experiments Tampere Robotics Didactic Factory

Current Experiments / Field Labs:

- BSc theses with industrial robotics and signal processing, MSc level education: Phenomena based and highly problem-solving oriented laboratory courses with industrial case problems and modern industry robots.
- Hand movement tracking with depth sensors and motion duplication with robot arm, Learning motion generating dynamical systems from human demonstration, Evaluation of Human-Robot Collaboration (HRC) in light-weight assembly task.
- Vision-Based Mobile Manipulation, Vision based safety system in HRC.
- Feasibility testing of HRC capabilities, feasibility test on manipulation of small and flexible parts, Technology transfer.

3.1.8 Didactic Factory 8: 'I4.0 LAB'

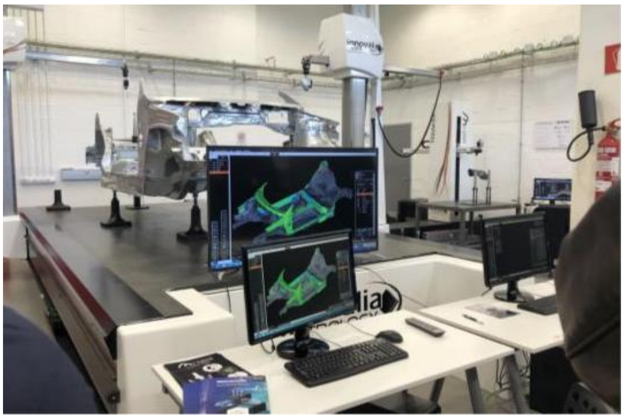


Figure 22 INNOVALIA METROLOGY Didactic Factory (I4.0 LAB)

Location: Parque Empresarial Boroa, P2-A4, 48340 Amorebieta-Etxano, Biscay, Spain

Website: https://www.innovalia-metrology.com/

AI REGIO Beneficiary: 23-CARSA

Contact Point: Alicia González | agonzalez@innovalia.org

Short Summary: The mission of the Didactic Factory by Innovalia consists on ensuring that every partner can fully benefit from digital opportunities (Technical support, Infrastructure, Trainings, Market intelligence…) on the following competences: Industrial IoT & CPPS, Metrology 4.0, Zero Defect Manufacturing, Business Digitization, Big Data & 3D Mobile Visualization, Cybersecurity and Digital Trust. As the Didactic factory is immersed in the Automotive Intelligence Centre (AIC), a strong network of international partners in the Automotive Sector has been built and several collaboration activities have taken place: Joint projects and long-term collaborations between the centre partners at regional, national and international level. Experiments carried out in several collaborative H2020 Projects, such as: SERENA; Z-BRE4K; BOOST4.0; BEinCPPS; L4MS; MIDIH; CAXMAN; QU4LITY; etc. ASF, the Automotive Smart Factory, at the Automotive Intelligence Center (AIC), is a joint collaborative laboratory with equipment and services provided by many partners, whose main goal is to cover the whole automotive manufacturing value chain for Demonstration purposes.

Current Experiments / Field Labs:

- An experiment took place between September and December 2021 regarding 5G connection at the Innovalia Metrology Didactic Factory. A series of enhancements have been developed in order to be able to operate a horizontal-arm-type Vulkan CMM equipped with an optical scanner, and a series of tests of wireless remote operation will take place.
- As part of the work at the Didactic Factory, Innovalia is also contributing to the International Data Spaces Association (IDSA) paradigm of trusted and secure data sharing, and is carrying currently experiments with various public and private agents in order to create a market ecosystem of trusted industrial data sharing.
- Experiments on machine state monitoring and predictive maintenance, in order to ever-improve and guarantee the best usage experience to the customers of the CMM machines manufactured by Innovalia Metrology, with the objective of, for instance, predicting when the air bearings of the machines would need a remanufacturing operation or replacement.

3.1.9 Didactic Factory 9: ‘SMILE’

Figure 23 SMILE Facility

Location: Red Kilometer, Gate 5 - Via Stezzano n. 87, 24126 Bergamo, Italy

Website: https://www.serviziconfindustria.it/it/servizi-confindustria-bergamo-srl/il-laboratorio-smile

AI REGIO Beneficiary: 29-IMECH

Contact Points: info@serviziconfindustria.it

Short Summary: SMILE – ‘’Smart Manufacturing Innovation Lab for Enterprises” is a project born from the collaboration among Kilometro Rosso, Confindustria Bergamo, Servizi Confindustria Bergamo, ITIS Paleocapa Bergamo, and with the co-financing of MIUR: a synergy between entities engaged in training, innovation and in education on the one hand and the business world on the other, which, starting from the concrete case-study linked to the digital factory, has created an innovative advanced training model.

The aim is to rekindle the interest of young people in the technical-scientific disciplines and steer them into a successful professional future as well as to carry out continuous digital training for those who are already operating in companies. This is the mission of SMILE, a collaboration platform that aims to establish a constructive and coherent dialogue among schools, universities, ITS (it will be the Laboratory of ITS Lombardia Meccatronica), associations, companies, and research and technology transfer centers.

Supported by Confindustria Bergamo and Confindustria Bergamo Servizi, which will coordinate the space management, it will operate, with the collaboration of some technological partners, in different areas: PLC programming, Virtual Commissioning, HMI, Industrial Automation, Robotics, Vision Systems, Analysis of production flows, Big data, 3D printing.

Current Experiments / Field Labs:

- Orientation to technical-scientific disciplines and contrasting early school leaving for secondary school students, thanks to NAUTILUS @ SMILE - the network of laboratories centered on the campus of the ITIS Paleocapa and ISIS Natta technical schools;
- Advanced training of teachers in advanced laboratory teaching of ITS and universities;
- Continuous training for workers' Upskilling and Reskilling, through skills development activities on the Smart Factory.

3.1.10 Didactic Factory 10: 'iiLab: Industry and Innovation Lab'

Figure 24 Robot Arm (iilab, Inesctec)

Location: INESC TEC, Campus da Faculdade de Engenharia da Universidade do Porto Rua Dr. Roberto Frias 4200-465 Porto Portugal

Website: https://www.inesctec.pt/en/laboratories/iilab-industry-and-innovation-lab#technologies

AI REGIO Beneficiary: 14-INESC TEC

Contact Points:

- Rafael Lírio Arrais | rafael.l.arrais@inesctec.pt
- Ana Cristina Barros | ana.c.barros@inesctec.pt

Short Summary: To disclose the state-of-the-art in advanced production technologies through the demonstration of research, experimentation and advanced training results. iiLab supports technology-based innovation in public and private organisations, thus contributing to the development of their skills in the development, adoption and implementation of advanced production technologies, leading to a sustainable competitiveness in the circular economy context.

Current Experiments / Field Labs: Multiple techonology demonstrators for European and National R&D initiatives in the domains of:

- Cyber Physical Systems (CPS) & Internet of Things (IoT)
- Advanced Automation & Industrial Robotics
- Mobile Robotics & Internal Logistics
- Industrial Vision Systems for Inspection and Quality Control
- Business Intelligence & Decision Support Systems.

3.1.11 Didactic Factory 11: ‘Smart Lab’

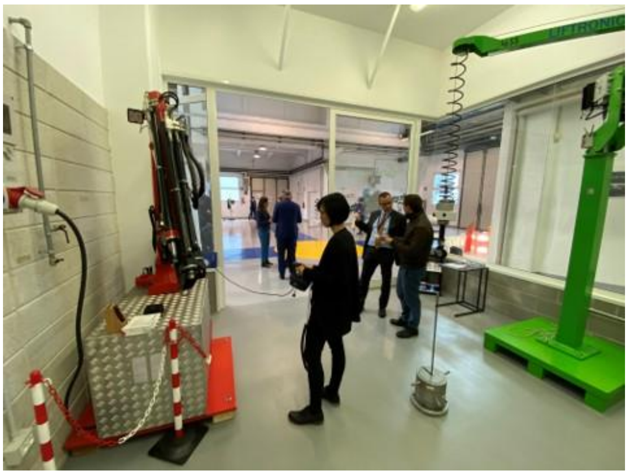


Figure 25 Intellimech Smart Lab

Location: Kilometro Rosso innovation district Via Stezzano, 87 – 24126 Bergamo

Website: https://www.intellimech.it/en/ricerca/

AI REGIO Beneficiary: 29-IMECH

Contact Point: Alissa Zaccaria | alissa.zaccaria@intellimech.it

Short Summary: The Smart Lab is a showroom established by Intellimech at the Point, the technological innovation hub for the province of Bergamo, headquartered in Dalmine. This laboratory is intended to exploit prototypes and demonstrators, resulting from joint researches between Intellimech and its partners.

Current Experiments / Field Labs:

- ‘Touchplant’ Project (smart monitoring of industrial machines and plants)
- Projects of the National Technology Cluster Intelligent Factory:
    - Adaptive project demonstrators
    - Demonstrators of the Smart Manufacturing project
- Web monitoring of industrial plants
- Predictive maintenance of low voltage circuit breakers
- Control and supervision of autonomous guided vehicles (AGVs)

3.2 AI REGIO Didactic Factories extended ecosystem

In the next section several Didactic Factories that joined the network in later instances will be introduced.

3.2.1 Didactic Factory Paris SACLAY Competence Center

Figure 26 SAYCLAY Competence Center

Location: 3 rue Joliot Curie, Bâtiment Bréguet, 91190 Gif-sur-Yvette, FRANCE

Website: http://www.horse-project.eu/CEA-Competence-Centre

AI REGIO Beneficiary: None

Contact Point: Pascale Betinelli | pascale.betinelli@cea.fr

Short Summary: Paris Saclay Competence Center is part of DIGIHALL. It will be the one-stop-shop dedicated to digital transformation of SMEs, Midcaps and startups in Paris region and connected to European network. DIGIHALL will deliver Practical and Efficient artificial intelligence (AI) for manufacturing, health and mobility, relying on Cybersecurity and HPC expertise. Located in the Paris region (Île-de-France), at the heart of the Paris-Saclay innovation ecosystem. The hub partners are representing academia, research institutions and industry clusters working on technological transfer for industry.

Current Experiments / Field Labs:

- Advices on the management of intellectual property rights
- Assistance to technology transfer
- Advices on how to deal with ethical, legal and societal issues in robotics
- Knowledge exchange workshops on robotics related issues
- Robotics experimenting, testing and proof of concept
- Training on various types of robots

3.2.2 Didactic Factory DATAROOM

Figure 27 Dataroom

Location: Ciudad Politécnica de la Innovación – UPV, Camino de Vera, s/n. Ed. 8G. Acc. B – Nivel 4, (46022) Valencia - España

Website: https://euhubs4data.eu/members/the-data-cycle-hub/

AI REGIO Beneficiary: None

Contact Point: Daniel Sáez-Domingo | dsaez@iti.es

Short Summary: is a Laboratory in Valencia (Spain) for demonstration and experimentation with Data for Industry 4.0, consisting of flexible manufacturing cells, robotics, automated warehouses, quality control by artificial vision, which incorporates Artificial Intelligence, Big Data, Digital Twin, Cloud Computing and IoT Technologies.

Current Experiments / Field Labs:

- 3D inspection System connected with production line
- IIoT/WSN technologies for monitoring (environment/process/energy) called deploids
- Iti Data Innvation space:
  - Integration with Big Data Analytics Infrastructure in the Cloud (streaming Predictive maintenance of low voltage circuit breakers
- Digital Twin Generation

3.2.3 Didactic Factory MADE – Competence Center I4.0

Figure 28 Made 'I4.0'

Location: Via Giovanni Durando, 10, 20158 Milano MI, Italië
Website: https://www.made-cc.eu/?lang=en

AI REGIO Beneficiary: None

Contact Point: Maria Rossetti | INFO@MADE-CC.EU

Short Summary: MADE's Digital and Sustainable Factory supports the enterprises in their digital transformation path towards Industry 4.0. It is part of the Industry 4.0 Italian ecosystem created by the Competence Centers and the Digital Innovation Hubs. MADE provides a wide range of knowledge, methodologies, and digital tools that encompass the entire product lifecycle: from the design to the engineering, from the production management to the delivery to the customer, and the end of the product life cycle

Current Experiments / Field Labs:

- Access to R&I funds
    - Opportunity and grants scouting
    - Consortia creation
    - Business development
- Teaching Industry 4.0
    - Online and on site course (e.g. “School of competence 4.0”)
    - Teaching factory
    - Train the trainer
    - Skills assessment
- Inform and implement digital technologies
    - Information and awareness raising
    - Company visit
    - Digital maturity assessment
    - Access to technology infrastructure
    - R&I project (PoC, TestBed, Prototype

3.2.4 Didactic Factory Swiss Smart Factory (SSF)

Figure 29 SSF

Location: Switzerland Innovation, Park Biel/Bienne AG, Aarbergstrasse 46, 2503 Biel/Bienne

Website: https://www.sipbb.ch/en/forschung/swiss-smart-factory/

AI REGIO Beneficiary: None

Contact Point: Dominic Gorecky | ssf@sipbb.ch

Short Summary: The Swiss Smart Factory’s vision is to become Switzerland’s leading, internationally recognised centre of competence in application-oriented research and transfer of

Industry 4.0. With every project we make, we expand our ecosystem of partners and knowledge that benefits all participants in the fourth industrial revolution.

Current Experiments / Field Labs: `

- AI-Start-Up Support: Development and promotion of demo and test cases
- AI-Training for SMEs: Regular big data and machine learning workshops, etc.
    - https://www.sipbb.ch/en/big-data/
- AI for Students: Internships, Bachelor and Master-Thesis

3.2.5 Didactic Factory Mini-Factory

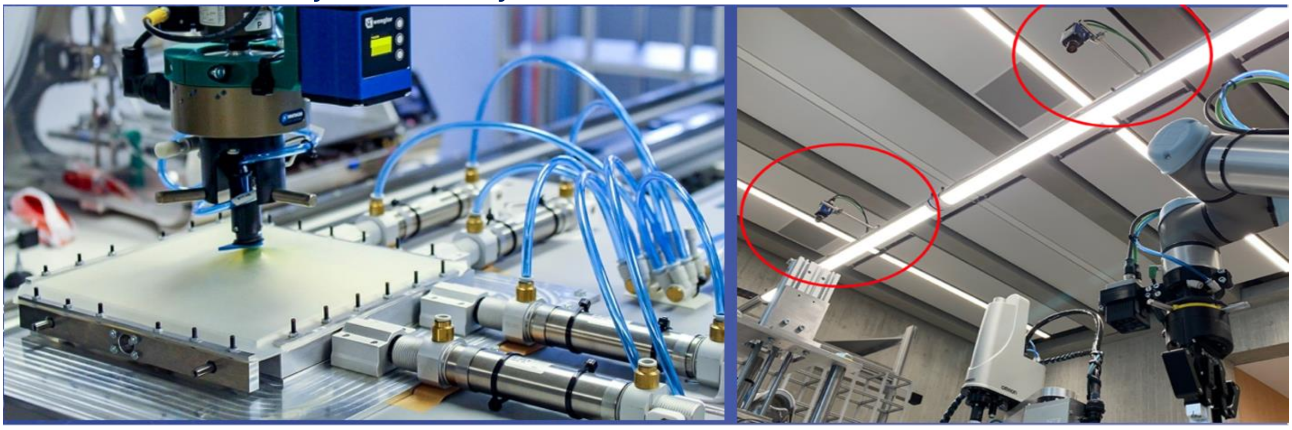


Figure 30 Mini-Factory

Location: Polo universitario Lugano, Campus Est, Via la Santa 1, 6962 Lugano-Viganello

Website: https://www.supsi.ch/home.html

AI REGIO Beneficiary: None

Contact Point: Paolo Pedrazzoli | paolo.pedrazzoli@supsi.ch

Short Summary: The aim of the Mini-Factory is to create a platform where researchers, students and industries meet, develop and empower the transfer of knowledge. They have the chance to experience both classical automation topics (PLC, MES and SCADA programming, precision axes control and pneumatics), as well as advanced technologies, typical of the most advanced smart-factories (IoT, vision systems, simulation and digital twin, H-R collaboration, AI-driven automation, advanced measuring methods).

Current Experiments / Field Labs:

- developing a HoloLens app with Unity and Vuforia QR Codes that will enable Operators to visualize factory data from the mini-factory: Status, the process progresses, alarms and warnings, tracking of the product, sensors values and power consumption.
- Power Consumption, usually neglected in the production lines' design phase. In this regard, a Smart IoT Sensor will be installed to measure the electrical power consumption. The data will be collected via Wi-Fi and accessed via the cloud.

3.2.6. Didactic Factory am-LAB

Figure 31 am-LAB

Location: Zanati u. 32-36, 9700, Szombathel

Website: www.am-lab.hu

AI REGIO Beneficiary: None

Contact Point: Balázs Barta | barta@pbn.hu

Short Summary: am-LAB aims at holistic digitalization support, with a broad service portfolio. It ranges from additive prototyping and series production, custom-based computer animation (CGI), augmented reality (AR) applications, through prototype development support, to data analytics, involving artificial intelligence-based algorithms.

Current Experiments / Field Labs:

- Most recent development is Teaching and Learning Factory with SMC
- Development of a multiple robot solutions for various workflows and functionalities at manufacturing companies
- Development of extended reality applications for iOS and Android devices in the several areas

3.3 AI REGIO Action Plan for Didactic Factories

The creation of the AI Regio network consists of two phases. The first phase focused on setting up the network and finding DFs. Activities in this phase are consulting consortium partners for input, define a state of play about DFs and develop a service portfolio. This phase ended in February 2022. This phase resulted in 11 DFs who expressed interest in the network. However, in a later instance 6 more DFs expressed interest in joining the network. They are called "extended network" and are described in chapter 3.2. The second phase of the DF network focusses on creating a network feeling and facilitate input for the champions. This phase starts in March 2022.

As the champions are identified the next step is to stimulate the feeling of being part of the network. By doing so the goal is to stimulate knowledge exchange, best practices and lessons learned between the champions. The objective is to create a team of the champions who cooperate which each other. Starting point of the second phase is the process of executing the DR Best taxonomy with the champions. The process of undergoing DR Best is fundamental since it provides insight in the services the DFs offer. DR Best focuses on the following services of the DFs: Data, Remotization, Business, Ecosystem, Skills and Technology category. All DFs already experienced the process of the DR Best taxonomy. This will be discussed in depth in chapter 4.

The second phase of the network focusses on competence and service development. In the following paragraph the next steps regarding the champions will be described. This will be done separately for the champions and the extended network.

3.3.1 DF Champions

The goal in the second phase of the AI Regio network is to create a network feeling across the champions. Important in creating a network is to work in collaboration with the champions and encourage dialogue across the network. March 2022 marks the second phase of AI Regio. An overview of the second phase can be found in the Gantt chart below. In the subsequent paragraph the next steps regarding the champions are explained.

March 2022 marks the second phase of the DF network. In this phase we want to promote interaction between the champions for outcomes such as knowledge sharing and lessons learned.

- The first step regards the DR Best taxonomy. All the champions underwent the DR Best taxonomy which helped them to gain insight in their services. The due date of the analysis for the champions was end of February 2022.
- Secondly, a kick-off session with the champions will be hosted at the end of March to elaborate on the second phase and give an overview of the second phase. This means explaining the next steps and the goal of those steps. The goal of this session is to inform but also gather input from the champions about their wishes for the network.
- The third step builds on the results of the DR Best. To develop a deeper understanding of the outcome of DR Best, the champions will carry out a SWOT analysis on the results of the DR Best analysis. This helps the champions to gain insight in their strong and weaker services. Moreover, this helps to gain understanding in the strong and weak points of the network as a whole. Next, the champions are randomly paired to another DF to review each other's SWOT analysis. The goal of this step is to stimulate contact between DFs and accommodate a form of knowledge exchange.

- Fourth, in the kick-off session the (individual) mapping session(s) will be announced. The goal is to collect the expectations from the champions regarding the network. Part of the agenda is to discuss the pains & needs and how the network can support the DFs. The output of those sessions will, in collaboration with the champions, be transformed in a road map. This roadmap should enhance competences based on the needs on an individual level per DF but also based on the needs of the network as whole
- The fifth task involves the development and implementation of intensification session(s). The output of the mapping session(s) will function as input for the roadmap concerning the future steps. To enhance the feeling of being part of the network a bottom-up approach will be applied. In the Gantt chart below several suggestions are made to achieve the goal of the second phase. However, they are labelled as suggestions since the goal is to implement intensification session(s) in coordination with the champions. However, the intention is to implement a buddy system within the network. Exploratory conversations with the champions will be organized to discuss how such a such a system could be organised.

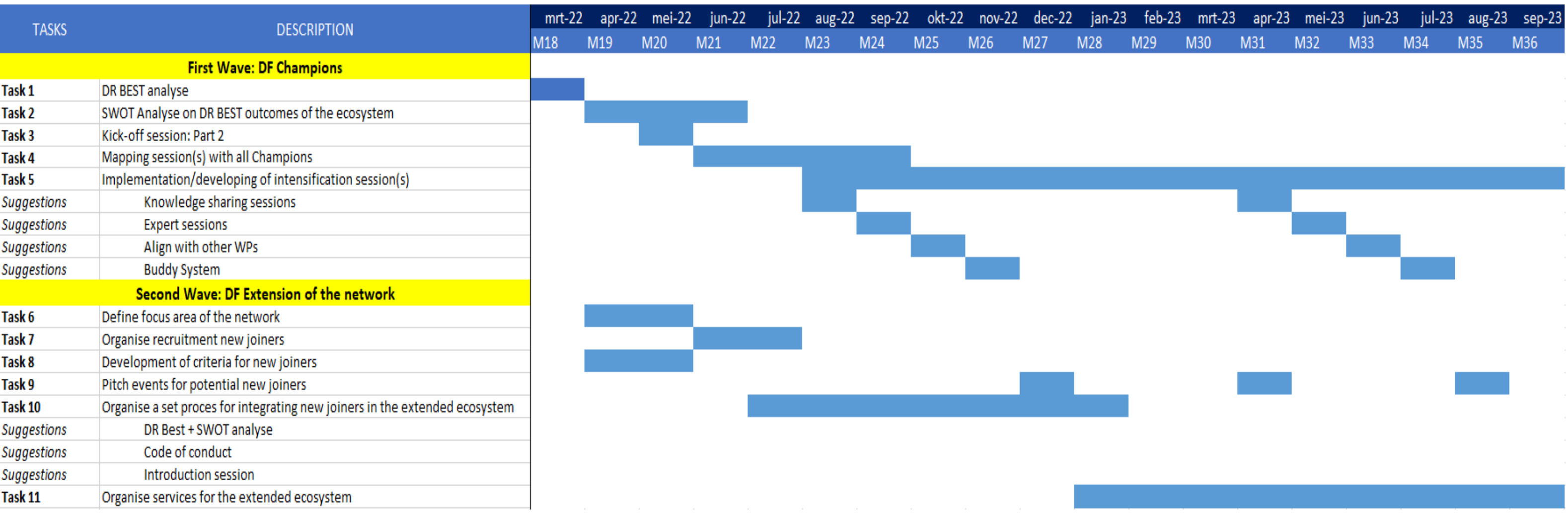


Figure 32 Gantt Chart

3.3.2 DF extended network

The champions function as a learning school for the extended network. The lessons learned from the network of champions will function as a starting point for the extension. In April a meeting will be held to configure the strategy and scope for the extended network. This meeting will focus on the scope of the extended network, how to organize a recruitment system and which role the extended network will play in relation the champion network. However, as shown in Figure 9 there are no DFs participating from eastern Europe. While, the goal is to create an interoperating network of DFs with a pan-EU AI-oriented portfolio. Therefore the focus of recruiting new participants will be on countries in Eastern Europe. Moreover, as already mentioned in chapter 2.3.2 a disruptive event will take place which is called AI TEF for Manufacturing. Therefore, in the meeting in April which involves decisions regarding next steps of the extended network, the start date of the event will be taken into account.

4 Didactic Factories services portfolio analysis

A preliminary activity that was run with the Champions Didactic Factories has been the definition of their service portfolio, in accordance to the DR BEST taxonomy.

Objective of the following paragraphs is to provide a short overview of such taxonomy (with a specific focus on the "Remote" services) and to analyse the Champions' portfolios identifying key aspects.

4.1 The DR BEST taxonomy

The DR BEST analysis is a structured approach proposed to Didactic Factories (DFs) in order to define their as-is service portfolio and to identify in their offering the gaps to be filled. Services are classified according to a 3-levels taxonomy and this has a twofold advantage: on one side it shows a full picture of the possible services that a DF could provide and on the other, it guarantees that services are presented in a standard and comprehensible way.

The macro-classification (level 1 of the taxonomy) groups services in six different classes (**Data, Remote, Business, Ecosystem, Skills, Technology**), from where =the name DR BEST comes; for each class, level 2 and level 3 are defined in order to better detail and classify the type of activity.

In AI REGIO, the taxonomy has been originally defined in WP3 to describe the Digital Innovation Hubs offering and it was called D BEST (without the "R"). For further details, you may refer to deliverable D3.1 of WP3, where the framework is presented and the analysis run on the DIHs' portfolios is provided.

In the context of WP7, the D BEST service taxonomy has been enriched, including also the "R" class of services, referring to that type of support that can be remotely offered by a Didactic Factory.

For sake of completeness, a short description of each class is provided here, just summarising key aspects in order to avoid repetitions with respect to D3.1.

The DR BEST catalogue contains in total **69 different services:** 12 are services related to Data management, 13 to services provided Remotely, 14 to Business activities, 12 to Ecosystem management and communication, 9 to Skill assessment and training and 9 to Technological support.

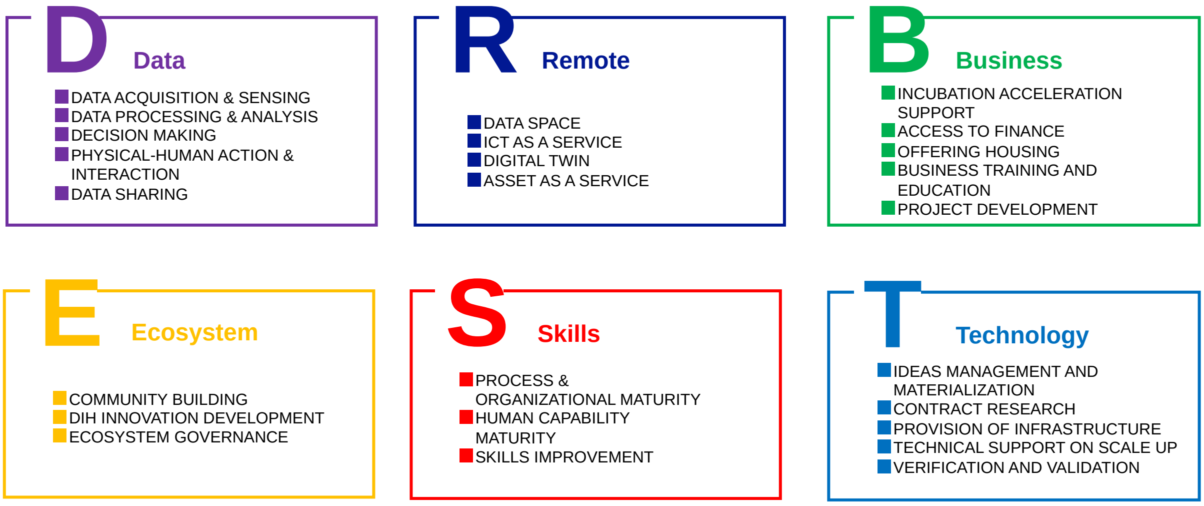


Figure 33 DR BEST taxonomy - level 1 and 2

- **Data**: this class contains all the services that a Didactic Factory may provide to support data management, including the creation of data spaces, from Data Acquisition to Data Sharing, from simple Data Analysis to complex Artificial Intelligence models.
  This class overlaps with: the "Ecosystem" one, in case the DF plays the role of intermediary, driving the customer toward a third party (a technology provider for example) who actually provide the service; with the "Technology" one, in case the DF directly offers a technical competence.

- **Remote**: this class contains all the services that a Didactic Factory may provide from remote to enable experimentation and that don't require the physical interaction with the customer. The sub-classes identified cover different degrees of DF-customer interaction, including four type of assets that can be put at disposal: data, software, simulations (Digital Twin), physical assets.

- **Business**: this class contains all the services that a Didactic Factory may provide to support the customer from the business perspective, including the research of funding opportunities, the support in project proposals development, the provision of training about business topics, the provision of working spaces.

- **Ecosystem:** this class contains all the services that a Didactic Factory may provide for the creation and management of a stakeholder ecosystem, including other DFs, Digital Innovation Hubs, enterprises, technology providers,…
  It means to create a network, to organize event, but also to monitor the market in order to be up-to-date with trends, latest news and innovative solutions to be shared in the community.

- **Skills:** this class contains all the services that a Didactic Factory may provide in terms of training and competences assessments, addressed to both single workers and organisations. It includes the provision of training and educational programmes, of training material and repository, but also maturity assessments (possibly followed by a detailed analysis to define the transformation roadmap).

- **Technology:** this class contains all the services that a Didactic Factory may provide to its customers to support the development of a new technological solution and it is related to "test-before-invest" paradigm, that helps enterprises to test and validate an idea before doing large investments to produce it. The set of services covers the entire lifecycle of an implementation, from the support in the design phase to the preparation of a Proof of Concept, from the provision of facilities/technological assets to test the solution to the technical support on scale-up.

4.1.1 The R dimension

To avoid repetitions with deliverable D3.1, D7.3 focusses mainly on the Remote class of services that has been included in the D(R) BEST taxonomy especially for Didactic Factories, to better describe their portfolio of services.

The provision of "R" services is assuming an increasing importance, mainly due to the covid-19 pandemics, after which it became quite fundamental, since it allows to have access to data and hardware/software assets without physically going to the DF's facility.

As mentioned before, the taxonomy has been conceived to cover four degrees of the remote experimentation, from the remote use of simple datasets (1) to the remote use of software/computational resources (2), including the simulation of physical models thanks to Digital Twins (3) and the use of physical assets thanks to a system of teleoperation and remote control (4).

The table below shows the DR BEST taxonomy for Remote services: as mentioned, it is a 3-levels taxonomy where level 1 coincides with the class (Remote in this case), level 2 is a more detailed classification and describes the type of the service (the four degrees of remote interaction, in this case) and finally level 3 is the service itself, that a DFs may or may not provide. Considering the last level, 13 different services have been identified.

DR BEST Taxonomy		
LEVEL 1 CLASS	**LEVEL 2 TYPE**	**LEVEL 3 SERVICE**
REMOTE	DATA SPACE	Real Time Industrial Data Platform
		Assets Administration Shell
		Open Data Repository
		Assets Data Marketplace
	ICT as a Service	Software as a Service
		Platform as a Service
		Infrastructure as a Service
	Digital Twin	FEM/CFD/FSI simulation
		Discrete event simulation
		Ambient virtualization
	Asset as a Service	Teleoperation
		Monitoring platform
		Avatar

Table 3 DR BEST Taxonomy for R services

DATA SPACES

This set of services is addressed to customers who need data, for different purposes (mainly to run and test models) and in different format. Typically the data provision is combined with other services to guarantee a secure and effective use of information, from cybersecurity to standardisation and model interoperability.

- **Real Time Industrial Data Platform:** the DF supports the customer in accessing data generated in real time by Industrial IoT Systems.
- **Assets Administration Shell:** the data of the DF's facility and its assets are structured according to the AAS principles and it speeds-up integration and exchange. The DF can also provide support the customer to develop the AAS representation of its own asset.
- **Open Data Repository:** the DF provides access to a repository of Open Data, collecting historical databases related to different sectors and use cases. This service leverages on the FAIR paradigm for Open Datasets, claiming that information put at disposal must be Findable, Accessible, Interoperable and Reusable.
- **Assets Data Marketplace:** the DF provides access to high value data sets with associated value and monetisation.

ICT AS A SERVICE

This set of services is addressed to customers who need hardware/software assets to run and test solutions, without investing money and resource to install a proprietary one on-premises. An additional service provided by the Didactic Factory may be the support in customising the asset for the specific use case.

- **Software as a Service:** the DF supports the customer by providing software licensing and delivery models in which software is licensed on a subscription basis and is centrally hosted.
- **Platform as a Service:** the DF supports the customer by offering cloud computing services allowing customers to develop, run and manage applications without the complexity of building and maintaining the infrastructure.
- **Infrastructure as a Service:** the DF supports the customer by offering online services that provide high-level APIs used to dereference various low-level details of underlying network infrastructure like physical computing resources, location, data partitioning, scaling, security, backup, etc.

DIGITAL TWIN

This set of services is addressed to customers who need to remotely simulate a behaviour (of a system, of a process or of an environment) leveraging of a Digital Twin, typically provided by the Didactic Factory and based on the DF's asset/facility.

- **FEM/CFD/FSI simulation:** the DF supports the customer in simulating physical behaviours of the system.
- **Discrete event simulation:** the DF supports the customer in simulating physical behaviours of the process.
- **Ambient virtualization:** the DF supports the customer in simulating physical behaviours of the environment.

ASSET AS A SERVICE

This set of services is addressed to customers who need to remotely perform activities in physical facilities or to monitor them.

- **Teleoperation:** the DF supports the customer in using software and tools to operate on the assets remotely and to transfer skills and expertise to remote place without physical presence.
- **Monitoring platform:** the DF supports the customer with tools and software for the status assessment of the assets and for the evaluation of production working progress.
- **Avatar:** the DF supports the customer by putting at disposal a physical system equipped with an avatar, that is, capable of replacing a person in the working environment to transfer his ability anywhere.

4.2 Service Portfolio Analysis in AI REGIO DF champions

The AI REGIO Didactic Factories Champions have been required to analyse their current Service Portfolio, applying the DR BEST taxonomy. It means to describe each service provided as an instantiation of one of the 69 activities described in the framework, at level 3. Doing so, the DFs have been invited to reasoning with a structured approach about their offering, evaluating their strengths and weaknesses also in comparison to other Didactic Factories and in a perspective of future collaboration.

So far, we have received the DR BEST Service Portfolio compiled by 8 Didactic Factories. The objective of this paragraph is to provide a general picture of the AI REGIO Network, without going into the details of the single DF portfolio, but to handle them as a single community.

4.2.1 The AI REGIO DFs Network's Service Portfolio

The AI REGIO Network of Didactic Factories has currently at disposal a Portfolio of 228 services, as combination of 8 different organisations. Missing partners will be included in the analysis, as soon as their Portfolios will be available.

As the chart below shows, services are quite balanced into the six DR BEST categories.

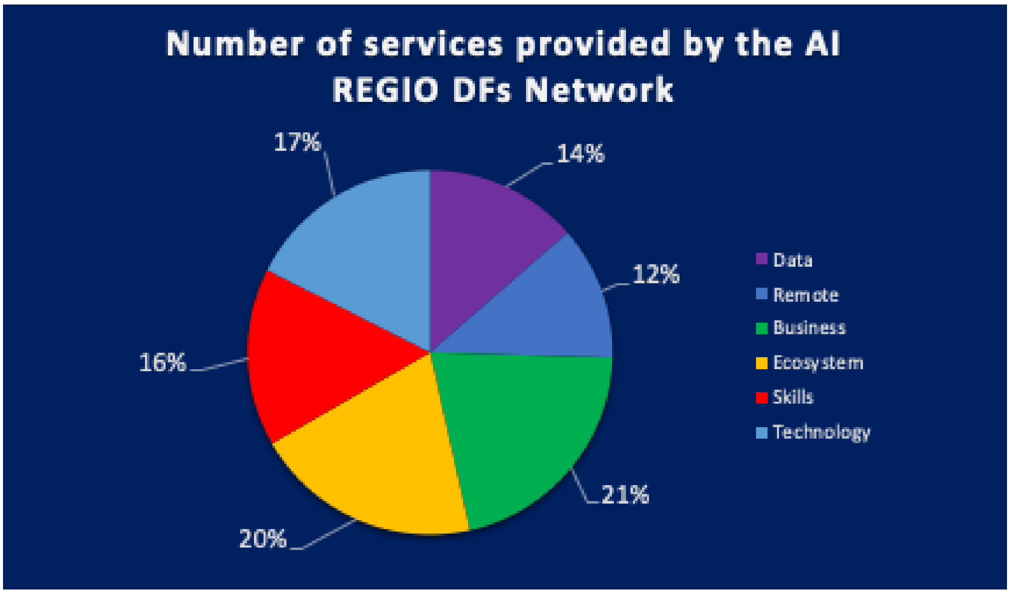


*Figure 34 Distribution of the AI REGIO **DFs** Network's portfolio by DR BEST classes*

The two classes with the highest number of services are Business and Ecosystem, covering the 21% and 20% respectively, but the gap with respect to the other classes is not so relevant and the pie chart is very well balanced. The DFs Network Service Portfolio provides all types of services, including the most technical and educational ones: this behaviour was expected, since by definition a Didactic Factory has a Didactic component (that is, Skill related) and it is a Factory (that is, equipped with a facility where it is possible to test new technological solutions).

Not surprisingly, the main difference between the Digital Innovation Hubs and the Didactic Factories Network is the evident technical component of the DFs, that balances the Business/Ecosystem one, which, instead, is a distinctive feature for DIHs.

Figure 35 is the equivalent of the previous one, but applied to the DIHs' context. At first glance, it is clear how in this scenario Business/Ecosystem services represent the main activity performed by the hubs: together, the two classes cover more than the 60% of the total available services, while the in the DFs' Portfolio, they sum only 41%. The large presence of the Business and Ecosystem offering is at the expenses of the technical component, that represents less than 40%, the opposite of the DFs' Portfolio. (Note that in this case, Remote services are missing since they have been conceived especially for DFs and not applicable to DIHs).

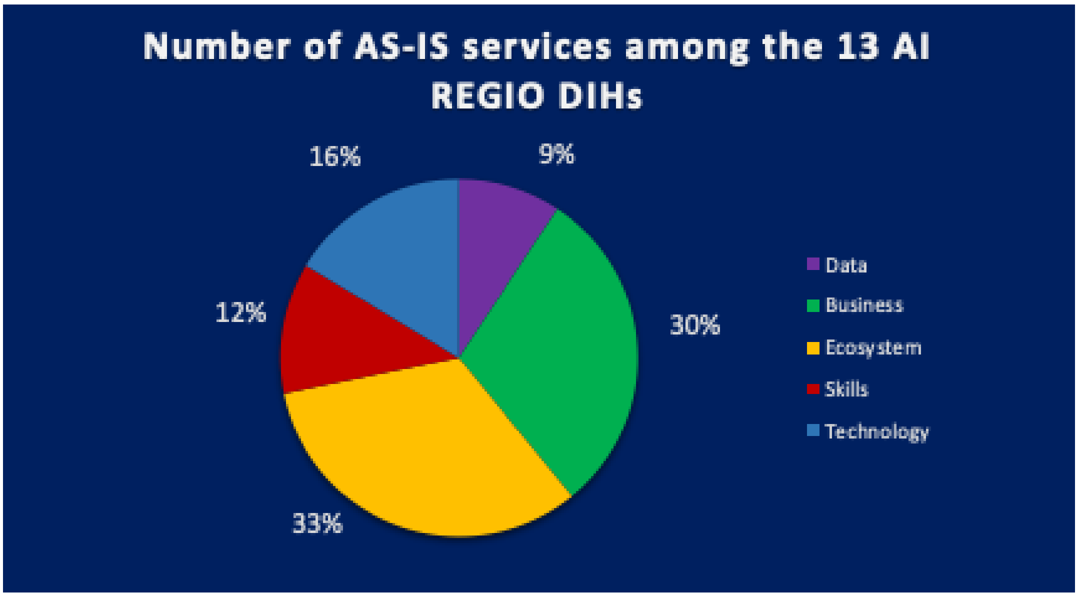


*Figure 35 Distribution of the AI REGIO **DIHs** Network's portfolio by DR BEST classes*

On average, a Didactic Factory offers 28,5 services, but the real number is very variable, since the Network consists of DFs very different one to the other. Some of them are large organisation with a strong internal structure deriving from years of experience, others are new-born companies specialised in a specific activity.

So, there are Factories providing more than 50 services alone, other with about 10-15 services in the Portfolio.

However, almost all the DFs are involved in activities dealing with the six DR BEST classes. The picture below shows, for each Class, how many DFs provide at least one service and the number varies from 7 to 8, showing that competencies are very well distributed inside the Network.

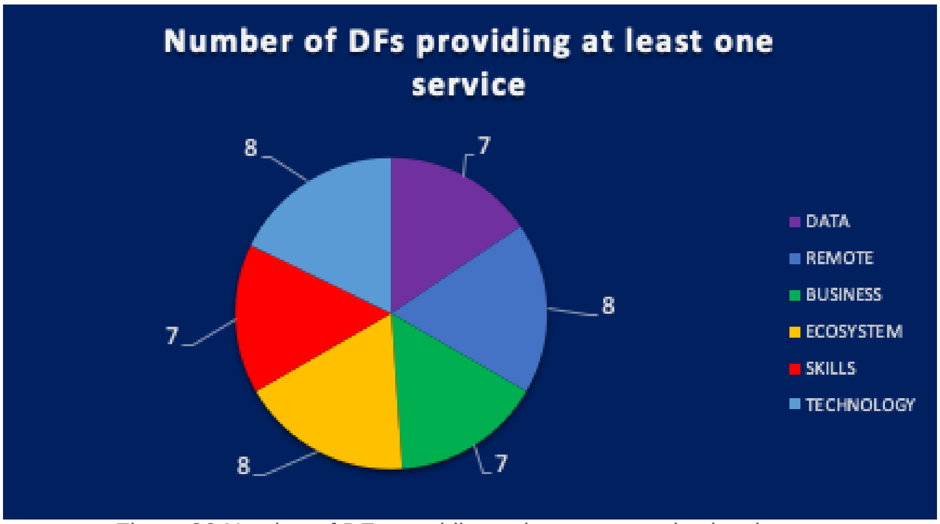


Figure 36 Number of DFs providing at least one service by class

Finally, to complement the analysis about the distribution of competences among the AI REGIO Didactic Factories and to try to identify their expertise leveraging on their portfolio, another type of chart is provided.

Figure 37 shows for each DF, how services are distributed in its portfolio, that is, how many services belong to a class in percentage to the total number of services provided: doing so, it is possible to evaluate the strengths of the Factory. Last column, with a dots-pattern, shows how the full catalogue is distributed, to have a term of comparison: the 69 services span quite homogeneously across the six classes, with a majority of Business services (14, that is the 20% of the total), followed by Remote (13, that is the 19%), Ecosystem and Data (12 for each, that is 17%) and finally Technology and Skills (9 for each, that is 13%).

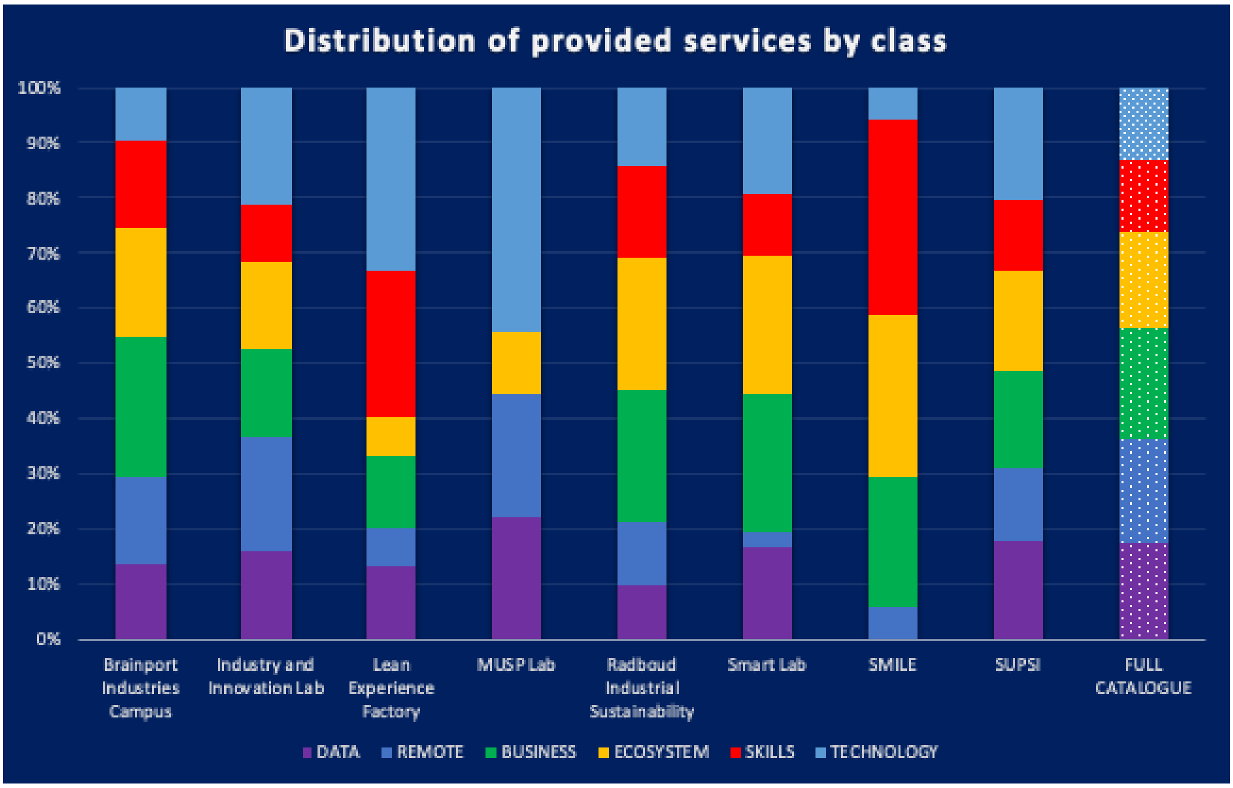


Figure 37 Distribution of provided services by class

The chart shows that there are DFs with a higher number of Skills services, if compared to the others, as the "Smile Lab" and the "Lean Experience Factory" for instance; the "MUSP Lab" has a strong Technological component, as well as the "Lean Experience Factory"; etc.

4.2.2 The Remote Service Portfolio of the AI REGIO DFs Network

As mentioned at the beginning of Chapter 4, the Service Portfolio taxonomy has been tailored to DFs' needs, including also the Remote offering. So, not surprisingly, the Remote class of services covers a relevant percentage in the overall Network Portfolio (the 12%, as shown in Figure 35).

Almost all the typologies of services identified in the taxonomy are covered, with the only exception of the "Avatar" as Asset as a Service and the Access to "Open Data" and "Data Marketplace", that are planned to be implemented in short term by some DFs, but not operative yet. However, the Portfolio of Data services shows that that the gap in "Data Space Remote services" is often complemented by the presence of other services, not provided remotely but related to data generation and data sharing.

The picture below counts the number of Remote offering by type (level 2) and service (level 3).

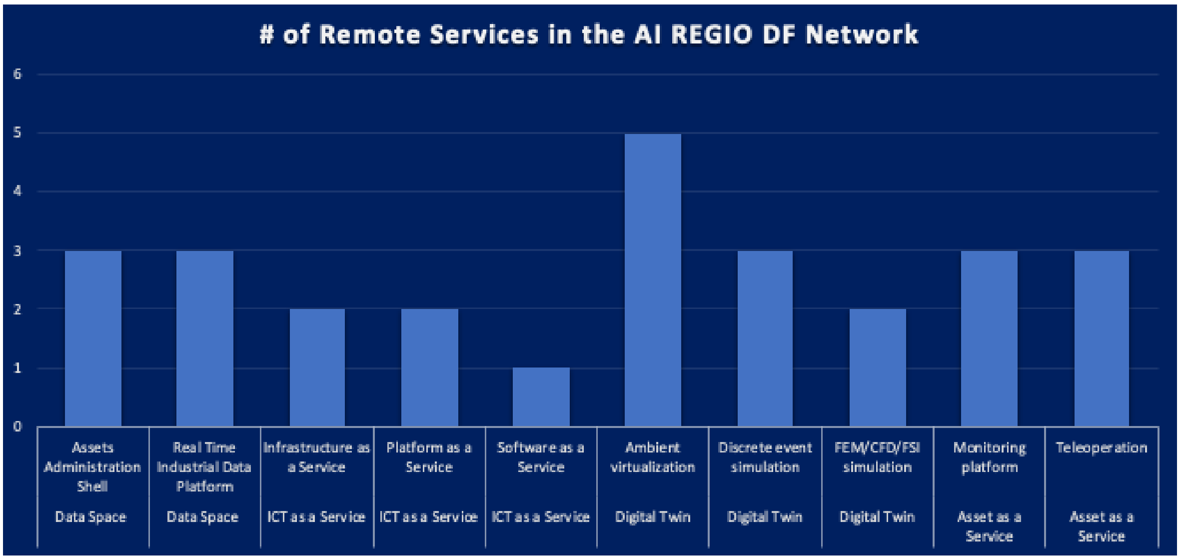


Figure 38 The Remote service portfolio for the AI REGIO DFs Network

The highest number of Remote services is provided in the context of the **Digital Twin for Ambient virtualisation,** where the overall Service Portfolio provides five of them. These five instantiations are of course different one from the other, since they are offered by different Didactic Factories: for instance, the "Smile" and the "Smart" Labs provide a virtual training tool for the Lab's automated assembly line; the "Industry&Innovation Lab" provides a digital model of the Lab's shop floor environment based on an Advanced Plant Model (APM) component; "Supsi" provides a Mini-Factory Digital Twin where it is possible to run several simulated production scenarios.

In the context of **Remote Data Space** services, Brainport DF is very active with its project of Digital Factory of the Future, that aims to create the outline for a digital factory, by integrating data-driven innovations and delivering an open reference architecture for sharing data. Considering the **Asset**

Administration Shell (AAS) framework, the "Industry&Innovation Lab" has represented its Robotic Systems (deployed in the Open Scalable Production System for the support of Cyber-Physical Production Systems) leveraging on the AAS principles. The "Lean Experience Factory" is offering **Real-time Industrial Platform Data** through experiential training; "Supsi" is part of a project developing a Gateway platform to enable the access to it.

So fare, five different **ICT** solutions are offered **as a Service** (other are planned to be implemented in short term)**:** Brainport, as part as Gaia-X, supports companies to create a digital infrastructure in a trusted environment and its Smart Connected Supplier Network (SCSN) offers as a Service a new technical infrastructure that makes sharing data in chains much more efficient; the "Industry&Innovation Lab" offers components of its Open Scalable Production System (OSPS), both software and hardware, to be accessed as a Service; the "MUSP Lab" has developed an Augmented Manufacturing Platform to be provided as a Service.

Additionally, some modules of the Augmented Manufacturing Platform aforementioned are designed to monitor processes and are included, in the portfolio, in the framework of **Asset as a Service – Monitoring platform**.

5 TEchnology and REgulatory SAndboxes in DF Network

5.1 What is a TERESA

As described in D7.1 "Legal, Regulatory and Ethical Framework", in particular in its Sect. 5 "TERESA Framework", a TERESA is a "Technical and Regulatory Sandboxes" for AI, enabling a direct testing environment for innovative CI-empowered products and services aimed at addressing ethical challenges and shortcomings of the regulatory framework concerning such products and services. Following the "test before invest" paradigm, the TERESAs allow to test/experiment innovative AI applications/tools/services for CI-driven human-machine interaction by running experiments on a limited scale, in a secure, gradual and controlled way, as well as in real regulatory conditions and pursuant to a specific testing plan, including also the involvement of volunteers and of the Competent Authority (CA).

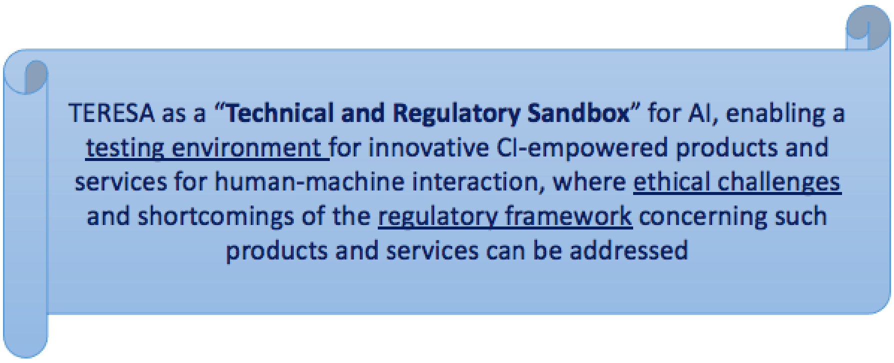


Figure 39 TERESA definition

The regulatory component of the sandboxes is functional to better understand the relevant regulatory and ethical implications and to better assess the viability of such innovative tools, in particular in terms of their application of and compliance with the existing regulatory, ethical and supervisory requirements. Thanks to the involvement in the TERESA, the Competent Authority (regulators, supervisors, policy-makers, innovation agencies, VI representatives, regional or local authorities, etc.) can, on the one hand, reach a better understanding of the given innovative AI artefacts, including their opportunities, risks and related regulatory treatment, thereby bringing the potential for "reducing the time-to-market cycle" for such products/services. On the other hand, the CA can assess the impact of such artefacts on EU values (such as non-discriminatory treatment, human control, autonomy and self-determination). In this way, the TERESA are expected to help the CA in identifying strengths and weaknesses of the existing regulatory policy approaches to tackle with the regulatory challenges posed by human-machine collaborative environment. In turn, this is expected to support the advancement or further development of regulations capable of keeping up with the fast pace of innovation, thereby facilitating an adequate policy response. In this regard, the TERESAs might be useful to explore the adequateness of some provisions of the regulatory reforms under development, in particular the AI Act. In other words, thanks to the TERESAs and to the expected enhancement of the CA's understanding of the new challenges and risks brought by human-machine collaboration and AI in this area, steps ahead might be moved towards the enhancement of the regulatory response to innovation in the manufacturing domain.

AI REGIO Didactic Factories, in their role of open testing and experimentation facilities extending the services of a Learning Factory towards the materialization of the EDIH "test before invest" pillar, will conceive, design and implement AI REGIO TERESAs, if opportune with the help of supporting technological partners from AI REGIO Consortium, and through the involvement of both the Competent Authority/ies and the participants who will voluntarily take part to these testing activities.

Thanks to their already functional experimental facilities and their ties to industry challenges, SMEs and manufacturing employees, Didactic Factories represent the ideal place within the project to implement the TERESAs, since the experiments can be run in facilities and situations close to real factories and constraints can be relaxed to some extent, while at the same time guaranteeing the safety of the participants involved in the experiment itself.

The TERESA deployment within the DFs is fully aligned with the EC's vision inspiring the Testing and Experimentation Facilities Initiative under the Digital Europe Programme, directed to optimise the development and deployment of AI and to build the AI ecosystem of excellence and trust in Europe (as laid out in the AI White Paper from February 2020) for contributing to more trustworthy AI made in Europe. In fact, the TEF are also seen as tools to support regulatory sandboxes thanks to the dialogue with competent national authorities for supervised testing and experimentation under real or close to real conditions.

5.2 Ongoing activities for designing, implementing and deploying AI REGIO TERESA

The TERESAs are conceived to become a powerful testing environment for innovative CI-empowered products and services for human-machine interaction within AI REGIO, focused on the ethical challenges and shortcomings of the regulatory framework concerning such products and services.

AI REGIO through its network of Didactic experimental facilities, closely associated to VANGUARD Pilot Plants and Regional / National Industry 4.0 initiatives, has already started the planning of the TERESAs, whose implementation relies on a "hands-on" bottom-up approach tailored to the specific needs of manufacturing.

Within AI REGIO ecosystem, a number of Didactic Factories (DFs) has already been identified towards the creation of a network of Didactic Factories, starting from the first wave of "AI REGIO Regional Champion Didactic Factories".

In some of the DFs of the network under development, the TERESA experiments are going to be run. In these Didactic Factories and their TERESAs, the ethical and regulatory issues arising from adoption of AI and human-machine interaction will be addressed. The core group of DFs interested in running a TERESA is as follows:

- MADE
- BIC
- Intellect
- INESC TEC
- CEA
- Mini-Factory (connected to SUPSI)
- Lean Experience Factory (LEF, connected to COMET)

A first subset of them has already started to define their experiments, filling in the first section of the TERESA Form described below in D7.1, Sect. 5.4 dwelling upon the key aspects to plan operations, including the abstract, motivation, Competent Authority to be engaged and CI innovation at stake (see sect. 5.3 hereunder). According to this overall plan, they are going involve and align with the relevant CA, engage, when opportune, the technology or industry partners, gather the authorizations for allowing exceptions to the regulatory framework, as well as the ethics approvals or other authorizations if necessary. In the next months they will also elaborate the overall Testing Plan, where the main elements and parameters of the TERESA will be defined, including enabling technologies, use cases to be tested, main objectives, risks and safeguards to be taken, and discuss it with the CA involved in this sort of regulatory experimentation. The testing plan will be discussed and agreed with the competent authority, ensuring an increased legal certainty of the innovators: they will be able to develop their solutions in a regulation-compliant way from the design stage, thus "reducing the time-to-market cycle" for such products/services.
The CA is also expected to closely monitor the actual development and testing of the innovative CI service, product or business model.

At the same time, the early-stage engagement with the CA allows the DFs and their innovators a better understanding of its expectations and encountered difficulties, to ask for clarifications or non-binding guidance about AI-related issues, thereby reducing regulatory uncertainty which can be a constrain to the rollout of innovative products and solutions. The effective consultation and exchange between the CA, the DFs and participants at the different stages of the TERESA establishment and implementation is meant to help to build trust, facilitate viable partnerships and set appropriate expectations at all levels.

As mentioned in D7.1, it is under exploration the opportunity to involve with the role of CA in one or more TERESA a Standardization Body (SB), in particular one or more SBs of the CEN National Standardization Bodies (NSBs), which cover 34 countries.

As regards the Ethical and Legal (EL) issues potentially testable in a TERESA, relying on the content of D7.1, the following four main categories were identified:

Figure 40 Main categories TERESA

The creation of TERESAs is interlinked with the growth of the Didactic Factory Network of AI REGIO, where to identify and launch additional TERESA experimentations in the participating Didactic Factories, testing the CI-driven solutions in a real Didactic Factory's experimentation facilities/environment.

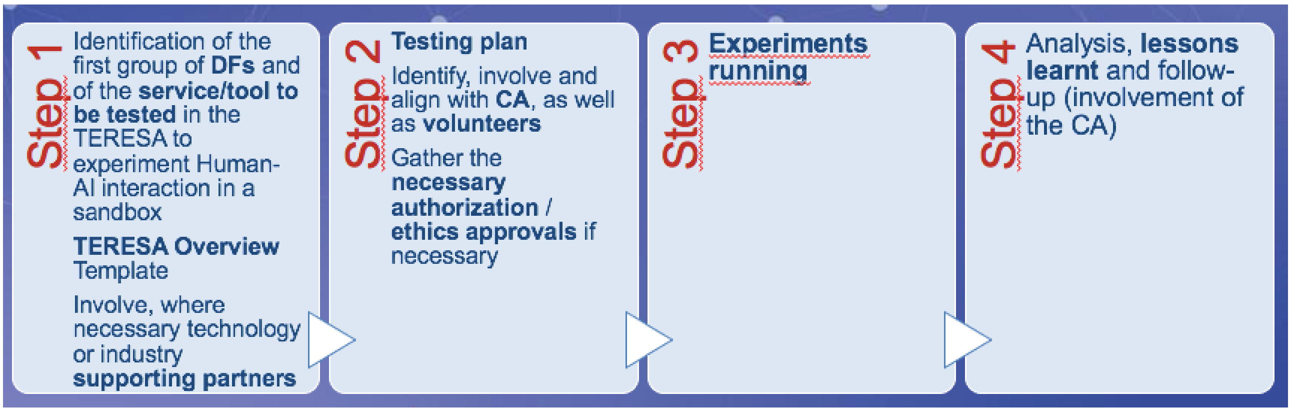


Figure 41 Plan for TERESA

With the aim of discussing next steps and investigate expectations regarding TERESA, current ideas on possible experimentations and challenges, a dedicated online workshop on TERESAs was organized on 17 February with the DFs. It was attended by AI REGIO Regional Champion Didactic Factories, in particular by those which expressed interest in the deployment of a TERESA.

The main findings of such Workshop, which included a participatory session conducted through Mentimeter, were as follows. All the participants confirmed the usefulness of the TERESA as a practical tool for testing cutting-edge AI products and services for human-machine interaction, focusing both on the technical dimension and, above all, on their ethical challenges and regulatory barriers. However, a number of challenges/barriers were identified for conducting a TERESA, ranging from cost constraints to the difficulty to engage SMEs in these experimentations, as well as to involve volunteers for testing the AI solutions, as shown by the picture below:

Figure 42 Challenges in conducting a TERESA

It was also stressed that some of their already existing experiments could be profitably enriched with legal and ethical considerations and interesting examples were provided.

When requested to select one of the four categories of the Ethical and Legal issues potentially testable in a TERESA (as identified hereabove), they expressed special interest in the category "Well-being, Comfort and Technology Acceptance", followed by the category "Improving working conditions", as shown by the following picture:

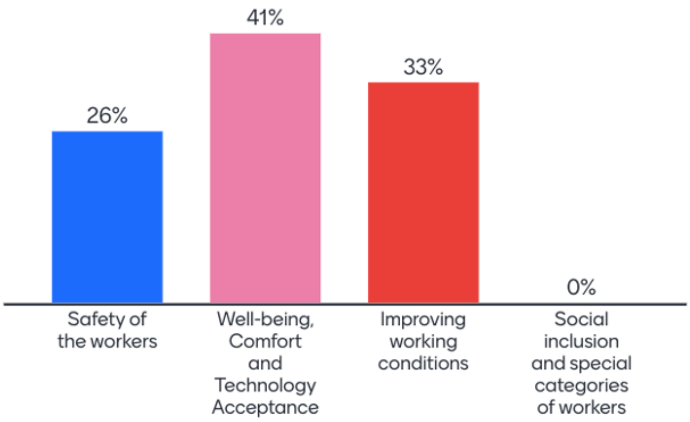


Figure 43 Ethical and legal issues for TERESA

The attendees also pointed out that they would be interested in focusing on EL aspects like data privacy, cooperation and relations within company teams, as well as the proper inclusion of workers during the development and implementation phases of an innovation.

Despite the majority of the participants confirmed their interest in involving a Standardisation Body as CA in their TERESA, some of them preferred different options, such as Regional Authorities or Local Bodies, as shown by the following picture:

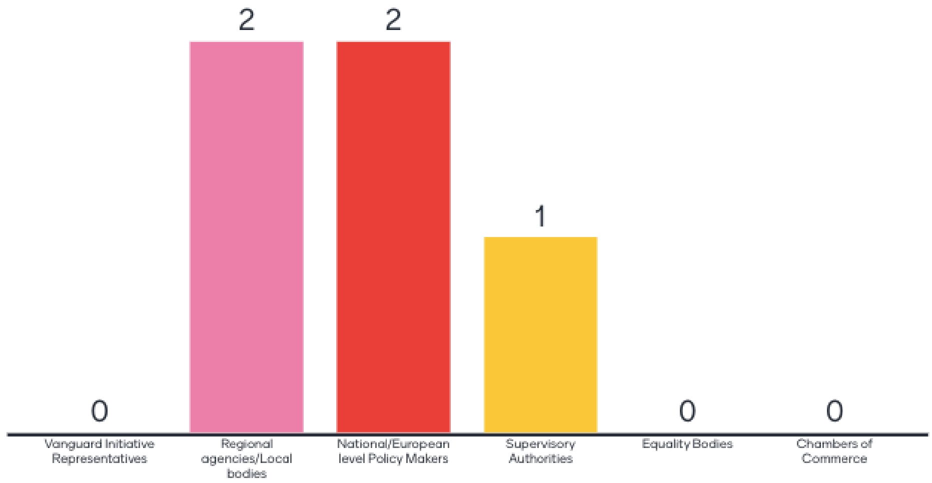


Figure 44 Authority preference

5.3 TERESA Examples in the DF Network

This chapter reports the initial ideas and planning for the TERESA's deployment, produced by some of the AI REGIO Regional Champion Didactic Factories.

5.3.1 "Lean Experience Factory" TERESA

5.3.1.1 TERESA's responsible

Name	Gouya Haririchi
Contact details (phone number, email, etc.)	Phone number: +39 0434 858756 E-mail: gouya.haririchi@lef-digital.com
Role in the DF	European Project Manager
Short profile	Gouya Haririchi has a Ph.D. in Economics and Management from Copenhagen Business School. In the last 10 years she has been involved as a researcher in several European and national funded R&I projects in various European academic environments. Within LEF she is the European Project Manager.

5.3.1.2 TERESA's Overview

"Lean Experience Factory" TERESA		
Location/facilities	**Didactic Factory name and description**	**Lean Experience Factory (LEF)** LEF is a capability center whose mission is to provide companies with the skills necessary to reach levels of operational excellence and to effectively implement digital transformation through the combination of a scientific approach and an experiential approach. Furthermore, it is one of the nodes of the Digital Innovation Hub within the region Friuli Venezia Giulia. The main objective of LEF is to support companies in developing a sustainable path towards operational efficiency and productivity growth. The center features a simulated firm, with real equipment and operators, that reproduces all the processes of all the value chain activities of a fully digitalized firm (i.e.simulating a real plant of refrigeration compressors). Trainees learn by observing and interacting with this purposedly designed environment. Trainees learn by experiencing direct contact with new technologies, best practices and successful approaches. Services address trainees at various levels: from technical experts, CxOs to students of schools and universities. In addition, the activities of LEF revolves around the dissemination of technical knowledge and organizational skills in partnership with the main players in the technological field at a territorial and global level. In general, LEF intervenes on three dimensions: 1. Processes and Technologies: The way in which activities and resources are employed and optimized to create value by minimizing loss factors. 2. Management Structure: The way structures, processes, and systems are organized to achieve shared goals by managing people and optimizing resources. 3. Mindsets and Behaviour: The way people think and act at work, both individually and in groups.

	Description of the experimentation facilities where TERESA will be conducted	LEF is part of the **McKinsey's Digital Capability Center Global Network** ((www. www.mckinsey.com). Capability Centers are **advanced tech-enabled innovation and learning hubs** that allow companies to experience the latest digital and analytics opportunities across the value chain and build the skills to apply them for holistic, lasting impact. Recently expanded to 3,000 square meters, LEF offers **remote and in-person capability-building programs** as part of an end-to-end transformation from lean excellence to a digitized industry leader. The center is home to an innovative model company that demonstrates realistic manufacturing processes with real products, back-office environments, and operators that can enact change resistance (which is typical for transformation programs). At the time of writing, LEF is the **largest and most integrated digital model company** in the world: at its core a real refrigeration compressor assembly line, a large-scale infrastructure open to technology providers providing technical support to **validate, test and demonstrate their latest SW and HW technologies** (including AI-powered ones), ultimately combining innovation, technology, services for businesses, start-ups and education. Besides from its hardware assets, LEF can leverage on well-established collaboration with both world tech giants (such as BLUE YONDER, CISCO, BOSCH REXROTH, ORACLE, ROBOTINUUM, etc…) and local ICT leading companies and system integrators. Technologies within LEF are spread along value chain of a typical manufacturing company. Starting from new product development (3D prototyping, Digital visual management, AR / VR tools for PD, Digital twin) going through supply chain & procurement (Supply chain risk assessment, Integrated Business Planning and Execution, Warehouse automation, AGV for line supply, AI (ML) based demand forecast), manufacturing (Quality Digital Twin, Real-time asset performance monitoring (OEE), Assembly on AGV, AI-based visual assembly inspection) and sales 6 customer care (RPA and smart workflows in sales back-office,

		Conversational AI chatbot), it cover all the processes that impact on the profitability of a firm.
	Pictures	  
	Activities	An important activity within LEF is the Use Case Program (UCP) where **Startups, SMEs and all types of companies** can experience and validate in a complex, real-world environment their innovative solutions, show them to their potential customers, and implement them much more easily with them. Use Case Program (UCP) is a **test field** where clients can:

		• deeply understand their customers' needs and design the best user experience of their new solutions • evaluate the maturity of new solutions • design the integration with the real user environment • validate and measure the benefits • make the implementation in any other real context effective The UCP team also provides experts' know-how in **design, lean manufacturing, six sigma and digital transformation** to help companies and to introduce their solutions into the market in the most efficient way.
Abstract of your TERESA	A TERESA will be conducted aside and as an evolution of the project ***"AIPRESTO - Artificial Intelligence for TOols PRESetting***", *funded under the first AI REGIO open call.* The project itself aims to develop an automatic visual inspection system applied on Computerized Numerical Control (CNC) machine tools, by setting up a **technological demo** hosted within the premises of LEF. **Ultimate goal:** increase the automation in quality inspection and control, while leaving the monotonous, repetitive tasks to the mechanical dimension and leaving the creative side to the human. Indeed, while CNC Machining is nowadays fully automated, the inspection (i.e. sizes, dimensions, and quality of the tools to be loaded on the CNC machining centre) is still prerogative of the operator. The overall system will leverage on **machine vision** using sensors (cameras), processing HW and SW algorithms to automate complex or mundane visual inspection tasks and precisely guide handling equipment during product assembly. The demo will be integrated with manipulation robots to perform tasks such as positioning, identification, verification, measurement and flaw detection. Within this framework, aim of the present TERESA will be to address the regulatory and ethical issues derived from the automatic visual inspection system, under controlled conditions.	
Scope of your TERESA	Inspired by both Industry 5.0 and Collaborative Intelligence concepts, testing activities will be focused on the **human – inspection system interactions**. In the Industry 5.0 perspective of AI-driven Autonomous Systems, the Collaborative Intelligence paradigm is indeed emerging as an innovative approach where "*Humans and AI join forces*". More in particular, the current TERESA will analyse to what extent the visual inspection system can assist the on-board machine operator and assume human features where workers can be effectively replaced (i.e. the inspection of sizes, dimensions, and quality of the tools to be loaded on the CNC machining centre). By demonstrating the overall validity of the system in assisting the operator on a real work environment, the overarching objectives for the sandbox will: • be addressed towards the promotion of the innovative product (promoting innovation); • inform policy makers and competent authorities through experimentation and learning, possibly helping them identify areas to improve the regulatory frameworks; • let Competent Authorities and regulators learn about developments in the marketplace.	
Motivation	The most developed area with the most mature AI applications is the machine tool level. A recent study (Columbus, L. (2020) "10 Ways AI is Improving Manufacturing in 2020"; May 18th, 2020), found that 29% of AI	

<table>
<tr>
<td></td>
<td colspan="2">implementations in manufacturing aim at maintaining machine tools. Nevertheless, there is still room of space on this level, as reported by the World Manufacturing Forum ("2020 World Manufacturing Report; page 27). Nowadays, modern CNC machine tools are equipped with a myriad of sensors that provide ample data to feed into AI learning algorithms to reliably predict the tool wear and performance to avoid product quality issues and accidental events such as tool breakage. The development of the machine vision AI-based system will mean an increased responsibility for the staff that need to supervise the quality of production.

This will unavoidably require an understanding on both regulatory and ethical issues in terms of ambiguous defect requirements, AI visual inspection systems can now solve. By way of example, it's not uncommon for two different persons to deliver a different verdict on the same error — one thinks the error is worth rejecting a part, while the other thinks the error is small enough to be ignored. With such an AI-based system the two opinions can be aligned on these issues by documenting defects programmed to highlight any ambiguities.

Nevertheless, while such an AI visual inspection system is expected to have a positive impact at the productive level, it also raises ethical dilemmas and regulatory issues that risk to hold back its adoption.

That's the underpinning reason of implementing the current "sandbox", In particular the following aspects related to the TERESA experiment should be taken into account, among the others:

How can the AI system capacities be used for the extensions of human abilities and their assistance in decision making?
To which extent increased automation can provide a unique opportunity to streamline processes and upskill workers if handled correctly? How can human agency and, ultimately, human judgement be maintained in such an AI-driven scenario?
Which are the risks in terms of deepening of the digital skills divide (between old operators and youngsters)?
Does actually exist any acceptance difficulty by the operator? To which extent?
How can we prevent AI from perpetuating existing biases?
Should the AI system be given legal personhood, and what are the consequences for machine-human relationships?
Who should be legally responsible for the decisions taken by algorithms?
</td>
</tr>
<tr>
<td>About your AI innovation to be tested</td>
<td>Description</td>
<td>Machine vision AI-based system will be integrated with manipulation robots to perform various tasks such as positioning, identification, verification, measurement and flaw detection, usually carried out by the on-board operator (object of the investigation) More in particular:

A Vision system that identifies the tools and sends the data to the robot control software;
A Robot picking up the tool and places it in the measuring station;
A Measuring station based on contactless gauging vision solution and telecentric lenses measures the tool (based on a recipe);
Data is saved to DB for successful analysis process for a) checking for anomalies b) generating data for CNC compensation parameter and c) predicting tool consumption;
</td>
</tr>
</table>

		• The Robot deposits the tool back in its "drawer" if it is usable, and deposits it in a special area if it is not usable (according to the rules given by the user).
	Expected use	The AI Visual Inspection system hosted within LEF premises might be used both for **Awareness** (i.e. encourage local manufacturing companies to adopt AI solutions) and **training purposes.** If feasible, the solution might be object of "Test before invest" related activities addressed towards the main target (e.g. CNC machining SMEs).
	Expected benefits of the service/tool/solution	• The development of the machine vision AI-based system will mean an overall increased **responsibility for the staff** that need to supervise the quality of production. Automatic visual inspection system indeed enables an optimization of the quality control phase which is beneficial from different point of views. A self-operating system will indeed incr**ease the accuracy in order processing and the speed of order fulfillment**. For companies working in the precision mechanic sector, it is crucial to provide customers with an excellent product and free from flaws. All of this has a positive impact on the level of responsiveness to clients, consolidating customers' loyalty and attracting new ones. Consequently, a **higher economic return** is expected due to an increase in orders in the long run. • Moreover, the automatic system will have some repercussions on human resources, too: having a computerized system will **free operators from the burden of performing repetitive and less stimulating tasks**.
	Expected risks	• Reliability of the AI Visual Inspection system; • Risk of misuse or incorrect use by the end-users (workers) in a real environment (at factory level); • Deepening of the digital skills divide (between elderly workers and youngsters); • Uncertainties regarding the applicable legal framework and who should be liable for the error or damage caused by AI.
Training opportunity (if any)	The TERESA will enrich the experience of LEF for future development of training courses on the topic of AI. To develop the skills needed to work with AI, conceptual education on AI capabilities and potential for use in manufacturing must be indeed complemented by **experiential learning**, including both experiences working side by side with AI systems and experience creating new AI solutions for manufacturing. Especially in terms of acceptance of AI and towards bridging the digital gap between old and youngster employees. With this regard, LEF can have a key role in facilitating knowledge transfer and training	

Legal Framework and regulatory requirements	All robotic agents operating at LEF facilities are compliant with ISO 10218-1:2011 and ISO 10218-2:2011. All mobile robotic agents are compliant with ISO 13855:2010. "Proposal for a regulation of the European Parliament and of the Council laying down harmonised rules on Artificial Intelligence" (the so-called "Artificial Intelligence Act") COM/2021/206 final "Ethics Guidelines for Trustworthy AI"; Independent High-Level Expert Group on Artificial Intelligence set up by The European Commission (2019) General Data Protection Regulation (EU) 2016/679 (GDPR)
ìLegal and ethical issues at stake	• **Well-being, Comfort and Acceptance:** Increase of impotence or usefulness feeling by the elderly workers not used to be replaced by a visual inspection system / machine; overconfidence on the machine. • **Improving working conditions:** Workers will not have to carry out inspection repetitive and unvaluable tasks (since they will be replaced by the machine with direct positive effects on their own skills). • **Social inclusion and special categories of workers:** the adoption of such an innovation will likely both have negative and positive effects; while there might be elderly workers' concerns/unwillingness in collaborating with a machine; the innovation can bring social inclusion of workers with cognitive disabilities/impairment.
HF issues at stake	The experiment will demonstrate the validity of a prototype for working scenario (the presetting of the CNC machining tools) where automation are not so high and the human factor is still of the upmost importance at the state of art.

5.3.2 "iiLab" TERESA

5.3.2.1 TERESA's responsible

Name	Rafael Arrais
Contact details (phone number, email, etc.)	rafael.l.arrais@inesctec.pt +351 222 094 000
Role in the DF	Researcher
Short profile	Rafael Arrais has an MSc degree in Electrical and Computer Engineering obtained at the Faculty of Engineering of the University of Porto (FEUP) and is a PhD candidate in the same institution. Since 2015 he is a Researcher and Project Manager at INESC TEC's Centre of Robotics in Industry and Intelligent Systems (CRIIS) and has participated and coordinated multiple R&D initiatives of European and Portuguese nature in the fields of Digital Manufacturing, Cyber-Physical Systems, Mobile Manipulators, Collaborative Robotics, and Software-based Safety Assurance. His main research interests are focused on the enhancement in vertical and horizontal interoperability between robotic and industrial automation systems and skill-based robot programming. He is the coordinator for the HORSE FLEXCoating experiment, the ROS-Industrial ROBIN project, and the COVR SAFECoating award.

5.3.2.2 TERESA's Overview

INESC TEC's Industry and Innovation Laboratory (iiLab)'s TERESA		
Location/facilities	**Didactic Factory name and description**	INESC TEC's Industry and Innovation Laboratory (iiLab) iiLab supports technology-based innovation in public and private organisations, thus contributing to the development of their skills in the development, adoption and implementation of advanced production technologies, leading to a sustainable competitiveness in the circular economy context. The iiLab aims to disclose the state-of-the-art in advanced production technologies through the demonstration of research, experimentation and advanced training results.
	Description of the experimentation facilities where TERESA will be conducted	The iiLab provides a controlled near-industrial test environment with production simulators, collaborative manipulators, cargo transport robots, and IoT platforms. The iiLab is equipped with multiple robotics and automation equipment. In specific, multiple collaborative robots (Universal Robot UR10, UR5; Yaskawa HC10; Kuka iiwa, etc.), industrial robots (ABB, Yaskawa), robotic actuators and sensors (Robotiq 2-finger gripper, 3-finger gripper, Photoneo PhoXi 3D Scanner M model, Zivid 3D sensor, etc.), AGVs (Omron, Husky and custom-made) and automation equipment (PLCs, industrial conveyors, etc.).

	Pictures	
	Activities	Multiple technology demonstrators for European and National R&D initiatives in the domains of Cyber Physical Systems (CPS) & Internet of Things (IoT); Advanced Automation & Industrial Robotics; Mobile Robotics & Internal Logistics; Industrial Vision Systems for Inspection and Quality Control; Business Intelligence & Decision Support Systems.
Abstract of your TERESA	The iiLab aims at disseminating the state-of-the-art of advanced production technologies and supporting technology-based innovation. The iiLab is meant to have continuous R&D projects demonstrations and act as a showroom focused on portraying concepts and advanced technologies in the areas of robotics, automation, industrial cyber-physical systems, and industrial internet of things (IIoT). The technological demonstrators installed in the iiLab are transferred to different industrial sectors such as automotive, aeronautics, machinery, metal working, textile, footwear, and logistics.	
Scope of your TERESA	With the iiLab, INESC TEC aims to disclose the state-of-the-art in advanced production technologies, vastly contributing to the industry's smart, sustainable, and technology-based growth.	
Motivation	The laboratory works in close collaboration with national and international initiatives such as national European DIHs and EIT Manufacturing in order to spread digitization technologies across all industrial sectors in the region, thus accelerating the development of new industrial technologies and maximizing its impact, promoting the digital transformation and competitiveness of manufacturing companies.	
About your AI innovation to be tested	**Description**	Create a near industrial scenario for both R&D, education and professional qualification, with emphasis on state-of-the-art

		methodologies for Human-Robot collaboration, full automation of industrial shop-floors and digital factories of the future.
	Expected use	The demonstrators are based on a ROS-based solution for task-based robot programming. The said solution allows for a great degree of automation. Tasks to be executed are sent by an Advanced Plant Model (APM) to robotic agents running a Task Manager (TM) ROS node. The APM holds a digital twin representation of the facilities where the robotic agents operate. It also knows the state of execution for each one of the tasks. A moving robotic agent equipped with cameras and artificial intelligence algorithms looks for inconsistencies, which are then communicated to the APM.
	Expected benefits of the service/tool/solution	- Automation of industrial plants leads top better production cost/ production time ratios. - Technologies for human-robot collaboration allow for higher degrees of product personalization without compromising the human operator's safety. - Augmented and virtual reality allow for operators to adapt to several types of situations quickly and help them solve problems faster. - Integration of new tools with existing industrial grade information technologies allow for an optimized management of the entire manufacturing processes.

	Expected risks	The experiment involves the capture of images by robotic agents. These images are then processed by the robotic agents in order to identify surrounding objects and detect inconsistencies in relation to the digital twin representation. During this process it is possible for the privacy of any human operator working near the robot to be compromised.
Training opportunity (if any)	The iiLab provides professional training in digital transformation management & advanced production technologies for senior managers and engineers of manufacturing companies and technology providers.	
Legal Framework and regulatory requirements	All robotic agents operating at the iiLab facilities are compliant with ISO 10218-1:2011 and ISO 10218-2:2011. All mobile robotic agents are compliant with ISO 13855:2010. All collaborative robots being used at the facilities are compliant with ISO/TS 15066:2016.	
Legal and ethical issues at stake	Not relevant.	
HF issues at stake	The experiment serves as a working prototype for working environments where levels of automation are high, and the human factor is still of the upmost importance. Such working environments will allow for a safer and more ergonomic cooperation between humans and robotic agents while increasing job interest, overall satisfaction and professional development.	

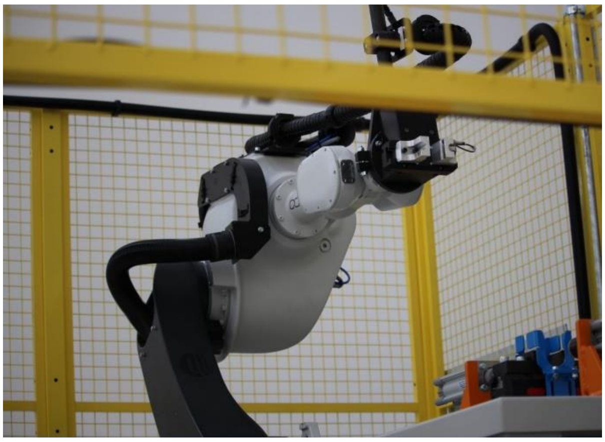
5.3.3 "Made" TERESA

5.3.3.1 TERESA's responsible

Name	Maria Rossetti
Contact details (phone number, email, etc.)	Maria.rossetti@made-cc.eu +393499249372
Role in the DF	Project Manager
Short profile	She holds a degree in international relations and MBA in management and design innovation. With over 7 years in EU and regional funded R&I project and innovation management, she's has been in charge of managing Enterprise Europe Network project, coordinating standardization working groups at national and EU level and coordinating European Digital Innovation Hub activities.

5.3.3.2 TERESA's Overview

Made's TERESA		
Location/facilities	**Didactic Factory name and description**	MADE Competence Center MADE is one of the 8 italian Competence Centers, officially acknowledged as Digital Innovation Hub by European Union. The MADE vision is to lead companies digital and sustainable transformation. On one hand, MADE provides a set of knowledge, methods, technical and managerial skills on digital technologies to support companies in their digital transformation towards Industry 4.0. On the other hand, thanks to the large demo-center of over 2000 m^2, it provides an I4.0 – based pilot production facility for pioneering test, demonstration and development project realization. MADE is a public-private consortium attracting investments for more than 22M EUR in 2019-2021 horizon. It is composed of more than 47 partners clustered in: 4 Universities, 2 research facilities, 42 Manufacturing Companies including software technology providers and one public entity. MADE – Competence Centre Industry 4.0 can simulate a complete production process cycle, from the planning stage to designing a product and then producing it, using a wide selection of technologies. From product design to internal logistics, 20 demonstrators provide orientation, learning and technological transfer with manufacturing companies in mind. Our facilities with lecture rooms and large internal spaces are unique in their kind, offering a welcoming atmosphere and a wide spectrum of resources to visitors from all round the world.
	Description of the experimentation facilities where TERESA will be conducted	The area is is reserved for digital twins, lean production and logistics 4.0 is a small compact plant, where the production of mechanical valves for the oil & gas industry is simulated, in a production chain involving: Robotics is the thread connecting with the third area. The focus is on human-machine and machine-machine collaboration, containing two technological cells. The first island accommodates a number of collaborative industrial robots of different sizes, which are used in the process to mount a fork to a motorbike frame, designed to operate safely when humans are present. A smaller collaborative robots assist the operator in completing the assembly, by carrying out automatic

		and interactive procedures in full safety. In the second island, we see how an "Operator 4.0" is "augmented" through cyber-physical smart systems, and can handle traditional operations using wearable devices and software to manage and improve adaptive interaction between human and machine.
	Pictures	 
	Activities	
Abstract of your TERESA		
Scope of your TERESA	Develops AI quality inspection system Capsule Picking Vision System to detect stacks of capsules to be picked up from boxes. It allows to practically deploy the concept of Industry 5.0 in manufacturing by ▪ Enhancing human-centric approach, exploiting the "train explain sustain". Humans train and overview machines to perform quality inspection process and elaborating the results of this process phase; ▪ Enhance cognitive ability of the worker, replacing repetitive task with high added value ones (i.e. planning, data, interpretation) ▪ Reskilling, shifting traditional low added value task (i.e. quality inspection of capsule) with higher added value ones (i.e. machine training, planning) thus enhancing upskilling of existing workforce towards less frustrating operation.	
Motivation	▪ Pre standardization of new reskilling methodologies; ▪ Requirements for human supervisory control of machine/robots in performance of manufacturing routine task.	
About your AI innovation to be tested	**Description**	Capsule Picking Vision System has been designed to detect stacks of capsules to be picked up from boxes.

	Expected use	The system is composed of a vision station with 3D inspection. Its aim is to recognize stacks of capsules located inside a box and identify their optimum gripping point so that they can be easily picked up by the robot. The vision station consists of three 3D sensors with integrated lighting responsible for the acquisition and analysis of the 3D clouds of the stacks. .The vision station consists of three 3D sensors with integrated lighting responsible for the acquisition and analysis of the 3D clouds of the stacks. The HMI opens up for a more inclusive quality inspection process scenarios where people - Can interact with the process, even if having lower education - Can leverage added value skills (e.g. data analysis) avoiding repetitive task
	Expected benefits of the service/tool/solution	- Cost/time effectiveness - Reskill existing workforce from repetitive task to cognitive ones - Involvement in quality inspection activities, people who was not skilled enough to perform such tasks (due to the HMI)
	Expected risks	Describe potential risks that such AI solution might arise
Training opportunity (if any)	Training opportunities: teaching factory/training: quality inspection through vision station with 3D non destructive system;	
Legal Framework and regulatory requirements	Not relevant	
Legal and ethical issues at stake	**a. Human supervisory control of machine/robots in performance of routine tasks.** Machines are capable of performing a limited series of actions automatically (i.e. capsule stack detection), based on a computer program, besides sensing its environment and its own joint positions and communicating such information back to a human operator who can update its computer instructions as required; b. **Deepening of the digital skills divide** #N. of workers employed in high added value activities (i.e. not repetitive task) #N. of instruction provided to the machine **c.Decrease of frustration and impotence feelings/feeling of usefulness/fiarness** #Increase in job's quality (survey) #n, of new jobs created to frail people (e.g. low education, low experience)	
HF issues at stake	Identify the HF issues relevant in this test	

5.3.4 "Mini-Factory" TERESA

5.3.4.1 "Mini-Factory" TERESA

Name	Elias Montini
Contact details (phone number, email, etc.)	elias.montini@supsi.ch
Role in the DF	Researcher
Short profile	Elias is a researcher of the Sustainable Production System Lab at University of Applied Science and Arts of Southern Switzerland and an executive PhD student at DEIB - Politecnico di Milano. He holds a Master of Science in Engineering with specialization in Business and Production. His research activities focus on collaborative robotics and on (Human) Digital Twins towards the design and development adaptive work environments, where humans and machines complement their capacities to optimize manufacturing performances and improve worker wellbeing. These activities have been carried out and are ongoing through research projects funded at national and international level in the context of digitalization in manufacturing, including DAEDALUS-H2020, COMPLEMANT: Open-call experiment, KITT4SME-H2020, STAR-H2020, BRILLIANT: Open-call experiment.

5.3.4.2 TERESA's Overview

"Mini-Factory" TERESA		
Location/facilities	**Didactic Factory name and description**	**Mini-Factory** The Mini-Factory is realised and developed by the Sustainable Production System (SPS) Lab of SUPSI. The activities of the SPS Lab focused on the development of human capital and the innovation of production systems and technologies through education activities at bachelor, master and employment levels, as well as through research, development and technology transfer activities concerning the life cycle of products and industrial processes, in the fields of design, automation and management of production systems and the relative value chains. Key research areas are Supply Chain & Operations, Human-Centred Workplaces, Sustainability and Personalisation, Simulation Technologies. SPS Lab has a twofold soul embodied by different teams pursuing the mission of innovating and digitalising processes by: (i) adapting automation behaviour based on human factors and needs towards human-centred production systems; (ii) assessing and optimising processes to improve sustainability and promoting circular economy. The Mini-Factory is a flagship and key asset of the Lab. It is a smart, automated, modular and multi-purpose learning factory

		empowered by the pervasive use of key digital technologies towards Industry 4.0 paradigm full implementation.
	Description of the experimentation facilities where TERESA will be conducted	The Mini-Factory is equipped with both classical automation technologies (PLC, MES and SCADA programming, precision axes control and pneumatics), as well as advanced technologies, typical of the most advanced smart-factories (IoT, vision systems, simulation and digital twin, advanced measuring methods and smart production management systems, collaborative robotics, AGVs). From an RTD point of view, the factory functions as a pilot plant for research and applied industrial projects, on top of which applications and technologies are developed, tested and integrated.
	Pictures	  

<table>
<tr><th></th><th>Activities</th><th></th></tr>
<tr><td>Abstract of your TERESA</td><td colspan="2">The TERESA in the Mini-Factory will be realised through different small experiments dedicated to collaborative robotics and human-centred production systems.</td></tr>
<tr><td>Scope of your TERESA</td><td colspan="2">The experiments will show different scenarios where a cobot and humans work together in various tasks (assembly, polishing, screwdriving) and with varying degrees of collaboration (separated and independent, sequential, synchronous, etc.). In some experiments, the humans will be equipped with wearables, allowing to collect data and monitor their conditions to show how humans' features, if merged with factory entities and process' features, can be used to improve both process performance and workers well-being. In this scenario, a Human Digital Twin is instantiated to manage data, integrate different AI modules, monitor and orchestrate the system. The twin is realised thanks to the Clawdite platform, a solution developed by the SPS Lab. This platform is designed to instantiate a single source of truth of production systems data, including workers-related ones. It offers a centralised access point that functional modules, including AI-based ones, can exploit to compute complex features, enriching the digital twin, or to make better decisions.</td></tr>
<tr><td>Motivation</td><td colspan="2">The motivation behind these experiments has two nuances:
To create production systems that seamlessly complement human capabilities, the digital factory has to include a precise and realistic digital representation of humans, the Human Digital Twin. In such a model, workers' behaviour is predicted by analysing historical data and psychophysiological status, aiming to optimise processes and to make better decisions.
These experiments aim to provide different instantiations of Human Digital Twin to show its potential and applications.
Unfortunately, the traditional approach to automation isn't much help for SMEs' cases. As a matter of fact, traditional automation relies on rigid programming made by experts, most of the time external to the manufacturing company, that perfectly optimise lines dedicated to a fixed production – a car, a fridge – for a consistent period. Transposing this approach to SMEs, even employing cobots, is simply going to fail, for their industrial needs are substantially different. Time is over for applications and use-cases that may solve specific problems but have no potential for replicability.
These experiments aim to provide and test smart packages and methodologies to easily implement and manage new collaborative installations that cope with continuous production changes.</td></tr>
<tr><td rowspan="4">About your AI innovation to be tested</td><td>Description</td><td>Fatigue Monitoring System (FaMS): it is an AI module to estimate humans' perceived exertion fatigue based on workers' dynamic (e.g., heart rate) and quasi-static (e.g., age, experience) data.

Intervention Manager: it allows to define rules to orchestrate a production system easily. It monitors the real-time status of the worker-factory ecosystem, elaborating data from sensors, machines, workers monitoring systems, ERP, etc., knows what interventions can apply and which are the rules to decide which is the best one".</td></tr>
<tr><td>Expected use</td><td>These modules will change the work cell configuration dynamically and trigger specific interventions (depending on the experiment), relying on the information collected in the Human Digital Twin, including the fatigue estimated by the Fatigue Monitoring System. While the work cell is operating, the Intervention Manager periodically selects the most appropriate configurations and interventions.</td></tr>
<tr><td>Expected benefits of the service/tool/solution</td><td>Increase process performance
Monitor and improve workers well-being</td></tr>
<tr><td>Expected risks</td><td>Adoption and acceptance of AI; adoption of wearables devices (even if non-invasive).</td></tr>
</table>

Training opportunity (if any)	Cobot programming training, design and deployment of human-centred/collaborative work cells.
Legal Framework and regulatory requirements	Not relevant
Legal and ethical issues at stake	Humans' personal data are collected in some experiments. All experiments will pay emphasis on ensuring compliance to GDPR.
HF issues at stake	Not relevant

5.3.5 "BIC" TERESA

5.3.5.1 TERESA's Responsible

Name	John Blankendaal
Contact details (phone number, email, etc.)	+31 (0)6 526 32 936 j.blankendaal@brainportindustries.nl
Role in the DF	Managing Director
Short profile	John Blankendaal (1961) started in 2011 as managing director of Brainport Industries. Before that he was program manager at the Brabant Development Agency. John is also the director of the foundation Smart Connected Supplier Netwerk (SCSN). This foundation is DIH and has the I-space gold label. He is board member of the EDIH and involved in several initiatives like GAIA-X-, Catena-X, IDSA and European projects like Market 4.0, EUR3KA, DIMOFAC and AIREGIO

5.3.5.2 TERESA's Overview

Name of your TERESA		
Location/facilities	**Didactic Factory name and description**	BIC: Factory of the Future Experience Center. From presentation rooms to machine park and anything in between. To facilitate innovation, the campus has everything under a single roof and it offers all the facilities to create a pleasant production and business climate. The BIC has a close connection with the Digital Innovation Hub SOUTH-NL.

	Description of the experimentation facilities where TERESA will be conducted	In the Factory of the Future, research is conducted into data-driven innovations within eight different areas of expertise. This is done in so-called Field Labs, in which partners work together on possibilities for the digital factory. Through research, presentations, test cases and digital twins, they take a step further towards Smart Industry together.
	Pictures	 
	Activities	**Flexible Manufacturing**: Flexible production and assembly solutions and focus on robotization of manufacturing processes. **Multi Material 3D**: Research Pilots with a focus on automation for multi-industry 3D applications. **High Tech Software Cluster:** focus on AI, ML, Big Data Analytics, Data Services, Industrial 5G, Industrial IOT, and Wireless Communication and Virtual Prototyping and Design. **Smart Connected Supplier Network:** Platform for information exchange in supply chains. **FutureTec**: The development of educational content and implementation of innovative technical education in the region
Abstract of your TERESA	The TERESA in BIC: Factory of the Future aims to realize fast, flexible and faultless assembly with projected work instructions. In the factory of the future multiple experiments will be conducted. With regards to how to handle machine data, production processes and information exchange along the chain. Another example is due to an operator support system in a manual assembly workplace. This system helps companies to perform fast, flexible and faultless assembly of different products.	
Scope of your TERESA	▪ Flexible production: different specifications, products, numbers, timing for high mix, low volume products. ▪ Develop a better understanding in the legal and regulatory framework regarding AI. ▪ inform policy makers and competent authorities through experimentation and learning, helping to identify areas to improve the regulatory frameworks ▪ Design & Manufacturing in the chain. Collecting and using data and in a controlled way sharing of data in the chain with customers.	

Motivation	Developments in technology are happening fast: more digitalization and robotization on the work floor. With the flexibility that is demanded, people and robots/machines will continue to cooperate. Companies need to be able to deploy wider target groups (experienced and inexperienced, young and old) quickly and flexibly in the primary process.	
About your AI innovation to be tested	**Description**	Several experiment regarding high mix low volume production will be conducted. One of them concerns an operator support system. This operator support system can deliver distinct products to assemble. The operator follows instructions through projection on the product that has to be assembled. The system learns from the operator while also teaches the (new) operator in best practices. The machine analyses hand movement of the operators. This is the basis for an ideal assemble combination. However, more experiments will be conducted regarding the different topics mentioned in the activity section.
	Expected use	A better cooperation between machine and humans in the manufacturing process. Experts with experience can teach the machine best practices. Moreover, the machine can teach new operators those best practices. Also, the machine helps to reduce errors. Also, the TERESA can help in understanding and developing machine data and machine learning.
	Expected benefits of the service/tool/solution	- Involvement in quality inspection activities, people who were not skilled enough to perform such tasks - Develop a better understanding regarding regulatory aspects of CA - Improve assembly time - Improve skills of new operators - Legal aspects and dispel concerns from users regarding legal aspects
	Expected risks	• Risk of misuse or incorrect use by the end-users (workers) in a real environment (at factory level); • Risk for the privacy of the operator. • Security for the operator
Training opportunity (if any)	In cooperation with educational institutes and also from the EDIH there are several training and education opportunities in place.	
Legal Framework and regulatory requirements	All collaborative robots being used at the facilities are compliant with ISO/TS 15066:2016, ISO 10218-1:2011 and ISO 10218-2:2011	
Legal and ethical issues at stake	All experiments will be conducted in compliance with GDPR. Other issues are still under investigation. This will be done in cooperation with regulatory authorities.	
HF issues at stake	Safety & Privacy.	

6 Conclusions and Future Outlook

This chapter will conclude by summarising the key findings. This deliverable introduced and defined Testing and Experimental Facilities, advanced the understanding of DFs and their network. The definition of DFs defined in this deliverable is as follows:

An open testing and experimentation facility which extends the services of a Learning Factory towards the materialization of the EDIH "test before invest" pillar. By providing access to technical expertise and experimentation as well as the possibility to "test before invest", A Didactic Factory, like a EDIH, helps companies innovating their business or production.

Moreover, AI TEF for Manufacturing is introduced and both AI Regio as AI TEF for Manufacturing have didactic purposes. Therefore, AI Regio aims to function as a precursor network for AI TEF for Manufacturing.

In the first phase of this project a network of 11 DF champions are identified and introduced. In addition 6 DFs expressed interest in joining the network, those DFs are labelled as extension of the network. In April 2022 a meeting regarding the next steps of the extended network will be organized. The second phase, starting March 2022, aims to stimulate knowledge exchange, best practices and lessons learned between the champions. The objective is to create a team of the champions who cooperate which each other. However, the next steps for the champions will be identified in collaboration with the champions in the form of mapping session(s). The output of those session will function as input for the next steps.

All the champions experienced a Didactic Factories services portfolio analysis in accordance to the DR BEST taxonomy. This deliverable provided a short overview of such taxonomy (with a specific focus on the "Remote" services) and analysed the Champions' portfolios identifying key aspects. The services presented by the DFs are almost equally present in quantity.

In the last chapter the concept of TERESA is introduced which is defined as follows: *For AI, enabling a direct testing environment for innovative CI-empowered products and services aimed at addressing ethical challenges and shortcomings of the regulatory framework concerning such products and services*

In some of the DFs of the DF network TERESA experiments are going to be run. In these Didactic Factories and their TERESAs, the ethical and regulatory issues arising from adoption of AI and human-machine interaction will be addressed. A core Group of 7 DFs are introduced along with their experiments. The DFs implementing a TERESA will follow several steps. The first step is identification of experiments and explain this in the TERESA overview. Next a testing plan will be drafted whereafter the experiments will be conducted. The last step concerns an analysis with lessons learned and a follow-up.