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D 2.3
Pathways alignment with National / Regional Initiatives- First Iteration

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[1] PU: Public, CO: Confidential, only for members of the consortium (including the Commission Services)
[2] RE: Report, OT: Other; ORDP: Open Research Data Pilot

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Abbreviations and acronyms

TERMS, ABBREVIATIONS AND ACRONYMS	
AAS	Asset Administration Shell
CC	Competence Center
CFII/CF2	Connected Factories II/2
DEI	Digitizing European Industry
DIH	Digital Innovation Hub
EC	European Commission
IdF	Industrie du Futur
IDS(A)	International Data Space (Association)
LNI	Labs Network Industrie
LEP	Local Enterpise Partnership
RAMI 4.0	Reference Architecture Model Industrie 4.0
RIS	Regional Innovation Scheme
SCI	Standardization Council Industrie
SME	Small Medium Enterprise
WPL	Work Package Leader

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Executive Summary

One of the key objectives of the Connected Factories II (CFII) project is to identify pathways to the industrial take-up of digital technologies and digital platforms by taking into account legacy systems, industrial requirements and challenges. In order to achieve this objective CFII engages with the research and industrial actors in both European, National and regional ecosystems, bringing together manufacturing companies, technology, component suppliers and more, and herewith make sure that requirements and boundary conditions are reflected in the pathways to digitalisation of manufacturing. Moreover, CFII aims at generating a broad awareness about the pathways as it is for example inspiring cases that include SMEs.

In accordance with the strategic objectives of CFII the objectives of this document are the following:

- Define a methodology for alignment of the pathways developed in CFII to Digitizing European Industry (DEI) initiatives
- Provide preliminary input from the national/regional/European

In CFI and CFII the following pathways have been developed (in CFI) or are under development (in CFII): Autonomous Smart Factories, Hyperconnected Factories, Collaborative Product-Service Factories, Dataspaces Pathway, Circular Economy Pathway and Cybersecurity Pathway.

In order to align the CFII pathways with National and Regional Digitizing European Industry Initiatives, an adapted waterfall method has been employed. The model emphasizes a linear management approach in which exchange of information between the both sides takes place since the early stages of the development. In this case the development refers to the definition of the CF2 pathways. The model is described in chapter 2.

Chapters 3 and 4 provide insight into National and EU level initiatives related to Digitizing European Industry with a focus on manufacturing industry. A list of national initiatives is presented in chapter 4. In each case, overall information is provided for the national activities while in some cases a projection to CFII pathways is presented. The feedback and analysis in national level depict that the CFI/II pathways definition is pertinent and reflects activities/initiatives in national and EU level. More feedback on their definition as well as cross-cutting factors are expected to be selected through workshop (WP5) during the course of the CFII project.

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1 Introduction

Connected Factories II (CFII) project aims at identifying pathways to the adoption of digital technologies and digital platforms. The pathways, that act as guides for industrial practitioners in their digital transformation journey, consider characteristics of the operational environment such as legacy systems, industrial requirements and challenges. In the process of defining, elaborating and fine tuning the pathways' definition, CFII engages with the research and industrial actors in both European, National and regional ecosystems. Manufacturing companies, technology, component suppliers, research institutes and more actors, in both European, National and regional ecosystems, are brought together in order to make sure that requirements and boundary conditions are reflected in the pathways to digitalisation of manufacturing. Finally, CFII aims at generating a broad awareness about the pathways as it is for example inspiring cases that include SMEs.

The objectives of this document, aligned to the overall objectives of CF II project are the following:

1. Define a methodology for alignment of the pathways developed in CFII to Digitizing European Industry (DEI) initiatives
2. Provide preliminary input from the national/regional/European

The information regarding the Connected Factories I/II pathways are provided in the following sources:

- Connected Factories I pathways:
  - Autonomous Smart Factories
  - Hyperconnected Factories
  - Collaborative Product-Service Factories

  More information on the pathways can be found here: https://www.connectedfactories.eu/pathways-digitalisation-manufacturing

- Connected Factories II pathways:
  - Dataspaces Pathway, information to appear in deliverable D2.2 "Pathways cross-fertilisation with Digital Technologies - First Iteration"
  - Circular Economy Pathway, information to appear in deliverable D2.1 "Pathways instantiation from DT-ICT-07 domains - First Iteration"
  - Cybersecurity Pathway, information to appear in deliverable D2.6 "Pathways cross fertilisation with Digital Technologies – Second iteration"

The structure of the document is as follows:

1. Chapter 2 describes the methodology to align the pathways to several initiatives.
2. Chapter 3 provides initial input from different initiatives in EU countries.
3. Chapter 4 provides input from EU level initiatives.
4. Chapter 5 provides some conclusions and discusses on the next steps in the context of this activity.

2 Method to align CFII pathways with National Regional DEI Initiatives

In order to align the CFII pathways with National and Regional Digitizing European Industry Initiatives, an adapted waterfall method has been employed. The model emphasizes a linear management approach in which exchange of information between the both sides takes place since the early stages of the development.

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In this case the development refers to the definition of the CFII pathways. On one side there is the CFII consortium responsible for the development of the pathways and the on the other side there are several DEI initiatives. The sequential steps of the method are described hereafter.

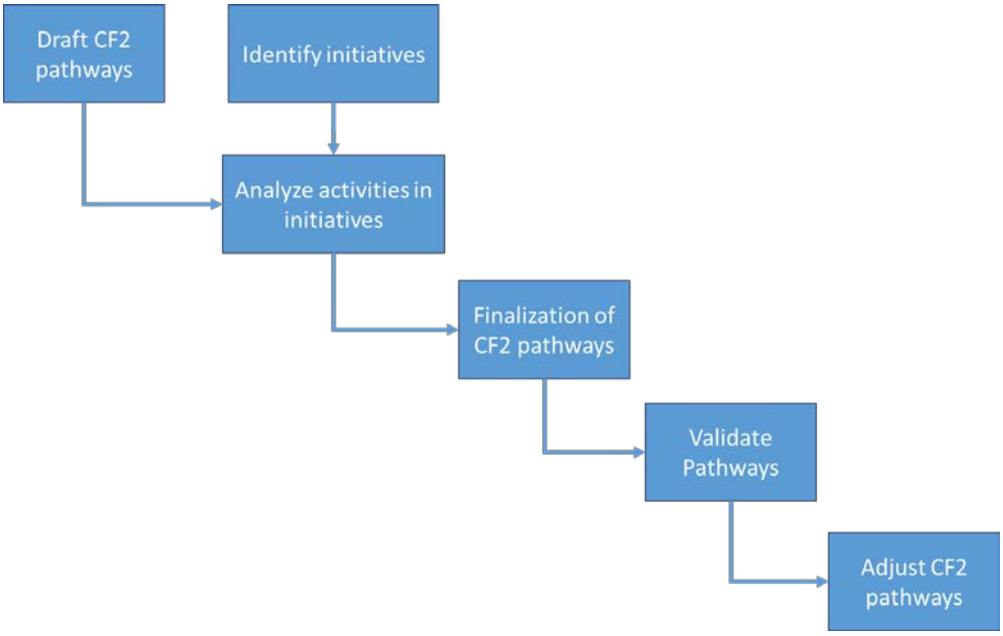


Figure 1: Method to align CF2 pathways with National and Regional Initiatives

Step I - Preparation

Initially, draft CFII pathways are provided to the CF2 so called "Ambassadors" that represent several EU countries and are members of the CFII project. Apart from the countries already represented in CFII projects initiatives, additional countries not represented in CFII project will be identified. This step provides the initial input to allow the rest of the process steps to enrol.

Step II – First iteration

In the second step, the activities in DEI initiatives related to the contents of the CFII pathways are analysed by CFII ambassadors. The objective of this step is to provide input to CFII pathways' developers in order to consider knowledge, best practices, cases etc. already available from other initiatives. The draft CFII pathways descriptions would facilitate this objective.

Step III – Full draft versions delivered

Input received from previous step as well as input received from organizing workshops (WP5) around the pathways will be considered and full draft versions of the pathways will be delivered.

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Step IV – Validation

The full draft versions of the pathways will be validated from the ambassadors either directly or through workshops. The feedback received will be utilized for finalizing the pathways definition in the final step.

Step V – Adjustment and fine tuning

Based on the feedback received form the validation phase, the descriptions will be adjusted in order to address the comments received. The outcome is the final description of CFII pathways.

3 National Initiatives and regional Initiatives (LMS overall)

3.1 Overview

This chapter provides an overview of the initiatives regarding digital transformation of manufacturing companies in Europe. In the paragraphs below a list of initiatives are examined in different EU countries with respect to examine activities that take place with respect to CFI and CFII pathways. The first objective is to gather information from the different initiatives that will contribute to the alignment of the CF1 and CF2 pathways with relevant work done within these initiatives and the second one is to identify the possible ways to validate the CF1 and CF2 pathways from organizations and stakeholders behind the initiatives.

3.2 Belgium

Due to the structure of the federal state, DEI related initiatives are launched at several levels to provide a maximum impact on the manufacturing industry: federal and regional. In addition to these country based initiatives, sectoral initiatives are deployed by sectoral federations (e.g. Agoria) and sectoral knowledge centres (e.g. Sirris).

3.2.1 Technological Sector initiatives: Made Different and Factory of the Future

The aim of the **Made Different** [3]action plan is for the Flemish government, the technology federation Agoria and its joint research centre Sirris to strengthen Flanders' manufacturing industry and make it a world leader. The Made Different action plan is designed to give to the manufacturing industry in Flanders a future in the industrial landscape of the 21st century. Our approach entails raising awareness, providing information and offering specific guidance. To ensure the latter, we have designed seven paths, each of which spotlights one of the seven necessary transformations our companies need to undergo to become real 'Factories of the Future'.

These 7 transformations can be partially mapped to CFII Pathways

1. World Class Manufacturing — CFI: Autonomous Smart Factories
2. Customer Focused Integrated Engineering — CFI: Collaborative Product-Service Factories

[3] https://www.madedifferent.be/en

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3. Digital Factory	CFI: Hyperconnected Factories
4. Human Centered Organisation	CFI: Autonomous Smart Factories
5. Eco Factory	CFII: Circular economy for manufacturing
6. Networked Factory	CFI: Hyperconnected Factories
7. Smart Manufacturing	CFII: Autonomous Smart Factories

Companies (LE, SME) can participate in a **manufacturing community**[4] where they will learn all about the various building blocks, the ones that they have already preceded and the ecosystem to which you have access. Typical building blocks are: Additive Manufacturing Technologies (3D-printing), Augmented Reality, Autonomous Robots, Big data, Blockchain, Cloud, Cyber Physical Systems, Cyber security, Digital Twin, Drones, Internet of things, Industrial Communication, Machine Learning, Simulation, Virtual Reality etc.

3.2.2 Regional Initiatives Flanders

In order to retain and strengthen the manufacturing industry, the Government of Flanders is investing heavily in the transition to industry 4.0[5]. This integrated approach is developing along five lines of action.

1. The creation of a central platform enables better consultation between the government, the business federations and the research institutions.
2. A strong knowledge base is important for conducting targeted research into new, advanced concepts.
3. Stimulating the use of new technologies and concepts is the essence of the action plan. We do this, for example, with **industry 4.0 living labs**[6]. In 2018 and 2019, 17 living labs were set up.
4. We are also making every effort to improve the environmental factors, particularly in the area of the central themes of work and training.
5. We allow companies to benefit from international programmes by encouraging and facilitating cross border cooperation.

The living labs are a very convenient way and low threshold initiative to let SME's discover and experiment with new technologies. Among the existing 17 labs, 9 are very strongly related to the CFII Pathways:

1. COLLABORATIVE WORKCELL 4.0[7]: This living lab combines a cobot, digital work instructions and light projections, with measurements of the physical/mental workload of the employee.
2. SMART CONNECTIVITY[8]: Learn how to obtain reliable data and localisation solutions in challenging situations, such as a factory hall with dynamic obstacles and moving personnel.
3. SMART MAINTENANCE[9]: Affordable sensors facilitate the shift from periodic to conditional maintenance, which allows industrial companies to save a lot of money. This living lab shows how to lower maintenance costs and how to increase productivity.

[4] https://manufacturingcommunity.agoria.be/
[5] https://www.industrie40vlaanderen.be/industry-40-flanders
[6] https://www.industrie40vlaanderen.be/sites/default/files/downloads/living_labs_poster_industrial.pdf
[7] https://www.industrie40vlaanderen.be/proeftuinen/collaboratieve-werkcel-40
[8] https://www.industrie40vlaanderen.be/proeftuinen/smart-connectivity
[9] https://www.industrie40vlaanderen.be/proeftuinen/smart-maintenance

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4. OPERATOR SUPPORT 4.0[10]: Assembly processes are becoming extremely complex. This Living Lab demonstrates solutions for maximum production flexibility without pushing employees to their limits. The fastest way to 'lot size 1'!
5. CONDITION-BASED & PREDICTIVE MAINTENANCE[11]: Production machines are home to a wealth of information. IoT sensors and cloud solutions pave the way for optimal maintenance and further digitisation.
6. DIGITAL SERVITISATION[12]: How do you quickly assess the feasibility of a new, smart product with an associated digital earning model? This living lab provides the building blocks (sensors, connectivity, data-analyses, dashboards) you need!
7. MACHINE UPGRADING 4.0[13]: By upgrading existing installations with sensors, actuators and computing power you give a new life to old machines.
8. MES4SME[14]: SMEs need reliable and easily configurable Manufacturing Execution Software. Experts show the best solutions in this test environment.
9. CYBERSECURITY 4.0[15]: The tsunami of data causes risks at production level. This living lab offers an overview of solutions in the area of cyber security and helps putting them into practice.

3.2.3 Regional Initiatives Wallonia

Digital Wallonia[16] is a framework programme for the Walloon region, which sets public policy priorities and objectives and provides a framework for support for private initiatives in favour of digital technology. This framework is a showcase of the digital sector in Wallonia, which offers reference content and provides services to stakeholders involved in the implementation of the digital strategy.

It focusses on 5 key areas: Digital sector, Digital business, Skills and education, Public Services and Digital territory.

One of the projects[17] as a Digital Innovation Hub[18] is based on the adoption of four key technologies : Artificial Intelligence, the Internet of Things, high-performance computing and cybersecurity. These technologies will be applied to all of the elements that form the foundations of an industrial manufacturing organisation. It will tackle all of the processes involved at all the different stages of managing the flow of goods, production and the associated information exchanges. The DIH will identify a user experience that should be able to help businesses gradually become more technologically mature. There will be a particular focus on experimentation, thanks to the involvement of research centres and access to Industry 4.0 demonstrators. The approach is designed to be multi- and cross-sectoral, with specific activities aimed at logistics.

[10] https://www.industrie40vlaanderen.be/proeftuinen/operatorondersteuning
[11] https://www.industrie40vlaanderen.be/proeftuinen/conditioneel-en-predictief-onderhoud-industrial-data-space
[12] https://www.industrie40vlaanderen.be/proeftuinen/digitale-servitisatie
[13] https://www.industrie40vlaanderen.be/proeftuinen/machine-upgrading-40
[14] https://www.industrie40vlaanderen.be/proeftuinen/mes4sme
[15] https://www.industrie40vlaanderen.be/proeftuinen/innovatieve-cyberbeveiliging-voor-industrie-40
[16] https://www.digitalwallonia.be/en
[17] https://www.digitalwallonia.be/en/projects
[18] https://www.digitalwallonia.be/en/posts/edih-industry40

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3.2.4 Federal Initiatives

Apart from a Digital Agenda[19] for Belgium, which is different from the regional agendas, the federal level is involved in **standardisation**[20] issues which closely relate to CFII Hyperconnected Factories and CFII Autonomous Smart Factories.

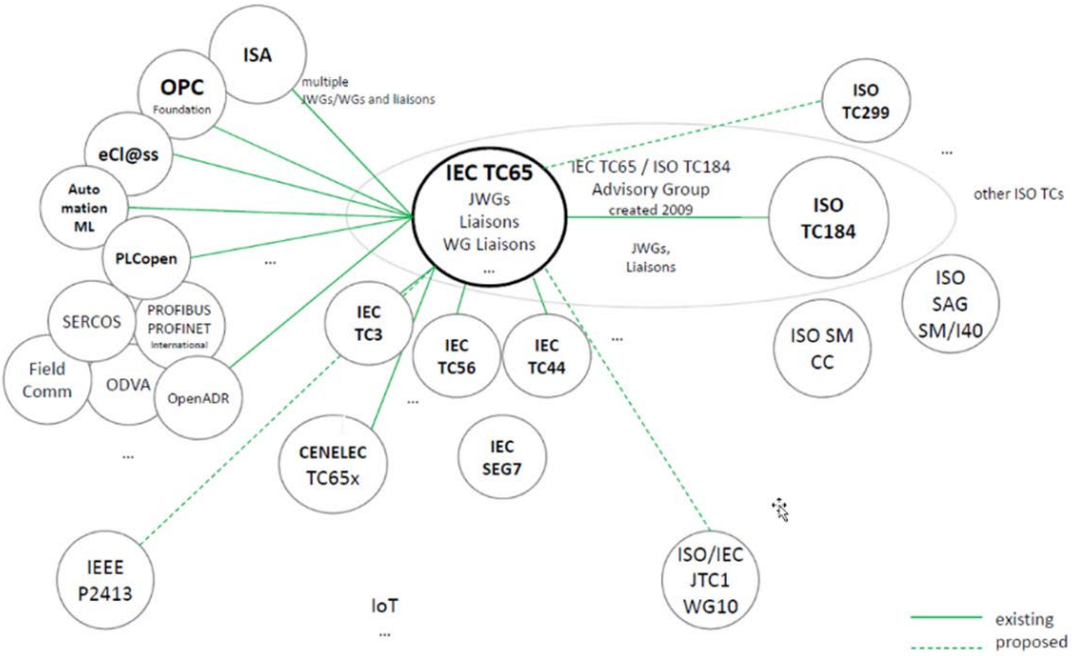


Figure 2: CLC/TC65X February 1 to 2, 2017-Annex-H-IEC_TC65_SmartManufacturing_2017

3.3 Germany

The recent years have been very productive for Industrie 4.0 initiatives in Germany in terms of making, testing and experimenting the boosting digital solution. In particular, several respective activities are worth to be presented in context of the ConnectdFactories2 as depicted in this subchapter.

3.3.1 Key Initiatives

The German Plattform Industrie 4.0 is one of the central nodes that successfully promotes the digital transformation of manufacturing in Germany. Under its umbrella, several experts from business, science, associations and the trade unions develop operational solutions together with representatives from various federal ministries in thematic working groups. In particular, the Plattform Industrie 4.0 has the goal to develop pre-competitive concepts and solutions and put these into practices; to support companies with recommendations for action, information and use cases; and to feed the results into the international Industrie 4.0 discourse, especially bringing these into the national and international standardization processes. The key work is being done by six working groups, which address topics from the fields of standardisation, technology and application scenarios, integrated systems security, legal frameworks, work, continuing vocational education and training, and digital business models.

[19] https://economie.fgov.be/en/themes/online/digital-belgium-digital-agenda
[20] https://www.sirris.be/standard-cell-industry-40-frequently-asked-questions#model

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The Standardization Council Industrie 4.0 (SCI 4.0) is an important strategic organization that establishes recommendations for action for Industrie 4.0 and coordinates their implementation in standards and specifications. Therefore, the SCI 4.0 thus mediates between the Platform Industrie 4.0 and the various standards organizations and bundles the stakeholders in Germany in cooperation with the Platform Industrie 4.0.

The Labs Network Industrie 4.0 (LNI 4.0) enables small and medium-sized enterprises to implement the strategic recommendations for action (defined by SCI 4.0 and other core initiatives) and further test new technologies and use cases in pilot projects approving the technical feasibility of the underlying concepts.

The Industrial Digital Twin Association (IDTA) is a brand new initiative that has been founded on 23 September 2020, by VDMA, ZVEI and 20 additional well-known German industrial companies to drive forward the broad use and application of the Asset Administration Shell and digital twin concepts.

The project GAIA-X aims to create a federated data infrastructure to strengthen the European ecosystem: a secure, federated system that meets the highest standards of digital sovereignty while promoting innovation.

The International Data Spaces Association (IDSA) has the mission to create the future of the global, digital economy with International Data Spaces (IDS), a secure, sovereign system of data exchange in which all participants can realize the full value of their data.

Fraunhofer IPA is deeply involved in the activities of the above-described initiatives and organisations at several working group levels (directly as member or indirectly expert discussions) establishing an important link to the transfer of ConnectedFactories2 results.

3.3.2 Integrated results and activities in focus

Several important activities and achievements of the platform could be summarized across the initiatives and highlighted in the next abstracts under the reference to ConnectedFactory2 objectives.

Pathways

At the German Federal Government's Digital Summit 2020, the platform presented practice examples and three pathways towards resource efficiency, transparency, and networking to an ecologically sustainable Industrie 4.0. According to it, sustainability is one of the fundamental cornerstones of societal values that becomes increasingly the focus of public debate. Therefore, the platform has compiled an analysis of more than 60 examples of sustainable, digital manufacturing from companies and research showing that Industrie 4.0 is already enabling more resource-efficient and climate-friendly manufacturing today.

Human at Work, Skills and Knowledge Transfer

Further work of the Plattform Industrie 4.0 includes the development of a "Charter for Learning and Working in Industrie 4.0", which is intended to help companies and employees collectively shape the transformation of Industrie 4.0 along the three dimensions 'people', 'technology' and 'organisation'.

Interoperability, Data Infrastructure and Standardization

In terms of interoperability, the Platform Industrie 4.0 have formulated a holistic approach to the design of digital ecosystems with the core idea based on three strategic fields of action in Industrie 4.0: Autonomy, Interoperability and Sustainability. The core principles are described in the 2030 Vision for Industrie 4.0: Shaping Digital Ecosystems Globally where it designs the mission statement 2030 and concentrates in the

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design of digital ecosystems. The statements clearly point out the main necessary activities to overcome in the next period. This work has been deeply analysed in the project's crosscutting task "Interoperability".

The further important work of the platform in terms of interoperability relates to the development of the Reference Architecture Model Industrie 4.0 (RAMI 4.0) and Asset Administration Shell (AAS). RAMI 4.0 has been so far accepted by international bodies as an international standard. The current work of the Plattform Industrie 4.0 together with national bodies is now focusing on internationalization of AAS concepts in IEC TC 65 Working Group 24 Asset Administration Shell for Industrial Applications. Very good results have been achieved in discussion regarding the AAS structure, properties and services. The Plattform Industrie 4.0 working group on standards invites everybody to join in and can create experimentally their own Asset Administration Shell in practical web seminars. The following work has been included in the analysis of the project's task "Standardization" and have been since the beginning the driving force in the discussion within the ConnectedFactories2 Digital Manufacturing Platform (DMP) Cluster.

The Plattform Industrie 4.0 also co-initiated the foundation of the *Industrial Digital Twin Association (IDTA).* The association further develops the industrial digital twin as an open source solution and brings it to the market. This work is monitored in the relation to the Connectedfactories2 digitalization pathway "Data space pathway".

One of the key outputs of the SCI 4.0 is the German Standardization Roadmap Industrie 4.0. This work document not only pursues the goal of initiating digital production standards in Germany but also defines the focus actors and needs for new projects and organizes their international implementation.

Cases and Ecosystems

In Germany, Industrie 4.0 is not only within reach of large companies but is also being successively prepared for small and medium-sized enterprises in close cooperation. Thus, LNI 4.0 is committed to and cooperates with numerous stakeholders in this area. In particular, it offers companies and research institutions suitable access to competence centres and test infrastructures in close physical proximity. At the test centre, the LNI 4.0 members can test their ideas for technological feasibility and market readiness in practice with suitable partners without risk. In addition, LNI 4.0 offers access to ongoing test projects and experts to enable a topic-specific exchange of experience. A profound list of use cases summarizes the work and gives an overview of the achieved work. Among other objectives, important Industrie 4.0 topics such as in the area of interoperability, security, artificial intelligence, 5G developments are addressed in LNI 4.0 applications.

Security and cybersecurity topics gain a very special focus throughout all German initiatives, industrial associations, and organisations addressing Industrie 4.0 concepts and developing solutions.

For instance, the work of the IDSA should not be missing in this context. It brings together more than 120 member organizations, i.e. companies, scientists, lawmakers and relevant stakeholders, to cooperate in an open, not-for-profit coalition creating the technical standard with a new vision for a global, digital future in Europe and worldwide. This vision includes a special framework that has been developed according to the International Data Spaces Reference Architecture Model (IDS-RAM) and that is integral to the overall EU data strategy.

The IDS standard is a central element of the GAIA-X architecture, which, in its term, also addresses data related topics. Thus, the ability to both access and share data securely and confidently is becoming more and more important in the vision of Industrie 4.0 and GAIA-X community. In this context, more than 300

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companies are already contributing to the development of the federated data infrastructure, i.e. the GAIA-X ecosystem that connects centralised and decentralised infrastructures in order to turn them into a homogeneous, user-friendly system. One of the crossing points with the work of ConnectedFactories2 is the standardization aspect that belongs to one of the GAYA-X key objectives.

3.4 Italy

Having a look to the Italian scenario, in February 2017, it was approved a 4 years plan (the so called Piano Industria 4.0), reinforced in 2019, aimed to cover the digital gap affecting Italian manufacturing enterprises with respect to other European countries. The new strategy takes into account two different aspects: on one side, it is addressed directly to enterprises, boosting investments in new technology, providing fiscal reductions and contributions; on the other side, it focusses on research and innovation, increasing investments for the development of **Competence Centers** and **Digital Innovation Hubs**, which is a long-term investment for industries.

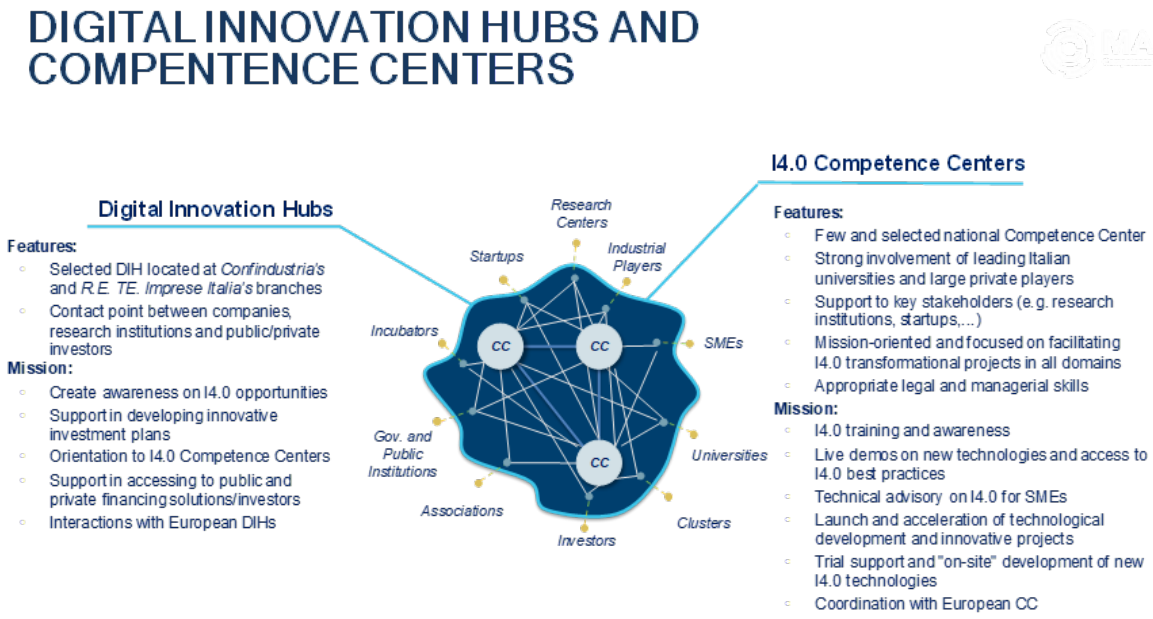


Figure 3: DIHs and CCs main features

Indeed, the idea of **Competence Center** is strictly related to the concept of Industry4.0: to foster the transition toward the digitalization and the adoption of new standards and solutions of enterprises, the Italian government financed the creation of 8 highly specialized competence centers, mainly built around the main Italian universities, with a specific focus on Industry4.0.

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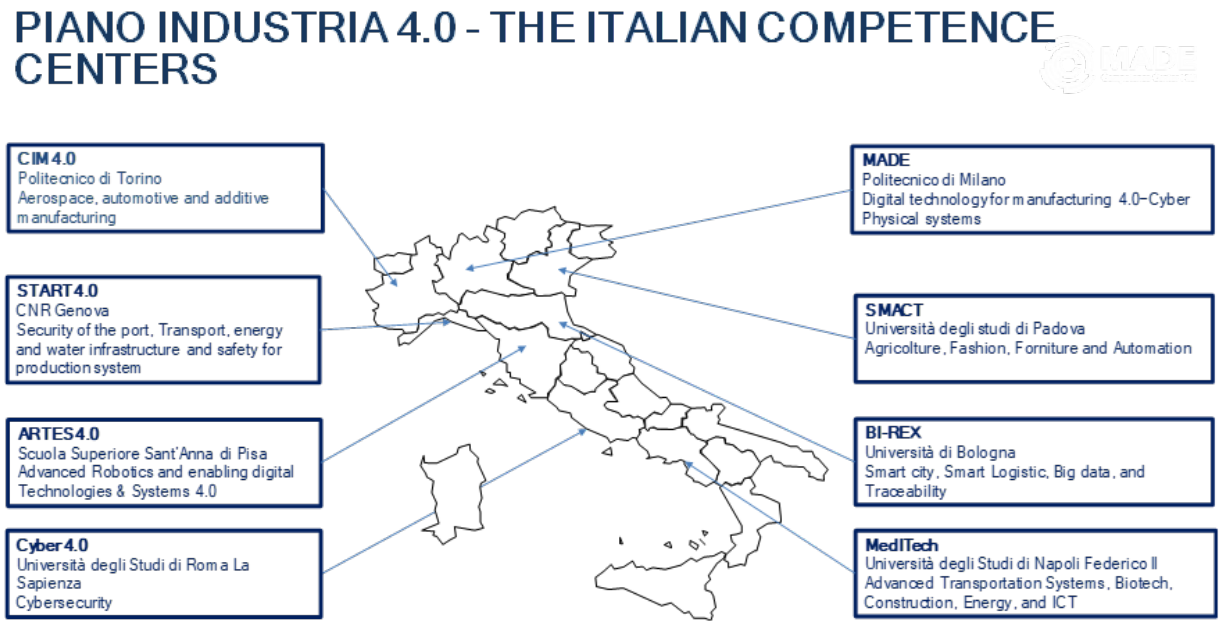


Figure 4: The Italian Competence Centers

Following the example of other European Research Centers, a **Competence Center** is an innovative hub aimed at developing new I4.0 solutions, consolidating and sharing I4.0 awareness among enterprises (mainly SMEs), exploiting new technologies making them accessible to public via live demos, webinars, etc.

The tactical relationship between Competence Centers and universities is fundamental to give visibility (and bring into the market) already existing technological solutions developed only in the research field and to intensify the university-business partnership, providing benefits to both side.
The strategic placement into the European research and innovation scenario allows to have a wide awareness of those that are the main international initiatives and to identify financing and fund possibilities.

Next to the creation of **competence centers,** the Italian Government, together with Confindustra, supports also the development of the so called **Digital Innovation Hubs**, with the purpose of boosting competitiveness of Italian manufacturing enterprises. A DIH perfectly answers to the increasing need of supporting companies in digital transformation: enterprises (especially when of small or medium size) face difficulties to orientate among the huge number of innovative solutions available in the market and very often, they also lack of internal skills.

Even if DIHs were born from a European project with the aim of creating a bridge between research and enterprises, they are national and regional realities, typically decentralized along the national territory, able to talk and to collaborate with local entities.

A DIH aims to:

- Create an ecosystem: Workshops, company visits, conferences, brokerage, project development
- Market ratings: Commercial evaluations, feasibility studies, intellectual property evaluations
- Provide skills: Research and Development Projects, Consultancy

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- Dissemination and awareness raising: Conferences, newsletters, publications, lobbying activities
- Trend analysis: Forecast studies, market surveys
- Obtain the infrastructure: Pilot production infrastructures, laboratories, demonstrations, validating solutions
- Education and information: Training courses, hosting training institutes, webinar
- Product ratings: Listen to the "customer's voice" and develop the business accordingly
- Mediation: Digital market, brokerage sessions to innovate, access to finance

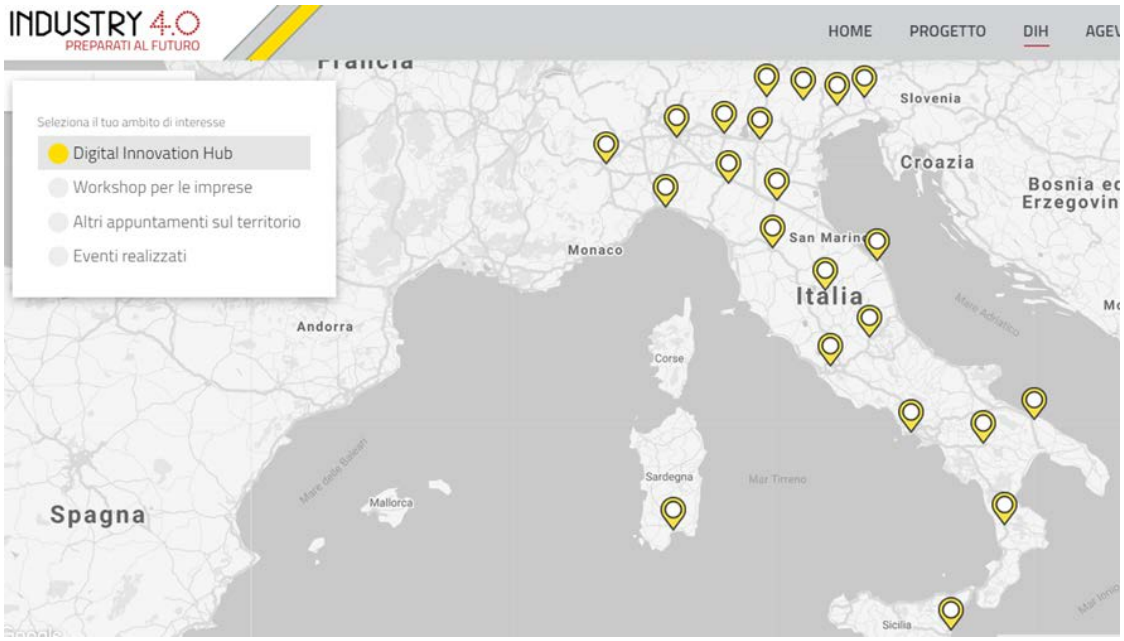


Figure 5: The Italian Digital Innovation Hubs

The **CF2 Italian beneficiary** (Fondazione Politecnico di Milano) is well connected with their CC or DIH. As an example, we describe in the following paragraphs the MADE CC and the DIH Lombardia which are located in the Lombardy region.

3.4.1 The MADE Competence Center

MADE in Italy 4.0 is the Competence Center supervised by Politecnico di Milano, recently born according to the Italian Industria 4.0 plan.

The hub has been built on a 2000 mq area, divided into 6 technological islands, each one related to a different aspect of I4.0: cyber security and Big Data Analytics, Virtual Design, Energy Monitoring and real time/remote control, Digital Twins, Smart Additive Manufacturing, Collaborative Robots.

The main objective is to support enterprises in their digital transformation path toward I4.0 and the set of activities performed to this scope is really heterogeneous, going from training support to technological consultancy and provisioning. In terms of solutions development, MADE provides a wide range of digital tools to 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 lifecycle.

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Going from the pure industrial research to collaboration with enterprises, MADE's activities are mainly focused on:

- Orientation, informing and showing I4.0 solutions by webinars and workshops.
- Training and education (to promote the training of qualified human resources)
- Technology Consultancy to identify the most suitable (existing) solution in the I4.0 scenario
- Development and implementation of Demos and PoCs of I4.0 tools
- Assistance in implementing and adopting of 4.0 tools
- Reshaping of organizational, business and strategical models according to I4.0 philosophy

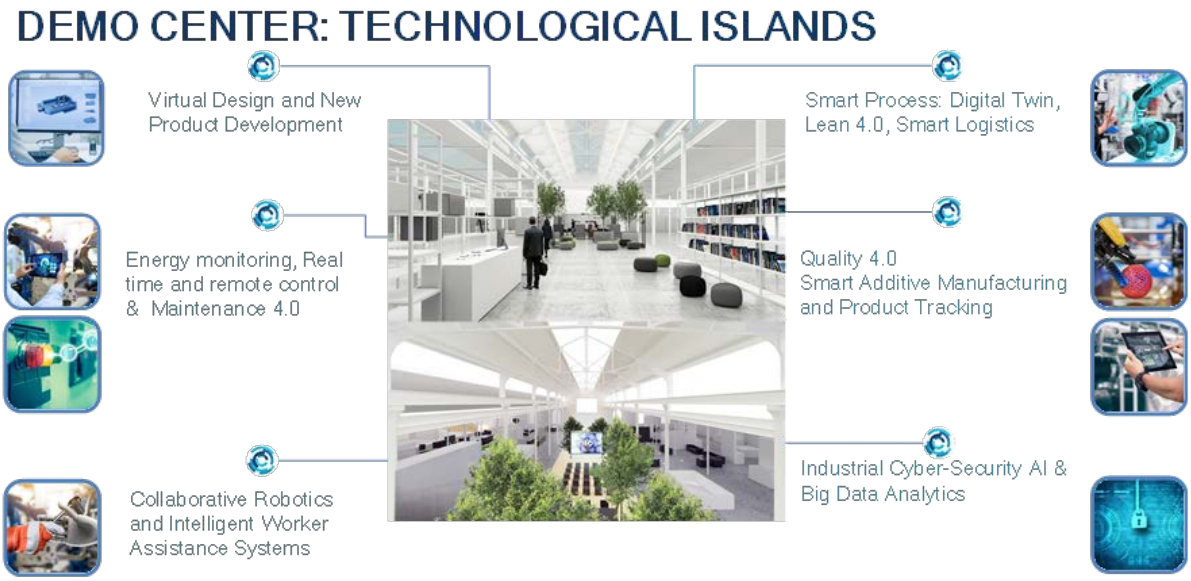


Figure 6: MADE Competence Center's Six Technological Islands

3.4.2 The DIH Lombardy

In the Lombardy region, the DIH Lombardia (the Digital Innovation Hub of Confindustria) gathers and coordinates local and regional organizations (respectively, "Antenne Territoriali" and "Digital Ecosytems"), with the aim of creating synergies to support companies' needs. The DIH Lombardia customers are mainly SMEs, of different sectors and sizes, that want to start their digital transformation journey.

In particular, with the aim of assessing the enterprise digital maturity and of tailoring a transformation roadmap, DIH Lombardia is conducting with companies the "Testindustria 4.0", in order to provide to them a picture of their current position in the I4.0 scenario.

Among the others, main activities run by DIH Lombardia are:

- Training and education (to promote the training of qualified human resources)

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- Sharing awareness of available opportunities regarding I4.0
- Support in the choice and planning of investments for innovation
- Orientation to the Competence Center I4.0
- Support in accessing to finance (public and private)
- European DIH ecosystem mapping and management
- Trans-sectoral DIHs which suit the characteristics of the Italian industrial system and business culture according to Confindustria system structure

3.4.3 CF1 and CF2 Pathways dissemination and exploitation in ITALY Industria 4.0

The three CF1 pathways have already influenced several initiatives in Italy and Lombardy, as for instance the CF1 workshop in Cernobbio during the World Manufacturing Forum. Now it is time to position Italian industrial cases in the new CF2 pathways' space. For doing that, FPM (Fondazione Politecnico Milano) in collaboration with AFIL (Cluster Intelligent Factory Lombardia) and DIH Lombardia are organising workshops especially focussing on Data Spaces and Circular Economy where companies will be required to express their positioning with respect to the evolutionary matrices of both pathways. In particular a Data Spaces maturity event will be organised in conjunction with the final event of the Lombardia AI Roadmap for Manufacturing, which will be held in April 2021.

Circular Economy pathway will be directly linked to the Lombardia CE Roadmap which was delivered in 2020. The "**Lombardy Region Roadmap for Research and Innovation on Circular Economy**" has been coordinated by the Lombardy Technological Clusters and involved a nourished and heterogeneous group of stakeholders including representatives of regional authorities, industrial associations, universities, research centres and companies, both SMEs and Large Enterprises.

3.5 Spain

3.5.1 Industria Conectada 4.0

Industria Conectada 4.0 is a joint national initiative between the public & private sectors[21]. The overall goal of the initiative is the realisation of industry 4.0 in Spain. Industria Conectada's aim is to create new industrial models that are characterised by collaborative innovation, interconnected productive means, the integration of supply chains and digital distribution. This approach will be supported by national Digital Innovation Hubs.

The national strategy is also concerned with collaborative platforms for industry, the provision of support for companies and the regulatory framework/standardisation.

Industria Connectada 4.0 connects to Spain's Digital Agenda and Agenda for the Strengthening of the Industrial Sector[22].

[21] http://www.industriaconectada40.gob.es/Paginas/index.aspx
[22] http://www.minetad.gob.es/industria/es-ES/Servicios/Paginas/agenda-sector-industrial.aspx

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 873086.

3.5.2 Basque country

This chapter describes the current status regarding digital transformation initiatives in Spain and in particular in the Basque country.

The Basque government has published the "Agenda for circular economy 2030" where the different aspects of circularity are analysed for all sectors and in particular for the manufacturing sector.

The main challenges are:

- Compactivity and innovation
  - Challenge 1 Promote the creation of new circular business models
  - Challenge 2 Innovation on materials (advance and renewables), processes and products
- Production
  - Challenge 3 Increase the product lifecycle
  - Challenge 4 Raw materials consumption reduction and waste generation
- Consumption
  - Challenge 5 Promote a circular consumption model
  - Challenge 6 Reduction of food waste (not manufacturing)
  - Challenge 7 Promote a more efficient use of plastics.
- Waste management and secondary raw materials
  - Challenge 8 Increase the ratio of waste reuse, recycle and recuperation
  - Challenge 9 Increase the use of secondary raw materials.

Considering this, the strategic objectives are

- Increase on 30% material productivity
- Increase on 30% the use of circular material
- Reduce on 30% the waste generation per PIB unit
- Reduce on 50% the food waste generation
- Make plastic containers 100% recyclable.

Considering all this, digitalization becomes an important tool and the different pathways will have a role in the consecution of the objectives, in particular

- Collaborative Product-Service Factories: in the new design of products and processes.
- Dataspaces: on the data transactions of materials and process information.
- Hyperconnected Factories : to interconnect the whole supply and value chain.

Other pathways will have probably less importance like

- Cybersecurity
- Autonomous Smart Factories

3.5.3 España Digital 2025[23]

España Digital 2025 includes a set of measures, reforms and investments, articulated in ten strategic axes, aligned with the digital policies set by the European Commission.

The actions of the Agenda are aimed at promoting more sustainable and inclusive growth, driven by the synergies of the digital and green transitions, reaching the whole of society and reconciling the new

[23] https://www.mineco.gob.es/stfls/mineco/prensa/ficheros/noticias/2018/Agenda_Digital_2025.pdf

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opportunities offered by the digital world with the respect to constitutional values and the protection of individual and collective rights:

1. Guarantee adequate digital connectivity for 100% of the population, promoting disappearance of the digital divide between rural and urban areas (goal 2025: 100% of the population with 100 Mbps coverage).

2. Continue to lead the deployment of 5G technology in Europe, incentivizing its contribution to increasing economic productivity, social progress and territorial structure (goal 2025: 100% of the radio spectrum prepared for 5G).

3. Strengthening the digital skills of workers and of citizens as a whole (2025 goal: 80% of people with basic digital skills, of which 50% will be women).

4. Strengthen the Spanish capacity in cybersecurity, consolidating its position as one of the European poles of entrepreneurial capacity (goal 2025: 20,000 new specialists in cybersecurity, AI and Data).

5. Promote the digitization of Public Administrations (goal 2025: 50% of services public available on mobile app).

6. Accelerate the digitisation of companies, with special attention to micro-SMEs and start-ups (goal 2025: 25% contribution of electronic commerce to the volume of SME business).

7. Accelerate the digitisation of the production model through sector transformation

8. Improve the attractiveness of Spain as a European platform for business, work, and investment in the audiovisual field (goal 2025: 30% increase in audiovisual production in Spain).

9. Help the transit towards a data economy, guaranteeing security and privacy and taking advantage of the opportunities offered by Artificial Intelligence (goal 2025: 25% of companies that use AI and Big Data).

10. Guarantee the rights of citizens in the new digital environment (goal 2025: a letter National Law on Digital Rights).

3.6 Portugal: Indústria 4.0

The "Indústria 4.0" Programme in Portugal (https://www.iapmei.pt/Paginas/Industria-4-0.aspx - in Portuguese) was launched in 2017 in its first stage with 6 main pillars: human resources capacitation, technological cooperation, startup I4.0 creation, financing, support to investment, internationalization, and legal and norm compliance. These then derived to a total of 64 measures, from which 95% were completed in the first stage, achieving a total of 24.000 companies and 550.000 people.

The 1st stage of the Programme naturally attracted companies already more willing to be innovation leaders and with more resources to do so, as well as some mid-tiers ones, frequently belonging to broader value chains of leading companies.

On the other hand, the 2nd stage (https://www.iapmei.pt/Paginas/Industria-4-0-Fase-II.aspx - in Portuguese) aims to reach a much larger number of actors, mostly SMEs with less resources and that lagging in their digital transformation. It is now taking place during 2020 and 2021 with 3 main pillars and their corresponding areas being:

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- Generalize i4.0
  - Digital Maturity Assessment
  - Experience 4.0
  - Stimulus to innovation
- Assimilate i4.0
  - Digital and sectoral qualification
  - Learning Factories
- Capacitation i4.0
  - Experimentation and Learning (linked to Digital Innovation Hubs)
  - Digital connection
  - Coaching i4.0
  - Innovation risk management
  - Access to financing
  - Financing and transformation

These areas are then linked to transversal programmes, such as the Circular Economy Programme (https://www.iapmei.pt/PRODUTOS-E-SERVICOS/Industria-e-Sustentabilidade/Sustentabilidade/Economia-Circular.aspx - in Portuguese) and INCoDe.2030 (https://www.incode2030.gov.pt/en) aimed at enhancing digital competences.

The ConnectedFactories 2 Pathways have a very significant alignment with these programmes and corresponding strategies and public funding. In fact, CF2's pathways will certainly help to point out the following goals to the following national framework programmes.

INESC TEC has been a leading organization in Portugal within these programmes, both supporting the development of public policies and helping companies assessing, implementing and applying Industry 4.0 concepts and technologies in their resources and processes towards a full digital transformation. Particularly, and among other initiatives led by INESC TEC, the institute developed and supplied a full set of online training and webinars to COTEC (the managing entity of Industry 4.0 programme) (https://cotecportugal.pt/pt/courses/formacao-4-0/ - in Portuguese). It focus on the main technologies of Industry 4.0.

The Digital Innovation Hubs Call

It should be highlighted that, in December 2020, the Ministry of Economy of the Portuguese Government launched the Digital Innovation Hubs Call ("Polos de Inovação Digital" in Portuguese - https://www.iapmei.pt/PRODUTOS-E-SERVICOS/Empreendedorismo-Inovacao/Inovacao-e-Competitividade/Programas-e-iniciativas/Rede-de-Polos-de-Inovacao-Digital.aspx). A total of 31 applications completed both stages of the process (January and February 2021 respectively), which is now under evaluation. These consortia have in common the fact that they intend to be a one-stop-shop for digital transformation and to boost the application of digital technologies in companies, mostly to SMEs. Several consortia aim to apply Artificial Intelligence, High Performance Computing, or Cybersecurity, or a combination of these main areas, as their core business. Some of the DIH applicants are sector-oriented, while others are transversal. Almost all of these stated they want to apply to the European DIH call. The Portuguese Government will choose 10 to such call and the results are likely to be public during March 2021.

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3.7 Finland

In line with the Connected Factories pathways development, the transition to circular and data based business in manufacturing continues in different Finnish networks and communities:

The national Sustainable Manufacturing Finland program promotes digital and green transitions in manufacturing. The program has been launched by the Business Finland and it aims to renew business models and increase productivity, while actively seeking solutions to the challenges of climate change. The program supports new sustainable solutions with significant export prospects. Furthermore, the Sustainable Manufacturing Finland program encourages companies to utilize European cooperation networks and EU funding instruments. Business Finland and VTT collaborate closely in supporting manufacturing companies in the participation in European collaboration and in agenda setting. Connected Factories pathways are important tools to engage companies active in the program to formulate digital and CE transition steps. For instance, at the national workshop (see CF National Workshop report - Circular economy and digital manufacturing – Building Sustainability and Circularity for Manufacturing Industry for details), Sustainable Manufacturing Finland program and associated companies gave valuable feedback on the pathways.

In addition, the national Sustainable Industry X hub, which is one of the Finnish European Digital Innovation Hub candidates, will offer services that help the manufacturing companies to realise transition to digital and circular business. Sustainable Industry X (SIX) Manufacturing EDIH will support the discrete manufacturing SMEs in their sustainable digitalization journey in an industry-driven way. The aim is to boost the performance of the Finnish manufacturing industry through enhancing national and international collaboration, operational excellence, knowledge and innovation capacity and skills development. The EDIH network will include the best manufacturing and digitalization ecosystems, and infrastructures. Services have been co-created based on validated industrial needs with the objective to enable companies to get the most out of the advanced technologies. The Connected Factories pathways have already been used in the development of the SIX services and offer important knowledge about the development needs of manufacturing industry SMEs.

Furthermore, the new national strategic agenda called Artificial Intelligence 4.0 will collect the key Finnish stakeholders together to accelerate twin transition towards green and digital industry. Finland has been among the first EU countries to create a national AI strategy (https://www.tekoalyaika.fi/en/), on which the current programme is based. The Artificial Intelligence 4.0 programme promotes the development and introduction of artificial intelligence (AI) and other digital technologies in companies. The programme focuses on several sectors in industry, including the manufacturing industry. With the Artificial Intelligence 4.0 programme, Finland aims to strengthen digitalisation and economic growth. Encouraging cooperation between different sectors, increasing investments in digitalisation and, in particular, improving digital skills in SMEs are the key objectives of the programme. The program also elaborates Finland's EDIH strategy, which is an opportunity to direct resources to twin transition in manufacturing industries. VTT supports the Artificial Intelligence 4.0 program and will identify the possible ways to validate the Connected Factories pathways with the organizations and stakeholders behind the initiative.

Finally, at Finland there are several national activities boosting also circular economy, sustainability and carbon neutrality. At Finland the world's first national road map to a circular economy was published in autumn 2016 and Finland aims to be carbon neutral in 2035. The circular economy road map's second edition

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update plans to reform its economic model to ensure successful sustainability. It reflects the actions needed from the perspectives of different stakeholder groups; citizen, enterprise, municipality and central government . In addition, Technology Industries of Finland Federation has recently published the Finland's low-carbon roadmap. According to the roadmap, the most significant means of reducing the industry's direct emissions are to electrify processes, machinery and equipment and to deploy new process concepts, such as bio or hydrogen reduction and carbon capture and recovery. Within these national agendas, Finland has an ambition to grow exports in these growing markets related to sustainability, circularity and carbon neutrality. The Connected Factories CE pathway has a close link to these national agendas.

3.8 United Kingdom

Within the UK, the largest and most famous Industry 4.0 manufacturing initiative is **Made Smarter**[24], which is a UK Government funded but independently industry-led report[25] into the challenges and opportunities of industrial digital technologies, followed by a programme of funding via the UK Industrial Strategy Challenge Fund[26] to address many of these challenges.

The Made Smarter review was published in 2017 and contains a substantial amount of information relevant to ConnectedFactories pathways:

- *Autonomous and Smart Factories Pathway*: Horizontal integration from design to manufacture and into service, as well as vertical integration from data to actionable insights are listed as key technical enablers. Big Data and Analytics are also highlighted, with intelligent assets and equipment, AI processes and operations, and smart resource optimisation as key business areas. These target the higher levels of the pathways.
- *Hyperconnected Factories Pathway:* Use of cloud technologies, horizontal and vertical integration, and industrial internet (including IIoT) are all listed as key enabling digital technologies for the fourth industrial revolution. In this sense, the report focuses on the connectivity and availability of data (e.g. 5G and LPWAN) more than the integration with ERP or scheduling software packages.
- *Cybersecurity Pathway:* Cybersecurity is a key concern in the Made Smarter report, and for the UK government in general. It is both a risk in its own sense, but also a barrier to the adoption of industrial digital technologies, particularly for SMEs who may have lower levels of experience and uptake of cybersecurity principles and thus see digital as a risky proposition.
- *Circular Economy Pathway:* The Made Smarter report views the circular economy as a primarily business model opportunity, enabling new methods of value exchange throughout the supply chain. The digital aspects are particularly highlighted, with the importance of data exchange between members of the sustainable supply chain key to success.

[24] https://www.madesmarter.uk/
[25] https://www.gov.uk/government/publications/made-smarter-review
[26] https://www.ukri.org/news/147-million-investment-in-manufacturing-made-smarter/

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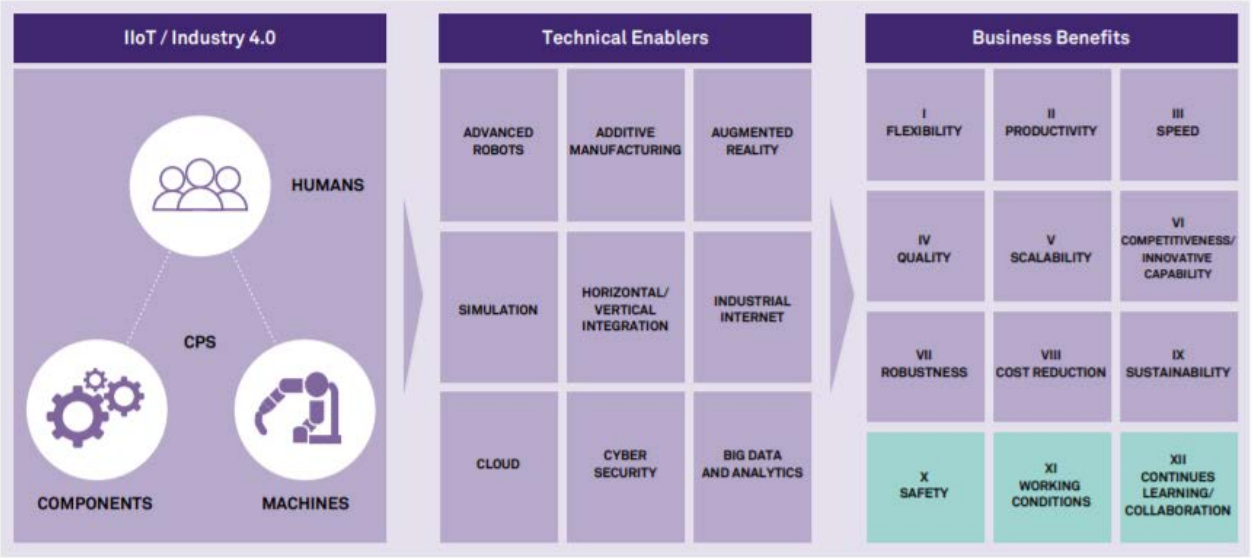


Figure 7: Key technical enablers and business benefits for the adoption of digital industrial technologies. From the Made Smarter report. Fig 7, Page 33.

A substantial focus of the report is on skills – what skills are missing and how the UK could start providing those skills, from school-age through to continuing professional development. There is a requirement for the existing manufacturing workforce to be upskilled and reskilled with emerging digital skills, particularly for SMEs to promote the adoption of digital technologies there.

Since the report, the Made Smarter initiative has moved to funding industrial digital technology programmes. The North West Pilot was the initial programme aimed at helping SMEs invest in digital technologies[27]. Since then, it provides impartial digital advice to companies[28] and works with the UK Industrial Strategy Challenge Fund[29] as part of UK Research and Innovation (UKRI) to issue periodic funding opportunities.[30]

UKRI, through its Engineering and Physical Sciences Research Council also fund activities relevant to ConnectedFactories, including funding future manufacturing research hubs[31], innovative manufacturing centres[32], and research networks. One of these networks is the **Connected Everything Network**[33], which aims to accelerate digital manufacturing research through improved collaboration. In addition to funding feasibility studies, it also reports on key thematic areas to focus network activities[34]. These would be applicable to the pathways as follows (thematic areas for which reports are available are underlined):

- *Autonomous and Smart Factories Pathway*: Cyber-Physical Production Systems, Data Analytics and Decision Making, Data-Driven Manufacturing, Resilient Manufacturing.
- *Hyperconnected Factories Pathway*: Industrial Internet of Things, The Future Industrial Worker.

[27] https://www.madesmarter.uk/resources/publication-made-smarter-technology-adoption-pilot-report/
[28] https://www.madesmarter.uk/support/business-growth-advice/
[29] https://www.ukri.org/our-work/our-main-funds/industrial-strategy-challenge-fund/
[30] https://apply-for-innovation-funding.service.gov.uk/competition/793/overview
[31] https://epsrc.ukri.org/research/centres/manufacturinghubs/
[32] https://epsrc.ukri.org/research/centres/innovativemanufacturing/
[33] https://connectedeverything.ac.uk/
[34] https://connectedeverything.ac.uk/activities/thematic-areas/

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- *Collaborative Product-Service Factories Pathway*: Design for Future Manufacturing, Service Design and Customisation, Creative Manufacturing Design and Customization.
- *Cybersecurity Pathway*: Resilient Manufacturing; Regulation, Standards and Guidance.
- *Circular Economy Pathway*: Creative Manufacturing Design and Customisation.
- *Data Spaces Pathway*: Data-Driven Manufacturing.

Other relevant EPSRC networks / hubs and their relevant to pathways include:

- *Hyperconnected Factories Pathwa*y: Internet of Food Things Network+
- *Collaborative Product-Service Factories Pathway:* Digitally Enhanced Advanced Services
- *Cybersecurity Pathway:* Discribe – Digital Security by Design Social Science Hub+, PETRAS National Centre of Excellence for IoT Systems Cybersecurity, REPHRAIN National Research Centre on Privacy, Harm Reduction and Adversarial Influence Online, SPRITE+ Hub.
- *Circular Economy Pathway:* Circular Economy Network+ in Transportation Systems, Circular Economy Hub, UK Manufacturing Symbiosis Network+.

A common issue in research bridging the gap between the fundamental research and industrial application has been a common challenge in all areas of research, and the UK Government **Catapult Network** looks to aid this. Of relevance to the ConnectedFactories project will be **Digital Catapult**[35] and the **High Value Manufacturing Catapult**[36] in the first instance, but other Catapult networks such as Cell and Gene Therapy and Medicines Discovery (manufacturing of medicines, with the challenges shown most clearly in the bottlenecks encountered in COVID-19 vaccine manufacture and distribution), Connected Places (IIoT deployment), Compound Semiconductor Applications (semiconductor manufacturing), Energy Systems and Offshore Renewable Energy (manufacturing energy generation equipment), and Satellite Applications (manufacture of space-bound equipment).

At a regional level, support for companies is available via the **Local Enterprise Partnerships** (LEP) programme, which supports regional businesses and the public sector. Though the LEP programme is not manufacturing specific, it has a major focus on supporting manufacturing. For example, the **Aerospace Unlocking Potential**[37] project funds SMEs in the aerospace manufacturing supply chain in eight LEPs in the centre of England for a variety of projects, including the integration of digital manufacturing technologies.

[35] https://www.digicatapult.org.uk/
[36] https://hvm.catapult.org.uk/
[37] www.aerospaceup.com

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Table 1: The main initiatives in UK

Initiative	Type	Description	Autonomous Smart Factories	Hyperconnected factories	Collaborative Product-service factories	Dataspaces	Circular economy	Cyber security
Made Smarter	National	Made Smarter is leading the UK's ambitious plans to grow manufacturing through digital technologies, innovation and skills. Made Smarter was created following an industry-led review of how UK manufacturing industries can prosper through digital tools and innovation. https://www.madesmarter.uk/about/what-is-made-smarter/	x	x	x	x		x
Northwest pilots	Regional	The £20m Pilot centres around getting real, practical and tangible advice out to small and medium-size businesses who are keen to adopt a technology like robotics, or initiate their first venture into data analytics, or get involved with making a part using additive manufacturing, but don't know how. To that end, a core part of the announcement was grants of up to £20,000 to help small businesses adopt and embrace industrial digital	x	x	x	x		x

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		technologies (IDT). https://www.themanufacturer.com/videos/the-made-smarter-north-west-pilot-turbocharging-manufacturing-in-the-uks-leading-industrial-region/						
Digital Manufacturing Accelerator	Regional	Based at the MTC in the heart of Liverpool, the Digital Manufacturing Accelerator project brings together world-leading manufacturing research and technology experts. The project will build a state-of-the-art reconfigurable factory with digital and physical test beds, to support manufacturing businesses and provide new engineering jobs and apprenticeships. http://www.the-mtc.org/news-items/mtc-and-lcrca-launch-digital-manufacturing-accelerator	x	x	x	x		
Industrial Challenge Fund	National	The Industrial Strategy Challenge Fund (ISCF) addresses the big societal challenges being faced by UK businesses today. It's made up of 23 challenges, covering the four themes of the government's industrial strategy: Clean growth, ageing society, future of mobility and AI & data economy. The fund is backed by £2.6 billion of public money, with £3 billion in matched funding from the private sector.				x	x	

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Liverpool City Region	Regional	LCR 4.0 was instrumental in transforming Liverpool City Region's manufacturing sector through digital innovation. As part of the programme, financed by the European Regional Development Fund, businesses had access to the expertise, technology and collaboration opportunities they needed to boost productivity and drive innovation.	x	x	x	x		

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3.9 France

The **Alliance Industry of the Future** (**AIF** - http://www.industrie-dufutur.org) is an association created in 2015 and regrouping 33 active members, bringing together the actors of its four Colleges: professional, technological, academic and funding organizations. Its role is to support French companies, in particular SMEs, in the modernization of their industrial tools and transformation of their economic models with new technologies, in particular digital. Beyond innovation, the AIF considers the integration of people with their know-how, skills, and interpersonal skills as a major element in the success of the modernization and transformation of SMEs.

The AIF is a founding member of the **French Fab** (https://www.lafrenchfab.fr/), banner of French industry. French Fab has deep ambitions for the French industrial fabric:



Figure 8: Overview of the French Fab

The AIF is organised around five strategic axes, divided in Working Groups (WG) which support modernisation and upmarket.

3.9.1 Axis 1: Dissemination of the Industry of the Future to SMEs in the territories

3.9.1.1 WG2 Regional Deployment

State and Regions programs (80 million € each) are put it place to improve the numerical and Industry of the future capacity & skills of SMEs, placed under the responsibility of the Regions which co-finance. Through industry of the Future diagnostics, more than 5000 companies have been audited/supported from July 2015. AIF's 2020-2022 roadmap plans another 10 000 accompaniments.

Through a network of Ambassadors and Correspondents, regional actions are coordinated throughout France: 13 Regional Ambassadors, 38 correspondents historically coming from 3 complementary sectors (mechanical, mechatronics, digital), and 11 Regional Cluster correspondents.

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3.9.1.2 WG 6 Showcases

The **"Vitrine Industrie du Futur" label** (https://vitrinesindustriedufutur.org) distinguishes emblematic French industrial achievements for showcases. The label has a triple objective:



- To promote the French technological and digital offer on national and international markets, by capitalising on the success of these first achievements, and by decompartimentalising sectors,
- To demonstrate the operational performance of production lines and processes, and the value created for the company, the primordial place of women and men,
- To stimulate a strong industrial dynamic: by allowing French manufacturers to enrich their projects for the introduction of new technologies, through mutual inspiration and the sharing of good practices.

In December 2020, 92 companies had been showcased in France, with an objective of reaching 100 labelised companies by the beginning of 2021. All labelised companies are visible on the website, and categorised according to:

- **Addressed issues**: adaptation of production to a fragmented market and offer, agility and ability to transform as a competitive advantage, attractiveness of the company to bring together key skills, cost competitiveness, creation of opportunities by disruption of the business model, offer differentiation, guaranteed availability of critical assets, elimination of non-value added operations, customer experience and performance as business lever, master of uses for the profitability of the business model, product and service traceability, CSR.
- **Implemented initiatives**: change of business model and/or value chain, development of the network and regional fabric, digital management of the offer lifecycle, organisational innovation, MES – ERP – real-time monitoring, process and product modularity, IOT, collaborative digital platform for design and execution, augmented reality, virtual reality, services on the cloud.
- **Obtained results**: creation of new customer value, operations fluidity, people entrepreneur and in the centre, business model impact and new value chain, incremental and adapted rapid change implementation, sharing of production means, compact production, flexible production adapting to demand change, productivity and deadlines by reducing takt time, productivity through guaranteed availability, pilot project replicated at group level, quality, reduction of auxiliary production and maintenance costs, stock reduction or suppression, strengthening of the regional fabric, CSR, health and comfort at work.

3.9.2 Axis 2: Knowledge and education development

3.9.2.1 WG 3 People and Industry of the Future

The AIF places Man at the heart of its project and intends to address this societal issue with a wide audience: young people, employees, public authorities and companies. The aim is to address the recruiting issue linked to the change in jobs and skills brought by new industry of the future technologies. The **website "Osons l'industrie"** – literally "Let's dare industry" – (http://www.industrie-dufutur.org/osons-lindustrie/) **promotes the new types of jobs** (in maintenance, Big Data, management, production, supply chain) to attract new

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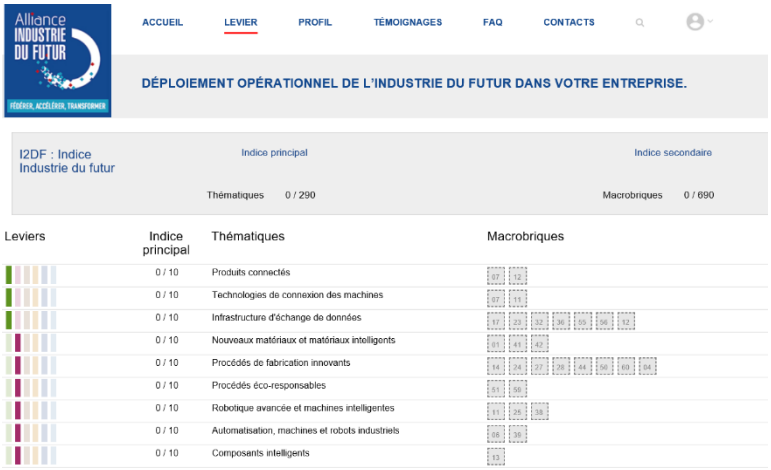
talents, by illustrating the main missions of the selected profession, the skills to be acquired to do this profession, a typical working day, training related to the profession, and many other resources.

3.9.3 Axis 3: Development of the technological offer of the future

3.10 WG 1 Development of the technological offer of the future

The role of this WG is to create a common "Industry of the Future" baseline to acquire winning technologies for the industry of the future, build projects and platforms for each challenge, document key technologies in particular for SMEs, and build an integrated cutting-edge French offering.

To this end, an **Industry of the Future Technology Guide** has been issued (available here in English: http://www.industrie-dufutur.org/content/uploads/2018/03/AIF_IndustryOfTheFutureTechnologyGuide_EN.pdf). It identifies the major issues involved and the means with which to address them: major business issues, major challenges of market changes, major technological challenges, major challenges at the organisational level, major environmental issues, and major challenges at the societal level. The means in question are available as components described in the fact sheets in the second part of the guide, forming a toolbox in which everyone can find the items needed to start and effectively maintain the transition.



In addition, an **Industry of the Future repository baseline** has been compiled (in English here: http://www.referentiel-idf.org/cetim/en), identifying for each competitiveness lever the main associated themes (29 in total) and technological macro-bricks (80 in total). Six competitiveness levers have been defined: connected objects and IOT; advanced production technologies; new approach to people at work; innovative organization and management; connected, piloted and optimized plants and lines/islands; integrated customer/supplier relationships; new economic and societal models, strategy and alliances. The website also includes **an application intended for company heads to allow self-evaluation of maturity** with regard to the industry of the future. This application is based on the **Industry of the Future Index**, named **I2DF©**, to measure in the field the progress of industrial SMEs towards the Industry of the Future. The anonymised data collected through this program will allow appreciating the transformation pace of French industry according to the French acceleration plan.

This WG has launched six technical committees:

- **5G**: a first brochure has been published in October 2020 (http://www.industrie-dufutur.org/content/uploads/2020/09/La-5G-et-lIndustrie-du-Futur-sept2020.pdf), it explores the new performance opportunities linked to new use-cases brought by the 5G technology,
- **Guide update**: updating the Industry of the Future Technology Guide, adding new technological bricks,
- **Edge/Data/AI,**

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- **Digital Twin**: this committee is working on converging on a single definition of the concept of Digital Twins, mapping the uses and opportunities brought by digital twins and associated value creation, identifying roadmaps for the implementation of digital twins in particular for SMEs.
- **Blockchain and traceability,**
- **Carbon footprint**: a first brochure has been published based on examples of implemented bricks in AIF Showcases, entitled "Industry of the Future: sustainable development and energy transition at the heart of transformation. What challenges and what technological responses for SMEs?" (http://www.industrie-dufutur.org/content/uploads/2020/09/Brochure-transition-%C3%A9nerg%C3%A9tique-et-d%C3%A9veloppement-durable-juin20.pdf)

In addition, a **guide on cybersecurity for manufacturing SMEs** has been published (http://www.industrie-dufutur.org/content/uploads/2018/05/2018_01_15_AIF_Guide-cybersecurite_HD.pdf). It raises awareness to a field which can worry given the multiplicity and the different forms of the attacks. At each stage in the life of the company and its ecosystem, the issues, vulnerabilities and risks surrounding digital security are described and possible recommendations are proposed.

3.10.1.1 WG 4 Standardisation

This WG is in charge of building a roadmap leading to international action, in particular in collaboration with Germany and Italy. It acts at the heart of international strategy towards a European reference architecture.

Digital cross-sector standardization is an issue of European sovereignty for the Industry of the Future. The AIF and its members have an essential role to play. The ATLAS project, proposed by AFNeT (the French Association of Digital Reference in Industrial Sectors -- http://afnet.fr/) and supported by the AIF, responds to this challenge. This 3-year project has just been launched. Its goals are to:

- Provide international cross-sector digital standards and norms necessary for the Digital Transformation of Industrial Sectors,
- Pool the efforts of all industrial sectors to amplify the efforts of the most advanced sectors, allow the least advanced sectors to catch up, increase the scope over the entire life cycle, reduce costs and risks and finally facilitate the ecological transition.

3.10.2 Axis 4: Promotion of French industrial achievements worldwide

This group is responsible for building of an international network and promoting emblematic industry projects of the future. It develops trilateral cooperation with German and Italian counterpart platforms and leads the network of AIF International Ambassadors to promote emblematic industry projects of the future. They have AIF ambassadors in several countries including Mexico.

3.10.3 Axis 5: Development of solution providers

3.10.3.1 WG 5 Promotion of the technological offer

This WG has compiled a database of more than 1 200 solution providers available here: http://www.industrie-dufutur.org/recherche?searchQuery=Offreurs%20de%20solutions&filters%5BtypeDocument%5D=solutions_offers&orderBy=date-desc

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3.11 Netherlands: Smart Industry

3.11.1 Smart Industry in the Netherlands

In this section we elaborate on the current status and activities regarding the digital transformation initiatives of the manufacturing industry in the Netherlands (called Smart Industry) related to the CFI and CFII pathways/topics, namely: (1) Autonomous Smart Factories, (2) Hyperconnected Factories, (3) Collaborative Product Service Factories, (4) Dataspaces, (5) Circular Economy, and (6) Cybersecurity. We will illustrate the status in the Netherlands by giving examples per pathway.

3.11.2 Autonomous Smart Factories

The first pathway concern the autonomous smart factories, which focuses on intra factory manufacturing automation and optimisation, including advanced human in the loop workspaces. Various manufacturing firms (including SMEs) in the Netherlands are active on this topic for instance via public private partnerships. A good example is the cooperation between 5 practise labs in the Netherlands and Belgium that enable firms in cooperation with knowledge institutes to develop, test and implement the following technologies[38]:

- Flexible operator support in the workplace: collaborative robots and augmented reality support in high mix low volume production environments.
- Connected workplaces and machines: smart integration and connection of machines in the workplace in the context of complex high quality components.

Other examples are the activities in the following field labs[39]:

- Smart welding factory[40]: "*The mission of Smart Welding Factory and the involved partners is to enable flexible and fully automated production using welding robots, with no programming time: "First Time Right" and "One Piece Flow".*
- Flexible manufacturing[41]: Firms and knowledge institutes collaborate in the development and demonstration of flexible production automation, assembly, robotics and digitalisation solutions for flexible and high quality small series production for the price of mass production.
- RoboHouse[42]: The main themes in RoboHouse are vision and human robot interaction.

3.11.3 Hyperconnected Factories

The second pathway is called the hyperconnected factories, which focuses on networked enterprises in complex, dynamic supply chains and value networks. A good example is the Dutch Smart Connected Supplier Network[43]; "*The partners of the Smart Connected Supplier Network (SCSN) digital innovation hub developed a standard for information sharing based on semantic technology, thereby ensuring optimal interoperability between the supply chain partners for the most important information streams. The SCSN standard builds on the International Data Spaces (IDS) standard. This is a European standard for data sharing that enables data sovereignty developed by the partners of the International Data Spaces Association. SCSN and IDS bring a "connect-once -reach the entire supply chain scenario" to manufacturing firms. This differs from traditional bilateral EDI approach or the use of centralized (cloud) platforms. Manufacturing firms need to establish a single connection, once, with an ICT Service Provider. There are multiple ICT Service Providers, which are interconnected amongst each other using IDS technology. In this way, a manufacturing company can connect to any company reachable in the SCSN network. This approach makes the supply chain collaboration easier*

[38] https://www.tno.nl/nl/aandachtsgebieden/industrie/roadmaps/smart-industry/projecten/naar-een-slimme-fabriek-van-de-toekomst/
[39] Field labs are shared facilities in which companies and knowledge institutions develop, test and implement targeted Smart Industry solutions, as well as an environment in which people learn to apply these solutions. Field labs also strengthen links with research, education and policy (Typologie en standaard voor fieldlabs | TNO Publications).
[40] Monitoring fieldlabs 2018
[41] Ibid
[42] Ibid
[43] https://repository.tudelft.nl/islandora/object/uuid%3A36745cb0-3d5f-4f79-9034-93e02e80529c

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to implement and scale, enables manufacturing firms to reduce the administrative burden and helps them to prevent errors. It also enables agility of the entire supply chain and a more successful risk management." Many firms are already connected via SCSN, for more details on the connected parties see the website[44].

3.11.4 Collaborative Product Service Factories

The third pathway is based on the collaborative product service factories, which focuses on data driven product service engineering in knowledge intensive factories. This is in the Netherlands called servitization: for which firms no longer sell their hardware, but a service while the hardware remains the property of the manufacturer.[45] Océ (leasing of copiers) is a good example of this, but firms such as ThermoFisher (electron microscopes) and machine manufacturer Boessenkool are also strongly committed to this. [46] Servitization is increasing in the Netherlands. Gradually more and more manufacturing firms decide to offer their products or parts on a subscription basis in combination with advice and maintenance.[47] In the Netherlands are also field labs that work on servtitization and help firms to change their business model in to a servitization based business model. At least 10 field labs are active on this topic.[48] Examples are field labs focused on condition based maintenance (e.g. Campione[49], Camino[50], Techport[51]), or to increase agricultural[52] productivity sustainably and efficiency through the deployment of IoT (sensor technology) and Big Data (e.g. Smart farming[53], Precision Agriculture Practice Center[54]).

3.11.5 Dataspaces

The fourth pathway focus on the dataspaces. The European Commission supports the creation of dataspaces for the manufacturing sector to ensure enhanced access to privately held data, via industrial data platforms.[55] The idea is that these data spaces will offer a secure and trusted environment for firms to share their data based upon voluntary agreements.[56] Dataspaces are actually an enabler for the aforementioned Hyperconnected factories since they enable the digital connection of partners in dynamic supply chains and value networks. Various manufacturing firms in the Netherlands use different types of dataspaces (e.g. based on decentralized or centralized architectures) and define them in different ways. There are too many initiatives discuss them all. So we limit the discussion to two examples. The first example is the aforementioned Smart Connected Supplier Network which provides a data space for supply chain partners based on a decentralized architecture. As a second example we refer to the manufacturing as a service platforms. These are multisided platforms that connect supply and demand for instance for CNC machining

[44] https://smart-connected.nl/aangesloten-bedrijven
[45] https://www.ptindustrieelmanagement.nl/manufacturing/artikel/2019/02/servitization-door-smart-industry-ontstaan-nieuwe-businessmodellen-1012092
[46] Ibid
[47] https://www.ctac.be/industrie/manufacturing/servitization
[48] Smart Industry field lab Monitoring 2018
[49] Fieldlab CAMPIONE - World Class Maintenance
[50] Fieldlab CAMINO - World Class Maintenance
[51] Fieldlab Techport Smart Maintenance - World Class Maintenance
[52] Digital and automation applications in archiculture are in the Netherlands part of Smart Industry
[53] For the onderlying platform: JoinData – The Future Of Smart Farming (join-data.nl)
[54] Proeftuin voor Precisielandbouw (pcvpl.nl)
[55] https://ec.europa.eu/digital-single-market/en/news/data-spaces-manufacturing-current-state-play
[56] Ibid

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or 3D printing (e.g. Batchforce[57], 3DHubs[58]) based on a data space with a centralized architecture (a central underlying cloud platform).[59]

3.11.6 Circular economy

The fifth pathway concerns circular economy. The core of circular economy is based on the high quality and long term and intensive use of as few materials, components and goods as possible in order to reduce the environmental footprint.[60] A lot of Dutch Smart Industry firms already work circular, in some cases without having circularity as their main driver [61], or without realizing they are circular.[62] The Dutch manufacturing industry works a lot with capital intensive assets, whereby intensive use, high uptime and a long lifespan directly contribute to the operational performance of the firms and their customers.[63] That explains why circularity is almost automatically incorporated in their approach. This approach often builds on maintenance strategies that are part of their service package, often with the help of recent technological developments.[64]

Other firms indicate that they are consciously engaged in sustainable innovations in a broad sense including innovations that fall under the circular action perspectives, such as refurbishment, predictive maintenance and various other forms of servitization (for more details on servitization see the third pathway). [65] The use of high-quality sensors is crucial in almost all cases in achieving the required results, meaning that "smartness" provides a significant contribution to more efficient use of materials.[66]

3.11.7 Cybersecurity

The sixth pathway, cybersecurity, concerns the protection of internet connected systems such as hardware, software and data from cyberthreats. In the Netherlands are various initiatives dedicated to cybersecurity for manufacturing firms active with Smart Industry such as the development of standards."[67] The Industrial Platform Cyber Security of the Dutch standardization organization NEN focuses on the cybersecurity risks in the industry with the aim of mitigating and limiting them. By bringing different disciplines together via the platform, Dutch manufacturing firms and their partners can be informed and can exchange knowledge on the relevant cyber security standards. [68]

[57] Direct CNC Productie Inkopen | Batchforce™ Supply Chain
[58] 3D Hubs | On-demand Manufacturing: Quotes in Seconds, Parts in Days
[59] https://repository.tno.nl/islandora/object/uuid%3A425cb6d9-57d3-4c81-8b3e-461d190f15b0
[60] https://www.duurzaam-ondernemen.nl/wordpress/wp-content/uploads/2018/07/Rapport-Smart-Industry-naar-een-CE.pdf
[61] Ibid
[62] https://circulairemaakindustrie.nl/app/uploads/2020/10/TNO-2019-R11623-CESI-Brabant-eindrapport-3.pdf
[63] https://www.duurzaam-ondernemen.nl/wordpress/wp-content/uploads/2018/07/Rapport-Smart-Industry-naar-een-CE.pdf
[64] Ibid
[65] https://circulairemaakindustrie.nl/app/uploads/2020/10/TNO-2019-R11623-CESI-Brabant-eindrapport-3.pdf
[66] Ibid
[67] Cyber Security - Smart Industry (nen.nl)
[68] Ibid

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Another initiative is the Cybersecurity Centre for the Manufacturing Industry. The aim of the centre is to make the manufacturing industry digitally resilient.[69] The centre provides a couple of services[70] such as a cybersecurity scan for firms, cyber alerts including advice how to increase resilience, and cyber meetups for firms to exchange knowledge and best practises. There are also various R&D projects running about cyber security for Smart Industry which indicate that that steps are taken towards a better and more mature cyber security in smart industry.[71]

3.11.8 Concluding remark

Based on the analysis of the aforementioned six CF pathways we see that Dutch manufacturing firms are active on each pathway, often stimulated by field labs and or other public private partnerships.

3.12 Hungary

3.12.1 Economic background and Industrial Policy

At the government level, the Hungarian Government intends to facilitate the digitisation of industry and, as a result, its development. In order to achieve this goal, traditional industries and existing business models need to be transformed since innovation is increasingly the key to value creation. In conclusion, Hungary needs to move forward from mass production to a country that offers quality, added value, and knowledge in conformance with its role in the global value chain – and the application of Industry 4.0, i.e. Connected Factories achievements are undoubtedly the decisive elements of success.

In order to meet the challenges of Industry 4.0 and taking into account local specificities, Hungary has also developed its own reindustrialization strategy and its complex set of tools, which the government identified as the Strategic Program for Innovative Industrial Development, named after János Irinyi. The ambitious goal of the Irinyi Industrial Policy Plan is for Hungary to become the strongest industrial performer in the EU. To attain this goal, an innovation-driven economy, a highly skilled and active workforce, greater added value, export-oriented value chains, and sustained balanced development are necessary. In line with the European Union reindustrialization strategy, the focus of the Iriny Plan is on machinery and vehicle manufacturing, the health and green economy, the food industry, the defense industry, and the ICT sector. The state takes an active role in innovation processes in a number of areas – with orders and investments.

The implementation of the sectoral development strategies is being carried out by the Irinyi Industrial Policy Plan's 5 horizontal aspects:

- the application of new and digital technologies,
- the production of energy- and material-efficient devices,
- the elimination of territorial inequalities,
- the expansion of employment
- the efficient use of domestic resources is the central issue.

[69] https://cybersecuritymaakindustrie.nl/nl/over-ons/

[70] Ibid

[71] https://www.ictinpractice.nl/previous-editions/ict-in-practice-2020/talks/casper-schellekens-cyber-security-in-smart-industry/

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This requires a more conscious entrepreneurial approach, adequate standardization, transparent regulations, and the establishment of predictable, regulated support systems (non-refundable grants or combined loan programs) as a prerequisite.

A significant proportion, 99,1%, of enterprises registered in Hungary are SMEs, which is much higher than the EU average. Their role in employment is also higher than in the EU, while their capital strength, export capacity, and contribution to GDP are below the EU average. SMEs represent a very significant economic factor at the local level, and their development is highly important, thus the development strategy has targeted interventions at all stages of the business life cycle (startup, growing, mature, renewable, declining) and the associated financial resources. Knowledge is much appreciated, the accumulation of knowledge in SMEs and their incorporation into high-tech processes is an important objective.

The key issue of the Industry 4.0 paradigm is the existence and competitiveness of smart factories, which is why the pathways identified within the connected factory are so important. In addition to Irinyi Plan a lot of initiatives have been taken in several areas. The following are the most related to this project.

3.12.2 Key initiatives

The Industry 4.0 National Technology Platform Association (I4.0 NTP)

The Industry 4.0 National Technology Platform **Association** - was established May 2016 under the leadership of the Institute for Computer Science and Control (SZTAKI), Hungarian Academy of Sciences, with the participation of research institutions, companies, universities and professional organizations having premises in Hungary, and with the full support and commitment of the Government of Hungary**.**

The background of the initiative is that Hungary, too, is witnessing the advent of the era of a new technological change, when the internet-based economy is transforming the very basics of the production and logistic systems. This process requires from all actors of the economy, especially from the key firms in the priority sectors defined in the Government's Irinyi Plan, from the Hungarian institutional innovation ecosystem as well as from the economic policy makers of the Government, to build progressively bridges between the physical and digital worlds, to show a special readiness for innovative adaptation, find answers to challenges in a prompter way than any time before, including bold steps to be made concerning innovation.

Having these factors in view and in order to strengthen the Hungarian achievements attained so far in the field of the global competitiveness, the founders emphasize the necessity of further deepening the existing successful partnership relationships as well as adopting the European best practices. This requires the creation of an action-oriented network system fostering intensive cooperation.

Through a successful activity, the Platform should be regarded as the catalyser of performing high added value research and development work in Hungary and an essential tool for preparing the industrial sector for and adapting it to the requirements of innovation. Finally, the Platform is expected to become a key factor to contribute to the overall success of the national Industry 4.0 program.

In the focus of the Platform's activity we find the following goals that are also reflected in its organizational structure and Work Groups' setup:

- to assist the actors in recognizing the paramount importance of the I4.0 paradigm, especially SMEs constitute the target group since they, as being in the supply chain of market leader international

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manufacturing companies, play a fundamental role in strengthening the competitiveness of the country,
- to propagate the new digitisation technologies,
- to facilitate the development of the digital competencies.

The platform operates the following Work Groups:

- Strategic Planning
- Employment, Education and Training
- Production, Logistics and Cyber-Physical Pilot Systems
- ICT Technologies (safety, reference architectures, standards)
- Innovation and Business Model

3.12.3 5GK - Hungarian 5G Coalition

The latest generation of mobile networking technology, 5G, opens up completely new dimensions in mobile data transmission. Hungary has the world's leading 4G and 4G + mobile networks, so we are in a good position to not only maintain our position in the field of mobile telecommunications, but also to gain a competitive advantage by taking the lead in 5G mobile developments in the next phase of the digital transformation.

The goal of the Hungarian 5G Coalition (5GC) is for Hungary to become one of the European centres of 5G developments and to play a leading regional role in the development and testing of 5G-based applications. Our goal is for Hungary to be one of the countries where the introduction and practical application of 5G technology is the first in the world.

After 2020, 5G mobile will be able to provide wide bandwidth in all walks of life, creating the infrastructural background for high-data developments such as self-driving and interconnected vehicles, remote diagnostics and operations, smart city developments. Today, 5G technology is being standardized and tested around the world. By mid-2018, the Zalaegerszeg automotive test track, which is also unique in Europe and suitable for testing self-driving vehicles, has been completed in Hungary. This environment will be suitable for testing 5G grid-connected vehicles in the field of intelligent transport and modeling traffic situations in a live environment.

The 5G Coalition in Hungary was formed on 19 June 2017 with the participation of forty-six governmental and market participants, professional and advocacy organizations, universities, and scientific workshops.

3.12.4 Artificial Intelligence Coalition

The Hungarian Artificial Intelligence Coalition (AI Coalition), aims to put Hungary at the forefront of artificial intelligence developments and applications in Europe and to become an important member of the international AI community.

The rapid technological development associated with digitalisation enables Hungary to be at the forefront of a well-chosen area; in addition to developments related to autonomous vehicles and 5G mobile technology, Artificial Intelligence (AI) can also be such an area for Hungary.

The founders of the AI Coalition intend to jointly define the directions and framework for the development of artificial intelligence in Hungary, providing a permanent professional and cooperation forum for AI developers, market and state actors representing the user side of AI, as well as academia, professional

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organisations and public institutions. The AI Coalition also participates in the development of Hungary's AI Strategy and in the analysis of the social and economic impacts related to the spread of AI. The formation of the AI Coalition is a clear message to the world: Hungary has opened its doors to AI developments.

The AI Coalition aims to:

- to significantly strengthen the competitiveness of domestic enterprises due to the widespread use and application of AI-based developments;
- Hungarian startups and SMEs should participate in a large proportion of AI developments, whether in large corporate, university or international partnerships;
- The state should play its part in the development of Hungarian society and the national economy through the judicious use of national data assets, as well as all actors in the digital ecosystem through the fair, regulated and efficient utilization of data assets and as users of AI solutions.

The Hungarian AI Coalition was formed on October 9, 2018 with the participation of 78 international and domestic companies, as well as universities, scientific workshops, professional and administrative organisations. The AI Coalition has 260 member organisations.

3.12.5 Digital Success Programme 2.0

In addition to making the Internet accessible and affordable for everyone, and besides infrastructure development, the digitalisation of education, and other ongoing programmes, the Digital Success Programme also intends to contribute to Hungary’s preparation for the digital transformation in new areas in the coming years. After broad consultations with the professional community and the general public, in the summer of 2017 the Government of Hungary decided to extend the Digital Success Programme and to accept Digital Success Programme 2.0., which is a strategy for gaining digital advantage, as its digitalisation-supporting programmes cover almost every field of the digital development of the Hungarian economy, the operation of the state, and the Hungarian society. Digitalisation is the largest economic development program of the coming decade and one of the most important means to achieve success and growth. DJP2.0 sets out 89 actions in 26 thematic areas along five pillars.

3.12.6 DJP2030 - Digital Government (Human-Machine-System / Data-Robot Network)

While a few years ago we could only say that proactive participation in digitisation is a basic condition for a nation’s competitiveness, today, by 2020, we need to say that digitisation is at least as much a sovereignty as it is a question of competitiveness. Not only because there is no sovereign state without a competitive national economy, but also because of the 19th century. By the end of the 2010s, the classical parliamentary, democratic governmental structure that had developed in the 20th century and was still functioning effectively, and the legal approaches based on it, faced challenges like never before. In an extremely fast-changing digital ecosystem, global stories written by global technology companies have a direct and powerful impact on people’s lives that traditional government operations can barely handle in many ways, especially consumer protection, burden-sharing, and data protection. The future of the Digital Success Programme is provided by the DJP2030 strategic framework, which builds on the successes of DJP 1.0 as well as 2.0 but identifies development challenges as well as opportunities and competitive disadvantages. One of the main tasks of DJP2030 is to propose new solutions and institutions that can effectively interpret and address the global challenges and opportunities created by digitalisation in international cooperation. The starting point

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of DJP is that the state is also responsible for the digital well-being of its citizens, therefore the central theme of the DJP2030 is digital state governance. The DJP2030 defines its strategic goals and areas of intervention in a triple division, in relation to the human-machine system. In 2020, several key strategic documents prepared within the framework of the DJP2030 will be submitted to the Government, such as the Artificial Intelligence and Sport Strategy of Hungary and the Action Plan of the Digital Agricultural Strategy.

3.12.7 Autonomous Systems National Laboratory

By concentrating the forces of the domestic professional and scientific community in the field of mobility, the National Laboratory aims to provide effective and innovative solutions for research tasks, relying on the available expertise, technical equipment and relevant research results in an integrated way with a focus on-road vehicles, aircraft and mobile robots. Its activity is directed towards mobility research, development demonstrating functional and cooperative operation, the facilitation of knowledge transfer, preparation of publicly funded and industrial projects, and education. The generated research results and know-how not only help to increase the added value of the domestic automotive industry but, through the communication of the results and the promotion of closer collaboration between industry and academia, it will also raise public confidence in autonomous vehicles.

The Autonomous Systems National Laboratory is interested in integrating academia, the industrial sector, micro, small and medium enterprises and educational institutions into the Hungarian innovation ecosystem and boost Hungary's competitiveness.

Central to the activity of the National Laboratory is mapping and continuously updating the national competence map. The competencies of the founding members are already known, but the national competence map and the needs of economic stakeholders suggest that it is necessary to expand the portfolio of funding schemes towards more interdisciplinary fields in law, telecommunications and cyber-security, aligned with industrial needs. The digitisation of industry leads to the challenging questions of autonomy and the design and operation of autonomous but connected production systems.

Research and development in cyber-physical production systems made up of autonomous elements focus on the following research activities:

- autonomous robotics, including in particular human-machine interaction and collaboration;
- the internal logistic system comprising autonomous vehicles;
- digital twin models and integration of the above systems;
- industrial data analysis;
- reliability identification and control of autonomous systems using the stochastic methods of machine learning;
- setting up a production and logistic lab organised from autonomous elements.

In the above fields, research is motivated by practical industrial needs, so the Laboratory intends to develop evidence-based solutions to complex problems such as the people-centred automation of production systems, human-robot collaboration, autonomous internal logistics, supported by digital twin modeling, and continuous adaptation through industrial data analysis. The facilitation of increased cooperation is a key factor in the production and logistic system of autonomous elements.

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The digital twin models of the consortium enable real-time monitoring of processes, identification and forecast of events, and (re)design of tasks to be performed. The innovative solutions are demonstrated in the cyber-physical production system labs in Budapest and Győr, which are open to both the industry and academia. The solutions that require special expertise and computational infrastructure are made widely accessible to domestic SMEs in the form of cloud services.

The National Laboratory considers it a mission to widely propagate its technical, economic and social research results in connection with autonomous systems, and more generally, the ecosystem approach.

3.12.8 Artificial Intelligence National Laboratory (MILAB)

The aim of the Artificial Intelligence National Laboratory (MILAB) is to strengthen Hungary's role in the field of AI. The international and domestic environment of AI is characterised by particularly fierce competition for professionals, disruptive opportunities and short time to market. The European Union is making great efforts to catch up with US and Chinese development capabilities. Domestic research on artificial intelligence is currently characterised by fragmentation, competition and separation. There is no single artificial intelligence umbrella over resources that fit into application-specific large-scale programs. Several universities/research sites have good relations with adopter businesses, but social innovation is also needed to embrace technological innovation. The consortium intends to build its domestic research on the base existing around some of the currently highly studied topics (e.g. health image processing, transport, manufacturing, logistics) and internationally outstanding Hungarian mathematical and physical researchers (graph theory, network research).

The goals and tasks of MILAB:

- Financing of key basic and applied research topics (publications, patents, new industrial relations, technology transfer).
- Networking, building on synergies between individual actors, representation of competencies in market and international projects.
- Internationalisation, interconnected research ecosystem.
- Source multiplication, risky research and research of high societal relevance.
- Coordination towards market and application needs, organization of demos and conferences.

Priority research areas (also set out in the strategy):

- Industrial research: medical diagnostic and biometric applications, agri-food industry, transport, manufacturing, telecommunications.
- Research on the mathematical foundations of artificial intelligence and deep learning.
- Development of machine vision, natural language processing.

Research on data processing technologies for the protection of personal data.

For more information please visit MLAB's website: https://mi.nemzetilabor.hu/

3.12.9 Connection to the Pathways

Finally, here is a table showing the relevance between each initiative and the predefined pathways.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 873086.

Initiative	Autonomous Smart Factories	Hyperconnected factories	Collaborative Product-service	Dataspaces	Circular economy	Cyber security
Industry 4.0 National Technology Platform Association	x	x	x		x	
Hungarian 5G Coalition	x	x		x		x
Artificial Intelligence Coalition	x	x		x		x
Digital Success Programme 2.0	x		x	x	x	
DJP2030 - Digital Government	x		x	x	x	
Autonomous Systems National Laboratory	x	x	x	x		x
Artificial Intelligence National Laboratory	x	x		x		x

3.13 Sweden

Produktion 2030 is the Swedish national platform with the aim to enhance long term competitiveness in the manufacturing industry.

Produktion2030 funds a large number of activities within its five instruments:

- Projects: (i) research and innovation projects (TRL 4-6) and (ii) test and demonstration projects (TRL 6-7)
- Education: (i) PhD school in production system and technologies and (ii) Industry 4.0-master level courses
- Small and medium sized enterprises (SME's): results from projects are packaged and disseminated to SMEs through industry networks on regional/local levels in Sweden
- Mobility: exchange programmes for individuals, between industry and research organizations
- Internationalization and analysis: influence and commitment to develop industrial research platforms in EU and Sweden. Business intelligence and global industry analysis is also carried out.

3.14 Irish Manufacturing Research Technology Centre

Irish Manufacturing Research Technology Centre

Ireland's national industry 4.0 approach is being realised through the IMRTC strategy. Representing 22% of Ireland's GDP, manufacturing is significant to Ireland's economy and competitiveness. As part of its national technology centres programme, Ireland has launched Irish Manufacturing Research (IMR). This technology centre is the first step towards the deployment of a national manufacturing hub under a national strategy.

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This hub will link to related specialised technology centres and support manufacturing research and innovation.

Project Ireland 2040 National Development Plan 2018—2027[72]

- Strategic Investment Priorities 2018–2027: A Strong Economy, supported by Enterprise, Innovation and Skills, €9.4 billion

4 European Initiatives

4.1 Digital Europe Programme

As part of the next long-term EU budget – the Multiannual Financial Framework – the Commission has proposed Digital Europe, a programme focused on building the strategic digital capacities of the EU and on facilitating the wide deployment of digital technologies[73].

The programme will boost investments in supercomputing, artificial intelligence, cybersecurity, advanced digital skills, and ensuring a wide use of digital technologies across the economy and society, including through Digital Innovation Hubs. Its goal is to improve Europe's competitiveness in the global digital economy and achieve technological sovereignty. It will do so by deploying and capacity-building new digital technologies, in order to support digital transformation that will guarantee high quality public services benefiting citizens and businesses. Digital Europe will complement other EU programmes, such as the Horizon Europe programme for research and innovation.

4.2 EIT Manufacturing

EIT Manufacturing (https://eitmanufacturing.eu) is Europe's largest manufacturing innovation community. The goal is to ensure that manufacturing innovation is led by Europe – the home of the manufacturing industry, and a pioneer in industrial innovation, including industry 4.0. Europe's two million manufacturing companies will be key drivers of Europe's green and digital (twin) transformation. EIT Manufacturing associates close to 60 organizations (universities, research institutes and business) including for example: Volkswagen, Volvo, Darmstadt University of Technology, the French Alternative Energies and Atomic Energy Commission (CEA), RISE, Siemens, Slovak University of Technology in Bratislava, Phillips, Procter & Gamble, Whirlpool Europe, Fraunhofer, POLIMI, INESCTEC and LMS-Laboratory for Manufacturing Systems & Automation.

In EIT Manufacturing **digital transformation** is present in all three schemes. In innovation scheme, which aims at the production or adoption, assimilation and exploitation of a value-added novelty in economic and social spheres, digital transformation is supported by thematic areas such as "Digital & collaborative solutions for innovative manufacturing ecosystems" and "Platforms for Digitalized Value Networks". In this context, EIT Manufacturing activities to be executed in 2021 provide pool of candidate use cases to map project and use cases to specific stages or digital transformation/transition projects. Emphasis in digital transformation of companies belonging in the Regional Innovation Scheme (RIS) countries in given in EIT-M. An indicative example comes from the DigTrafoRis (Digital Transformation in RIS countries) project

[72] Project Ireland 2040 National Development Plan 2018—2027: https://www.gov.ie/en/policy-information/07e507-national-development-plan-2018-2027/

[73] https://ec.europa.eu/digital-single-market/en/europe-investing-digital-digital-europe-programme

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https://eitmanufacturing.eu/digital-transformation-in-ris/ that supported via open calls activities more than 20 manufacturing SMEs in their digital transformation journey. The project aimed at supporting projects mainly in the "autonomous factories" pathway by supporting the transformation and integration of technologies such as ERP, PLM, IIoT, SCADA etc that stand more on the control and operation of manufacturing systems. The "Digital Transformation for manufacturing in EIT RIS countries" scheme provides an excellent potential source of potential cases that can be used to evaluate CFI and CFII pathways.

4.3 Smart Specialisation Platform for Industrial Modernisation

The Smart Specialization Strategy for **Industrial Modernisation** (S3P-Industry) is a strategy defined with the contribution of European regions, with the objective of identifying guidelines to prioritise and align efforts between public and private stakeholders. Following a bottom-up approach, that means starting from interregional cooperation, cluster participation and industry involvement, the goal is to foster the generation of a pipeline of industrial investment projects.

One of the Thematic Areas of S3P-Industry is the Vanguard PILOT ESM **Efficient and Sustainable Manufacturing**[74]**,** grouping 20 vanguard EU regions, chaired by Lombardy and Catalunya. Driven by the awareness that one of the main obstacle for manufacturing enterprises is the need of testing solutions before implementing them in the plant, the goal is to create a European network of infrastructure and pilot plants in manufacturing areas.

The advantage is twofold: on one side, pilot plants aim to overcome barriers that limit enterprises innovation, on the other, the European approach helps to increase competitiveness, exploit synergies and complementarities of different regional specialisation. Moreover, by exploiting and valorising available research results, it is possible to take advantage from pilot plants also to foster **efficient and sustainable solutions**.

Each Region will develop and operate pilot plant nodes coherent to regional industry and competences, offering European companies a "one-stop shop" for the industrial uptake of new technologies and innovative business model.

Talking about **Efficient and Sustainable Manufacturing,** it is worth to mention the **Digital Transformation** democase, led by Brabant, Tampere and Lombardy regions, that represents a relevant contact point for our project. In its last Meeting in February in Bruxelles, the DT democase launched a call for industrial pilots to be implemented across the EU Regions along the 2020. The success of the AI REGIO innovation action (see above DT-ICT-03) will implement such a call in the next three years through local experimentations and Open calls.

[74] https://s3platform.jrc.ec.europa.eu/efficient-and-sustainable-manufacturing

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Figure 9: EU Regions involved in Digital Transformation democase

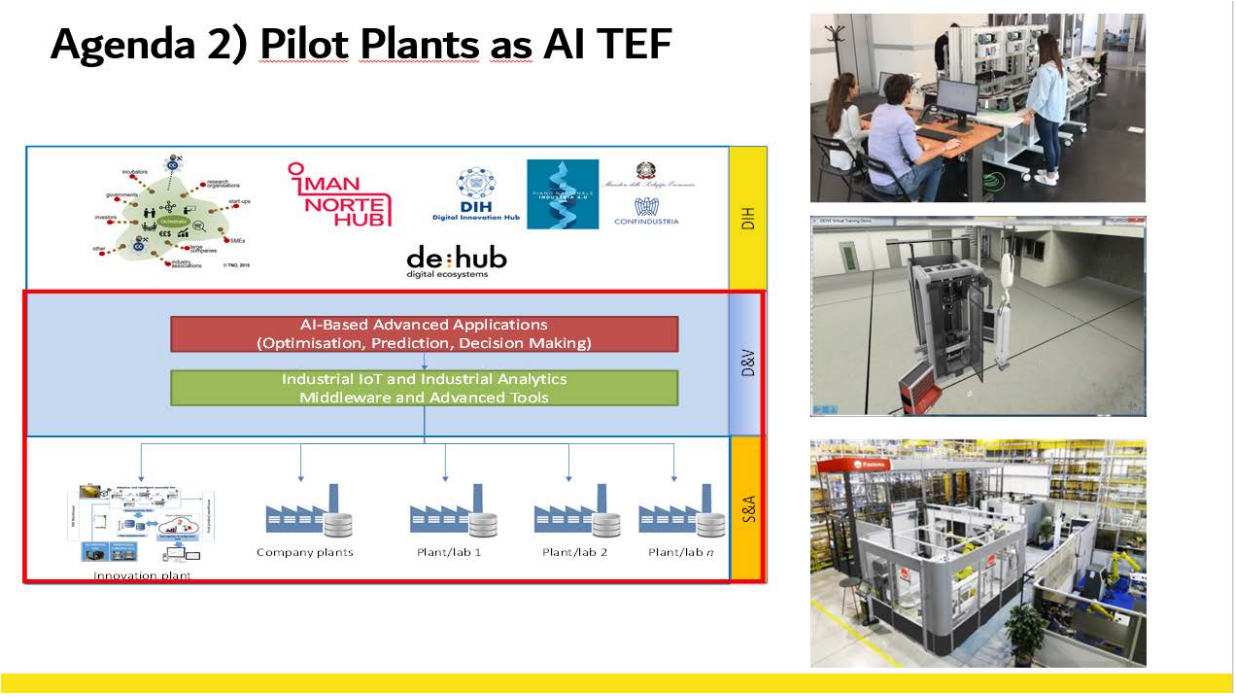


Figure 10: Pilot Plants (AI TEF) in Digital Transformation democase

The CF1 and CF2 pathways will be subject to further validation by the Digital Transformation demo-case of the Efficient and Sustainable Manufacturing pilot. Thanks to the synergy with the AI REGIO I4MS Phase IV projects, such pathways will be presented and discussed also in the Vanguard Initiative regions and SME-driven pilot plants

5 Conclusions and next steps

In accordance with the strategic objectives of CFII, this document has contributed with the following outcomes:

- Definition of a practical methodology for alignment of the pathways developed in CFII to Digitizing European Industry (DEI) initiatives. In order to align the CFII pathways with National and Regional Digitizing European Industry Initiatives an adapted waterfall method has been employed and presented

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(Chapter 2). The model emphasizes on a linear management approach in which exchange of information between the both sides takes place from the early stages of the pathways' development.

- Collection of preliminary input from the national/regional/European initiatives. National (Chapter 3) and EU level (Chapter 4) initiatives related to Digitizing European Industry with a focus on manufacturing industry are discussed. In each case, overall information is provided for the national activities while in some cases a projection to CFI/II pathways is presented. The feedback and analysis in national level depicts that the CFI/II pathways definition are pertinent and reflect activities/initiatives in national and EU level.

This document reports the first iteration between CFII and national/regional initiative. The second iteration will be reported on project Month 34 under deliverable D2.7 "Pathways alignment with National / Regional Initiatives -Second Iteration". More feedback on the pathways definition as well as cross-cutting factors are expected to be selected through workshops (WP5) during the course of the CFII project.

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